SINAMICS G120

SINAMICS G120C conveter

Operating instructions · 01/2013

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SINAMICS G120C
SINAMICS G120C converter

Operating Instructions

Edition 01/2013, Firmware 4.6

Original instructions
01/2013, FW V4.6
A5E02999804C AB

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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Disclaimer of Liability

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

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A5E02999804C AB
Ⓟ 04/2013 Technical data subject to change

Change history

Main changes with respect to the manual, edition 3/2012

New functions in firmware V4.6	In Chapter
Dead zone for analog inputs	Analog input (Page 84)
Firmware update of the converter	New and extended functions (Page 357) Upgrading the firmware (Page 314)
EtherNet/IP	Communication via EtherNet/IP (Page 118)

See section Firmware downgrade (Page 316) for an overview of new and changed functions in firmware V4.6.

Revised descriptions	In Chapter
Safety instructions	in the whole manual
Add-ons in CANopen	Communication via CANopen (Page 154)
PROFIenergy functions of the converter added	PROFIenergy profile for PROFINET (Page 115)
Function "energy saving" added	Energy-saving display (Page 236)
Acceptance test of the fail-safe function "safe torque off" (STO)	Acceptance test (Page 273)
Ramp function generator • Rounding-off times added • Ramp scaling during operation added	Ramp-function generator (Page 213)

Table of contents

Safety notes 1

Use for the intended purpose

The frequency converter described in this manual is a device for controlling an asynchronous low-voltage motor. The converter is designed for installation in electrical installations or machines.

It has been approved for industrial and commercial use on industrial networks. Its use in public line supplies requires a different configuration and/or additional measures.

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

⚠DANGER

Danger to life when live parts are touched

Touching live parts can result in death or severe injury.

Note the following:

- Only work on electrical equipment if you are qualified to do so.
- When carrying out any work, always comply with the country-specific safety rules.

Follow the six steps to ensure safety:

1. Prepare for shutdown and inform team members who will be affected by the procedure.
2. Switch off the machine so that it is in a no-voltage state:
   - 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 that all auxiliary circuits are also in a no-voltage state.
   - Ensure that the motor 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. Lock out all energy sources to prevent reclosing.
6. Make sure that the machine is completely locked out ... and that you have the right machine!

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

WARNING

Danger of fire spreading due to inadequate housing

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 inside and outside the device is prevented.

WARNING

Danger to life when live parts are touched on damaged devices

Hazardous voltages can be present at the housing or exposed components on damaged devices.

- Ensure compliance with the limit values specified in the technical specifications during transport, storage and operation.
- Do not use any damaged devices.
- The components must be protected against conductive contamination (e.g. by installing them in a cabinet with degree of protection IP54B to EN 60529).

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

WARNING

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

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

- Switch off mobile radios and mobile telephones when you are close to the converter.

NOTICE

Damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can result in malfunctions as a result of damaged individual components, integrated circuits, modules or devices.

- Package, store, transport and send the electronic components, modules or devices only in the original product packaging or in other suitable materials, e.g. conductive foam rubber or aluminum foil.
- Only touch components, modules and devices if you are grounded by means of one of the following measures:
  - Wearing an ESD armband or
  - 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, for example).

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.

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 defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - 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 malfunctions
   - Software errors
   - Operating and/or ambient conditions outside of 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 the contact with fire inside and outside the inverter is not possible.
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions outside of 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 this manual

Who requires the operating instructions and what for?

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

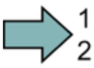
What is described in the operating instructions?

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

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

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

What is the meaning of the symbols in the manual?

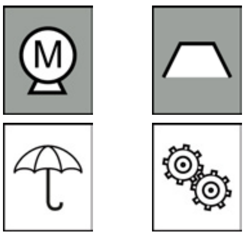


An operating instruction starts here.

This concludes the operating instruction.

The following text applies to the Basic Operator Panel BOP-2.

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



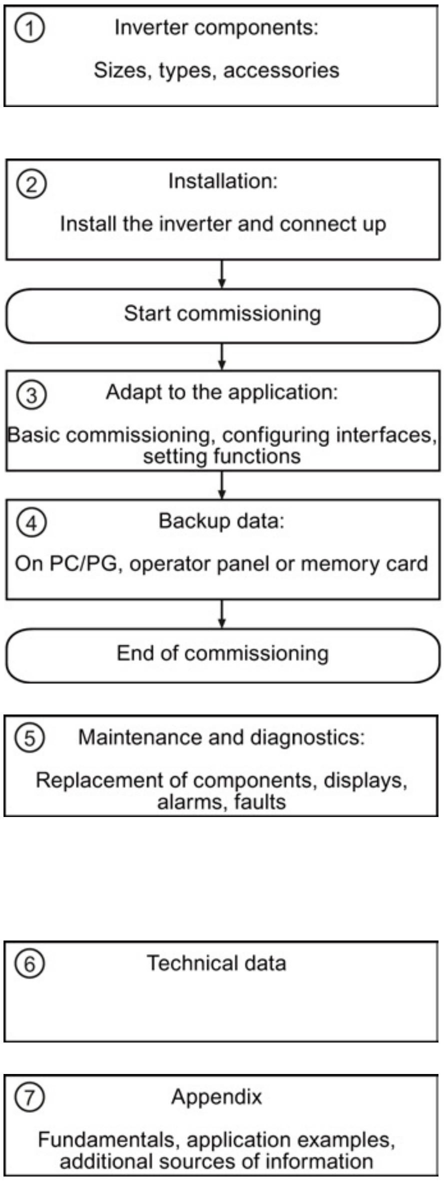
Examples for the symbols of the inverter functions.

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

See also: Overview of the inverter functions (Page 191).

2.2 Guide through this manual

In this manual, you will find background information on your inverter, as well as a full description of the commissioning procedure:



① Here you will find information about the hardware of your inverter and the commissioning tools:

- Product overview (Page 21)

② • Installing (Page 25)

All information relating to the commissioning of your inverter is located in the following chapters:

③ • Basic commissioning (Page 66)
- Adapting the terminal strip (Page 79)
- Configuring the fieldbus (Page 91)
- Setting functions (Page 191)

④ • Backup data and series commissioning (Page 281)

⑤ Information regarding the maintenance and diagnostics of your inverter is located in the following chapters:

- Repair (Page 303)
- Alarms, faults and system messages (Page 321)

⑥ The most important technical data for your inverter is located in this chapter:

- Technical data (Page 339)

⑦ The appendix contains some background information and explanatory examples:

- Appendix (Page 357)

Description

3.1 Product overview

The SINAMICS G120C is a range of converters for controlling the speed of three phase motors. The converter is available in three frame sizes.

You find a label with the order number:

- On the front of the converter after removing the blind cover or the operator panel.
- On one side of the converter.

	Rated output power	Rated output current	Order number					
	based on Low Overload		Unfiltered			Filtered		
 Frame Size A	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
 Frame Size B	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
 Frame Size C	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	

Figure 3-1 Identifying the converter

3.2 Components, which you require depending on your application

Line reactor

A line reactor protects the converter from the rough characteristics of an industrial grid. A line reactor supports the overvoltage protection, smoothes harmonics and bridges commutation notches.

Note

If the relative short-circuit voltage u_k of the line transformer is smaller than 1 %, you have to install a line reactor in order to ensure the optimal lifetime of your converter.

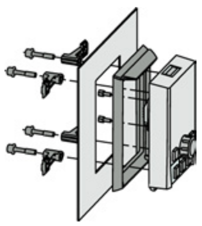
Braking resistor

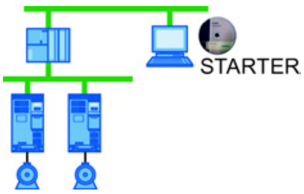
The braking resistor enables loads with a large moment of inertia to be braked quickly.

<table>
<tr><th colspan="2">Converter</th><th>Braking resistor</th><th>Line reactor</th></tr>
<tr><td rowspan="3">Frame Size A</td><td>0.55 kW … 1.1 kW</td><td rowspan="2">6SL3201-0BE14-3AA0</td><td>6SL3203-0CE13-2AA0</td></tr>
<tr><td>1.5 kW</td><td rowspan="2">6SL3203-0CE21-0AA0</td></tr>
<tr><td>2.2 kW … 4.0 kW</td><td>6SL3201-0BE21-0AA0</td></tr>
<tr><td>Frame Size B</td><td>5.5 kW … 7.5 kW</td><td>6SL3201-0BE21-8AA0</td><td>6SL3203-0CE21-8AA0</td></tr>
<tr><td>Frame Size C</td><td>11.0 kW … 18.5 kW</td><td>6SL3201-0BE23-8AA0</td><td>6SL3203-0CE23-8AA0</td></tr>
</table>

3.3 Commissioning tools

Accessories for commissioning and data backup

Operator Panels for commissioning, diagnostics and controlling inverters		Order number
	BOP-2 (Basic Operator Panel) - for snapping onto the frequency inverter • Copying of drive parameters • Two-line display • Guided basic commissioning	6SL3255-0AA00-4CA1
	IOP (Intelligent Operator Panel) - for snapping onto the frequency inverter • Copying of drive parameters • Plain text display • Menu-based operation and application wizards	6SL3255-0AA00-4JA0
	Door mounting kit for IOP/BOP-2 • For installation of theBOP-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	6SL3256-0AP00-0JA0
	IOP - with handheld For mobile use of the IOP	6SL3255-0AA00-4HA0

PC tools for commissioning, diagnostics and controlling of the converter		
	PC Connection Kit Includes a STARTER DVD and USB port.	6SL3255-0AA00-2CA0
	STARTER Commissioning tool (PC software) connection to the converter via USB port, PROFIBUS or PROFINET Downloading: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	STARTER on the DVD: 6SL3072-0AA00-0AG0
	Drive ES Basic As an option to STEP 7 with routing function via network limits for PROFIBUS and PROFINET	6SW1700-5JA00-5AA0
Memory cards: to save and transfer the converter settings		
	MMC card	6SL3254-0AM00-0AA0
	SD card	6ES7954-8LB00-0AA0

Installing 4

⚠ WARNING
Danger of fire through overheating due to insufficient ventilation clearances
Insufficient ventilation clearances increase the probability of failure and reduce the service life of devices. In the worst-case scenario, devices overheating can put persons at risk through smoke development and fire.
• Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component. Minimum clearances can be found in the dimension drawings or in the "Product-specific safety instructions" at the start of the respective section.

