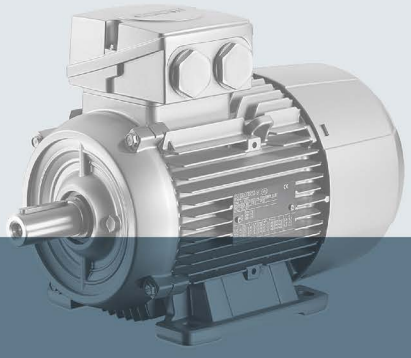
SIEMENS





SINAMICS

SINAMICS G120C low voltage inverter

Chassis units with frame sizes AA ... C

Operating Instructions

Edition 07/2015

siemens.com

Additional requirements for Branch Circuit Protection

The following information is additional information regarding the specific details of the requirements for Branch Circuit Protection for the SINAMICS G120C converter.

Branch circuit protection according to IEC

Frame size	Rated power	Drive	Article number		Max. rated current of the protection device	Minimum enclosure volume
			Fuse	Motor starter protector		
FSA	0.55 kW	6SL3210-1KE11-8...	3NA3805	3RV2011-4AA…	16 A	0.03 m^3
	0.75 kW	6SL3210-1KE12-3...				
	1.1 kW	6SL3210-1KE13-2...				
	1.5 kW	6SL3210-1KE14-3...				
	2.2 kW	6SL3210-1KE15-8...				
	3 kW	6SL3210-1KE17-5...				
	4 kW	6SL3210-1KE18-8...				
FSB	5.5 kW	6SL3210-1KE21-3...	3NA3812	3RV2021-4EA…	32 A	0.06 m^3
	7.5 kW	6SL3210-1KE21-7...				
FSC	11 kW	6SL3210-1KE22-6...	3NA3822	3RV1041-4JA…	63 A	0.2 m^3
	15 kW	6SL3210-1KE23-2...				
	18.5 kW	6SL3210-1KE23-8...				

Siemens 3NA38 series fuses and 3RV series motor starter protectors of a lower current rating than shown may also be used. The converter must be mounted in a suitable enclosure (e.g. metal equipment cabinet).

If a motor starter protector is used, the enclosure interior volume should not be less than that shown in the table above.

Branch circuit protection according to UL standards

Use in North America requires protection devices that meet UL standards as detailed in the following tables. The converter must be mounted in a UL approved enclosure not less than the minimum enclosure volume unless the branch circuit protection is a class AJT fuse by Mersen (Ferraz Shawmut).

Table 1: Overview of the approved protection devices according to UL standards

Protection device	UL category
Fuses of any manufacturer with faster tripping characteristic than class RK5 and rated 600V AC, e.g. class J, T, CC, G, or CF	JDDZ
SIEMENS circuit breaker	DIVQ
SIEMENS Type E combination motor controllers	NKJH

The converter is suitable for use on a circuit capable of delivering the short circuit current shown in the tables below when protected by the branch circuit protection indicated.

Table 2: Branch circuit protection with non-semiconductor fuses Class J, T, CC, G, CF (JDDZ)

Frame size	Rated power	Drive	Max. rated current of the fuse	Short-circuit current rating (SCCR)	Minimum enclosure volume
FSA	0.55 kW	6SL3210-1KE11-8...	10 A	100 kA, 480 V AC	1830 in^3
	0.75 kW	6SL3210-1KE12-3...			
	1.1 kW	6SL3210-1KE13-2...			
	1.5 kW	6SL3210-1KE14-3...			
	2.2 kW	6SL3210-1KE15-8...	15 A		
	3 kW	6SL3210-1KE17-5...			
	4 kW	6SL3210-1KE18-8...			
FSB	5.5 kW	6SL3210-1KE21-3...	35 A		3660 in^3
	7.5 kW	6SL3210-1KE21-7...			
FSC	11 kW	6SL3210-1KE22-6...	60 A		12200 in^3
	15 kW	6SL3210-1KE23-2...			
	18.5 kW	6SL3210-1KE23-8...			

Table 3: Branch circuit protection with circuit breakers (DIVQ)

Frame size	Rated power	Drive	Max. rated current of the circuit breaker	Circuit breaker types	Short-circuit current rating (SCCR)	Minimum enclosure volume
FSA	0.55 kW	6SL3210-1KE11-8...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	1830 in^3
				3RV2711	65 kA, 480Y / 277V AC	
	0.75 kW	6SL3210-1KE12-3...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
	1.1 kW	6SL3210-1KE13-2...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
	1.5 kW	6SL3210-1KE14-3...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
	2.2 kW	6SL3210-1KE15-8...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
	3 kW	6SL3210-1KE17-5...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
	4 kW	6SL3210-1KE18-8...	15 A	3RV1742, LGG, CED6	65 kA, 480 V AC	
				3RV2711	65 kA, 480Y / 277V AC	
FSB	5.5 kW	6SL3210-1KE21-3...	35 A	NCGA	35 kA, 480 V AC	3660 in^3
				3RV2721	50 kA, 480Y / 277V AC	
				LGG, CED6, HCGA	65 kA, 480 V AC	
				3RV1742	65 kA, 480Y / 277V AC*	
				3RV2711	65 kA, 480Y / 277V AC	
	7.5 kW	6SL3210-1KE21-7...	35 A	NCGA	35 kA, 480 V AC	
				3RV2721	50 kA, 480Y / 277V AC	
				LGG, CED6, HCGA	65 kA, 480 V AC	
				3RV1742	65 kA, 480Y / 277V AC*	
				3RV2711	65 kA, 480Y / 277V AC	
FSC	11 kW	6SL3210-1KE22-6...	60 A	NCGA	35 kA, 480 V AC	8780 in^3
				LGG, CED6, HCGA	65 kA, 480 V AC	
				3RV1742	65 kA, 480Y / 277V AC*	
	15 kW	6SL3210-1KE23-2...	60 A	NCGA	35 kA, 480 V AC	
				LGG, CED6, HCGA	65 kA, 480 V AC	
				3RV1742	65 kA, 480Y / 277V AC*	
	18.5 kW	6SL3210-1KE23-8...	60 A	NCGA	35 kA, 480 V AC	
				LGG, CED6, HCGA	65 kA, 480 V AC	
				3RV1742	65 kA, 480Y / 277V AC*	

* 65kA, 480V AC for 3RV1742 type with current rating < 35 A

Table 4: Branch circuit protection with Type E combination motor controllers (NKJH)

Frame size	Rated power	Drive	CMC model no. *	Max. rated current of the CMC	Rated power of the CMC at 460 VAC	Short-circuit current rating (SCCR)	Minimum enclosure volume
FSA	0.55 kW	6SL3210-1KE11-8...	3RV20_1-1JA…	10 A	5 HP	65 kA, 480Y / 277V AC	1830 in^3
	0.75 kW	6SL3210-1KE12-3...	3RV20_1-1JA…	10 A	5 HP		
	1.1 kW	6SL3210-1KE13-2...	3RV20_1-1JA…	10 A	5 HP		
	1.5 kW	6SL3210-1KE14-3...	3RV20_1-1JA…	10 A	5 HP		
	2.2 kW	6SL3210-1KE15-8...	3RV20_1-4AA…	16 A	10 HP		
			3RV_031-4AA…	16 A	10 HP		
	3 kW	6SL3210-1KE17-5...	3RV20_1-4AA…	16 A	10 HP		
			3RV_031-4AA…	16 A	10 HP		
	4 kW	6SL3210-1KE18-8...	3RV20_1-4AA…	16 A	10 HP		
			3RV_031-4AA…	16 A	10 HP		
FSB	5.5 kW	6SL3210-1KE21-3...	3RV2021-4DA…	25 A	15 HP	65 kA, 480Y / 277V AC	3660 in^3
			3RV2021-4EA…	32 A	20 HP	50 kA, 480Y / 277V AC	
			3RV_031-4EA…	32 A	20 HP	65 kA, 480Y / 277V AC	
	7.5 kW	6SL3210-1KE21-7...	3RV2021-4DA…	25 A	15 HP	65 kA, 480Y / 277V AC	
			3RV2021-4EA…	32 A	20 HP	50 kA, 480Y / 277V AC	
			3RV_031-4EA…	32 A	20 HP	65 kA, 480Y / 277V AC	
FSC	11 kW	6SL3210-1KE22-6...	3RV_031-4HA…	50 A	40 HP	65 kA, 480Y / 277V AC	12200 in^3
			3RV1041-4JA…	63 A	50 HP		
	15 kW	6SL3210-1KE23-2...	3RV_031-4HA…	50 A	40 HP		
			3RV1041-4JA…	63 A	50 HP		
	18.5 kW	6SL3210-1KE23-8...	3RV_031-4HA…	50 A	40 HP		
			3RV1041-4JA…	63 A	50 HP		

* "_"can be replaced by "1" or "2"

Listed (NKJH) Siemens CMCs of the same type with a current rating lower than that specified in the table, corresponding to G120C drive model number and with a voltage rating of at least 480V AC may also be used.

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SINAMICS G120C
SINAMICS G120
Inverter with CU230P-2, CU240B/E-2, CU250S-2 Control Units

Product information **07/2015**

Modified behavior when commissioning the drive

With firmware V4.7 SP3, the commissioning Wizard has been revised and standardized for the following inverters:

- SINAMICS G120 with PM240, PM240-2 or PM330 Power Module
- SINAMICS G120C

The SINAMICS application classes *Standard Drive Control*, *Dynamic Drive Control* and *Expert* have been newly developed. The commissioning Wizard sets the application class depending on the particular inverter:

- *Standard Drive Control* for SINAMICS G120C and SINAMICS G120 with Power Module PM240, PM240-2 up to frame size FSD
- *Dynamic Drive Control* for SINAMICS G120 with PM240, PM240-2 Power Modules from frame size FSD and with PM330 Power Modules
- *Expert* for SINAMICS G120 with PM230, PM250 and PM260 Power Modules

Motor data identification (MotID) is permanently set for *Standard Drive Control*. After the commissioning Wizard has been exited, the inverter responds to the first ON command as follows:

1. The inverter carries out a MotID with the motor at a standstill. The duration of the MotID, when compared to firmware V4.7, was shortened to approx. ⅓.
2. The inverter accelerates the motor to the specified setpoint. The second ON command after the MotID is not necessary for *Standard Drive Control*.

For *Dynamic Drive Control,* a MotID is also set as default with the motor at a standstill. The default setting can be changed:

- In addition, you can also select the MotID with rotating measurement. The inverter optimizes the closed-loop speed control based on the results of the rotating measurement.
- You can select as to whether, after the MotID, the motor immediately accelerates to the specified setpoint, or a second ON command is required.

To a large extent, Expert corresponds to the commissioning Wizard for firmware < V4.7 SP3.
A MotID is not set as default. You can select the following:

- No MotID, MotID with measurement with the motor at a standstill or MotID with rotating measurement
- After the MotID, the motor immediately accelerates to the specified setpoint, or only after a second ON command.

The following commissioning tools support the new commissioning wizard:

- STARTER from 4.4 SP1 or higher
- Startdrive from V13 SP1 and higher with Hardware Support Package V4.7 SP3
- IOP from V1.6 and higher
- BOP-2

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SINAMICS G120C converter

Operating Instructions

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Appendix A

Edition 07/2015, firmware 4.7 SP3

Original instructions
07/2015, FW V4.7 SP3
A5E34263257B AC

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

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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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℗ 08/2015 Subject to change

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Change history

The most important changes with respect to the 04/2015 edition of the manual

New hardware	In Chapter
New inverter frame size AA	Description (Page 25) Installing the inverter (Page 39) Connecting the inverter (Page 57) Power-dependent technical data (Page 360)
Line reactor, filter, output reactors and braking resistor as base components	Installing the inverter (Page 39) Mounting base components (Page 44) Accessories (Page 372)

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Fundamental safety instructions

1

1.1 General safety instructions



⚠ DANGER

Danger to life due to live parts and other energy sources

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

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

Generally, six steps apply when establishing safety:

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

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



⚠ WARNING

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

Touching live components can result in death or severe injury.

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



⚠WARNING

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

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

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



⚠WARNING

Danger to life through electric shock due to unconnected cable shields

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

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



⚠WARNING

Danger to life due to electric shock when not grounded

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

- Ground the device in compliance with the applicable regulations.



⚠WARNING

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

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

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

⚠WARNING

Danger to life due to fire spreading if housing is inadequate

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

⚠ WARNING

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

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

⚠WARNING

Danger to life when safety functions are inactive

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

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

Note

Important safety notices for Safety Integrated functions

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

⚠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 this address (http://www.siemens.com/industrialsecurity).

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

⚠WARNING

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

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

- Keep the software up to date.

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

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

1.5 Residual risks of power drive systems

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

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

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

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

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

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

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

Note

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

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

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

Introduction 2

2.1 About the 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.



Symbol for inverter functions.

See also: Overview of the inverter functions (Page 127).

2.2 Guide through the manual

Section	In this section you will find answers to the following questions:
Description (Page 25)	• How is the inverter marked? • What components make up the inverter? • What optional components are available for the inverter? • What is the purpose of the optional components? • Which motors can be fed from the inverter? • What commissioning tools are there?
Installing (Page 31)	• Which sequence is recommended when installing the inverter? • What does EMC-compliant installation actually mean? • What options are available to install optional components below the inverter? • What are the inverter dimensions? • What mounting and installation materials are required when installing the inverter? • To which line supplies can the inverter be connected? • How is the inverter connected to the line supply? • How is the braking resistor connected to the inverter? • Which terminals and fieldbus interfaces does the inverter have? • What are the interface functions?
Commissioning (Page 89)	• Which motor data are required for commissioning • How is the inverter set in the factory? • What is the commissioning procedure? • How do you restore the inverter factory settings?
Advanced commissioning (Page 127)	• Which functions are included in the inverter hardware? • How do the functions interoperate with one another? • How are the functions set?
Backing up data and series commissioning (Page 283)	• Why is it necessary to back up the inverter settings? • What options are available to back up the settings? • How does the data backup function? • How do you prevent the inverter settings from being changed? • How do you prevent the inverter settings from being read out?
Corrective maintenance (Page 309)	• How do you replace inverter components? • How do you change the firmware version of the inverter?
Alarms, faults and system messages (Page 335)	• What is the meaning of the LEDs provided on the inverter? • How does the system runtime you respond? • How does the inverter save alarms and faults? • What do the inverter alarms and faults mean? • How are inverter faults resolved? • Which I&M data are saved in the inverter?

Section	In this section you will find answers to the following questions:
Technical data (Page 355)	• What is the inverter technical data? • What do "High Overload" and "Low Overload" mean?
Appendix (Page 383)	• What are the new functions of the current firmware? • What are the most important inverter parameters? • How is the inverter operated using the BOP-2 operator panel? • How does the device trace function in STARTER? • How can signal interconnections be changed in the inverter firmware? • What does "BiCo technology" mean? • Where can you find additional manuals and information about the inverter?

Description

3

Use for the intended purpose

The inverter described in this manual is a device to control a three-phase 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.

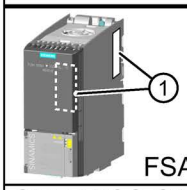
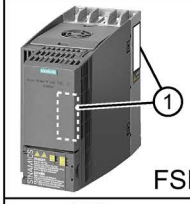
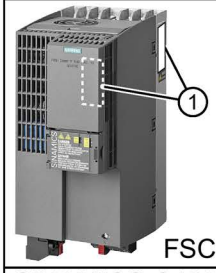
3.1 Scope of delivery

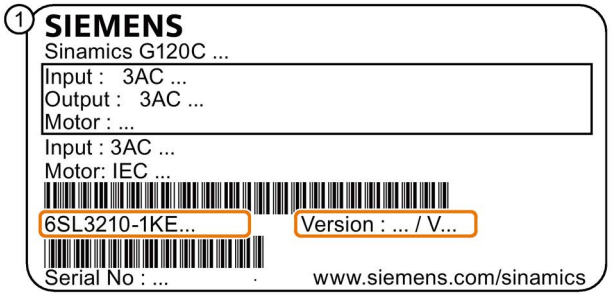
The delivery comprises at least the following components:

- A ready to run inverter with loaded firmware. Options for upgrading and downgrading the firmware can be found on the Internet: Firmware (http://support.automation.siemens.com/WW/news/en/67364620)

  You can find the Article number 6SL3210-1KE…, the hardware version (e.g. C02) and the firmware (e.g. V4.7) on the inverter rating plate.
- 1 set of connectors for connecting the inputs and outputs
- 1 set of connectors for connecting the line supply, motor and braking resistor
- Only for inverters with fieldbus via USS or Modbus RTU: 1 connector for connecting the fieldbus
- 1 set of shield plates
- Compact Operating Instructions in German and English
- The inverter contains open-source software (OSS). The OSS license terms are saved in the inverter.

Rating plate and technical data

Frame size	Rated output power	Rated output current	Article No.	
	Based on a low overload		Without filter	With filter
 FSAA	0.55 kW	1.7 A	6SL3210-1KE11-8U □ 2	6SL3210-1KE11-8A □ 2
	0.75 kW	2.2 A	6SL3210-1KE12-3U □ 2	6SL3210-1KE12-3A □ 2
	1.1 kW	3.1 A	6SL3210-1KE13-2U □ 2	6SL3210-1KE13-2A □ 2
	1.5 kW	4.1 A	6SL3210-1KE14-3U □ 2	6SL3210-1KE14-3A □ 2
SINAMICS G120C USS/MB (USS, Modbus RTU)			B	B
SINAMICS G120C DP (PROFIBUS)			P	P
SINAMICS G120C PN (PROFINET, EtherNet/IP)			F	F
 FSA	0.55 kW	1.7 A	6SL3210-1KE11-8U □ 1	6SL3210-1KE11-8A □ 1
	0.75 kW	2.2 A	6SL3210-1KE12-3U □ 1	6SL3210-1KE12-3A □ 1
	1.1 kW	3.1 A	6SL3210-1KE13-2U □ 1	6SL3210-1KE13-2A □ 1
	1.5 kW	4.1 A	6SL3210-1KE14-3U □ 1	6SL3210-1KE14-3A □ 1
	2.2 kW	5.6 A	6SL3210-1KE15-8U □ 1	6SL3210-1KE15-8A □ 1
	3.0 kW	7.3 A	6SL3210-1KE17-5U □ 1	6SL3210-1KE17-5A □ 1
	4.0 kW	8.8 A	6SL3210-1KE18-8U □ 1	6SL3210-1KE18-8A □ 1
 FSB	5.5 kW	12.5 A	6SL3210-1KE21-3U □ 1	6SL3210-1KE21-3A □ 1
	7.5 kW	16.5 A	6SL3210-1KE21-7U □ 1	6SL3210-1KE21-7A □ 1
 FSC	11.0 kW	25.0 A	6SL3210-1KE22-6U □ 1	6SL3210-1KE22-6A □ 1
	15.0 kW	31.0 A	6SL3210-1KE23-2U □ 1	6SL3210-1KE23-2A □ 1
	18.5 kW	37.0 A	6SL3210-1KE23-8U □ 1	6SL3210-1KE23-8A □ 1
SINAMICS G120C USS/MB (USS, Modbus RTU)			B	B
SINAMICS G120C DP (PROFIBUS)			P	P
SINAMICS G120C PN (PROFINET, EtherNet/IP)			F	F
SINAMICS G120C CANopen			C	C



The rating plate contains the Article No. and the hardware and firmware version of the inverter. You will find a rating plate at the following locations on the inverter:

- At the front, after removing the blanking cover for the operator panel.
- At the side on the heat sink

3.2 Optional components for the inverter

Braking resistor

The braking resistor allows the inverter to actively brake loads with high moments of inertia

Line reactor

The line reactor increases the level of protection for the inverter against overvoltages, harmonics and commutation dips.

Note

In order that the inverter service life is not reduced, a line reactor is required for a relative short-circuit voltage u_k of the line transformer < 1 %.

Output choke

The output reactor increases the maximum permissible length of the motor cables.

Assignment of the inverter to braking resistor, line reactor and output reactor

6SL3210-… inverter			Braking resistor	Line reactor	Output choke
Frame size AA, A	0.55 kW … 1.1 kW	…1KE11-8□□□, …1KE12-3□□□, …1KE13-2□□□	6SL3201-0BE14-3AA0	6SL3203-0CE13-2AA0	6SL3202-0AE16-1CA0
	1.5 kW	…1KE14-3□□□		6SL3203-0CE21-0AA0	
Frame size A	2.2 kW	…1KE15-8□□1	6SL3201-0BE21-0AA0		
	3.0 kW … 4.0 kW	…1KE17-5□□1, …1KE18-8□□1			6SL3202-0AE18-8CA0
Frame size B	5.5 kW … 7.5 kW	…1KE21-3□□1, …1KE21-7□□1	6SL3201-0BE21-8AA0	6SL3203-0CE21-8AA0	6SL3202-0AE21-8CA0
Frame size C	11.0 kW … 18.5 kW	…1KE22-6□□1, …1KE23-2□□1, …1KE23-8□□1	6SL3201-0BE23-8AA0	6SL3203-0CE23-8AA0	6SL3202-0AE23-8CA0

Memory cards

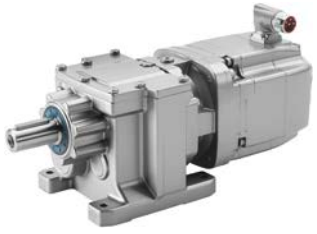
Table 3- 1 Memory cards to back up inverter settings

Scope of delivery	Article number
Memory card without firmware	6SL3054-4AG00-2AA0
Memory card with firmware V4.6	6SL3054-7EG00-2BA0
Memory card with firmware V4.7	6SL3054-7EH00-2BA0
Memory card with firmware V4.7 SP3	6SL3054-7TB00-2BA0

3.3 Motor series that are supported

Supported motors

The inverter is designed for the following motor series:

SIMOTICS GP, SIMOTICS SD IEC motors  1LG6, 1LA7, 1LA9 and 1LE1 standard induction motors For installations in compliance with IEC, multi-motor drive operation is permissible, i.e. simultaneously operating several motors on one inverter. See also: Multi-motor drive (http://support.automation.siemens.com/WW/view/en/84049346). For installations in compliance with UL, multi-motor drive operation is not permissible.	**SIMOTICS M main motors**  1PH8 induction motors
SIMOTICS S 1FK7 permanent-magnet synchronous motors without encoder  1FK7 synchronous motors	**SIMOTICS 1FG1 geared synchronous motors without encoder**  1FG1 geared synchronous motor
Motors from other manufacturers Standard induction motors Synchronous motors (on request)	

Operation with 1FK7 or 1FG1 synchronous motor without encoder

The control dynamic that can be achieved using a synchronous motor corresponds to that of an induction motor:

- Power-up time from standstill to rated speed ≥ 1 s
- Starting torque ≤ 2 × rated torque of the motor

Operation is intended for applications where increased energy efficiency is required when compared to an induction motor.

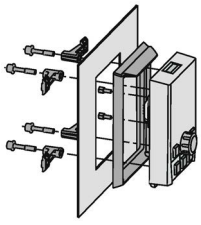
Some restrictions apply for operation:

Table 3- 2 Restrictions for operation with encoderless synchronous motors

Property	Restriction
Firmware	Firmware version ≥ FW V4.7 SP3
Hardware	• Frame size FSAA: all versions • Frame size FSA: from version C02 • Frame sizes FSB and FSC: From version C01
Applications	Suitable for applications for steady-state operation in the range of the rated motor speed: • Conveyor drives • Pumps • Fans
Speed of the motor	• Speed ≤ rated motor speed Operation is not permitted in field weakening. • In steady-state operation ≥ 15 % of the rated speed. For accelerating and reversing functions, speeds 0 … 15 % of the rated speed are permitted.
Switching on when motor is rotating	The "flying restart" function is not possible.
Safety Integrated	Only "STO" is permitted by the safety functions integrated in the drive.
Ambient temperature of motor	≤ 40 °C The inverter monitors the motor using a temperature model. The temperature model presumes an ambient temperature of 40°C. In the case of higher ambient temperatures, the inverter will no longer be able to provide sufficient protection for the motor. If you operate the motor in ambient temperatures > 40 °C, you must reduce the power of the motor sufficiently. Information on temperature-dependent power de-rating can be found in the motor manual.

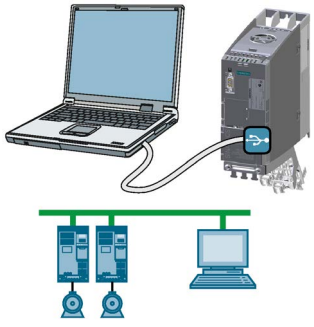
3.4 Tools to commission the converter

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

<table>
<tr><td colspan="4">Operator panels</td><td>Article number</td></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 with European languages:
6SL3255-0AA00-4JA1

IOP with Chinese:
6SL3255-0AA00-4JC1

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>
<tr><td colspan="5">PC tools</td></tr>
<tr><td colspan="2" rowspan="3">  </td><td colspan="2">STARTER
Connected to the inverter via USB port, PROFIBUS or PROFINET
Download: STARTER
(http://support.automation.siemens.com/WW/view/en/26233208)</td><td>STARTER on DVD:
6SL3072-0AA00-0AG0</td></tr>
<tr><td colspan="2">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 colspan="2">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 Procedure for installing the converter

Prerequisites for installing the converter

Check that the following prerequisites are fulfilled before you install the converter:

- Are the components, tools and small parts required for installation available?
- Are the ambient conditions permissible? See Technical data (Page 355).

Installation sequence

1. Mount the converter.
2. If required, mount the line reactor.
3. If required, mount the braking resistor.
4. Connect the following components:
   - Converter - motor
   - Converter - line reactor - line
   - Converter - braking resistor
5. Wire the terminal strip of the control unit.
6. When the installation has been complete and checked, power can then be applied to the converter.

You start to commission the converter once installation has been completed.

4.2 EMC-compliant installation

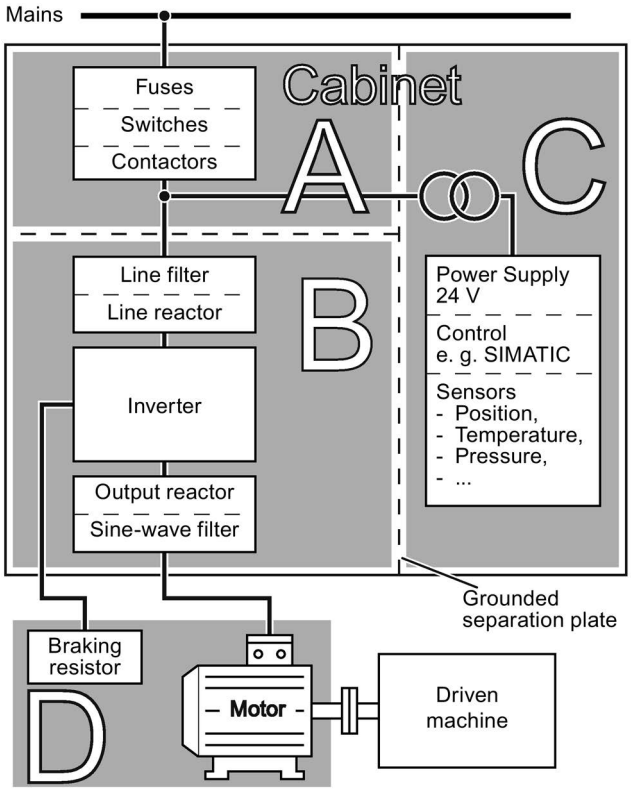
4.2.1 EMC-compliant cabinet design

The most cost-effective method of implementing interference suppression measures within the control cabinet is to ensure that interference sources and interference sinks are spatially separated.

EMC zone concept within the control cabinet

Split up the complete control cabinet into EMC zones.

Electromagnetically decouple the zones from one another, either using large clearances (approximately 25 cm) – or using a separate metal enclosure or sheet metal partition with a large surface area. Assign the various devices to zones in the control cabinet.



- **Zone A:**
  Line supply connection
  Limit values for conducted interference emission and interference immunity must not be exceeded.
- **Zone B:**
  Power electronics
  Sources of interference
- **Zone C:**
  Controller and sensors
  Interference sinks

  Zone D:
  Motor, braking resistor and corresponding cables
  Sources of interference

Classification of the control cabinet or the drive system into EMC zones

Non-shielded cables can be used within a zone. It is not permissible to route cables of various zones in common cable harnesses or common cable ducts.

If necessary, you must use filters and/or coupling modules at the interfaces of the zones.

Use shielded cables for all communication and signal cables that exit the control cabinet. Connect the shields to the cabinet ground through a large surface area and low ohmic

connection. Ensure that there are no potential differences between these zones, to avoid inadmissibly high equalization currents flowing through the cable shields.

Control cabinet design

- All connections should be durable.
- Connect all the metallic parts of the control cabinet (doors, rear panels, side, top section and base plates) to the frame of the cabinet so that there is a good electrical connection.
- For screw connections at painted or anodized metal parts, either use special serrated washers, which penetrate the insulating surface – or remove the insulating surface at the contact locations in order to establish a good contact between the metals.
- Connect the PE bar and the EMC shield bar to the control cabinet frame through a good electrical connection established through a large surface area.
- Connect all metal enclosures of the components installed in the cabinet with the control cabinet frame through a large surface area to ensure a good electrical connection. To achieve this, mount the components on a bare metal surface and mounting plate with good conductivity, which you then connect to the control cabinet frame through the largest possible surface area to establish a good connection, especially with the PE and EMC shield bars.

Radio interference suppression

- Connect interference suppressors to all contactors, relays, solenoid valves and motor holding brakes directly at the coil in order to dampen high-frequency radiation when these devices are switched off. Use RC elements or varistors for AC-operated coils and freewheeling diodes or varistors for DC-operated coils.

Cable routing inside the cabinet

- Route the power cables of the drive so that there is a minimum clearance of 25 cm to signal and data cables. Power cables are line, DC link and motor cables – as well as connecting cables between the Braking Module and braking resistor. Alternatively, the separation can be realized using metal partitions connected to the mounting plate through a good electrical connection.
- Route power cables with low noise levels separately from power cables with high noise levels
  - Power cables with low noise level:
    - line cables from the line to the line filter
  - Power cables with high noise level:
    - cables between the line filter and inverter
    - DC link cables
    - cables between the Braking Module and braking resistor
    - motor cables
- Route the cables so that signal and data cables as well as power cables with low noise level only cross power cables with a high noise level at right angles.
- Keep the cables as short as possible.

- Route the cables as close as possible to grounded enclosure parts such as mounting plates or the cabinet frame.
- Route signal and data cables as well as the associated equipotential bonding cables parallel and as close to one another as possible.
- Route incoming and outgoing cables/conductors within a zone (where unshielded single-conductor cables are used), twisted or in parallel and as close to one another as possible.
- Ground any unused conductors of signal and data cables at both ends.
- Signal and data cables should enter the cabinet only at one point (e.g. from below).

Cables outside the control cabinet

- Route the power cables of the drive so that there is a minimum clearance of 25 cm to signal and data cables.
- Use shielded motor cables.
- Use shielded signal and data cables.

Cable shields

- For shielded cables, only use cables with finely-stranded, braided shields.
- Connect the shield at the grounded enclosure as well as at the EMC shield bar.
  - Connect the shields to the grounded enclosures through a large surface area at both ends of the cables to establish a low ohmic connection. Attach the shields to the appropriate EMC shield bars.
  - Immediately after the cable enters the cabinet, connect the cable shields to the EMC shield bar through a larger surface area to establish a low ohmic conduction.
- If possible, always route the cable shields without any interruptions.
- Only use metallic or metallized connectors for the plug connections for shielded data cables (e.g. PROFIBUS connection).

Grounding measures

Proceed as follows to ground the drive system:

- For several cabinets, install a common PE bar for all cabinet elements
- Connect all of the drive system components to the PE conductor
- Connect the PE conductor to the PE bar of the control cabinet.

Measures for high frequency equipotential bonding

Proceed as follows, to ensure high-frequency equipotential bonding:

- Connect the metallic components in the control cabinet to the PE bar and the EMC bar through a larger surface area so that a good electrical connection is established.
  - Either through a large surface area between the metal contact surfaces of the cabinet components with a minimum cross-section of several cm² for each contact location.
  - Or, alternatively using short, finely stranded, braided copper wires with cross-sections ≥ 95 mm² / 000 (3/0) (-2) AWG.
- In plants and systems with several cabinet elements, screw the frames of the individual cabinet elements at several locations to one another using serrated washers to establish a good electrical connection.
- In plants and systems with very long rows of cabinets, which are installed in two groups back to back, connect the PE bars of the two cabinet groups at as many locations as possible.
- Therefore, connect the protective ground conductor and the cable shield to the motor and the inverter.

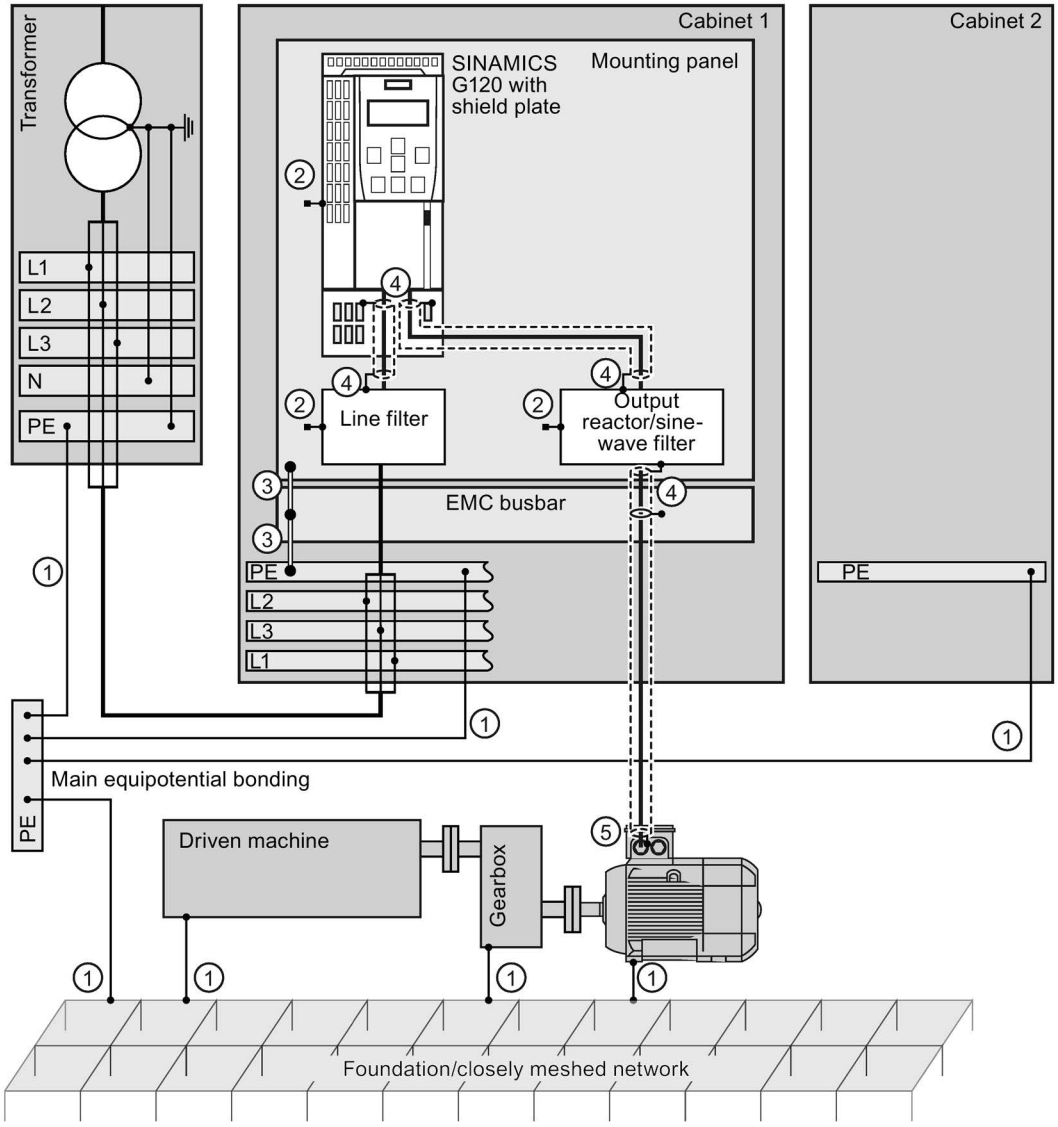
Additional measures for high frequency equipotential bonding

Route finely stranded or braided copper conductors in parallel to the motor cable with the shortest possible distance between them:

- in older systems with already existing unshielded cables
- for cables with poor high-frequency properties of the shield
- for poor grounding systems

Diagrams for grounding and high-frequency equipotential bonding measures

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



Grounding measures

① Conventional grounding without any special HF properties

High-frequency equipotential bonding measures

② Electrically conductive connection to the mounting panel through the largest possible surface

③ HF equipotential bonding

④ Connect the shield through a large contact surface and ground

⑤ Connect the shield through an electrically conductive heavy-gauge threaded joint (gland) and ground

Figure 4-1 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

The following diagram shows the additional measures for high-frequency equipotential bonding

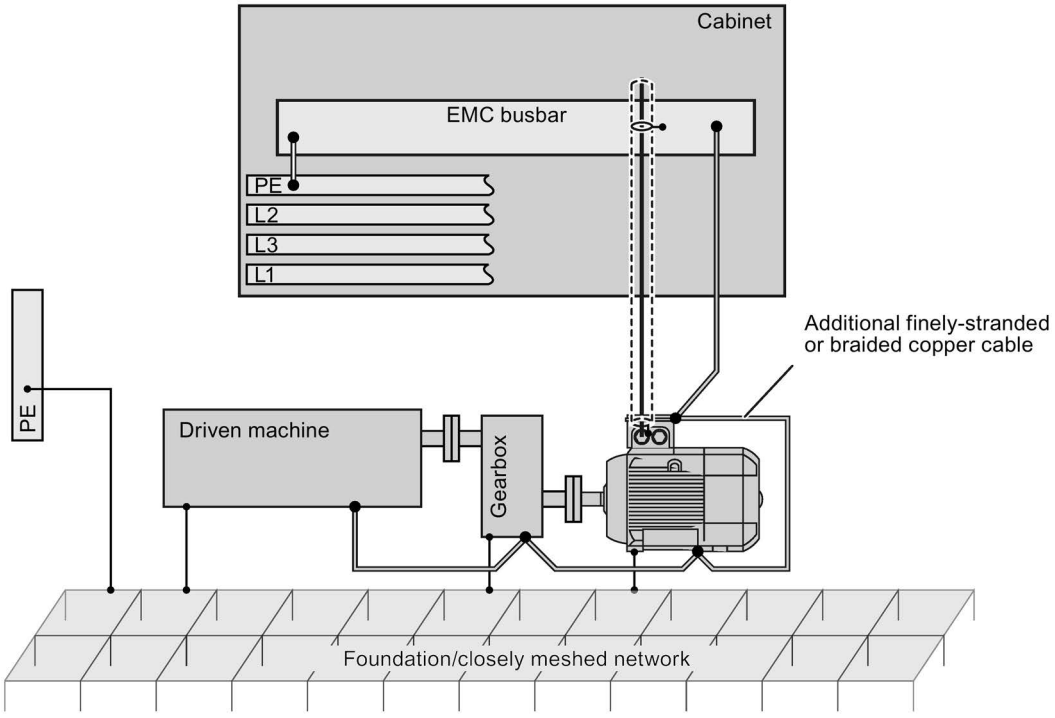


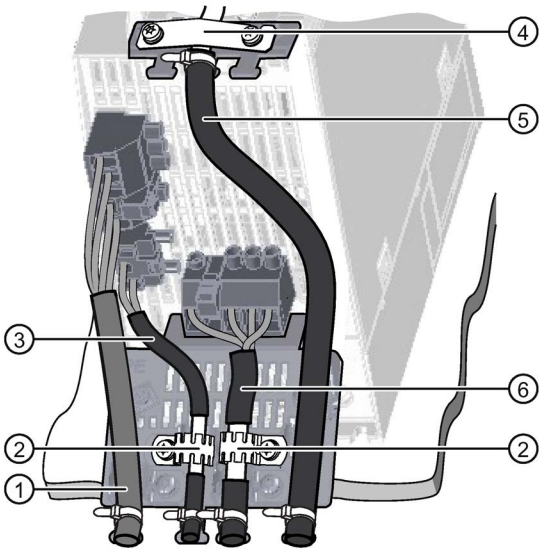
Figure 4-2 Additional measures for high frequency equipotential bonding of the drive system

Further information

You can find additional information about the EMC installation guidelines on the Internet: EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658).

4.2.2 Installing the converter in compliance with EMC rules

Overview



EMC-compliant wiring shown using the example of a frame size A inverter

① Unshielded line supply cable
② EMC clamps (serrated rails) on the shield plate of the Power Module
③ Shielded cable to the braking resistor (not available for all inverters)
④ EMC clamp for the cable to the terminal strip on the shield plate of the CU
⑤ Shielded cable to the terminal strip
⑥ Shielded motor cable

Rules for cable installation to ensure EMC

- Install the inverter on a metal mounting plate. The mounting plate must be unpainted and highly electrically conductive.
- Use shielded cables for the following connections:
  - Motor and motor temperature sensor
  - Braking resistor (not available for all inverters)
  - Fieldbus
  - Inputs and outputs of the terminal strip
- Connect the cable shields to ensure EMC:

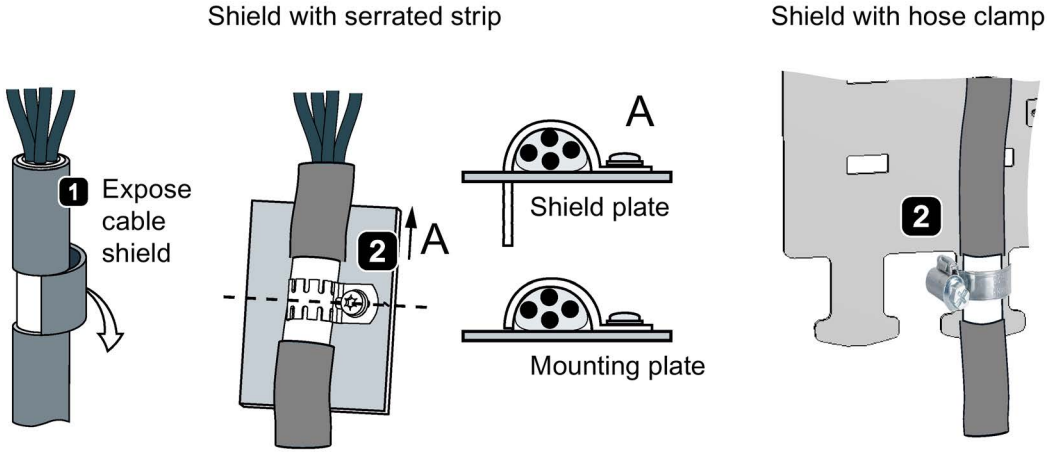


Figure 4-3 Examples of correct EMC-compliant shield connection

4.3 Installing the inverter

Mounting orientation

Mount the converter in a control cabinet.

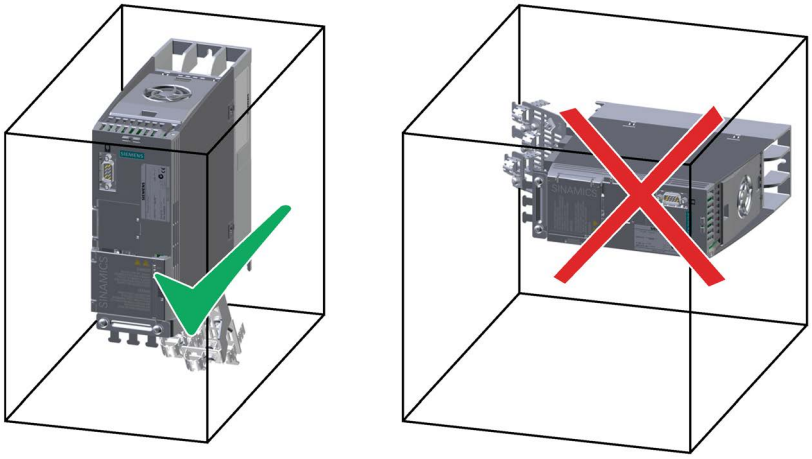


Figure 4-4 The converter must not be installed horizontally.

Devices that could impede the flow of cooling air must not be installed in this area. Make sure that the ventilation openings for the cooling air for the converter are not covered and that the flow of cooling air is not obstructed.

Dimensions

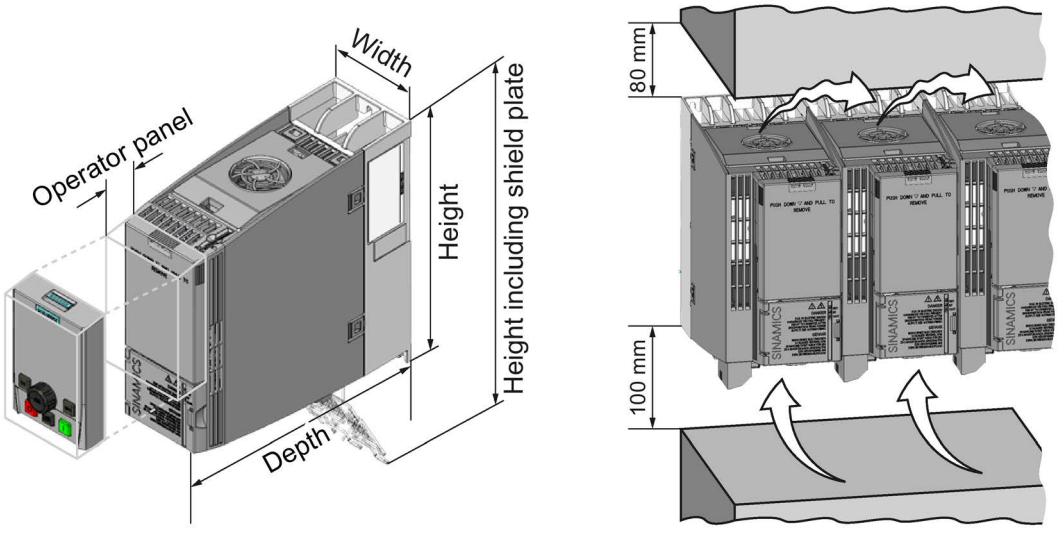


Figure 4-5 Dimensions and minimum spacing to other devices

Table 4- 1 Dimensions

	Frame Size AA 0.55 kW … 1.5 kW	**Frame Size A 0.55 kW … 4.0 kW**	**Frame size B 5.5 kW … 7.5 kW**	**Frame size C 11 kW … 18.5 kW**
Height including connectors	181 mm	196 mm	196 mm	295 mm
Height including shield plate	268 mm	276 mm	276 mm	375 mm
Width	73 mm	73 mm	100 mm	140 mm
Depth of the inverter with PROFINET interface	178 mm	226 mm	226 mm	226 mm
Depth of the inverter with USS/MB, CANopen, or PROFIBUS interface	155 mm	203 mm	203 mm	203 mm
Additional depth when the Operator Panel is attached	+ 21 mm with IOP (Intelligent Operator Panel) attached			
	+ 11 mm with BOP-2 (Basic Operator Panel) attached			

Mounting shield plates

We recommend that you mount the shield plates provided. The shield plates make it simpler to install the inverter in compliance with EMC regulations and to provide strength relief for the connected cables.

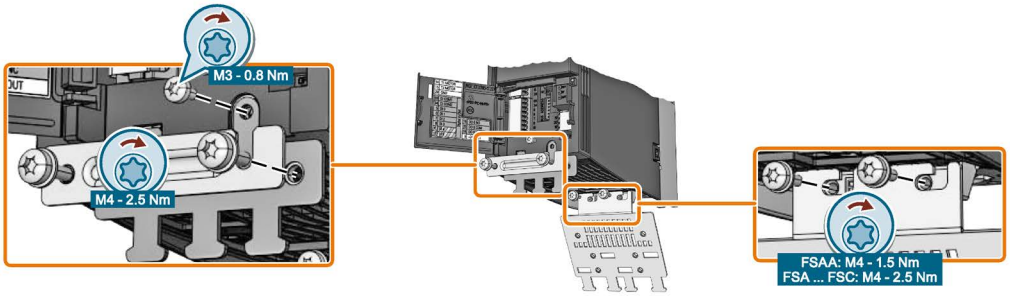
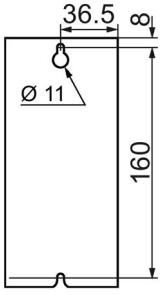
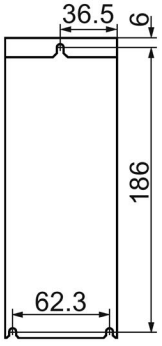
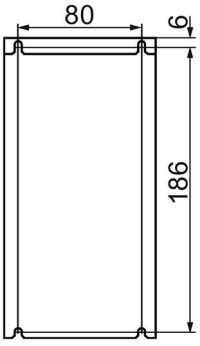
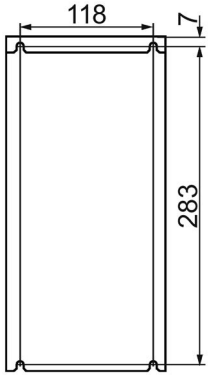


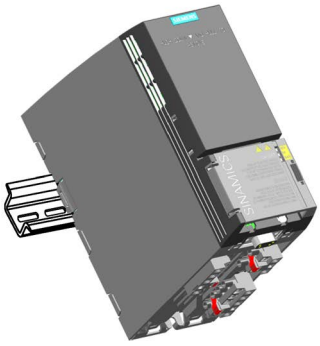
Figure 4-6 Mounting a shield plate using as example a frame size A inverter

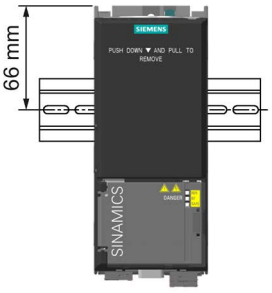
Mounting on a control cabinet panel

Table 4- 2 Drilling patterns and mounting equipment

	Frame Size AA 0.55 kW … 1.5 kW	**Frame Size A 0.55 kW … 4.0 kW**	**Frame size B 5.5 kW … 7.5 kW**	**Frame size C 11 kW … 18.5 kW**
Drilling pattern	 Drilling pattern without shield plate When the shield plate is mounted, the drilling pattern is compatible to frame size A			
Mounting parts	2 x M4 bolts 2 x M4 nuts 2 x M4 washers	3 x M4 studs, 3 x M4 nuts, 3 x M4 washers	4 x M4 studs, 4 x M4 nuts, 4 x M4 washers	4 x M5 studs, 4 x M5 nuts, 4 x M5 washers
Locked-rotor (starting) torque	2.5 Nm	2.5 Nm	2.5 Nm	2.5 Nm

Mounting on a mounting rail (TS 35)





You can mount inverters, frame size FSAA on a TS 35 mounting rail.

Procedure

1
2

Proceed as follows to mount the inverter on a mounting rail:

1. Mount the inverter on the top edge of the mounting rail.
2. Using a screwdriver, actuate the release button on the upper side of the inverter.
3. Continue to actuate the release button until the inverter audibly snaps onto the mounting rail.

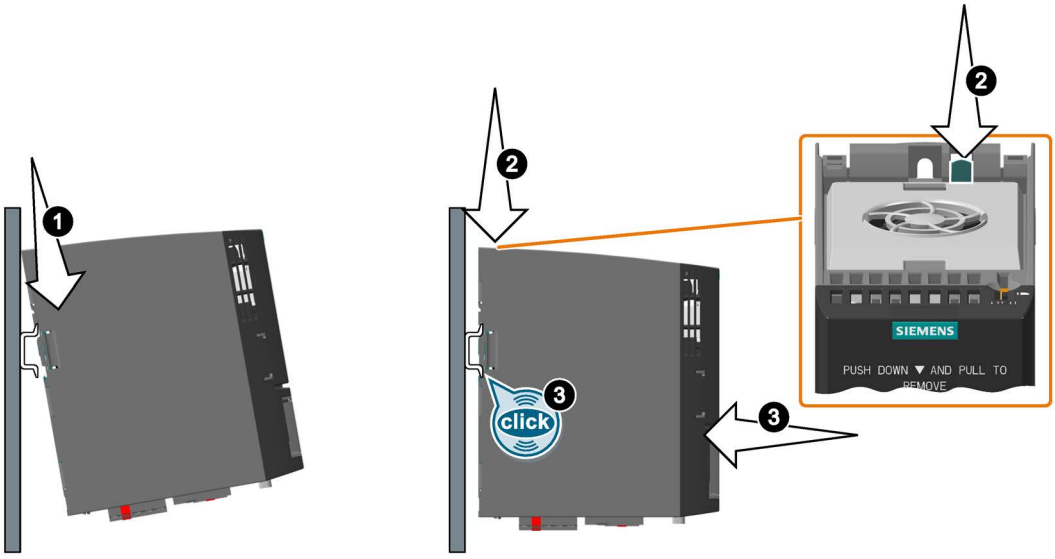


Figure 4-7 Mounting on a standard mounting rail

You have mounted the inverter on a mounting rail.

To remove, actuate the release button and at the same time withdraw the inverter from the mounting rail.

Mounting on a base component (only frame size FSAA)

Reactors, filters and braking resistors are available as base components for inverters, frame size FSAA.

Mount the inverter using two M4 screws on the base component.

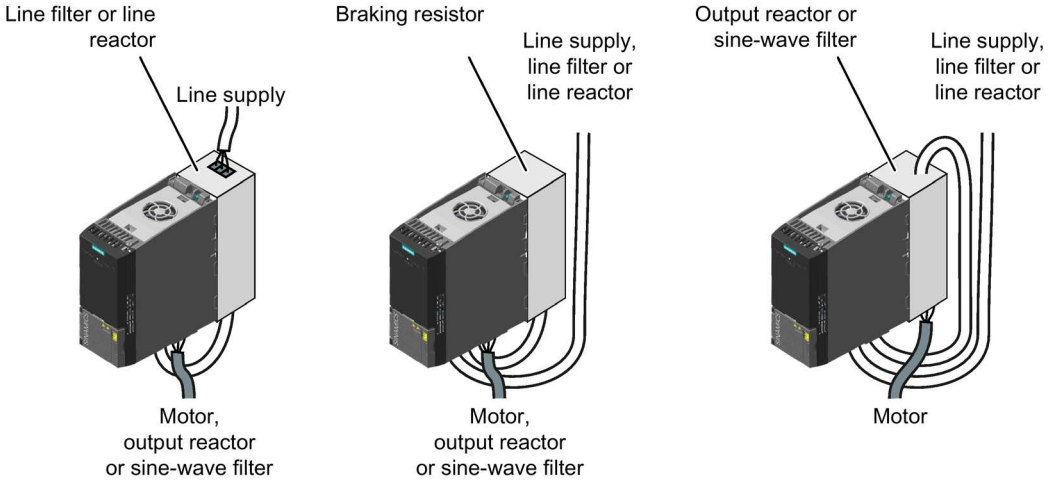


Figure 4-8 Available base components

You can combine up to two base components.

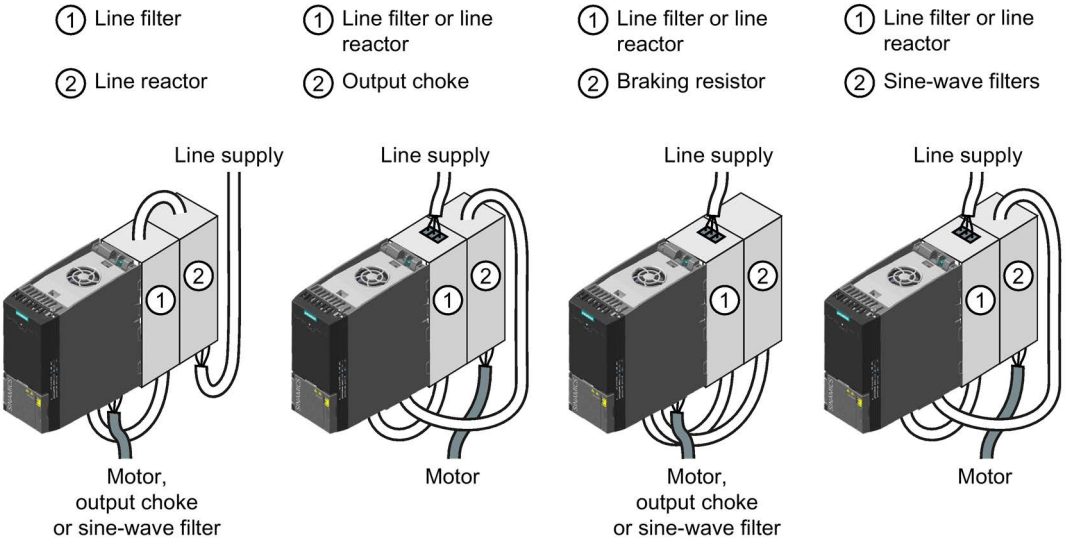
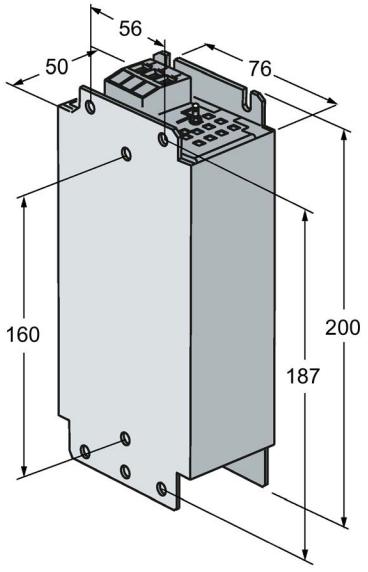
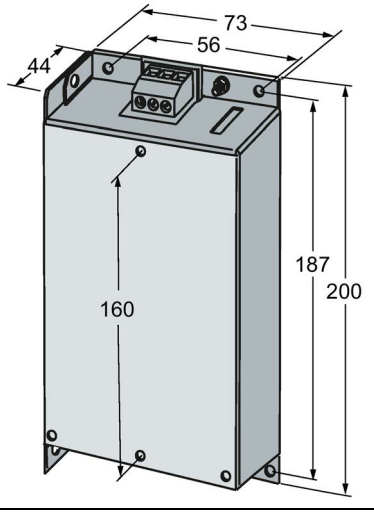


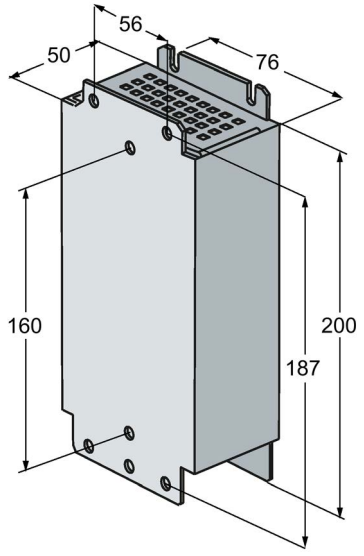
Figure 4-9 Permissible combination of two base components

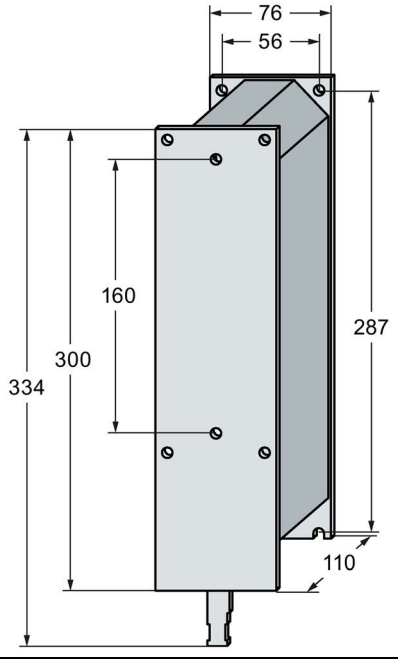
4.4 Mounting base components

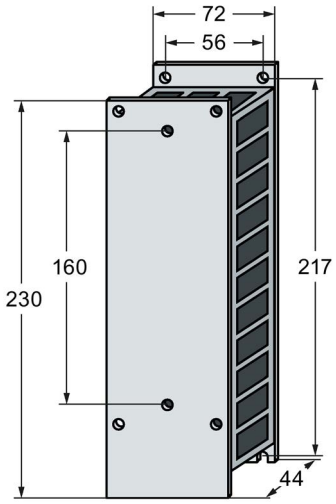
Dimensions

Line reactor as base component, 0.55 kW … 1.5 kW	
	Mounting: 4 × M4 screws 4 × M4 nuts 4 × M4 washers Tightening torque: 5 Nm

Line filter as base component, 0.55 kW … 1.5 kW	
	Mounting: 4 × M4 screws 4 × M4 nuts 4 × M4 washers Tightening torque: 5 Nm

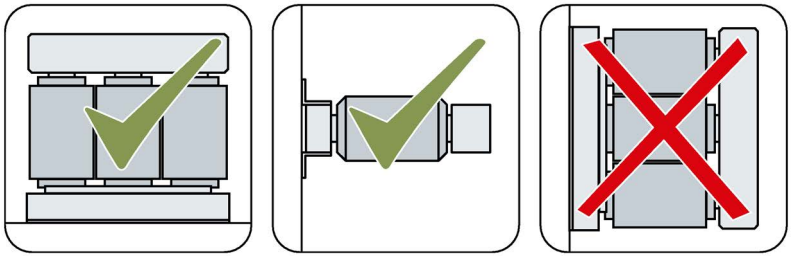
Output reactor as base component, 0.55 kW … 1.5 kW	
	Mounting: 4 × M4 screws 4 × M4 nuts 4 × M4 washers Tightening torque: 5 Nm

Sine-wave filter as base component, 0.55 kW … 1.5 kW	
	Mounting: 4 × M4 screws 4 × M4 nuts 4 × M4 washers Tightening torque: 5 Nm

Braking resistor as base component, 0.55 kW … 1.5 kW	
	Mounting: 4 × M4 screws 4 × M4 nuts 4 × M4 washers Tightening torque: 5 Nm

4.5 Mounting the line reactor

Mounting position



Clearances to other devices

For a line reactor, a minimum clearance to other devices must be maintained on all sides.

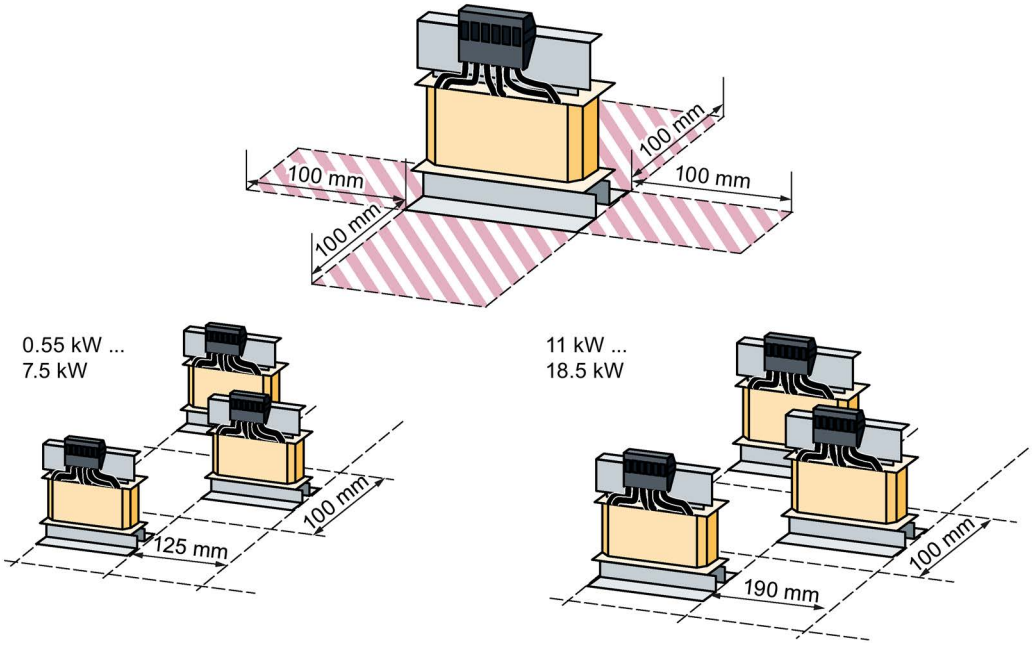
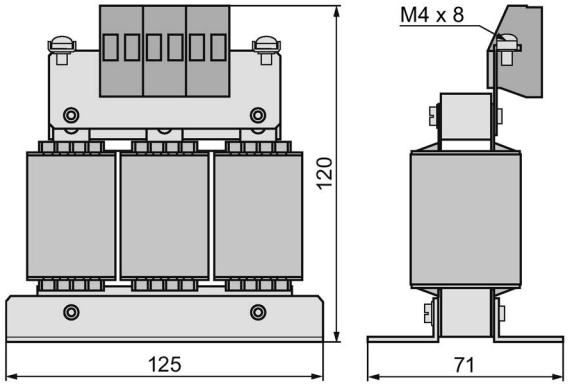
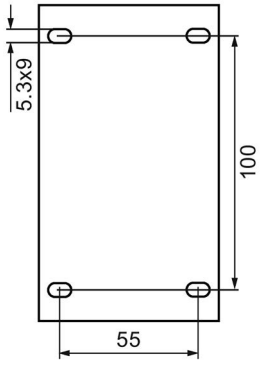


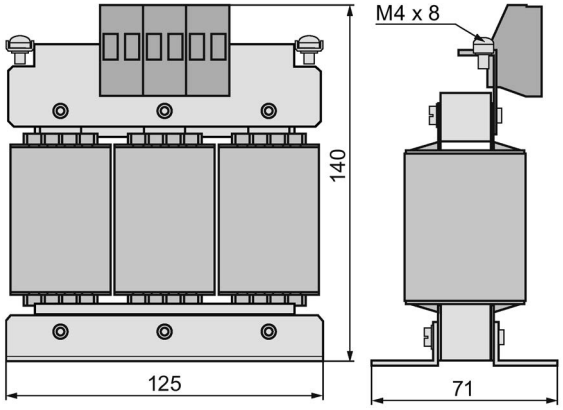
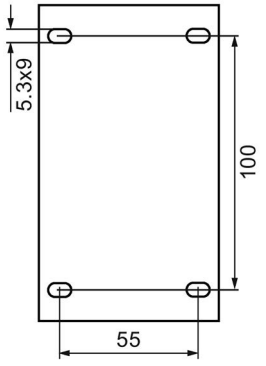
Figure 4-10 Clearances between the line reactors and other devices, examples for space-saving installation

Dimensions and drilling patterns

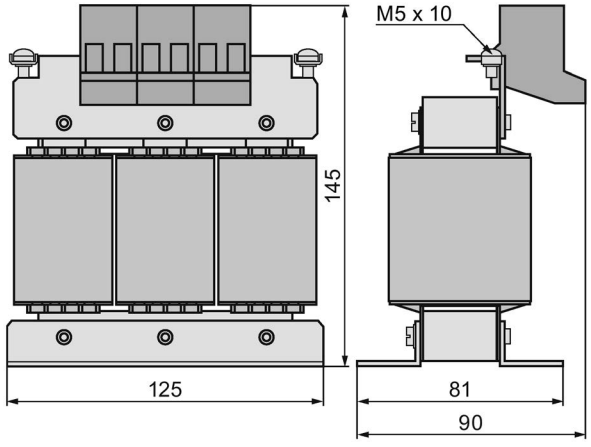
0.55 kW ... 1.1 kW

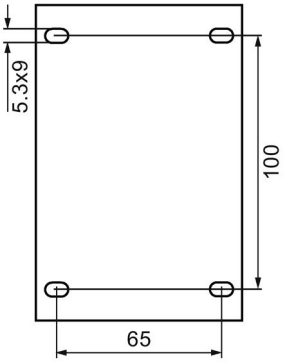
Dimensions [mm]	Drilling pattern [mm]
	 Fixings: 4 x M5 bolts 4 x M5 nuts 4 x M5 washers Tightening torque: 6 Nm

1.5 kW ... 4.0 kW

Dimensions [mm]	Drilling pattern [mm]
	 Fixings: 4 x M5 bolts 4 x M5 nuts 4 x M5 washers Tightening torque: 6 Nm

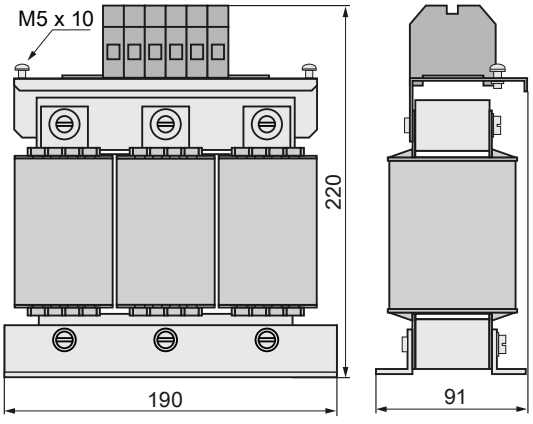
5.5 kW … 7.5 kW

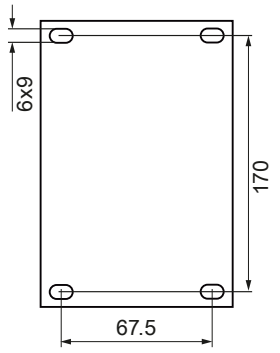




Fixings:
4 x M5 bolts
4 x M5 nuts
4 x M5 washers
Tightening torque: 6 Nm

11 kW … 18.5 kW

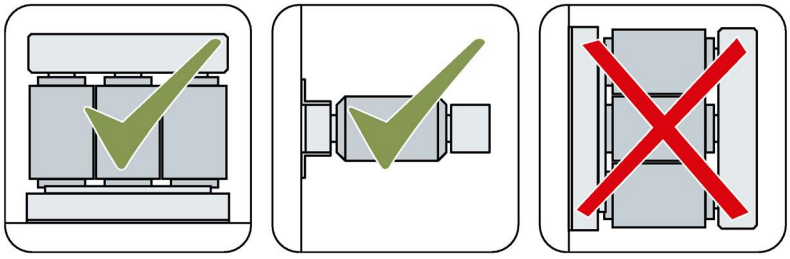




Fixings:
4 x M5 bolts
4 x M5 nuts
4 x M5 washers
Tightening torque: 6 Nm

4.6 Mounting the output reactor

Mounting position



Clearances to other devices

Keep shaded areas free of any devices and components.