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 339).

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 Mounting the converter

Mounting orientation

Mount the converter in a control cabinet.

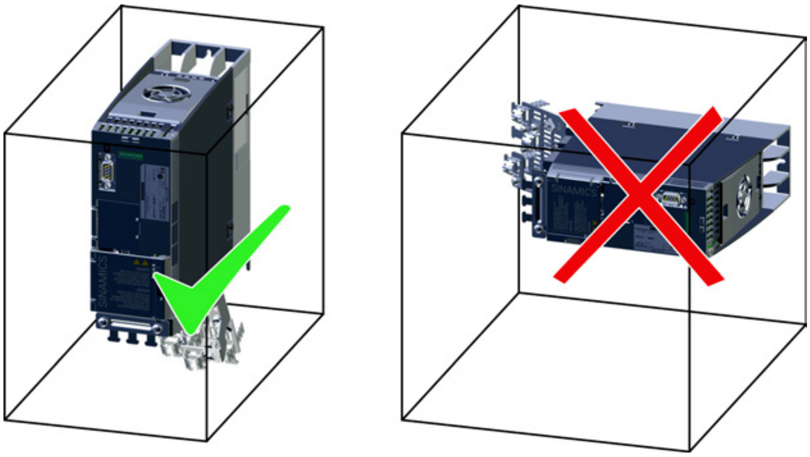


Figure 4-1 The converter must not be installed horizontally.

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.

4.2.1 Mechanical installation

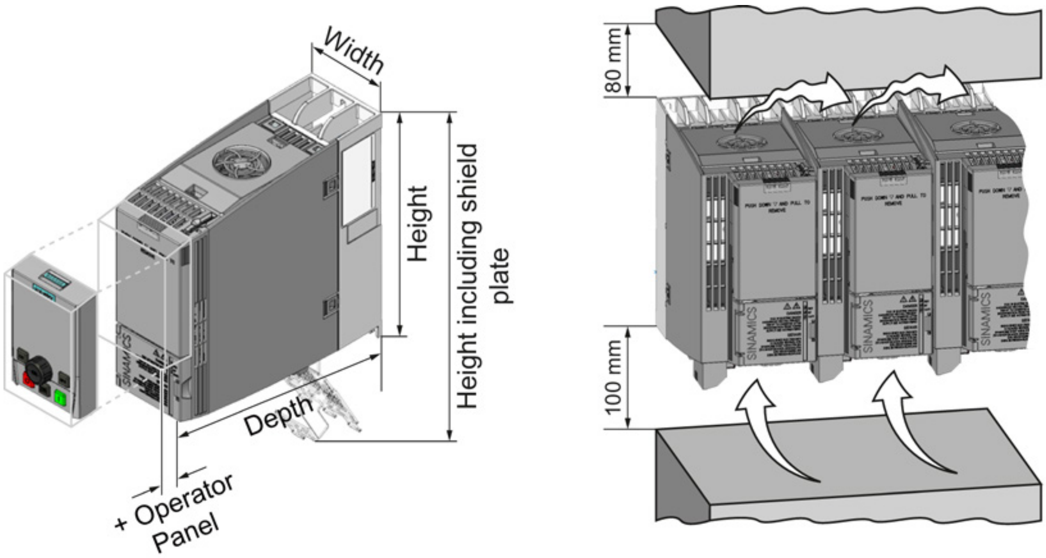
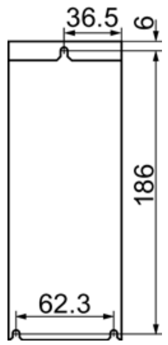
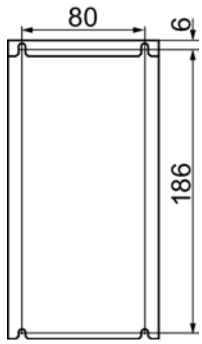
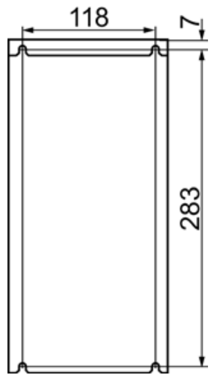


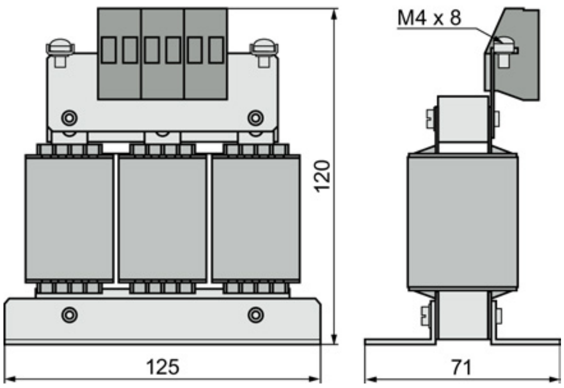
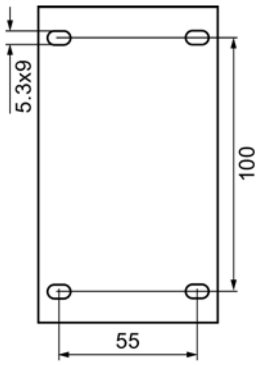
Figure 4-2 Dimensions and minimum spacing to other devices

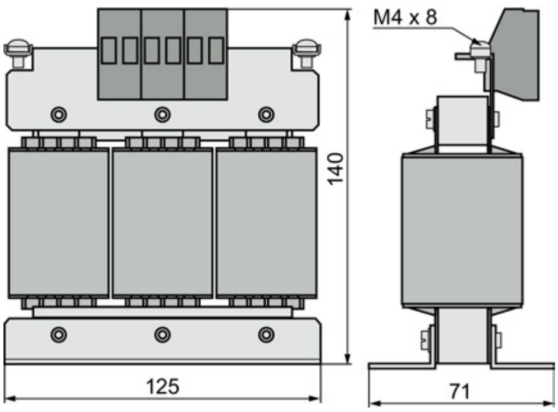
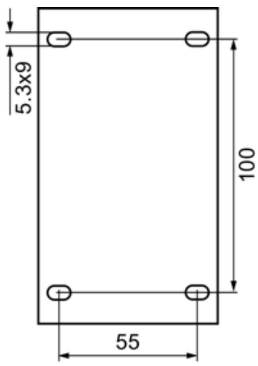
Table 4- 1 Dimensions, drilling patterns, and fixing elements

	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	196 mm	196 mm	295 mm
Height including shield plate	276 mm	276 mm	375 mm
Width	73 mm	100 mm	140 mm
Depth of the converter with PROFINET interface	225.4 mm	225.4 mm	225.4 mm
Depth of the converter with USS/MB, CANopen, or PROFIBUS interface	203 mm	203 mm	203 mm
Additional depth when the Operator Panel is attached	+ 21 mm when Operator Panel IOP (Intelligent Operator Panel) is attached		
	+ 6 mm when Operator Panel BOP-2 (Basic Operator Panel) is attached		
Drilling pattern			
Fixing elements	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

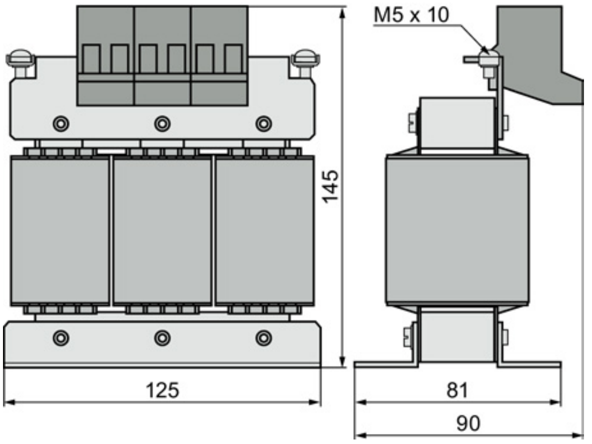
4.3 Mounting the line reactor

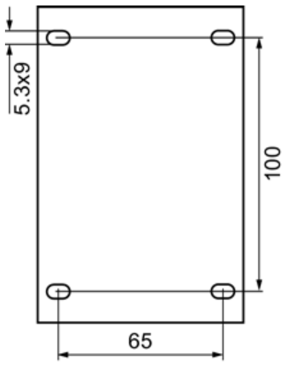
Dimensions and drill patterns

Frame Size A, 0.55 kW … 1.1 kW	
Dimensions [mm]	Drill pattern [mm]
 	 Fixings: 4 x M5 bolts 4 x M5 nuts 4 x M5 washers Tightening torque: 6 Nm

Frame Size A, 1.5 kW … 4.0 kW	
Dimensions [mm]	Drill pattern [mm]
 	 Fixings: 4 x M5 bolts 4 x M5 nuts 4 x M5 washers Tightening torque: 6 Nm

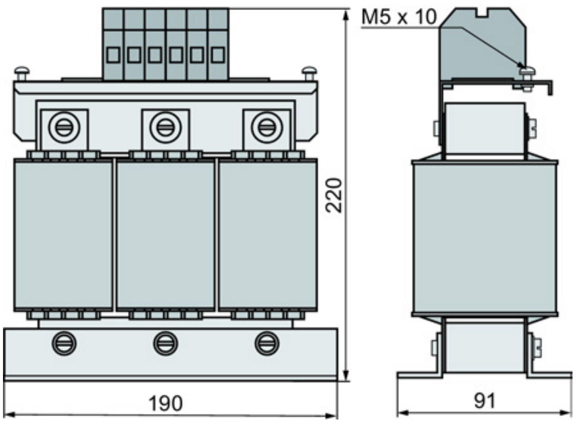
Frame Size B, 5.5 kW … 7.5 kW

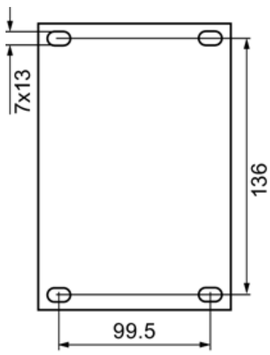




Fixings:
4 x M5 bolts
4 x M5 nuts
4 x M5 washers
Tightening torque: 6 Nm

Frame Size C, 11 kW … 18.5 kW





Fixings:
4 x M6 bolts
4 x M6 nuts
4 x M6 washers
Tightening torque: 10 Nm

Distances to other equipment

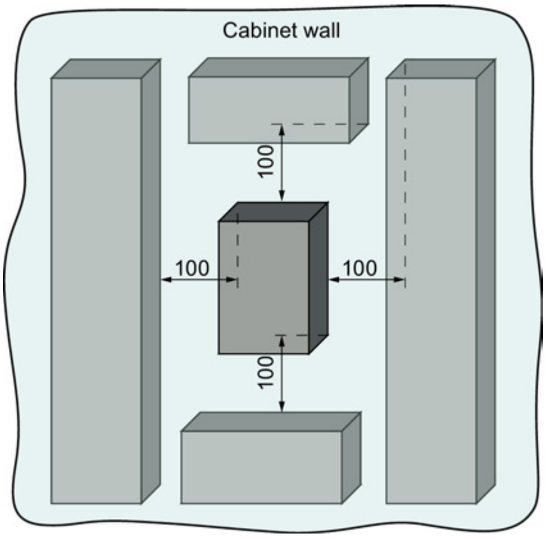


Figure 4-3 Distances of line reactors to other equipment [mm]

4.4 Mounting the braking resistor

Mounting orientation

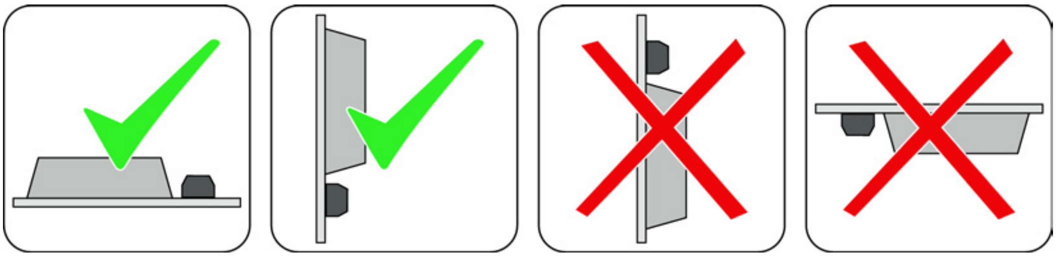


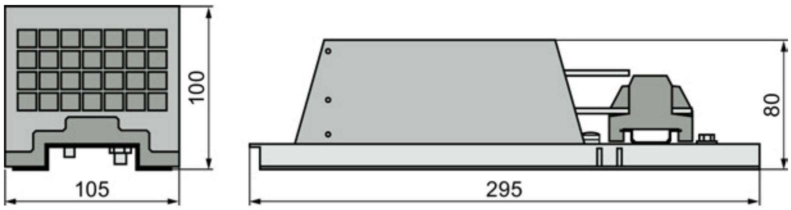
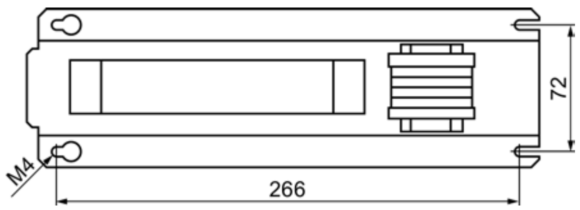
Figure 4-4 Permissible mounting orientation of the braking resistor

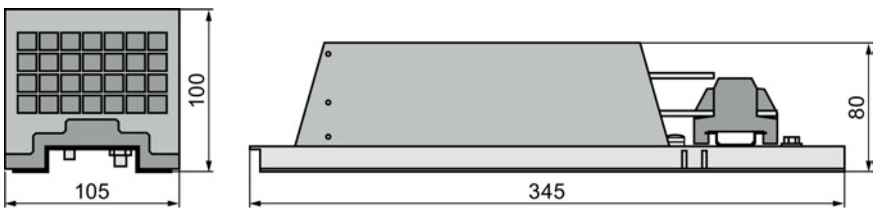
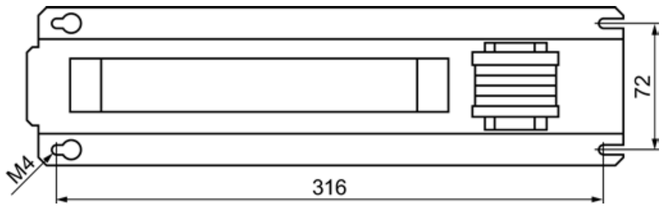
⚠ CAUTION
The operation of the braking resistor without housing is not permitted.

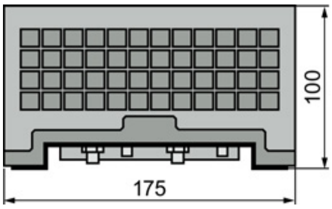
⚠ WARNING
Risk of fire If an unsuitable braking resistor is used, this could result in a fire and severely damage, people, property and equipment. Use the adequate braking resistor and install it correctly. The temperature of a braking resistor increases significantly during operation. Avoid coming into direct contact with braking resistors.

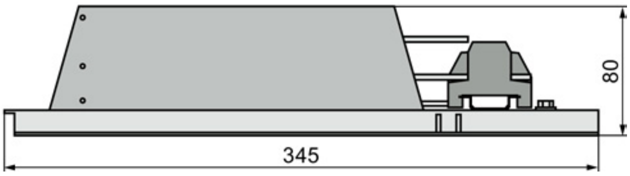
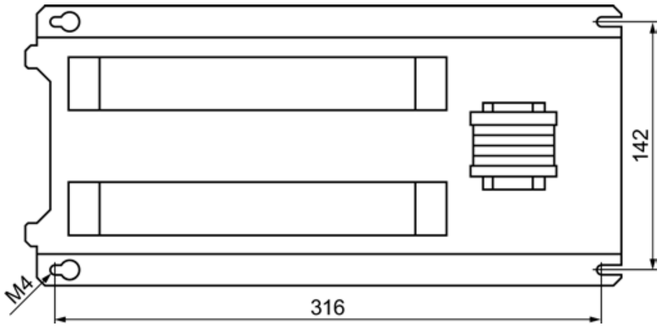
⚠ CAUTION
Risk of burns due to touching hot surfaces
During operation and for a short time after the frequency converter shuts down, the surface of the device can reach a high temperature. Touching the surface of the converter can cause burns. • Do not touch the device during operation. • After shutting down the converter, wait for the device to cool down before touching it.

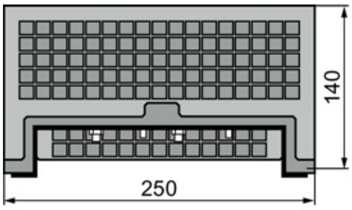
Dimensions and drill patterns

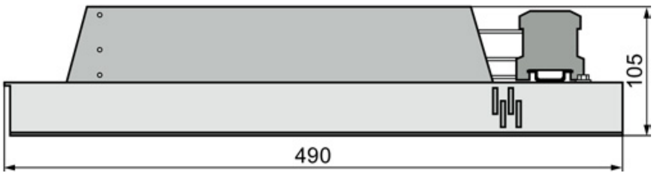
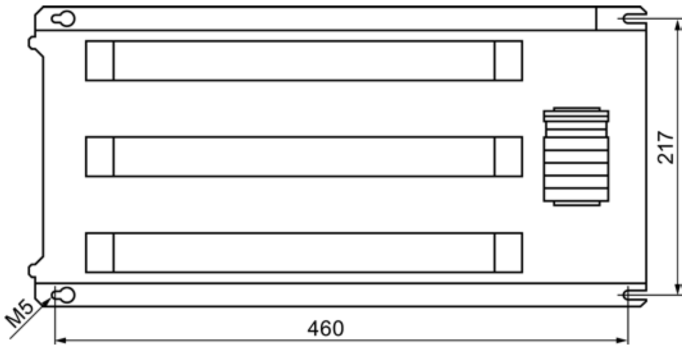
Frame Size A, 0.55 kW … 1.5 kW	
Dimensions [mm]	
	
Drill pattern [mm]	
	Fixing: 4 × M4 bolts 4 × M4 nuts 4 × M4 washers Tightening torque 3 Nm

Frame Size A, 2.2 kW … 4.0 kW	
Dimensions [mm]	
	
Drill pattern [mm]	
	Fixing: 4 × M4 bolts 4 × M4 nuts 4 × M4 washers Tightening torque 3 Nm

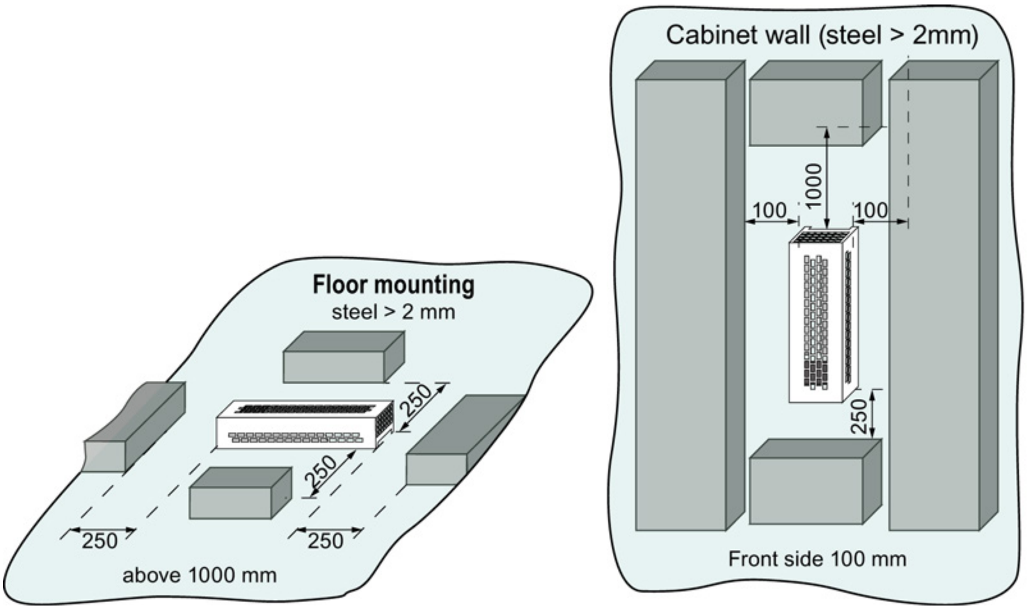
<table>
<tr><td colspan="2">Frame Size B, 5.5 kW … 7.5 kW</td></tr>
<tr><td colspan="2">Dimensions [mm]</td></tr>
<tr><td colspan="2">


</td></tr>
<tr><td colspan="2">Drill pattern [mm]</td></tr>
<tr><td>
</td><td>Fixing:
4 × M4 bolts
4 × M4 nuts
4 × M4 washers
Tightening torque 3 Nm</td></tr>
</table>