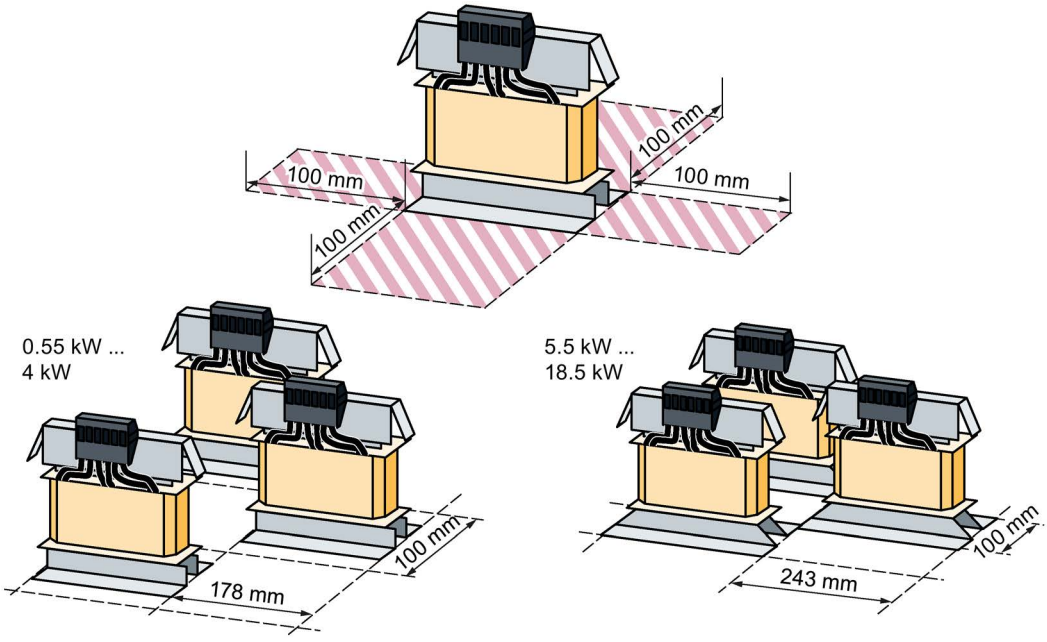
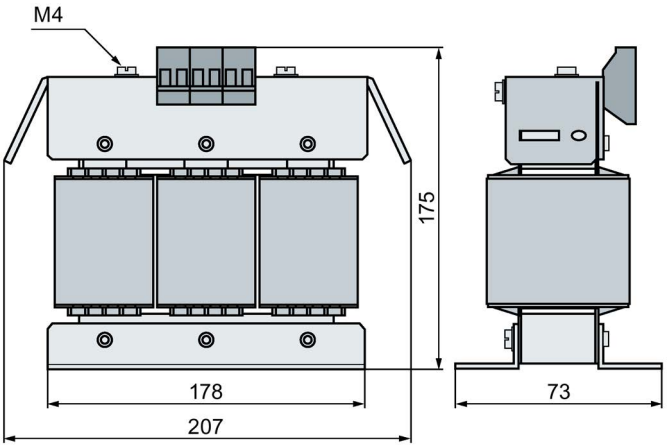
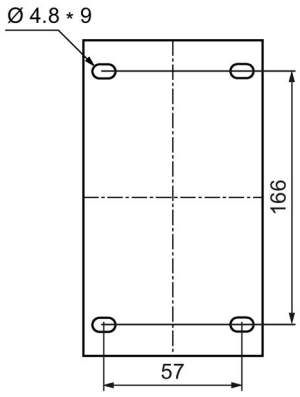


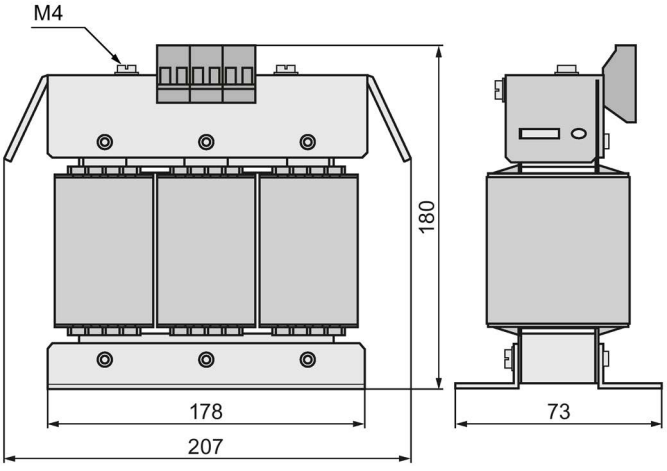
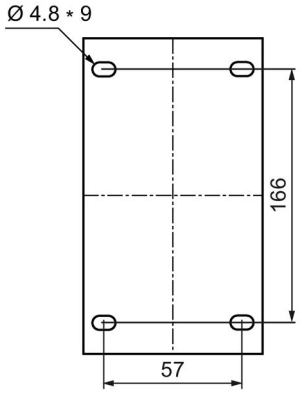
Figure 4-11 Minimum clearances of the output reactor to other devices, space-saving mounting examples

Dimensions and drilling patterns

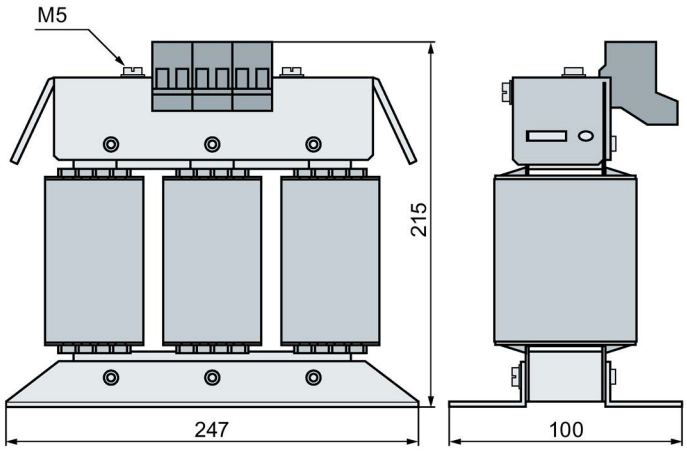
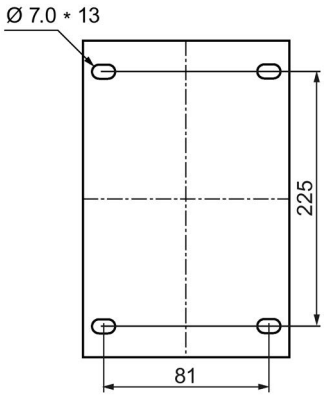
0.55 kW … 2.2 kW

Dimensions [mm]	Drilling pattern [mm]
	 Mounting: 4 * M4 bolts 4 * M4 nuts 4 * M4 washers Tightening torque: 3 Nm

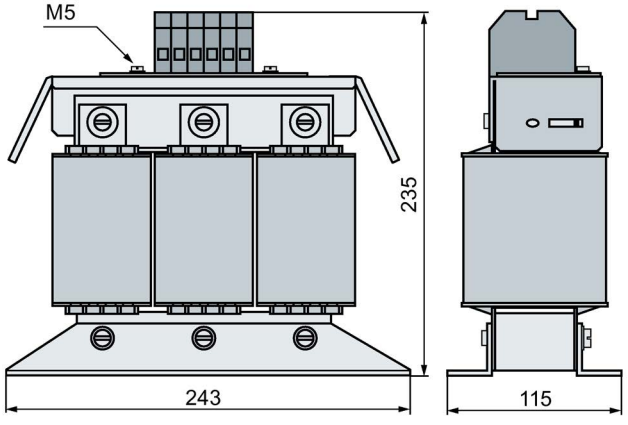
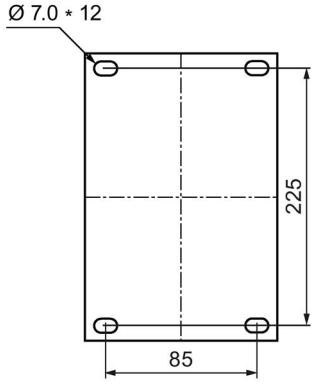
3.0 kW … 4.0 kW

Dimensions [mm]	Drilling pattern [mm]
	 Mounting: 4 * M4 bolts 4 * M4 nuts 4 * M4 washers Tightening torque: 3 Nm

5.5 kW … 7.5 kW

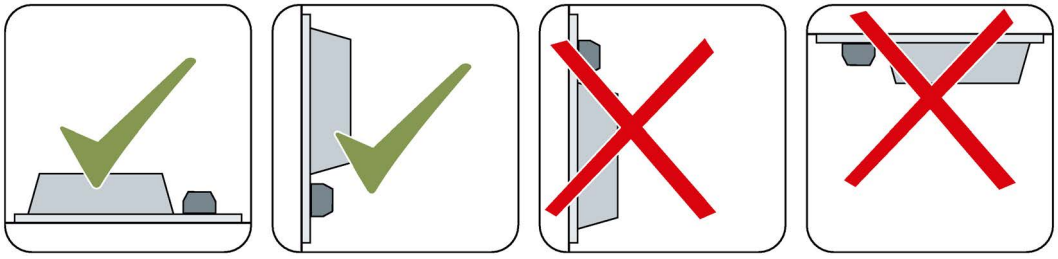
Dimensions [mm]	Drilling pattern [mm]
	 Fixing: 4 * M5 bolts 4 * M5 nuts 4 * M5 washers Tightening torque: 6 Nm

11 kW … 18.5 kW

Dimensions [mm]	Drilling pattern [mm]
	 Fixing: 4 * M5 bolts 4 * M5 nuts 4 * M5 washers Tightening torque: 5 Nm

4.7 Mounting the braking resistor

Mounting position





⚠ CAUTION

Risk of burns due to touching hot surfaces

During operation and for a short time after the frequency converter shuts down, the surface of the device can reach a high temperature. Touching the surface of the converter can cause burns.

- Do not touch the device during operation.
- After shutting down the converter, wait for the device to cool down before touching it.

Mounting instructions

Mount the resistor on a heat resistant surface with a high thermal conductivity.

Do not cover the ventilation openings of the braking resistor.

Clearances to other devices

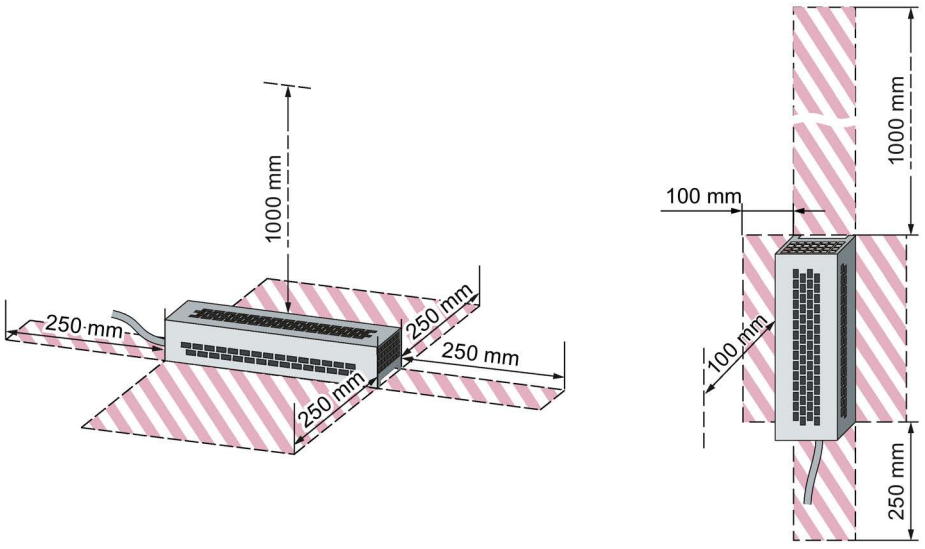
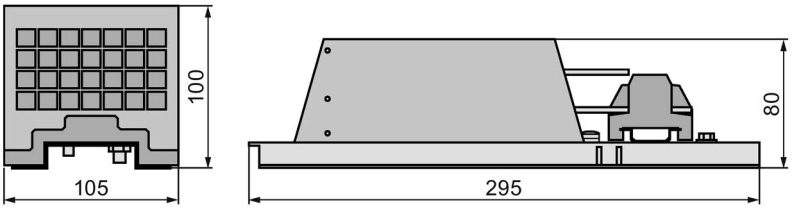
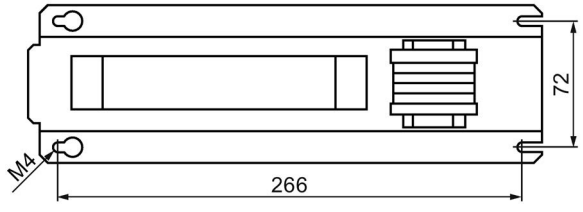


Figure 4-12 Minimum clearances for the braking resistor when mounting on a flat surface and for wall/panel mounting

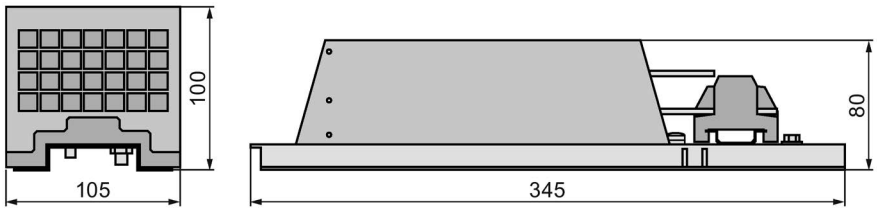
Keep shaded areas free of any devices and components.

Dimensions and drilling patterns

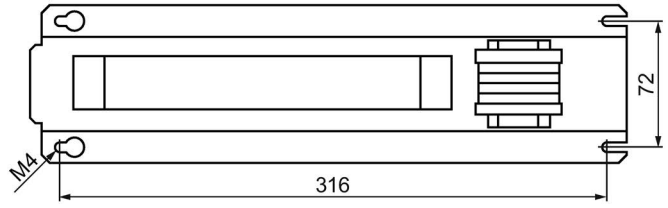
Frame size AA, frame size A: 0.55 kW … 1.5 kW	
Dimensions [mm]	
	
Drilling pattern [mm]	
	Fixing: 4 × M4 screws 4 × M4 nuts 4 × M4 washers tightening torque 3 Nm

Frame size A, 2.2 kW … 4.0 kW

Dimensions [mm]



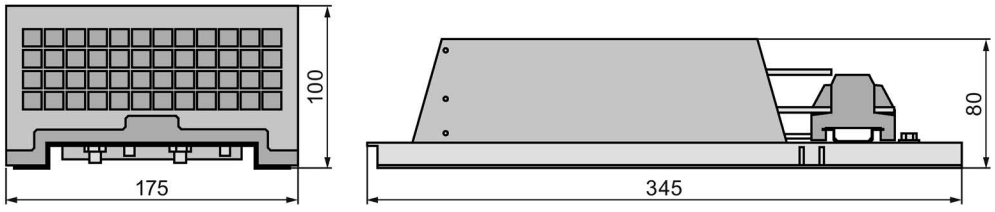
Drilling pattern [mm]



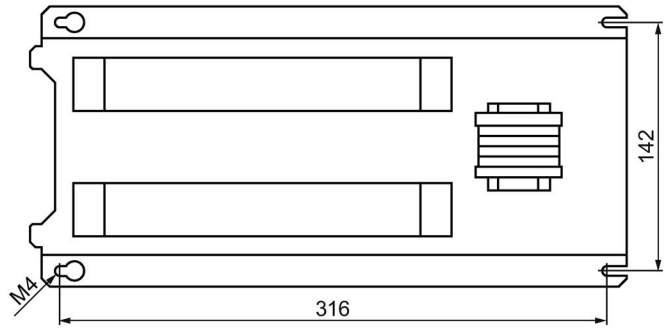
Fixing:
4 × M4 screws
4 × M4 nuts
4 × M4 washers
tightening torque 3 Nm

Frame size B, 5.5 kW … 7.5 kW

Dimensions [mm]



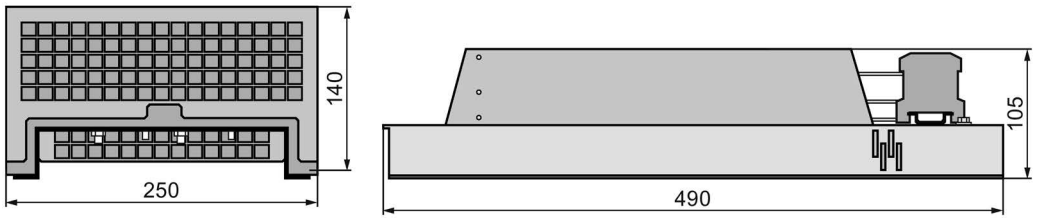
Drilling pattern [mm]



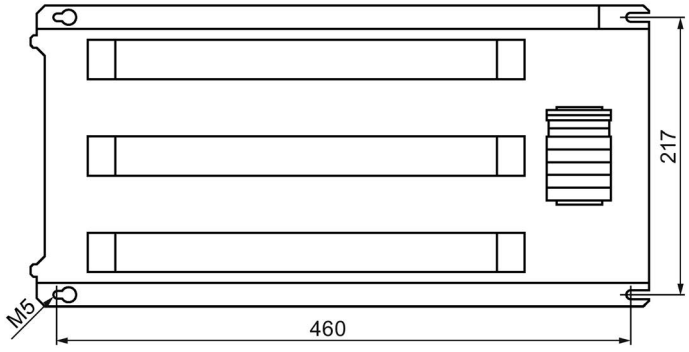
Fixing:
4 × M4 screws
4 × M4 nuts
4 × M4 washers
tightening torque 3 Nm

Frame size C, 11 kW ... 18.5 kW

Dimensions [mm]



Drilling pattern [mm]



Fixing:

4 × M5 screws
4 × M5 nuts
4 × M5 washers
tightening torque 6 Nm

4.8 Connecting the inverter

4.8.1 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. Also see: Current derating - depending on the installation altitude (Page 370).

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.

Inverter connected to a TN line supply

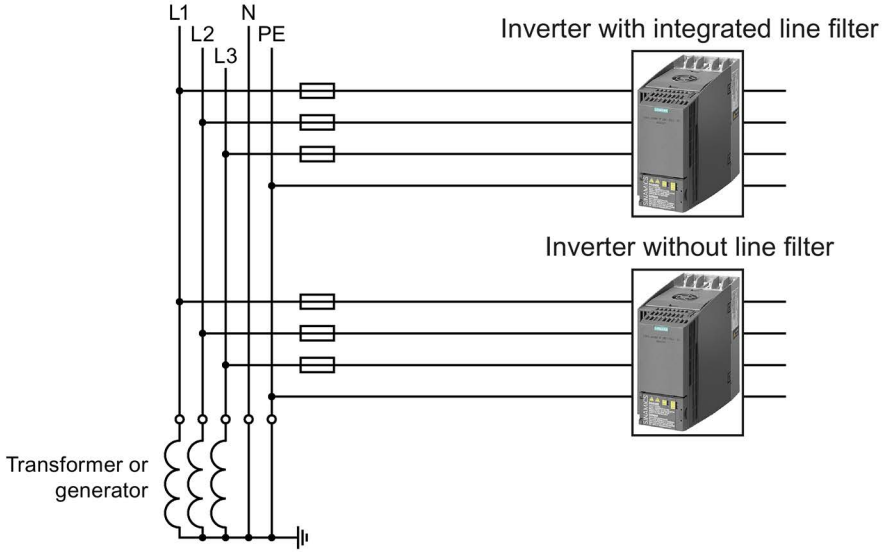


Figure 4-13 TN line supply with separate transfer of N and PE and with a grounded neutral point

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.
- For installations in compliance with IEC, operation on a TT line system is permissible. For installations in compliance with UL, operation on a TT line system is not permissible.

Inverter connected to a TT line supply

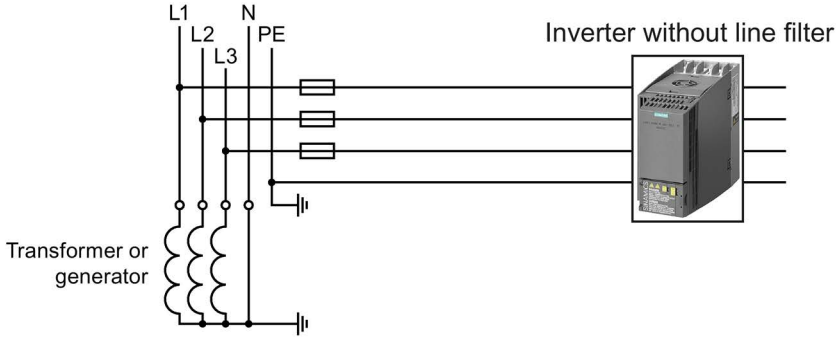


Figure 4-14 TT line system where the neutral conductor N is transferred

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.

Inverter connected to an IT line supply

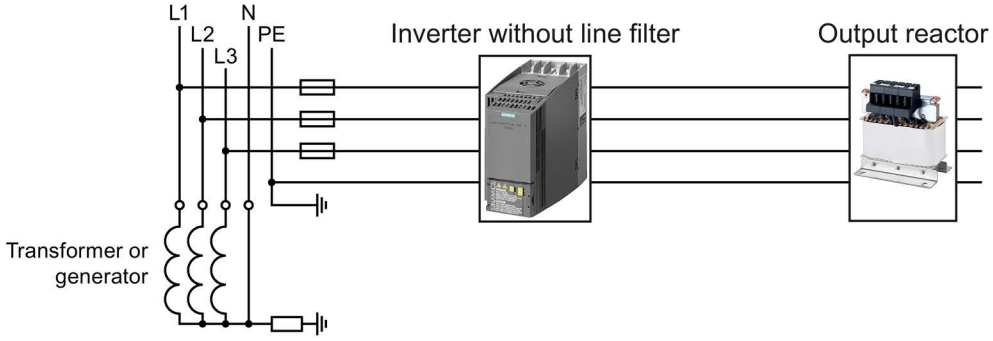


Figure 4-15 IT line supply where the neutral conductor N is transferred and with impedance with respect to the PE protective conductor

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.

4.8.2 Connecting the inverter and inverter components to the supply

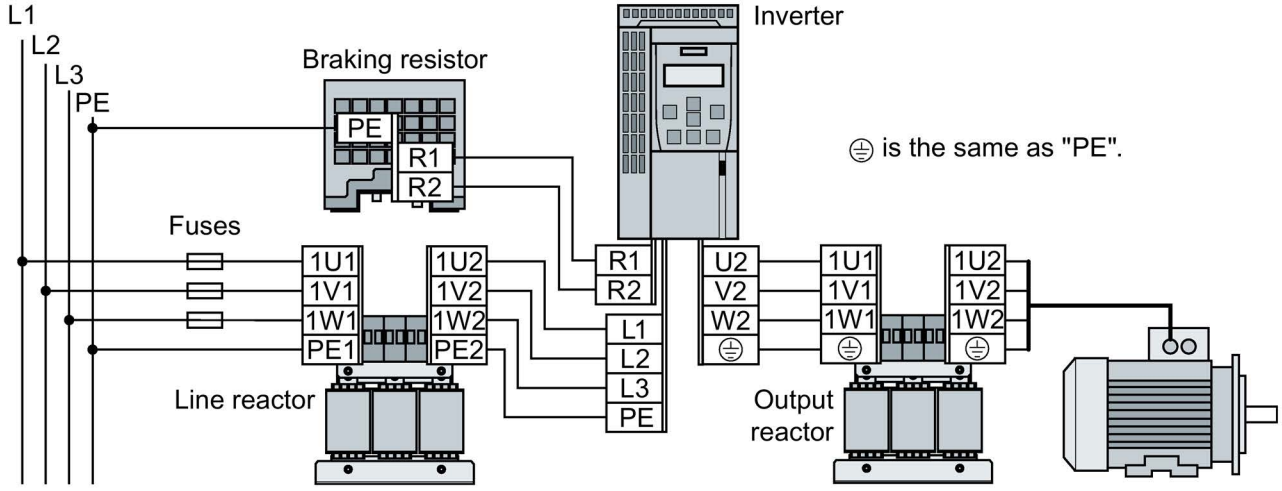
⚠WARNING

Danger to life caused by high leakage currents when the external PE conductor is interrupted

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

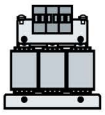
- Ensure that the external PE conductor complies with at least one of the following conditions:
  - It is laid protected against mechanical damage.[1)]
  - As a core of a multi-core cable, it has a cross section of at least 2.5 mm² Cu.
  - It has a parallel, second PE conductor with the same cross section.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

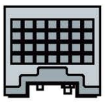
[1)] Cables routed in control cabinets or enclosed machine enclosures are considered to be adequately protected against mechanical damage.

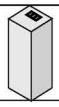


Converter			
Frame size, rated power		Connection cross-section (tightening torque)	
FSAA, FSA	0.55 kW … 4.0 kW	1.0 ... 2.5 mm² (0.5 Nm)	18 ... 14 AWG (4.5 lbf in)
FSB	5.5 kW … 7.5 kW	4.0 ... 6.0 mm² (0.6 Nm)	12 ... 10 AWG (5.5 lbf in)
FSC	11 kW	6.0 ... 16 mm² (1.5 Nm)	10 ... 5 AWG (13.5 lbf in)
	15 kW … 18.5 kW	10 ... 16 mm² (1.5 Nm)	7 ... 5 AWG (13.5 lbf in)

Rated power of the inverter	Line reactor Connection cross-section (tightening torque)		
0.55 kW … 4.0 kW	2.5 mm² (0.8 Nm)	14 AWG (7 lbf in)	PE M4 (3 Nm / 27 lbf in)
5.5 kW … 7.5 kW	6 mm² (1.8 Nm)	10 AWG (16 lbf in)	PE M5 (5 Nm / 44 lbf in)
11 kW … 18.5 kW	16 mm² (4 Nm)	5 AWG (35 lbf in)	

Rated power of the inverter		Output choke Connection cross-section (tightening torque)		
0.55 kW … 4.0 kW		2.5 mm² (0.8 Nm)	14 AWG (7 lbf in)	PE M4 (3 Nm / 27 lbf in)
5.5 kW … 7.5 kW		10 mm² (1.8 Nm)	8 AWG (16 lbf in)	PE M5 (5 Nm / 44 lbf in)
11 kW … 18.5 kW		16 mm² (4 Nm)	5 AWG (35 lbf in)	

Rated power of the inverter		Braking resistor Connection cross-section (tightening torque)			
		R1, R2, PE		Temperature contact	
0.55 kW … 7.5 kW		2.5 mm² (0.5 Nm)	14 AWG (4.5 lbf in)	2.5 mm² (0.5 Nm)	14 AWG (4.5 lbf in)
11 kW … 18.5 kW		6 mm² (0.6 Nm)	10 AWG (5.5 lbf in)		

Converter Frame size, rated power			Reactor, filter or braking resistor as base components Connection cross-section (tightening torque)	
FSAA	0.55 kW … 1.5 kW		1.0 ... 2.5 mm² (1.1 Nm)	17 ... 14 AWG (10 lbf in)

Procedure



To connect the inverter and its components, proceed as follows:

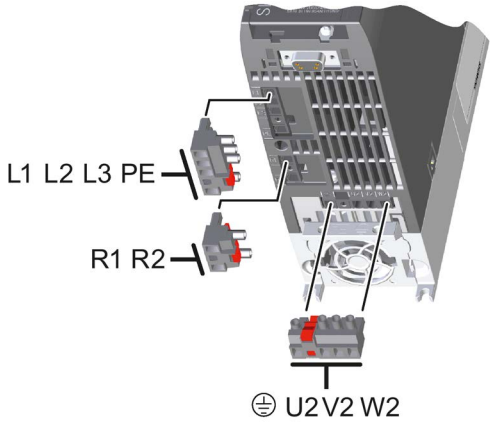
1. Install the appropriate fuses:

Converter		Fuse according to IEC	Fuse according to UL/cUL
FSAA, FSA	0.55 kW … 1.1 kW	3NA3801 (6 A)	10 A, 600 V_{AC}, Class J
	1.5 kW … 2.2 kW	3NA3803 (10 A)	
	3.0 kW … 4.0 kW	3NA3805 (16 A)	15 A, 600 V_{AC}, Class J
FSB	5.5 kW	3NA3807 (20 A)	20 A, 600 V_{AC}, Class J
	7.5 kW	3NA3810 (25 A)	25 A, 600 V_{AC}, Class J
FSC	11 kW	3NA3817 (40 A)	40 A, 600 V_{AC}, Class J
	15 kW	3NA3820 (50 A)	50 A, 600 V_{AC}, Class J
	18.5 kW	3NA3822 (63 A)	60 A, 600 V_{AC}, Class J

2. Connect the inverter and its components.

   The plugs for connecting the line supply, motor, and braking resistor can be found on the lower side of the inverter.

3. If an EMC-compliant installation is required, you must use shielded cables. See also Section: EMC-compliant installation (Page 32).





You have now connected the inverter and its components.

Installation in the United States and Canada (UL or CSA)

To install the inverter in compliance with UL/cUL, perform the following steps:

- Use UL/CSA Class J fuses.
- A multi-motor drive is not permissible, i.e. simultaneously operating several motors connected to one inverter.
- The integrated semiconductor short-circuit protection in the inverter does not provide branch protection. Install branch protection in compliance with the National Electric Code and possibly relevant local regulations.
- The following restrictions apply to the minimum size of the electrical cabinet:
  - Inverters, frame size FSAA: ≥ 30000 cm³ (≥ 1830 in³)
  - Inverters, frame sizes FSA … FSC No restrictions regarding UL regulations
- Install the inverters in line supplies ≤ 40000 A (symmetrical, ≤ 480 V.
- Use copper cables, Class 1, ≥ 60° C for frame size FSAA.
- Use copper cables, Class 1, 75° C for frame sizes FSA … FSC.
- Leave parameter p0610 in its factory setting.

  The factory setting p0610 = 12 means: The inverter responds to motor overtemperature immediately with an alarm and after a certain time with a fault.

Additional requirements for CSA compliance:

- Use a surge protection device with Article No. 5SD7424-1.
- Alternative: Install the inverter with an external surge protection device with the following attributes:
  - Surge protection device with ‘listed’ test symbol: category checking numbers VZCA and VZCA7
  - Rated voltage 3-phase 480/277 V AC, 50/60 Hz
  - Terminal voltage V_{PR} = 2000 V, I_N = 3 kA min, MCOV = 508 VAC, SCCR = 40 kA
  - Suitable for SPD applications, type 1 or type 2
- When commissioning the drive system, set the motor overload protection to 115 %, 230 % or 400 % of the rated motor current using parameter p0640. This means that motor overload protection according to CSA C22.2 No. 274 is complied with.

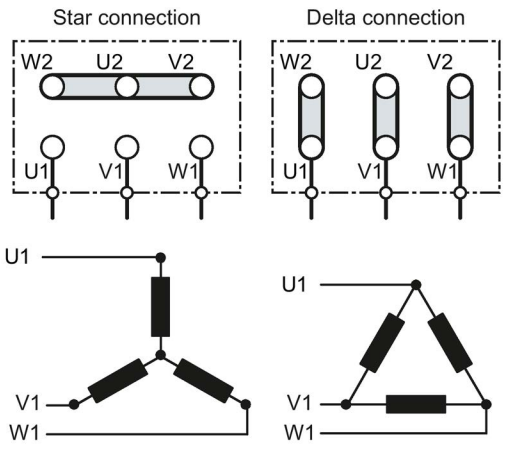
4.8.3 Connecting the motor

Connecting a motor using a star or delta connection

With SIEMENS motors, you will see a diagram of both connection types on the inside of the cover of the terminal box:

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

The motor rating plate provides information about the correct connection data.



Examples for operating the inverter 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.

4.8.4 Operating a converter on the residual current device



⚠WARNING

Live enclosure parts due to unsuitable protection equipment

The frequency inverter can cause a direct current in the protective conductor. If an unsuitable residual current device (RCD) or residual current monitoring equipment (RCM) is used to protect against direct or indirect contact, the direct current in the protective conductor prevents the protective device from being triggered if a fault occurs.

As a result, parts of the inverter without touch protection can carry a dangerous voltage.

- Adhere to the conditions for residual current devices as listed below.

Preconditions for operating the inverter with a residual current device

You can operate the inverter with a residual current device (RCD, ELCB or RCCB) or residual current monitoring equipment (RCM) under the following conditions:

- The inverter is connected to a TN system.
- You are using an inverter, with frame sizes FSAA, FSA or FSB.
- You are using a super-resistant (universal current-sensitive) RCD/RCM, type B, such as a SIQUENCE circuit breaker from Siemens.
  - RCD/RCM tripping current for filtered devices = 300 mA
  - RCD/RCM tripping current for unfiltered devices = 30 mA
- Each inverter is connected via its own RCD/RCM.
- Maximum length of shielded motor cables: 15 m.
- Maximum length of non-shielded motor cables: 30 m.

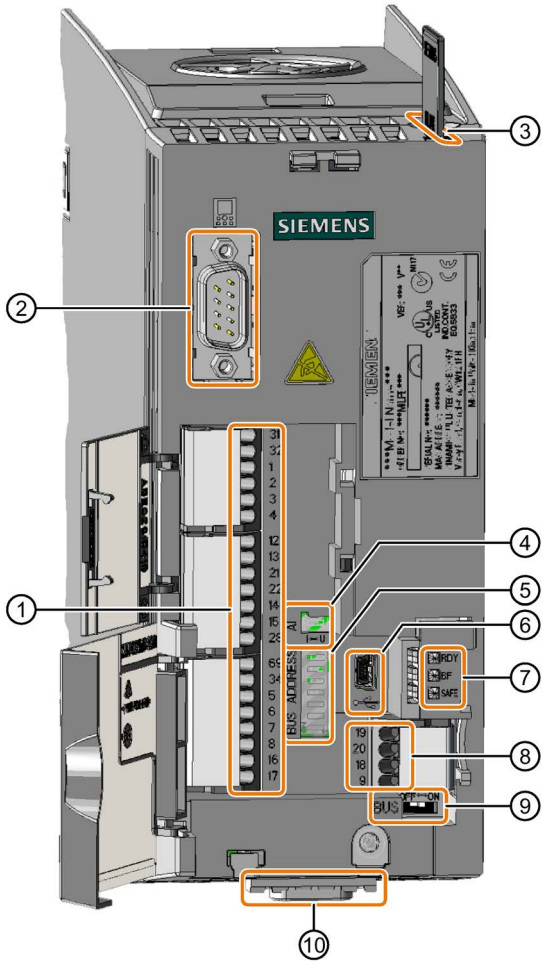
Measures for touch protection without RCD/RCM

Establish touch protection using one of the following measures:

- Double insulation
- Transformer for isolating the inverter from the line supply

4.8.5 Overview of the interfaces

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.



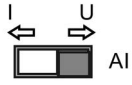
① Terminal strips

② Connection to the operator panel

③ Memory card slot

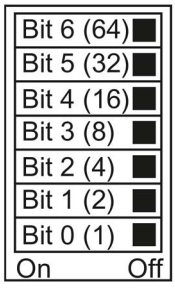
④ Switch for AI 0 (U/I)

- I 0/4 mA … 20 mA
- U -10/0 V … 10 V



⑤ Depending on the fieldbus:

- G120C PN: No function
- G120C DP, G120C USS/MB and G120C CANopen: Switch for the bus address



⑥ USB interface for connection to a PC

⑦ Status LED



LNK1/2 only for G120C PN

⑧ Terminal strip

⑨ Depending on the fieldbus:

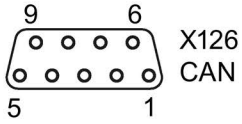


- USS, Modbus: Bus termination
- PROFIBUS, PROFINET, EtherNet/IP: No function

⑩ Fieldbus interface at the bottom

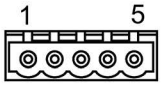
4.8.6 Fieldbus interface assignment

The fieldbus interface is on the underside of the converter.



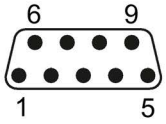
X126
CAN

1 ---
2 CAN_L, CAN signal (dominant low)
3 CAN_GND, ground
4 ---
5 CAN _SHLD, shield
6 GND, optional ground
7 CAN_H, CAN signal (dominant high)
8 ---
9 ---



X128
RS485

1 0 V
2 RS485P, receive and transmit (+)
3 RS485N, receive and transmit (-)
4 Shield
5 ---



X126
PROFIBUS

1 ---
2 ---
3 RxD/TxD-P, receive and transmit (B/B')
4 CNTR-P, control signal
5 GND, reference for data (C/C')
6 + 5 V power supply
7 ---
8 RxD/TxD-N, receive and transmit (A/A')
9 ---

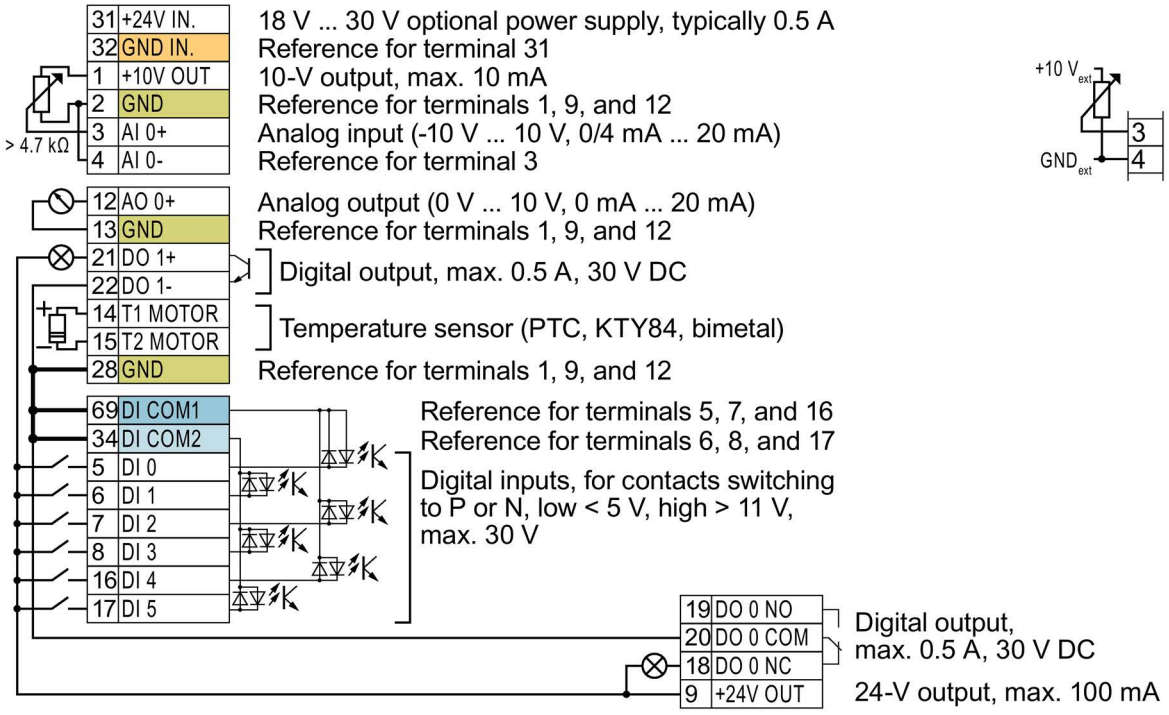


X150 P1
X150 P2
PROFINET

1 RX+ Receive data +
2 RX- Receive data -
3 TX+ Transmit data +
4 ---
5 ---
6 TX- Transmit data -
7 ---
8 ---

4.8.7 Terminal strips

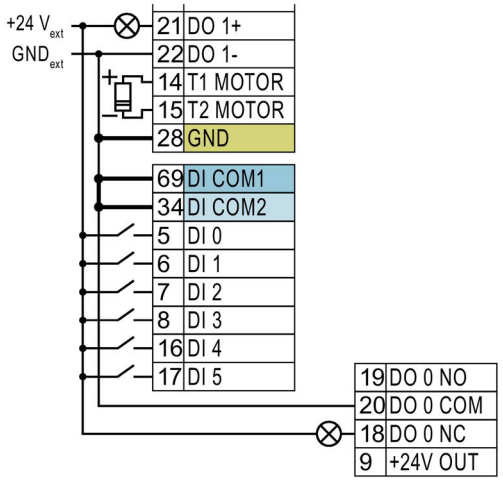
Wiring variations of the terminal strips



GND	All terminals with the reference potential "GND" are connected to each other inside the inverter.
DI COM1 DI COM2	The reference potentials "DI COM1" and "DI COM2" are galvanically isolated from "GND." → If you use the 24-V power supply at terminal 9 to power the digital inputs, you must interconnect "GND," "DI COM1," and "DI COM2."
Terminals 31, 32: GND IN	When an optional 24-V power supply is connected to terminals 31, 32, the Control Unit remains in operation even after the Power Module has been disconnected from the line supply. The Control Unit thus maintains fieldbus communication, for example. → Connect only power supplies that are SELV (Safety Extra Low Voltage) or PELV (Protective Extra Low Voltage) to terminals 31, 32 . → If you also wish to use the power supply at terminals 31, 32 for the digital inputs, then you must connect "DI COM1/2" and "GND IN" with one another.
Terminals 3, 4:	For the analog input, you can use the internal 10-V power supply or an external voltage source. Typical current consumption: 10 mA … 20 mA. → If you use the internal 10-V supply, you must connect AI 0- to GND.

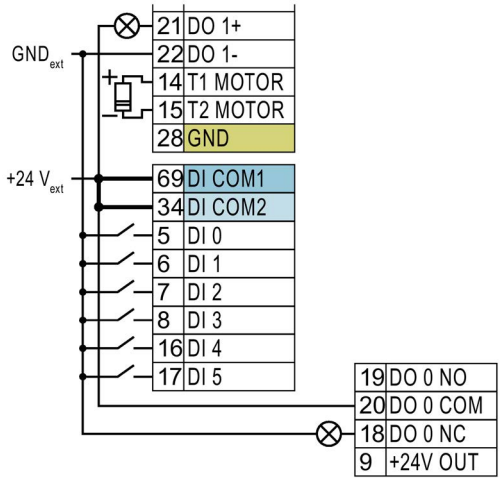
Figure 4-16 Example of wiring digital inputs with the inverter's internal 24-V power supply

Further wiring options for digital inputs



Connection of contacts switching to P potential with an external power source

If you want to connect the potential of the external power source to the potential of the inverter's internal power supply, you must connect "GND" to terminals 34 and 69.



Connection of contacts switching to N potential with an external power source

Connect terminals 69 and 34 to each other.

Factory settings of the terminal strip

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

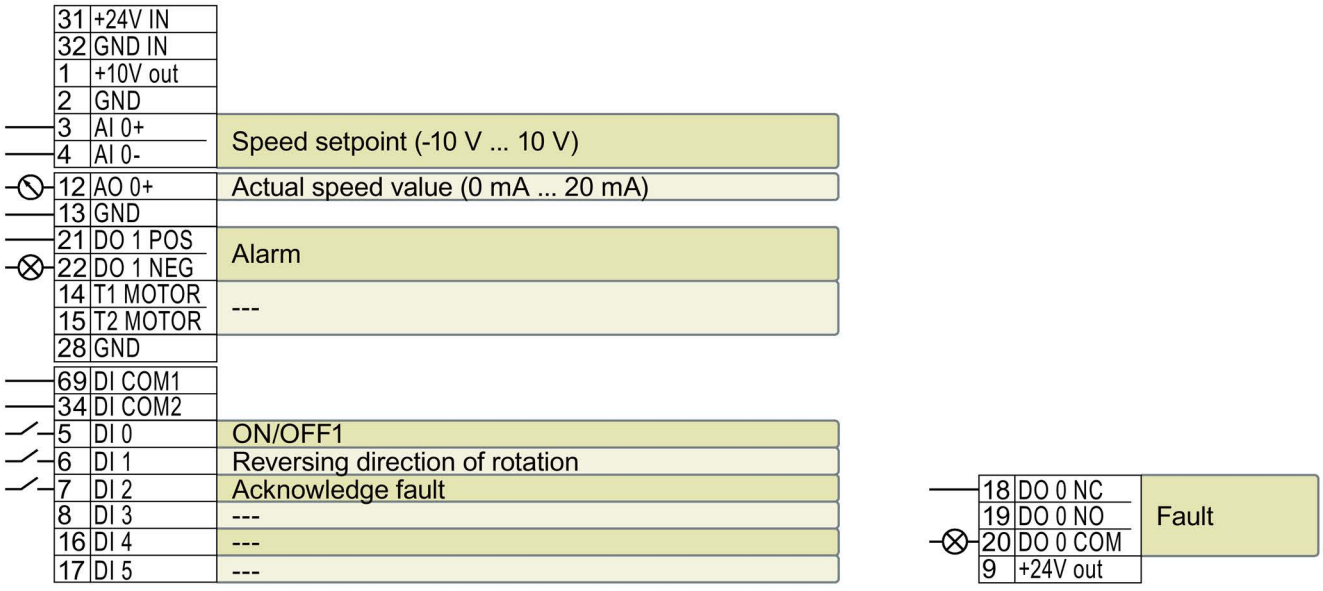


Figure 4-17 Factory setting of the terminals for G120C USS and G120C CAN

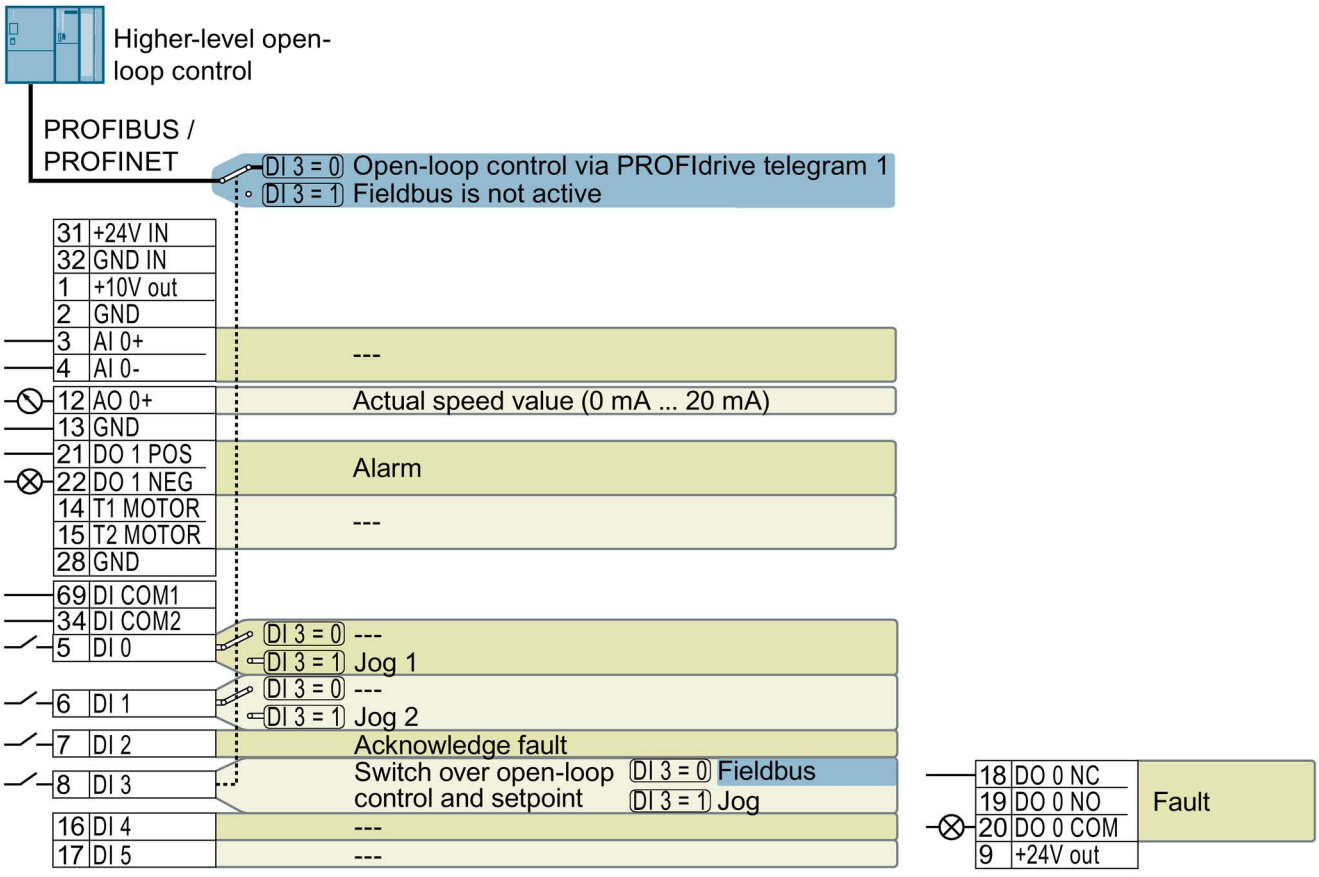


Figure 4-18 Factory setting of the terminals for G120C DP and G120C PN

Changing the function of the terminals

The function of the terminals marked in color in the two diagrams above, can be set.

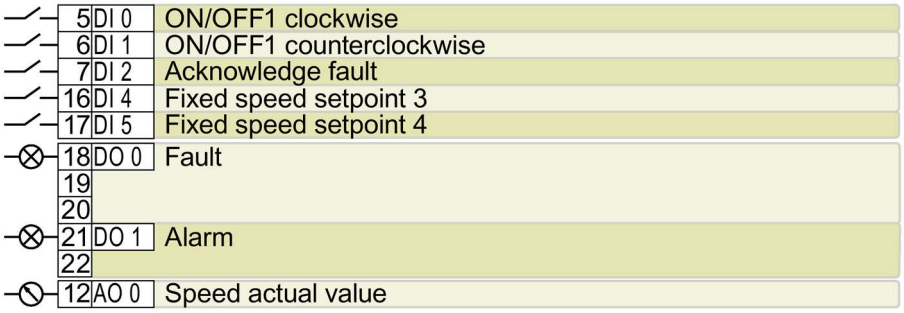
In order not to have to successively change terminal for terminal, several terminals can be jointly set using default settings ("p0015 Macro drive unit").

The terminal settings made in the factory described above correspond to the following default settings:

- Default setting 12 (p0015 = 12): "Standard I/O with analog setpoint"
- Default setting 7 (p0015 = 7): "Fieldbus with data set switchover"

4.8.8 Default setting of the interfaces

Default setting 1: "Conveyor technology with 2 fixed frequencies"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5

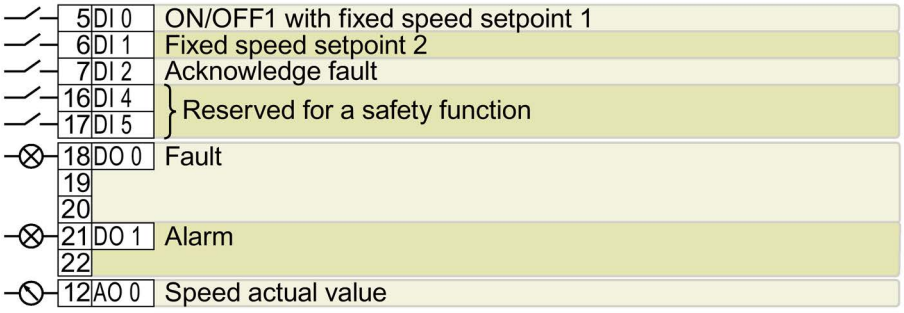
Fixed speed setpoint 3: p1003, fixed speed setpoint 4: p1004, fixed speed setpoint active: r1024

Speed setpoint (main setpoint): p1070[0] = 1024

DI 4 and DI 5 = high: the inverter adds the two fixed speed setpoints

Designation in the BOP-2: coN 2 SP

Default setting 2: "Conveyor system with Basic Safety"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5

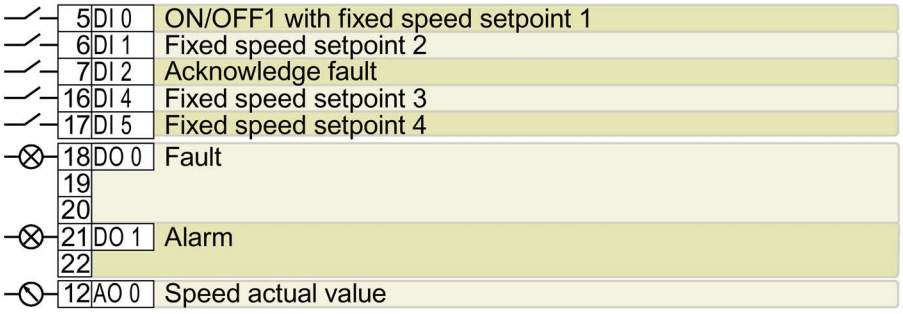
Fixed speed setpoint 1: p1001, fixed speed setpoint 2: p1002, fixed speed setpoint active: r1024

Speed setpoint (main setpoint): p1070[0] = 1024

DI 0 and DI 1 = high: the inverter adds the two fixed speed setpoints.

Designation in the BOP-2: coN SAFE

Default setting 3: "Conveyor system with 4 fixed frequencies"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5

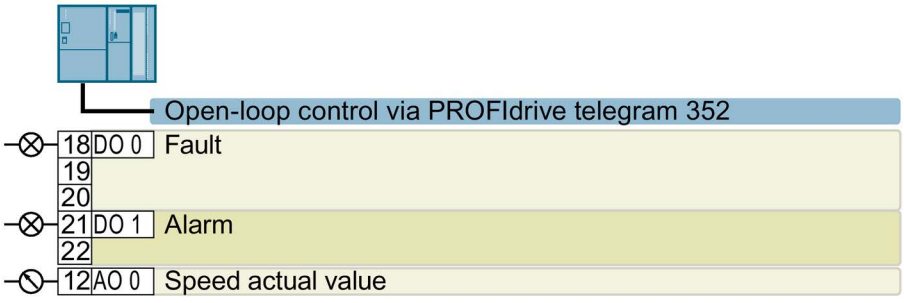
Fixed speed setpoint 1: p1001, … fixed speed setpoint 4: p1004, fixed speed setpoint active: r1024

Speed setpoint (main setpoint): p1070[0] = 1024

Several of the DI 0, DI 1, DI 4, and DI 5 = high: the inverter adds the corresponding fixed speed setpoints.

Designation in the BOP-2: coN 4 SP

Default setting 4: "Conveyor system with fieldbus"

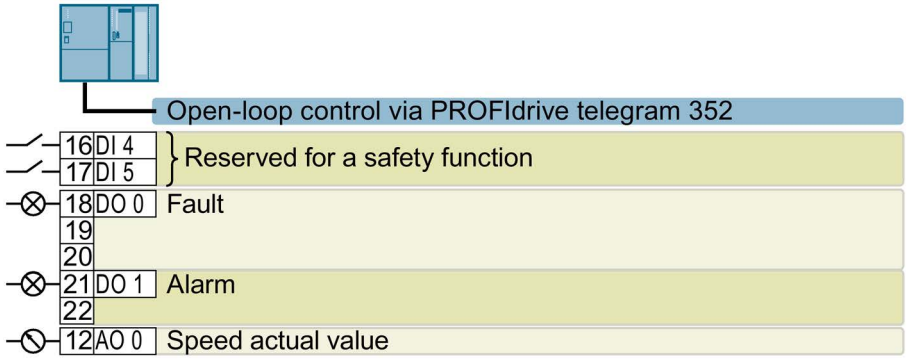


DO 0: p0730, DO 1: p0731 AO 0: p0771[0]

Speed setpoint (main setpoint): p1070[0] = 2050[1]

Designation in the BOP-2: coN Fb

Default setting 5: "Conveyor system with fieldbus and Basic Safety"



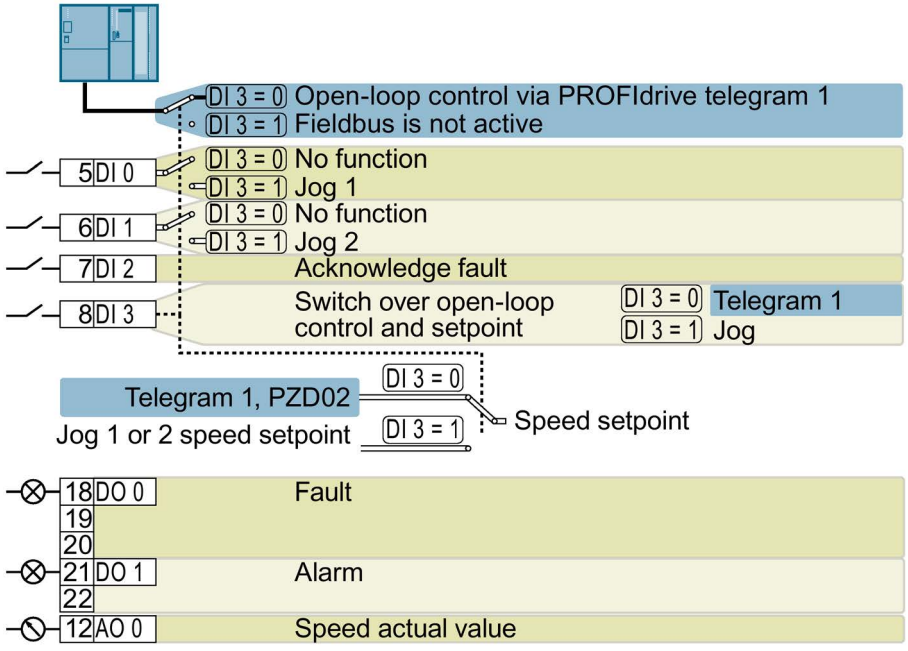
DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 4: r0722.4, DI 5: r0722.5

Speed setpoint (main setpoint): p1070[0] = 2050[1]

Designation in the BOP-2: coN Fb S

Default setting 7: "Fieldbus with data set switchover"

Factory setting for inverters with PROFIBUS or PROFINET interface



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 3: r0722.3

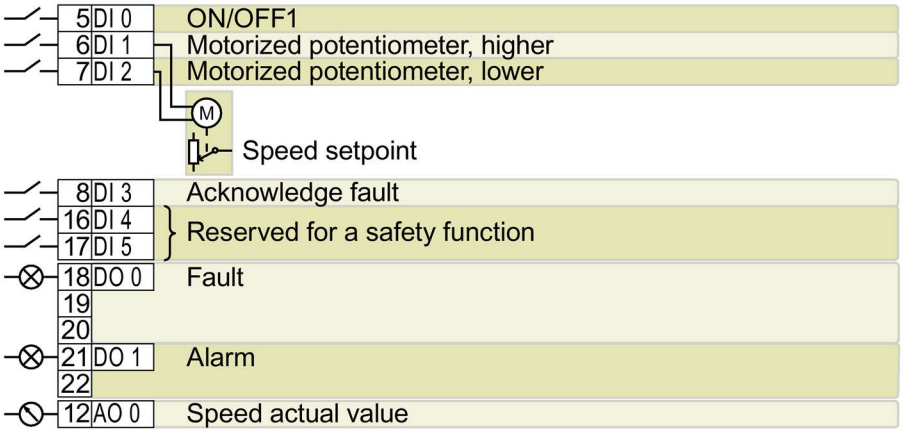
Speed setpoint (main setpoint): p1070[0] = 2050[1]

Jog 1 speed setpoint: p1058, factory setting: 150 rpm

Jog 2 speed setpoint: p1059, factory setting: -150 rpm

Designation in the BOP-2: FB cdS

Default setting 8: "MOP with Basic Safety"



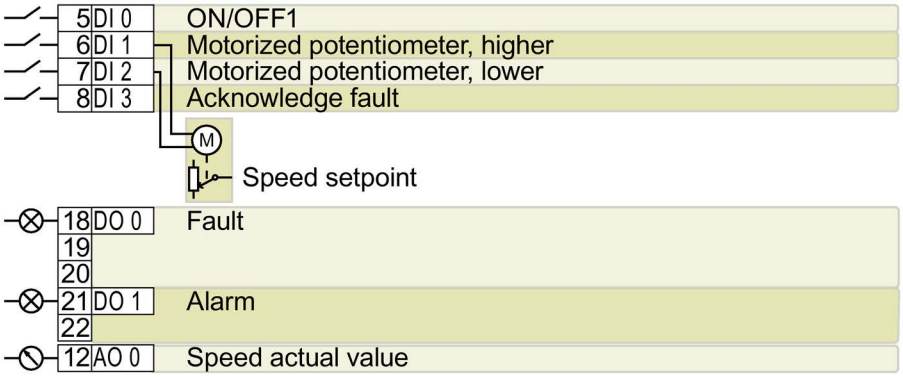
DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5

Motorized potentiometer, setpoint after the ramp-function generator: r1050

Speed setpoint (main setpoint): p1070[0] = 1050

Designation in the BOP-2: MoP SAFE

Default setting 9: "Standard I/O with MOP"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 3: r0722.3

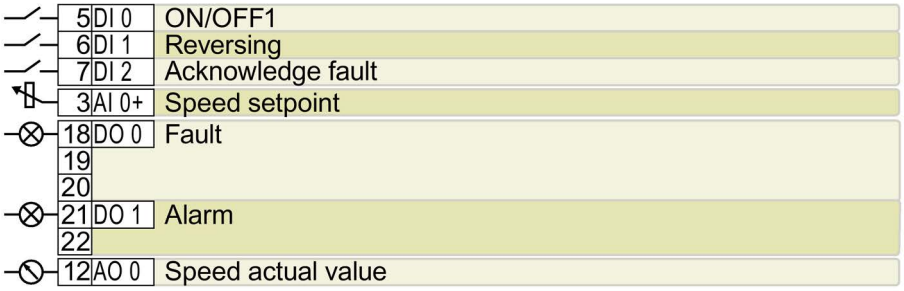
Motorized potentiometer, setpoint after the ramp-function generator: r1050

Speed setpoint (main setpoint): p1070[0] = 1050

Designation in the BOP-2: Std MoP

Default setting 12: "Standard I/O with analog setpoint"

Factory setting for inverters with USS interface

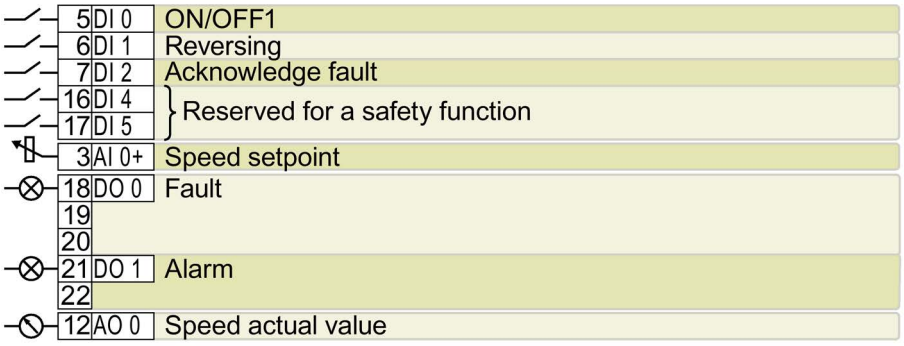


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 2: r0722.2 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: Std ASP

Default setting 13: "Standard I/O with analog setpoint and safety"

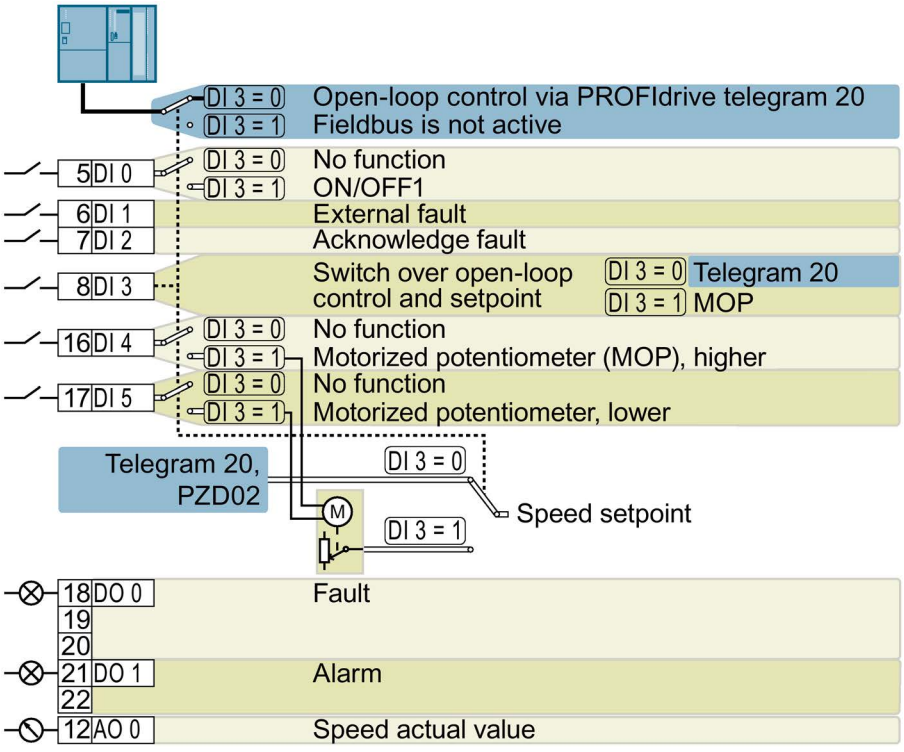


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: ASPS

Default setting 14: "Process industry with fieldbus"



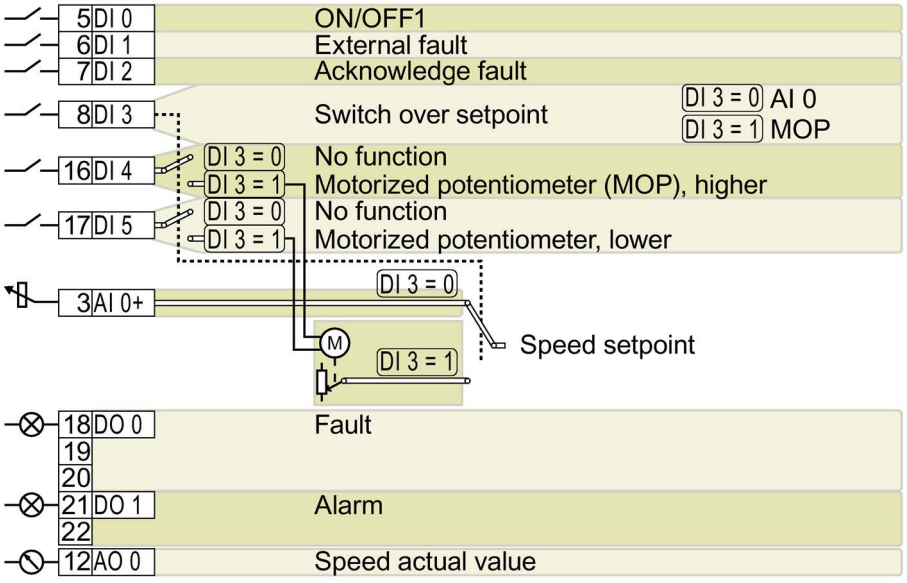
DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5

Motorized potentiometer, setpoint after the ramp-function generator: r1050

Speed setpoint (main setpoint): p1070[0] = 2050[1], p1070[1] = 1050

Designation in the BOP-2: Proc Fb

Default setting 15: "Process industry"



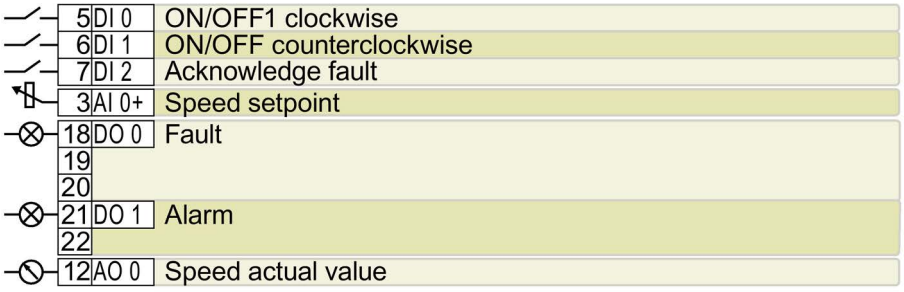
DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 5: r0722.5 AI 0: r0755[0]

Motorized potentiometer, setpoint after the ramp-function generator: r1050

Speed setpoint (main setpoint): p1070[0] = 755[0], p1070[1] = 1050

Designation in the BOP-2: Proc

Default setting 17: "2-wire (forw/backw1)"

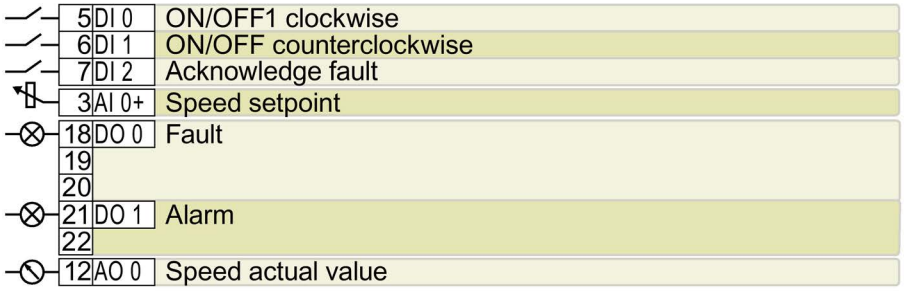


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 2: r0722.2 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: 2-wIrE 1

Default setting 18: "2-wire (forw/backw2)"

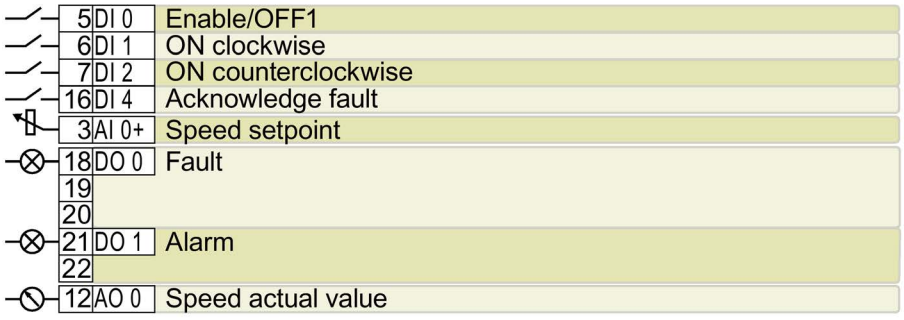


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 2: r0722.2 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: 2-wIrE 2

Default setting 19: "3-wire (enable/forw/backw)"

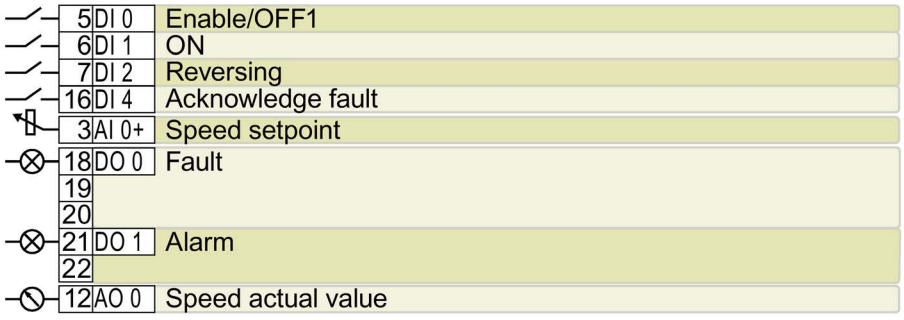


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 4: r0722.4 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: 3-wIrE 1

Default setting 20: "3-wire (enable/on/reverse)"

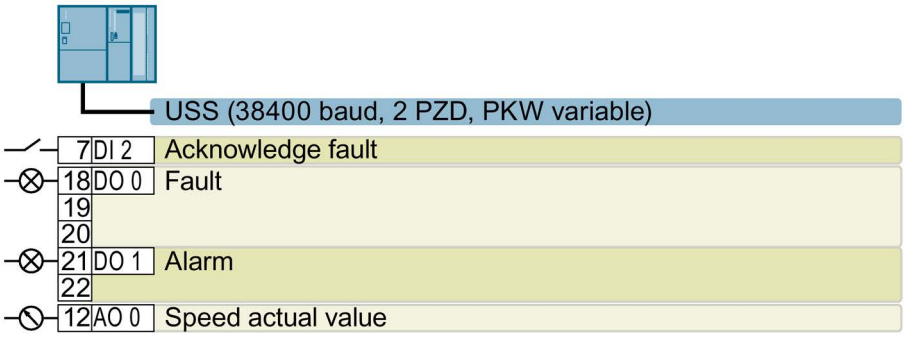


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 0: r0722.0, …, DI 4: r0722.4 AI 0: r0755[0]

Speed setpoint (main setpoint): p1070[0] = 755[0]

Designation in the BOP-2: 3-wIrE 2

Default setting 21: "USS fieldbus"

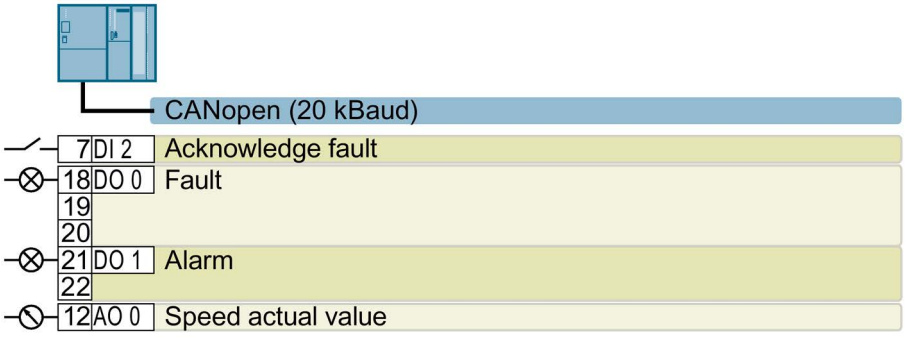


DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 2: r0722.2

Speed setpoint (main setpoint): p1070[0] = 2050[1]

Designation in the BOP-2: FB USS

Default setting 22: "CAN fieldbus"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0] DI 2: r0722.2

Speed setpoint (main setpoint): p1070[0] = 2050[1]

Designation in the BOP-2: FB CAN

4.8.9 Wiring the terminal strip

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.