<table>
<tr><td colspan="2">Frame Size C, 11 kW … 18.5 kW</td></tr>
<tr><td colspan="2">Dimensions [mm]</td></tr>
<tr><td colspan="2">


</td></tr>
<tr><td colspan="2">Drill pattern [mm]</td></tr>
<tr><td>
</td><td>Fixing:
4 × M5 bolts
4 × M5 nuts
4 × M5 washers
Tightening torque 6 Nm</td></tr>
</table>

Distances to other equipment



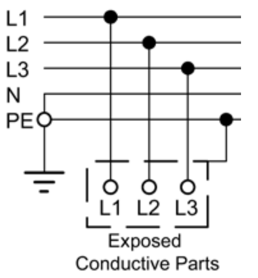
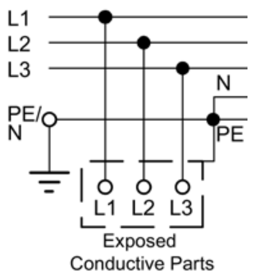
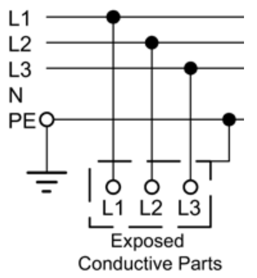
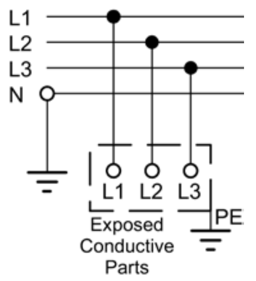
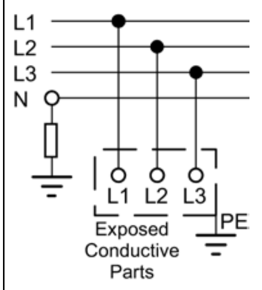
Mount the resistor on a heat resistant surface with a high thermal conductivity. Do not install devices that could impede the flow of cooling air in this area. Do not cover the ventilation openings of the braking resistor.

4.5 Connecting the converter

4.5.1 Power distribution systems

The converter is designed for the following power distribution systems as defined in EN 60950.

Table 4- 2 Power distribution systems for the converter

TN-S Power System	TN-C-S Power System	TN-C Power System	TT Power System	IT Power System
				
A TN-S power system has separate neutral and protective ground conductors throughout the system.	In a TN-C-S power system, the neutral and protective functions are combined in a single part of the system.	In a TN-C power system, the neutral and protective functions are combined in a single conductor throughout the system.	A TT power system has one point directly grounded, the exposed conductive parts of the installation being connected to a ground, which is electrically independent of the ground of the power system.	An IT power system has no direct connection to ground - instead the exposed parts of the electrical installation are grounded.

4.5.2 Connecting to the line supply

DANGER

Danger to life when live parts are touched

Touching live parts can result in death or severe injury.

Note the following:

- Only work on electrical equipment if you are qualified to do so.
- When carrying out any work, always comply with the country-specific safety rules.

Follow the six steps to ensure safety:

1. Prepare for shutdown and inform team members who will be affected by the procedure.
2. Switch off the machine so that it is in a no-voltage state:
   – 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 that all auxiliary circuits are also in a no-voltage state.
   – Ensure that the motor 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. Lock out all energy sources to prevent reclosing.
6. Make sure that the machine is completely locked out ... and that you have the right machine!

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

DANGER

Electric shock through contact with the motor connections

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

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

⚠ WARNING

Danger of death caused by high leakage currents when the external protective conductor is interrupted

The inverter conducts high leakage currents > 3.5 mA via the protective conductor. When the protective conductor is interrupted, touching live components can result in electric shock, which can lead to death or serious injuries.

- Connect a protective conductor, which satisfies at least one of the following conditions, to the inverter:
  - The protective conductor is routed so that it is protected against mechanical damage.

    Cables routed in control cabinets or enclosed machine enclosures are considered to be adequately protected.
  - The protective conductor routed as an individual conductor has a cross-section of ≥ 10 mm² Cu.
  - In a multi-core cable the protective conductor has a cross-section of ≥ 2.5 mm² Cu.
  - Two parallel protective conductors with the same cross-section are installed.
  - The protective conductor corresponds to the local regulations for equipment with increased leakage current.

NOTICE

Damage to the converter through inappropriate supply system

Operating the converter with integrated or external line filter on an ungrounded supply system will destroy the line filter.

- Therefore, always connect the converter with an integrated or external line filter only to supply systems with grounded star point (TN system).

⚠ WARNING

Fire hazard for the motor due to overload of the insulation

There is a greater load on the motor insulation due to a ground fault in an IT system. A possible result is the failure of the insulation with a risk for personnel through smoke development 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.

NOTICE

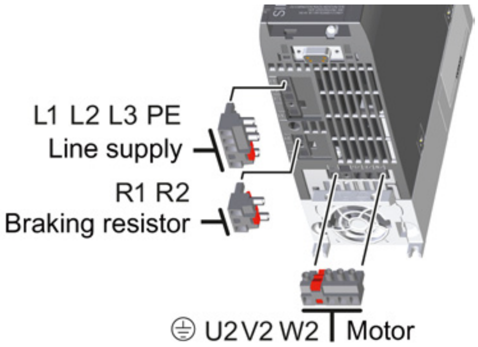
Damage to the converter through fault in IT system

A ground fault on the motor cable during operation can result in a shutdown of the converter due to overcurrent. Under unfavorable conditions, the overcurrent may damage the converter.

- Use an output reactor in the IT system.

Overview of the connection plugs

The plugs for connecting the line supply, motor, and braking resistor can be found on the underside of the converter.



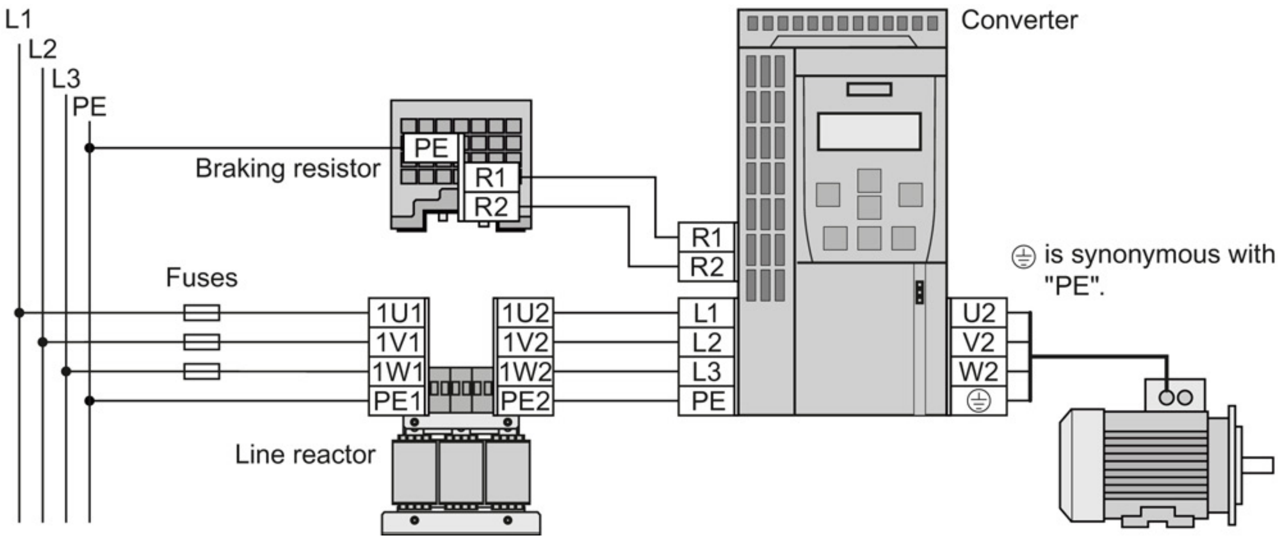
Connecting the converter and its components

Procedure

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

1. Check the table below to ensure you are using the correct fuses.
2. If you are using a line reactor or braking resistor, use the table below to check whether these components are suitable for the converter.
3. Connect the converter and its components.
4. If an EMC-compliant installation is required, you must use shielded cables. Refer also to section: EMC-compliant installation (Page 49).

You have now connected the converter and its components.



Converter		Fuse	UL/cUL fuse	Braking resistor	Line reactor
FSA	0.55 kW … 1.1 kW	3NA3801 (6 A)	10 A Class J	6SL3201-0BE14-3AA0	6SL3203-0CE13-2AA0
	1.5 kW	3NA3803 (10 A)			6SL3203-0CE21-0AA0
	2.2 kW			6SL3201-0BE21-0AA0	
	3.0 kW … 4.0 kW	3NA3805 (16 A)	15 A Class J		
FSB	5.5 kW	3NA3807 (20 A)	20 A Class J	6SL3201-0BE21-8AA0	6SL3203-0CE21-8AA0
	7.5 kW	3NA3810 (25 A)	25 A Class J		
FSC	11 kW	3NA3817 (40 A)	40 A Class J	6SL3201-0BE23-8AA0	6SL3203-0CE23-8AA0
	15 kW	3NA3820 (50 A)	50 A Class J		
	18.5 kW	3NA3822 (63 A)	60 A Class J		

Converter		Converter cable cross-section (tightening torque)		Line reactor (tightening torque)			Braking resistor (tightening torque)	
FSA	0.55 kW … 4 kW	2.5 mm^2 (0.5 Nm)	14 AWG (4.5 lbf in)	4 mm^2 (0.8 Nm)	12 AWG (7 lbf in)	PE M4 (3 Nm/26.5 lbf in)	2.5 mm^2 (0.5 Nm)	14 AWG (4.5 lbf in)
FSB	5.5 kW … 7.5 kW	6 mm^2 (0.6 Nm)	10 AWG (5.5 lbf in)	10 mm^2 (1.8 Nm)	8 AWG (16 lbf in)	PE M5 (5 Nm / 44 lbf in)		
FSC	11 kW … 18.5 kW	16 mm^2 (1.5 Nm)	5 AWG (13.5 lbf in)	16 mm^2 (4 Nm)	5 AWG (35 lbf in)		6 mm^2 (0.6 Nm)	10 AWG (5.5 lbf in)

Components for United States / Canadian installations (UL/CSA)

This equipment is capable of providing internal motor overload protection according to UL508C. Take the following actions In order to comply with UL508C:

- Use UL/CSA-certified J-type fuses, overload circuit-breakers or intrinsically safe motor protection devices.
- For each frame size A to C use class 1 75° C copper wire only.
- Install the converter with any external recommended suppressor with the following features:
  - Surge-protective devices; device shall be a Listed Surge-protective device (Category code VZCA and VZCA7).
  - Rated nominal voltage 480/277 V_{AC}, 50/60 Hz, 3-phase.
  - Clamping voltage V_{PR} = 2000 V, I_N = 3 kA min, MCOV = 508 V_{AC}, SCCR = 40 kA.
  - Suitable for Type 1 or Type 2 SPD application.
  - Clamping shall be provided between phases and also between phase and ground.
- Do not change the parameter p0610 (factory setting of p0610 = 12 means: the drive reacts on a motor overtemperature with an immediate alarm and after a certain time with a fault).

4.5.3 Operating a converter on the residual current device

WARNING

Live enclosure parts due to unsuitable protection equipment

The frequency converter 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 converter without touch protection can carry a dangerous voltage.

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

Requirements for using a residual current device

- The converter is connected to a TN system.

Conditions for operating the converter with a residual current device

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

- You are using an FSA or FSB converter.
- 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 converter is connected via its own RCD/RCM.
- Shielded motor cables must be shorter than 15 m.
- Unshielded motor cables must be shorter than 30 m.

Measures for touch protection without RCD/RCM

Establish touch protection using one of the following measures:

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

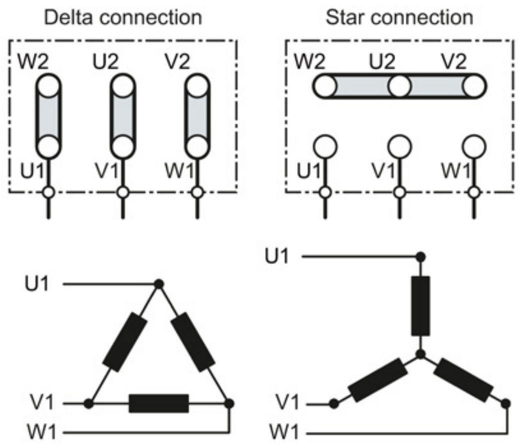
4.5.4 Connecting the motor

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.

4.5.5 Interfaces, connectors, switches, terminal blocks and LEDs of the converter

In the diagrams below, the complete breakdown of all user interfaces are explained.

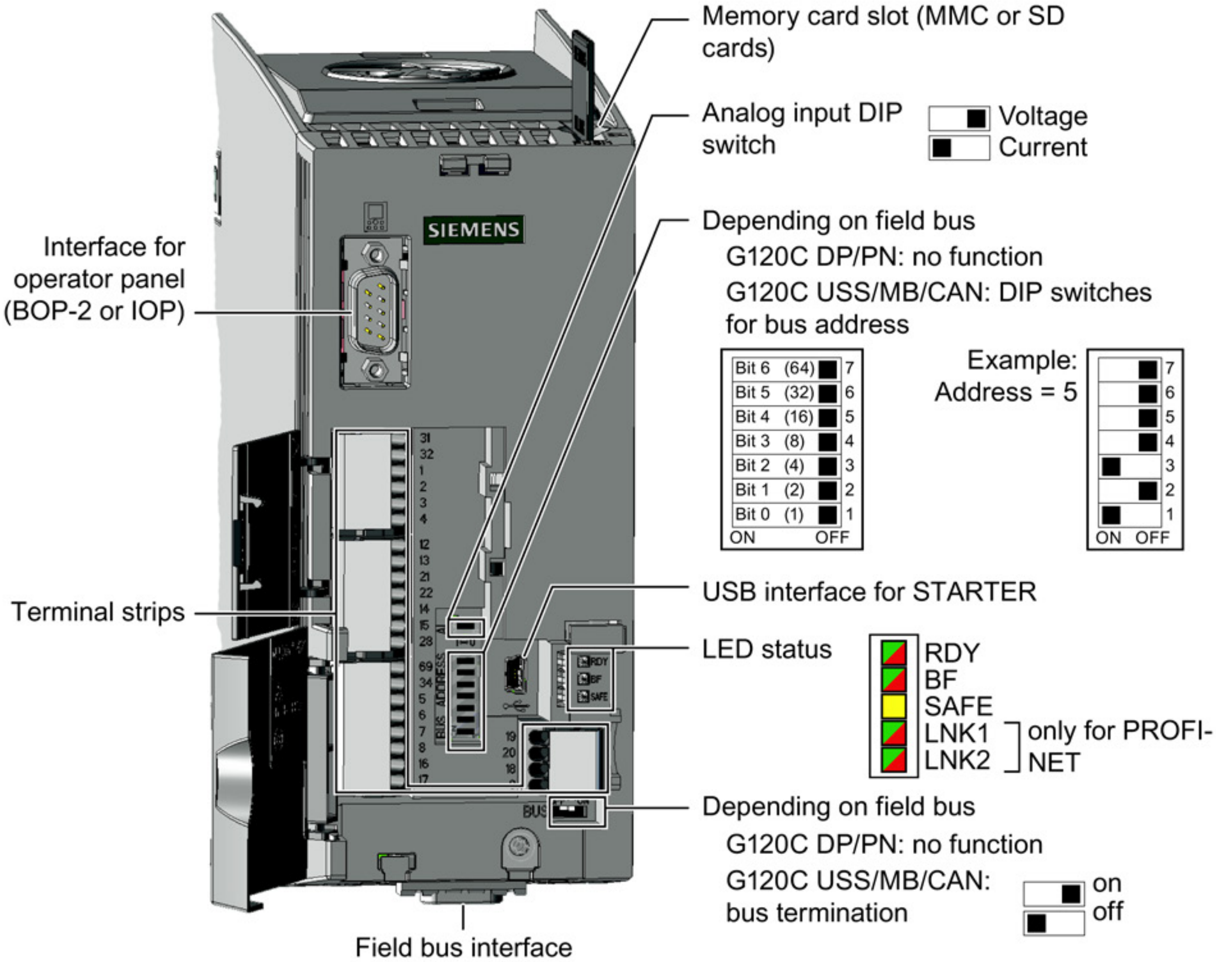
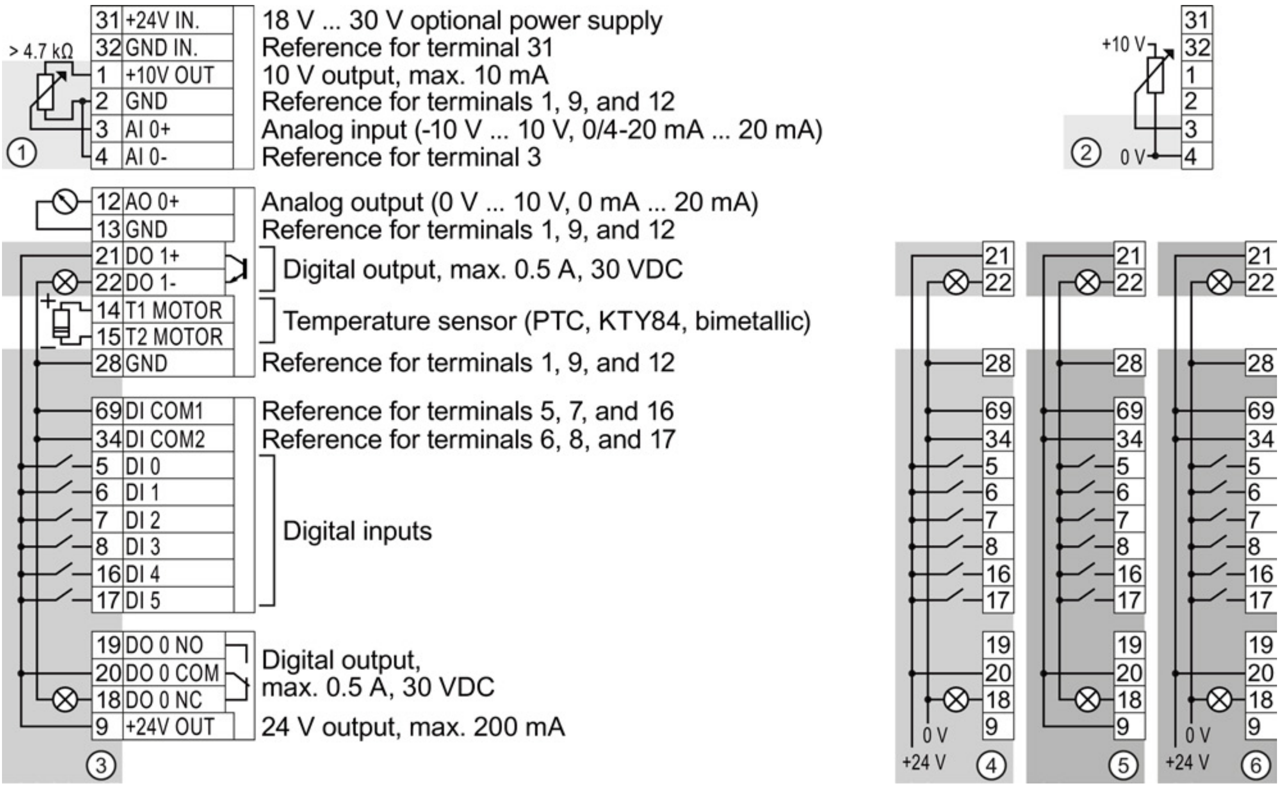


Figure 4-5 Interfaces and connectors

4.5.6 Terminal strips

Wiring variations of the terminal strips



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

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

③ Wiring when using the internal power supplies. Connecting a contact that switches to P potential.

④ Wiring when using external power supplies. Connecting a contact that switches to P potential.

⑤ Wiring when using the internal power supplies. Connecting a contact that switches to M potential.

⑥ Wiring when using external power supplies. Connecting a contact that switches to M potential.

⚠ 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.

4.5.7 Finding a suitable setting for the interfaces

The inputs and outputs of the frequency inverter and the fieldbus interface have specific functions when set to the factory settings.

When you put the frequency inverter into operation, you can change the function of each of its inputs and outputs and the setting of the fieldbus interface.

To make the setting process easier, the inverter has various predefined assignments (macros).

Only the inputs and outputs whose functions change by selecting a specific assignment, are shown on the following pages.