⚠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.



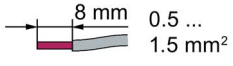
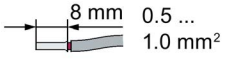
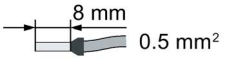
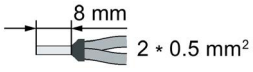
⚠WARNING

Danger to life due to electric shock caused by sparkovers to the motor temperature sensor cable

Voltage flashovers to the electronics of the inverter can occur in motors without safe electrical separation of the temperature sensors when the motor develops a fault.

- Only use motor temperature sensors that fully comply with the specifications of the electrical separation according to IEC 61800-5-1. dragon

Table 4- 3 Permissible cables and wiring options

Solid or finely stranded cable	Flexible conductor with non-insulated end sleeve	Flexible conductor with non-insulated end sleeve	Two finely stranded cables with the same cross-section with partially insulated twin end sleeves
			

Wiring the terminal strip to ensure EMC

- If you use shielded cables, you must connect the shield to the mounting plate of the control cabinet or to the shield contact of the inverter over a large surface area and highly conductively.
  See also:EMC installation guideline
  (http://support.automation.siemens.com/WW/view/en/60612658)
- Use the shield connection plate of the inverter as strain relief.

4.8.10 Monitoring the temperature of the braking resistor



WARNING

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

Using an unsuitable or improperly installed braking resistor can cause fires and smoke to develop. Fire and smoke development can cause severe personal injury or material damage.

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

Procedure

1
2

Proceed as follows to monitor the braking resistor temperature:

1. Connect the temperature monitoring system of the braking resistor (terminals T1 and T2 on the braking resistor) to a free digital input on the inverter.

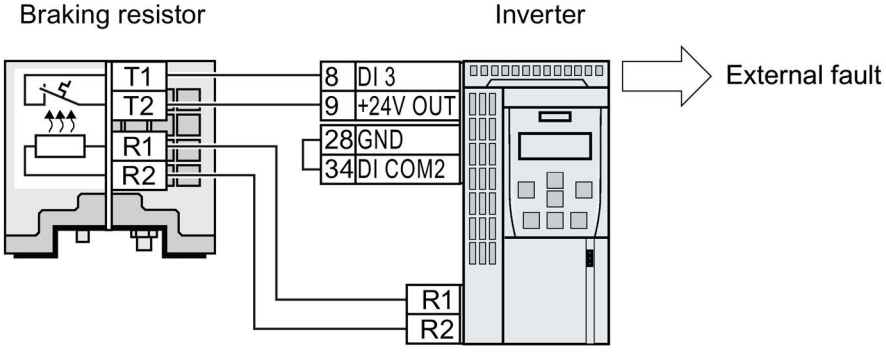


Figure 4-19 Example: Temperature monitoring of the braking resistor via digital input DI 3 on the Control Unit

2. Define the function of the digital input used as an external fault with p2106.

   As an example with temperature monitoring via digital input DI 3: p2106 = 722.3.

You have ensured that the temperature is monitored.

4.8.11 Connecting the inverter to the fieldbus

4.8.11.1 Communication interfaces

Fieldbus interfaces of the converter

The converter is available in different versions for communication with higher-level controls with the subsequently listed fieldbus interfaces:

Fieldbus	Interface	Profile
PROFIBUS DP (Page 86)	SUB D female connector	PROFIdrive and PROFIsafe [1]
PROFINET IO (Page 83)	Two RJ45 connectors	-
EtherNet/IP [2]	Two RJ45 connectors	-
USS [2]	RS485 connector	-
Modbus RTU [2]	RS485 connector	-
CANopen [2]	SUB D male connector	-

[1] You find information on PROFIsafe in the Function Manual Safety Integrated.

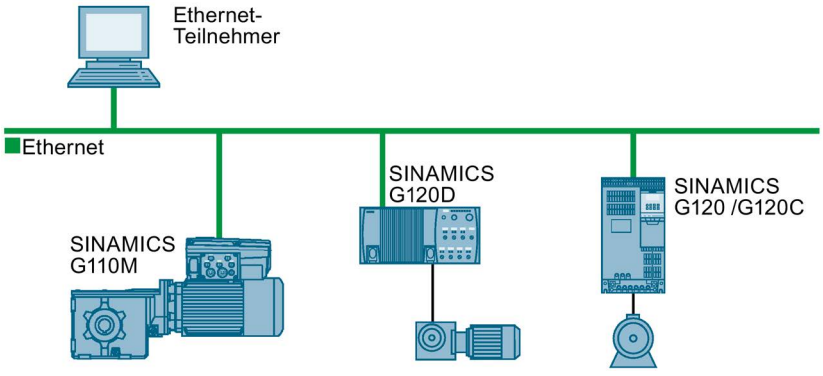
[2] You find information on these field busses in the Function Manual Field Busses.

See also section: Manuals for your inverter (Page 409).

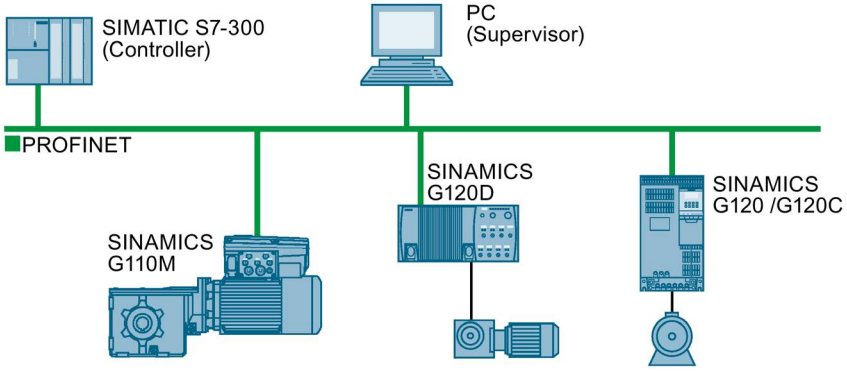
4.8.11.2 PROFINET

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

- The inverter as an Ethernet station (Page 409)



- PROFINET IO operation (Page 84)



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 85).
- 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 409) in the section "The inverter as an Ethernet station".

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 inverter via the fieldbus.

Questions	Answer/description	Example
Is the inverter correctly connected to the bus network?	See: Integrating inverters into PROFINET (Page 84)	
Do the IP address and device name in the inverter and controller match?	See Manuals for your inverter (Page 409)	Refer to manuals for your inverter, fieldbus function manual (Page 409)
Is the same telegram set in the inverter as in the higher-level controller?	Setting the telegram in the control	
Are the signals that the inverter and the controller exchange via PROFINET correctly interconnected?	Interconnection in the inverter in conformance with PROFIdrive, see: Control via PROFIBUS or PROFINET with the PROFIdrive profile (Page 151)	

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 Overview of the interfaces (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.

Configuring communication to the control

Configuring the communication using SIMATIC S7 control

You have the following options, if the inverter is not included in the hardware library:

- Install the most up to date STARTER version
- Install the GSDML of the inverter using “Tools/Install GSDML file" in HW Config.

Additional information on this topic is provided in the "Fieldbuses" Function Manual, also see Manuals for your inverter (Page 409).

Configuring the communication using a non-Siemens control

1. Import the device file (GSDML) of the inverter into the engineering tool for 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. Save the GSDML to your PC .
   - From the Internet: GSDML (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   - From your inverter:

     Insert a memory card into the inverter.

     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.

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 409)) and activate it by booting up.

4.8.11.3 PROFIBUS

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 inverter via the fieldbus.

Questions	Description	Examples
Is the inverter correctly connected to the PROFIBUS?	See Section: Integrating inverters into PROFIBUS (Page 86).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring the communication using SIMATIC S7 control (Page 87)	See Manuals for your inverter (Page 409)
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 87).	
Is the same telegram set in the higher-level controller and in the inverter?	Setting the telegram in the control	
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. The interconnection in the inverter in conformance with PROFIdrive is provided in Section: Control via PROFIBUS or PROFINET with the PROFIdrive profile (Page 151).	

Integrating inverters into PROFIBUS

Procedure

1
2

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 65).

   The maximum permitted cable length to the previous station and the subsequent one is 100 m at a baud rate of 12 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 control, even when the line voltage is switched off

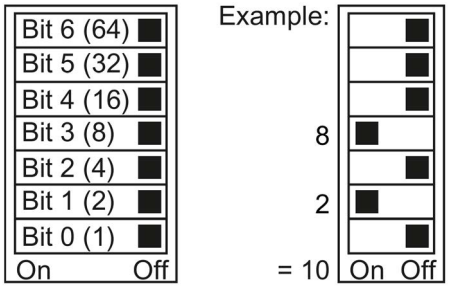
If, in your plant or system, communication with the control system should continue to function even when the line voltage is switched off, then you must externally supply the inverter/Control Unit with 24 V DC. To do this, use terminals 31 and 32 – or connector X01. You can find additional details in the operating instructions for the inverter or the Control Unit.

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.

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 65).

Procedure

1
2

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 off the inverter supply voltage.

3. Wait until all LEDs on the inverter go dark.
4. Switch on the inverter supply voltage again.

   Your settings become active after switching on.

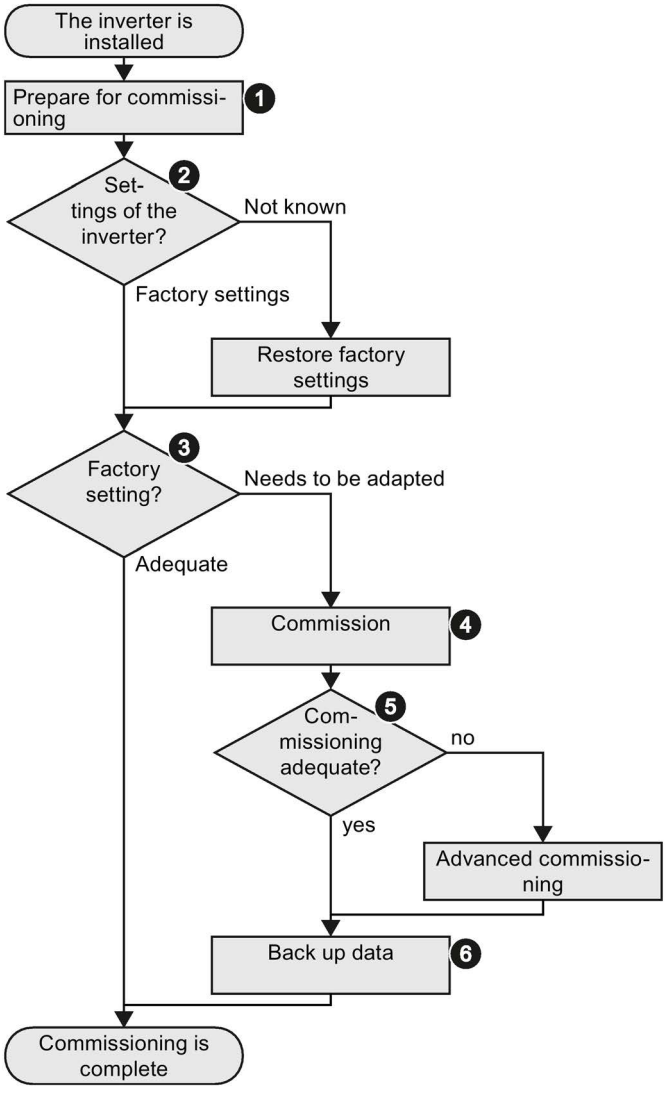
☐ You have now changed the bus address.

Commissioning

5

5.1 Commissioning guidelines

Overview



1. Define the requirements of your application placed on the drive. → (Page 90) .
2. Reset the inverter when required to the factory setting. → (Page 121) .
3. Check whether the factory setting of the inverter is already sufficient for your application.
4. When commissioning the drive, set the following:
   - The closed-loop motor control
   - The inputs and outputs
   - The fieldbus interface
5. When required, adapt the drive → (Page 127).
6. Back up your settings → (Page 283).

5.2 Preparing for commissioning

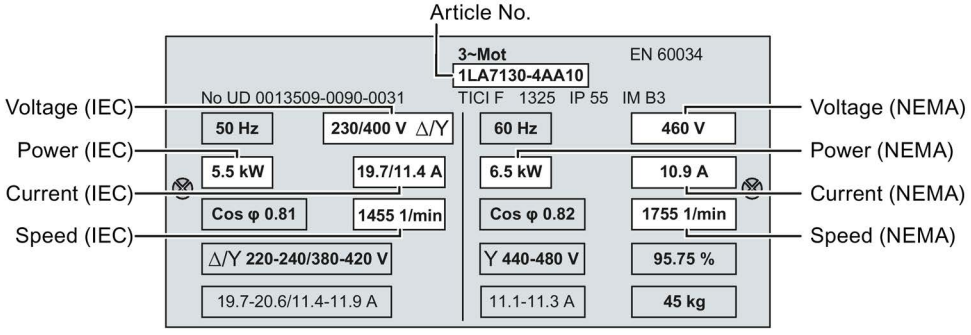
5.2.1 Collecting motor data

Before starting commissioning, you must know the following data:

- **Which motor is connected to the inverter?**

  Note down the Article No. of the motor and the motor's nameplate data.

  If available, note down the motor code on the motor's nameplate.



- **In which region of the world is the motor to 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.

5.2.2 Inverter factory setting

Motor

With its factory settings, the inverter is set up for an induction motor suitable for the power rating of the Power Module.

Inverter control

You will find the factory setting of the inverter control in chapter: Terminal strips (Page 67)

Switching the motor on and off

The inverters are set in the factory in such a way that, after switching on, the motor will accelerate 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.

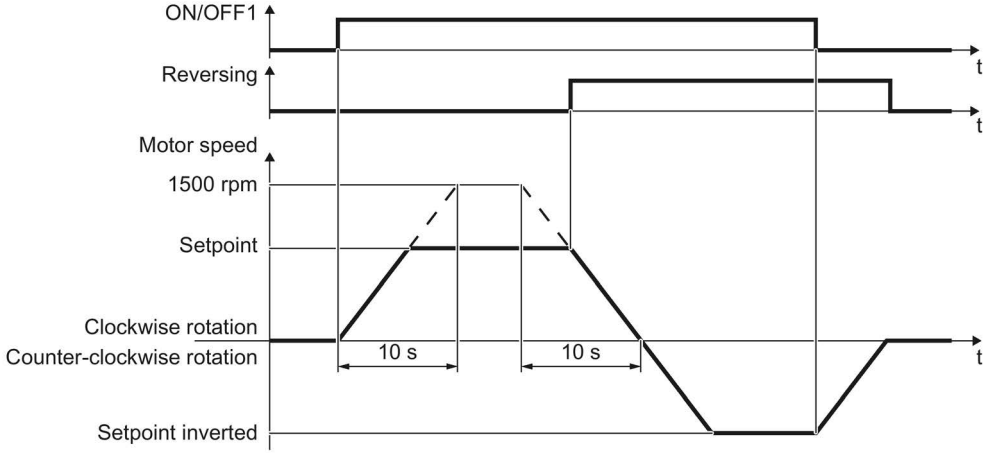


Figure 5-1 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

In the case of inverters with a PROFIBUS or PROFINET interface, operation can be switched via digital input DI 3. The motor is either switched on and off via PROFIBUS – or operated in jog mode via its digital inputs.

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

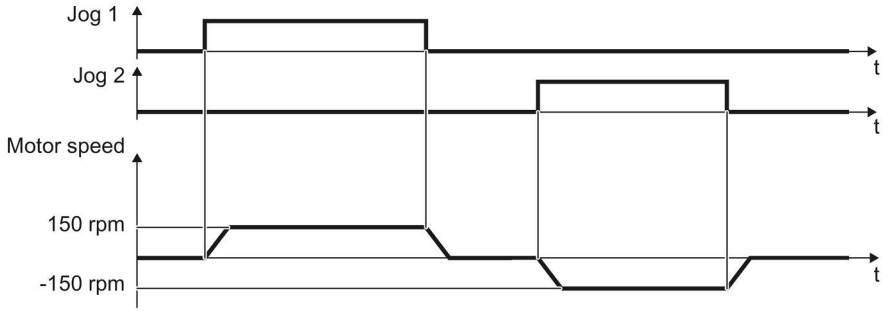


Figure 5-2 Jogging the motor with the factory settings

Operating the motor with the factory settings

In simple applications, you can attempt to operate the drive with a power rating < 18.5 kW without having commissioned it. Check that the control quality of the drive is good enough for the requirements of the application without commissioning.

We recommend configuring the drive with the precise motor data.

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 Commissioning using a BOP-2 operator panel

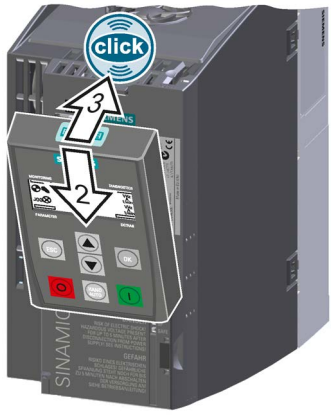
Plug Basic Operator Panel BOP-2 into the inverter

Procedure

1
2

To plug Basic Operator Panel BOP-2 onto the inverter, proceed as follows:

1. Remove the blanking cover of the inverter.
2. Locate the lower edge of the BOP-2 housing in the matching recess of the inverter housing.
3. Press the BOP-2 onto the inverter until you hear the latching mechanism on the inverter housing engage.



You have plugged the BOP-2 onto the inverter

When you power up the inverter, the BOP-2 will be ready for operation.

5.3.1 Starting basic commissioning

Carry out basic commissioning

Preconditions

SP 000.0 1/min
0.0 1/min

- The power supply is switched on.
- The operator panel displays setpoints and actual values.

Procedure

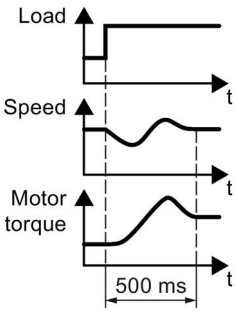
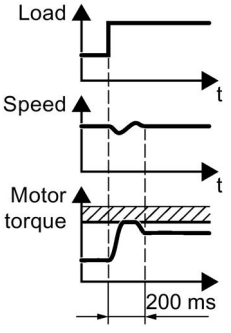
1
2

Proceed as follows to carry out basic commissioning:

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. DRV APPL P96 OK When selecting an application class, the inverter assigns the motor control with the appropriate default settings:
   - STANDARD → Standard Drive Control (Page 95)
   - DYNAMIC → Dynamic Drive Control (Page 97)
   - EXPERT → Basic commissioning for experts (Page 101)

Select the suitable application class

When you select an application class, the inverter assigns suitable settings to the motor control:

Application class	Standard Drive Control	Dynamic Drive Control
Motors that can be operated	Induction motors	Induction and synchronous motors
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
Characteristics	• Typical settling time after a speed change: 100 ms … 200 ms • Typical settling time after after a sudden load change: 500 ms • Standard Drive Control is suitable for the following requirements: – All motor power ratings – Ramp-up time 0 → rated speed (depending on the motor power rating): 1 s (0.1 kW) … 10 s (18.5 kW) – Applications with continuous load torque without sudden load changes • Standard Drive Control is insensitive to inaccurate motor data settings 	• Typical settling time after a speed change: < 100 ms • Typical settling time after after a sudden load change: 200ms • Dynamic Drive Control controls and limits the motor torque • Typically achieves a torque accuracy: ± 5 % for 15 % … 100 % of the rated speed • We recommend Dynamic Drive Control for the following applications: – Motor power ratings > 11 kW – On sudden load changes 10% ... >100% of the motor rated torque • Dynamic Drive Control is necessary for a ramp-up time 0 → rated speed (depending on the motor power rating): < 1 s (0.1 kW) … < 10 s (18.5 kW). 
Max. output frequency	550 Hz	240 Hz
Commissioning	• Unlike "Dynamic Drive Control," no speed controller needs to be set • As compared with "configuration for experts": – Simplified commissioning using predefined motor data – Reduced number of parameters	• Reduced number of parameters as compared with "configuration for experts"

5.3.2 Standard Drive Control

6. 

Motor standard
KW 50HZ IEC
HP 60HZ NEMA
KW 60HZ IEC 60 Hz

7. 

Supply voltage for the inverter

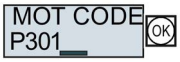
8. Enter the motor data:

8.1. 

Motor type

Depending on the particular inverter, it is possible that the BOP-2 does not list all of the following motor types.

INDUCT	Third-party induction motor
SYNC	Third-party synchronous motor
RELUCT	Third-party reluctance motor
1L… IND	1LE1, 1LG6, 1LA7, 1LA9 induction motors
1LE1 IND 100	1LE1□9 with motor code on the rating plate
1PH8 IND	Induction motor
1FP1	Reluctance motor
1F… SYN	1FG1, 1FK7 synchronous motor, without encoder

8.2. 

If you have selected a motor type > 100, then you must enter the motor code:

With the correct motor code, the inverter assigns the motor data the following values.

If you do not know the motor code, then you must set the motor code = 0, and enter the motor data from p0304 and onwards from the rating plate.

8.3. 

87 Hz motor operation

The BOP-2 only displays this step if you previously selected IEC as the motor standard (EUR/USA, P100 = KW 50HZ).

8.4. 

Rated voltage

8.5. 

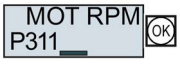
Rated current

8.6. 

Rated power

8.7. 

Rated frequency

8.8. 

Rated speed

8.9. MOT COOL P335_ (OK) Motor cooling

SELF	Natural cooling
FORCED	Forced-air cooling
LIQUID	Liquid cooling
NO FAN	Without fan

9. TEC APPL P501_ (OK) Select the application:

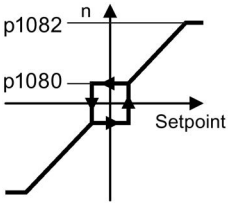
VEC STD Constant load: Typical applications include belt conveyor drives.

PUMP FAN Speed-dependent load: Typical applications include pumps and fans.

10. MAc PAr P15_ (OK) Select the default setting for the interfaces of the inverter that is suitable for your application. You will find the available default settings in Section: Default setting of the interfaces (Page 71)

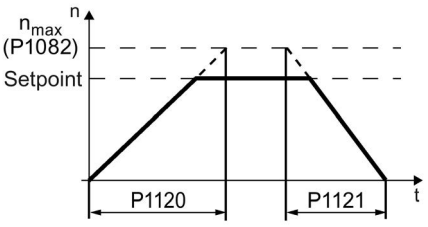
11. MIN RPM P1080_ (OK) Minimum and maximum motor speed

12. MAX RPM P1082_ (OK)



13. RAMP UP P1120_ (OK) Motor ramp-up time

14. RAMP DWN P1121_ (OK) Motor ramp-down time



15. OFF3 RP P1135_ (OK) Ramp-down time for the OFF3 command

16. FINISH _ (OK) Complete the basic commissioning:

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

16.2. Press the OK key.

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

5.3.3 Dynamic Drive Control

6. EUR/USA P100 OK — Motor standard
   - KW 50HZ IEC
   - HP 60HZ NEMA
   - KW 60HZ IEC 60 Hz
7. INV VOLT P210 OK — Supply voltage for the inverter
8. Enter the motor data:
   - 8.1. MOT TYPE P300 OK — Motor type

     Depending on the particular inverter, it is possible that the BOP-2 does not list all of the following motor types.
     - INDUCT Third-party induction motor
     - SYNC Third-party synchronous motor
     - RELUCT Third-party reluctance motor
     - 1L… IND 1LE1, 1LG6, 1LA7, 1LA9 induction motors
     - 1LE1 IND 100 1LE1□9 with motor code on the rating plate
     - 1PH8 IND Induction motor
     - 1FP1 Reluctance motor
     - 1F… SYN 1FG1, 1FK7 synchronous motor, without encoder
   - 8.2. MOT CODE P301 OK — If you have selected a motor type > 100, then you must enter the motor code:

     With the correct motor code, the inverter assigns the motor data the following values.

     If you do not know the motor code, then you must set the motor code = 0, and enter the motor data from p0304 and onwards from the rating plate.
   - 8.3. 87 HZ OK — 87 Hz motor operation

     The BOP-2 only displays this step if you previously selected IEC as the motor standard (EUR/USA, P100 = KW 50HZ).
   - 8.4. MOT VOLT P304 OK — Rated voltage
   - 8.5. MOT CURR P305 OK — Rated current
   - 8.6. MOT POW P307 OK — Rated power
   - 8.7. MOT FREQ P310 OK — Rated frequency
   - 8.8. MOT RPM P311 OK — Rated speed

8.9. MOT COOL P335_ OK — Motor cooling

SELF	Natural cooling
FORCED	Forced-air cooling
LIQUID	Liquid cooling
NO FAN	Without fan

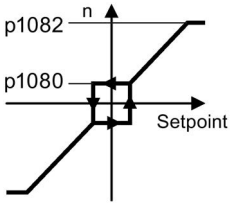
9. TEC APPL P502_ OK — Select the application:

OP LOOP	Recommended setting for standard applications.
CL LOOP	Recommended setting for applications with short ramp-up and ramp-down times. This setting is not suitable for hoisting gear and cranes/lifting gear.
HVY LOAD	Recommended setting for applications with a high break loose torque.

10. MAc PAr P15_ OK — Select the default setting for the interfaces of the inverter that is suitable for your application. You will find the available default settings in Section: Default setting of the interfaces (Page 71)

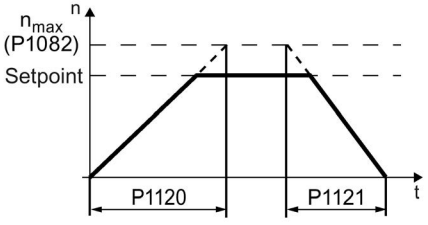
11. MIN RPM P1080_ OK — Minimum and maximum motor speed

12. MAX RPM P1082_ OK



13. RAMP UP P1120_ OK — Motor ramp-up time

14. RAMP DWN P1121_ OK — Motor ramp-down time



15. OFF3 RP P1135_ OK — Ramp-down time for the OFF3 command

16. MOT ID P1900_ OK — Motor data identification

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

OFF	Motor data is not measured.
ST RT OP	Recommended setting: Measure the motor data at standstill and with the motor rotating.
STILL OP	Measure the motor data at standstill. Select this setting if the motor cannot rotate freely – for example, if the traversing range is mechanically limited.

17. FINISH OK — Complete the basic commissioning:

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

17.2. 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

The inverter has several techniques to automatically identify the motor data and optimize the speed control.

To start the motor data identification routine, you must switch-on the motor via the terminal strip, fieldbus or from the operator panel.

⚠ WARNING

Risk of death due to machine motion while motor data identification is active

For the stationary measurement, the motor can make several rotations. The rotating measurement accelerates the motor up to its rated speed. Secure dangerous machine parts before starting motor data identification:

- 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 a motor data identification method, e.g. measuring the motor data at standstill

  After basic commissioning has been completed, the inverter outputs alarm A07991.

	This is symbol in the BOP-2 indicates an active alarm.

- The motor has cooled down to the ambient temperature.

  An excessively high motor temperature falsifies the motor data identification results.

Procedure when using the BOP-2 operator panel

1
2

To start the motor data identification, proceed as follows:

1.  ⇒  Press the HAND/AUTO key. The BOP-2 displays the symbol for manual operation.
2.  Switch on the motor.
3.  The motor data identification takes several seconds.

   Wait until the inverter switches off the motor after motor data identification has been completed.

    If you have also selected a rotating measurement in addition to the motor data identification, then the inverter again issues the alarm A07991.
4.  Switch the motor on again in order to optimize the rotating measurement.
5.  Wait until the inverter switches off the motor after completion of the optimization. The optimization time depends on the rated motor power: 20 s … 2 min.
6.  Switch the inverter control from HAND to AUTO.

You have now completed motor data identification.

5.3.4 Basic commissioning for experts

6. EUR/USA P100 OK — Motor standard

KW / 50HZ	IEC
HP / 60HZ	NEMA
KW / 60HZ	IEC 60 Hz

7. Overload capability and supply voltage of the inverter

7.1. LOAD TYP P205 OK — Overload capability

HIGH OVL	Load cycle with "High Overload"
LOW OVL	Load cycle with "Low Overload"

7.2. INV VOLT P210 OK — Inverter supply voltage

8. Enter the motor data:

8.1. MOT TYPE P300 OK — Motor type

Depending on the particular inverter, it is possible that the BOP-2 does not list all of the following motor types.

INDUCT	Third-party induction motor
SYNC	Third-party synchronous motor
RELUCT	Third-party reluctance motor
1L… IND	1LE1, 1LG6, 1LA7, 1LA9 induction motors
1LE1 IND 100	1LE1□9 with motor code on the rating plate
1PH8 IND	Induction motor
1FP1	Reluctance motor
1F… SYN	1FG1, 1FK7 synchronous motor, without encoder

8.2. MOT CODE P301 OK — If you have selected a motor type > 100, then you must enter the motor code:

With the correct motor code, the inverter assigns the motor data the following values.

If you do not know the motor code, then you must set the motor code = 0, and enter the motor data from p0304 and onwards from the rating plate.

8.3. 87 HZ OK — 87 Hz motor operation

The BOP-2 only displays this step if you previously selected IEC as the motor standard (EUR/USA, P100 = KW 50HZ).

8.4. MOT VOLT P304 OK — Rated voltage

8.5. MOT CURR P305 OK — Rated current

8.6. MOT POW P307 OK — Rated power

8.7. MOT FREQ P310 OK — Rated frequency

8.8. 

Rated speed

8.9. 

Motor cooling

SELF	Natural cooling
FORCED	Forced-air cooling
LIQUID	Liquid cooling
NO FAN	Without fan

9. Application and control mode

9.1. 

Select the application:

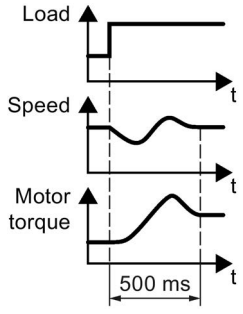
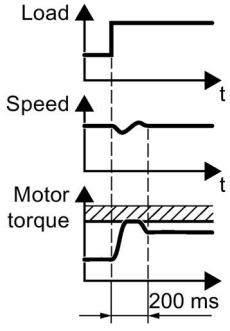
VEC STD	In all applications, which do not fit the other setting options.
PUMP FAN	Applications involving pumps and fans
SLVC 0HZ	Applications with short ramp-up and ramp-down times. However, this setting is not suitable for hoisting gear and cranes/lifting gear.
PUMP 0HZ	Setting only for steady-state operation with slow speed changes. We recommend setting VEC STD if load surges in operation cannot be ruled out.

9.2. 

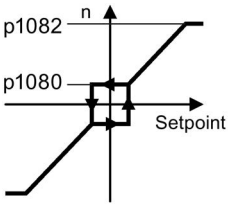
Select the control mode:

VF LIN	U/f control with linear characteristic
VF LIN F	Flux current control (FCC)
VF QUAD	U/f control with square law characteristic
SPD N EN	Vector control without encoder

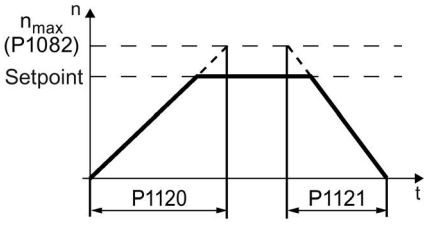
Select a suitable control mode

Control mode	U/f control or flux current control (FCC)	Sensorless vector control
Motors that can be operated	Induction motors	Induction and synchronous motors
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
Properties	• Typical correction time after a speed change: 100 ms … 200 ms • Typical correction time after a load surge: 500 ms • The control mode is suitable to address the following requirements: – All power ratings – Ramp-up time 0 → Rated speed (dependent on the rated motor power): 1 s (0.1 kW) … 10 s (18.5 kW) – Applications with constant load torque without load surges • The control mode is insensitive with respect to imprecise setting of the motor data 	• Typical correction time after a speed change: < 100 ms • Typical correction time after a load surge: 200 ms • The control mode controls and limits the motor torque • Torque accuracy that can be achieved: ± 5 % for 15 % … 100 % of the rated speed  • We recommend the control mode for the following applications: – Motor power ratings > 11 kW – For load surges 10 % … >100 % of the rated motor torque • The control mode is necessary for a ramp-up time 0 → Rated speed (dependent on the rated motor power): < 1 s (0.1 kW) … < 10 s (18.5 kW).
Max. output frequency	550 Hz	240 Hz
Torque control	Without torque control	Speed control with lower-level torque control
Commissioning	• Contrary to vector control without encoder, a speed controller does not have to be set.	

10. MAc PAr P15 OK — Select the default setting for the interfaces of the inverter that is suitable for your application. You will find the available default settings in Section: Default setting of the interfaces (Page 71)
11. MIN RPM P1080 OK — Minimum speed of the motor
12. MAX RPM P1082 OK



13. RAMP UP P1120 OK — Motor ramp-up time.
14. RAMP DWN P1121 OK — Motor ramp-down time



15. OFF3 RP P1135 OK — Ramp-down time for the OFF3 command
16. 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 control mode "SPD N EN", however, the motor cannot freely rotate - for a mechanically limited travel range, for example.
    - You have selected U/f control as control mode, e.g. "VF LIN"or "VF QUAD".

    ROT — Measuring the motor data while it is rotating.
17. FINISH OK — Complete the basic commissioning:
    17.1. Switchover the display using an arrow key: nO → YES
    17.2. 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

The inverter has several techniques to automatically identify the motor data and optimize the speed control.

To start the motor data identification routine, you must switch-on the motor via the terminal strip, fieldbus or from the operator panel.

⚠ WARNING

Risk of death due to machine motion while motor data identification is active

For the stationary measurement, the motor can make several rotations. The rotating measurement accelerates the motor up to its rated speed. Secure dangerous machine parts before starting motor data identification:

- 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 a motor data identification method, e.g. measuring the motor data at standstill

  After basic commissioning has been completed, the inverter outputs alarm A07991.

	This is symbol in the BOP-2 indicates an active alarm.

- The motor has cooled down to the ambient temperature.

  An excessively high motor temperature falsifies the motor data identification results.

Procedure when using the BOP-2 operator panel

1
2

To start the motor data identification, proceed as follows:

1.  ⇒  Press the HAND/AUTO key. The BOP-2 displays the symbol for manual operation.
2.  Switch on the motor.
3.  The motor data identification takes several seconds.

   Wait until the inverter switches off the motor after motor data identification has been completed.

    If you have also selected a rotating measurement in addition to the motor data identification, then the inverter again issues the alarm A07991.
4.  Switch the motor on again in order to optimize the rotating measurement.
5.  Wait until the inverter switches off the motor after completion of the optimization. The optimization time depends on the rated motor power: 20 s … 2 min.
6.  Switch the inverter control from HAND to AUTO.

You have now completed motor data identification.

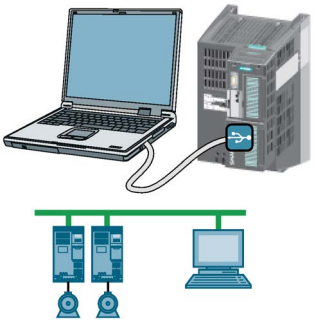
5.4 Commissioning with a PC

PC-based commissioning tools

STARTER and Startdrive are PC tools to commission Siemens inverters. The graphic user interface supports you when commissioning your inverter. Most of the inverter functions are available in screen forms.

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

Preconditions for commissioning



You can access the inverter with STARTER or Startdrive either via a USB connection or via the fieldbus.

System requirements and download:

- STARTER download (http://support.automation.siemens.com/WW/view/en/10804985/133100)
- Startdrive (http://support.automation.siemens.com/WW/view/en/88851265)

Help for operation and for the functions of the commissioning tools:

- STARTER videos (http://www.automation.siemens.com/mcms/mc-drives/en/low-voltage-inverter/sinamics-g120/videos/Pages/videos.aspx)
- Startdrive tutorial (http://support.automation.siemens.com/WW/view/en/73598459)

Overview of basic commissioning

Basic commissioning using a PC essentially consists of the following steps:

1. Creating a 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.

5.4.1 Creating a project

Creating a project

Procedure

1
2

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

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

You have created a new project.

5.4.2 Transfer inverters connected via USB into the project

Transferring inverters connected via USB to the project

Procedure

1
2

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

1. Switch on the inverter supply voltage.
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 commissioning software.
5. Select the "Accessible nodes".

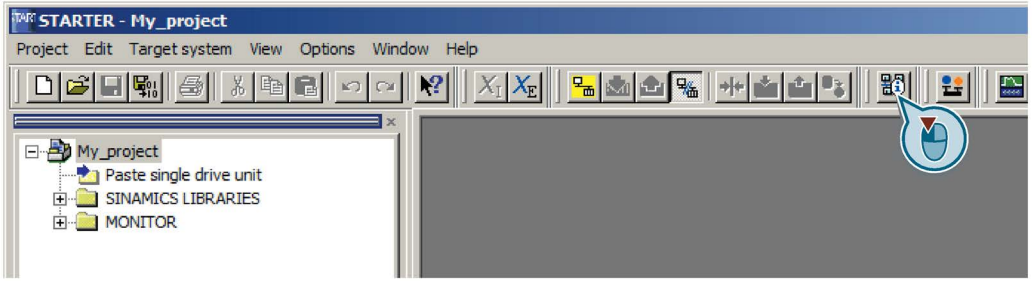


Figure 5-3 "Accessible nodes" in STARTER

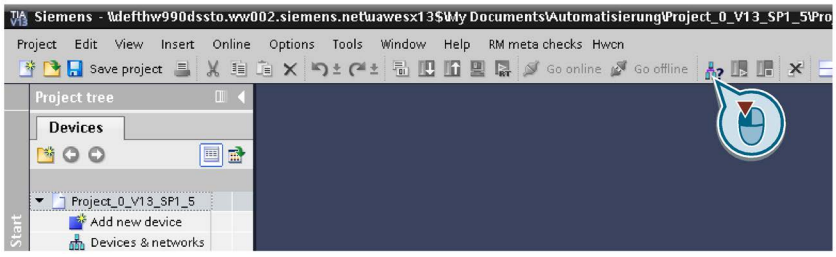


Figure 5-4 "Accessible nodes" in Startdrive

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



Figure 5-5 Inverters found in STARTER

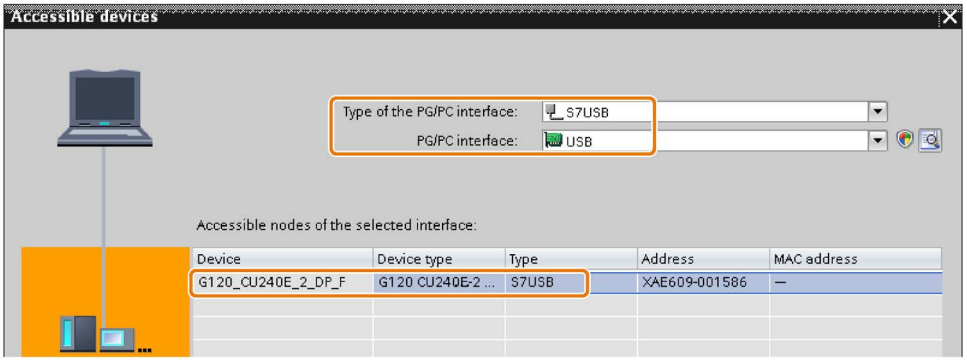


Figure 5-6 Inverters found in Startdrive

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. Proceed as follows:

With STARTER	With Startdrive
• Select the inverter ☑. • Press the "Accept" button.	• Accept the inverter into the project using the menu: • "Online - Upload device as new station (hardware and software)"

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

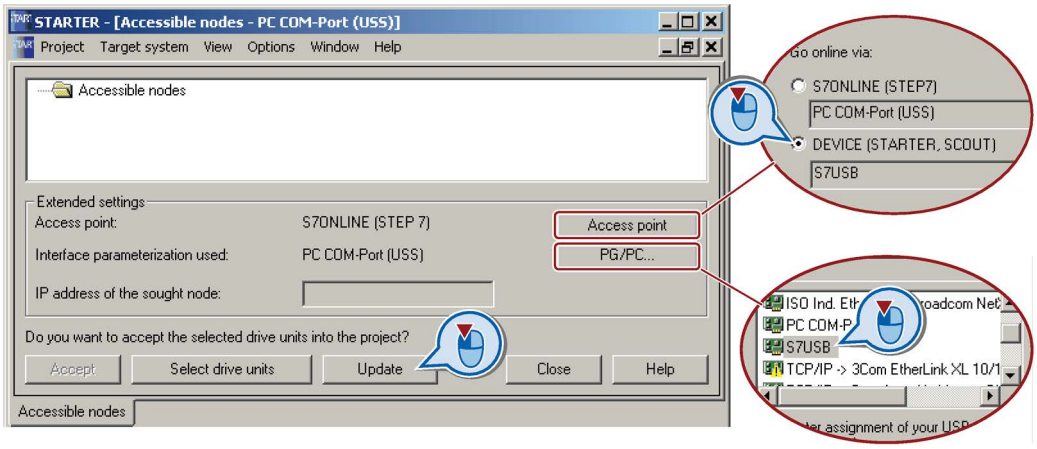
Setting the USB interface in STARTER

Procedure

1
2

Proceed as follows to set the USB interface in STARTER:

1. 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.

5.4.3 Go online and start the configuration wizards

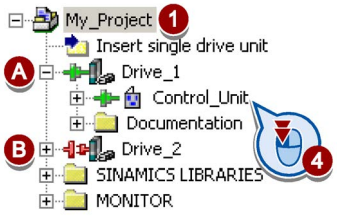
Procedure with STARTER

1
2

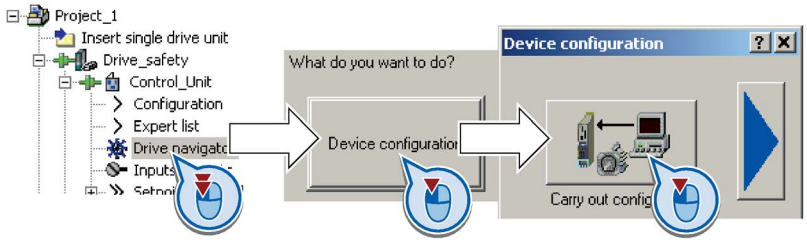
Proceed as follows to start configuration of the inverter:

1. Select your project and go online: .
2. In the following screen form, select the inverter with which you wish to go online.
3. Download the hardware configuration found online in your project (PG or PC).

   Significance of the symbol in front of the inverter:
   (A) The inverter is online.
   (B) The inverter is offline



4. When you are online, double-click on "Control Unit".
5. Start the configuration wizards:



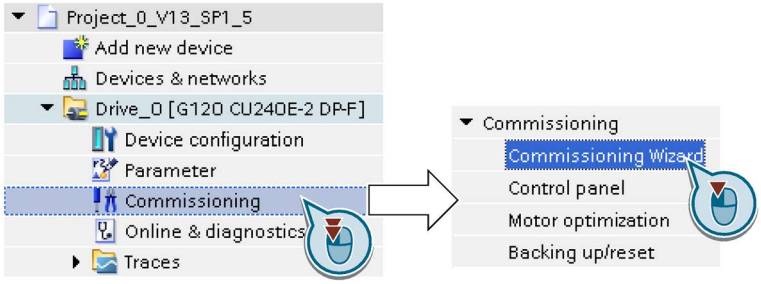
You have started to configure the inverter.

Procedure with Startdrive

1
2

Proceed as follows to start configuration of the inverter:

1. Select your project and go online: Go online
2. In the following screen form, select the inverter with which you wish to go online.
3. Once you are online, select "Commissioning" → "Commissioning Wizard":



You have started to configure the inverter.

Configuring the drive

Procedure



To configure the drive, proceed as follows:

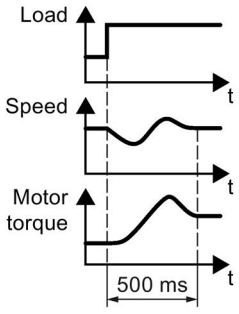
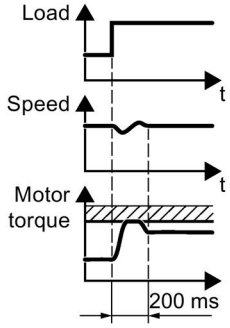
1. ☑ Application class — When selecting an application class, the inverter assigns the motor control with the appropriate default settings:
   - [1] Standard Drive Control (Page 114)
   - [2] Dynamic Drive Control (Page 115)
   - [0] Expert - or if no application class is listed:

     → Configuration for experts (Page 116)

Select the suitable application class

When you select an application class, the inverter assigns suitable settings to the motor control:

Application class	Standard Drive Control	Dynamic Drive Control
Motors that can be operated	Induction motors	Induction and synchronous motors
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

Application class	Standard Drive Control	Dynamic Drive Control
Characteristics	• Typical settling time after a speed change: 100 ms … 200 ms • Typical settling time after after a sudden load change: 500 ms • Standard Drive Control is suitable for the following requirements: – All motor power ratings – Ramp-up time 0 → rated speed (depending on the motor power rating): 1 s (0.1 kW) … 10 s (18.5 kW) – Applications with continuous load torque without sudden load changes • Standard Drive Control is insensitive to inaccurate motor data settings 	• Typical settling time after a speed change: < 100 ms • Typical settling time after after a sudden load change: 200ms • Dynamic Drive Control controls and limits the motor torque • Typically achieves a torque accuracy: ± 5 % for 15 % … 100 % of the rated speed  • We recommend Dynamic Drive Control for the following applications: – Motor power ratings > 11 kW – On sudden load changes 10% ... >100% of the motor rated torque • Dynamic Drive Control is necessary for a ramp-up time 0 → rated speed (depending on the motor power rating): < 1 s (0.1 kW) … < 10 s (18.5 kW).
Max. output frequency	550 Hz	240 Hz
Commissioning	• Unlike "Dynamic Drive Control," no speed controller needs to be set • As compared with "configuration for experts": – Simplified commissioning using predefined motor data – Reduced number of parameters	• Reduced number of parameters as compared with "configuration for experts"

5.4.4 Standard Drive Control

Procedure for application class [1]: Standard Drive Control

2. ☑ Defaults of the setpoin — Select the I/O configuration to preassign the inverter interfaces. The possible configurations are listed in Sections: Terminal strips (Page 67) and Default setting of the interfaces (Page 71).
3. ☑ Drive setting — Set the applicable motor standard and the inverter supply voltage.
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 article number, the data has already been entered.
6. ☑ Important parameters — Set the most important parameters to suit your application.
7. ☑ Drive functions — Select the application:
   - [0] Constant load: Typical applications include conveyor drives
   - [1] Speed-dependent load: Typical applications include pumps and fans

☐ You have now configured the inverter.

5.4.5 Dynamic Drive Control

Procedure for application class [2]: Dynamic Drive Control

2. ☑ Defaults of the setpoin: Select the I/O configuration to preassign the inverter interfaces. The possible configurations are listed in Sections: Terminal strips (Page 67) and Default setting of the interfaces (Page 71).
3. ☑ Drive setting: Set the applicable motor standard and the inverter supply voltage.
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 article number, the data has already been entered.
6. ☑ Important parameters: Set the most important parameters to suit your application.
7. ☑ Drive functions: Application:
   - [0]: Recommended setting for standard applications.
   - [1]: Recommended setting for applications with ramp-up and ramp-down times < 10 s. This setting is not suitable for hoisting gear and cranes.
   - [5] Recommended setting for applications with a high break loose torque.

   Motor identification:
   - [11]: Recommended setting. After an ON command, the inverter identifies the motor data – and with a new ON command, optimizes the speed controller.
   - [12]: After an ON command, the inverter identifies the motor data at standstill. Recommended setting if the motor cannot freely rotate, e.g. for a mechanically limited traversing path.

☐ You have now configured the inverter.

5.4.6 Configuration for experts

Procedure without application class or for the application class [0]: Expert

2. ☑ Control structure — Select the control mode.
3. ☑ Defaults of the setpoin — Select the I/O configuration to preassign the inverter interfaces. The possible configurations are listed in Sections: Terminal strips (Page 67) and Default setting of the interfaces (Page 71).
4. ☑ Drive setting — Set the applicable motor standard and the inverter supply voltage.

   Select the application for the inverter:

   - "[0] Load cycle with high overload for applications requiring a high dynamic performance, e.g. conveyor systems.
   - "[1] Load cycle with low overload ..." for applications that do not require a high dynamic performance, e.g. pumps or fans.
   - [6], [7]: Load cycles for applications with encoderless 1FK7 synchronous motors.
5. ☑ Motor — Select your motor.
6. ☑ Motor data — Enter the motor data according to the rating plate of your motor. If you have selected a motor based on its article number, the data has already been entered.
7. ☑ Important parameters — Set the most important parameters to suit your application.
8. ☑ Drive functions — Application:

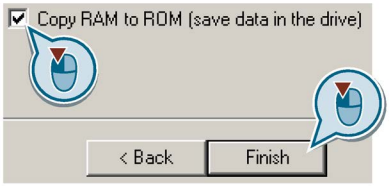
   - [0]: In all applications that do not fall under [1] … [3]
   - [1]: Applications involving pumps and fans
   - [2]: Applications with short ramp-up and ramp-down times. However, this setting is not suitable for hoisting gear and cranes/lifting gear.
   - [3]: Setting only for steady-state operation with slow speed changes. We recommend setting [1] if load surges in operation cannot be ruled out.

   Motor identification:

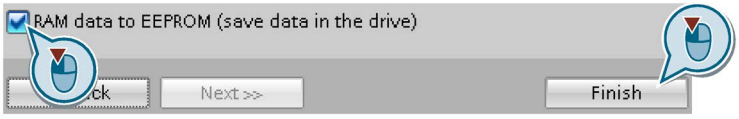
   - [1]: Recommended setting. After an ON command, the inverter identifies the motor data – and with a new ON command, optimizes the speed controller.
   - [2]: After an ON command, the inverter identifies the motor data at standstill. Recommended setting for the following cases:
     - You have selected "Speed 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.
   - [3]: This setting only makes sense after the motor identification [2]. The inverter optimizes the speed controller at the next ON command.

   Calculating the motor parameters: Select "Complete calculation".

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



Complete the configuration in STARTER

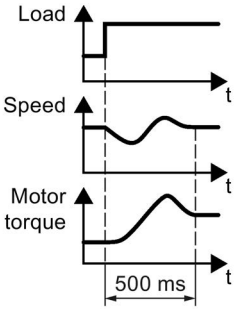
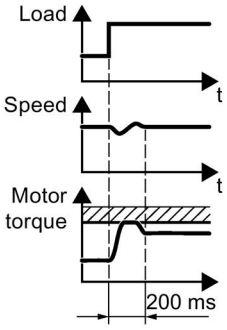


Complete the configuration in Startdrive

You have now configured the inverter.

Select a suitable control mode

Control mode	U/f control or flux current control (FCC)	Sensorless vector control
Motors that can be operated	Induction motors	Induction and synchronous motors
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

Control mode	U/f control or flux current control (FCC)	Sensorless vector control
Properties	• Typical correction time after a speed change: 100 ms … 200 ms • Typical correction time after a load surge: 500 ms • The control mode is suitable to address the following requirements: – All power ratings – Ramp-up time 0 → Rated speed (dependent on the rated motor power): 1 s (0.1 kW) … 10 s (18.5 kW) – Applications with constant load torque without load surges • The control mode is insensitive with respect to imprecise setting of the motor data 	• Typical correction time after a speed change: < 100 ms • Typical correction time after a load surge: 200 ms • The control mode controls and limits the motor torque • Torque accuracy that can be achieved: ± 5 % for 15 % … 100 % of the rated speed  • We recommend the control mode for the following applications: – Motor power ratings > 11 kW – For load surges 10 % … >100 % of the rated motor torque • The control mode is necessary for a ramp-up time 0 → Rated speed (dependent on the rated motor power): < 1 s (0.1 kW) … < 10 s (18.5 kW).
Max. output frequency	550 Hz	240 Hz
Torque control	Without torque control	Speed control with lower-level torque control
Commissioning	• Contrary to vector control without encoder, a speed controller does not have to be set.	

5.4.7 Identify motor data

Identify motor data

WARNING

Danger to life from machine movements while motor data identification is in progress

The stationary measurement can turn the motor a number of revolutions. The rotating measurement accelerates the motor up to the rated speed. Secure dangerous machine parts before starting motor data identification:

- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's working area against unintended access.
- Lower suspended loads to the floor.

Preconditions

- You selected a method of motor data identification during basic commissioning, e.g. measurement of the motor data while the motor is stationary.

  When basic commissioning is complete, the inverter issues alarm A07991.
- The motor has cooled down to the ambient temperature.

  An excessively high motor temperature distorts the results of motor data identification.

Procedure with STARTER

1
2

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

1. Open the control panel.

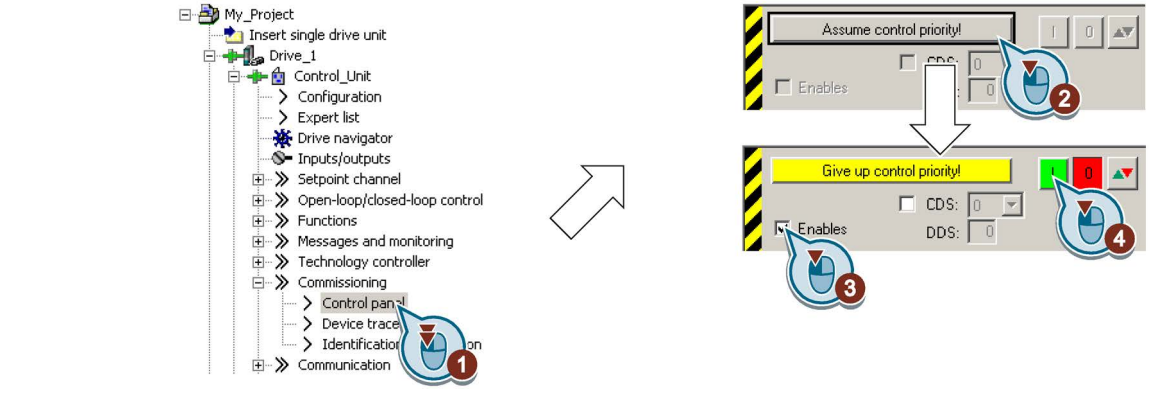


Figure 5-7 Control panel

2. Assume master control for the inverter.
3. Set the "Enable signals"

4. Switch on the motor.

   The inverter starts the motor data identification. This measurement can take several minutes. After the measurement, the inverter switches off the motor.

5. Relinquish the master control after the motor data identification.
6. Press button (RAM to ROM).

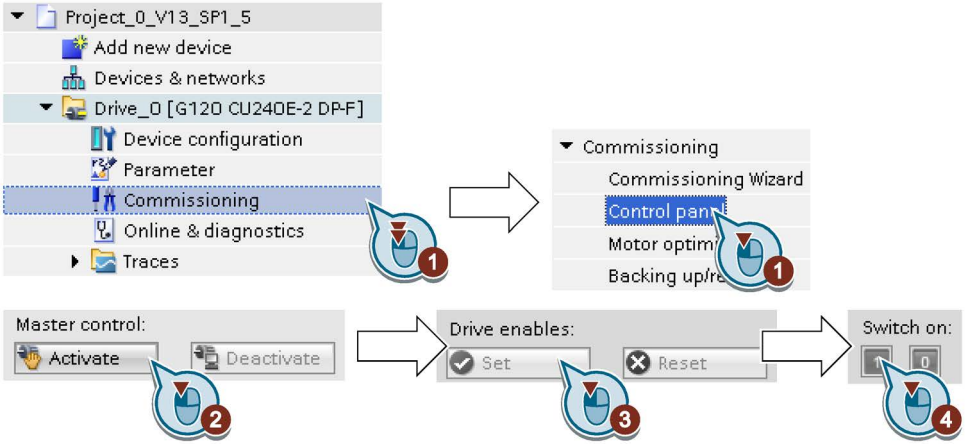
You have completed the motor data identification.

Procedure with Startdrive

1
2

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

1. Open the control panel.



2. Assume master control for the inverter.
3. Set the "Drive enables"
4. Switch on the motor.

   The inverter starts the motor data identification. This measurement can take several minutes. After the measurement, the inverter switches off the motor.

5. Relinquish the master control after the motor data identification.
6. Save the settings in the inverter (RAM → EEPROM):



You have completed the motor data identification.

Self-optimization of the speed control

If you have selected not only motor data identification but also rotating measurement with self-optimization of the speed control, you must switch on the motor again as described above and wait for the optimization run to finish.

5.5 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 setting.

Restoring the factory settings when the safety functions are enabled

If you are using the integrated safety functions of the inverter, e.g. "Safe Torque Off", you must reset the safety functions separately from the remaining inverter settings.

The settings of the safety functions are protected by a password.

Settings that are not changed when restoring the factory setting

The communication settings and the settings of the motor standard (IEC/NEMA) are kept when restoring the factory setting.

5.5.1 Resetting the safety functions to the factory setting

Procedure with STARTER

1
2 To reset the safety function settings to the factory setting without changing the standard settings, proceed as follows:

1. Go online.
2. Open the screen form of the safety functions.
3. Select the button to restore the factory settings.



4. Enter the password,for the safety functions.
5. Confirm that the parameters have been saved (RAM to ROM).
6. Go offline.
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.

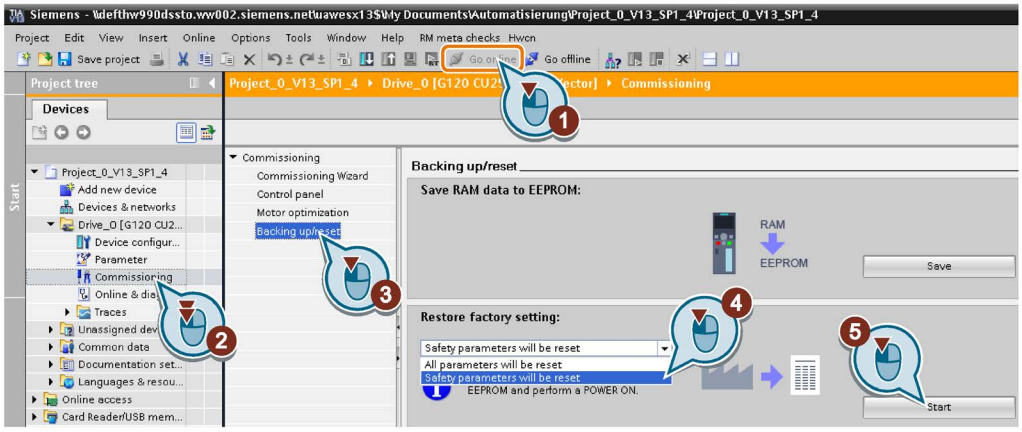
You have restored the safety functions in the inverter to the factory settings.