Procedure

To select one of the inverter's pre-assigned settings, proceed as follows:

1. Think about which of the input and output functions you are using in the application.
2. Find the I/O configuration (macro) that best suits your application.
3. Note the macro number of the corresponding default setting.

   You must set this macro number when putting the frequency inverter into operation.

You have found the appropriate inverter pre-assignment.

Macro 1: Two fixed speeds	Macro 2: Two fixed speeds with safety function	Macro 3: Four fixed speeds
5 DI 0 ON/OFF1 right 6 DI 1 ON/OFF1 left 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 Fixed speed 3 17 DI 5 Fixed speed 4 3 AI 0 --- 4 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V DI 4 and DI 5 = high: The converter adds both fixed speeds.	5 DI 0 ON/OFF1 Fixed speed 1 6 DI 1 Fixed speed 2 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 Reserved for 17 DI 5 safety function 3 AI 0 --- 4 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V DI 0 and DI 1 = high: The converter adds both fixed speeds.	5 DI 0 ON/OFF1 Fixed speed 1 6 DI 1 Fixed speed 2 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 Fixed speed 3 17 DI 5 Fixed speed 4 3 AI 0 --- 4 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V Multiple DIs = high: The converter adds the corresponding fixed speeds.

Macro 4: PROFIBUS or PROFINET

PROFIdrive telegram 352

5	DI 0	---
6	DI 1	---
7	DI 2	Acknowledge
8	DI 3	---
16	DI 4	---
17	DI 5	---
3, 4	AI 0	---
18, 19, 20	DO 0	Fault
21, 22	DO 1	Alarm
12, 13	AO 0	Speed 0 V ... 10 V

Macro 5: PROFIBUS or PROFINET with safety function

PROFIdrive telegram 1

5	DI 0	---
6	DI 1	---
7	DI 2	Acknowledge
8	DI 3	---
16	DI 4	Reserved for safety function
17	DI 5	Reserved for safety function
3, 4	AI 0	---
18, 19, 20	DO 0	Fault
21, 22	DO 1	Alarm
12, 13	AO 0	Speed 0 V ... 10 V

Macro 7: Switching between fieldbus and jog via DI 3

Factory setting for converters with PROFIBUS or PROFINET interface

PROFIdrive telegram 1

5	DI 0	---	Jog 1
6	DI 1	---	Jog 2
7	DI 2	Acknowledge	Acknowledge
8	DI 3	LOW	HIGH
16	DI 4	---	---
17	DI 5	---	---
3, 4	AI 0	---	---
18, 19, 20	DO 0	Fault	Fault
21, 22	DO 1	Alarm	Alarm
12, 13	AO 0	Speed 0 V ... 10 V	Speed 0 V ... 10 V

Macro 8: Motorized potentiometer (MOP) with safety function

5	DI 0	ON/OFF1
6	DI 1	MOP raise
7	DI 2	MOP lower
8	DI 3	Acknowledge
16	DI 4	Reserved for safety function
17	DI 5	Reserved for safety function
3, 4	AI 0	---
18, 19, 20	DO 0	Fault
21, 22	DO 1	Alarm
12, 13	AO 0	Speed 0 V ... 10 V

Terminal	Signal	**Macro 9: Motorized potentiometer (MOP)**	**Macro 12: Two-wire control using method 1** **Factory setting for converters without PROFIBUS or PROFINET interface.**	**Macro 13: Setpoint via analog input with safety function**
5	DI 0	ON/OFF1	ON/OFF1	ON/OFF1
6	DI 1	MOP raise	Reverse	Reverse
7	DI 2	MOP lower	Acknowledge	Acknowledge
8	DI 3	Acknowledge	---	---
16	DI 4	---	---	Reserved for safety function
17	DI 5	---	---	Reserved for safety function
3	AI 0	---	Setpoint	Setpoint
4			I U -10 V ... 10 V	I U -10 V ... 10 V
18	DO 0	Fault	Fault	Fault
19				
20				
21	DO 1	Alarm	Alarm	Alarm
22				
12	AO 0	Speed	Speed	Speed
13		0 V ... 10 V	0 V ... 10 V	0 V ... 10 V

Macro 14: Switching between fieldbus and motorized potentiometer (MOP) via DI 3

Terminal	Signal	PROFIdrive telegram 1	
5	DI 0	---	ON/OFF1
6	DI 1	External fault	External fault
7	DI 2	Acknowledge	Acknowledge
8	DI 3	LOW	HIGH
16	DI 4	---	MOP raise
17	DI 5	---	MOP lower
3	AI 0	---	---
4			
18	DO 0	Fault	Fault
19			
20			
21	DO 1	Alarm	Alarm
22			
12	AO 0	Speed	Speed
13		0 V ... 10 V	0 V ... 10 V

Macro 15: Switching between analog setpoint and motorized potentiometer (MOP) via DI 3		Macro 17: Two-wire control using method 2 Macro 18: Two-wire control using method 3
5 DI 0 ON/OFF1 6 DI 1 External fault 7 DI 2 Acknowledge 8 DI 3 LOW 16 DI 4 --- 17 DI 5 --- 3 AI 0 Setpoint 4 I ☐■ U -10 V ... 10 V 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V	5 DI 0 ON/OFF1 6 DI 1 External fault 7 DI 2 Acknowledge 8 DI 3 HIGH 16 DI 4 MOP raise 17 DI 5 MOP lower 3 AI 0 --- 4 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V	5 DI 0 ON/OFF1 right 6 DI 1 ON/OFF1 left 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 --- 3 AI 0 Setpoint 4 I ☐■ U -10 V ... 10 V 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V

Macro 19: Three-wire control using method 1	Macro 20: Three-wire control using method 2	Macro 21: USS fieldbus Macro 22: CANopen fieldbus
5 DI 0 Enable/OFF1 6 DI 1 ON right 7 DI 2 ON left 8 DI 3 Acknowledge 16 DI 4 --- 17 DI 5 --- 3 AI 0 Setpoint 4 I ☐■ U -10 V ... 10 V 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V	5 DI 0 Enable/OFF1 6 DI 1 ON 7 DI 2 Reverse 8 DI 3 Acknowledge 16 DI 4 --- 17 DI 5 --- 3 AI 0 Setpoint 4 I ☐■ U -10 V ... 10 V 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V	USS setting: 38,400 baud, 2 PZD, PKW variable CANopen setting: 20 kBaud 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 --- 3 AI 0 --- 4 18 DO 0 Fault 19 20 21 DO 1 Alarm 22 12 AO 0 Speed 13 0 V ... 10 V

4.5.8 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. Overvoltage 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.

Prerequisites

- Use suitable cables:
  - Solid or flexible cables.
  - Suitable cable cross-section: 0.5 mm² (21 AWG) to 1.5 mm² (16 AWG).

    When completely connecting up the unit, we recommend cables with a cross-section of 1 mm² (18 AWG).
- Do not use wire end ferrules.
- You have found an appropriate pre-assignment for the terminal strips, which you can now use to wire the inverter.

  See also Section: Finding a suitable setting for the interfaces (Page 43).
- You have the appropriate tools:
  - Small screwdriver to open the spring-loaded terminals
  - Tool for stripping the cables

Procedure

To wire the inverter's terminal strip, proceed as follows:

1. Remove the last 10 mm (approx.) of the cable insulation.
2. Using the screwdriver, press on the orange operator control of the spring-loaded terminal hard enough to open the terminal.
3. Insert the cable into the terminal as far as it will go and remove the screwdriver.
4. Ensure that the cable is securely connected by pulling on it lightly.
5. Wire all the required terminals on the strip in this way.
6. Route the signal cables in such a way that you can completely close the front doors after wiring the terminal strip.

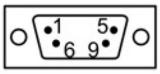
7. If you use shielded cables, then you must connect the shield to the mounting plate of the control cabinet or with the shield support of the inverter through a good electrical connection and a large surface area.
   See also: EMC installation guideline
   (http://support.automation.siemens.com/WW/view/en/60612658)
8. Use a cable grip.

You have now wired the inverter's terminal strips.

4.5.9 Fieldbus interface assignment

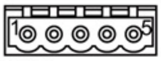
The fieldbus interface is on the underside of the converter.

CANopen



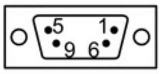
1 Not used
2 CAN_L, CAN signal (dominant, low)
3 CAN_GND, CAN reference
4 ---
5 (CAN _SHLD), optional cable shield
6 (GND), optional CAN reference
7 CAN_H, CAN signal (dominant, high)
8 ---
9 ---

USS / Modbus RTU



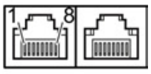
1 0 V, reference potential
2 RS485N, receive and send (+)
3 RS485P, receive and send (-)
4 Cable shield
5 ---

PROFIBUS



1 Shield, ground connection
2 Not used
3 RxD/TxD-P, receive/send data P(B/B')
4 CNTR-P, control signal
5 DGND, data reference potential (C/C')
6 VP, supply voltage positive
7 ---
8 RxD/TxD-N, receive/send data N(A/A')
9 ---

PROFINET EtherNet/IP



1 RX+, receive data +
2 RX-, receive data -
3 TX+, transmission data +
4 ---
5 ---
6 TX-, transmission data -
7 ---
8 ---

4.6 EMC-compliant installation

4.6.1 Installing the converter in compliance with EMC rules

Rules for EMC-compliant cable routing

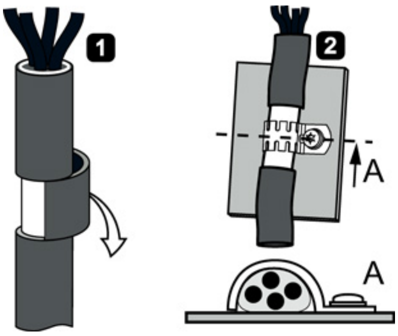
Preconditions

- The converter is mounted on a metal mounting plate. The mounting plate is unpainted and has good electrical conductivity.
- Use shielded cables for the following connections:
  - Motor and motor temperature sensor
  - Braking resistor
  - Fieldbus
  - Inputs and outputs of the terminal strip

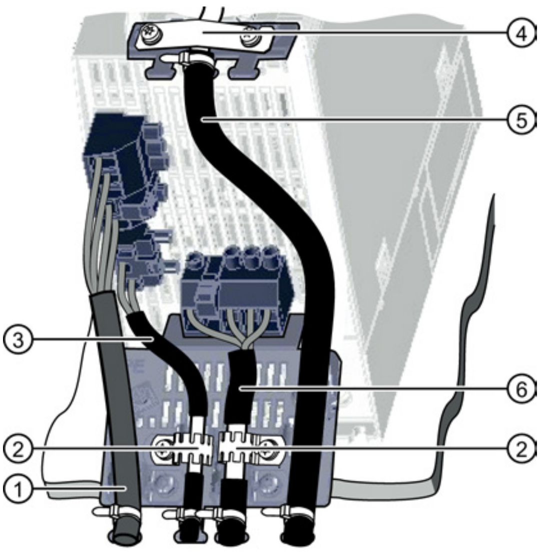
Procedure

To install the converter cables in compliance with EMC rules, proceed as follows:

1. Expose the shields of the shielded cables.
2. Place the shields on the mounting plate or on the converter shield plate using EMC clamps.



The converter is wired in compliance with EMC rules.



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

① Unshielded line supply cable

② EMC clamps on the shield plate

③ Shielded cable to the braking resistor

④ EMC clamp for the cable to the terminal strip

⑤ Shielded cable to the terminal strip

⑥ Shielded motor cable

4.6.2 EMC-compliant cabinet design

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

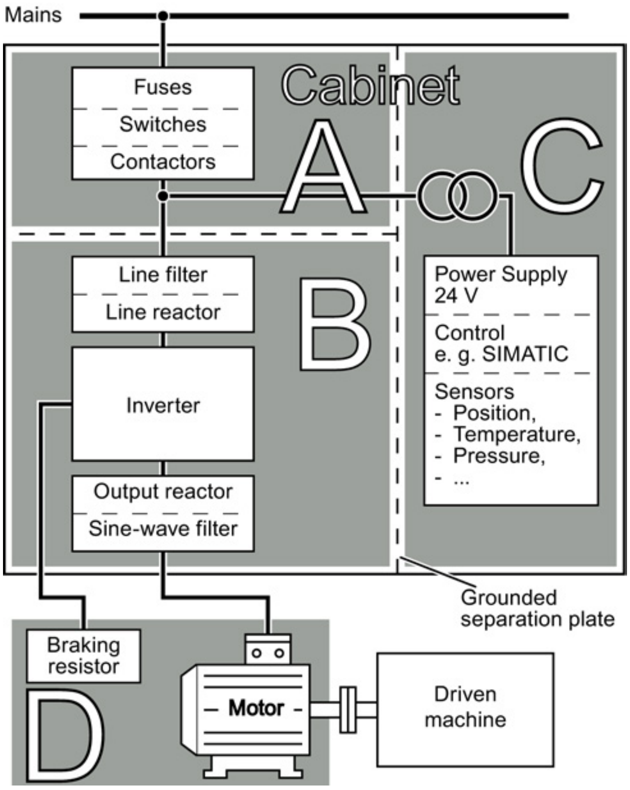
EMC-zone concept within the control cabinet

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

The different zones must be electromagnetically decoupled. One method is to ensure that the zones are not positioned directly next to each other (minimum distance app. 25 cm / 9.84 in). A better, more compact method, however, is to use separate metallic housings or separation plates with large surface areas.

Cables within each zone can be unshielded. Cables connecting different zones must be separated and must not be routed within the same cable harness or cable channel. If necessary, filters and/or coupling modules should be used at the interfaces of the zones. Coupling modules with electrical isolation are an effective means of preventing interference from spreading from one zone to another.

All communication and signal cables leaving the cabinet must be shielded. For longer, analog signal cables isolating amplifiers should be used. Sufficient space for bonding the cable shields must be provided, whereby the braided cable shield must be connected to the cabinet ground with excellent electrical conductivity and with a large contact area. Differences in the ground potential between the zones must be avoided to ensure that impermissible, high compensating currents are kept away from the cable shields.



- **Zone A:**
  Supply connection
  Limit values for conducted interference emissions and conducted interference immunity must not be exceeded
- **Zone B:**
  Power electronics
  Sources of interference
- **Zone C:**
  Controller and sensors
  Potentially susceptible equipment

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

Division of the cabinet and installation into different EMC zones

Control cabinet design

- All metallic components of the cabinet (side panels, back walls, roof plates, and floor plates) must be connected to the cabinet frame with excellent electrical conductivity, ideally with a large contact area or by means of several point-like screwed connections (i.e. to create a Faraday cage).
- The cabinet doors must be connected to the cabinet frame with excellent electrical conductivity by means of short, finely stranded, braided grounding strips, which are ideally placed at the top, in the middle, and at the bottom of the doors.
- The PE busbar and EMC shield busbar must be connected to the cabinet frame with excellent electrical conductivity with a large contact area.
- All metallic housings of devices and additional components integrated in the cabinet (such as converter or line filter) must be connected to the cabinet frame with excellent electrical conductivity and with a large contact area. The best option here is to mount devices and additional components on a bare metal mounting plate (back plane) with excellent electrical conductivity. This mounting plate must be connected to the cabinet frame and, in particular, to the PE and EMC shield busbars with excellent electrical conductivity and a large contact area.

- All connections should be made so that they are permanent. Screwed connections on painted or anodized metal components must be made either by means of special contact washers, which penetrate the isolating surface and establish a metallically conductive contact, or by removing the isolating surface on the contact points.
- Contactor coils, relays, solenoid valves, and motor holding brakes must have interference suppressors to reduce high-frequency radiation when the contacts are opened (RC elements or varistors for AC currentoperated coils, and freewheeling diodes for DC current-operated coils). The interference suppressors must be connected directly on each coil.

Cable routing inside the cabinet

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

Cables outside the cabinet

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

Cable shields

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

Equipotential bonding

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

Grounding and high-frequency equipotential bonding measures

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

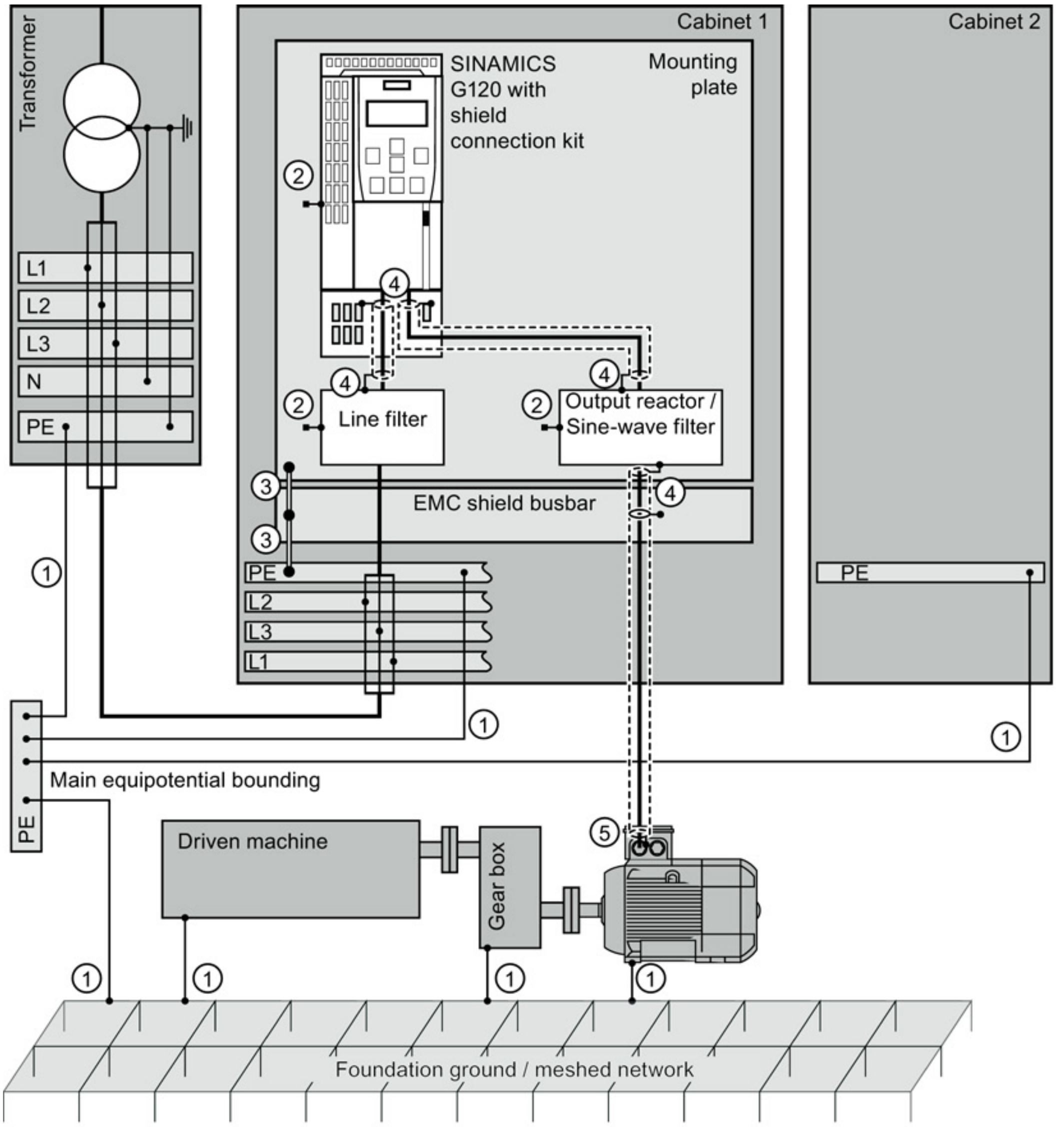
The ground connections ① represent the conventional grounding system for the drive components.

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

The connections ② inside the cabinet provide solid bonding for high-frequency currents between the metal housings of the integrated components and the EMC shield busbar of the cabinet. These internal connections should be made via a large area using non-isolated metal construction components of the cabinet. In this case, the contact surface must be bare metal and each contact area must have a minimum cross-section of several cm². Alternatively, these connections can be made with short, finely stranded, braided copper wires with a large cross-section (≥ 95 mm² / 000 (3/0) (-2) AWG) between the integrated components and the EMC shield busbar.

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

Therefore connect the protective earth conductor and the cable shield as well to the motor as to the converter.



① Conventional grounding system without special high-frequency properties
② Electrically conductive connection to the mounting plate through the largest possible surface area
③ High-frequency equipotential bonding
④ Connect shield with a large contact area and connect protective earth conductor
⑤ Connect shield via electrically conductive PG gland and connect protective earth conductor

Figure 4-6 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

Additional measures

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

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

The connections in the figure below provide a solid, high-frequency bonding between the motor housing, the motor terminal box, the gearbox, the driven machine and the EMC busbar.