Procedure with Startdrive

1
2

To reset the safety function settings to the factory setting without changing the standard settings, proceed as follows:

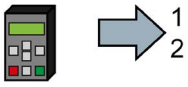
1. Go online.



2. Select "Commissioning".
3. Select "Backing up/reset".
4. Select "Safety parameters are reset".
5. Click the "Start" button.
6. Enter the password,for the safety functions.
7. Confirm that the parameters have been saved (RAM to ROM).
8. Go offline.
9. Switch off the inverter supply voltage.
10. Wait until all LEDs on the inverter go dark.
11. Switch on the inverter supply voltage again.

You have restored the safety functions in the inverter to the factory settings.

Procedure with an operator panel



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

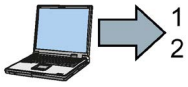
1. p0010 = 30Set
   Activate reset settings.
2. p9761 = …
   Enter the password for the safety functions
3. Start the reset with p0970 = 5.
4. Wait until the inverter sets p0970 = 0.
5. Set p0971 = 1.
6. Wait until the inverter sets p0971 = 0.
7. Switch off the inverter supply voltage.
8. Wait until 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.

5.5.2 Restore the factory settings (without safety functions)

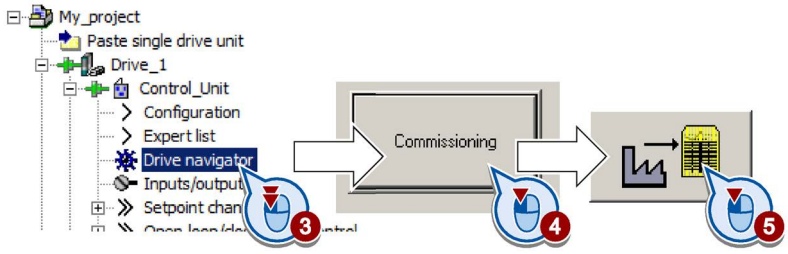
Restore the factory inverter settings

Procedure with STARTER



Proceed as follows to reset the inverter to factory settings:

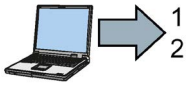
1. Select your drive.
2. Go online.
3. Open "Drive Navigator".



4. Select the "Commissioning" button.
5. Press the "Factory setting" button.
6. ☑ In the screen form, select "After loading copy RAM to ROM".
7. Start the reset.
8. Wait until the inverter has been reset to the factory setting.

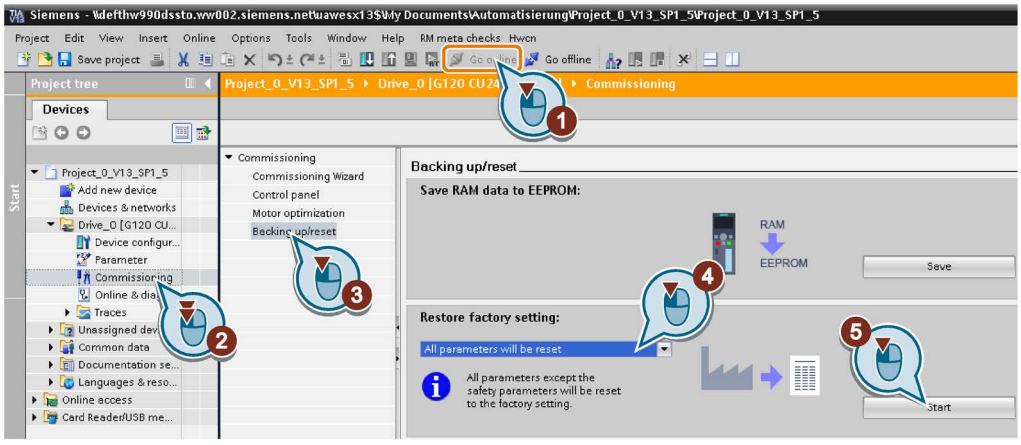
You have reset the inverter to factory settings.

Procedure with Startdrive



Proceed as follows to reset the inverter to factory settings:

1. Go online.
2. Select "Commissioning".
3. Select "Backing up/reset".
4. Select "All parameters are reset".
5. Press the "Start" button.



6. Wait until the inverter has been reset to the factory setting.

You have reset the inverter to factory settings.

Procedure with the BOP-2 operator panel



Proceed as follows to reset the inverter to factory settings:

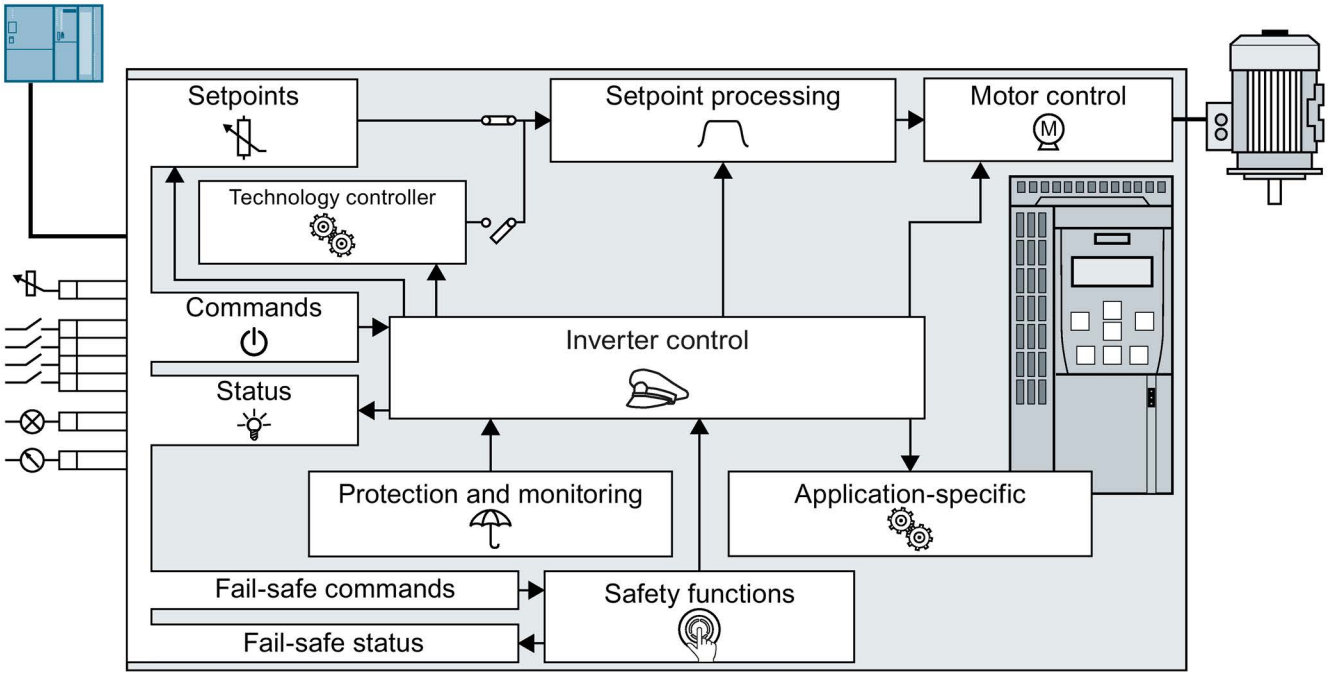
1. In the "Options" menu, select the "DRVRESET" entry
2. Confirm the reset using the OK key.
3. Wait until the inverter has been reset to the factory setting.

You have reset the inverter to factory settings.

Advanced commissioning

6

6.1 Overview of the inverter functions



	The **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 128)		The **motor closed-loop control** ensures that the motor follows the speed setpoint. Motor control (Page 193)
	The **commands** from the higher-level control are sent to the inverter via digital inputs or the fieldbus. The inverter returns its **status messages** to the digital outputs or to the fieldbus. Adapt the default setting of the terminal strip (Page 130) Connecting the inverter to the fieldbus (Page 82)		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 222)
	The **setpoint** defines the motor speed, for example. Setpoints (Page 175)		The **protection and monitoring** functions prevent damage to the motor, inverter and driven load, e.g. by monitoring the temperature or torque. Protection functions (Page 214)
	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 183)		The **safety function** fulfills requirements regarding the functional safety of the drive. Safe Torque Off (STO) safety function (Page 259)

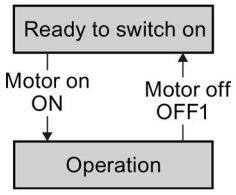
6.2 Inverter control

6.2.1 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

With the exception of ON/OFF1, "Ready to switch on" and "Ready" there are no additional inverter states and commands to switch on and 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.
- Block operation - The inverter switches the motor off.
- Enable operation - The inverter switches the motor on.

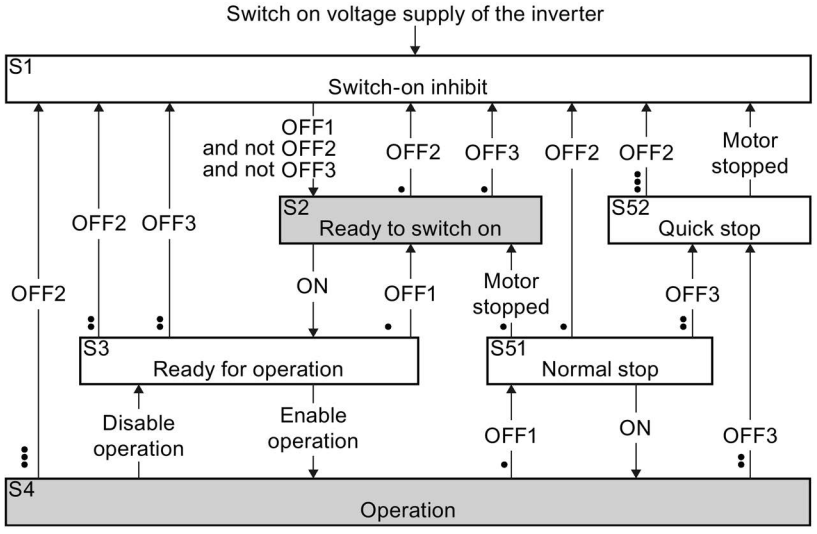


Figure 6-1 Internal sequence control of the converter when the motor is switched on and off

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.
S51	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
S52	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time, or at the current limit.

6.2.2 Adapt the default setting of the terminal strip

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

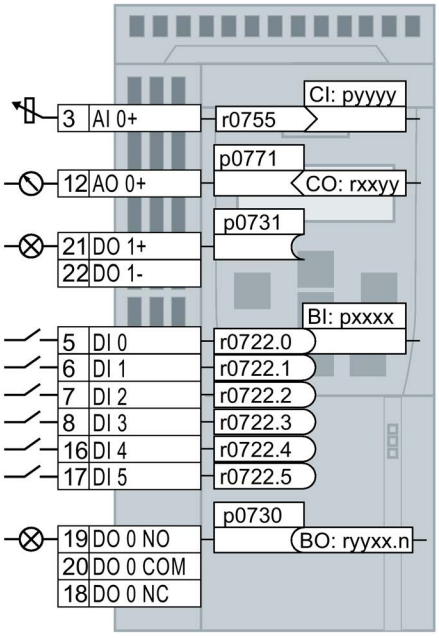
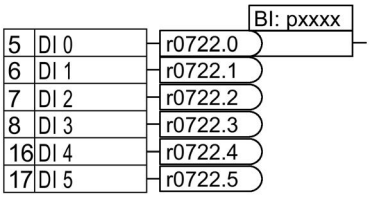


Figure 6-2 Interconnecting the inputs and outputs in the inverter

6.2.2.1 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 converter (Page 399).

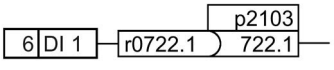
Binector inputs are marked with "BI" in the parameter list of the List Manual.

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



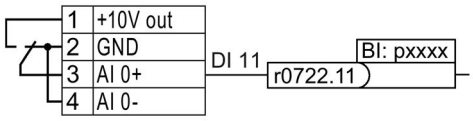
To acknowledge fault messages of the inverter using digital input DI 1, you must interconnect DI1 with the command to acknowledge faults (p2103): Set p2103 = 722.1.

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 input as digital input



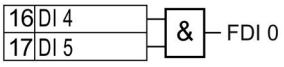
To use the analog input as additional digital input, you must connect the analog input as shown, and interconnect status parameter r0722.11 with a binector input of your choice.

6.2.2.2 Fail-safe 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 (Page 67)).



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 259).

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

Bright and dark test

The inverter filters signal changes using bright and dark tests at its safety-related inputs. The safety-related inputs of the inverter have an adjustable software filter.

Special measures when establishing connections

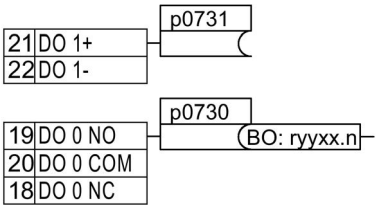
When routing cables over longer distances, e.g. between remote control cabinets, you have the following options to reduce the risk of damaged cables of your plant or machine:

- 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 402).

6.2.2.3 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 converter (Page 399).

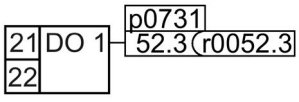
Binector outputs are marked with "BO" in the parameter list of the List Manual.

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.

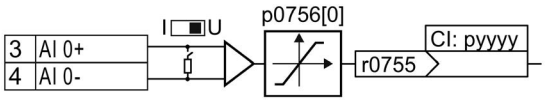
Advanced settings

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.

6.2.2.4 Analog input

Overview



Changing the function of the analog input:

1. Define the analog input type using parameter p0756[0x] and the switch on the inverter.
2. Define the function of the analog input by interconnecting parameter p0755[0] with a connector input CI of your choice.

   See also Section: Interconnecting signals in the converter (Page 399).

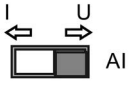
Define the analog input type

The inverter offers a series of default settings, which you can select using parameter p0756[0]:

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

- 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.

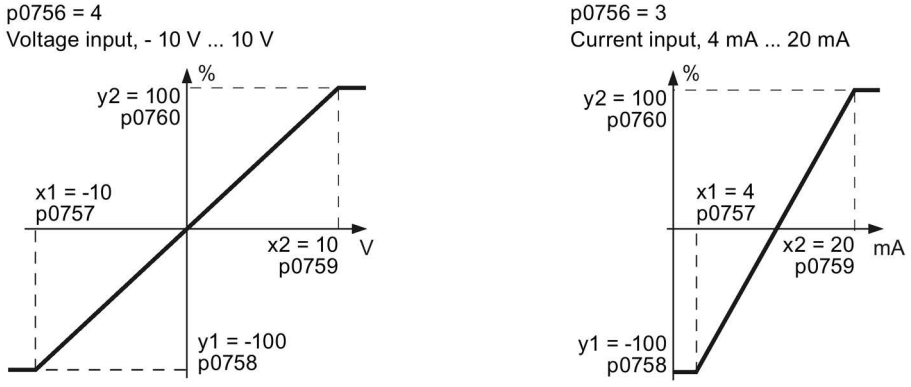


Figure 6-3 Examples for scaling characteristics

Parameter	Description
p0757	**x coordinate of the 1st Characteristic point [V or mA]**
p0758	**y coordinate of the 1st Characteristic point [% of p200x]** p200x are the parameters of reference variables, e.g. p2000 is the reference speed
p0759	**x coordinate of the 2nd Characteristic point [V or mA]**
p0760	**y coordinate of the 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

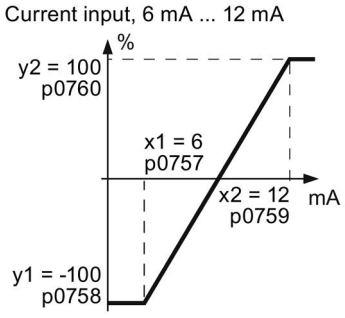
The inverter should convert a 6 mA … 12 mA signal into the value range -100 % … 100 % via analog input 0. The wire break monitoring of the inverter should respond when 6 mA is fallen below.

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 p0756[0] = 3
   This means that you define analog input 0 as current input with wire breakage 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

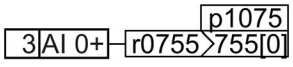
You define the analog input function by interconnecting a connector input of your choice with parameter p0755. Parameter p0755 is assigned to the particular analog input based on its index, e.g. parameter p0755[0] is assigned to analog input 0.

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.

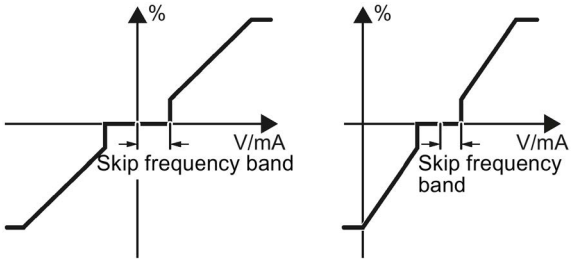
Defining the function of an analog input - example



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].

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

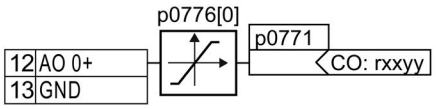
p0764[0]	**Skip frequency band of the analog input AI 0** (factory setting: 0)

Using an analog input as digital input

An analog input can also be used as digital input. See also Section: Digital inputs (Page 131).

6.2.2.5 Analog output

Overview



Changing the function of the analog output:

1. Define the analog output type using parameter p0776[0].
2. Interconnect parameter p0771 with a connector output of your choice.

   See also Section: Interconnecting signals in the converter (Page 399).

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

Define the analog output type

The inverter offers a series of default settings, which you can select using parameter p0776[0]:

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

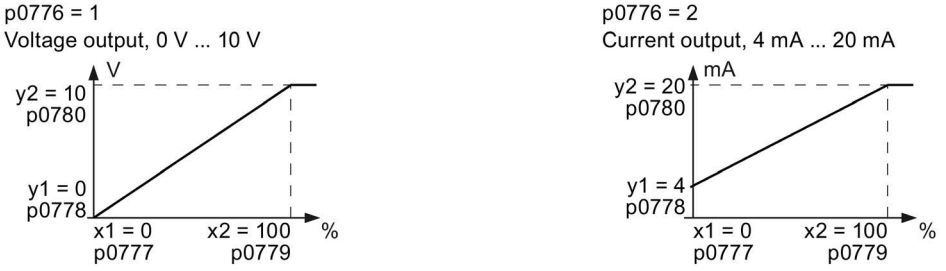


Figure 6-4 Examples for scaling characteristics

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]**

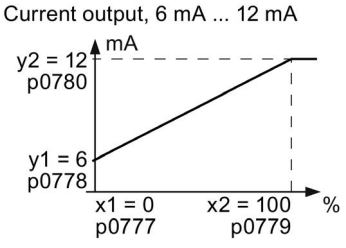
Setting the characteristic

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

Example:

Via analog output 0, the inverter should convert a signal in the value range 0 % … 100 % into an output signal 6 mA … 12 mA.

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 output via its index, e.g. parameter p0771[0] is assigned to analog output 0.

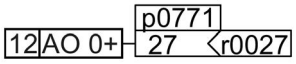
Table 6- 5 Connector outputs (CO) of the inverter (selection)

CO	Meaning	CO	Meaning
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:

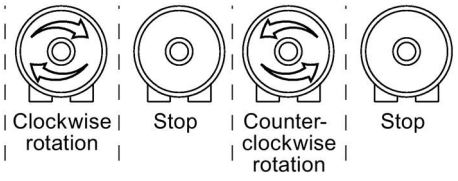
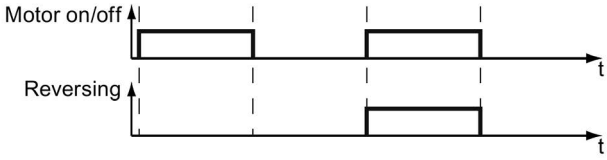
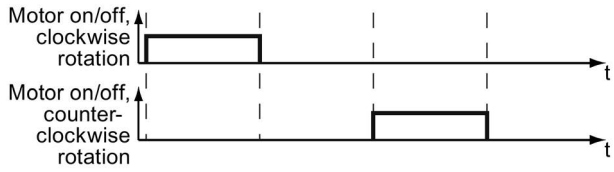
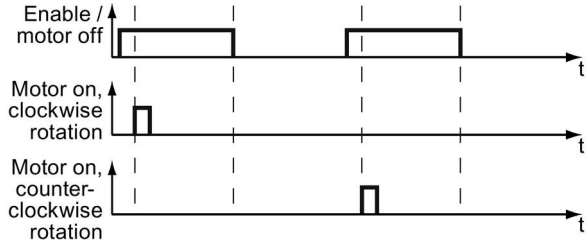
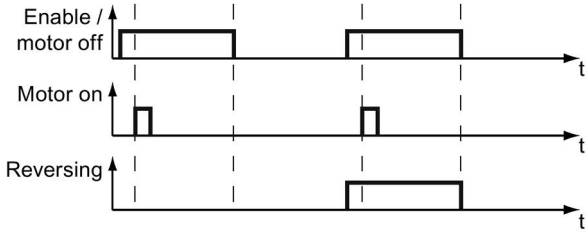
- Absolute-value generation of the signal (p0775)
- Signal inversion (p0782)

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

6.2.3 Inverter control using digital inputs

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

Table 6- 6 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.	-

6.2.4 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.

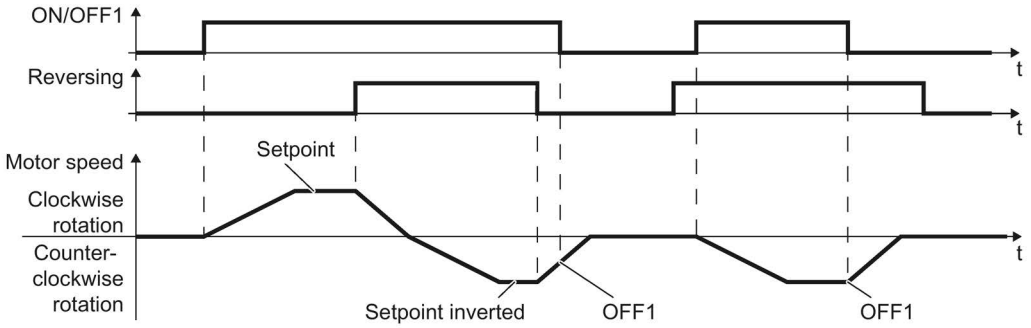


Figure 6-5 Two-wire control, method 1

Table 6- 7 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)		

6.2.5 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.

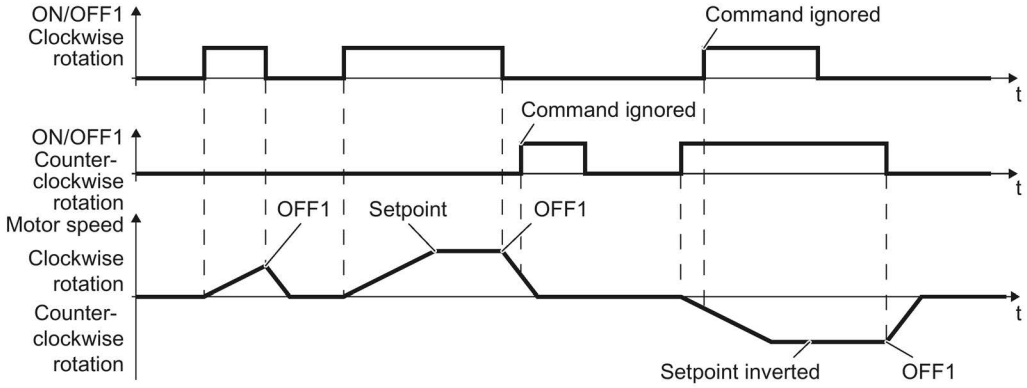


Figure 6-6 Two-wire control, method 2

Table 6- 8 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.

Parameter	Description		
p0015 = 17	**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.		

6.2.6 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.

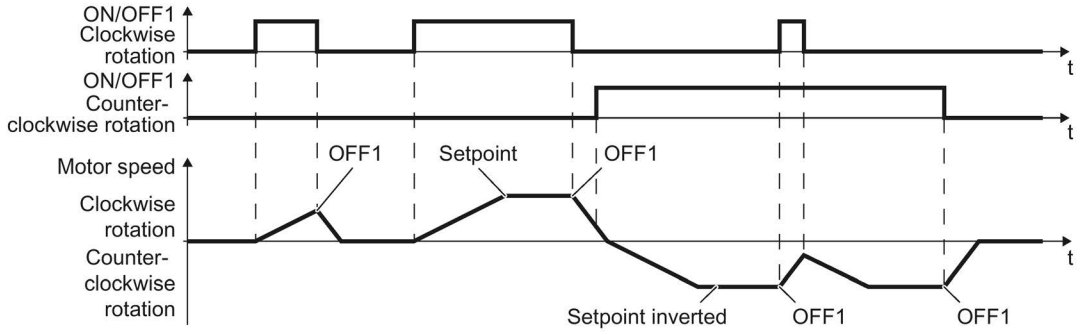


Figure 6-7 Two-wire control, method 3

Table 6- 9 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 clock-wise 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.		

6.2.7 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).

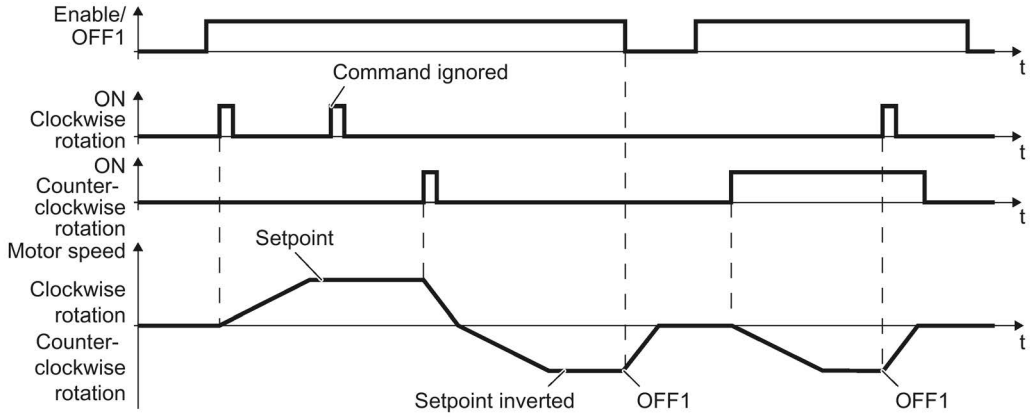


Figure 6-8 Three-wire control, method 1

Table 6- 10 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.

Parameter	Description			
p0015 = 19	**Macro drive unit**			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable / OFF1	ON clockwise rotation	ON counter-clockwise rotation
Advanced setting Interconnecting control commands with digital inputs of your choice (DI x).				
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (enable/OFF1)			
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON clockwise rotation)			
p3332[0 … n] = 722.x	**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.			

6.2.8 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).

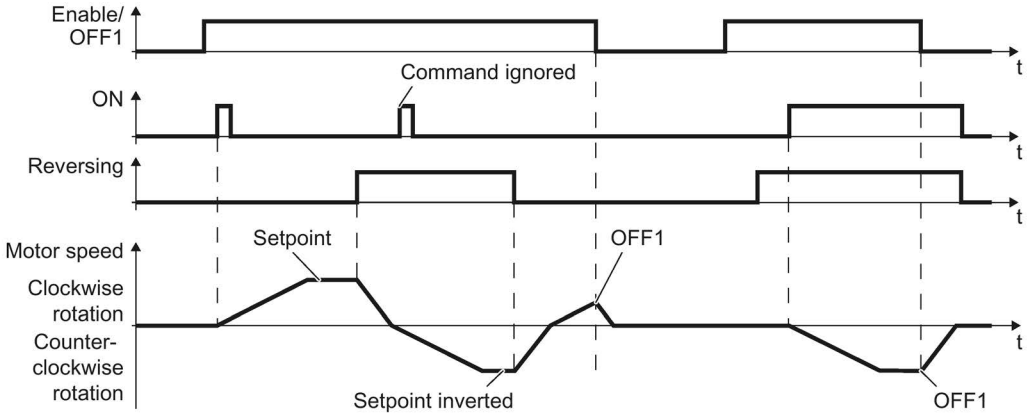


Figure 6-9 Three-wire control, method 2

Table 6- 11 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.

Parameter	Description			
p0015 = 20	**Macro drive unit**			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable / OFF1	ON	Reversing
Advanced setting Interconnecting control commands with digital inputs of your choice (DI x).				
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (enable/OFF1)			
p3331[0 … n] = 722.x	**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.			
p3332[0 … n] = 722.x	**BI: 2/3 wire control command 3** (reversing)			

6.2.9 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.

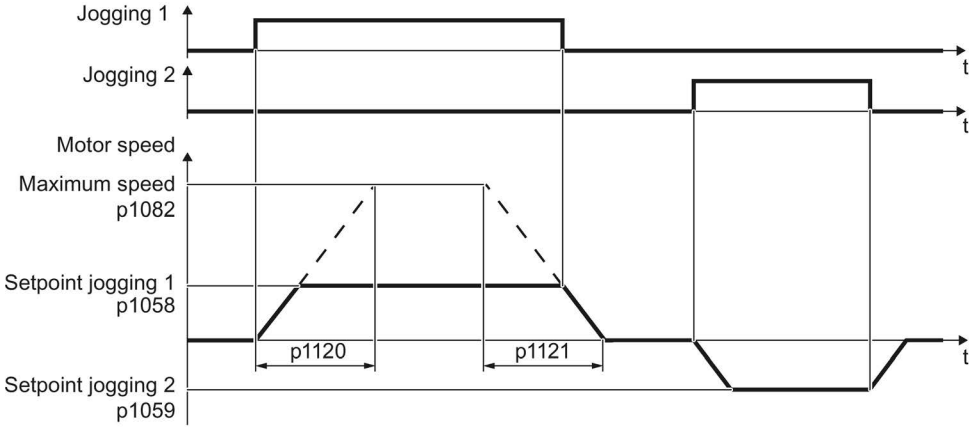
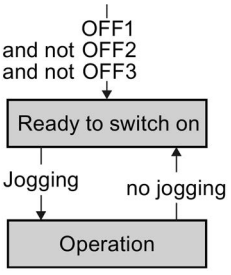


Figure 6-10 Behavior of the motor when "jogging"

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	

6.2.10 Control via PROFIBUS or PROFINET with the PROFIdrive profile

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

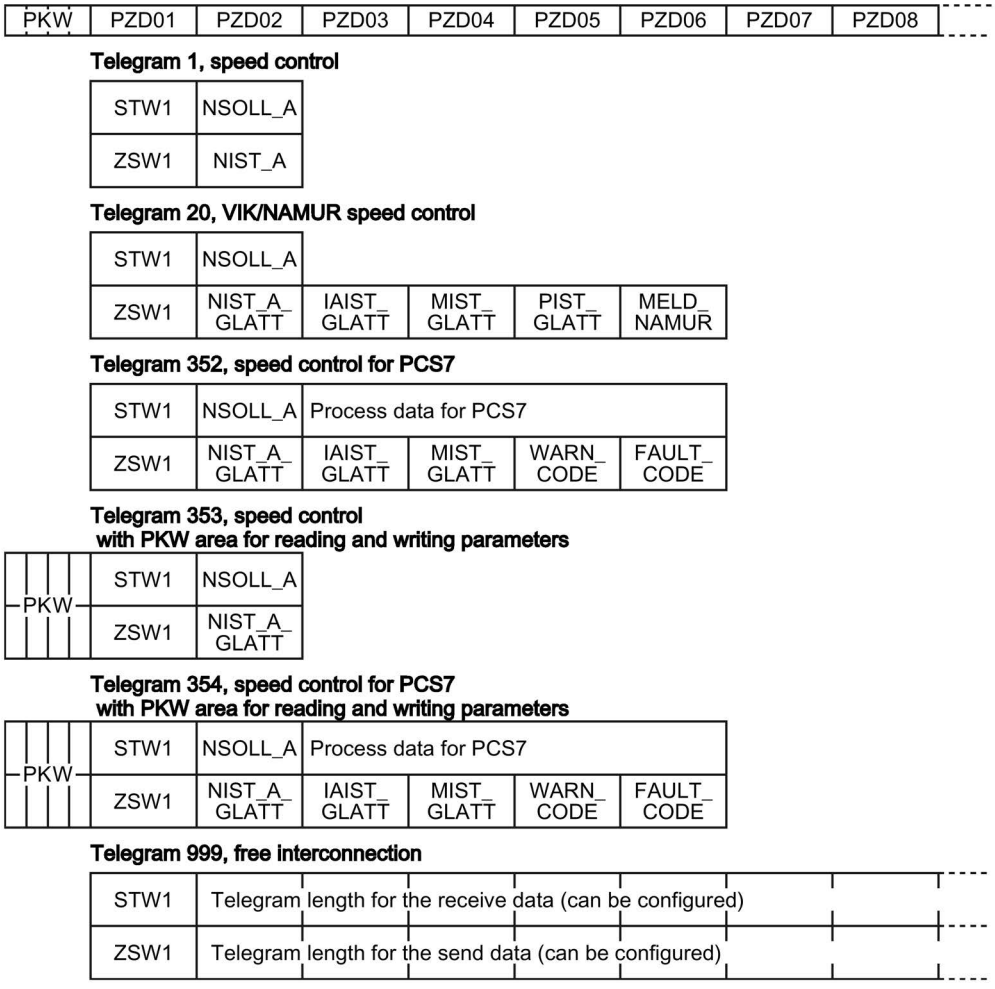


Figure 6-11 Telegrams for cyclic communication

Table 6- 12 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

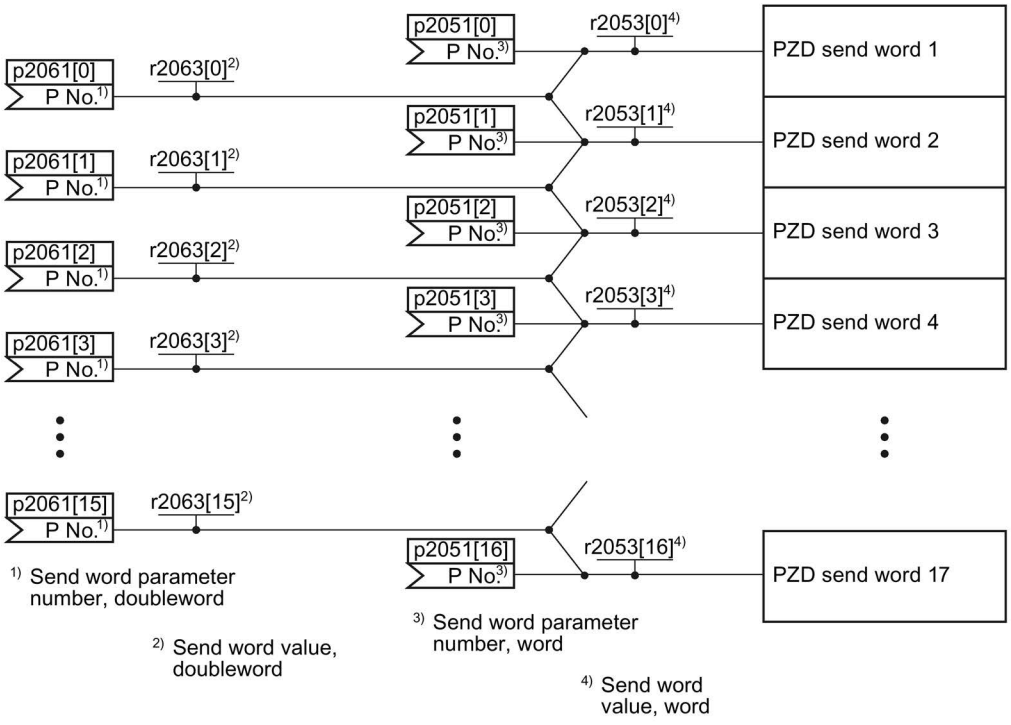


Figure 6-12 Interconnection of the send words

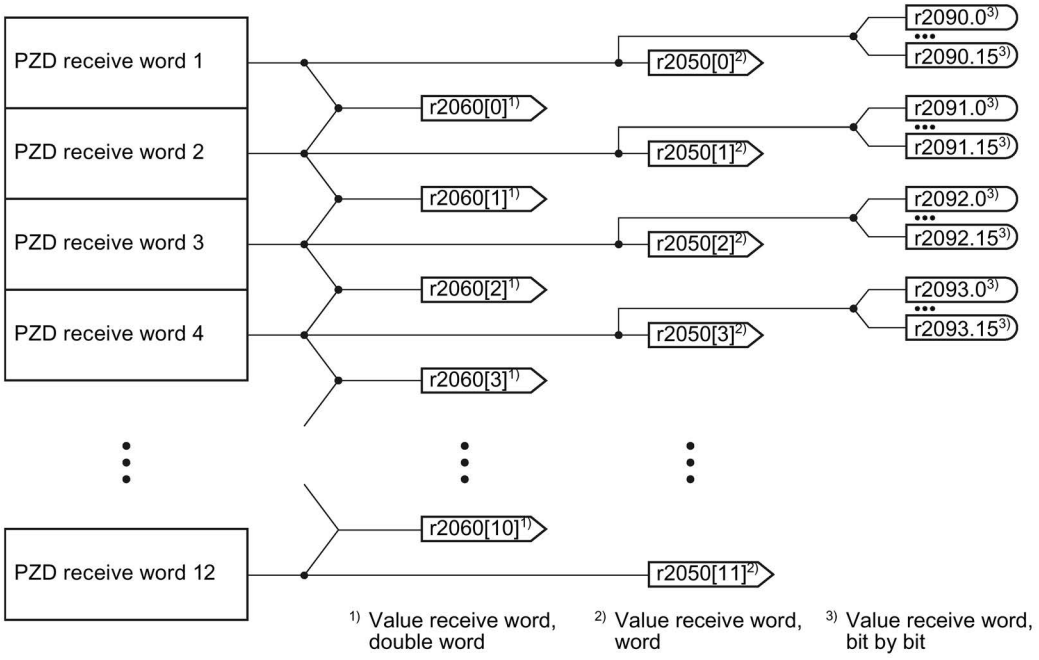


Figure 6-13 Interconnection of the receive words

The telegrams use - with the exception of telegram 999 (free interconnection via BICO) - 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 adapt one of the predefined telegrams via parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

6.2.10.1 Control and status word 1

Control word 1 (STW1)

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			

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
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.	
11	1 = 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)

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

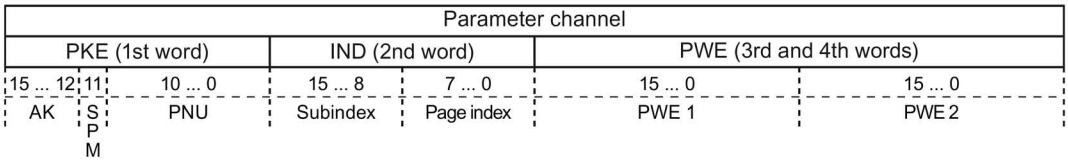
[1)] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

6.2.10.2 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.



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

Request and response IDs

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

Table 6- 13 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 6- 14 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 6- 15 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 closed-loop controller that is enabled**. (The operating state of the inverter prevents a parameter change.)

No.	Description
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 6- 16 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 6- 17 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

6.2.10.3 Examples of the parameter channel

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.

| Parameter channel | | |

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)

| Parameter channel | | |

6.2.10.4 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 configuration
p2079	**PROFIdrive PZD telegram selection extended**	
	1: 20: 352: 353: 354:	Standard telegram 1, PZD-2/2 Standard telegram 20, PZD-2/6 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 configuration
p2079	**PROFIdrive PZD telegram selection extended**
	999: Free telegram 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.

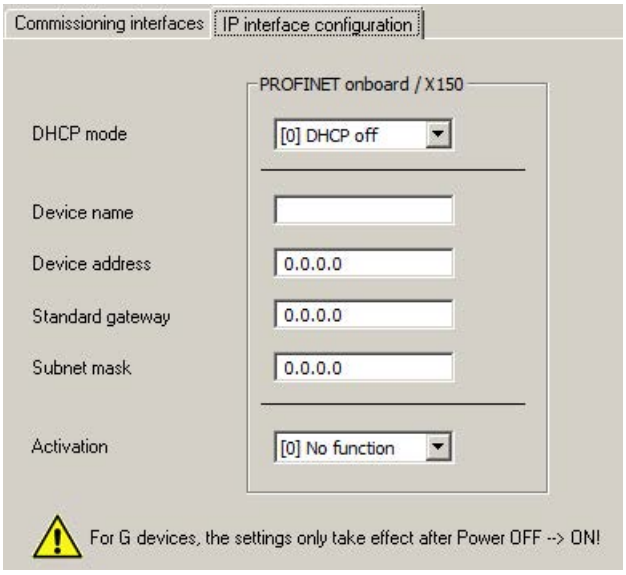
For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

6.2.10.5 Configuring the IP interface

Configure communication with STARTER

STARTER provides a screen form to set the communication with the control system.

Open the dialog screen form "Control_Unit/Communication/Commissioning interface" and activate the "Configure IP interfaces" tab



- Set the DHCP mode to 0 (factory setting).
- Enter the device name, address, gateway and the address for the subnet mask.
- In the Activation field select “[2] Save and activate configuration”.
- To activate the settings, you must switch off the inverter power supply and then switch on again.

You can also enter or read out data using the expert list. You can find the corresponding parameters in the number range r8909 … p8925

6.2.10.6 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 function manual (Page 409)".

6.2.10.7 Acyclically reading and writing inverter parameters

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

- For PROFIBUS: Up to 240 bytes per write or read request via data set 47
- For PROFINET: Write or read requests via B02E hex and B02F hex

You will find more information on acyclic communication in the Fieldbus Function Manual; see also section: Manuals for your inverter (Page 409).

6.2.11 Control via additional fieldbuses

6.2.11.1 Modbus RTU

Settings for Modbus RTU

Parameter	Explanation		
p2020	**Fieldbus interface baudrate** (Factory setting: 7)	5: 4800 baud 6: 9600 baud 7: 19200 baud 8: 38400 baud 9: 57600 baud	10: 76800 baud 11: 93750 baud 12: 115200 baud 13: 187500 baud
p2021	**Fieldbus interface address** (Factory setting: 1) Valid USS addresses: 1 … 247. The parameter is only active if address 0 is set at the Control Unit address switch. A change only becomes effective after the inverter power supply has been switched off and switched on again.		
p2024	**Fieldbus interface times** (Factory setting: [0] 1000 ms, [2] 0 ms)	[0] Maximum permissible telegram processing time of the Modbus slave [2] dead time between two telegrams	
r2029	**Fieldbus interface error statistics**	[0] number of error-free telegrams [1] number of rejected telegrams [2] number of framing errors [3] number of overrun errors	[4] number of parity errors [5] number of starting character errors [6] number of checksum errors [7] number of length errors
p2030 = 2	**Fieldbus interface protocol selection:** Modbus RTU		
p2031	**Fieldbus interface Modbus parity** (Factory setting: 2)	0: No parity 1: Odd parity 2: Even parity	
p2040	**Fieldbus interface monitoring time** (Factory setting: 100 ms) p2040 = 0: The monitoring is deactivated		

Control word 1 (STW1)

Bit	Meaning	Explanation	Signal interconnection in the inverter
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.	
11	1 = Direction reversal	Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Reserved		
13	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	Reserved		

Status word 1 (ZSW1)

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

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

Further information

You can find additional information about Modbus RTU in the "Fieldbuses" Function Manual: Download manuals (http://support.automation.siemens.com/WW/view/en/48213081/133300).

6.2.11.2 USS

Settings for USS

Parameter	Explanation		
p2020	**Fieldbus interface baudrate** (Factory setting: 8)	4: 2400 baud 5: 4800 baud 6: 9600 baud 7: 19200 baud 8: 38400 baud	9: 57600 baud 10: 76800 baud 11: 93750 baud 12: 115200 baud 13: 187500 baud
p2021	**Fieldbus interface address** (Factory setting: 0) Valid USS addresses: 0 … 30. The parameter is only active if address 0 is set at the Control Unit address switch. A change only becomes effective after the inverter power supply has been switched off and switched on again.		
p2022	**Fieldbus interface USS PZD number** (Factory setting: 2)		
p2023	**Fieldbus interface USS PKW number** (Factory setting: 127)		0: PKW 0 words 3: PKW 3 words 4: PKW 4 words 127: PKW variable
p2024	**Fieldbus interface times** (Factory setting: [0] 1000 ms, [1] 0 ms, [2] 0 ms)	[0] Maximum permissible telegram processing time of the Modbus slave [1] Character delay time [2] dead time between two telegrams	
r2029	**Fieldbus interface error statistics**	[0] number of error-free telegrams [1] number of rejected telegrams [2] number of framing errors [3] number of overrun errors	[4] number of parity errors [5] number of starting character errors [6] number of checksum errors [7] number of length errors
p2030 = 1	**Fieldbus interface protocol selection**: USS		
p2031	**Fieldbus interface Modbus parity** (Factory setting: 2)	0: No parity 1: Odd parity 2: Even parity	
p2040	**Fieldbus interface monitoring time** (Factory setting: 100 ms) p2040 = 0: The monitoring is deactivated		

Control word 1 (STW1)

Bit	Meaning	Explanation	Signal interconnection in the inverter
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.	
11	1 = Direction reversal	Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Reserved		
13	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	Reserved		

Status word 1 (ZSW1)

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

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

Further information

You can find additional information about USS in the "Fieldbuses" Function Manual: Download manuals (http://support.automation.siemens.com/WW/view/en/48213081/133300).

6.2.11.3 CANopen

The most important settings for CANopen

Parameter	Explanation			
p8620	**CAN Node ID** (Factory setting: 126) Valid USS addresses: 1 … 247. The parameter is only active if address 0 is set at the Control Unit address switch. A change only becomes effective after the inverter power supply has been switched off and switched on again.			
p8622	**CAN Bit rate** (Factory setting: 6)	0: 1 Mbit/s 1: 800 kbit/s 2: 500 kbit/s	3: 250 kbit/s 4: 125 kbit/s 5: 50 kbit/s	6: 20 kbit/s 7: 10 kbit/s
p8700 … p8707	**CAN Receive PDO n** (n = 1 … 8)	[0] = COB-ID of the PDO [1] = Transmission Type of the PDO		
p8710 … p8717	**CAN Receive Mapping for RPDO n** (n = 1 … 8)	[0] = Mapped object 1 … [3] = Mapped object 4		
p8720 … p8727	**CAN Transmit PDO n** (n = 1 … 8)	[0] = COB-ID of the PDO [1] = Transmission Type of the PDO [2] = Inhibit Time (in 100 µs) [3] = reserved [4] = Event Timer (in ms)		
p8730 … p8737	**CAN Transmit Mapping for TPDO n** (n = 1 … 8)	[0] = Mapped object 1 … [3] = Mapped object 4		
p8744	**CAN PDO Mapping Konfiguration** (Factory setting: 2)	1: Predefined connection set 2: Free PDO mapping		
r8784	**CAN status word**	.00 Ready to switch on .01 Ready .02 Operation enabled .03 Fault active .04 No coast down active .05 No fast stop active .06 Switching-on inhibited active .07 Alarm active	.08 Can be freely interconnected (p8785) .09 Control requested .10 Target reached .11 Torque limit reached .12 Velocity equal to zero .14 Can be freely interconnected (p8786) .15 Can be freely interconnected (p8787)	
r8795	**CAN control word**	.00 ON/OFF1 .01 Do not activate coast down .02 Do not activate quick stop .03 Enable operation .04 Enable ramp-function generator .05 Freeze ramp-function generator continuation	.06 Enable speed setpoint .07 Acknowledge fault .08 Stop .11 Can be freely interconnected … .15 Can be freely interconnected	

Further information

You can find additional information about CANopen in the "Fieldbuses" Function Manual: Download manuals (http://support.automation.siemens.com/WW/view/en/48213081/133300).

6.2.11.4 Ethernet/IP

Settings for Modbus RTU

Parameter	Explanation		
p2030 = 10	**Fieldbus interface protocol selection**: Ethernet/IP		
p8920	**PN Name of Station**		
p8921	**PN IP address** (Factory setting: 0)		
p8922	**PN default gateway** (factory setting: 0)		
p8923	**PN Subnet Mask** (Factory setting: 0)		
p8924	**PN DHCP mode** (Factory setting: 0)	0: DHCP off 2: DHCP on, identification based on MAC address 3: DHCP on, identification based on Name of Station	
p8925	**PN interface configuration** (Factory setting: 0)	0: No function 1: Reserved 2: Save the configuration and activate 3: Delete configuration	
p8980	**Ethernet/IP profile** (Factory setting: 0) A change only becomes effective after the inverter power supply has been switched off and switched on again.		0: SINAMICS 1: ODVA AC/DC
p8982	**Ethernet/IP ODVA speed scaling** (Factory setting: 128) A change only becomes effective after the inverter power supply has been switched off and switched on again.		
	123: 32 124: 16 125: 8 126: 4	127: 2 128: 1 129: 0.5 130: 0.25	131: 0.125 132: 0.0625 133: 0.03125

Further information

You can find additional information about USS in the "Fieldbuses" Function Manual: Download manuals (http://support.automation.siemens.com/WW/view/en/48213081/133300).

6.2.12 Switching over the inverter control (command data set)

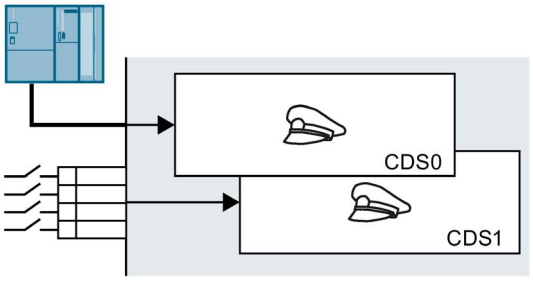
In some applications, it must be possible to switch over the master control for operating the inverter.

Example: The motor is to be operable either from a central control via the fieldbus or from a local control box via the terminal strip.

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 assigned to a specific master control, are termed the 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.

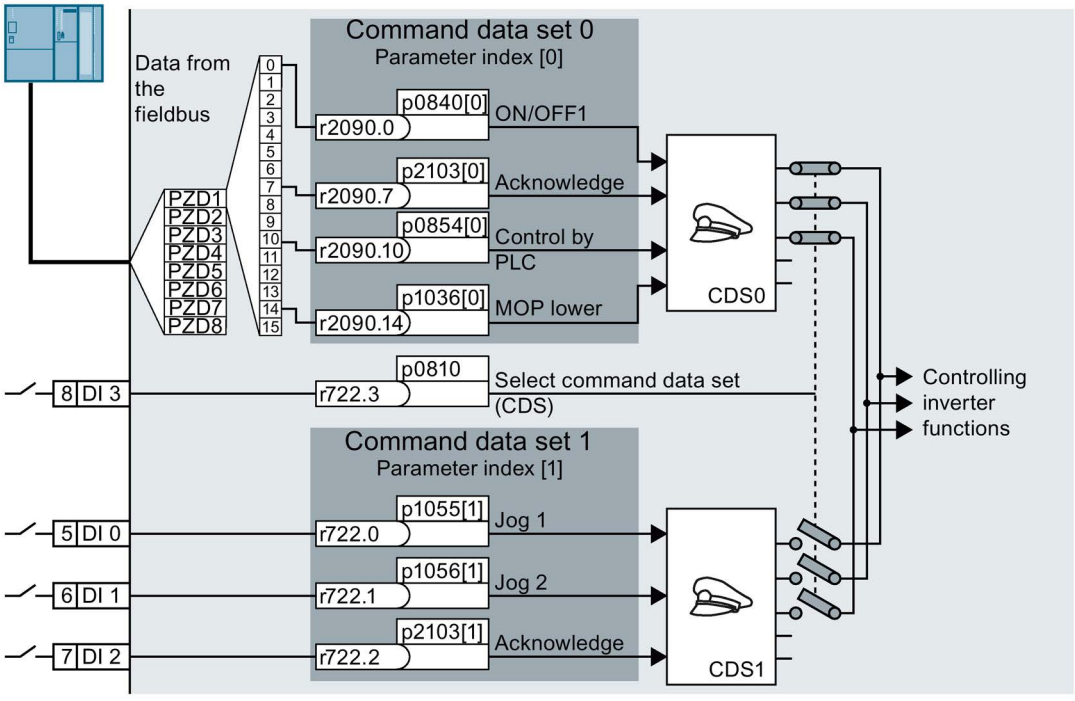


Figure 6-17 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

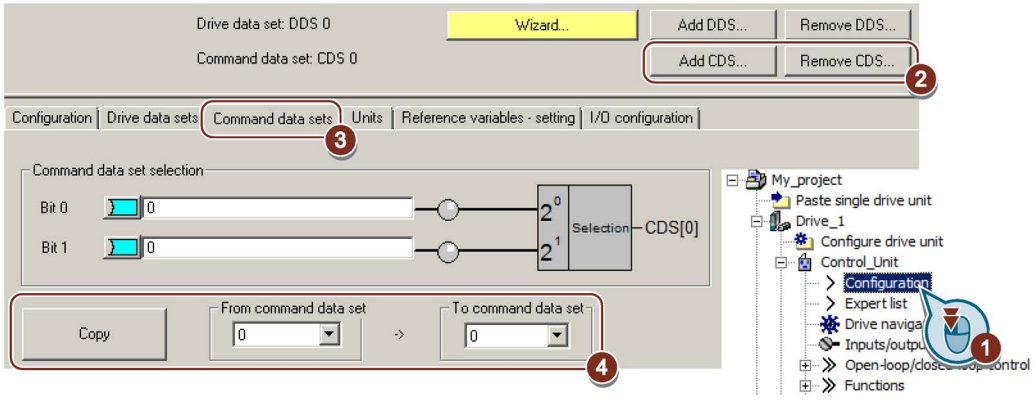
An overview of all the parameters that belong to the command data sets is provided in the List Manual.

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.



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.

Figure 6-18 Editing command data sets in STARTER

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**

6.3 Setpoints

6.3.1 Overview

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

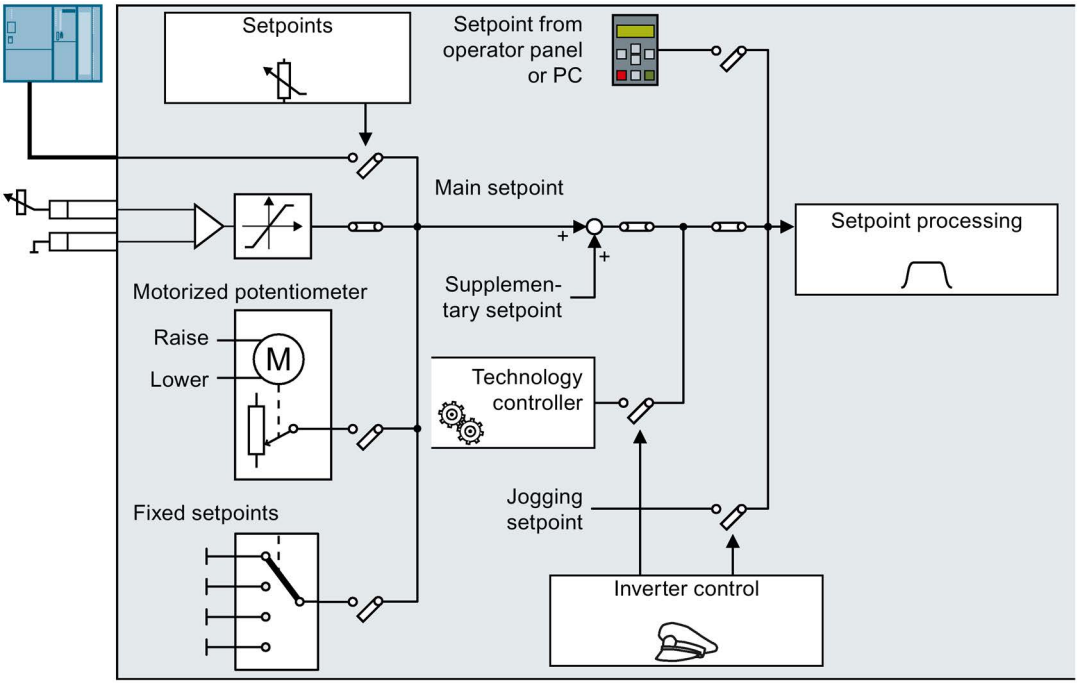


Figure 6-19 Setpoint sources for the inverter

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.

6.3.2 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.

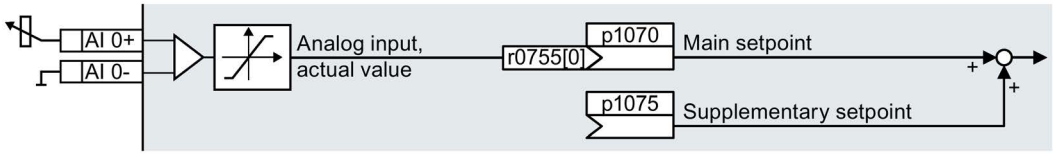


Figure 6-20 Example: Analog input 0 as setpoint source

Table 6- 18 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 input (Page 136).

6.3.3 Specifying the setpoint via the fieldbus

Interconnecting the fieldbus with the main setpoint

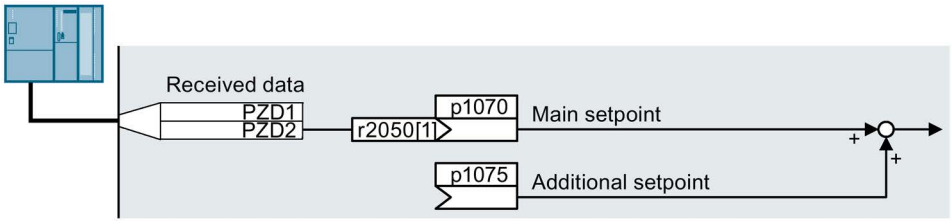


Figure 6-21 Fieldbus as setpoint source

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

Table 6- 19 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.

6.3.4 Motorized potentiometer as setpoint source

The "Motorized potentiometer" function emulates an electromechanical potentiometer. The output value of the motorized potentiometer can be set with the "higher" and "lower" control signals.

Interconnecting the motorized potentiometer (MOP) with the setpoint source

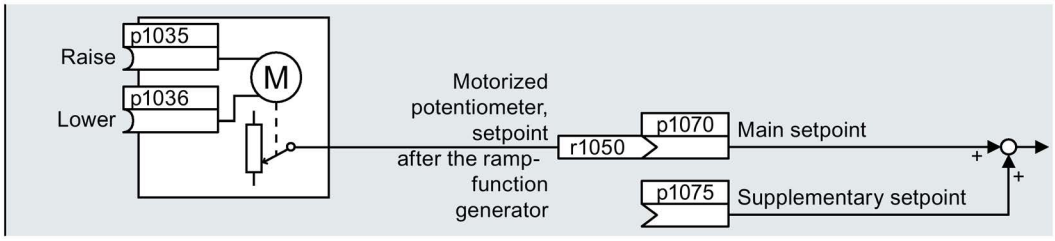


Figure 6-22 Motorized potentiometer as setpoint source

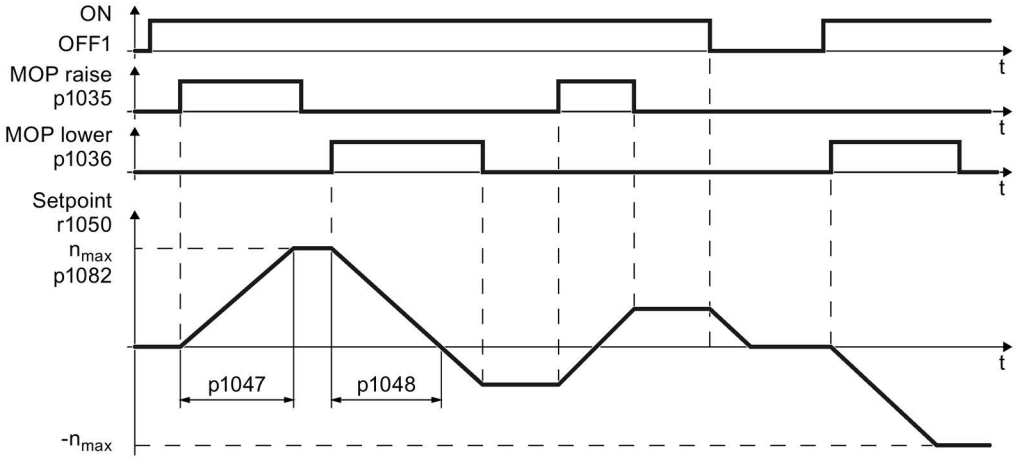


Figure 6-23 Function chart of the motorized potentiometer

Table 6- 20 Basic setup of motorized potentiometer

Parameter	Description	
p1035	**Motorized potentiometer setpoint higher**	Interconnect these commands with signals of your choice.
p1036	**Motorized potentiometer setpoint lower**	
p1040	**MOP start value** (factory setting: 0 rpm) Defines the start value [rpm] that is effective when the motor is switched on.	
p1047	**MOP ramp-up time** (factory setting: 10 s)	
p1048	**MOP ramp-down time** (factory setting: 10 s)	
r1050	**Motorized potentiometer setpoint after the ramp-function generator**	
p1070 = 1050	**Main setpoint**	

Table 6- 21 Extended setup of motorized potentiometer

Parameter	Description	
p1030	**MOP configuration** (factory setting: 00110 bin)	
	.00	Storage active = 0: After the motor has been switched on, the setpoint = p1040 = 1: After the motor has switched off, the inverter saves the setpoint. After the motor has switched on, the setpoint = the stored value
	.01	Automatic mode, ramp-function generator active (1-signal via BI: p1041) = 0: Ramp-up/ramp-down time = 0 = 1: With ramp-function generator In manual mode (p1041 = 0), the ramp-function generator is always active.
	.02	Initial rounding active 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes
	.03	Storage in NVRAM active 1: If bit 00 = 1, the setpoint is retained during a power failure
	.04	Ramp-function generator always active 1: The inverter also calculates the ramp-function generator when the motor is switched off
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	
p1039	**Motorized potentiometer, inversion** (factory setting: 0) Signal source for inverting the minimum speed / velocity or maximum speed / velocity	
p1041	**Motorized potentiometer, manual/automatic** (factory setting: 0) Signal source for switchover from manual to automatic	
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.

6.3.5 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

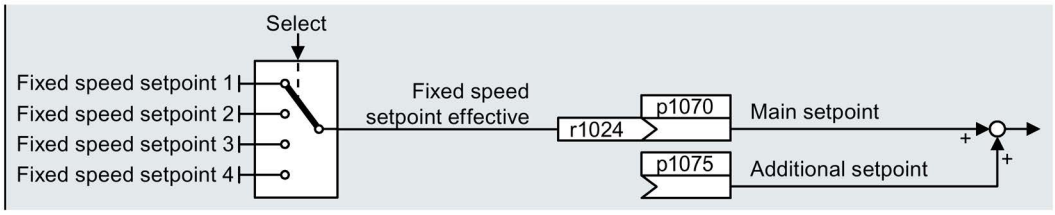


Figure 6-24 Fixed speeds as setpoint source

Table 6- 22 Setting the fixed speed as a setpoint source

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

Select fixed setpoint by direct or binary selection

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.

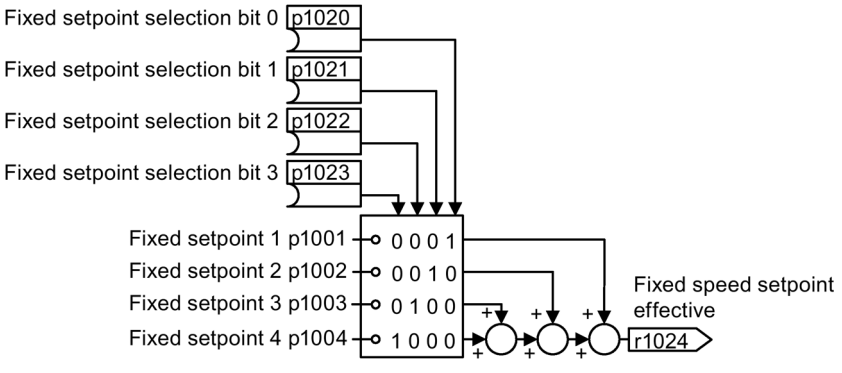


Figure 6-25 Simplified function diagram for directly selecting fixed setpoints

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.

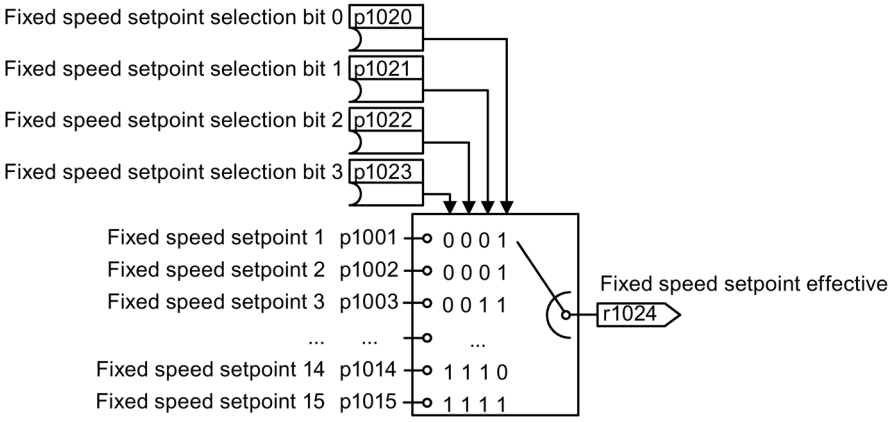


Figure 6-26 Simplified function diagram for binary selection of the setpoints

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	**Speed fixed setpoint mode** (factory setting: 1)	
	1:	Direct
	2:	Binary
p1020	**Speed fixed setpoint selection bit 0** (factory setting: 0)	
p1021	**Speed fixed setpoint selection bit 1** (factory setting: 0)	
p1022	**Speed fixed setpoint selection bit 2** (factory setting: 0)	
p1023	**Speed fixed 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 6- 23 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 6- 24 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

6.4 Setpoint calculation

6.4.1 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.

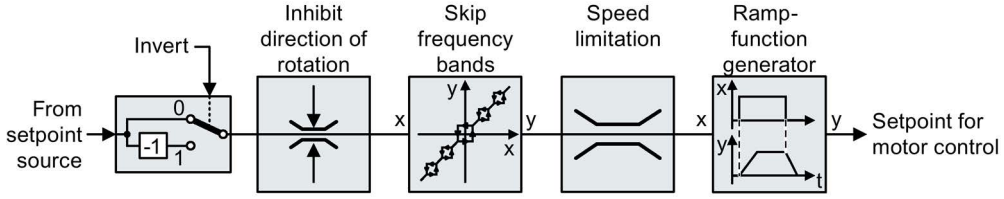
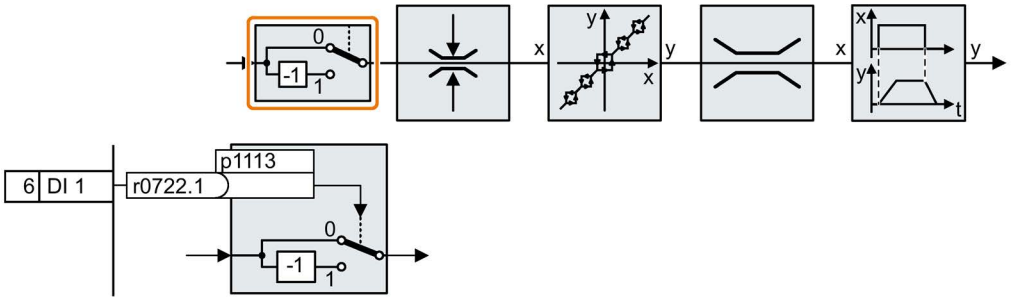


Figure 6-27 Setpoint processing in the converter

6.4.2 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.



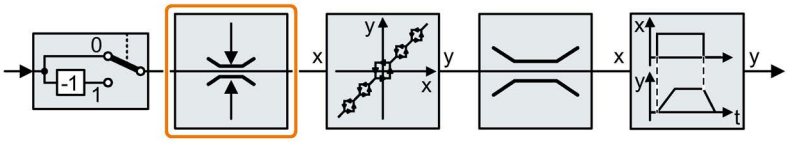
In order to invert the setpoint through the digital input DI 1, connect the parameter p1113 with a binary signal, e.g. the digital input 1.

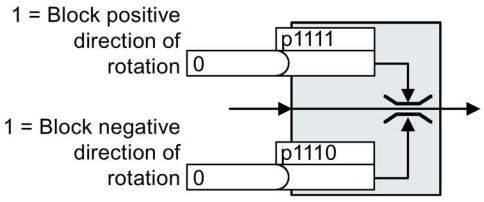
Table 6- 25 Examples of settings to invert the setpoint

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.

6.4.3 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 6- 26 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.

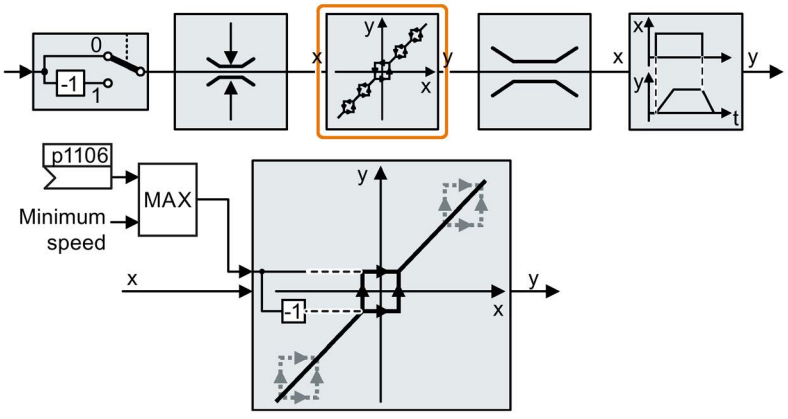
6.4.4 Skip frequency bands and minimum speed

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 for your inverter (Page 409).

Minimum speed

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



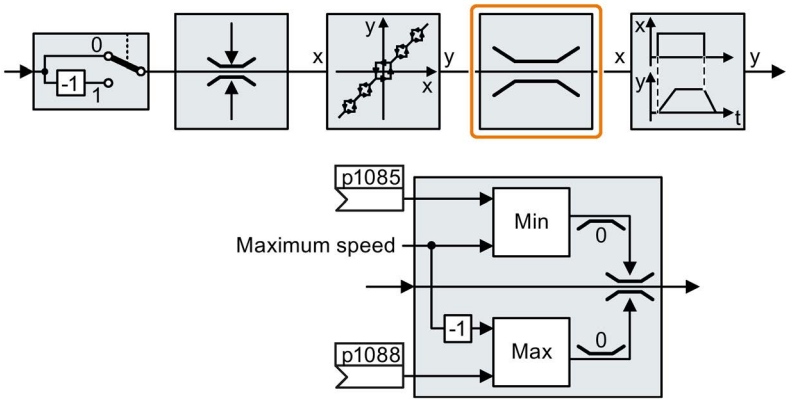
Speeds where the absolute value is less than the minimum speed are only possible during motor operation when accelerating or braking.

Table 6- 27 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

6.4.5 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 6- 28 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)

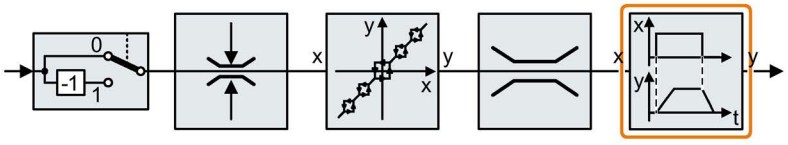
6.4.6 Ramp-function generator

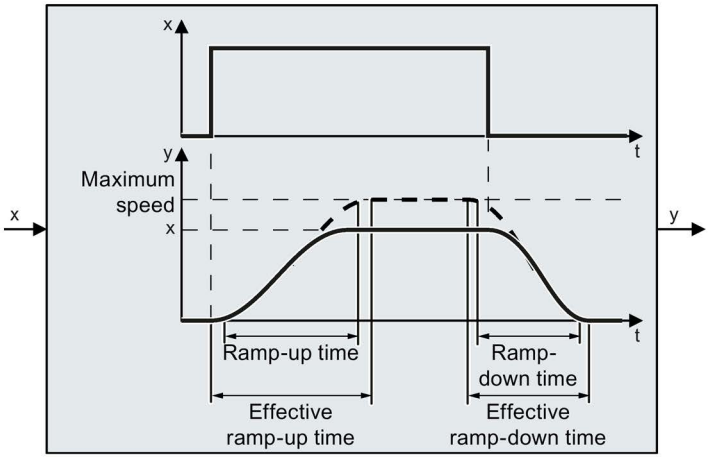
The ramp-function generator in the setpoint channel limits the rate change of the speed setpoint (acceleration). A reduced acceleration reduces the accelerating torque of the motor. As a consequence, the motor reduces the stress on the mechanical system of the driven machine.

The extended ramp-function generator not only limits the acceleration, but by rounding the setpoint, also acceleration changes (jerk). This means that the motor does not suddenly generate a torque.

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).



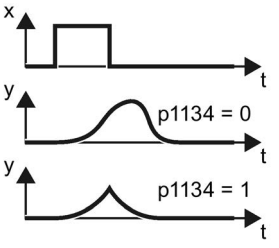


Initial and final rounding permit smooth, jerk-free acceleration and braking.

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 6- 29 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	**Ramp-function generator selection** (factory setting: 0) 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.

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.

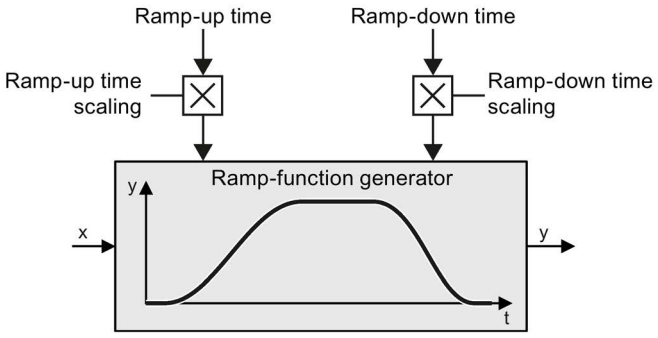


Table 6- 30 Parameters for setting the scaling

Parameter	Description
p1138	**Up ramp scaling** (factory setting: 1) Signal source for scaling the acceleration ramp.
p1139	**Down ramp scaling** (factory setting: 1) Signal source for scaling the deceleration ramp.

Example

In the following example, the higher-level control sets the ramp-up and ramp-down times of the inverter via PROFIBUS.

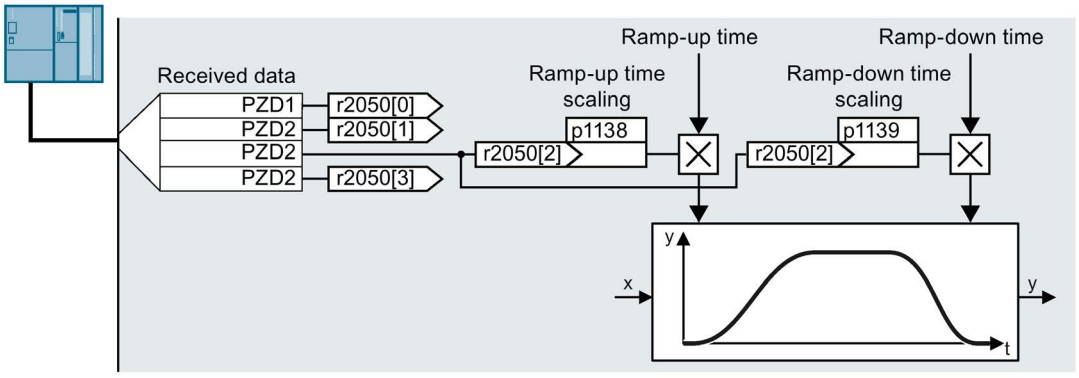


Figure 6-28 Example for changing the ramp-function generator times in operation

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 161).
- 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.

You will find further information in the Internet at: FAQ (https://support.industry.siemens.com/cs/ww/en/view/82604741).

6.5 Motor control

The inverter has two alternative methods to control (closed loop) the motor speed:

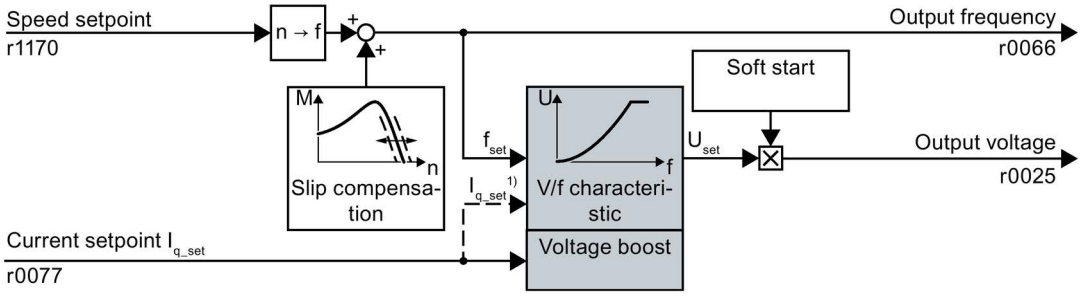
- U/f control
- Vector control with speed controller

6.5.1 V/f control

Overview of the U/f control

The U/f control is a closed-loop speed control with the following characteristics:

- The inverter controls the output voltage using the V/f characteristic
- The output frequency is essentially calculated from the speed setpoint and the number of pole pairs of the motor
- The slip compensation corrects the output frequency depending on the load and thus increases the speed accuracy
- Not using a PI controller prevents the speed control from becoming unstable
- In applications in which greater speed accuracy is required, a closed-loop control with load-dependent voltage boost can be selected (flux current control, FCC)



1) In the U/f control variant, "flux current control (FCC)," the inverter controls the motor current (starting current) at low speeds

Figure 6-29 Simplified function diagram of the U/f control

One function not shown in the simplified function diagram is the resonance damping for damping mechanical oscillations. You will find the complete function diagrams 6300 et seq. in the List Manual.

For operation of the motor with U/f control, you must set at least the subfunctions shown with a gray background in the figure to adapt them to your application:

- V/f characteristic
- Voltage boost

Default setting after selecting the application class Standard Drive Control

Selecting application class Standard Drive Control adapts the structure and the setting options of the U/f control as follows:

- Starting current closed-loop control: At low speeds, a controlled motor current reduces the tendency of the motor to oscillate.
- With increasing speed, transition from closed-loop starting current control into U/f control with voltage boost depending on the load.
- Soft starting is not possible.
- Fewer parameters

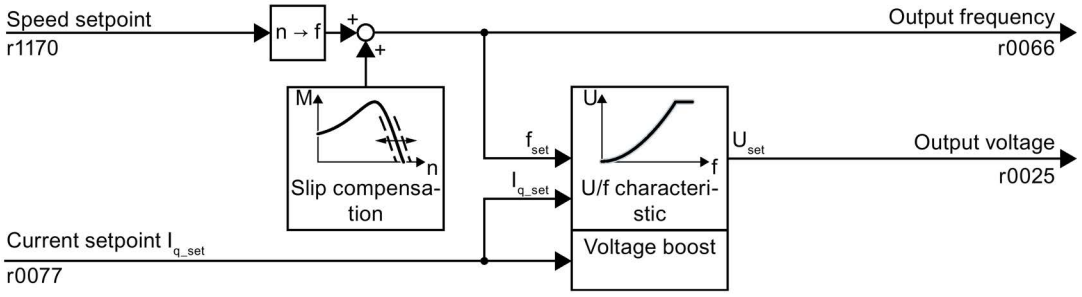
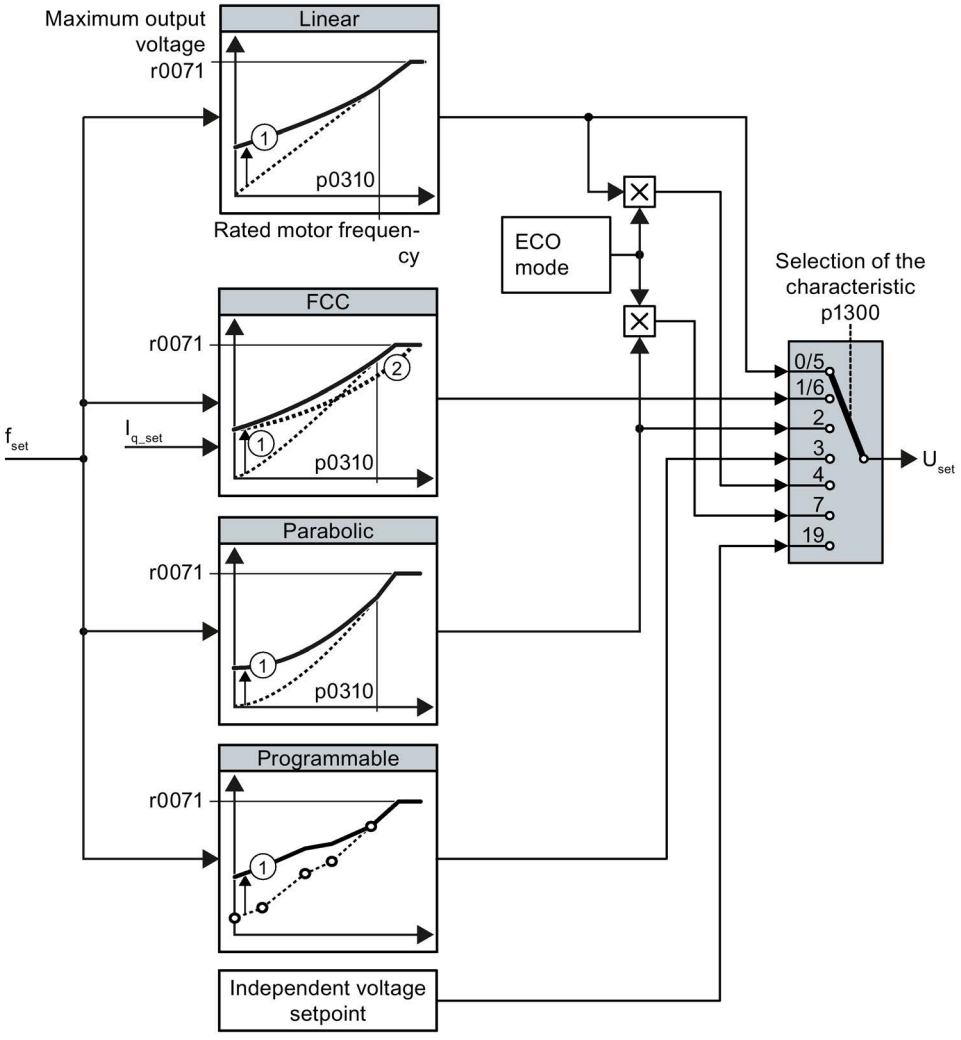


Figure 6-30 Default setting of the U/f control after selecting Standard Drive Control

The complete function diagrams 6850 ff. for application class Standard Drive Control are provided in the List Manual.

6.5.1.1 Characteristics of U/f control

The inverter has different V/f characteristics.



① The voltage boost of the characteristic optimizes the speed control at low speeds

② With the flux current control (FCC), the inverter compensates for the voltage drop in the stator resistor of the motor

Figure 6-31 Characteristics of U/f control

The inverter increases its output voltage to the maximum possible output voltage. The maximum possible output voltage of the inverter depends on the line voltage.

When the maximum output voltage is reached, the inverter only increases the output frequency. At this point, the motor enters the field weakening range: At constant torque, the slip decreases quadratically as the speed increases.

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 355).

Table 6- 31 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 6- 32 Characteristics for special applications

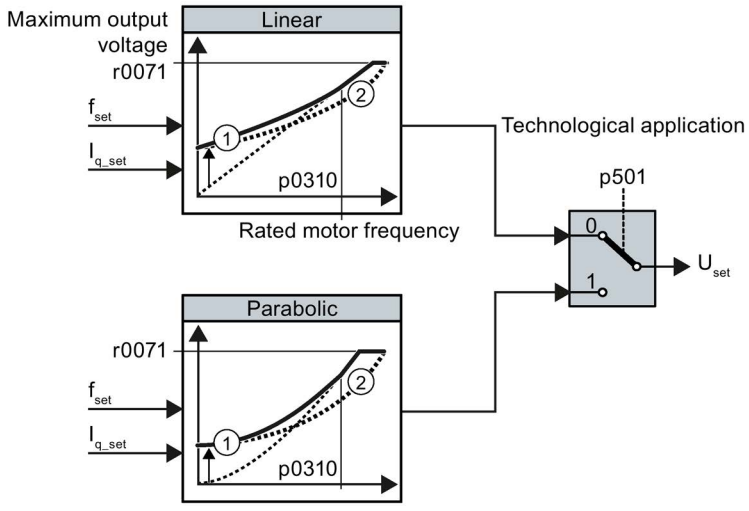
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and 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.

Characteristics after selecting the application class Standard Drive Control

Selecting application class Standard Drive Control reduces the number of characteristics and the setting options:

- A linear and a parabolic characteristic are available.
- Selecting a technological application defines the characteristic.
- The following cannot be set - ECO mode, FCC, the programmable characteristic and a specific voltage setpoint.



① The closed-loop starting current control optimizes the speed control at low speeds
② The inverter compensates the voltage drop across the motor stator resistance

Figure 6-32 Characteristics after selecting Standard Drive Control

Table 6- 33 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	p0501 = 0
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	p0501 = 1

Additional information on the characteristics can be found in the parameter list and in the function diagrams 6851 ff of the List Manual.

6.5.1.2 Optimizing motor starting

Setting the voltage boost for U/f control

After selection of the V/f characteristic, no further settings are required in most applications.

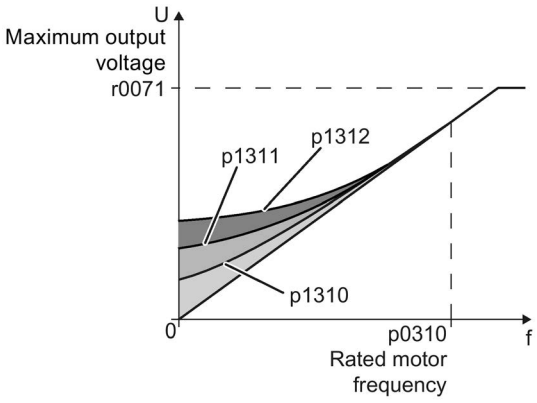
In the following circumstances, the motor cannot accelerate to its speed setpoint after it has been switched on:

- Load moment of inertia too high
- Load torque too large
- Ramp-up time p1120 too short

To improve the starting behavior of the motor, the V/f characteristic can be raised at low speeds.

The inverter raises the voltage in accordance with the starting currents p1310 … p1312.

The adjacent diagram shows the resulting voltage boost using a linear characteristic as an example.



Requirements

- Set the ramp-up time of the ramp-function generator to a value 1 s (< 1 kW) … 10 s (> 10 kW), depending on the power rating of the motor .
- Increase the starting current in steps of ≤ 5 %. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

  If the message A07409 appears, you must not increase any of the parameters.

Procedure

1
2

Proceed as follows to set the voltage boost:

1. Switch off the motor with a setpoint of just a few revolutions per minute.
2. Check whether the motor rotates smoothly.
3. If the motor rotates eccentrically or even stops, increase the voltage boost p1310 until the motor rotates smoothly.
4. Accelerate the motor to the maximum speed with maximum load.
5. Check whether the motor is following the setpoint.
6. If necessary, increase the voltage boost p1311 until the motor accelerates without problem.

In applications with a high break loose torque, you must additionally set parameter p1312 higher to achieve a satisfactory response.

You have set the voltage boost.

Parameter	Description
p1310	**Starting current (voltage boost) permanent** (factory setting 50 %) Compensates for voltage drops caused by long motor cables and the ohmic losses in the motor.
p1311	**Starting current (voltage boost) when accelerating** (factory setting 0 %) Provides additional torque when the motor accelerates.
p1312	**Starting current (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").

You will find more information on this function in the parameter list and in function diagram 6301 in the List Manual.

Starting current (boost) after selecting the application class Standard Drive Control

After selecting application class Standard Drive Control, in most applications, and no additional settings have to be made.

At standstill, the inverter ensures that at least the rated motor magnetizing current flows. Magnetizing current p0320 approximately corresponds to the no-load current at 50 % … 80 % of the rated motor speed.

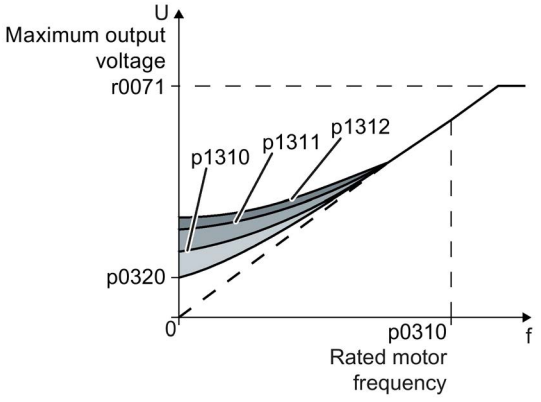
In the following situations, after it has been switched on, the motor cannot accelerate up to its speed setpoint:

- Excessively high load moment of inertia
- Excessively high load torque
- Ramp-up time p1120

The current can be increased at low speeds to improve the starting behavior of the motor.

The inverter boosts the voltage corresponding to the starting currents p1310 … p1312.

The adjacent diagram shows the voltage boost using a linear characteristic as example.



Requirements

- Depending on the rated power of the motor, set the ramp-up time of the ramp-function generator to a value of 1 s (< 1 kW) … 10 s (> 10 kW).
- Increase the starting current in steps of ≤ 5 %. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

  When message A07409 is displayed, it is not permissible that you further increase the value of any of the parameters.

Procedure



Proceed as follows to set the voltage boost:

1. Switch on the motor with a setpoint of a few revolutions per minute.
2. Check whether the motor rotates smoothly.
3. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until the motor runs smoothly.
4. Accelerate the motor to the maximum speed with maximum load.
5. Check that the motor follows the setpoint.
6. When required, increase the voltage boost p1311 until the motor accelerates without any problem.

In applications with a high break loose torque, you must also increase parameter p1312 in order to achieve a satisfactory motor response.

You have set the voltage boost.

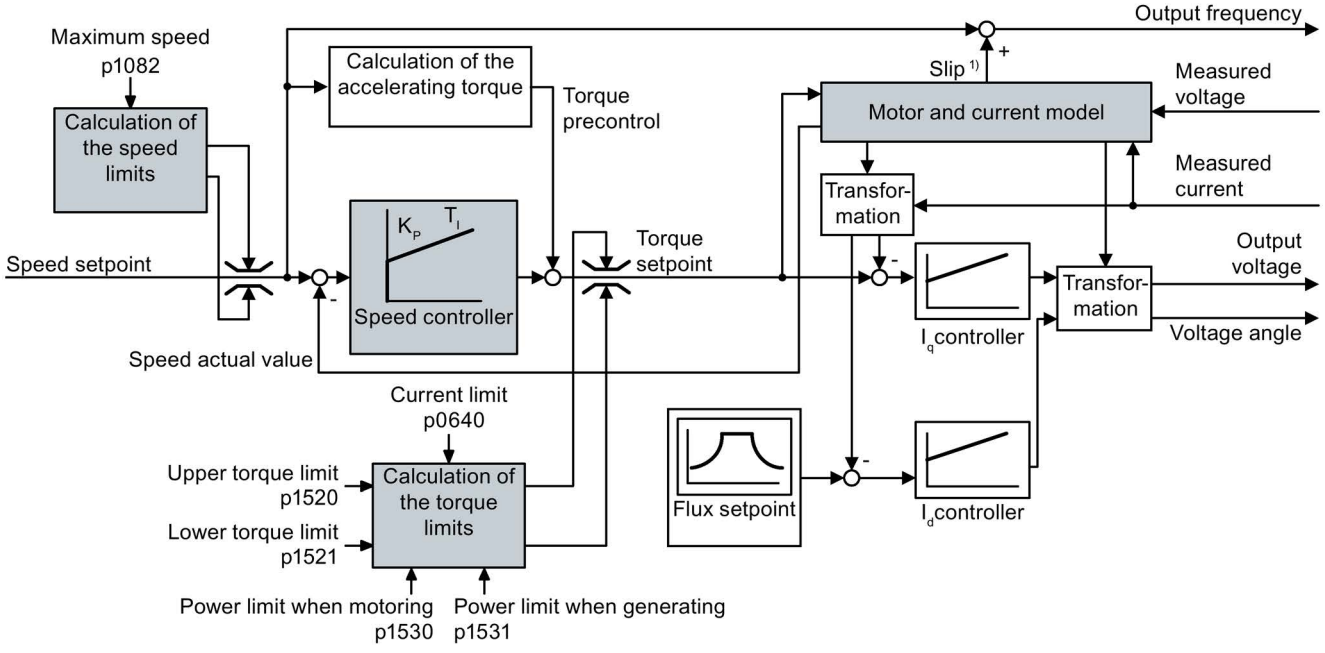
Parameter	Description
p1310	**Starting current (voltage boost) permanent** (Factory setting 50 %) Compensates voltage losses as a result of long motor cables and the ohmic losses in the motor. After commissioning, depending on the motor power rating and the technological application p0501, the inverter sets p1310.
p1311	**Starting current (voltage boost) when accelerating**(Factory setting 0%) Provides additional torque when the motor accelerates. After commissioning, depending on the motor power rating and the technological application p0501, the inverter sets p1311.
p1312	**Starting current (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").

You can find more information about this function in the parameter list and in function diagram 6851 of the List Manual.

6.5.2 Vector control with speed controller

Overview

The vector control comprises closed-loop current control and a higher-level closed-loop speed control.



1) For induction motors

Figure 6-33 Simplified function diagram for sensorless vector control with speed controller

All of the function block diagrams 6020 ff. for vector control are provided in the List Manual:

Using the motor model, the inverter calculates the following closed-loop control signals from the measured phase currents and the output voltage:

- Current component I_d
- Current component I_q
- Speed actual value

The setpoint of the current component I_d (flux setpoint) is obtained from the motor data. For speeds above the rated speed, the inverter reduces the flux setpoint along the field weakening characteristic.

When the speed setpoint is increased, the speed controller responds with a higher setpoint for the current component I_q (torque setpoint). The closed-loop control responds to a higher torque setpoint by adding a higher slip frequency to the output frequency. Also in the motor, the higher output frequency results in a higher slip, which is proportional to the accelerating torque. I_q and $I_d$controllers keep the motor flux constant using the output voltage, and adjust the matching current component I_q in the motor.

In order to achieve a satisfactory controller response, as a minimum, you must match the subfunctions having a gray background as shown in the diagram above with your particular application.

- **Motor and current model**: In the basic commissioning, correctly set the motor data from the rating plate corresponding to the connection type (Y/Δ), and carry out a motor data identification routine at standstill.
- **Speed limits** and **torque limits**: In the basic commissioning, set the maximum speed (p1082) and current limit (p0640) to match your particular application**.** When completing the basic commissioning, the inverter calculates the torque and power limits corresponding to the current limit. The actual torque limits are obtained from the converted current and power limits and the set torque limits.
- **Speed controller**: Start the rotating measurement of the motor data identification. You must manually optimize the controller if the rotating measurement is not possible.

Default settings after selecting the application class Dynamic Drive Control

Selecting application class Dynamic Drive Control adapts the structure of the vector control and reduces the setting options:

	Vector control after selecting the application class Dynamic Drive Control	**Vector control without selecting an application class**
Hold or set the integral component of the speed controller	Not possible	Possible
Acceleration model for precontrol	Default setting	Can be activated
Motor data identification at standstill or with rotating measurement	Shortened, with optional transition into operation	Complete

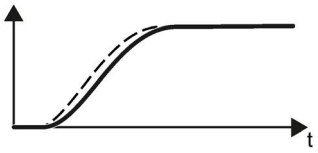
6.5.2.1 Optimizing the speed controller

Optimum control response - post optimization not required

Preconditions for assessing the controller response:

- The moment of inertia of the load is constant and does not depend on the speed
- The inverter does not reach the set torque limits during acceleration
- You operate the motor in the range 40 % … 60 % of its rated speed

If the motor exhibits the following response, the speed control is well set and you do not have to adapt the speed controller manually:



The speed setpoint (broken line) increases with the set ramp-up time and rounding.

The actual value follows the setpoint without overshooting.

Control optimization required

In some cases, the self-optimization result is not satisfactory or self-optimization is not possible because the motor cannot rotate freely.

In these cases, you must optimize the closed-loop speed control manually. The following parameters influence the response of the speed control:

- p1496 Acceleration pre-control scaling
- p0342 Ratio between the total and motor moment of inertia
- p1470 P gain K_P
- p1472 Integration time (integral time) T_I
- p1452 Speed controller actual speed value smoothing time (without encoder)

Optimizing the speed controller

Requirements

- Torque precontrol is active: p1496 = 100 %.
- The load moment of inertia is constant and independent of the speed.
- The inverter requires 10 % … 50 % of the rated torque to accelerate.

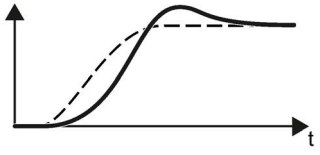
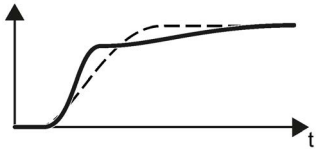
  When necessary, adapt the ramp-up and ramp-down times of the ramp-function generator (p1120 and p1121).
- You have prepared the trace function in STARTER or Startdrive to be able to trace the speed setpoint and the speed actual value.

Procedure

1
2

To optimize the speed controller, proceed as follows:

1. Switch on the motor.
2. Enter a speed setpoint of approximately 40 % of the rated speed.
3. Wait until the actual speed has stabilized.
4. Increase the setpoint up to a maximum of 60 % of the rated speed.
5. Monitor the associated characteristic of the setpoint and actual speed.
6. Optimize the controller by adapting the ratio of the moments of inertia of the load and motor (p0342):

	Initially, the actual speed follows the setpoint speed; however, it then overshoots the setpoint speed. • Increase p0342
	Initially, the actual speed exceeds the setpoint speed; however, it does not overshoot but instead approaches the setpoint speed "from below". • Reduce p0342

7. Switch off the motor.
8. Start a new calculation of the speed controller: p0340 = 4.
9. Switch on the motor.
10. Over the complete speed range check whether the speed control responds satisfactorily with the optimized settings.

You have optimized the speed controller.

When necessary, set the ramp-up and ramp-down times of the ramp-function generator (p1120 and p1121) back to the value before optimization.

Mastering critical applications

The drive control can become unstable for drives with a high load moment of inertia and gearbox backlash or a coupling between the motor and load that can possibly oscillate. In this case, we recommend the following settings:

- Increase the smoothing of speed actual value p1452.
- Increase the integral time: $T_I \geq 4 \times$ p1452.
- If the closed-loop speed control no longer has an adequate dynamic performance after these measures, then increase the P gain K_P step-by-step.

6.5.2.2 Friction characteristic

Function

In many applications, e.g. applications with geared motors or belt conveyors, the frictional torque of the load is not negligible.

The inverter provides the possibility of precontrolling the torque setpoint, bypassing the speed controller. The precontrol reduces overshooting of the speed after speed changes.

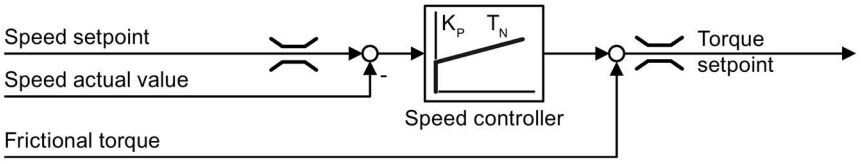


Figure 6-34 Precontrol of the speed controller with frictional torque

The inverter calculates the current frictional torque from a friction characteristic with 10 intermediate points.

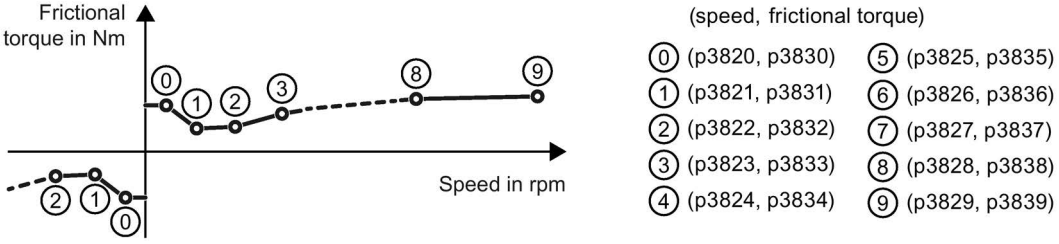


Figure 6-35 Friction characteristic

The intermediate points of the friction characteristic are defined for positive speeds. In the negative direction of rotation, the inverter uses the intermediate points with a negative sign.

Recording a friction characteristic

After basic commissioning, the inverter sets the speeds of the intermediate points to values suitable for the rated speed of the motor. The frictional torque of all intermediate points is still equal to zero. On request, the inverter records the friction characteristic: The inverter accelerates the motor step by step up to the rated speed, measures the frictional torque und writes the frictional torque into the intermediate points of the friction characteristic.

Requirement

The motor is permitted to accelerate up to the rated speed without endangering persons or property.

1
2

Procedure

To record the friction characteristic, proceed as follows:

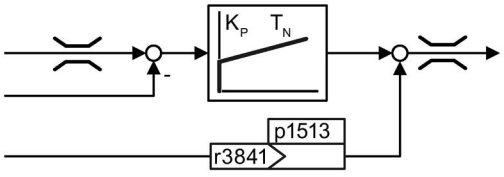
1. Set P3845 = 1: The inverter accelerates the motor successively in both directions of rotation and averages the measurement results of the positive and negative directions.
2. Switch on the motor (ON/OFF1 = 1).
3. The inverter accelerates the motor.

   During measurement, the inverter signals the warning A07961.

   When the inverter has determined all the intermediate points of the friction characteristic without fault code F07963, the inverter stops the motor.

You have recorded the friction characteristic.

Interconnect the precontrol of the speed controller with the frictional torque



To interconnect the precontrol of the speed controller with the frictional torque, set p1513 = r3841 (frictional torque = additional torque 2).

You will find additional information in function diagram 6060 of the List Manual.

Parameter

Parameter	Explanation	
p3820 … p2839	Intermediate points of the friction characteristic [rpm; Nm]	
r3840	**Friction characteristic status word**	
	.00	1 signal: Friction characteristic OK
	.01	1 signal: Determination of the friction characteristic is active
	.02	1 signal: Determination of the friction characteristic is complete
	.03	1 signal: Determination of the friction characteristic has been aborted
	.08	1 signal: Friction characteristic positive direction
r3841	**Friction characteristic, output** [Nm]	
p3842	**Activate friction characteristic** 0: Friction characteristic deactivated 1: Friction characteristic activated	
p3845	**Activate friction characteristic plot** (factory setting: 0) 0: Friction characteristic plot deactivated 1: Friction characteristic plot activated, both directions 2: Friction characteristic plot activated, positive direction 3: Friction characteristic plot activated, negative direction	
p3846	**Friction characteristic plot ramp-up/ramp-down time** (factory setting: 10 s) Ramp-up/ramp-down time for automatic plotting of the friction characteristic.	
p3847	**Friction characteristic plot warm-up period** (factory setting: 0 s) At the start of automatic plotting, the inverter accelerates the motor up to the speed = p3829 und keeps the speed constant for this time.	

You will find more information in the List Manual.

6.5.2.3 Moment of inertia estimator

Background

From the load moment of inertia and the speed setpoint change, the inverter calculates the accelerating torque required for the motor. Via the speed controller precontrol, the accelerating torque specifies the main percentage of the torque setpoint. The speed controller corrects inaccuracies in the precontrol (feed-forward control).

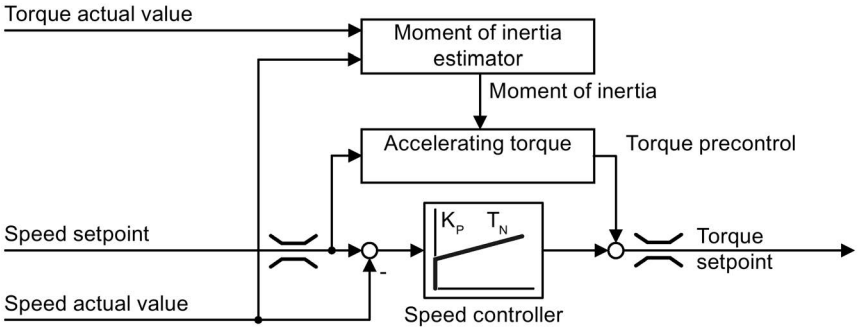


Figure 6-36 Influence of the moment of inertia estimator on the speed control

The more precise the value of the moment of inertia in the inverter, the lower the overshoot after speed changes.

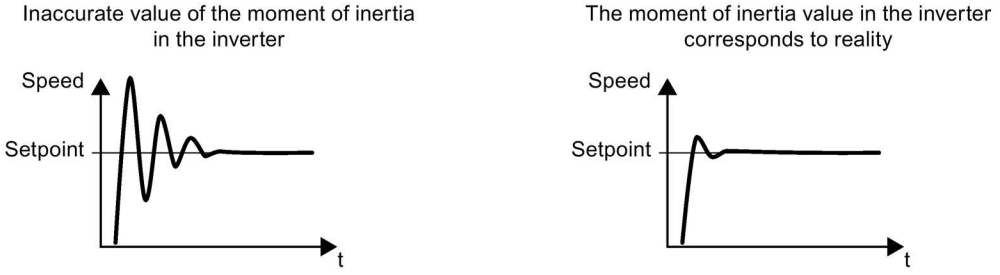


Figure 6-37 Influence of the moment of inertia estimator on the speed

Function

From the actual speed, the actual motor torque and the frictional torque of the load, the inverter calculates the total moment of inertia of the load and motor.

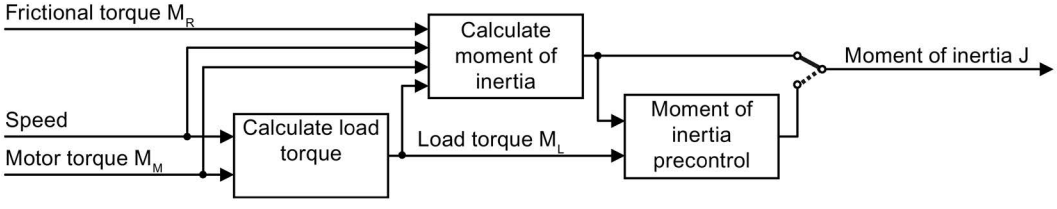
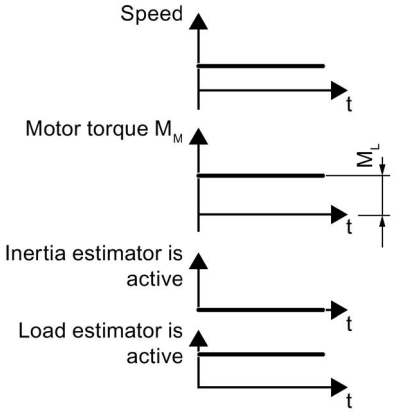


Figure 6-38 Overview of the function of the moment of inertia estimator

Calculating the load torque

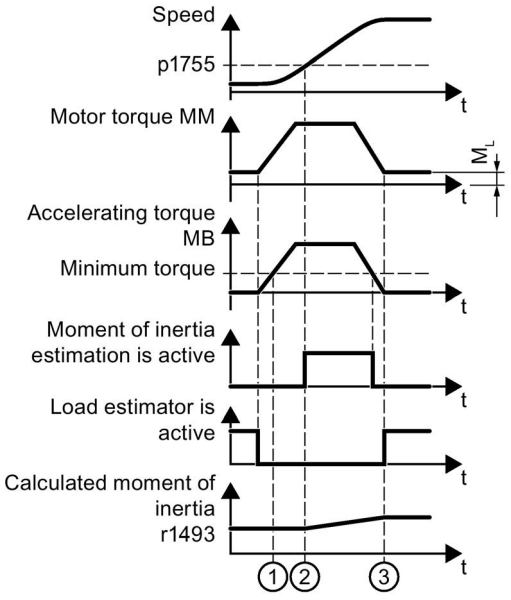


At low speeds, the inverter calculates the load torque M_L from the actual motor torque.

The calculation takes place under the following conditions:

- Speed ≥ p1226
- Acceleration setpoint < 8 1/s² (≙ speed change 480 rpm per s)
- Acceleration × moment of inertia (r1493) < 0.9 × p1560

Calculating the moment of inertia



For larger changes, the inverter initially calculates the accelerating torque M_B as difference between the motor torque M_M, load torque M_L and frictional torque M_R:

$M_B = M_M - M_L - M_R$

The moment of inertia J of the motor and load is then obtained from the accelerating torque M_B – and the angular acceleration α (α = rate of change of speed):

$J = M_B / \alpha$

If all of the following conditions are met, the inverter calculates the moment of inertia:

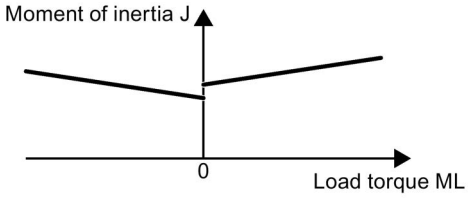
- ① The rated accelerating torque M_B must satisfy the following two conditions:
  - The sign of M_B is the same as the direction of the actual acceleration
  - M_B > p1560 × rated motor torque (r0333)
- ② speed > p1755
- The inverter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 1/s² (≙ speed change 480 rpm per s)

③ The inverter calculates the load torque again after acceleration.

Moment of inertia precontrol

In applications where the motor predominantly operates with a constant speed, the inverter can only infrequently calculate the moment of inertia using the function described above. Moment of inertia precontrol is available for situations such as these. The moment of inertia precontrol assumes that there is an approximately linear relationship between the moment of inertia and the load torque.

Example: For a horizontal conveyor, in a first approximation, the moment of inertia depends on the load.



The relationship between load torque and torque is saved in the inverter as linear characteristic.

In a positive direction of rotation:

Moment of inertia J = p5312 × load torque M_L + p5313

In a negative direction of rotation:

Moment of inertia J = p5314 × load torque M_L + p5315

You have the following options to determine the characteristic:

- You already know the characteristic from other measurements. In this case, you must set the parameters to known values when commissioning the system.
- The inverter iteratively determines the characteristic by performing measurements while the motor is operational.

Activating the moment of inertia estimator

The moment of inertia estimator is deactivated in the factory setting. p1400.18 = 0, p1400.20 = 0, p1400.22 = 0.

If you performed the rotating measurement for the motor identification during basic commissioning, we recommend leaving the moment of inertia estimator deactivated.

Preconditions

- You are using a 1FK7 encoderless permanent-field synchronous motor.
- You have selected encoderless vector control.
- The load torque must be constant whilst the motor accelerates or brakes.

  Typical of a constant load torque are conveyor applications and centrifuges, for example.

  Fan applications, for example, are not permitted.
- The speed setpoint is free from superimposed unwanted signals.
- The motor and load are connected to each other with an interference fit.

  Drives with slip between the motor shaft and load are not permitted, e.g. as a result of loose or worn belts.

If the conditions are not met, you must not activate the moment of inertia estimator.

Procedure



To activate the moment of inertia estimator, proceed as follows:

1. Set p1400.18 = 1
2. Check: p1496 ≠ 0
3. Activate the acceleration model of the speed controller pre-control: p1400.20 = 1.

You have activated the moment of inertia estimator.

Parameter	Explanation		
r0333	**Rated motor torque** [Nm]		
p0341	**Motor moment of inertia** (factory setting: 0 kgm²) The inverter sets the parameter when selecting a listed motor. The parameter is then write-protected.		
p0342	**Moment of inertia ratio, total to motor** (factory setting: 1) Ratio of moment of inertia load + motor to moment of inertia of motor without load		
p1400	**Speed control configuration**		
	.18	1 signal: Moment of inertia estimator active	
	.20	1 signal: Acceleration model on	
	.22	1 signal	Moment of inertia estimator retain value when motor switched off
		0 signal	Moment of inertia estimator reset value to initial value J_0 when motor switched off: J_0 = p0341 × p0342 + p1498 If the load torque can change when the motor is switched off, set p1400.22 = 0.
	.24	1 signal	Accelerated moment of inertia estimator is active.
r1407	**Status word, speed controller**		
	.24	1 signal: Moment of inertia estimator is active	
	.25	1 signal: Load estimator is active	
	.26	1 signal: Moment of inertia estimator is engaged	
	.27	1 signal: Accelerated moment of inertia estimator is active.	
r1493	**Total moment of inertia, scaled** r1493 = p0341 × p0342 × p1496		
p1496	**Acceleration precontrol scaling** (factory setting: 0 %) According to rotating measurement of the motor data identification is p1496 = 100 %.		
p1498	**Load moment of inertia** (factory setting: 0 kgm²)		
p1502	**Freeze moment of inertia estimator** (factory setting: 0) If the load torque changes when accelerating the motor, set this signal to 0.		
	0 signal	Moment of inertia estimator is active	
	1 signal	Determined moment of inertia is frozen	
p1775	**Motor model changeover speed encoderless operation** Defines the switchover between open-loop and closed-loop controlled operation of the encoderless vector control. When selecting the closed-loop speed control, the inverter sets p1755 = 13.3 % × rated speed.		

Advanced settings

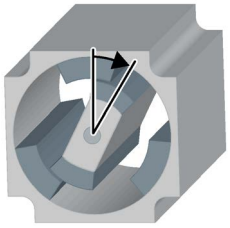
Parameter	Explanation		
p1226	**Standstill detection, speed threshold** (Factory setting: 20 rpm) The moment of inertia estimator only measures the load torque for speeds ≥ p1226. p1226 also defines from which speed the inverter switches-off the motor for OFF1 and OFF3.		
p1560	**Moment of inertia estimator accelerating torque threshold value** (factory setting: 10 %)		
p1561	**Moment of inertia estimator change time inertia** (factory setting: 500 ms)		The lower that p1561 or p1562 is, the shorter the moment of inertia estimator measurements. The larger p1561 or p1562 is, the more accurate the results provided by the moment of inertia estimator.
p1562	**Moment of inertia estimator change time load** (factory setting: 10 ms)		
p1563	**Moment of inertia estimator load torque positive direction of rotation**(factory setting: 0 Nm)		
p1564	**Moment of inertia estimator load torque negative direction of rotation**(factory setting: 0 Nm)		
p5310	**Moment of inertia precontrol configuration** (factory setting: 0000 bin)		
	.00	1 signal: activates calculation of the characteristic (p5312 … p5315)	
	.01	1 signal: activates moment of inertia precontrol	
		p5310.00 = 0, p5310.01 = 0	Deactivating moment of inertia precontrol
		p5310.00 = 1, p5310.01 = 0	Adapting the moment of inertia precontrol
		p5310.00 = 0, p5310.01 = 1	Activating the moment of inertia precontrol. The characteristic of the moment of inertia precontrol remains unchanged.
		p5310.00 = 1, p5310.01 = 1	Activating the moment of inertia precontrol. The inverter adapts the characteristic in parallel.
r5311	**Moment of inertia precontrol status word**		
	.00	1 signal: New measuring points for the characteristic of the moment of inertia precontrol are available	
	.01	1 signal: new parameters are been calculated	
	.02	1 signal: moment of inertia precontrol active	
	.03	1 signal: the characteristic in the positive direction of rotation has been calculated and is ready	
	.04	1 signal: the characteristic in the negative direction of rotation has been calculated and is ready	
	.05	1 signal: The inverter writes actual results to the parameter	
p5312	**Moment of inertia precontrol linear positive** (factory setting: 0 1/s²)		In a positive direction of rotation: Moment of inertia = p5312 × load torque + p5313
p5313	**Moment of inertia precontrol constant positive** (factory setting: 0 kgm²)		
p5314	**Moment of inertia precontrol linear negative** (factory setting: 0 1/s²)		In a negative direction of rotation: Moment of inertia = p5314 × load torque + p5315
p5315	**Moment of inertia precontrol constant negative** (factory setting: 0 kgm²)		

6.5.2.4 Pole position identification

The pole position of a synchronous motor

The pole position of a synchronous motor is the deviation between the magnetic axis in the rotor and the magnetic axis in the stator.

The image below shows you the pole position of a synchronous motor in a simplified cross-section.



The inverter must know the pole position of the rotor in the motor in order to be able to control the torque and speed of a synchronous motor.

Pole position identification

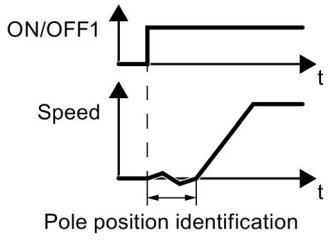
The inverter must measure the pole position for motors not equipped with an encoder, or for encoders, which do not supply the information regarding the pole position.

If you are using a Siemens motor, then the inverter automatically selects the appropriate technique to determine the pole position, and when required starts the pole position identification.

Motor without an encoder

Each time the motor is switched on (ON/OFF1 command), the inverter measures the pole position.

As a result of the measurement, the motor responds to an ON command with a delay of up to 1 second. The motor shaft can rotate slightly during the measurement.



Identifying the pole position using a measurement

6.6 Protection 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.

6.6.1 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)
- 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** [%] The I^2t monitoring calculates the inverter utilization based on a current reference value defined in the factory. • Actual current > reference value: r0036 becomes higher. • Actual current < reference value: r0036 becomes lower or remains = 0.
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.

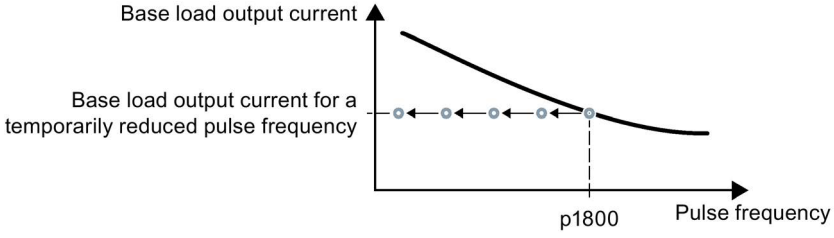


   Figure 6-39 Derating characteristic and base load output current for overload

   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.

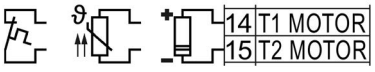
If it is not possible to temporarily reduce the pulse frequency, or the measure cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

6.6.2 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.

6.6.3 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 6- 34 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.

6.6.4 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 energy into electrical energy. The electrical energy flows back into the inverter. If the inverter cannot dissipate the electrical energy, for example in a braking resistor, then the DC link voltage Vdc increases in the inverter.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before the voltage can reach critical levels, however, the inverter switches the motor off with the fault message "DC-link overvoltage".

Protecting the motor and inverter against overvoltage

The Vdc_max control avoids an excessively high DC link voltage, assuming that the application permits this. The Vdc_max control increases the ramp-down time of the motor when braking, so that the motor feeds back only as little energy to the inverter as is covered by the losses in the inverter.

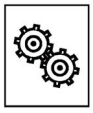
The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Electrically braking the motor (Page 229).

Table 6- 35 V_{DCmax} controller parameters

Parameter for U/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**V_{DC} controller or V_{DC} monitoring configuration**(factory setting: 1)1: Enable V_{DCmax} controller
r1282	r1242	**V_{DCmax} controller switch-on level** Shows the value of the DC-link voltage above which the V_{DCmax} controller is active
p1283	p1243	**V_{DCmax} controller dynamic factor** (factory setting: 100 %) scaling of the control parameters P1290, P1291 and P1292
p1294	p1254	**V_{DCmax}-controller automatic recording ON-signal level**(factory setting p1294: 0, factory setting p1254: 1)Activates or deactivates automatic detection of the switch-on levels of the V_{DCmax}-controller. 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 intervention thresholds of the V_{DCmax} controller. 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).

6.7 Application-specific functions



The inverter offers a series of functions that you can use depending on your particular application:

- Unit changeover (Page 223)
- Calculating the energy saving (Page 227)
- Braking functions
  - Electrically braking the motor (Page 229)
  - Motor holding brake (Page 238)
- Flying restart – switching on while the motor is running (Page 243)
- Automatic restart (Page 245)
- Kinetic buffering (Vdc min control) (Page 249)
- PID technology controller (Page 253)

6.7.1 Unit changeover

Description

Using the unit switchover function, you can switch over parameters and process variables for input and output to an appropriate system of units: US units, SI units or relative variables as a %.

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 224) IEC/NEMA
- Changing over the unit system (Page 225)
- Changing over process variables for the technology controller (Page 225)

The motor standard, the unit system as well as the process variables can only be changed offline.

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

6.7.1.1 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 6- 36 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
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

6.7.1.2 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".

6.7.1.3 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.

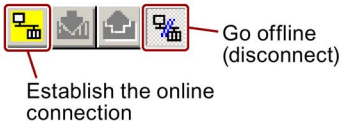
6.7.1.4 Switching units with STARTER

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.

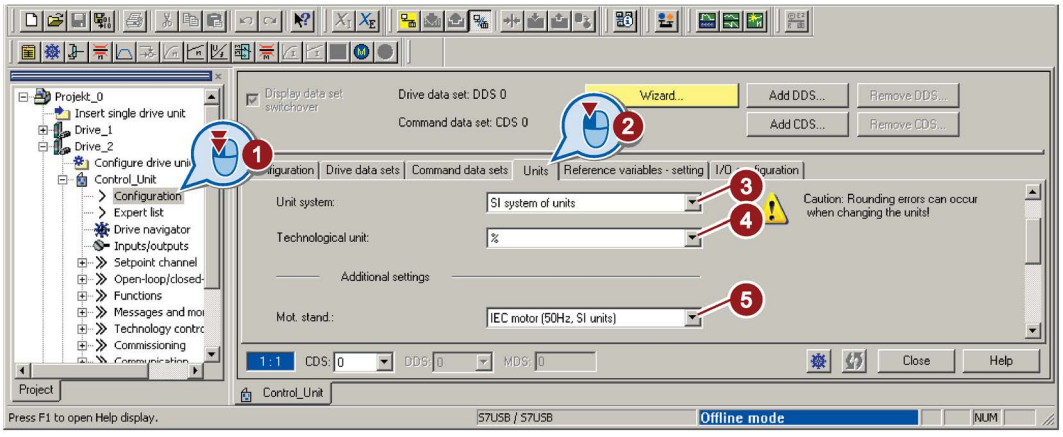


Procedure

1
2

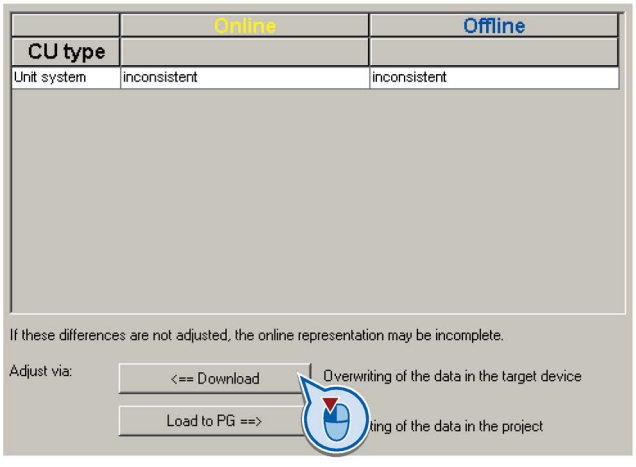
To change over the units with STARTER, proceed as follows:

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.

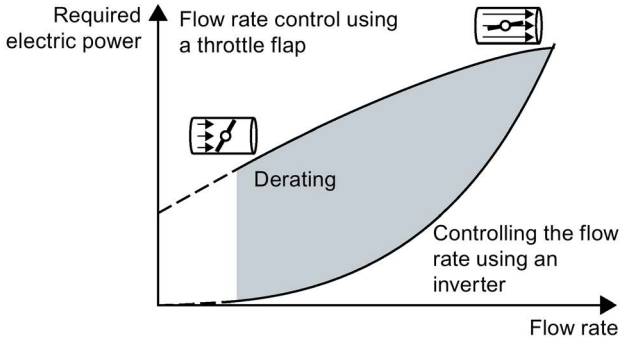
6.7.2 Calculating the energy saving

Background

Fluid flow machines, which mechnically control the flow rate using valves or throttle flaps, operate with a constant speed corresponding to the line frequency. The lower the flow rate, the poorer the system efficiency. The machine has the poorest efficiency when the valve or throttle flaps are completely closed. Further, undesirable effects can occur, for example the formation of vapor bubbles in liquids (cavitation) or the temperature of the medium being pumped can increase.

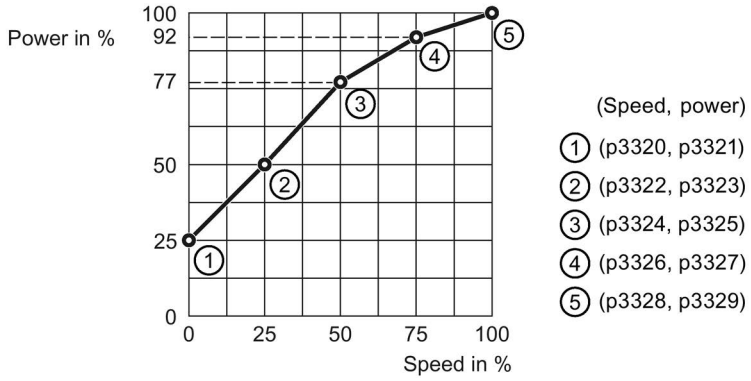
The converter controls the flow rate by appropriately varying the speed of the fluid flow machine. As a consequence, the fluid flow machine has the optimum efficiency for each flow rate, and draws less electric power in the partial load range than for closed-loop control concepts based on valves and throttle flaps.

Function



The converter calculates the energy saving from the flow characteristic associated with a mechanical flow control and the measured electric power that is drawn.

The calculation is suitable for centrifugal pumps, fans, radial and axial compressors, for instance.

Parameter	Description	
p3320 … p3329	**Flow characteristic**  Factory setting of the flow characteristic To set the characteristic, you require the following data from the machine manufacturer for each speed interpolation point: • The flow rate of the fluid-flow machine associated with the 5 selected converter speeds • The power drawn at constant speed associated with the five flow rates corresponds to the line frequency and mechanical throttling of the flow rate.	
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, r0041 = 0 and r0042 = 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.	
r0042	**CO: Process energy display** [1 ≙ 1 Wh] For display as process variable. Enable with p0043.	
	[0]	**Energy balance** Energy consumption since the last reset.
	[1]	Energy drawn since the last reset
	[2]	Energy fed back since the last reset.
p0043	**BI: Enable energy usage display** 1 signal: Process energy display is active in r0042.	

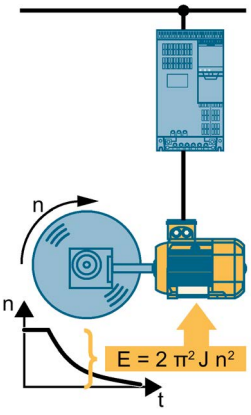
6.7.3 Electrically braking the motor

Braking with the motor in generating mode

If the motor brakes the connected load electrically, it will convert the kinetic energy of the motor to electrical energy. The electrical energy E released on braking the load is proportional to the moment of inertia J of the motor and load and to the square of the speed n. The motor attempts to pass the energy on to the inverter.

Main features of the braking functions

DC braking



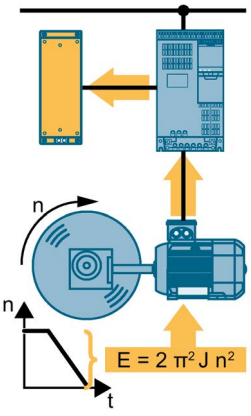
DC braking prevents the motor from transferring braking energy to the inverter. The inverter impresses a DC current into the motor, therefore braking the motor. The motor converts braking energy E of the load into heat.

- *Advantage:* The motor brakes the load without the inverter having to process regenerative power.
- *Disadvantages:* significant increase in the motor temperature; no defined braking characteristics; no constant braking torque; no braking torque at standstill; braking energy is lost as heat; does not function when the power 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



Using a braking resistor, the inverter converts the electrical energy into heat.

- *Advantages:* defined braking response; motor temperature does not increase any further; constant braking torque
- *Disadvantages:* Braking resistor required; braking energy E is lost in the form of heat

Braking method depending on the application

Table 6- 37 What braking method is suitable for what application?

Application examples	Electrical braking methods
Pumps, fans, mixers, compressors, extruders	Not required
Grinding machines, conveyor belts	DC braking, compound braking
Centrifuges, vertical conveyors, hoisting gear, cranes, winders	Dynamic braking

6.7.3.1 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

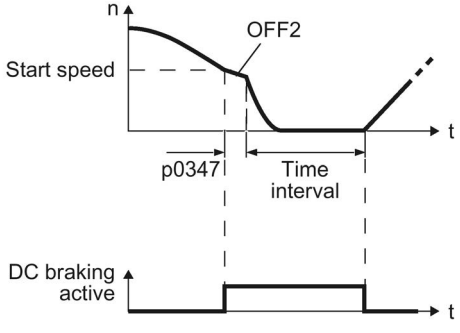
Function

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.

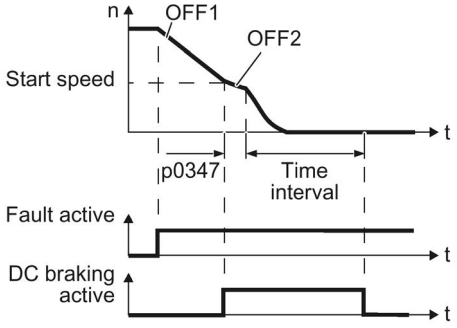
With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

The DC-braking function is possible only for induction motors.

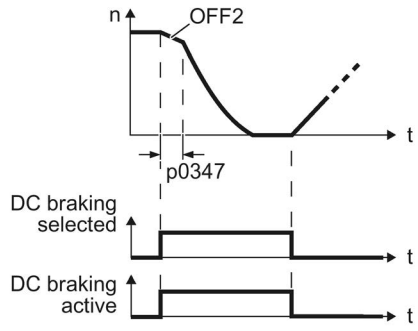
DC braking when falling below a start speed
Precondition: p1230 = 1 and p1231 = 14



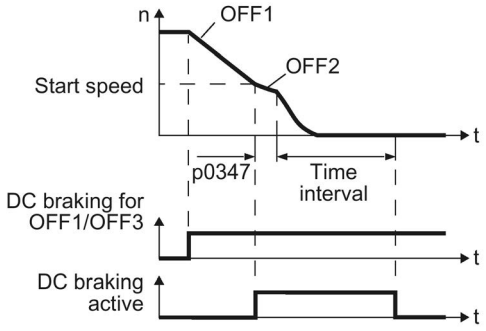
DC braking when a fault occurs
Precondition: Fault number and fault response are assigned using p2100 and p2101



DC braking initiated using a control command
Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)



DC braking when switching off the motor
Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14



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 4 5 14	No DC braking General release for DC braking DC braking for OFF1/OFF3 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 .10 .11 .12 .13	DC braking active DC braking ready DC braking selected DC braking selection internally locked DC braking for OFF1/OFF3

Table 6- 38 Configuring DC braking as a response to faults

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.	

6.7.3.2 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

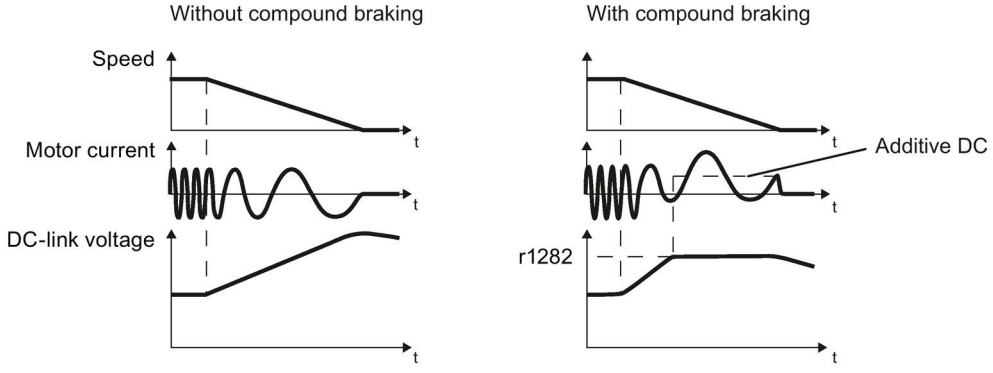


Figure 6-40 Motor brakes with and without active compound braking

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.

6.7.3.3 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 $U_{DC\ link,\ max}$.

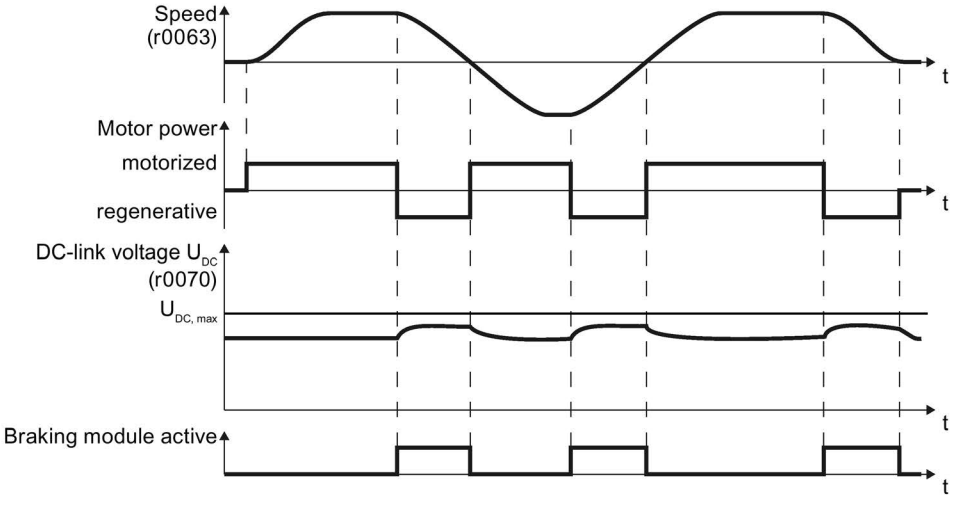


Figure 6-41 Simplified representation of dynamic braking with respect to time

Set dynamic braking

Parameter	Description	
p0219	**Braking power of the braking resistor** (factory setting: 0 kW) Set the braking power of the braking resistor. **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 rating of 1 kW × 2 s / 10 s = 0.2 kW, and set the maximum braking power to: p0219 = 1 (kW). Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor. For p0219 > 0, the inverter deactivates the VDC_max controller.	
p0844	**No coast down/coast down (OFF2) signal source 1**	
	p0844 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the inverter.

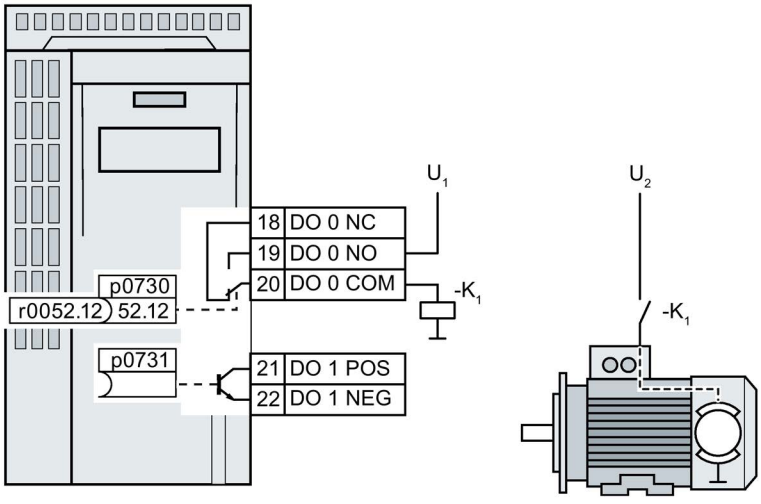
6.7.4 Motor holding brake

The motor holding brake holds the motor in position when it is switched off. If the setting is correct, the motor will produce an electrical holding torque before the inverter opens the brake. The inverter does not close the motor holding brake until the motor is at a standstill.

Connecting a motor holding brake

You can use any inverter digital output to control the motor holding brake.

If the current or voltage rating of the digital output is not sufficient, then you must control the motor holding brake through a coupling relay.



U_1 Power supply for the interface relay

U_2 Power supply for the motor holding brake

Figure 6-42 Connect the motor holding brake to digital output DO 0 of the inverter via interface relay K1.

To define which of the digital outputs of the inverter is used to control the motor holding brake, you must interconnect the corresponding digital output with the brake control signal:

- Digital output DO 0: p0730 = 52.12
- Digital output DO 1: p0731 = 52.12

Function after OFF1 and OFF3 command

The converter controls the motor holding brake in the following way:

1. After the ON command (to switch on motor), the inverter magnetizes the motor.
2. At the end of the magnetizing time (p0346), the converter issues the command to open the brake.
3. The converter keeps the motor at a standstill until this time p1216 has ended. The motor holding brake must open within this time.
4. At the end of the brake opening time the motor accelerates to the speed setpoint.
5. The motor brakes down to standstill after the OFF1 or OFF3 command.
6. If the actual speed is less than 20 rpm, then the converter issues the command to close the brake. The motor comes to a standstill but remains switched on.
7. After the brake closing time p1217, the converter switches off the motor.
   The motor holding brake must close within this time.

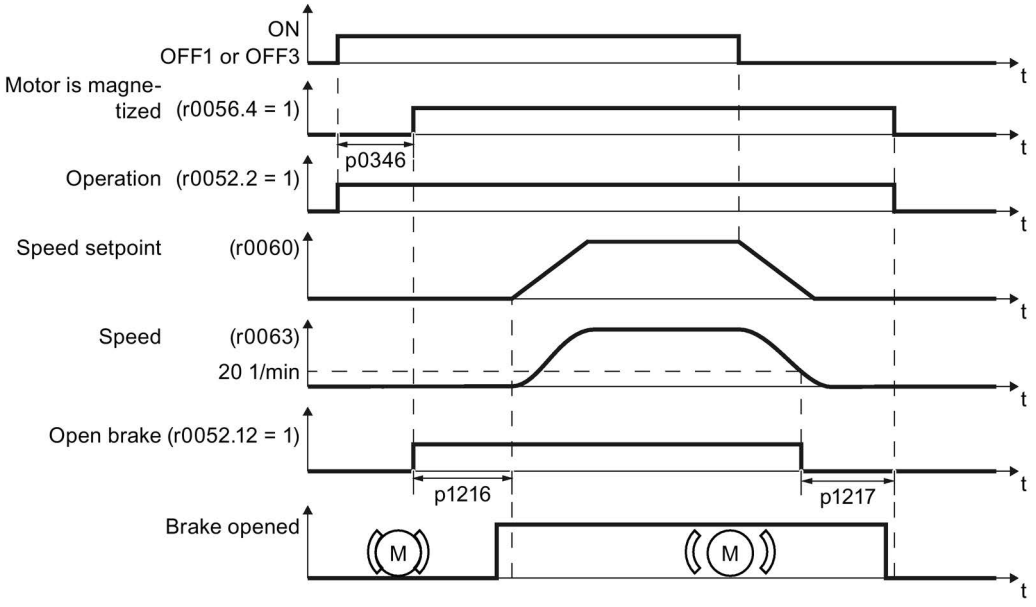


Figure 6-43 Controlling the motor holding brake when the motor is switched on and off

Function after an OFF2 command

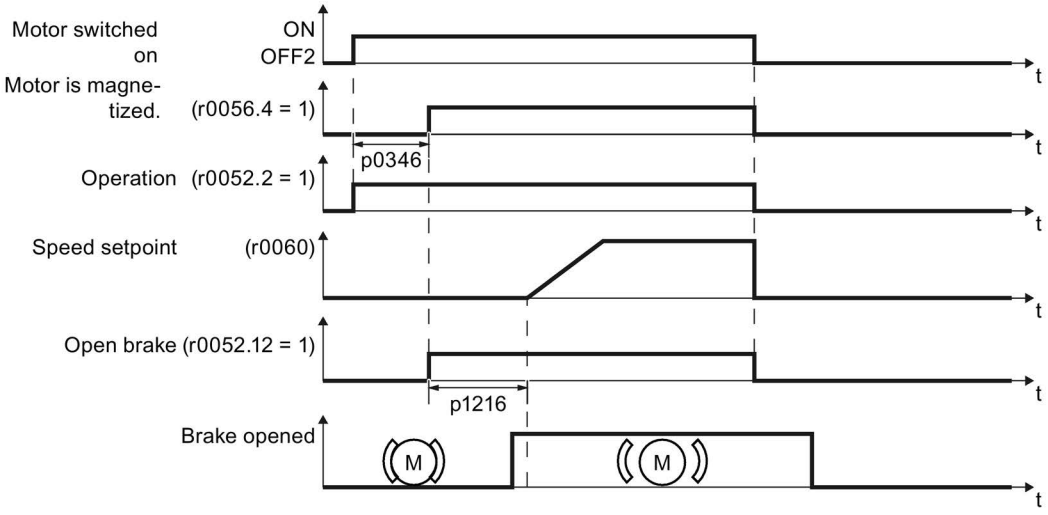


Figure 6-44 Controlling the motor holding brake after OFF2

After an OFF2 command, the inverter issues the signal to immediately close the motor holding brake, irrespective of the motor speed.

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

To commission the "motor holding brake" function, proceed as follows:



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. Find out the mechanical opening and closing times from the technical data of 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 suitably for the mechanical opening and closing times of the motor holding brake:
   - p1216 > mechanical opening time of the motor holding brake
   - p1217 > mechanical closing time of the motor holding brake
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   - If the motor holding brake opens too late, the inverter will accelerate the motor suddenly against the closed motor holding brake.

     Set p1216 larger.
   - If the motor waits too long before accelerating after the motor holding brake has opened, reduce 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:
   - V/f control (p1300 = 0 to 3):
     Increase p1310 in small steps.
     Increase p1351 in small steps.
   - Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the behavior of the drive immediately after the motor has been switched off:
   - If the motor holding brake closes too late, the load briefly sags before the motor holding brake closes.

     Set a larger value for p1217.
   - If the motor waits too long before switching off after the motor holding brake has closed, reduce p1217.

☐ You have commissioned the "Motor holding brake" function.

Table 6- 39 Control logic parameters of the motor holding brake

Parameter	Description
p1215 = 1	**Enable motor holding brake** 0 Motor holding brake locked (factory setting) 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**
p0730 = 52.12	**Signal source for terminal DO 0** Control motor holding brake via digital output 0
p0731 = 52.12	**Signal source for terminal DO 1** Control motor holding brake via digital output 1

Table 6- 40 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)
p1351	**Starting frequency of 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.

6.7.5 Flying restart – switching on while the motor is running

If you switch on the motor while it is still rotating, without the "Flying restart" function, there is a high probability that a fault will occur as a result of overcurrent (F30001 or F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

- The motor rotates after a brief line interruption.
- A flow of air turns the fan impeller.
- A load with a high moment of inertia drives the motor.

Principle of operation

The "Flying restart" function comprises the following steps:

1. After the on command, the inverter impresses the search current in the motor and increases the output frequency.
2. When the output frequency reaches the actual motor speed, the inverter waits for the motor excitation build up time.
3. The inverter accelerates the motor to the actual speed setpoint.

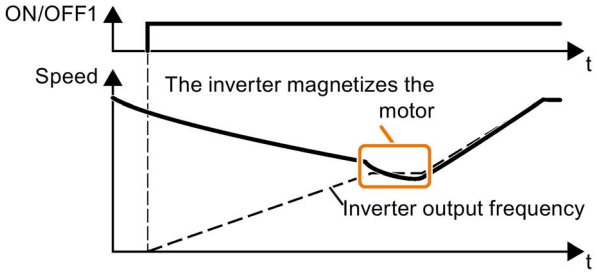


Figure 6-45 Principle of operation of the "flying restart" function

Setting "flying restart" function

Parameter	Description	
p1200	**Flying restart operating mode** (factory setting: 0)	
	0	Flying restart is disabled
	1	Flying restart is enabled, search for the motor in both directions, start in the direction of the setpoint
	4	Flying restart is enabled, search for the motor only in the direction of the setpoint

No "Flying restart" function for group drives

It is not permissible that you enable the "Flying restart" function if the inverter is simultaneously driving several motors.

Exception: a mechanical coupling ensures that all of the motors always operate with the same speed.

Table 6- 41 Advanced settings

Parameter	Description
p0346	**Motor excitation build up time** Wait time between switching on the motor and enabling the ramp-function generator.
p0347	**Motor de-excitation time** Within the motor de-excitation time, after an OFF command, the inverter prevents the induction motor from being switched on again. When using a reluctance motor, the inverter ignores the motor de-excitation time.
p1201	**Flying restart enable signal source** (factory setting: 1) Defines a control command, e.g. a digital input, which enables the flying restart function.
p1202	**Flying restart search current** (Factory setting depends on the Power Module) Defines the search current with respect to the magnetizing current (r0331), which flows in the motor during the flying restart.
p1203	**Flying restart search current factor** (Factory setting depends on the Power Module) 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 inverter does not find the motor, reduce the search speed (increase p1203).

6.7.6 Automatic restart

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

Danger to life as a result of machine parts unexpectedly starting

When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. Unexpected movement of machine parts can result in serious injury and material damage.

- Block off hazardous areas within the machine to prevent inadvertent access.

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 243).

Using p1210, select the automatic restart mode that best suits your application.

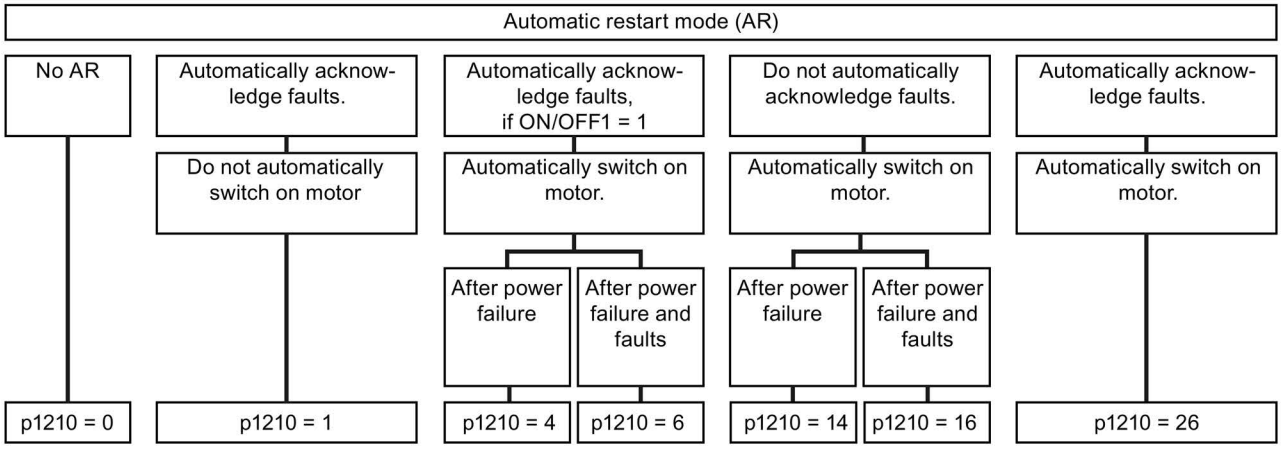
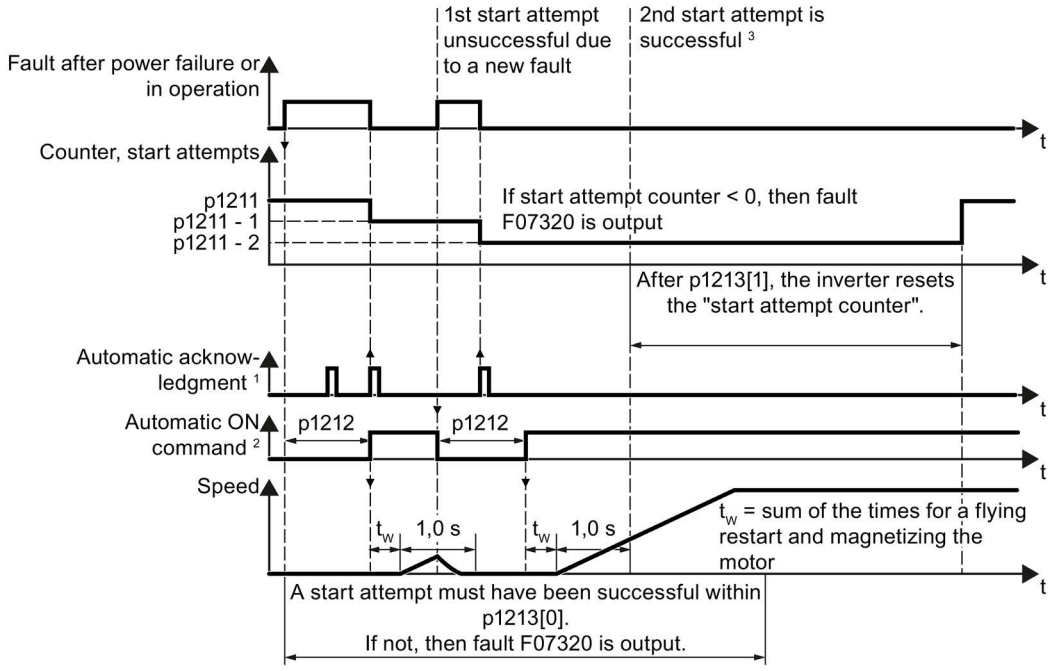


Figure 6-46 Automatic restart modes

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, after a flying restart and magnetization (r0056.4 = 1) no fault occurs within one second, then the start attempt was successful.

Figure 6-47 Time response of the automatic restart

Parameter for setting the automatic restart

Parameter	Explanation	
p1210	**Automatic restart mode** (factory setting: 0)	
	0:	Disable automatic restart.
	1:	Acknowledge all faults without restarting.
	4:	Restart after power failure without further restart attempts.
	6:	Restart after fault with further restart attempts.
	14:	Restart after power failure after manual acknowledgement.
	16:	Restart after fault after manual acknowledgement.
	26:	Acknowledgement of all faults and restart with ON/OFF1 = 1 command.

Parameter	Explanation
p1211	**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. p1211 = 0 or 1: The inverter only tries to start once. After an unsuccessful start attempt, the inverter issues fault F07320. p1211 = n, n > 1: The inverter tries to start n-times The inverter outputs fault F07320 if the nth starting attempt was unsuccessful. 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.
p1212	**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.
p1213[0]	**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.
p1213[1]	**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, during the monitoring time p1213[1], the inverter made more successful starting attempts than defined in p1211, the inverter interrupts the automatic restart function and signals fault F07320. To switch on the motor again you must acknowledge the fault and switch on the inverter (ON/OFFS1 = 1).

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

Danger to life if an OFF command has no effect.

When the inverter is only controlled via the fieldbus interface, the motor restarts with the setting p1210 = 6, 16, 26 – even if the communication link is currently interrupted. When communication is interrupted, the control system cannot switch off the motor.

- Enter the fault number of the communication error in parameter p1206.

  Example:

  Fault number F01910 means: Communication via PROFIBUS failed.

  Set p1206[n] = 1910 (n = 0 … 9).

6.7.7 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.

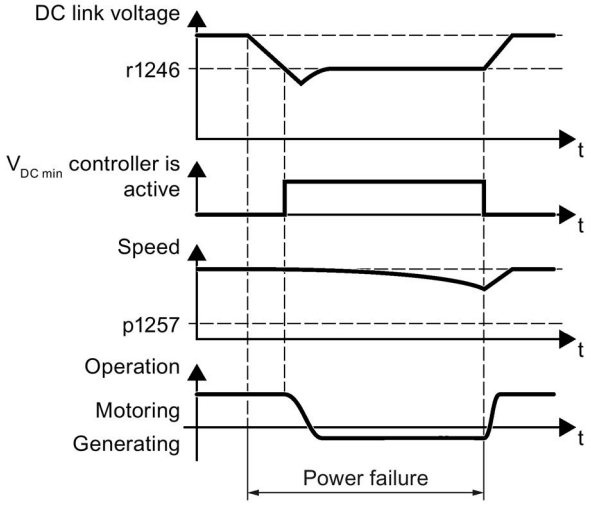


Figure 6-48 Principle mode of operation of kinetic buffering

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.	

6.7.8 Line contactor control

The line contactor control is used to switch on and switch off the power supply voltage for the inverter via a digital output of the inverter. Precondition is an external 24 V power supply for the inverter CU.

You can monitor when the line contactor opens and closes using the feedback signal contact of the contactor.

The function has the advantage that you only switch on the line voltage for the inverter briefly before the motor must be switched on. If the motor is switched off, after an adjustable wait time, the line voltage for the inverter is switched off again.

This means that you reduce the inverter losses for the times when the motor is not operational.

Activate line contactor control

You activate the line contactor control by interconnecting the signal source of a digital output of the inverter (depending on the particular inverter, p0730 … p0741) with the signal to control the line contactor (r0863.1). For example: p0732 = 863.1.

Line contactor control without monitoring - factory setting:

In the factory setting, the function for a line contactor without feedback signal contact is set. The feedback signal is linked with the signal to control the line contactor: p0860 = 863.1.

For an OFF1, the line contactor opens after the delay time setting in p0867.

Line contactor control with monitoring:

If you use a line contactor with feedback signal contact, activate the feedback signal by linking the parameter for the feedback signal - p0860 -with the inverted signal of a digital input: p0860 = 723.x.

If monitoring is active, when switching off or switching on, message F07300 is output, if, after the time set in p0861 no feedback signal is received via r723.x.

In addition for inverters with STO: Sequence control via p0869

Using p0869, you set whether the line contactor immediately opens for an STO signal, or only after the time set in p0867 has expired.

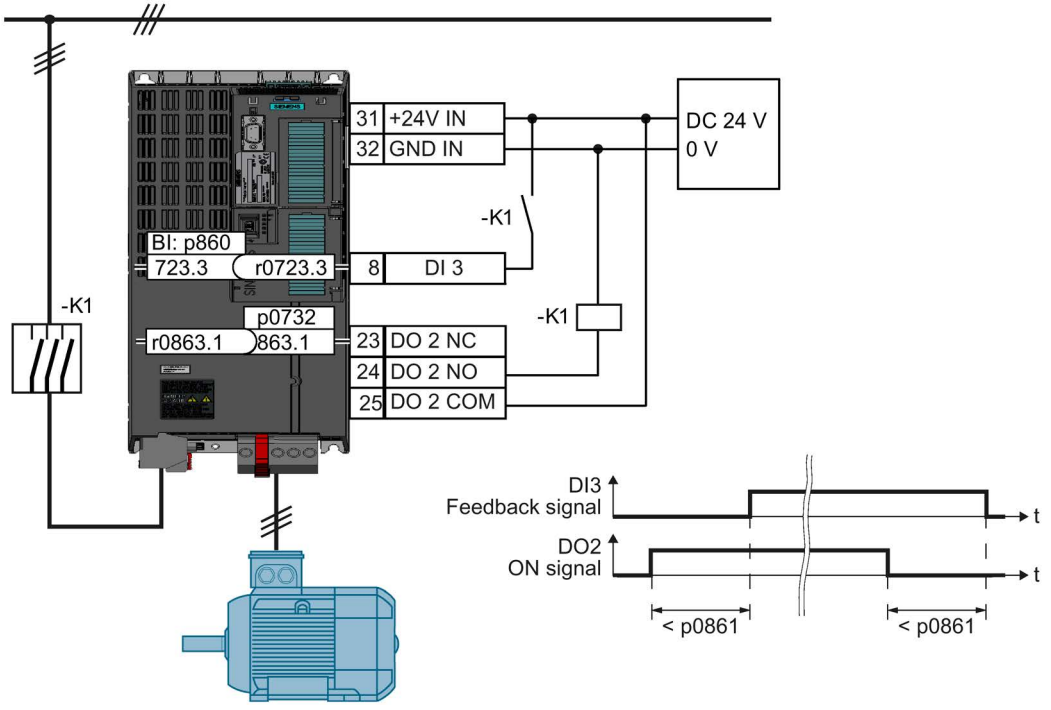


Figure 6-49 Line contactor control with monitoring

Parameter to set the line contactor control

Parameter	Explanation
p0860	**Line contactor feedback signal** • p0860 = 863.1: No feedback signal • p0860 = 723.x: Feedback signal via DIx
p0861	**Line contactor monitoring time** (Factory setting: 100 ms) Fault F07300 is output if, for an activated feedback signal, no feedback signal is received via the selected digital input after the time set here has expired.
r0863.1	**Drive coupling status/control word** Bit to activate the line contactor control: Assign 863.1 to DO x, Example: Control line contactor via digital output DO 2: p0732 = 863.1
p0867	**Main contactor holding time after OFF1** (Factory setting: 50 ms) Time where, after an OFF1, the main contactor remains closed.
p0869	**Sequence control configuration** • p0689 = 0: Line contactor opens immediately for an STO • p0689 = 1: For an STO, the line contactor opens after the time set in p0867 has expired

6.7.9 PID technology controller

6.7.9.1 Overview

The technology controller controls process variables, e.g. pressure, temperature, level or flow.

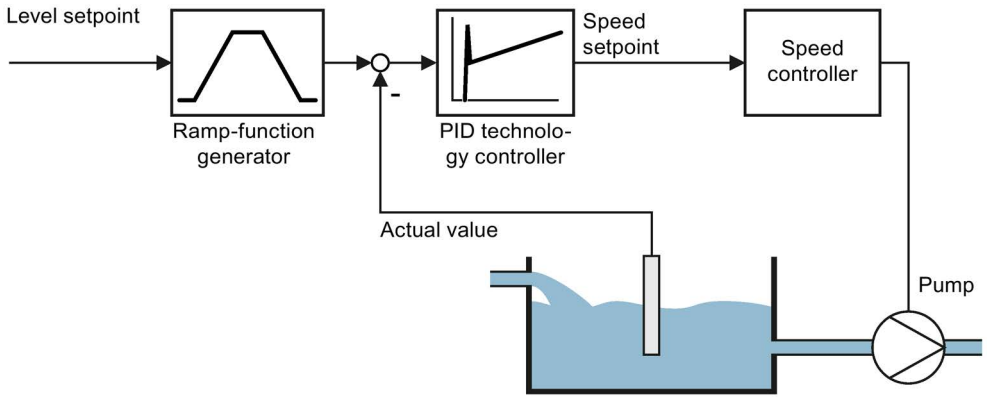
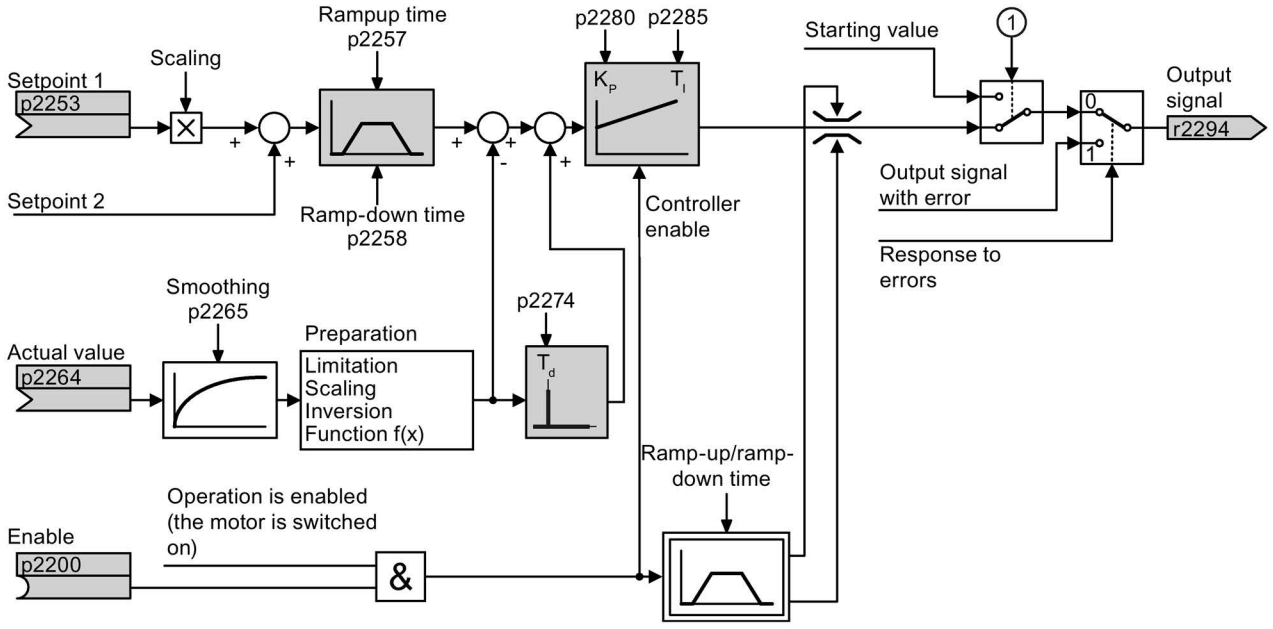


Figure 6-50 Example: Technology controller as a level controller

6.7.9.2 Setting the controller

Simplified representation of the technology controller

The technology controller is implemented as a PID controller (controller with proportional, integral, and derivative action).



① The inverter uses the start value when all the following conditions are simultaneously satisfied:

- 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.

Figure 6-51 Simplified representation of the technology controller

The settings required as a minimum are marked in gray in the function diagram: Interconnect setpoint and actual values with signals of your choice, set the ramp-function generator and controller parameters K_P, T_I and T_d.

You will find information on the following PID controller topics in the Internet at: FAQ (http://support.automation.siemens.com/WW/view/en/92556266)

- Setpoint value specification: Analog value or fixed setpoint
- Setpoint channel: Scaling, ramp-function generator and filter
- Actual value channel: Filter, limiting and signal processing
- PID controller Principle of operation of the D component, inhibiting the I component and the control sense
- Enable, limiting the controller output and fault response

Setting the technology controller

Parameter	Remark
p2200	**BI: Technology controller enable** (factory setting: 0)
	1 signal: Technology controller is enabled.
r2294	**CO: Technology controller output signal** To interconnect the main speed setpoint with the technology controller output, set p1070 = 2294.
p2253	**CI: Technology controller setpoint 1** (factory setting: 0) 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	**CI: Technology controller actual value** (factory setting: 0) Technology controller actual value.
p2257, p2258	**Technology controller ramp-up time** and **ramp-down time** (factory setting: 1 s)
p2274	**Technology controller differentiation time constant T_d** (factory setting: 0.0 s) The differentiation improves the rise time for very slow controlled variables, e.g. a temperature control.
p2280	**Technology controller proportional gain K_P** (factory setting: 1,0)
p2285	**Technology controller integration time (integral time) T_d** (factory setting: 30 s)

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	**CI: Technology controller maximum limiting signal source** (factory setting: 1084)	
p2298	**CI: Technology controller minimum limiting signal source** (factory setting: 2292)	
p2291	**CO: Technology maximum limiting** (factory setting: 100 %)	
p2292	**CO: Technology minimum limiting** (factory setting: 0 %)	
Manipulating the actual value of the technology controller		
p2267	**Technology controller upper limit actual value** (factory setting: 100 %)	
p2268	**Technology controller lower limit actual value** (factory setting: -100 %)	
p2269	**Technology controller gain actual value** (factory setting: 100 %)	
p2271	**Technology controller actual value inversion (sensor type)**	
	0:	No inversion
	1:	Inversion actual value signal If the actual value decreases with increasing motor speed, then p2271 must be set = 1.
p2270	**Technology controller actual value function**	
	0:	No function
	1:	√
	2:	x^2
	3:	x^3

For further information refer to the function block diagrams 7950 ff of the List Manual.

Autotuning of the PID controller

Requirements

The PID technology controller must be set the same as when used in subsequent operation:

- The actual value is interconnected.
- Scalings, filter and ramp-function generator have been set.
- The PID technology controller has been enabled (p2200 = 1 signal)

Procedure



Proceed as follows to auto tune the PID controller:

1. Set p2350 to a value of your choice.
2. Set offset p2355. The slower the controlled variable responds, the higher p2350 must be.
3. Switch on the motor.

   The inverter signals Alarm A07444.

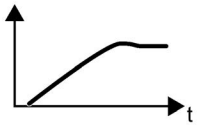
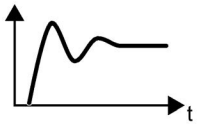
4. Wait until alarm A07444 goes away.

   The inverter has recalculated parameters p2280, p2274 and p2285.

   If the inverter signals fault F07445, then increase p2354 and repeat the autotuning.

5. Back up the calculated values so that they are protected against power failure, e.g. using the BOP-2: OPTIONS → RAM-ROM.

You have auto tuned the PID controller.

Parameter	Remark		
p2350	**PID Autotune Enable** (Factory setting: 0)		
	0:	No function	
	1:	Autotuning based on the “Ziegler Nichols” technique. The controlled variable follows the setpoint relatively quickly after a step-like setpoint change, however with some overshoot.	
	2:	Faster controller setting than setting 1, with a higher overshoot of the controlled variable.	
	3:	Slower controller setting then setting 1. Overshoot of the controlled variable is, to a large extent, avoided.	
	4:	The autotuning only optimizes the P and I component of the PID controller.	
p2354	**PID tuning timeout length** (Factory setting: 240 s) Max. wait time until the autotuning must have identified the control loop oscillating.		
p2355	**PID tuning offset** (Factory setting: 5 %) Offset and deviation for autotuning		

6.7.9.3 Optimizing the controller

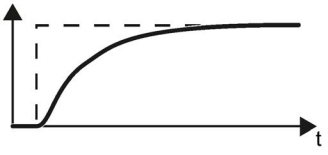
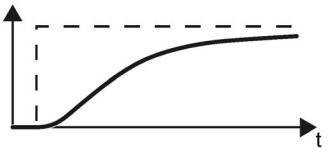
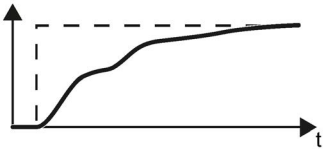
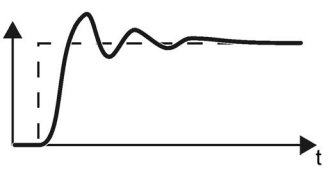
Setting the technology controller without autotuning (manual)

Procedure

1
2

Proceed as follows to manually 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_I.
	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_I.

3. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.

You have now manually set the technology controller.

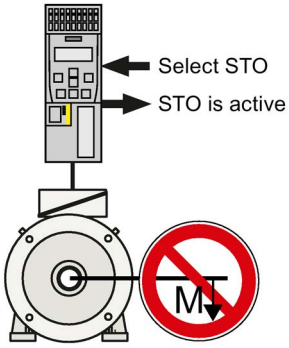
6.8 Safe Torque Off (STO) safety function

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 409).

6.8.1 Function description

How does the STO safety function work?



The inverter with active STO function prevents machine components from inadvertently starting.

Table 6- 42 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 motor holding brake. If you use a line contactor, the inverter opens the line contactor.
3.	The inverter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	---

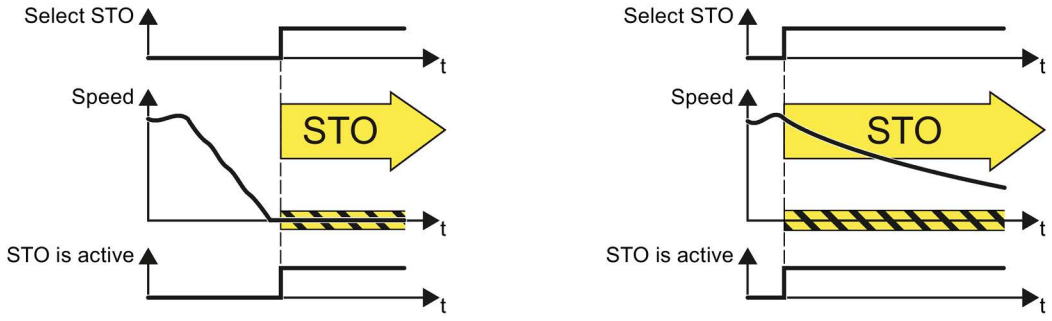


Figure 6-52 Functionality of STO when motor is rotating and at a standstill

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:

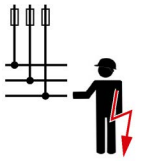
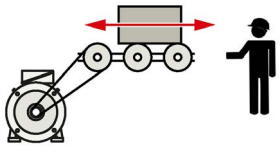
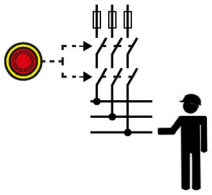
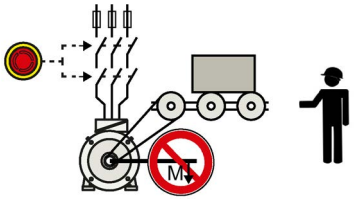
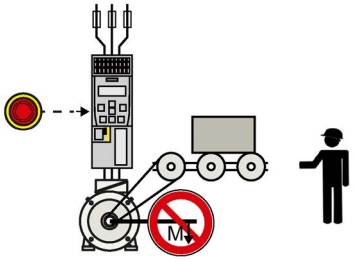
"[…] [The inverter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)."

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.

6.8.2 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.

6.8.3 Commissioning STO

6.8.3.1 Commissioning tools

We strongly recommend that you commission the safety functions using a PC tool.

Table 6- 43 PC-based commissioning tools

Download	Article number	More information
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3072-0AA00-0AG0	STARTER videos (http://www.automation.siemens.com/mcms/mc-drives/en/low-voltage-inverter/sinamics-g120/videos/Pages/videos.aspx)
Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)	6SL3072-4CA02-1XG0	Tutorial (http://support.automation.siemens.com/WW/view/en/73598459)

6.8.3.2 Protection of the settings from unauthorized changes

The safety functions are protected against unauthorized changes by a password.

Table 6- 44 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**

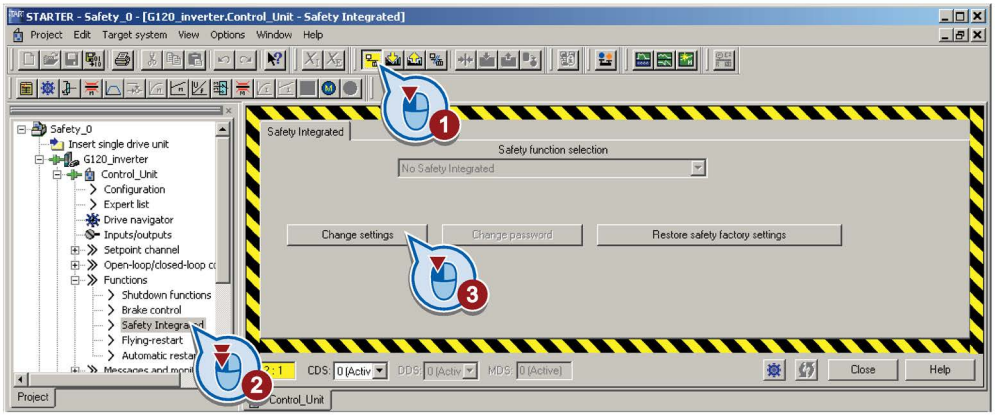
6.8.3.3 Configuring a safety function

Procedure with STARTER

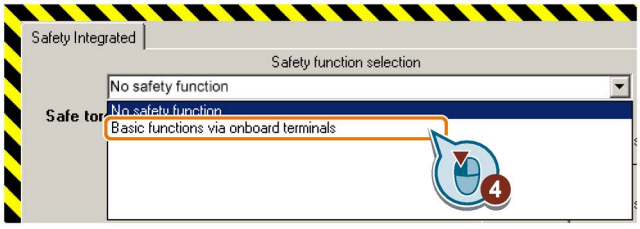
1
2

To configure the safety functions, proceed as follows:

1. Go online.
2. Select the "Safety Integrated" function
3. Select "Change settings".



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.

The other selection options are described in the "Safety Integrated Function Manual". See also section: Manuals for your inverter (Page 409).

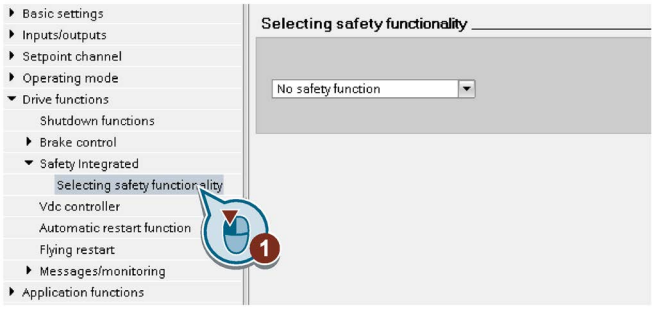
6.8.3.4 Configuring a safety function

Procedure with Startdrive

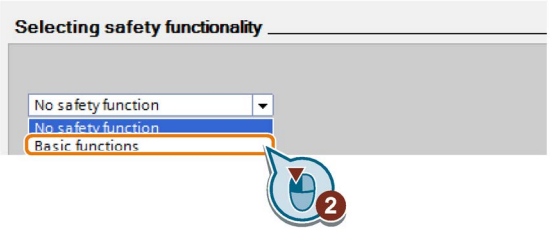
1
2

Proceed as follows to configure the safety functions:

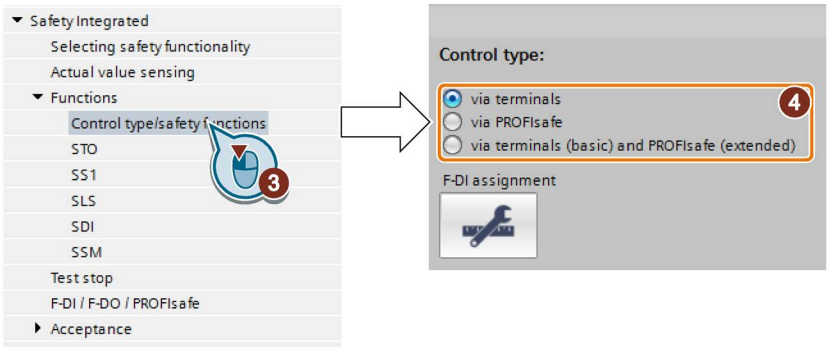
1. Select "Select safety functionality".



2. Enable the safety functions:



3. Select the control type of the safety functions:



4. Define the interface for controlling the safety functions.

You have configured the safety functions

Parameter	Description	
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
		Enabled functions:
	0 hex	None
	1 hex	Basic functions via onboard terminals
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Password confirmation**	

6.8.3.5 Interconnecting the "STO active" signal

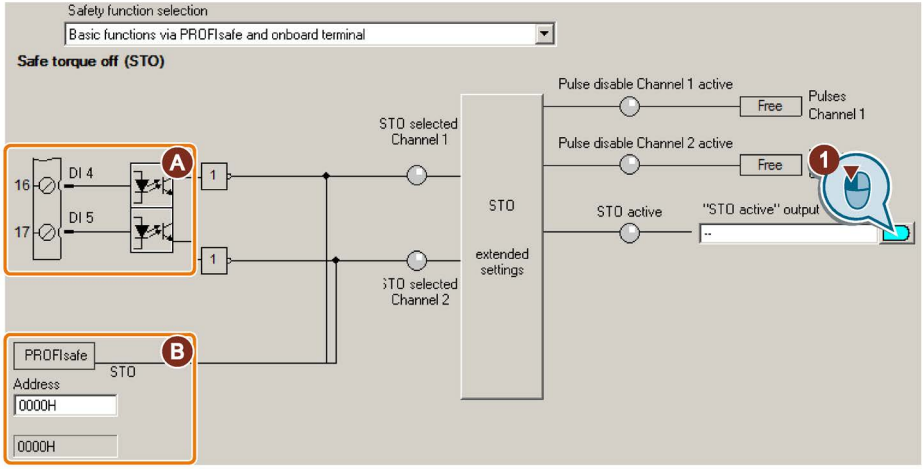
If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure with STARTER and Startdrive

1
2

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.

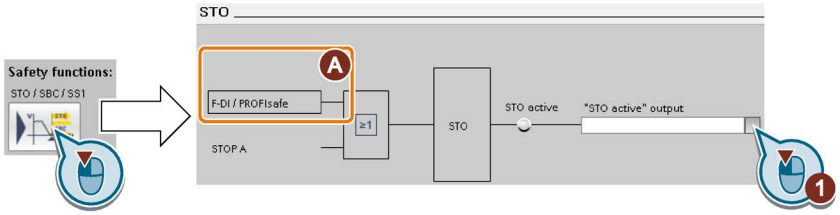


The screen form varies depending on the interface selected.

(A) Input terminals

(B) PROFIsafe interface

Figure 6-53 Interconnecting "STO active" in STARTER



The screen form varies depending on the interface selected.

(A) Control type

Figure 6-54 Interconnecting "STO active" in Startdrive

2. Select the signal that matches your particular application.

You have interconnected the "STO active" checkback signal. After STO has been selected, the inverter signals "STO active" to the higher-level control.

Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

6.8.3.6 Setting the filter for safety-related inputs

Requirement

You are online with STARTER or Startdrive online.

Procedure with STARTER and Startdrive

1
2

To set the input filter and simultaneity monitoring of the safety-related input, proceed as follows:

1. Navigate to the filter settings.

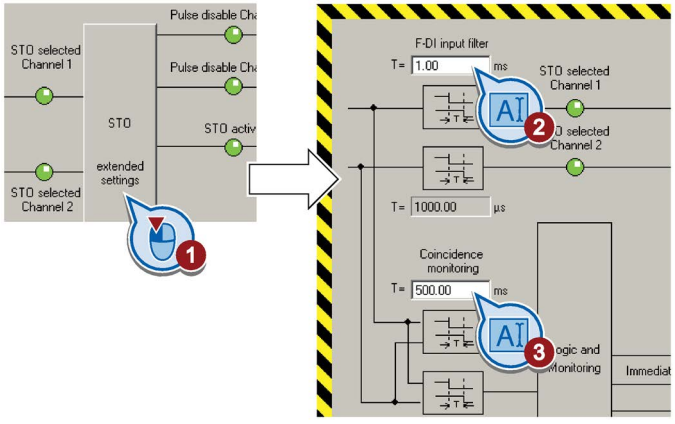


Figure 6-55 Input filter and simuntaneity monitoring in STARTER

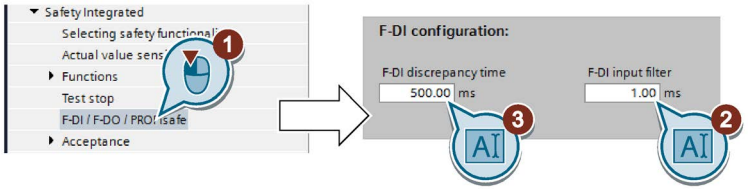


Figure 6-56 Input filter and simuntaneity monitoring in Startdrive

2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Only applies to STARTER: 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 time for the simultaneity monitoring.
- A filter to suppress short signals, e.g. test pulses.

Tolerance time for the simultaneity 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.

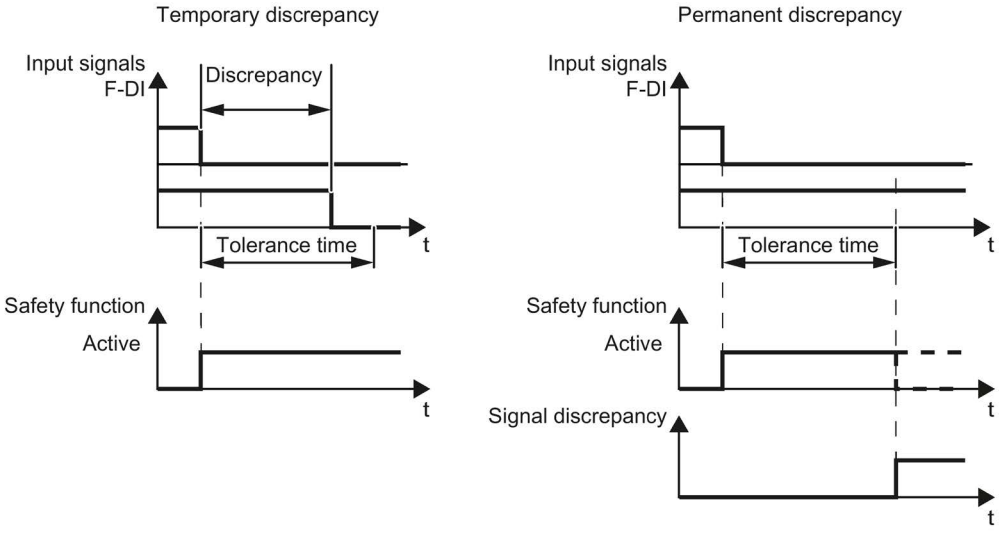


Figure 6-57 Tolerance regarding discrepancy

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.

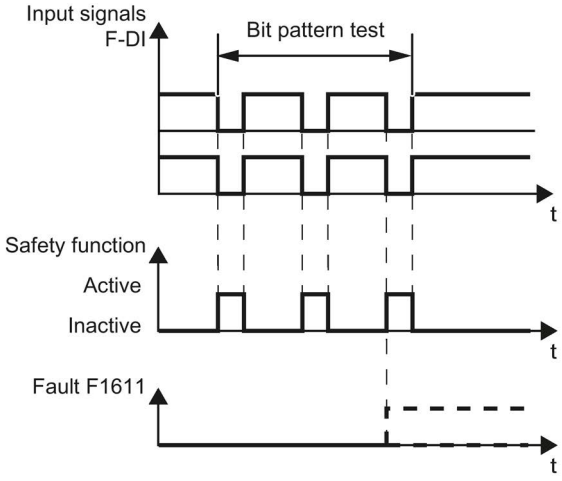


Figure 6-58 Inverter response to a bit pattern test

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.

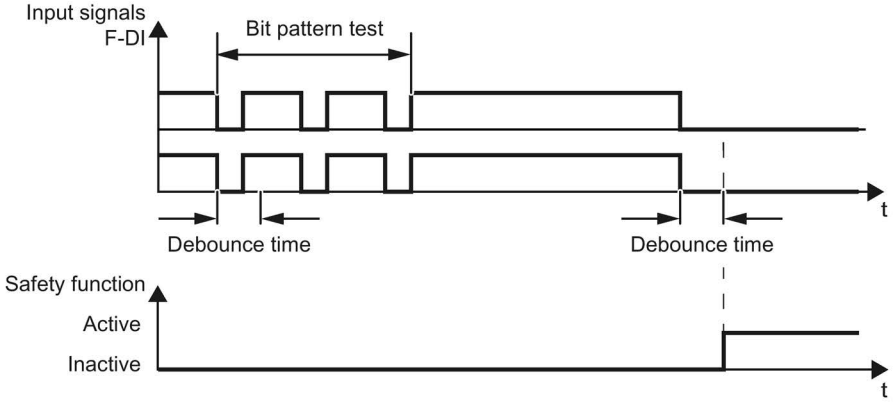


Figure 6-59 Filter for suppressing temporary signal changes

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.

6.8.3.7 Setting the forced checking procedure (test stop)

Requirement

You are online with STARTER or Startdrive online.

Procedure with STARTER and Startdrive

1
2

To set the forced checking procedure (test stop) of the basic functions, proceed as follows:

1. Select the screen form for setting the forced checking procedure.

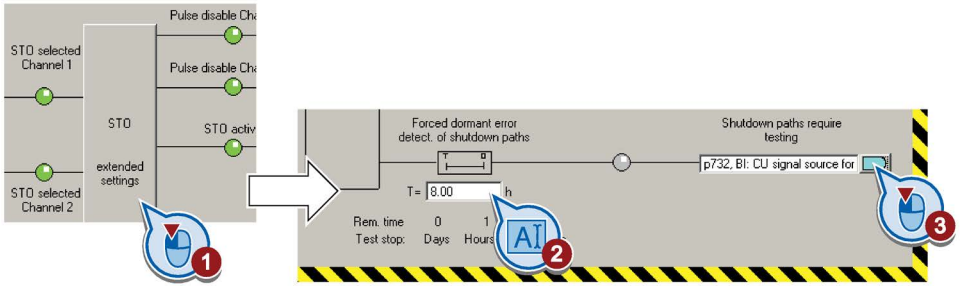


Figure 6-60 Setting the forced checking procedure with STARTER

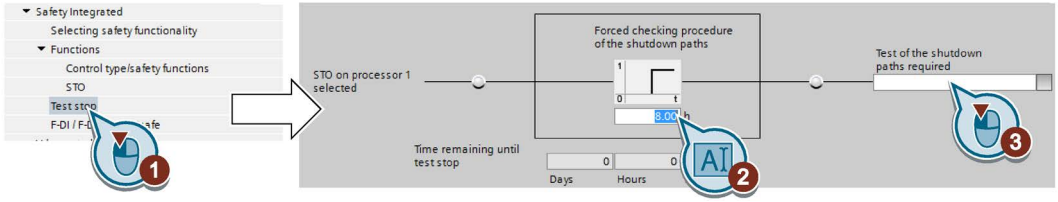


Figure 6-61 Setting the forced checking procedure with Startdrive

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.
4. Only applies to STARTER: Close the screen form.

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.

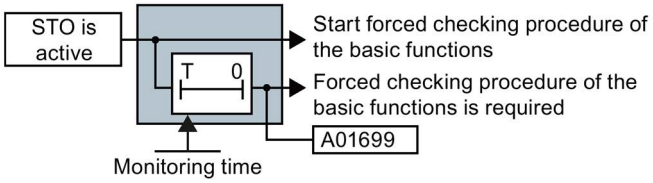


Figure 6-62 Starting and monitoring the forced checking procedure (test stop)

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.

6.8.3.8 Activating the settings and checking the digital inputs

Activate settings

Requirement

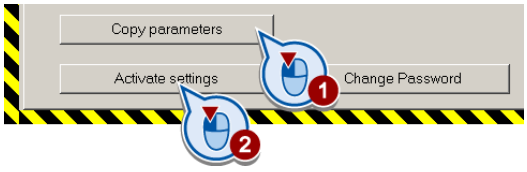
You are online with STARTER or Startdrive online.

Procedure with STARTER

1
2

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.

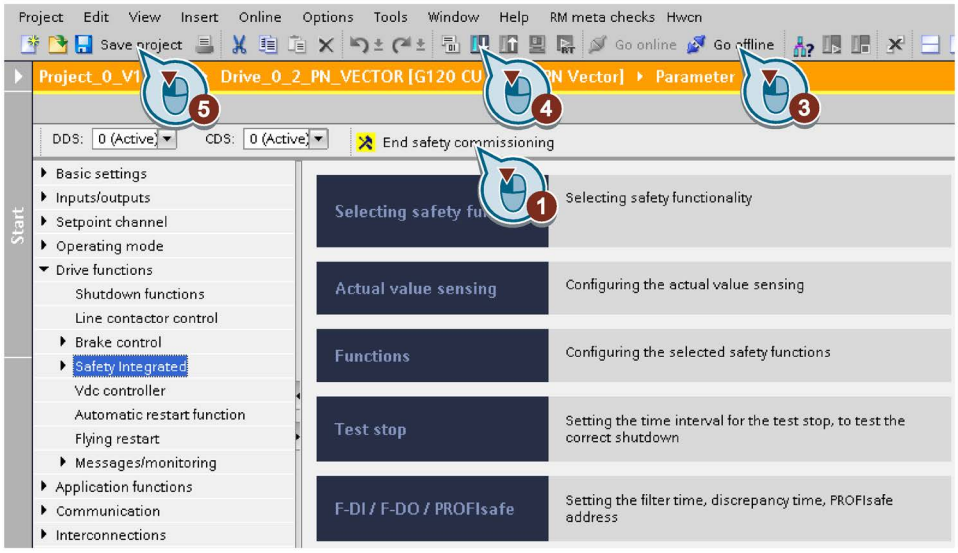
Your settings are now active.

Procedure with Startdrive

1
2

To activate the settings of the safety functions in the drive, proceed as follows:

1. Click the "End safety commissioning" button.



2. Confirm the prompt for saving your settings (copy RAM to ROM).
3. Disconnect the online connection.
4. Select the "Load from device (software)" button.
5. Save the project.
6. Switch off the inverter supply voltage.
7. Wait until all LEDs on the inverter go dark (no voltage condition).
8. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = D0 hex	**SI copy function** (factory setting: 0) Start 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.

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.

Procedure with STARTER

1
2

Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:

1. In the project navigator, select the inputs/outputs.
2. Select the screen for the digital inputs.
3. Remove all digital input interconnections that you use as safety-related input F-DI:

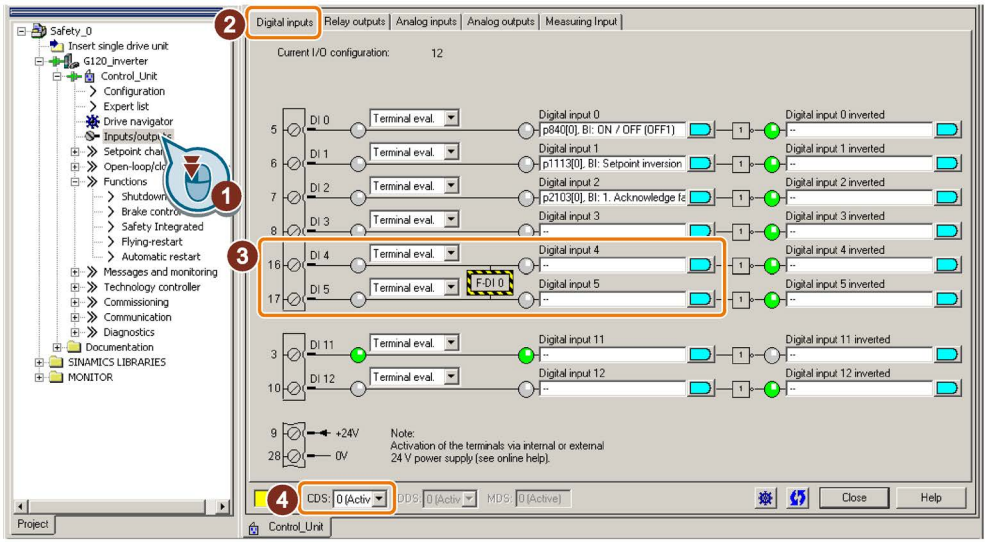


Figure 6-63 Removing the DI 4 and DI 5 digital-input connections

4. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

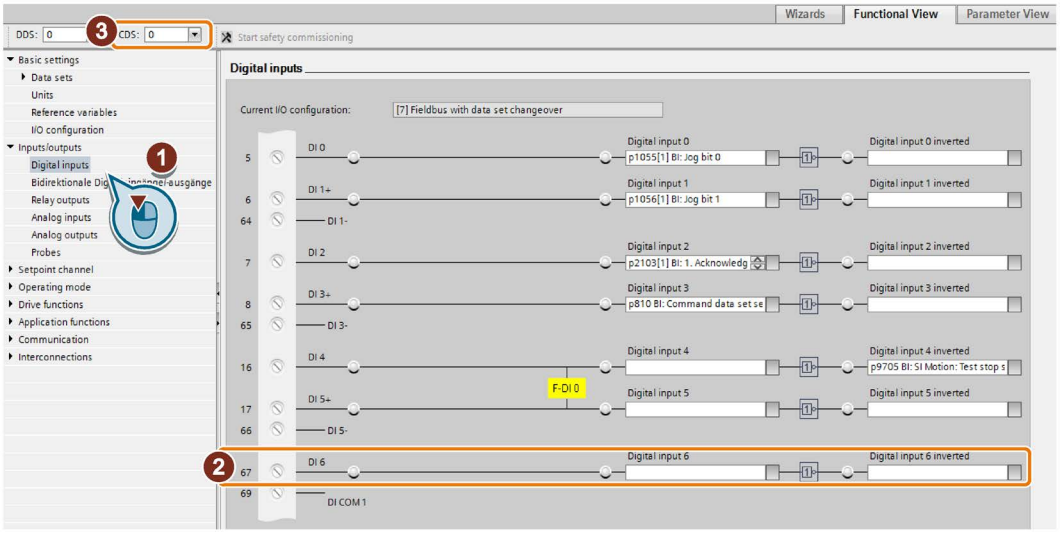
   You can find a description of the CDS switchover in the operating instructions.

You have ensured that the safety-related inputs only control safety functions in the inverter.

Procedure with Startdrive

1
2 Proceed as follows to check as to whether the safety-related inputs are only used for the safety functions:

1. Select the screen for the digital inputs.
2. Remove all digital input interconnections that you use as safety-related input F-DI:



3. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

   You can find a description of the CDS switchover in the operating instructions.

You have ensured that the safety-related inputs only control safety functions in the inverter.

6.8.3.9 Acceptance - completion of 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: Recommended acceptance test (Page 403).

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 278).

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

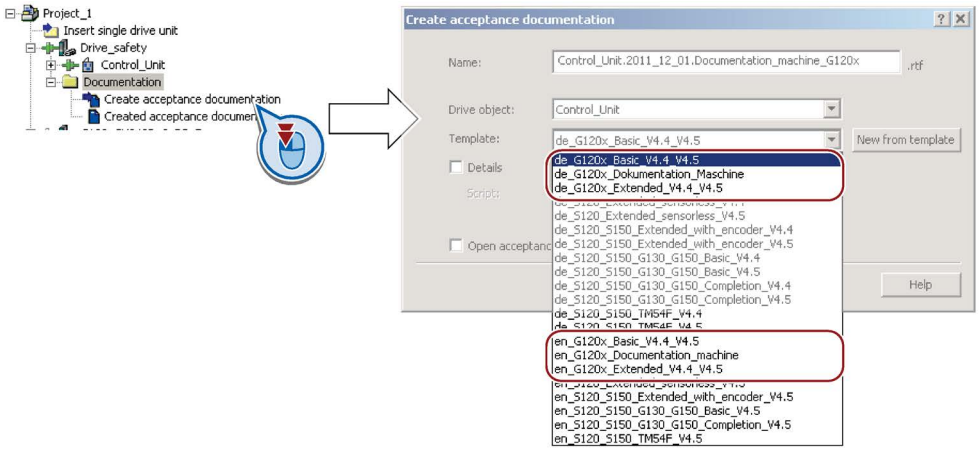
The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

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:

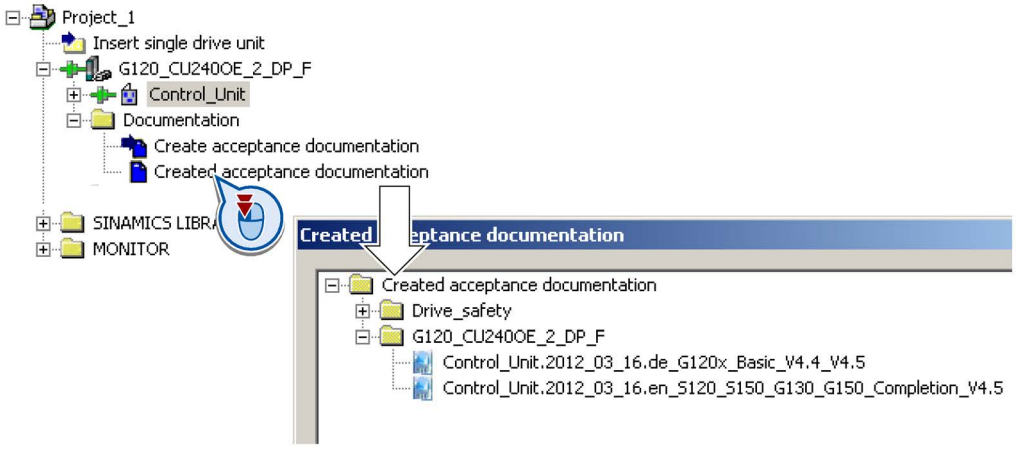
     de_G120x_Dokumentation_Maschine: German template.

     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 test for the safety function (Page 403).

6.9 Switchover between different settings

In several applications, the inverter must be able to be operated with different 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 parameterize several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0 or 1). Via control commands select one of the two indices and therefore one of the two saved settings.

The settings in the inverter with the same index are known as drive data set.

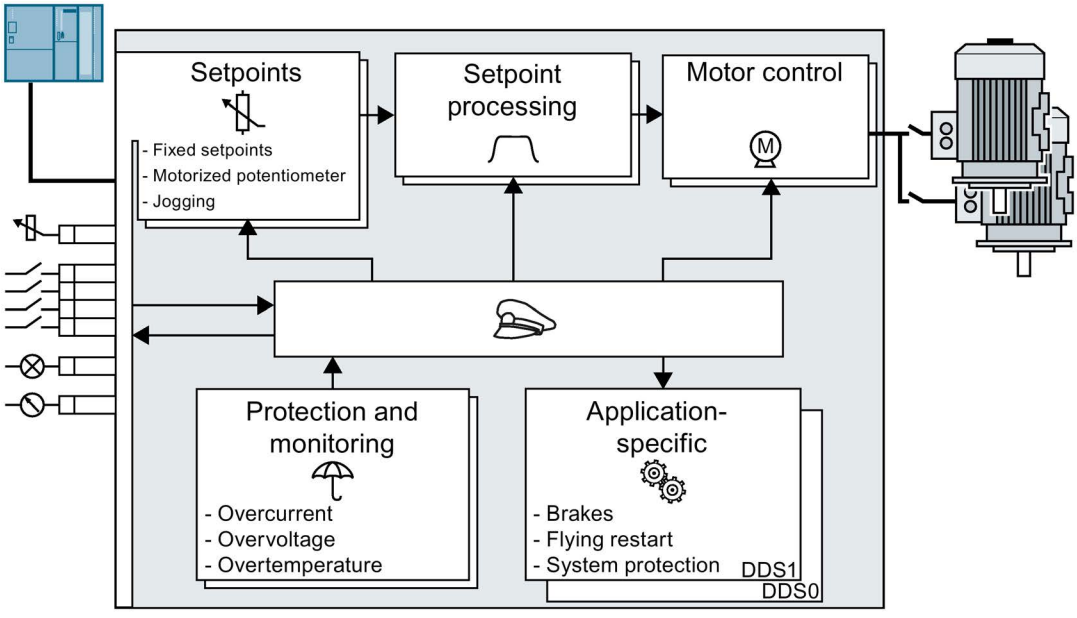


Figure 6-64 DDS switchover in the inverter

You can use parameter p0180 to define the number of drive data sets (1 or 2).

Table 6- 45 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 6- 46 Parameters for switching the drive data sets:

Parameter	Description
p0820	**Drive data set selection DDS**
p0826	**Motor changeover, motor number**
r0051	**Displaying the number of the DDS that is currently effective**

For an overview of all the parameters that belong to the drive data sets and can be switched, see the Parameter Manual.

Note

You can only switch over the motor data of the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.

If you do not switch over the motor data together with the drive data sets (i.e. same motor number in p0826), then the drive data sets can also be switched over in operation.

Table 6- 47 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).

Backing up data and series commissioning 7

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 a converter without data backup (Page 318)).

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 article 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.

7.1 Saving settings on a memory card

What memory cards do we recommend?

You will find the recommended memory cards in section: Scope of delivery (Page 25).

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 the recommended memory cards.
- Know-how protection is only possible with one of the recommended memory cards.
- Under certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the inverter.

7.1.1 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 back up the inverter settings on a memory card, you have two options:

Automatically backing up

Preconditions

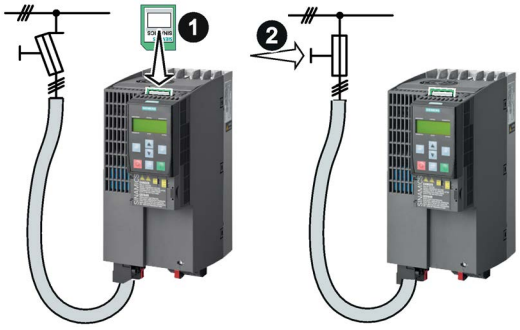
- The inverter power supply has been switched off.
- No USB cable is inserted in the inverter.

Procedure

1
2

Proceed as follows to automatically back up your settings:

1. Insert an empty memory card into the inverter.
2. Switch on the operating voltage of the inverter.



After the power supply has been switched on, the inverter copies its changed settings to the memory card.

Note

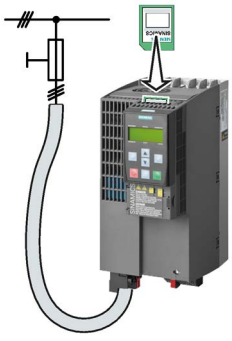
If the memory card is not empty, then the inverter accepts the data from the memory card. This data then overwrites the data in the inverter.

- Only use empty memory cards when automatically backing up your settings for the first time.

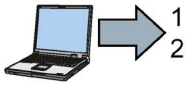
Manually backing up

Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

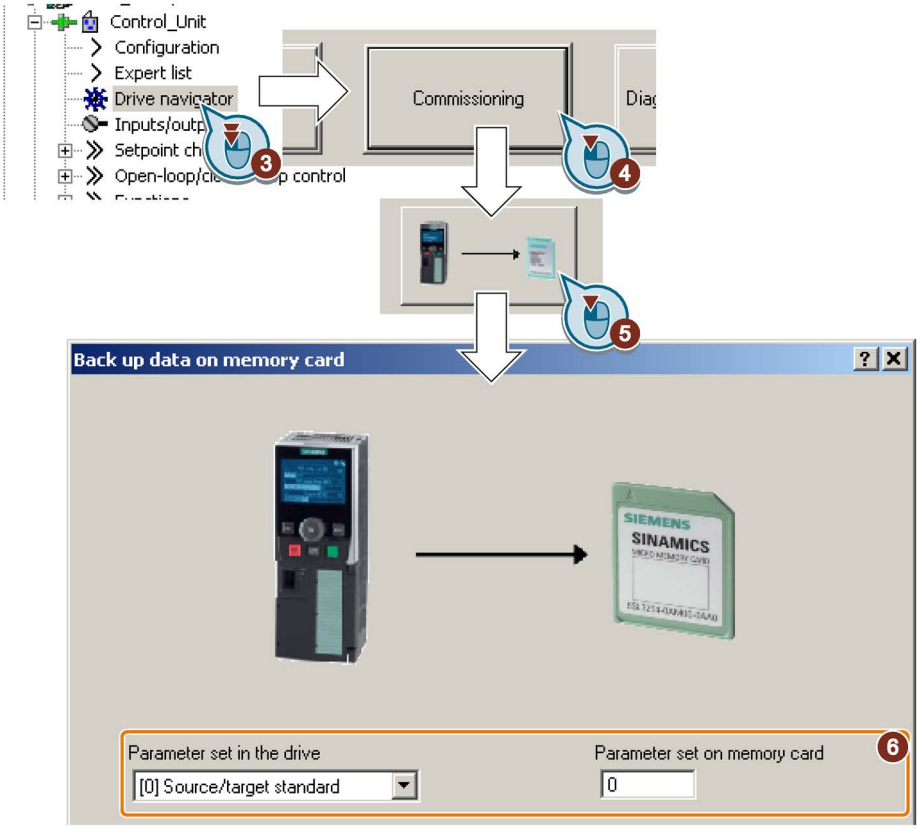


Procedure with STARTER



Proceed as follows to back up your settings on a memory card:

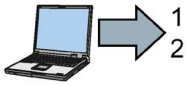
1. Go online.
2. Press the “Copy RAM to ROM” button .
3. In your drive, select "Drive Navigator".



4. Select the "Commissioning" button.
5. Select the button to transfer the settings to the memory card.
6. Select the settings as shown in the diagram and start the data backup.
7. Wait until STARTER signals that the data backup has been completed.
8. Close the screen forms.

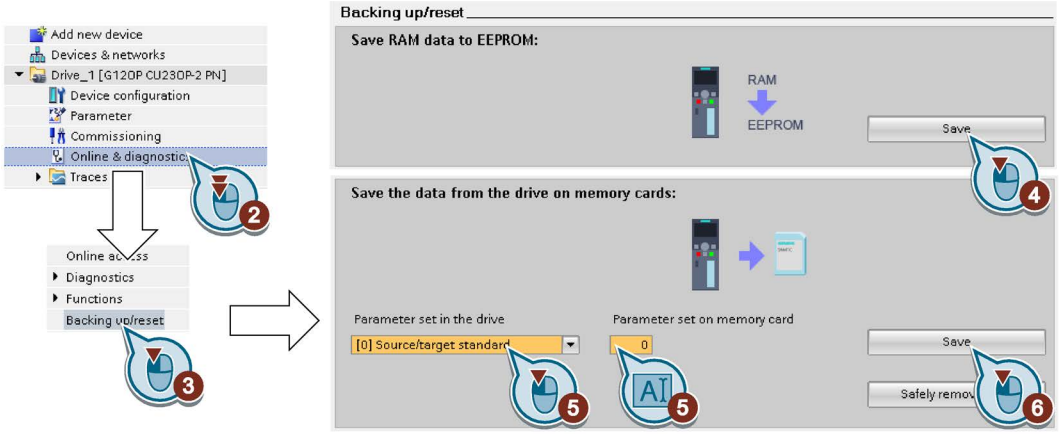
You have backed up the settings of the inverter on the memory card.

Procedure with Startdrive



Proceed as follows to back up the inverter settings to a memory card:

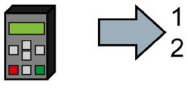
1. Go online.
2. Select "Online & diagnostics".



3. Select "Backing up/reset".
4. Back up the settings to the EEPROM of the inverter.
5. Select the settings as shown in the diagram.
6. Start data transfer
7. Wait until Startdrive has signaled that the data backup has been completed.

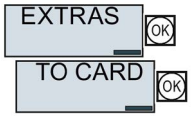
You have backed up the inverter settings to a memory card.

Procedure with BOP-2

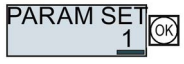


Proceed as follows to back up your settings on a memory card:

1. If a USB cable is inserted in the inverter, withdraw it.
2. Go to the "OPTIONS" menu.
3. In the "OPTIONS" menu, select “TO CARD”.



4. Set the number of your data backup. You can back up 99 different settings on the memory card.



5. Start data transfer with OK.



6. Wait until the inverter has backed up the settings to the memory card.



You have backed up the settings of the inverter on the memory card.

7.1.2 Transferring the setting from the memory card

Automatically transferring

Precondition

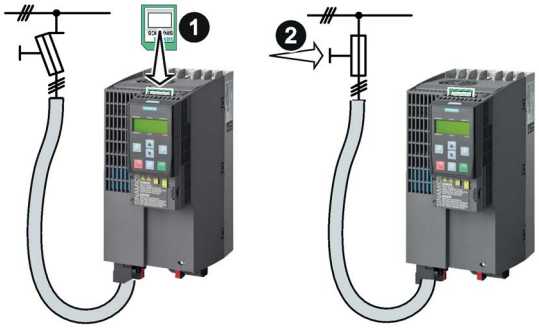
The inverter power supply has been switched off.

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.

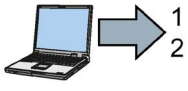
Manually transferring

Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.



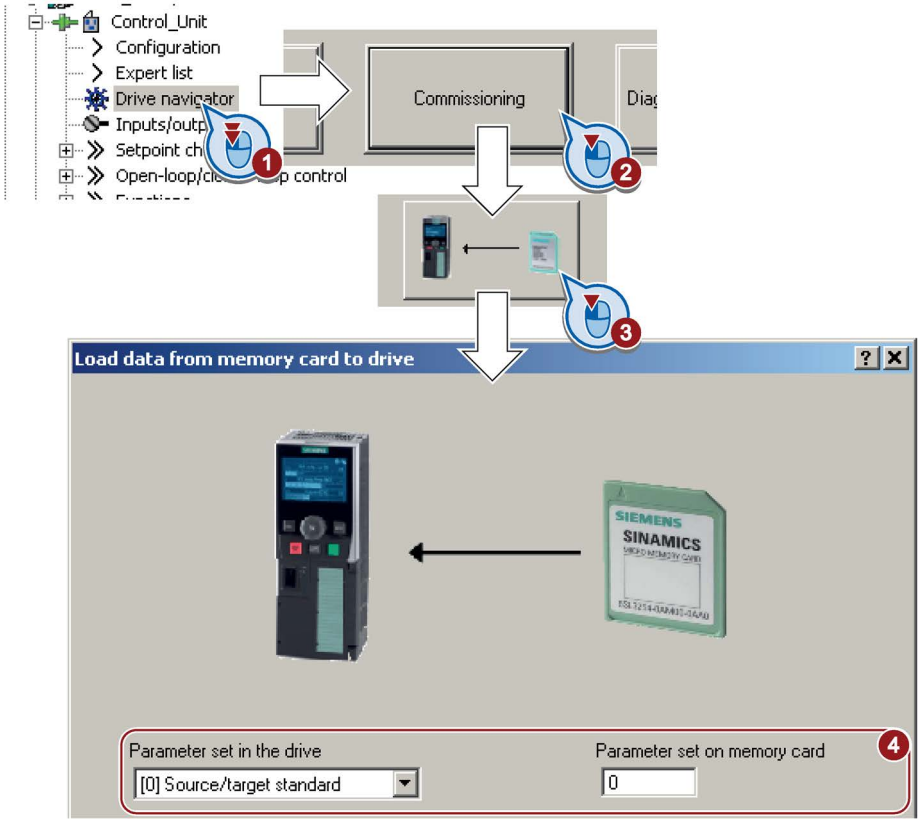
Procedure with STARTER



Proceed as follows to transfer settings from a memory card to the inverter:

1. Go online 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.

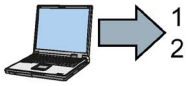


5. Wait until STARTER signals that the data backup has been completed.
6. Close the screen forms.
7. Go offline.
8. Switch off the inverter power supply.
9. Wait until all LEDs on the inverter are dark.
10. Switch on the inverter power supply again.

    Your settings become effective after switching on.

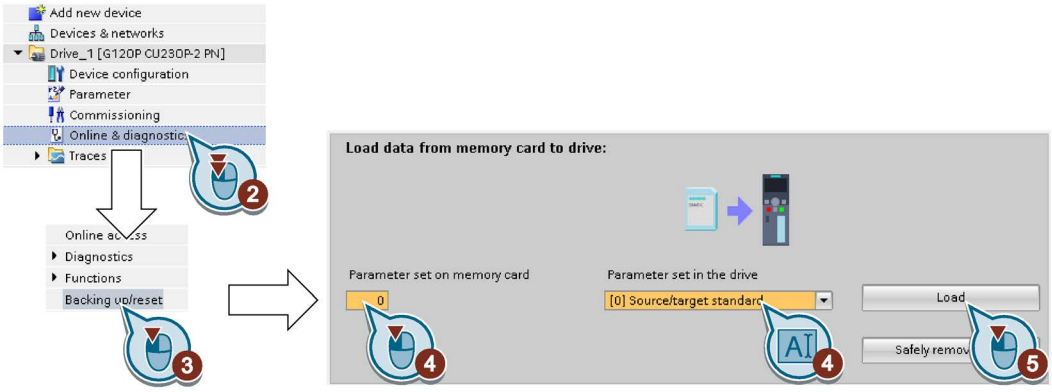
You have now transferred your settings from a memory card to the inverter.

Procedure with Startdrive



Proceed as follows to transfer settings from a memory card to the inverter:

1. Go online.
2. Select "Online & diagnostics".
3. Select "Backing up/reset".



4. Select the settings as shown in the diagram.
5. Start data transfer
6. Wait until Startdrive has signaled that the data transfer has been completed.
7. Go offline.
8. Switch off the inverter power supply.
9. Wait until all LEDs on the inverter are dark.
10. Switch on the inverter power supply again.

    Your settings become effective after switching on.

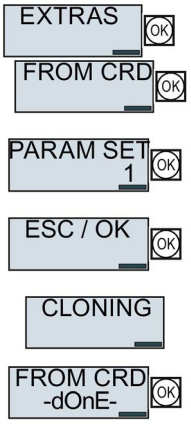
You have now transferred your settings from a memory card to the inverter.

Procedure with the BOP-2



Proceed as follows to transfer the settings from a memory card to the inverter

1. If a USB cable is inserted in the inverter, withdraw it.
2. Go to the menu level “OPTIONS”.
3. In the "OPTIONS" menu, select "FROM CRD".
4. Set the number of your data backup. You can back up 99 different settings on the memory card.
5. Start data transfer with OK.
6. Wait until the inverter has transferred the settings from the memory card.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark.
9. Switch on the inverter power supply again.

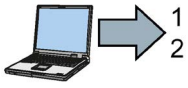


You have transferred the settings from the memory card to the inverter.

7.1.3 Safely remove the memory card

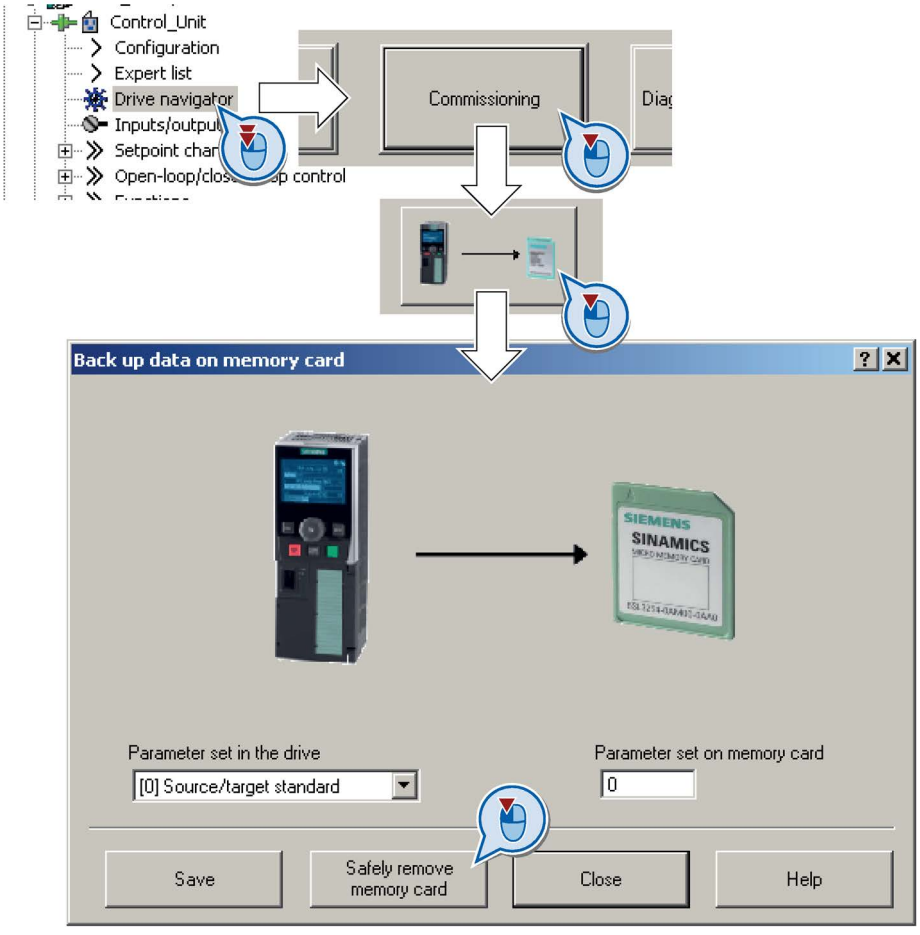
NOTICE
Data loss from improper handling of the memory card If you remove the memory card when the converter is switched on without implementing the "safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting. • Only remove the memory card using the "safe removal" function.

Procedure with STARTER



To safely remove the memory card, proceed as follows:

1. Go online.
2. In the Drive Navigatorselect the following screen form:

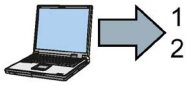


3. Click on the button to safely remove the memory card.

   STARTER will tell you whether you can remove the memory card from the inverter.

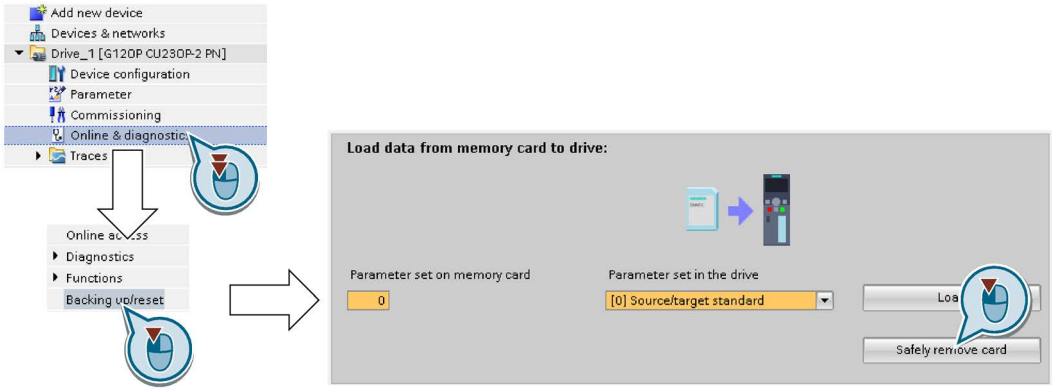
You have now safely removed the memory card from the inverter.

Procedure with Startdrive



To safely remove the memory card, proceed as follows:

1. In the Drive Navigatorselect the following screen form:

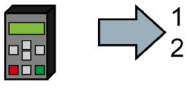


2. Click on the button to safely remove the memory card.

   Startdrive will tell you whether you can remove the memory card from the inverter.

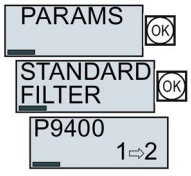
You have now safely removed the memory card from the inverter.

Procedure with the BOP-2

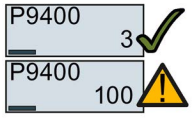


To safely remove the memory card using BOP-2, proceed as follows:

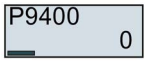
1. Go to parameter p9400. If a memory card is correctly inserted, then p9400 = 1.
2. Set p9400 = 2.



3. The inverter sets p9400 = 3 or p9400 = 100.
   - p9400 = 3: You may remove the memory card from the inverter.
   - p9400 = 100: It is not permissible that you remove the memory card. Wait for several seconds and then set p9400 = 2 again.



4. Remove the memory card. After removing the memory card, p9400 = 0.



You have now safely removed the memory card using BOP-2.

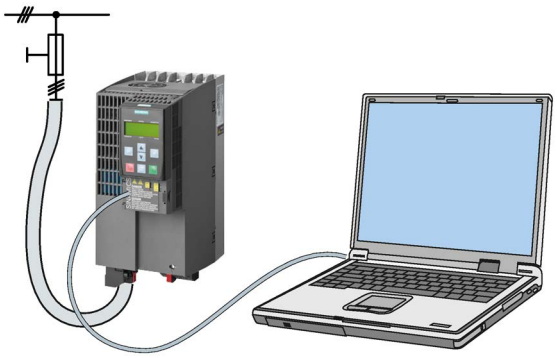
7.2 Saving settings on a PC

You can transfer the inverter settings to a PG/PC, or vice versa, the data from a PG/PC to the inverter.

Requirements

- The inverter power supply has been switched on.
- You have installed one of the commissioning tools STARTER or Startdriveto your PG/PC.

  Additional information regarding commissioning tools is provided in Section: Tools to commission the converter (Page 30).



Inverter → PC/PG

Procedure with STARTER

1
2

To back up the settings with STARTER, proceed as follows:

1. Go online:  .
2. Click the "Download project to PG" button:  .
3. Save the project:  .
4. Wait until STARTER reports that data backup has been completed.
5. Go offline:  .

You have backed up the settings with STARTER.

Procedure with Startdrive

1
2

To back up the settings with Startdrive, proceed as follows:

1. Go online.
2. Select "Online" > "Upload device to PG/PC."
3. Back up the project with "Project" > "Save."
4. Wait until Startdrive reports that data backup has been completed.
5. Go offline.

You have backed up the settings with Startdrive.

PC/PG → inverter

The procedure depends on whether you also transfer settings of safety functions or not.

Procedure with STARTER without enabled safety functions

1
2

To load the settings from the PG to the inverter with STARTER, proceed as follows:

1. Go online:  .
2. Click the "Download project to target system" button:  .
3. Wait until STARTER reports that loading has been completed.
4. To save the data to the non-volatile memory of the inverter, select the "Copy RAM to ROM" button:  .
5. Go offline:  .

You have transferred the settings from the PG to the inverter with STARTER.

Procedure with Startdrive without enabled safety functions

1
2

To transfer the settings from the PG to the inverter with Startdrive, proceed as follows:

1. Go online.
2. Select "Load to device" > "Hardware and software" from the shortcut menu.
3. Wait until Startdrive reports that loading has been completed.
4. Go offline.
5. Confirm the dialog box that then opens by clicking "Yes" to save the data to the non-volatile memory of the inverter (Copy from RAM to ROM).

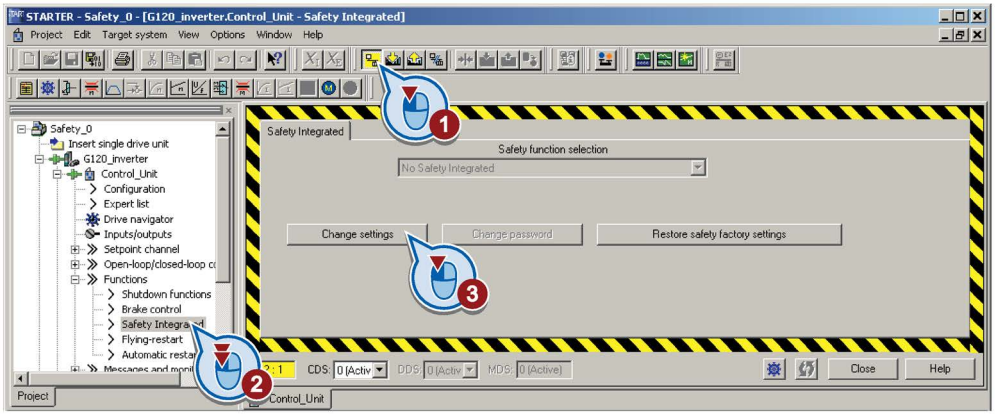
You have transferred the settings from the PG to the inverter with Startdrive.

Procedure with STARTER with enabled safety functions

1
2

To load the settings from the PG to the inverter with STARTER and to activate the safety functions, proceed as follows:

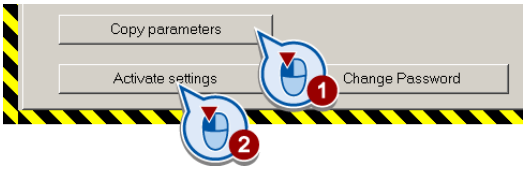
1. Go online:  .
2. Click the "Download project to target system" button:  .
3. Call the STARTER screen form for the safety functions.



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, click the "Copy RAM to ROM" button:  .
4. Go offline:  .
5. Switch off the inverter power supply.
6. Wait until all LEDs on the inverter go off.
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 with STARTER and activated the safety functions.

Procedure with Startdrive

1
2 To transfer the settings from the PG to the inverter with Startdrive and activate the safety functions, proceed as follows:

1. Save the project.
2. Select "Load to device."

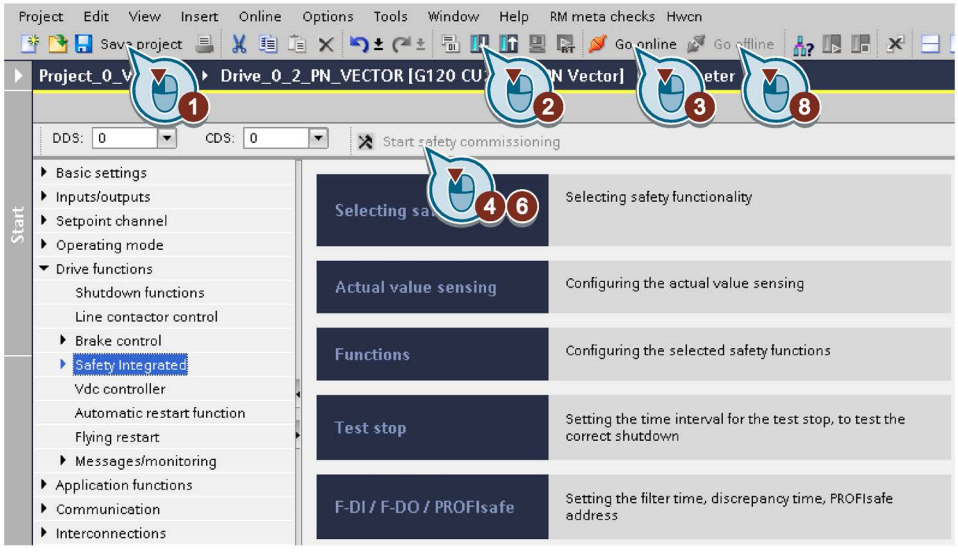


Figure 7-1 Activating settings in Startdrive

3. Connect Startdrive online with the drive.
4. Click the "Start safety commissioning" button.
5. Enter the password for the safety functions.

   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.
6. Click the "End safety commissioning" button.
7. Confirm the prompt for saving your settings (copy RAM to ROM).
8. Disconnect the online connection.
9. Switch off the inverter supply voltage.
10. Wait until all LEDs on the inverter go dark (no voltage condition).
11. Switch on the inverter supply voltage again.

You have transferred the settings from the PG to the inverter with Startdrive and have activated the safety functions.

7.3 Saving settings on an operator panel

You can transfer the inverter settings to the Operator Panel BOP-2 or vice versa, the data from the BOP-2 to the inverter.

Precondition

The inverter power supply has been switched on.

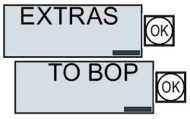
Inverter → BOP-2

Procedure



To back up the settings on the BOP-2, proceed as follows:

1. Go to the menu level “OPTIONS”.
2. In the “OPTIONS” menu, select “TO BOP”.



3. Start data transfer with OK.



4. Wait until the inverter has backed up the settings to the BOP-2.



You have backed up the settings on the BOP-2.

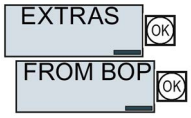
BOP-2 → inverter

Procedure

1
2

To transfer the settings to the inverter, proceed as follows:

1. Go to the menu level “OPTIONS”.
2. In the "OPTIONS" menu, select "FROM BOP".



3. Start data transfer with OK.



4. Wait until the inverter has written the settings to the memory card.



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.
   Your settings become effective after switching on.

You have transferred the settings to the inverter.

7.4 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).

7.5 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.

7.5.1 Write protection

Write protection prevents inadvertently changing inverter settings. If you are working with a PC tool, such as STARTER, then write protection is only effective online. The offline project is not write-protected.

Write protection is applicable for all user interfaces:

- BOP-2 and IOP operator panels
- STARTER or Startdrive PC tool
- Parameter changes via a fieldbus

The write protection is not password-protected.

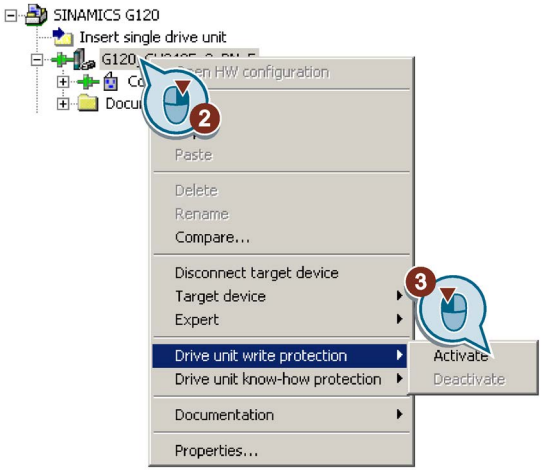
Activate and deactivate write protection

Procedure with STARTER



Proceed as follows to activate or deactivate the write protection:

1. Go online.
2. Open the inverter shortcut menu.
3. Activate or deactivate write protection.
4. Press the “Copy RAM to ROM” button to retentively save the settings.



You have activated or deactivated write protection.

Parameters		
r7760	**Write protection/know-how protection status**	
	.00	Write protection active
p7761	**Write protection** (factory setting: 0)	
	0:	Deactivate write protection
	1:	Activate write protection

Exceptions to write protection

Some functions are excluded from write protection, e.g.:

- Activating/deactivating write protection
- 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".

Note

Write protection for multimaster fieldbus systems

When using multimaster fieldbus systems (e.g. CAN Bus, BACnet), parameters can be changed in spite of an active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

In STARTER, this setting is only possible via the expert list.

7.5.2 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.

Know-how protection with copy protection is only possible using the recommended Siemens card, see also Section: Scope of delivery (Page 25)

List of exceptions

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 307).
3. Activate the know-how protection (Page 305).
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.

7.5.2.1 Settings for know-how protection

Activating know-how protection

Preconditions

- You are online.

  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: Scope of delivery (Page 25).

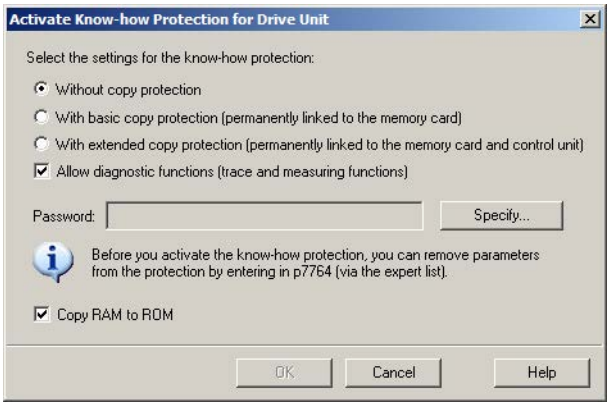
Procedure

1
2

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project and in the shortcut menu select "Know-how protection drive device/activate …" (see also Write protection (Page 301)).
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 know-how protection is activated, you can save the settings to the memory card using p0971.

To do this, set p0971 = 1. The data are written to the memory card encrypted. After saving, p0971 is reset to 0.

Deactivating know-how protection, deleting a password

Preconditions

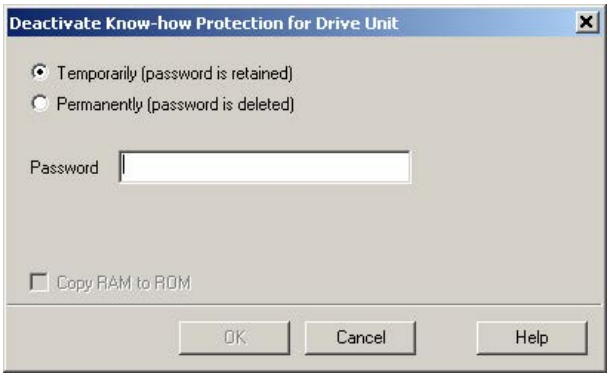
- You are online with STARTER.
- You have inserted the recommended Siemens card. See also Section: Scope of delivery (Page 25).

Procedure

1
2

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and using the right-hand mouse button, open the dialog window “Know-how protection drive device/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 screen form using the shortcut menu “Know-how protection drive device/change password …”.

7.5.2.2 Generating an exception list for know-how protection

Using the exception list, as machine manufacturer you can make individual adjustable parameters accessible to end users 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

1
2

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 deactivate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

Corrective maintenance

8

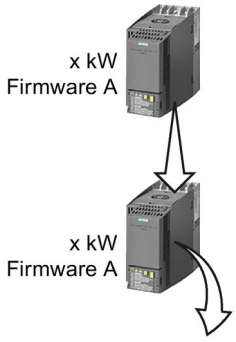
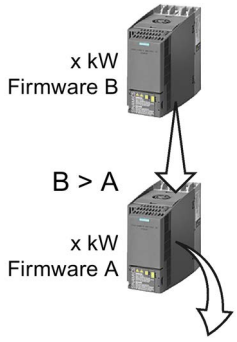
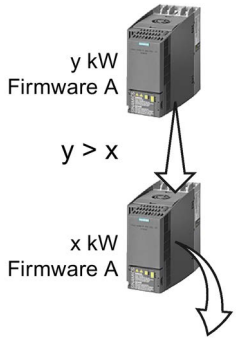
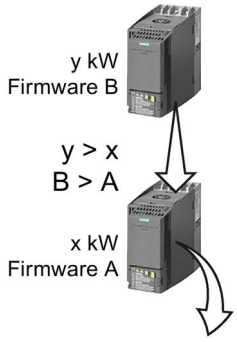
8.1 Replacing inverter components

8.1.1 Overview of how to replace an inverter

Permissible replacement

You must replace the inverter if it continually malfunctions.

In the following cases you will need to replace the inverter:

Replacement: • Same power rating • Same firmware version	Replacement: • Same power rating • *Higher* firmware version (e.g. replace FW V4.2 by FW V4.3)	Replacement: • Same frame size • *Higher* power rating • Same firmware version	Replacement: • Same frame size • *Higher* power rating • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
			
		inverter and motor must be adapted to one another (ratio of the motor and inverter rated power > 1/8)	

After you have carried out the replacement, 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 inverter 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).

8.1.2 Replacing a converter with enabled safety function



⚠DANGER

Danger from touching energized Power Module 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 at a non-hazardous level. Death or serious injury can result when live parts are touched.

- Check that the inverter connections are in a no-voltage condition before you carry out any installation work.

NOTICE

Material damage from swapping the motor's connection lines

The direction in which the motor rotates changes if you interchange the two phases of the motor cable. A motor running backwards may damage the machine or installation.

- Connect the three phases of the motor cables in the correct sequence.
- After replacing the inverter, check the direction in which the motor rotates.

Replacing an inverter with data backup on a memory card

Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
2. Remove the connecting cables of the inverter.
3. Remove the defective inverter.
4. Install the new inverter.
5. Remove the memory card from the old inverter, and insert this into the new inverter.
6. Connect all of the cables to the inverter.
7. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
8. The inverter loads the settings from the memory card.
9. 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:

     Carry out a **reduced**acceptance test, see Section Reduced acceptance after component replacement and firmware change (Page 332).



You have replaced the inverter and transferred the safety function settings from the memory card to the new inverter.

Replacing an inverter with data backup in STARTER

Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using STARTER.

Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
2. Remove the connecting cables of the inverter.
3. Remove the defective inverter.
4. Install the new inverter.
5. Connect all of the cables to the inverter.
6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
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 are dark.
15. Switch on the inverter supply voltage again.
16. Carry out a **reduced**acceptance test, see Section Reduced acceptance after component replacement and firmware change (Page 332).



You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

Replacing an inverter with data backup in Startdrive

Requirement

You have backed up the actual settings of the inverter to be replaced to a PC using Startdrive.

Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
2. Remove the connecting cables of the inverter.
3. Remove the defective inverter.
4. Install the new inverter.
5. Connect all of the cables to the inverter.
6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
7. In Startdrive, open the project that matches the drive.
8. Select "Load to device".
9. Connect Startdrive online with the drive.

   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
10. Press the "Start safety commissioning" button.
11. Enter the password for the safety functions.
12. Confirm the prompt for saving your settings (copy RAM to ROM).
13. Disconnect the online connection.
14. Switch off the inverter supply voltage.
15. Wait until all LEDs on the inverter go dark.
16. Switch on the inverter supply voltage again.
17. Carry out a **reduced**acceptance test, see Section Reduced acceptance after component replacement and firmware change (Page 332).



You have replaced the inverter and transferred the safety function settings from the PC to the new inverter.

Replacing the inverter with data backup in the operator panel (BOP-2 or IOP)

Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
2. Remove the connecting cables of the inverter.
3. Remove the defective inverter.
4. Install the new inverter.
5. Connect all of the cables to the inverter.
6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
7. Attach the operator panel to the inverter.
8. Transfer the settings from the operator panel to the inverter, e.g. via menu "EXTRAS" - "FROM BOP" in the BOP-2.
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 supply voltage.
12. Wait until all LEDs on the inverter go dark.
13. Switch on the inverter supply voltage again.

    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 not lost when the power fails:
    - For BOP-2, in the menu "EXTRAS" - "RAM-ROM".
    - For IOP, in the menu "SAVE RAM TO ROM".
19. Switch off the inverter power supply.
20. Wait until all LEDs on the inverter are dark.

21. Switch on the inverter supply voltage again.
22. Carry out a **reduced**acceptance test, see Section Reduced acceptance after component replacement and firmware change (Page 332).

☐ You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

8.1.3 Replacing a converter without enabled safety function

Replacing a converter with data backup on a memory card

Procedure



To replace the converter, proceed as follows:

1. Disconnect the line voltage to the converter and (if installed) the external 24 V supply or the voltage for the digital outputs of the converter.



⚠ DANGER

Death as a result of electric shock!

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the remaining voltage is non-hazardous.

- Check the voltage at the converter connections, before you carry out any installation work.

2. Remove the connecting cables of the converter.
3. Remove the defective converter.
4. Install the new converter.
5. Remove the memory card from the old converter, and insert this into the new converter.
6. Connect all of the cables to the converter.

NOTICE

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.

- 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.

7. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the converter.
8. The converter loads the settings from the memory card.
9. After loading, check whether the converter outputs Alarm A01028.
   - Alarm A01028:

     The loaded settings are not compatible with the converter.

     Clear the alarm with p0971 = 1 and recommission the drive.
   - No alarm A01028:

     The converter has accepted the settings that have been loaded.

You have successfully replaced the converter.

Replacing a converter with data backup in the PC

Procedure



To replace the converter, proceed as follows:

1. Disconnect the line voltage to the converter and (if installed) the external 24 V supply or the voltage for the digital outputs of the converter.



⚠DANGER

Death as a result of electric shock!

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the remaining voltage is non-hazardous.

- Check the voltage at the converter connections before you carry out any installation work.

2. Remove the connecting cables of the converter.
3. Remove the defective converter.
4. Install the new converter.
5. Connect all of the cables to the converter.
6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the converter.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC into the converter by pressing the  button.
   The converter 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).



You have successfully replaced the converter.

8.1.4 Replacing a converter without data backup

If the settings have not been backed up, after replacing the inverter, you must recommission the drive.

Procedure



To replace the inverter, proceed as follows:

1. Disconnect the line voltage to the inverter and (if installed) the external 24 V supply or the voltage for the digital outputs of the inverter.
2. Remove the connecting cables of the inverter.
3. Remove the defective inverter.
4. Install the new inverter.
5. Connect all of the cables to the inverter.
6. Reconnect the line voltage, and (if being used) the external 24 V supply or the voltage for the digital outputs of the inverter.
7. Recommission the drive.

Inverter commissioning has been completed after it has been commissioned.

8.1.5 Replacing devices with active know-how protection

Replacing devices with know-how protection without copy protection

In the case of know-how protection without copy protection, the inverter settings can be transferred to another inverter using a memory card.

See also:

- Saving setting on memory card (Page 285)
- Transferring the setting from the memory card (Page 288)

Replacing devices with 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 how to replace an inverter (Page 309)."

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 know-how protection (Page 305)
  - 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 know-how protection (Page 305)
  - 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 know-how protection (Page 305)
  - 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 know-how protection (Page 305)
  - 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).

8.1.6 Spare parts

		Article number
5 sets of I/O terminals, 1 set of front doors and 1 piece operator panel blind cover		6SL3200-0SK41-0AA0
Screening plates including mounting accessories	Frame size AA	6SL3266-1ER00-0KA0
	Frame size A	6SL3266-1EA00-0KA0
	Frame size B	6SL3266-1EB00-0KA0
	Frame size C	6SL3266-1EC00-0KA0
1 set of connector plugs for mains, motor and breaking resistor	Frame size AA, A	6SL3200-0ST05-0AA0
	Frame size B	6SL3200-0ST06-0AA0
	Frame size C	6SL3200-0ST07-0AA0
Fan unit for the heat sink, consists of plugable frame with built in fan	Frame size A	6SL3200-0SF12-0AA0
	Frame size B	6SL3200-0SF13-0AA0
	Frame size C	6SL3200-0SF14-0AA0
Top fan, consists of top cover with built in fan	Frame size AA	6SL3200-0SF38-0AA0
	Frame size A	6SL3200-0SF40-0AA0
	Frame size B	6SL3200-0SF41-0AA0
	Frame size C	6SL3200-0SF42-0AA0

8.1.7 Replace the fan unit for the heat sink

Inverters, frame sizes FSA … FSC have a fan unit for the heat sink. The fan unit for the heat sink is located at the lower side of the inverter.

When must the fan unit be replaced?

A defective fan unit in operation results in an overtemperature condition of the inverter. For example, the following messages indicate that the fan unit is defective:

- A05002 (air intake overtemperature)
- A05004 (rectifier overtemperature)
- F30004 (heat sink overtemperature)
- F30024 (temperature model overtemperature)
- F30025 (chip overtemperature)
- F30035 (air intake overtemperature)
- F30037 (rectifier overtemperature)

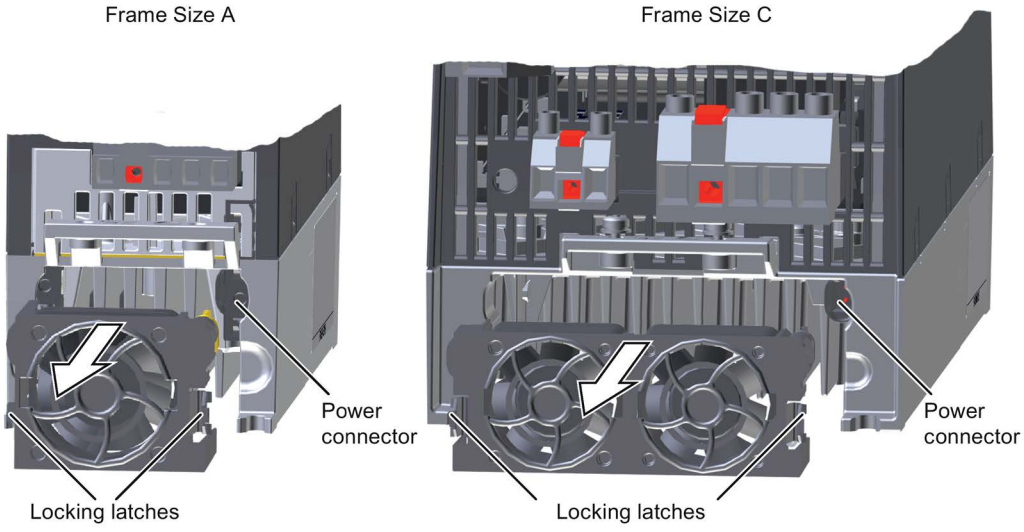


Figure 8-1 Removing and installing the fan unit for the heatsink

Removing the fan unit

Procedure



Proceed as follows to remove the fan unit:

1. Switch off the inverter power supply.



DANGER

Danger to life as a result of live parts and components

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

- Wait until the discharge time elapses, which is stamped on the inverter warning plates and labels.

2. Withdraw the cables for the line supply, motor and braking resistor.
3. Remove the shield plate.
4. Using your fingers, press on the sides of the fan unit locking lugs.
5. Withdraw the fan unit from the housing.

You have withdrawn the fan unit.

Installing the fan unit

Procedure



Proceed as follows to install the fan unit:

1. Align the power supply connection of the fan unit to the connector in the inverter.
2. Carefully insert the fan unit into the heatsink until until the locking lugs engage.
3. Mount the shield plate.
4. Insert the cables for the line supply, motor and braking resistor.
5. Switch on the power supply for the inverter.

You have installed the fan unit.

8.1.8 Replacing the roof-mounted fan

Inverters, frame sizes FSAA … FSC have a roof-mounted fan. The roof-mounted fan is located at the upper side of the inverter.

When must the roof-mounted fan be replaced?

A defective roof-mounted fan in operation results in an overtemperature condition of the inverter. For example, the following messages indicate that a roof-mounted fan is defective:

- A30034 (overtemperature inside the enclosure)
- F30036 (overtemperature, inside area)
- A30049 (defective fan inside the enclosure)
- F30059 (defective fan inside the enclosure)

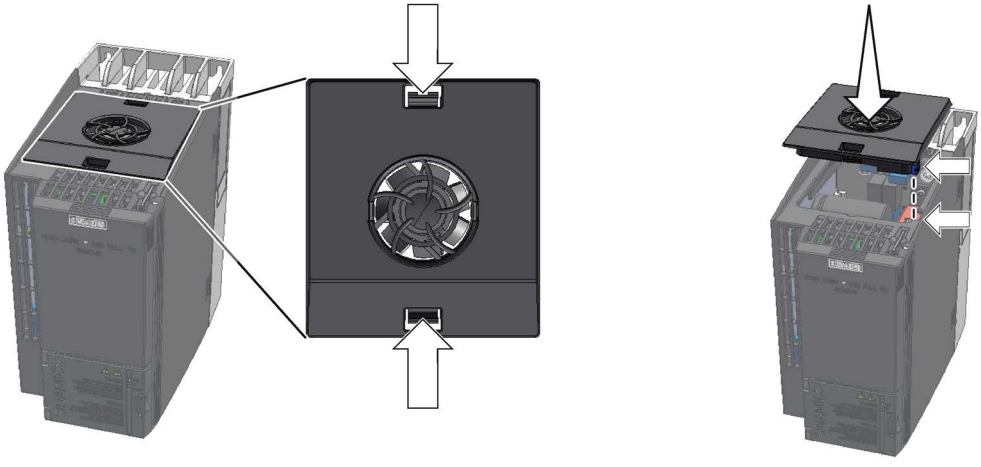


Figure 8-2 Removing and installing the roof-mounted fan

Removing the roof-mounted fan

Procedure



Proceed as follows to remove the roof-mounted fan:

1. Switch off the inverter power supply.



⚠DANGER

Danger to life as a result of live parts and components

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

- Wait until the discharge time elapses, which is stamped on the inverter warning plates and labels.

2. Using a screwdriver, press the locking lugs of the roof-mounted fan together.
3. Withdraw the roof-mounted fan from the inverter.

You have removed the roof-mounted fan

Installing the roof-mounted fan

Procedure



Proceed as follows to install the roof-mounted fan:

1. Align the power supply connection of the roof-mounted fan to the connector in the inverter.
2. Carefully insert the roof-mounted fan into the inverter until it engages in the inverter housing.
3. Switch on the power supply for the inverter.

You have inserted the roof-mounted fan.

8.2 Firmware upgrade and downgrade

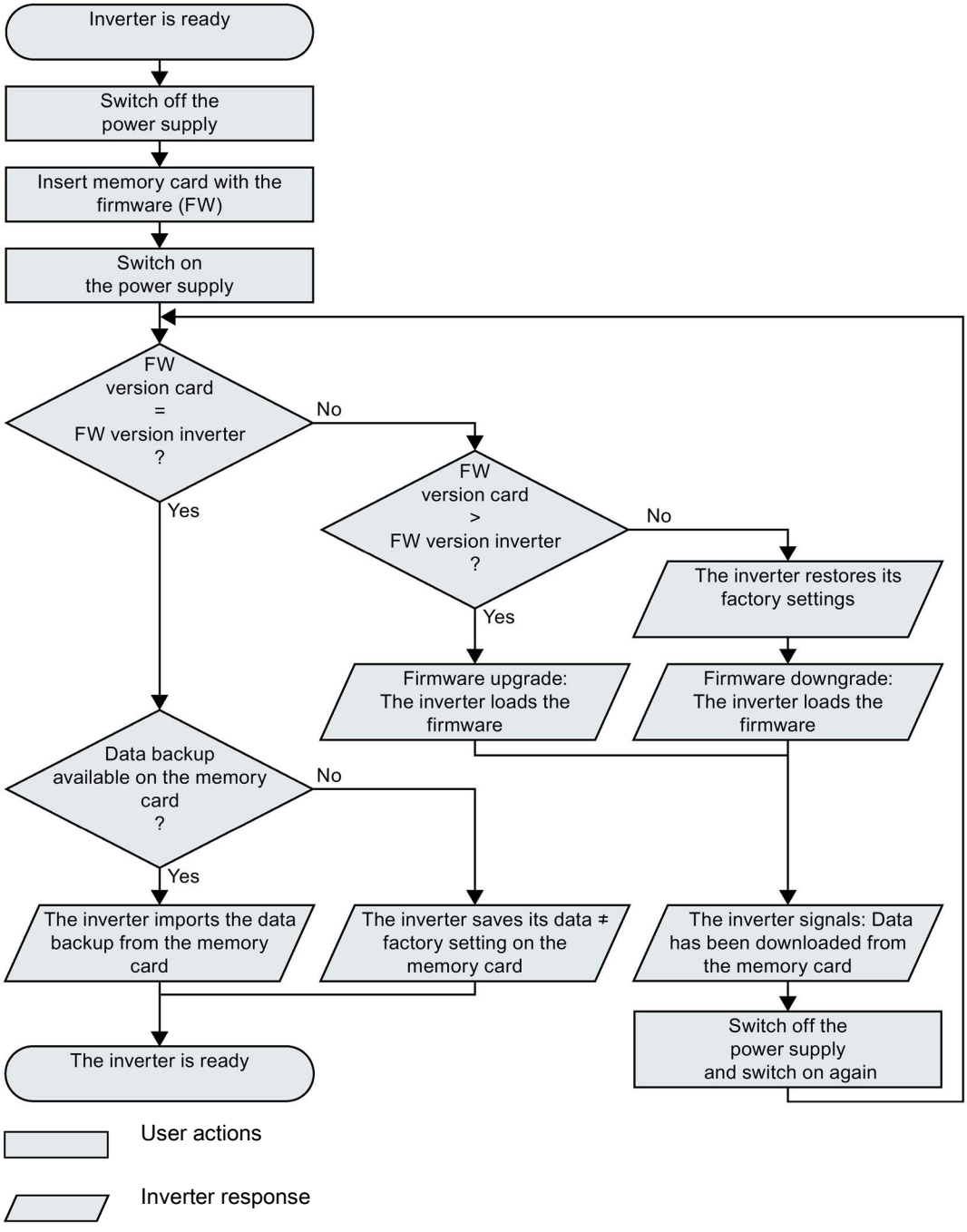


Figure 8-3 Overview of the firmware upgrade and firmware downgrade

You will find more information in the Internet at: Download (https://support.industry.siemens.com/cs/ww/en/view/67364620)

8.2.1 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

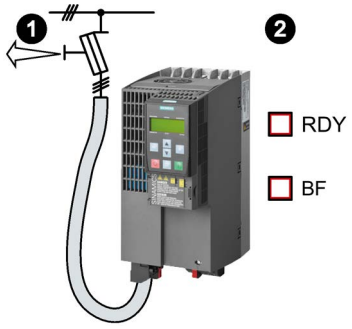
- The firmware version of your inverter is at least V4.5.
- Inverter and memory card have different firmware versions.

Procedure

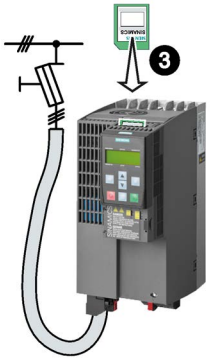
1
2

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 are dark.



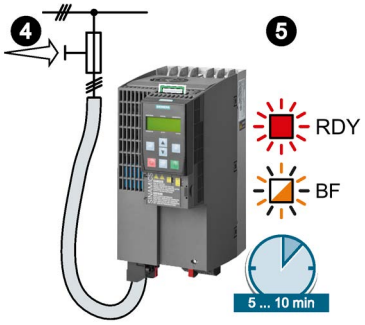
3. Insert the card with the matching firmware into the inverter slot until it latches into place.



4. Switch on the inverter power supply again.
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.

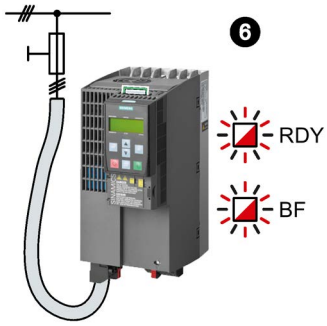


6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during transfer

   The inverter firmware will be incomplete if the power supply fails during the transfer.

   - Start again with step 1 of the instructions.



7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark.

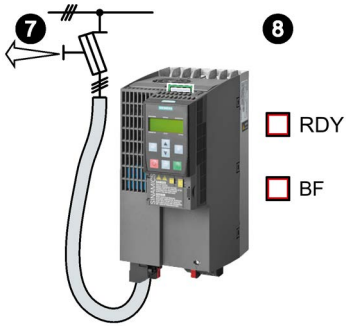
   Decide whether you will withdraw the memory card from the inverter:

   - You leave the memory card in the inverter:

     ⇒ If the memory card still does not have a data backup of the inverter settings, in step 9 the inverter writes its settings to the memory card.

     ⇒ If the memory card already includes a data backup, the inverter imports the settings from the memory card in step 9.

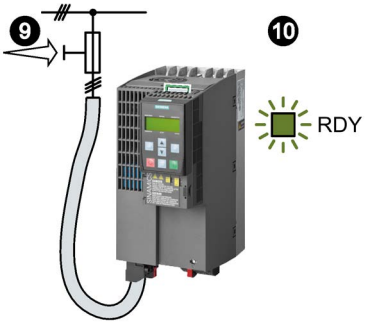
   - You remove the memory card: ⇒ The inverter retains its settings.



9. Switch on the inverter power supply again.
10. If the firmware upgrade was successful, after several seconds the inverter LED RDY turns green.

    If the memory card is still inserted, depending on the previous content of the memory card, one of the two following cases has occurred:

    - The memory card contains a data backup: ⇒ The inverter has taken the settings from the memory card.
    - There was no data back up on the memory card: ⇒ The inverter has written its settings to the memory card.



☐ You have upgraded the inverter firmware.

8.2.2 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

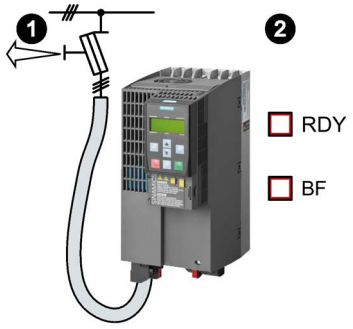
- The firmware version of your inverter is at least V4.6.
- Inverter and memory card have different firmware versions.
- You have backed up your settings on the memory card, in an operator panel or in a PC.

Procedure

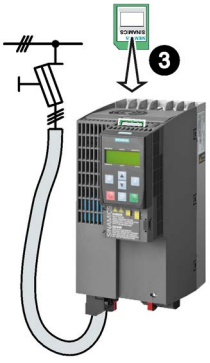


Proceed as follows to downgrade the inverter firmware to an older version:

1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter are dark.



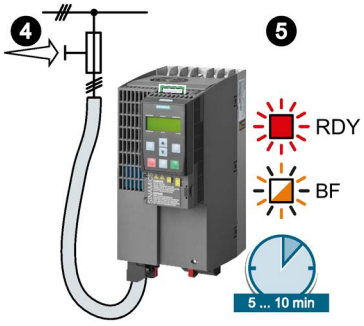
3. Insert the card with the matching firmware into the inverter slot until it latches into place.



4. Switch on the inverter power supply again.
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.

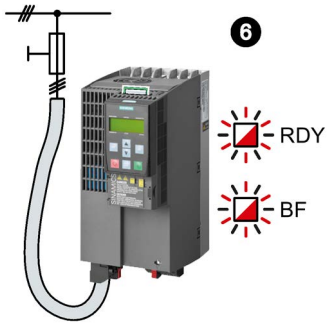


6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during transfer

   The inverter firmware will be incomplete if the power supply fails during the transfer.

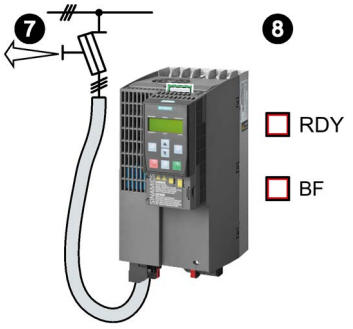
   - Start again with Step 1 of these instructions.



7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark.

   Decide whether you will withdraw the memory card from the inverter:

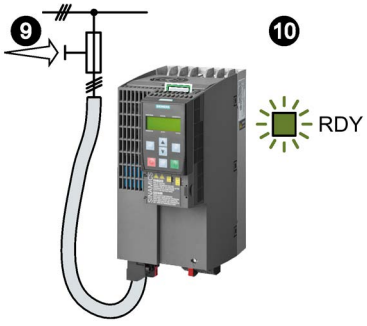
   - The memory card contains a data backup: ⇒ The inverter has taken the settings from the memory card.
   - There was no data backup on the memory card: ⇒ The inverter has the factory settings.



9. Switch on the inverter power supply again.
10. If the firmware downgrade was successful, after several seconds the inverter LED RDY turns green.

    If the memory card is still inserted, depending on the previous content of the memory card, one of the two following cases has occurred:

    - The memory card contains a data backup: ⇒ The inverter has taken the settings from the memory card.
    - There was no data backup on the memory card: ⇒ The inverter has the factory settings.



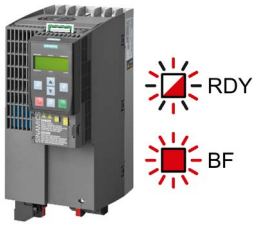
11. If the memory card did not contain a data backup of the inverter settings, then you must transfer your settings to the inverter from another data backup.

    See also Section: Backing up data and series commissioning (Page 283).

You have replaced the inverter's firmware by an older version.

8.2.3 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.

8.3 Reduced acceptance after component replacement and firmware change

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Measure	Reduced acceptance test	
	Acceptance test	Documentation
Replacing the inverter with an identical type	No. Only check the direction of rotation of the motor.	• Supplement inverter data • Log the new checksums • Countersignature • 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		
Replace the safety-related peripherals (e.g. Emergency Off switch).	No. Only check the control of the safety functions affected 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.

8.4 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

1
2

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

9

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

9.1 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:

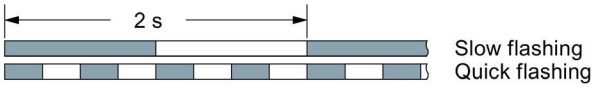


Table 9- 1 Inverter diagnostics

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 9- 2 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.

Table 9- 3 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 9- 4 Communication diagnostics via RS485

LED		Explanation
BF	RDY	
off	Not relevant	Data exchange between the inverter and control system is active
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 parameterization, incorrect memory card or firmware update unsuccessful
	All other states	No bus connection available
YELLOW - variable frequency	RED - on	Firmware update in progress

Communication via Modbus or USS:

If the fieldbus monitoring is deactivated with p2040 = 0, the BF-LED remains dark, independent of the communication state.

Table 9- 5 Communication diagnostics via PROFIBUS DP

LED		Explanation
BF	RDY	
GREEN - on	Not relevant	Data exchange between the inverter and control system is active
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

LED BF display for CANopen

In addition to the signal states "on" and "off" there are three different flashing frequencies:

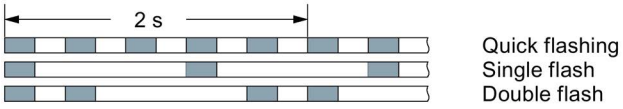


Table 9- 6 Communication diagnostics via CANopen

LED		Explanation
BF	RDY	
GREEN - on	Not relevant	Data is being exchanged between the inverter and control ("Operational")
GREEN - fast		Bus state "Pre-Operational"
GREEN - single flash		Bus state "Stopped"
RED - on		No bus
RED - single flash		Alarm - limit reached
RED - double flash		Error event in control (Error Control Event)
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
YELLOW - variable frequency	RED - on	Firmware update in progress

9.2 Alarms

Alarms have the following properties:

- They do not have a direct effect in the inverter 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

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

Alarm buffer

The inverter saves an alarm code and an alarm value for every alarm it receives.

	Alarm code	Alarm value	
1st alarm	r2122[0]	r2124[0] I32	r2134[0] Float

Figure 9-1 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 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	
1st alarm	r2122[0]	r2124[0]	r2134[0]
2nd alarm	[1]	[1]	[1]

Figure 9-2 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.

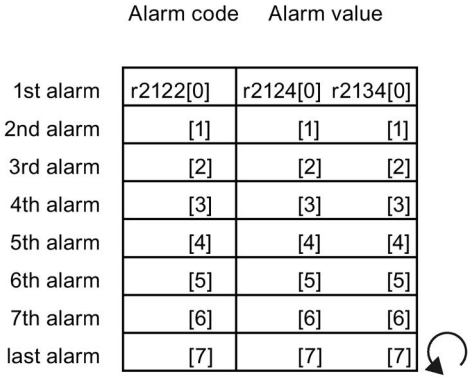


Figure 9-3 Complete alarm buffer

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 inverter shifts all alarms that have been removed from the alarm buffer into the alarm history. The inverter sorts the alarms in the alarm history in the inverse sequence to the alarm buffer.

- the youngest alarm is in index 8
- the second youngest alarm is in index 9
- etc.

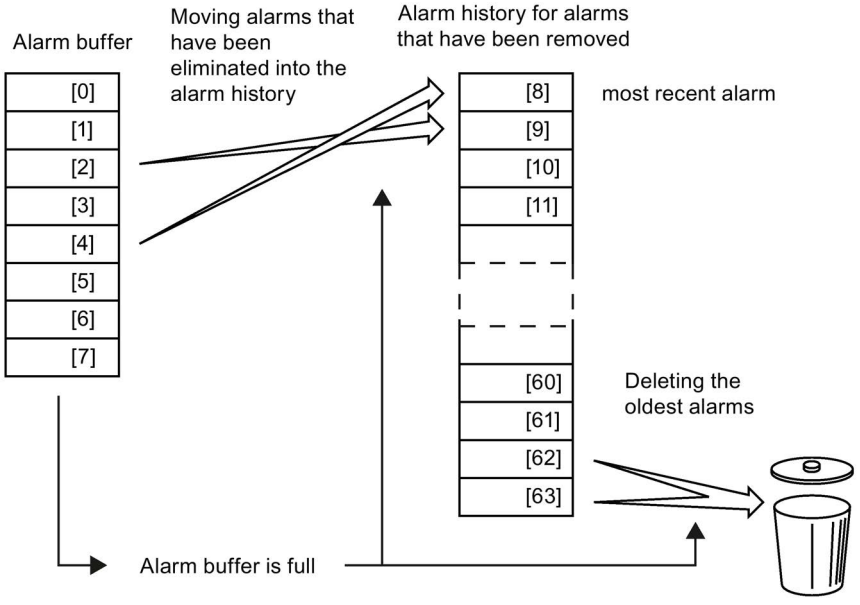


Figure 9-4 Shifting alarms that have been removed into the alarm history

The alarms that have still not been removed remain in the alarm buffer and are resorted so that gaps between the alarms are filled.

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

Table 9- 7 Important parameters for alarms

Parameter	Description
r2122	**Alarm code** Displays the numbers of alarms that have occurred
r2124	**Alarm value** Displays additional information about the alarm
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]
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

Extended settings for alarms

Table 9- 8 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** Select 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.

9.3 Faults

A fault displays a severe fault during operation of the inverter.

The inverter signals a fault as follows:

- at the Operator Panel with Fxxxxx
- on the converter using the red LED RDY
- in bit 3 of the status word 1 (r0052)
- via STARTER

To delete a fault message, you need to remedy the cause of the fault and acknowledge the fault.

Every fault has a clear fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The converter saves a fault code and fault value for every fault it receives.

	Fault code	Fault value	
1st fault	r0945[0]	r0949[0]	r2133[0]
		I32	Float

Figure 9-5 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.

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	
1st fault	r0945[0]	r0949[0]	r2133[0]
2nd fault	[1]	[1]	[1]

Figure 9-6 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.

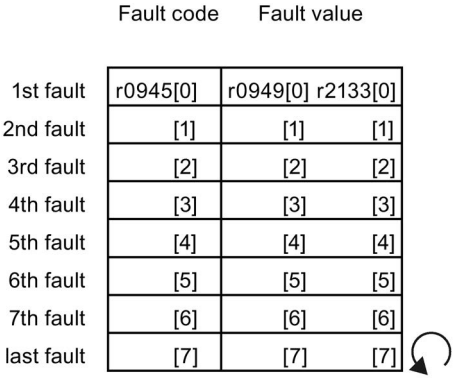


Figure 9-7 Complete fault buffer

Fault acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch-off the inverter power supply and switch-on again.
- Press the acknowledgement button on the operator panel
- Acknowledgement signal at digital input 2
- Acknowledgement signal in bit 7 of control word 1 (r0054) for Control Units with fieldbus interface

Faults that are triggered by internal converter hardware and firmware monitoring functions can only be acknowledged by switching off and on again. You will find a note about this restricted option to acknowledge faults in the fault list of the List Manual.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The fault acknowledgement has no effect as long as none of the fault causes of the fault 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 (indices 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.

3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

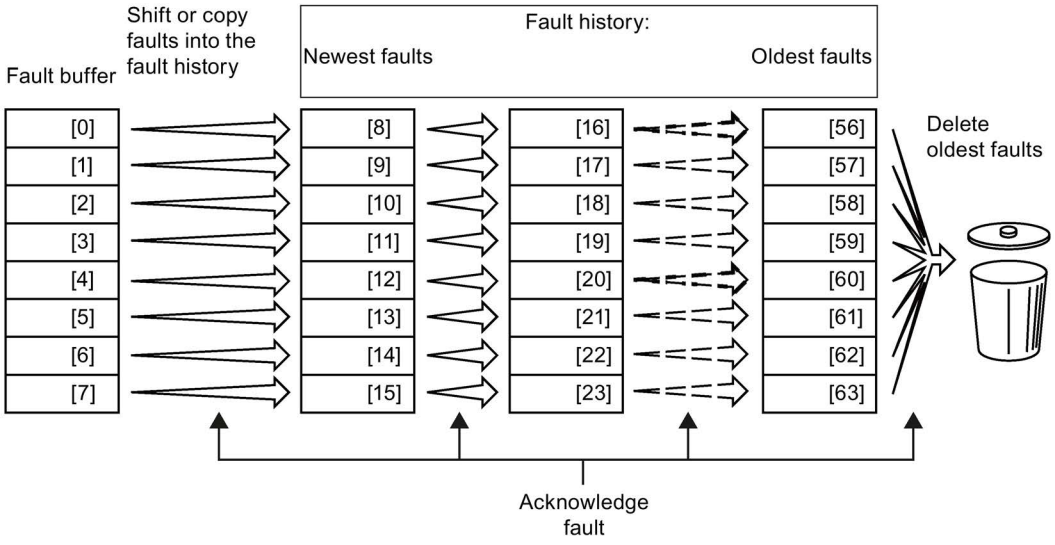


Figure 9-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indices remain empty.

The inverters shifts the values previously saved in the fault history each by eight indices. Faults, which were saved in indices 56 … 63 before the acknowledgement, 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

Table 9- 9 Important parameters for faults

Parameter	Description
r0945	**Fault code** Displays the numbers of faults that have occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgement The fault buffer is deleted with p0952 = 0.
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

The motor cannot be switched-on

If the motor cannot be switched-on, then check the following:

- Is a fault present?
  If yes, then remove the fault cause and acknowledge the fault
- Is p0010 = 0?
  If not, the converter is e.g. still in a commissioning state.
- Is the inverter reporting the "ready to start" status (r0052.0 = 1)?
- Is the inverter missing enabling (r0046)?
- Are the interfaces of the converter (p0015) correctly parameterized?
  In other words, how is the converter receiving its setpoint and its commands?

Extended settings for faults

Table 9- 10 Advanced settings

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** Selecting the faults for which the fault response should be changed
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgement mode** Selecting the faults for which the acknowledgement type should be changed
p2127	**Setting, acknowledgement mode** Setting the acknowledgement 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** Selecting the message for which the message type should be selected
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.

9.4 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 9- 11 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 9- 12 Faults, which can only be acknowledged by switching the inverter off and on again

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 inverter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the inverter.
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 9- 13 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	1. Switch off the converter power supply and switch it on again. 2. After this fault, the converter powers up with the factory settings. 3. Recommission the converter.
A01028	Configuration error	Explanation: The parameter assignments on the memory card were made with a different type of module (Article No.). Check the module parameters and recommission if necessary.
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter to a value other than 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Unit switchover: 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).
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 the maintenance.
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.
A01910 F01910	Fieldbus SS 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 connection to the signal source for interrupts. Check the level of the signal supplied. 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.

Number	Cause	Remedy
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 parameterized	Check the parameterized supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check sensor's wiring and connection.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check 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).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The current number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Create 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 search current (P1202), check motor connection.
A07400	V_{DC_max} controller active	If the controller is not to intervene: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for V/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 load. • Increase the ramp-up time to the speed setpoint.
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).

Number	Cause	Remedy
F07801	Motor overcurrent	Check current limits (p0640). U/f control: Check the current limiting controller (p1340 … p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short circuit and ground fault. Check motor for star-delta connection and rating plate parameterization. Check power unit / motor combination. Select 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.
F07807	Short circuit detected	• Check the converter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850	External alarm 1	The signal for "external alarm 1" has been triggered. Parameter p2112 defines the signal source of the external alarm. Remedy: Rectify the cause of this alarm.
F07860	External fault 1	Remove the external causes for this fault.
F07900	Motor blocked	• Make sure that the motor can rotate freely. • Check the torque limit: r1538 for a positive direction of rotation; r1539 for a negative direction of rotation.
F07901	Motor overspeed	Activate precontrol of the speed limiting controller (p1401 bit 7 = 1).
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform 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.
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 data identification activated	Switch on the motor and identify the motor data.

Number	Cause	Remedy
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller to RUN mode. • If the error 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.
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 during checking of the memory card. • Insert a suitable memory card and switch the converter 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.

Number	Cause	Remedy
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor's 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	Converter overtemperature	Check whether the converter 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 converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the converter's input fuses. Check the motor 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 line voltage. 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	

Number	Cause	Remedy
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.
F30074	Communications fault between Control Unit and Power Module	The 24V voltage supply of the converter (terminals 31 and 32) was interrupted briefly. Please check the voltage supply and the wiring.
A30502	DC link overvoltage	• Check the device supply voltage (p0210). • Check the line reactor dimensioning
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 a faulty configuration telegram. Check to see 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 present.

For further information, please refer to the List Manual.

9.5 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	✓	✓

Technical data

10

10.1 Technical data of inputs and outputs

Feature	Data
24 V power supply	There are two options regarding the 24 V supply. • The inverter generates its 24 V power supply from the line voltage • The inverter obtains is 24 V power supply via terminals 31 and 32 with 20.4 V … 28.8 V DC. – Typical current drain: 0.5 A – Use a PELV, Class 2 power supply. According to EN 61800-5-1: PELV = Protective Extra Low Voltage – Connect the 0 V of the power supply to the protective conductor.
Output voltages	• 24 V (max. 100 mA) • 10 V ± 0.5 V (max. 10 mA)
Setpoint resolution	0.01 Hz
Digital inputs	• 6 digital inputs, DI 0 … DI 5, isolated; • Low < 5 V, high > 11 V, max. input voltage 30 V, current drain 5.5 mA • Response time: 5.5 ms ± 1 ms
Analog input (differential input, 12-bit resolution)	• AI 0 can be switched over: – 0 V … 10 V or -10 V … +10 V: Typical current drain: 0.1 mA, maximum voltage 35 V – 0 mA … 20 mA: Maximum voltage 10 Volt, maximum current 80 mA • Response time: 10 ms ± 2 ms • If AI 0 has been configured as additional digital input: Maximum voltage < 35 V, low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for de-bounce time p0724 = 0.
Digital outputs /relay outputs	• DO 0: Relay output, DC 30 V / max. 0.5 A for ohmic loads • DO 1: Transistor output, 30 V DC / max. 0.5 A for ohmic loads, reverse polarity protection. • Update time of all DO: 2 ms
Analog output	• AO 0, can be switched over: – 0 V … 10 V – 0 mA … 20 mA – Reference potential: "GND", 16-bit resolution, update time: 4 ms
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω, switching threshold 1650 Ω • KTY84 • Sensor with isolated contact

Feature	Data
Safety input	• If you enable safety function STO, then DI 4 and DI 5 form a safety-related input. • Max. Input voltage, 30 V, 5.5 mA • Response time: – When the debounce time p9651 > 0: Typical 5 ms + p9651, worst case 15 ms + p9651 – When debounce time = 0: Typical 6 ms, worst case 16 ms
PFH (Probability of Failure per Hour)	Probability of failure of the safety functions: 5 × 10E-8
USB interface	Mini-B

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.

10.2 High Overload and Low Overload

Permissible inverter overload

The inverter has two different power data: "**Low Overload**" (LO) and "**High Overload**" (HO), depending on the expected load.

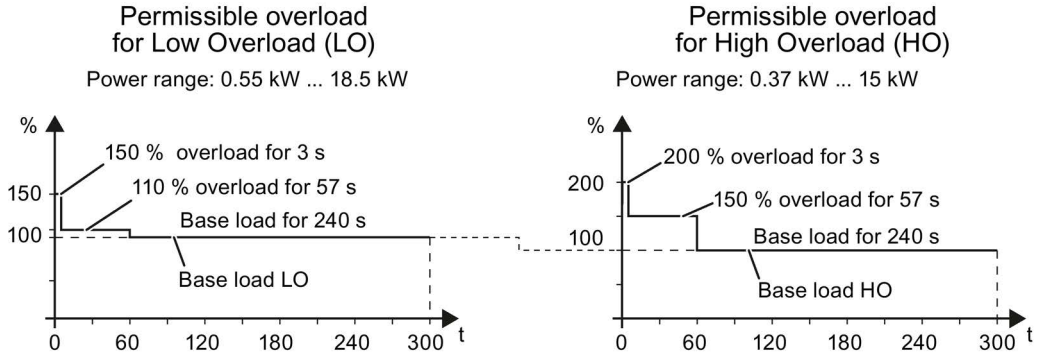


Figure 10-1 Duty cycles, "High Overload" and "Low Overload"

Overload capability of the inverter

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

Table 10- 1 Load cycles and typical applications:

"Low Overload" load cycle	"High Overload" load cycle
The "Low Overload" load cycle assumes a uniform base load with low requirements placed on brief accelerating p phases. Typical applications when designing according to "Low Overload" include: • Pumps, fans and compressors • Wet or dry blasting technology • Mills, mixers, kneaders, crushers, agitators • Basic spindles • Rotary kilns • Extruders	The "High Overload" load cycle permits, for reduced base load, dynamic accelerating phases. Typical applications when designing according to "High Overload" include: • Horizontal and vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors) • Centrifuges • Escalators/moving stairways • Lifters/Lowerers • Elevators • Gantry cranes • Cable railways • Storage and retrieval machines

Definitions

- **Base load**

  Constant load between the accelerating phases of the drive

Low Overload	High Overload
• **LO base load input current** Permissible input current for a “Low Overload” load cycle • **LO base load output current** Permissible output current for a “Low Overload” load cycle • **LO base load power** Rated power based on the LO base load output current	• **HO base load input current** Permissible input current for a “High Overload” load cycle • **HO base load output current** Permissible output current for a “High Overload” load cycle • **HO base load power** Rated power based on the HO base load output current

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

We recommend the "SIZER" engineering software to select the inverter. You will find additional information about SIZER on the Internet at: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000).

10.3 Common technical power data

Feature	Data		
Line supply voltage	3 AC 380 V … 480 V + 10 % - 20 %	The actual permissible line voltage depends on the installation altitude.	
Output voltage	3-ph. 0 V … line voltage × 0.95 (max.)		
Input frequency	47 Hz … 63 Hz		
Minimum cable impedance U_K	1 %		
Power factor λ	0.70		
Pulse frequency	4 kHz The pulse frequency can be increased in 2 kHz steps. A higher pulse frequency reduces the permissible output current.		
Maximum motor cable length	Shielded: 50 m unshielded: 100 m	Without output reactor or output options for a switching frequency of 4 kHz	
	Shielded: 150 m unshielded: 225 m	Line voltage < 440 V: With output reactor for a switching frequency of 4 kHz	
	Shielded: 100 m unshielded: 150 m	Line voltage > 440 V: With output reactor for a switching frequency of 4 kHz	
	25 m (shielded)	To satisfy EMC Cat. C2 cable-conducted interference emission for a 4 kHz switching frequency	
Possible braking methods	DC braking, compound braking, dynamic braking with integrated chopper		
Degree of protection	IP20, installation in a control cabinet		
Ambient temperature	-10 °C … +40 °C	Without derating	
	-10 °C … +50 °C	Inverter, frame size FSAA	The output power must be reduced, also see Section: Temperature and voltage derating (Page 369)
	-10 °C … +55 °C	Inverters, frame sizes FSA … FSC with PROFINET interface.	
	-10 °C … +60 °C	Inverters, frame sizes FSA … FSC with USS, MB, CANopen or PROFIBUS interface.	
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)		
Relative humidity	< 95 % relative humidity – condensation not permissible		
Installation altitude	Up to 1000 m above sea level	At higher installation altitudes, the output power must be reduced	
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 acc. to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration in operation according to Class 3M2 acc. to EN 60721-3-3: 1995		
Short-circuit current rating (SCCR)	40 kA		

10.4 Power-dependent technical data

Note

The specified input currents apply for a 400 V line where V_k = 1 % referred to the converter power. When using a line reactor, the currents are reduced by a few percent.

Table 10- 2 Frame size AA, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	Without filter, IP20 with filter, IP20	6SL3210-1KE11-8U*2 6SL3210-1KE11-8A*2	6SL3210-1KE12-3U*2 6SL3210-1KE12-3A*2	6SL3210-1KE13-2U*2 6SL3210-1KE13-2A*2
Values for rated load/low overload				
Rated/LO power		0.55 kW	0.75 kW	1.1 kW
Rated/LO input current		2.3 A	2.9 A	4.1 A
Rated/LO output current		1.7 A	2.2 A	3.1 A
Values for high overload				
HO power		0.37 kW	0.55 kW	0.75 kW
HO input current		1.9 A	2.5 A	3.2 A
HO output current		1.3 A	1.7 A	2.2 A
Power loss with filter		0.041 kW	0.045 kW	0.054 kW
Power loss without filter		0.040 kW	0.044 kW	0.053 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Weight without filter		1.2 kg	1.2 kg	1.2 kg
Weight with filter		1.4 kg	1.4 kg	1.4 kg

Table 10- 3 Frame size AA, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	Without filter, IP20 with filter, IP20	6SL3210-1KE14-3U*2 6SL3210-1KE14-3A*2
Values for rated load/low overload		
Rated/LO power		1.5 kW
Rated/LO input current		5.5 A
Rated/LO output current		4.1 A
Values for high overload		
HO power		1.1 kW
HO input current		4.5 A
HO output current		3.1 A
Power loss with filter		0.073 kW
Power loss without filter		0.072 kW
Required cooling air flow		5 l/s
Weight without filter		1.2 kg
Weight with filter		1.4 kg

Table 10- 4 Frame size A, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	**without filter, IP20** **with filter, IP20**	**6SL3210-1KE11-8UC1** **6SL3210-1KE11-8AC1**	**6SL3210-1KE12-3UC1** **6SL3210-1KE12-3AC1**	**6SL3210-1KE13-2UC1** **6SL3210-1KE13-2AC1**
Values for rated load/low overload				
Rated/LO power		0.55 kW	0.75 kW	1.1 kW
Rated/LO input current		2.3 A	2.9 A	4.1 A
Rated/LO output current		1.7 A	2.2 A	3.1 A
Values for high overload				
HO power		0.37 kW	0.55 kW	0.75 kW
HO input current		1.9 A	2.5 A	3.2 A
HO output current		1.3 A	1.7 A	2.2 A
Power loss with filter		0.041 kW	0.045 kW	0.054 kW
power loss without filter		0.040 kW	0.044 kW	0.053 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Weight without filter		1.7 kg	1.7 kg	1.7 kg
Weight with filter		1.9 kg	1.9 kg	1.9 kg

Table 10- 5 Frame size A, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	**Without filter, IP20** **with filter, IP20**	**6SL3210-1KE14-3UC1** **6SL3210-1KE14-3AC1**	**6SL3210-1KE15-8UC1** **6SL3210-1KE15-8AC1**
Values for rated load/low overload			
Rated/LO power		1.5 kW	2.2 kW
Rated/LO input current		5.5 A	7.4 A
Rated/LO output current		4.1 A	5.6 A
Values for high overload			
HO power		1.1 kW	1.5 kW
HO input current		4.5 A	6.0 A
HO output current		3.1 A	4.1 A
Power loss with filter		0.073 kW	0.091 kW
power loss without filter		0.072 kW	0.089 kW
Required cooling air flow		5 l/s	5 l/s
Weight without filter		1.7 kg	1.7 kg
Weight with filter		1.9 kg	1.9 kg

Table 10- 6 Frame size A, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	Without filter, IP20 with filter, IP20	6SL3210-1KE17-5U*1 6SL3210-1KE17-5A*1	6SL3210-1KE18-8U*1 6SL3210-1KE18-8A*1
Values for rated load/low overload			
Rated/LO power		3.0 kW	4.0 kW
Rated/LO input current		9.5 A	11.4 A
Rated/LO output current		7.3 A	8.8 A
Values for high overload			
HO power		2.2 kW	3.0 kW
HO input current		8.2 A	10.6 A
HO output current		5.6 A	7.3 A
Power loss with filter		0.136 kW	0.146 kW
Power loss without filter		0.132 kW	0.141 kW
Required cooling air flow		5 l/s	5 l/s
Weight without filter		1.7 kg	1.7 kg
Weight with filter		1.9 kg	1.9 kg

Table 10- 7 Frame size B, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	Without filter, IP20 with filter, IP20	6SL3210-1KE21-3U*1 6SL3210-1KE21-3A*1	6SL3210- 1KE21-7U*1 6SL3210-1KE21-7A*1
Values for rated load/low overload			
Rated/LO power		5.5 kW	7.5 kW
Rated/LO input current		16.5 A	21.5 A
Rated/LO output current		12.5 A	16.5 A
Values for high overload			
HO power		4.0 kW	5.5 kW
HO input current		12.8 A	18.2 A
HO output current		8.8 A	12.5 A
Power loss with filter		0.177 kW	0.244 kW
Power loss without filter		0.174 kW	0.24 kW
Required cooling air flow		9 l/s	9 l/s
Weight without filter		2.3 kg	2.3 kg
Weight with filter		2.5 kg	2.5 kg

Table 10- 8 Frame size C, 3 AC 380 V … 480 V, +10 %, -20 %

Article no.	**Without filter, IP20** **with filter, IP20**	**6SL3210-1KE22-6U*1** **6SL3210-1KE22-6A*1**	**6SL3210-1KE23-2U*1** **6SL3210-1KE23-2A*1**	**6SL3210-1KE23-8U*1** **6SL3210-1KE23-8A*1**
Values for rated load/low overload				
Rated/LO power		11 kW	15 kW	18.5 kW
Rated/LO input current		33.0 A	40.6 A	48.2 A
Rated/LO output current		25 A	31 A	37 A
Values for high overload				
HO power		7.5 kW	11 kW	15 kW
HO input current		24.1 A	36.4 A	45.2 A
HO output current		16.5 A	25 A	31 A
Power loss with filter		0.349 kW	0.435 kW	0.503 kW
Power loss without filter		0.344 kW	0.429 kW	0.493 kW
Required cooling air flow		18 l/s	18 l/s	18 l/s
Weight without filter		4.4 kg	4.4 kg	4.4 kg
Weight with filter		4.7 kg	4.7 kg	4.7 kg

10.5 Data regarding the power loss in partial load operation

You can find data regarding power loss in partial load operation in the Internet:

Partial load operation (http://support.automation.siemens.com/WW/view/en/94059311)

10.6 Electromagnetic compatibility of the converters

The electromagnetic compatibility refers to both the immunity and the emitted interference of a device.

The following disturbance variables must be taken into consideration when evaluating the electromagnetic compatibility:

- Conducted low-frequency disturbance variables (harmonics)
- Conducted high-frequency disturbance variables
- Field-based, low-frequency disturbance variables
- Field-based, high-frequency disturbance variables

The permitted limit values are defined in the EMC product standard EN 61800-3 in EMC categories C1 to C4.

Below you will find some key definitions relating to this.

Classification of EMC behavior

The EMC environment and the EMC Categories are defined in the EMC product standard EN 61800-3 as follows:

Environments:

First environment (public systems)

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

Example: Houses, apartments, commercial premises, or offices in residential buildings.

Second environment (industrial systems)

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

Example: Industrial areas and technical areas of buildings that are supplied by an assigned transformer.

Categories

Category C4

Drive systems with a rated voltage ≥ 1,000 V, with an LO output current ≥ 400 A, or for use in complex systems in the second environment

Drive systems which correspond to category C4 may only be installed in the second environment.

Category C3

Drive systems with a rated voltage < 1,000 V, which are intended for use in the second environment and not for use in the first environment.

Drive systems which correspond to category C3 may only be installed in the second environment.

Category C2

Drive systems with a rated voltage < 1,000 V, which are neither plug-in devices nor moveable devices and which, when used in the first environment, are only intended to be installed and commissioned by an expert.

Drive systems which correspond to category C2 may only be used in the first environment if they are installed by an expert, with limit values for electromagnetic compatibility observed.

Category C1

Drive systems with a rated voltage < 1000 V, which are intended for use in the first environment.

Drive systems which correspond to category C1 can be installed in the first environment without restrictions.

Note

Expert

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

10.6.1 Assigning converters to EMC categories

The inverters have been tested in accordance with the EMC product standard EN 61800-3.

You can find the declaration of conformity in the Internet at: Declaration of Conformity (http://support.automation.siemens.com/WW/view/en/58275445)

Requirements for electromagnetic compatibility

To comply with the requirements of EN 61800-3, all drives must be installed in accordance with the manufacturer's instructions and EMC directives. See also: EMC-compliant installation (Page 32).

The inverter must be permanently installed on the basis of the leakage currents (> 3.5 mA).

In particular, installation must be carried out by an expert who has the necessary experience for installing and/or commissioning power drives, included the associated EMC aspects.

Second environment - category C4

The unfiltered inverters correspond to category C4.

EMC measures in the second environment, category C4, are carried out on the basis of an EMC plan on the system level. See also EMC-compliant installation (Page 32).

Second environment - category C3

Immunity

With respect to their immunity, the inverters are suitable for the second environment, Category C3.

Interference emission for filtered inverters

Inverters with integrated filter are suitable for use in the second environment, Category C3.

Interference emission for unfiltered inverters

If you are using unfiltered inverters in an industrial plant, you must either use an external filter for the converter or install corresponding filters on the system level (conducted high-frequency disturbance variables).

When installed professionally in accordance with EMC guidelines, the converters fulfill the requirements of the standard in relation to category C3 (field-based high-frequency disturbance variables).

Second environment - category C2

Immunity

With respect to their immunity, the inverters are suitable for the second environment.

Emitted interference

In order for the inverters to comply with the limit values for category C2 relating to emitted interference, the following conditions must be fulfilled:

- You are using an inverter with an integrated filter, frame size FSA or FSB
- The motor connection cable is shorter than 25 m
- The pulse frequency does not exceed 4 kHz
- The current does not exceed the value of the LO input current (high-frequency conducted interference), see Power-dependent technical data (Page 360)
- You are using a shielded motor connection cable with low capacitance (high-frequency, radiated faults)
- If you are using an inverter with frame size FSB with a PROFINET interface (Auto No. 6SL32101KE21-*AF*), you must also use a line reactor.

First environment - category C2

To enable you to use the converter in the first environment, during installation you must observe the limit values for the **conducted low-frequency disturbance variables (harmonics)** in addition to the limit values for the "second environment - category C2".

A table showing the typical harmonics of the power module can be found in the section entitled Harmonics (Page 368).

Contact your system operator to obtain approval for an installation in the first environment.

First Environment

The inverter is not intended for use in the first environment.

10.6.2 Harmonics

Table 10- 9 Typical harmonic currents as a % referred to the LO input current for U_K 1%

Harmonic number	5th	7th	11th	13th	17th	19th	23rd	25th
Value as %	54	39	11	5.5	5	3	2	2

10.6.3 EMC limit values in South Korea

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

The EMC limit values to be complied with for South Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3, Category C2 or limit value class A, Group 1 according to EN55011. By applying suitable supplementary measures, the limit values according to Category C2 or according to limit value class A, Group 1 are maintained. Further, additional measures may be required, for instance, using an additional radio interference suppression filter (EMC filter). The measures for EMC-compliant design of the system are described in detail in this manual respectively in the Installation Guideline EMC.

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

10.7 Temperature and voltage derating

Derating as a function of the ambient temperature

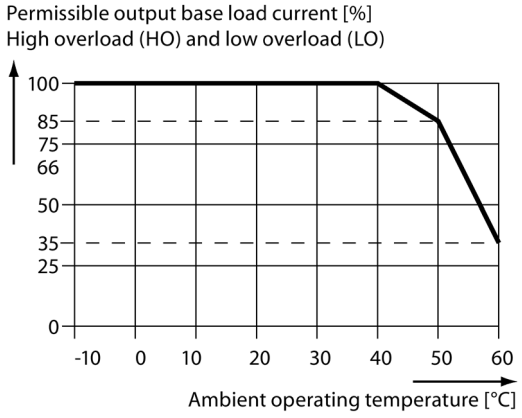


Figure 10-2 Derating as a function of the ambient temperature

Derating as a function of the operating voltage

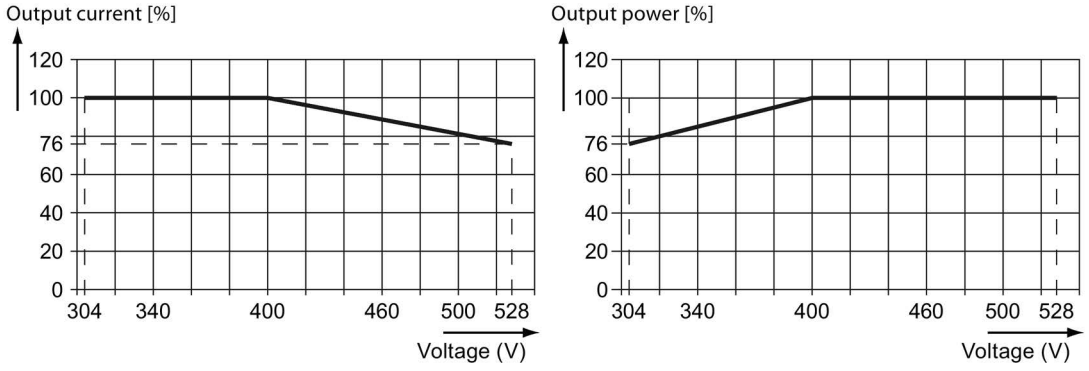
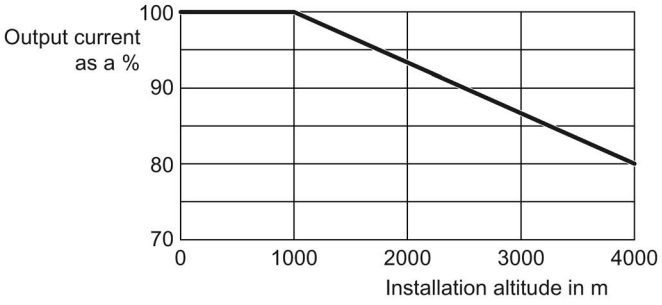


Figure 10-3 Current and voltage derating required as a function of the input voltage

10.8 Current derating - depending on the installation altitude

Current derating depending on the installation altitude

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



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.

Note

690 V Power Modules

For 690 V Power Modules, the TN line system must be established with grounded neutral point through an isolating transformer.

10.9 Current reduction depending on pulse frequency

Relationship between pulse frequency and output base-load current reduction

Table 10- 11 Current reduction depending on pulse frequency [1]

Rated power based on LO	Rated output current at pulse frequency of						
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
0.55 kW	1.7 A	1.4 A	1.2 A	1.0 A	0.9 A	0.8 A	0.7 A
0.75 kW	2.2 A	1.9 A	1.5 A	1.3 A	1.1 A	1.0 A	0.9 A
1.1 kW	3.1 A	2.6 A	2.2 A	1.9 A	1.6 A	1.4 A	1.2 A
1.5 kW	4.1 A	3.5 A	2.9 A	2.5 A	2.1 A	1.8 A	1.6 A
2.2 kW	5.6 A	4.8 A	3.9 A	3.4 A	2.8 A	2.5 A	2.2 A
3.0 kW	7.3 A	6.2 A	5.1 A	4.4 A	3.7 A	3.3 A	2.9 A
4.0 kW	8.8 A	7.5 A	6.2 A	5.3 A	4.4 A	4.0 A	3.5 A
5.5 kW	12.5 A	10.6 A	8.8 A	7.5 A	6.3 A	5.6 A	5.0 A
7.5 kW	16.5 A	14.0 A	11.6 A	9.9 A	8.3 A	7.4 A	6.6 A
11.0 kW	25.0 A	21.3 A	17.5 A	15.0 A	12.5 A	11.3 A	10.0 A
15.0 kW	31.0 A	26.4 A	21.7 A	18.6 A	15.5 A	14.0 A	12.4 A
18.5 kW	37.0 A	31.5 A	25.9 A	22.2 A	18.5 A	16.7 A	14.8 A

[1] The permissible motor cable length depends on the cable type and the chosen pulse frequency.

10.10 Accessories

10.10.1 Line reactor

Table 10- 12 Technical data of the line reactors as base component

Topic	Suitable for inverters with a rated power of		
	0.55 kW	0.75 kW … 1.5 kW	
	FSAA		
Article no.	6SE6400-3CC00-2AD3	6SE6400-3CC00-4AD3	
Article no. of the corresponding inverter	6SL3210-1KE11-8 □ □ 2	6SL3210-1KE12-3 □ □ 2 6SL3210-1KE13-2 □ □ 2 6SL3210-1KE14-3 □ □ 2	
Inductance	2.5 mH		
Power loss at 50/60 Hz	25 W		
Degree of protection	IP20		
Overall dimensions Width Height Depth	 76 mm 200 mm 50 mm		
Mounting dimensions Width Height	 56 mm 187 mm		
Fastening screw	4 × M4 (4 Nm)		
Weight	0.6 kg	0.8 kg	

Table 10- 13 Technical data of the line reactors

Feature	Suitable for inverters with a rated power of		
	0.55 kW … 1.1 kW	1.5 kW … 4.0 kW	5.5 kW … 7.5 kW
	FSAA, FSA		FSB
Article no.	6SL3203-0CE13-2AA0	6SL3203-0CE21-0AA0	6SL3203-0CE21-8AA0
Article no. of the corresponding inverter	6SL3210-1KE11-8 □ □ □ 6SL3210-1KE12-3 □ □ □ 6SL3210-1KE13-2 □ □ □	6SL3210-1KE14-3 □ □ □ 6SL3210-1KE15-8 □ □ 1 6SL3210-1KE17-5 □ □ 1 6SL3210-1KE18-8 □ □ 1	6SL3210-1KE21-3 □ □ 1 6SL3210-1KE21-7 □ □ 1
Inductance	2.5 mH	2.5 mH	0.5 mH
Power loss at 50/60 Hz	25 W	40 W	55 W
Degree of protection	IP20	IP20	IP20
Overall dimensions Width Height Depth	 125 mm 120 mm 71 mm	 125 mm 140 mm 71 mm	 125 mm 145 mm 91 mm
Mounting dimensions Width Height	 100 mm 55 mm	 100 mm 55 mm	 100 mm 65 mm
Fixing screw	4 × M5 (6 Nm)	4 × M5 (6 Nm)	4 × M5 (6 Nm)
Weight	1.1 kg	2.1 kg	2.95 kg

Table 10- 14 Technical data of the line reactors

Feature	Suitable for inverters with a rated power of	
	11.0 kW … 18.5 kW	
	FSC	
Article no.	6SL3203-0CE23-8AA0	
Article no. of the corresponding inverter	6SL3210-1KE22-6 □ □ 1 6SL3210-1KE23-2 □ □ 1 6SL3210-1KE23-8 □ □ 1	
Inductance	0.3 mH	
Power loss at 50/60 Hz	90 W	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 190 mm 220 mm 91 mm	
Mounting dimensions Width Height	 170 mm 68 mm	
Fixing screw	4 × M8 (10 Nm)	
Weight	7.8 kg	

10.10.2 Line filter

Table 10- 15 Technical data of the line filter as base component

Feature	**Suitable for inverters with a rated power of**		
	0.55 kW … 1.1 kW		
	FSAA		
Filter class according to EN 55011	Class A	Class B	
Article no.	6SE6400-2FA00-6AD0	6SE6400-2FB00-6AD0	
Article no. of the corresponding inverter	6SL3210-1KE11-8 □ □ 2 6SL3210-1KE12-3 □ □ 2 6SL3210-1KE13-2 □ □ 2		
Power loss at 50/60 Hz	25 W		
Degree of protection	IP20		
Overall dimensions Width Height Depth	 73 mm 200 mm 44 mm		
Mounting dimensions Width Height	 56 mm 187 mm		
Fixing screw	4 × M4 (4 Nm)		
Weight	0.5 kg		

10.10.3 Output reactors

Preconditions for using reactors:

- Maximum permissible output frequency of the inverter: 150 Hz
- Inverter pulse frequency: 4 kHz

Table 10- 16 Technical data of the output reactor as base component

Feature	**Suitable for inverters with a rated power of**	
	0.55 kW … 1.5 kW	
	FSAA	
Article no.	6SE6400-3TC00-4AD2	
Article no. of the corresponding inverter	6SL3210-1KE11-8 □ □ 2 6SL3210-1KE12-3 □ □ 2 6SL3210-1KE13-2 □ □ 2 6SL3210-1KE14-3 □ □ 2	
Inductance	2.5 mH	
Power loss at 50/60 Hz	25 W	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 76 mm 200 mm 110 mm	
Mounting dimensions Width Height	 56 mm 187 mm	
Fixing screw	4 × M4 (4 Nm)	
Weight	0.8 kg	

Table 10- 17 Technical data of the output reactors

Feature	Suitable for inverters with rated powers of		
	0.55 kW … 2.2 kW	3.0 kW … 4.0 kW	5.5 kW … 7.5 kW
	FSAA, FSA	FSA	FSB
Article no.	6SL3202-0AE16-1CA0	6SL3202-0AE18-8CA0	6SL3202-0AE21-8CA0
Article No. of the corresponding inverter	6SL3210-1KE11-8 □ □ □ 6SL3210-1KE12-3 □ □ □ 6SL3210-1KE13-2 □ □ □ 6SL3210-1KE14-3 □ □ □ 6SL3210-1KE15-8 □ □ 1	6SL3210-1KE17-5 □ □ 1 6SL3210-1KE18-8 □ □ 1	6SL3210-1KE21-3 □ □ 1 6SL3210-1KE21-7 □ □ 1
Inductance	2.5 mH	1.3 mH	0.54 mH
Power loss	90 W	80 W	80 W
Degree of protection	IP20	IP20	IP20
Overall dimensions Width Height Depth	 207 mm 175 mm 73 mm	 207 mm 180 mm 73 mm	 247 mm 215 mm 100 mm
Mounting dimensions Width Height	 166 mm 57 mm	 166 mm 57 mm	 225 mm 81 mm
Fixing screw	4 × M4 (3 Nm)	4 × M4 (3 Nm)	4 × M5 (5 Nm)
Weight	3.4 kg	3.9 kg	10.1 kg

Table 10- 18 Technical data of the output reactors

Feature	Suitable for inverters with rated powers of	
	11.0 kW … 18.5 kW	
	FSC	
Article no.	6SL3202-0AE23-8CA0	
Article No. of the corresponding inverter	6SL3210-1KE22-6 □ □ 1 6SL3210-1KE23-2 □ □ 1 6SL3210-1KE23-8 □ □ 1	
Inductance	0.26 mH	
Power loss at 50/60 Hz	110 W	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 257 mm 235 mm 115 mm	
Mounting dimensions Width Height	 225 mm 85 mm	
Fixing screw	4 × M5 (5 Nm)	
Weight	11.2 kg	

10.10.4 Sine-wave filter

Preconditions for using a sine-wave filter:

- Maximum permissible output frequency of the inverter: 150 Hz
- Inverter pulse frequency: 4 kHz

Table 10- 19 Technical data of the sine-wave filter as base component

Feature	**Suitable for inverters with a rated power of**	
	0.55 kW … 1.1 kW	
	FSAA	
Article no.	6SE6400-3TD00-4AD0	
Article No. of the corresponding inverter	6SL3210-1KE11-8 □ □ 2 6SL3210-1KE12-3 □ □ 2 6SL3210-1KE13-2 □ □ 2	
Power loss at 50/60 Hz	25 W	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 76 mm 300 mm 110 mm	
Mounting dimensions Width Height	 56 mm 287 mm	
Fixing screw	4 × M4 (4 Nm)	
Weight	0.8 kg	

10.10.5 Braking resistor

Table 10- 20 Technical data of the braking resistor as base component

Feature	**Suitable for inverters with a rated power of**	
	0.55 kW … 1.5 kW	
	FSAA	
Article no.	6SE6400-4BD11-0AA0	
Article No. of the corresponding inverter	6SL3210-1KE11-8 □ □ 2 6SL3210-1KE12-3 □ □ 2 6SL3210-1KE13-2 □ □ 2 6SL3210-1KE14-3 □ □ 2	
Resistance	390 Ω	
Pulse power P_{max}	2.0 kW	
Rated power P_{DB}	100 W	
Temperature contact	NC contact	
Temperature contact, maximum load	250 V AC / 2.5 A	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 72 mm 230 mm 44 mm	
Mounting dimensions Width Height	 56 mm 187 mm	
Fixing screw	4 × M4 (4 Nm)	
Weight	1.0 kg	

Table 10- 21 Technical data of the braking resistors

Feature	Suitable for inverters with a rated power of		
	0.55 kW … 1.5 kW	2.2 kW … 4.0 kW	5.5 kW … 7.5 kW
	FSAA, FSA	FSA	FSB
Article No.	6SL3201-0BE14-3AA0	6SL3201-0BE21-0AA0	6SL3201-0BE21-8AA0
Article No. of the corresponding inverter	6SL3210-1KE11-8 □ □ □ 6SL3210-1KE12-3 □ □ □ 6SL3210-1KE13-2 □ □ □ 6SL3210-1KE14-3 □ □ □	6SL3210-1KE15-8 □ □ 1 6SL3210-1KE17-5 □ □ 1 6SL3210-1KE18-8 □ □ 1	6SL3210-1KE21-3 □ □ 1 6SL3210-1KE21-7 □ □ 1
Resistance	370 Ω	140 Ω	75 Ω
Pulse power P_{max}	1.5 kW	4 kW	7.5 kW
Rated power P_{DB}	75 W	200 W	375 W
Temperature contact	NC contact	NC contact	NC contact
Temperature contact, maximum load	AC 250 V / 2.5 A	AC 250 V / 2.5 A	AC 250 V / 2.5 A
Degree of protection	IP20	IP20	IP20
Overall dimensions Width Height Depth	 105 mm 295 mm 100 mm	 105 mm 345 mm 100 mm	 175 mm 345 mm 100 mm
Drilling pattern Width Height	 72 mm 266 mm	 72 mm 316 mm	 142 mm 316 mm
Fixing screws	4 × M4 (3 Nm)	4 × M4 (3 Nm)	4 × M4 (3 Nm)
Weight	1.5 kg	1.8 kg	2.7 kg

Table 10- 22 Technical data of the braking resistors

Feature	Suitable for inverters with a rated power of	
	11.0 kW ... 18.5 kW	
	FSC	
Article No.	6SL3201-0BE23-8AA0	
Article No. of the corresponding inverter	6SL3210-1KE22-6 □ □ 1 6SL3210-1KE23-2 □ □ 1 6SL3210-1KE23-8 □ □ 1	
Resistance	30 Ω	
Pulse power P_{max}	18.5 kW	
Rated power P_{DB}	925 W	
Temperature contact	NC contact	
Temperature contact, maximum load	AC 250 V / 2.5 A	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 250 mm 490 mm 140 mm	
Drilling pattern Width Height	 217 mm 460 mm	
Fixing screws	4 × M5 (6 Nm)	
Weight	6.2 kg	

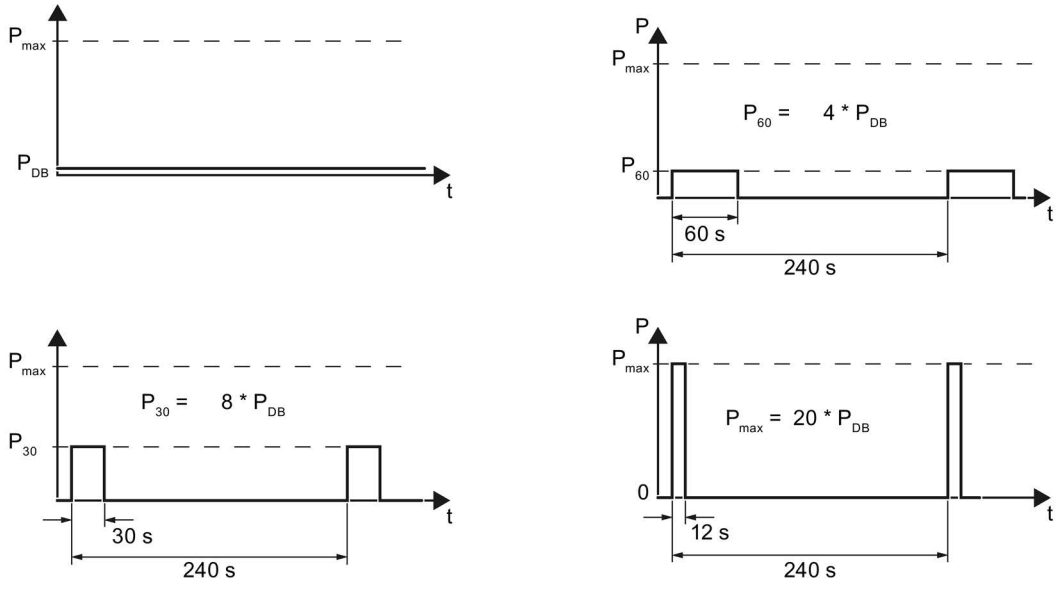


Figure 10-4 Pulse power P_{max} and rated power P_{DB} as a function of the switch-on duration

10.11 Standards

CE	**European Low-Voltage Directive** The SINAMICS G120C product series is in compliance with the Low-Voltage Directive 2006/95/EC. The devices are certified that they comply with the following standards: EN 61800-5-1 - Semiconductor - General Requirements and Line Commutated Inverters EN 60204-1 - Safety of machinery - Electrical equipment of machines
	European Machinery Directive SINAMICS G120C inverters does not fall within the area covered by the Machinery Directive. However, the use of the products in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety. A declaration regarding the acceptance is available upon request.
	European EMC directive When installed according to the recommendations described in this manual, the SINAMICS G120C fulfils all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN 61800-3.
c UL us LISTED	**Underwriters Laboratories** This device is designed to ensure internal motor overload protection in accordance with UL508C.
SEMI F47	**Specification for semiconductor process equipment voltage drop immunity** SINAMICS G120C inverters meet the requirements of standard SEMI F47-0706.
	ISO 9001 Siemens AG uses a quality management system that meets the requirements of ISO 9001.

Certificates can be downloaded from the Internet under the following link:

Standards (http://support.automation.siemens.com/WW/view/en/22339653/134200)

Appendix

A

A.1 New and extended functions

Table A- 1 New functions and function changes in Firmware 4.7 SP3

	Function	SINAMICS								
			G120					G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC-2
1	PM240-2 Power Modules, frame sizes FSD and FSE are supported	-	-	✓	✓	✓	✓	-	-	-
	The Safety Integrated basic function Safe Torque Off (STO) is supported via the terminals of the PM240-2 Power Module, frame sizes FSD and FSE	-	-	-	-	✓	✓	-	-	-
2	Revised PM230 Power Module with new Article numbers supported: • IP55 degree of protection: 6SL3223-0DE . . - . . **G** . • IP20 degree of protection and Push Through: 6SL321 . - 1NE . . - . . **G** .	-	-	✓	✓	✓	-	-	-	-
	The Safety Integrated basic function Safe Torque Off (STO) is supported with the revised PM230 Power Module	-	-	-	-	✓	-	-	-	-
3	PM330 Power Module, frame size HX is supported	-	-	✓	-	-	-	-	-	-
4	1FP1 reluctance motors are supported	-	-	✓	-	-	-	-	-	-
5	Encoderless 1FK7 synchronous motors are supported	-	✓	-	✓	✓	✓	✓ [1]	-	-
6	Encoderless 1FG1 geared synchronous motors are supported	-	✓	-	✓	✓	✓	✓	-	-
7	SINAMICS “Standard Drive Control” and “Dynamic Drive Control” application classes to simplify commissioning and increase the degree of ruggedness of the closed-loop motor control. The SINAMICS application classes are available with the following inverters: • SINAMICS G120C • SINAMICS G120 with PM240, PM240-2 and PM330 Power Modules	-	✓	✓	✓	✓	✓	-	-	-
8	Moment of inertia estimator with moment of inertia precontrol to optimize the speed controller in operation	✓	✓	-	✓	✓	✓	✓	✓	✓
9	Friction torque characteristic with automatic plotting to optimize the speed controller	✓	✓	-	✓	✓	✓	✓	✓	✓
10	Automatic optimization of the technology controller	-	-	✓	✓	✓	-	-	-	-

	Function	SINAMICS								
			G120					G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC-2
11	The sign of the system deviation for the additional, free technology controller can be switched over. A new parameter defines the sign of the system deviation matching the particular application, e.g. for cooling or heating applications.	-	-	✓	-	-	-	-	-	-
12	Line contactor control using a digital output of the inverter to save energy when the motor is switched off	✓	✓	✓	✓	✓	✓	✓	✓	-
13	Fast flying restart for PM330 Power Modules: The "Flying restart" function does not have to wait for the motor demagnetization time, and identifies the motor speed without requiring a search operation.	-	-	✓	-	-	-	-	-	-
14	Load torque monitoring extended to include the following functions: • Protection against blocking, leakage and dry running operation in pump applications • Protection against blocking and broken belts in fan applications	-	✓	✓	✓	✓	-	-	-	-
15	Automatic switchover of the real time clock from daylight saving time (summer time) to standard time (winter time).	-	-	✓	-	-	-	-	-	-
16	New or revised default settings of the interfaces: p0015 macros 110, 112 and 120	-	-	✓	-	-	-	-	-	-
17	Expansion of the temperature sensors to include DIN-Ni1000 for analog inputs AI 2 and AI 3	-	-	✓	-	-	-	-	-	-
18	Communication via AS-Interface. Default setting of the communication via AS-i: p0015 macros 30, 31, 32 and 34	✓	-	-	-	-	-	-	-	-
19	Communication expansion via Modbus: Adjustable parity bit, access to parameters and analog inputs	-	-	✓	-	-	-	-	-	-
20	Extending communication via BACnet: Access to parameters and analog inputs	-	-	✓	-	-	-	-	-	-
21	The bus error LED for communication via USS and Modbus can be switched off	✓	✓	✓	✓	✓	✓	-	-	-

[1] Operation with 1FK7 synchronous motors without encoder has already been released with firmware V4.7 for SINAMICS G120D with CU240D-2 Control Units.

In the preface you can find references to the description of the new functions: Change history (Page 5).

Table A- 2 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
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 between 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 Article No. with allocated code number • It is not necessary to input individual motor data	-	-	-	-	-	-	✓	-
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	-	-	✓	-	-	-	-	-

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	-	✓	-	-	-	-	-

Table A- 4 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	✓	✓	✓	✓	✓	✓	✓

Table A- 5 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.2 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.

Commonly used parameters

Table A- 6 **Switching to commissioning mode or restore the factory setting**

Parameter	Description
p0010	**Commissioning parameters** 0: Ready (factory setting) 1: Perform quick commissioning 3: Perform motor commissioning 5: Technological applications and units 15: Define number of data records 30: Factory setting - initiate restore factory settings

Table A- 7 **How to determine the firmware version of the Control Unit**

Parameter	Description
r0018	**The firmware version is displayed:**

Table A- 8 **How you select the command source and setpoint sources**

Parameter	Description
p0015	Parameter p0015 allows the setting of pre-defined I/O configurations. Further information is given in the section: Commissioning using a BOP-2 operator panel (Page 93).

Table A- 9 **This is how you parameterize the up and down ramps**

Parameter	Description
p1080	**Minimum speed** 0.00 [rpm] factory setting
p1082	**Maximum speed** 1500.000 [rpm] factory setting
p1120	**Rampup time** 10.00 [s]
p1121	**Rampdown time** 10.00 [s]

Table A- 10 **This is how you set the closed-loop type**

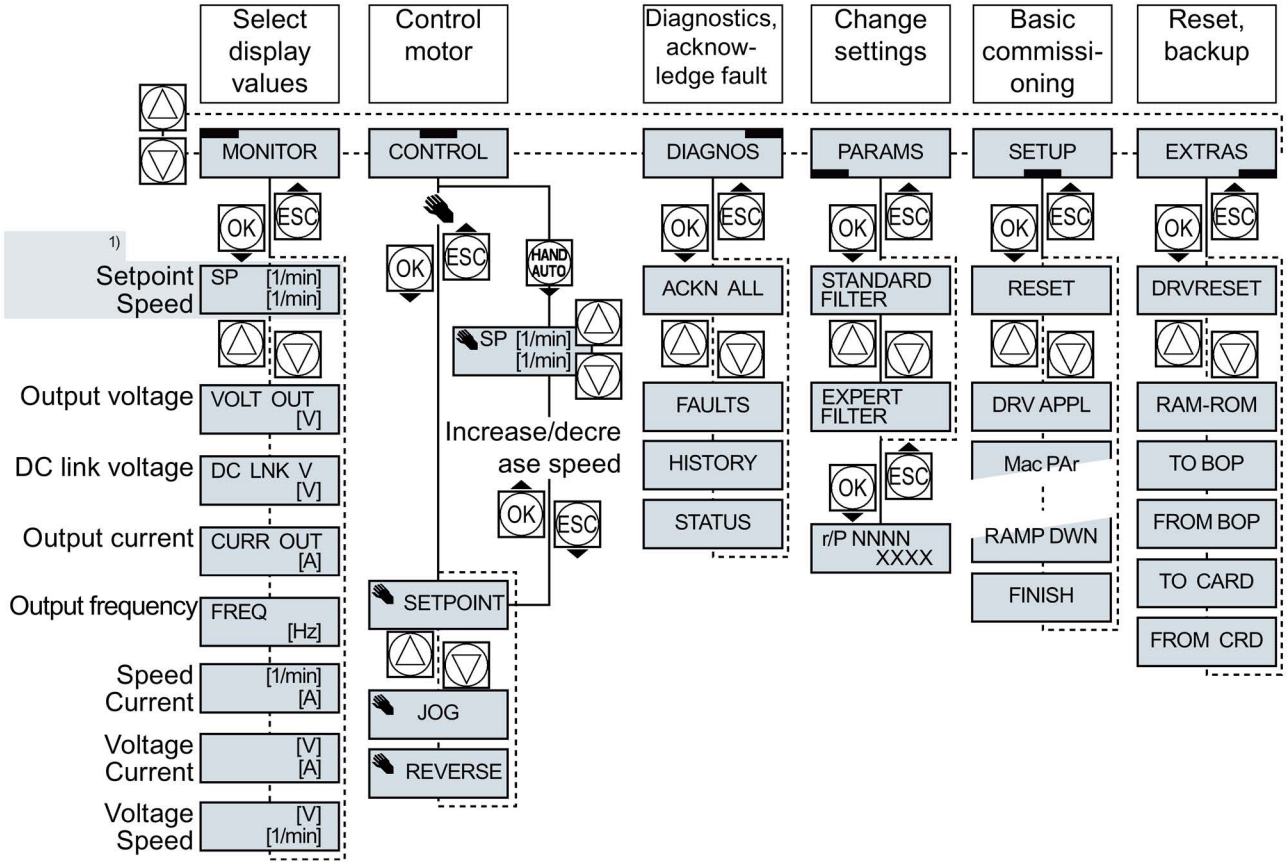
Parameter	Description
p1300	0: V/f control with linear characteristic 1: V/f control with linear characteristic and FCC 2: V/f control with parabolic characteristic 3: V/f control with parameterizable characteristic 4: V/f control with linear characteristic and ECO 5: V/f control for drives requiring a precise frequency (textile area) 6: V/f control for drive requiring a precise frequency and FCC 7: V/f control with parabolic characteristic and ECO 19: V/f control with independent voltage setpoint 20: Speed control (without encoder)

Table A- 11 **Optimizing starting behavior for V/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 voltage boost at zero speed 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 for an additional voltage boost when powering-up, however, only for the first acceleration phase.

A.3 Using the operator panel BOP-2

A.3.1 Menu structure, symbols and keys



1) Status display once the power supply for the inverter has been switched on.

Figure A-1 Menu of the BOP-2


The motor is switched on



Jog is active


An alarm is active


Flashing symbol:
A fault is active

Procedure for switching the motor on and off via the operator panel:



1. Press MANUAL AUTO


2. Master control of the inverter is released via the BOP-2


3. Switch on motor


4. Switch off the motor

Figure A-2 Other keys and symbols of the BOP-2

A.3.2 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.

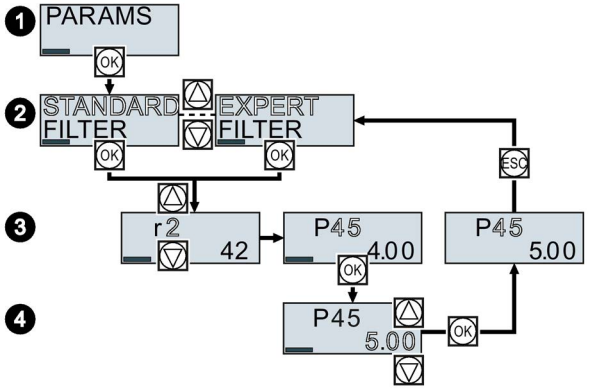
The value of a read-only parameter cannot be changed. Read-only parameters begin with an "r", for example: r2.

Procedure

1
2

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.3.3 Changing indexed parameters

Changing indexed parameters

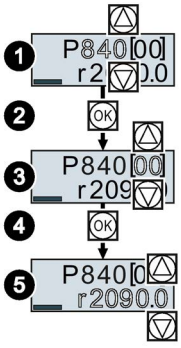
For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

Procedure

1
2

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.3.4 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

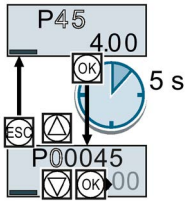
The parameter number is flashing in the BOP-2 display.

Procedure

1
2

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

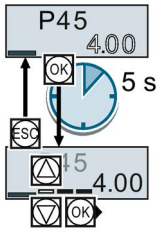
The parameter value flashes in the BOP-2 display.

Procedure

1
2

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.

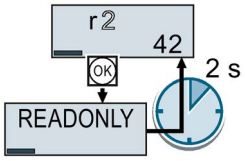


You have now entered the parameter value directly.

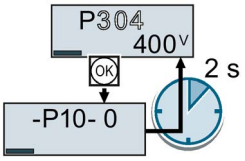
A.3.5 A parameter cannot be changed

When must you not change a parameter?

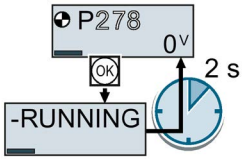
The converter indicates why it currently does not permit a parameter to be changed:



You have attempted to change a read-only parameter.



You must change to basic commissioning to set this parameter.



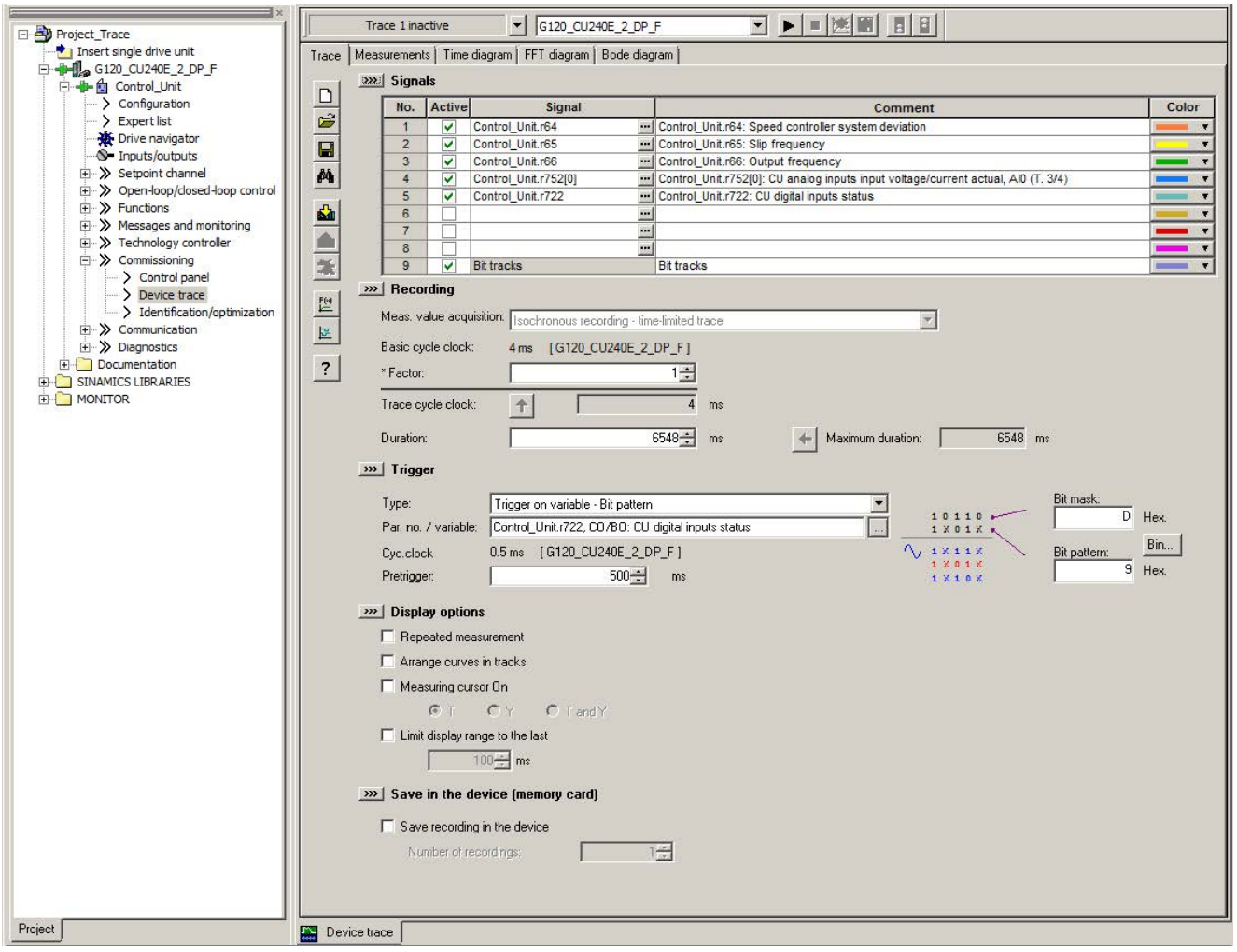
You must turn the motor off to set this parameter.

The operating state in which you can change a parameter is provided in the List Manual for each parameter.

A.4 The device trace in STARTER

Description

The device trace graphically displays inverter signals with respect to time.



Signals

In two settings that are independent of one another, using ... you can interconnect eight signals each.

Recording

You can start a measurement as frequently as you require. As long as you do not exit START, the results remain under the "Measurements" tab with data 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 settings in the project or export them in *.clg format, and load or import them, if necessary.

You can record individual bits of a parameter (e.g. r0722. 1) by allocating the relevant bit using "bit track" ( ).

Using the mathematical function ( ) you can define a curve, for example, the difference between the speed setpoint and the speed actual value.

The device trace shows "individual bits" or "mathematical functions" as signal No. 9.

Recording cycle and duration

The device trace records data in a CU-dependent basic cycle clock. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

Proceed as follows to extend the recording duration:

1. Multiply the trace clock cycle by an integral number.
2. Accept the displayed maximum duration using .

Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

Trigger (condition to start the device trace)

The device trace starts as soon as you press the (start trace) button.

Using the button , you can define another trigger to start the device trace.

The pretrigger defines the time in which the signals are traced before the trigger condition. As a consequence, the trigger condition traces itself.

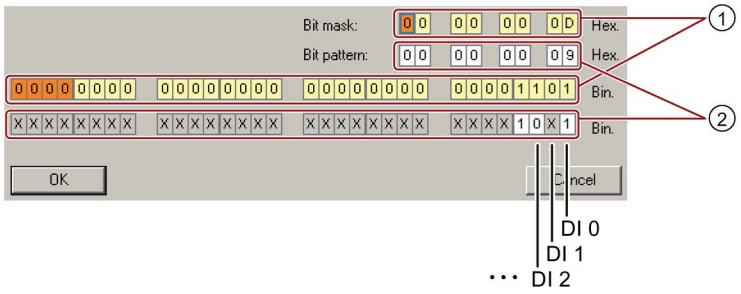
Example of a bit pattern as trigger:

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 Trigger as bit pattern of r0722 (status of the digital inputs)

In the example, the trace starts if digital inputs DI 0 and DI 3 are high, and DI 2 is low. The state of the other digital inputs is not relevant for the trigger condition.

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.

- Repeat measurement
  This places the measurements that you wish to perform at different times above one other.
- Arrange curves in tracks
  This defines whether the device trace will show all measured values on a common zero line or on separate zero lines.
- Measuring cursor On
  This allows you to analyze the measuring intervals in more detail.

Save to device (memory card)

In this area, you define whether the device trace will save successive measurements in directory /USER/SINAMICS/DATA/TRACE on a inserted memory card.

Displaying the measurements backed up on the memory card

Procedure

1
2

To display the measurements backed up on the memory card, proceed as follows:

1. Insert the memory card into a card reader.
2. Go to the "Measurements" tab in the device trace.
3. Open the read out ACX files with the "Open measurements" button.

STARTER shows the measurements backed up on the memory card.

A.5 Interconnecting signals in the converter

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.

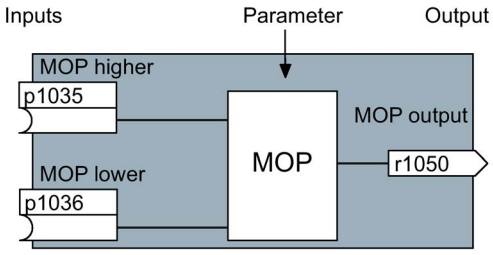


Figure A-4 Example of a block: Motorized potentiometer (MOP)

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.

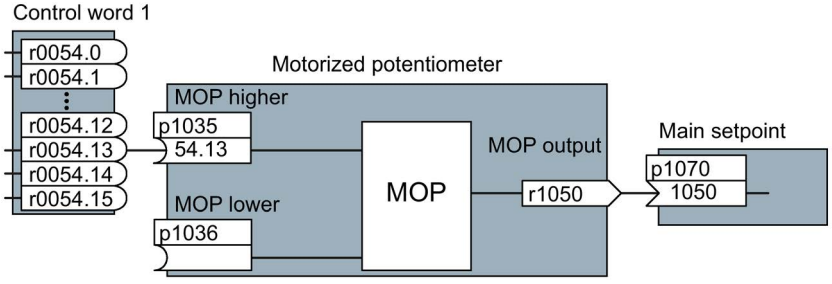


Figure A-5 Example: Signal interconnection of two blocks for digital input 0

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)

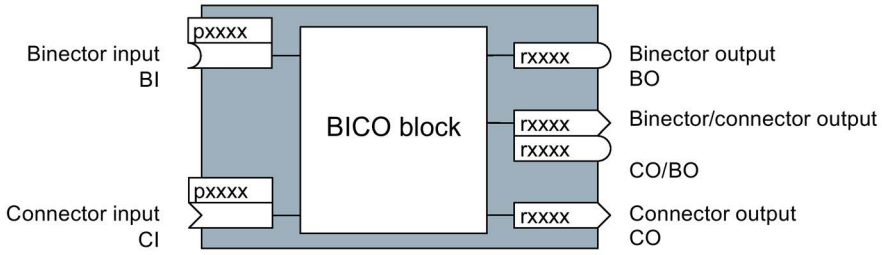


Figure A-6 Symbols for binector and connector inputs and outputs

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.

Principle when connecting BICO blocks using BICO technology

An interconnection between two BICO blocks comprises a connector or binector and a BICO parameter. The interconnection is always established from the perspective of the input of a particular BICO block. This means that the output of an upstream block must always be assigned to the input of a downstream block. The assignment is always made by entering

the number of the connector/binector from which the required input signals are read in a BICO parameter.

This interconnection logic involves the question: **where does the signal come from?**

Example

You have to use the BICO technology when adapting the function of inputs and outputs. You find examples in the section Adapt the default setting of the terminal strip (Page 130).

A.6 Connecting the safety-related input

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.

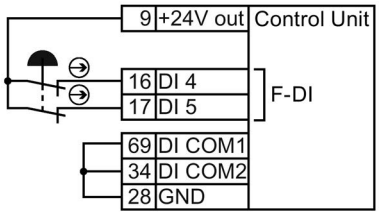


Figure A-7 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

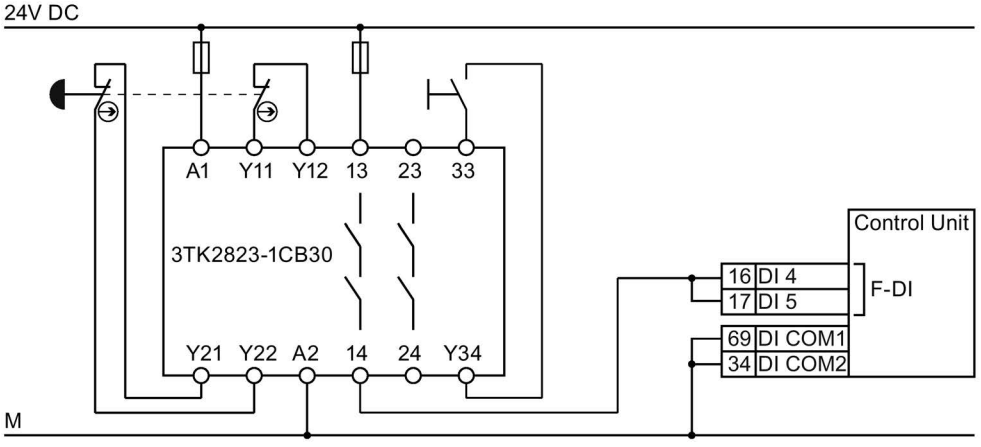


Figure A-8 Connecting a safety relay, e.g. SIRIUS 3TK28

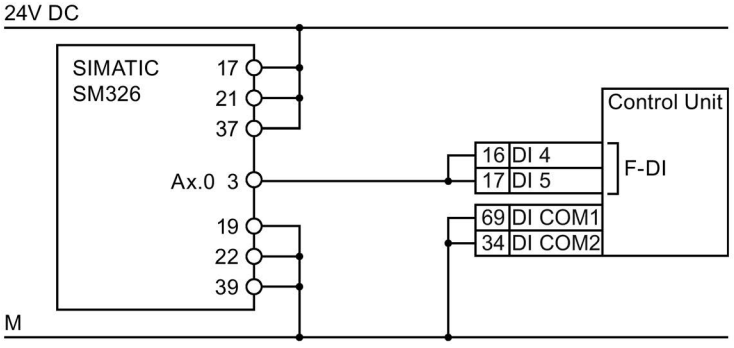


Figure A-9 Connecting an F digital output module, e.g. SIMATIC F digital output module

You can find additional connection options and connections in separate control cabinets in the Safety Integrated Function Manual, see Section: Further information on your inverter (Page 409).

A.7 Acceptance test for the safety function

A.7.1 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

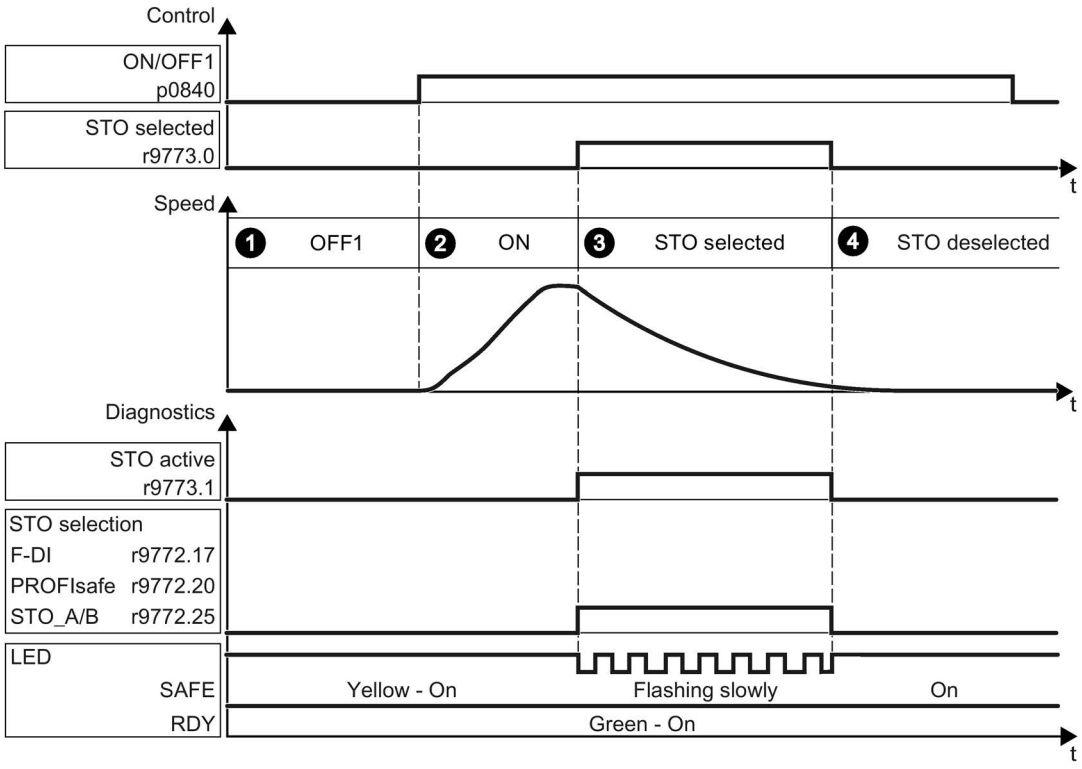


Figure A-10 Acceptance test for STO (basic functions)

Procedure

1
2 To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

			Status
1.	**The inverter is ready**		
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
	• STO is not active (r9773.1 = 0).		
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	

					Status
3.	**Select STO**				
	3.1.	Select STO while the motor is running. *Test each configured activation, e.g. via digital inputs and PROFIsafe.*			
	3.2.	Check the following:			
		When controlled via PROFIsafe	When controlled via fail-safe digital inputs (F-DI)	When controlled via terminals STO_A and STO_B on Power Module PM240-2	
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)	• The inverter signals the following: "STO Selection via terminal on Power Module" (r9772.25 = 1)	
		• 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 standstill.			
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			
		• The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).			
4.	**Deselect STO**				
	4.1.	Deselect STO.			
	4.2.	Check the following:			
		• STO is not active (r9773.1 = 0).			
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			

☐ You have performed the acceptance test of the STO function.

A.7.2 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	Article 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.7.3 Log of the settings for the basic functions, firmware V4.4 ... V4.7 SP2

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>
SI forced checking procedure STO via PM terminals time		p9661	<p9661_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.8 Further information on your inverter

A.8.1 Manuals for your inverter

Table A- 19 Manuals for your inverter

Depth of the information	Manual	Contents	Available languages	Download or article number
++	**Compact operating instructions** SINAMICS G120C	Installing and commissioning the inverter.	Chinese, English, French, German, Italian, Spanish, Turkish	Download (http://support.automation.siemens.com/WW/view/en/48213081/133300) **SINAMICS Manual Collection** Documentation on DVD, Article No. 6SL3097-4CA00-0YG0
+++	**Operating instructions**	(this manual)		
+++	**Function Manual for Safety Integrated** for the inverters SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2	Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter.	English, German, Chinese	
+++	**Fieldbus function manual** for the SINAMICS G120, G120C and G120D inverters	Configuring fieldbuses.		
+++	**List Manual** SINAMICS G120C	Complete list of all parameters, alarms and faults. Graphic function diagrams.	English, German, Chinese	
+	**Installation Instructions** for reactors and braking resistors	Installing components	English	
+++	**Operating Instructions**for Operator Panels BOP-2 and IOP	Operating operator panels, installing door assembly for IOP	English, German	

A.8.2 Configuring support

Table A- 20 Support when configuring and selecting the inverter

Manual or tool	Contents	Available languages	Download or article number
Catalog D 31	Ordering data and technical information for SINAMICS G inverters	English, German, Italian, French, Spanish	All about SINAMICS G120C (www.siemens.com/sinamics-g120c)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology	English, German, Italian, French	You obtain SIZER on a DVD (Article number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)

A.8.3 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".

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