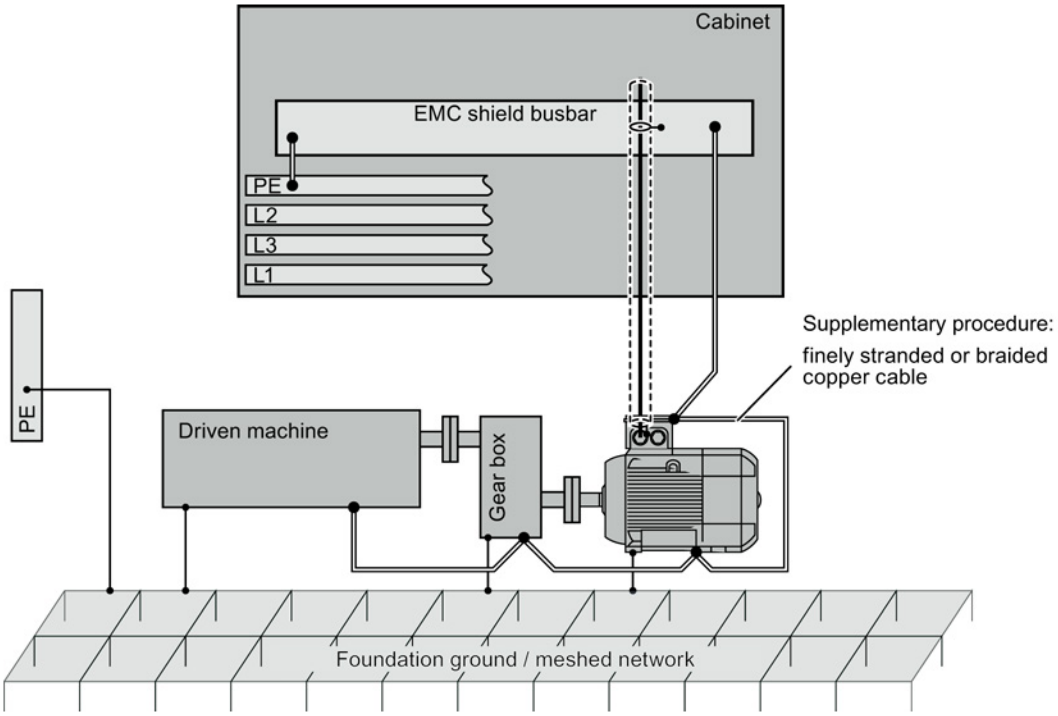


Figure 4-7 Additional high-frequency bonding of the drive system

Commissioning 5

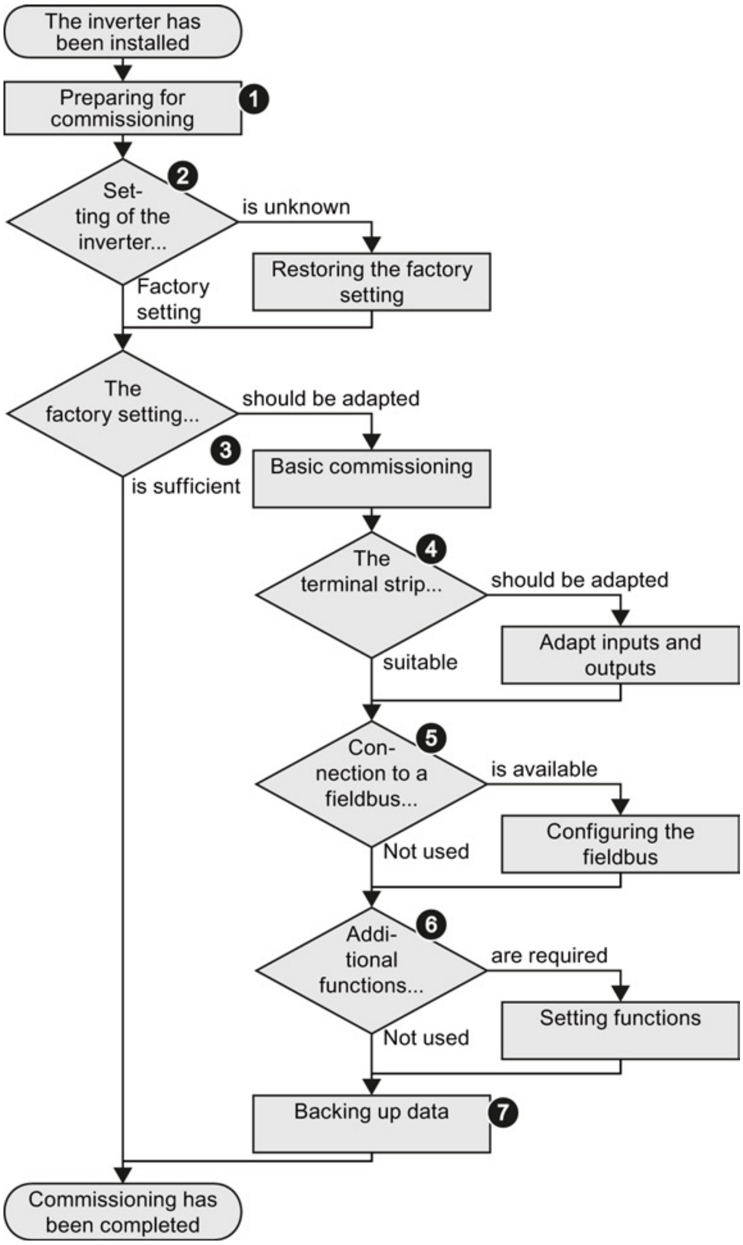
5.1 Commissioning guidance

Procedure

Proceed as follows to commission the inverter:

1. Define the requirements of your application placed on the drive. → (Page 58) .
2. Reset the inverter when required to the factory setting. → (Page 65) .
3. Check whether the factory setting of the inverter is appropriate for your application.

   If not, start with the basic commissioning. → (Page 66).
4. Check whether you need to adapt the functions of the terminal strip that you specify in the basic commissioning. → (Page 79).
5. If necessary, adapt the communications interface in the inverter. → (Page 91) .
6. If necessary, set further functions in the inverter. → (Page 191) .
7. Save your settings. → (Page 281) .



You have commissioned the inverter.

5.2 Preparing commissioning

Overview

Before starting commissioning, you must answer the following questions:

- What data does my converter have?
  → Product overview (Page 21).
- What is the data for the connected motor?
  → Collecting motor data (Page 58).
- Which interfaces of the converter are active?
  → Wiring examples for the factory setting (Page 60).
- Via which converter interfaces does the higher-level controller operate the drive?
- How is my converter set?
  → Factory setting of the inverter control (Page 62).
- What technological requirements must the drive fulfill?
  → Factory setting of the inverter control (Page 62).
  → Defining additional requirements for the application (Page 64).

5.2.1 Collecting motor data

Which motor is connected to the inverter?

If you are using the STARTER commissioning tool and a Siemens motor, you only need the motor order number. Otherwise, note down the data on the motor rating plate.

In which region of the world is the motor used?

- Europe IEC: 50 Hz [kW]
- North America NEMA: 60 Hz [hp] or 60 Hz [kW]

How is the motor connected?

Pay attention to the connection of the motor (star connection [Y] or delta connection [Δ]). Note the appropriate motor data for connecting.

What is the operating temperature of the motor?

For commissioning you need the motor environmental temperature if it varies from 20° C.

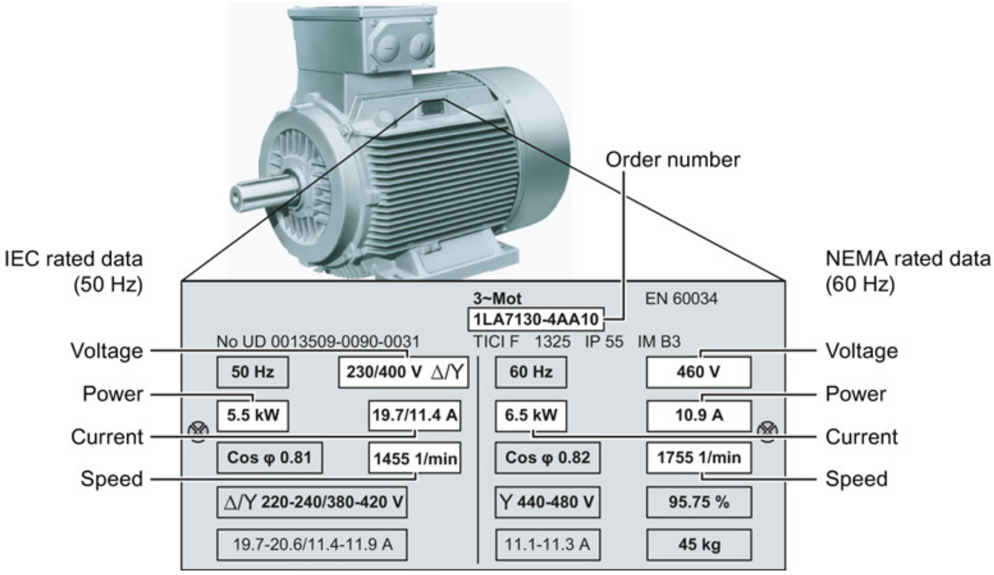
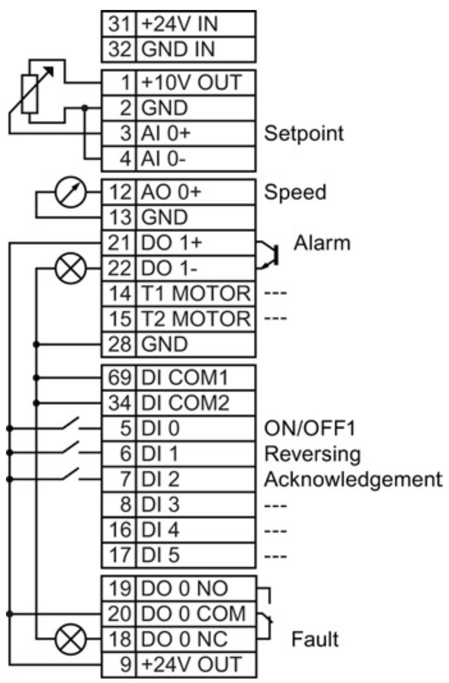
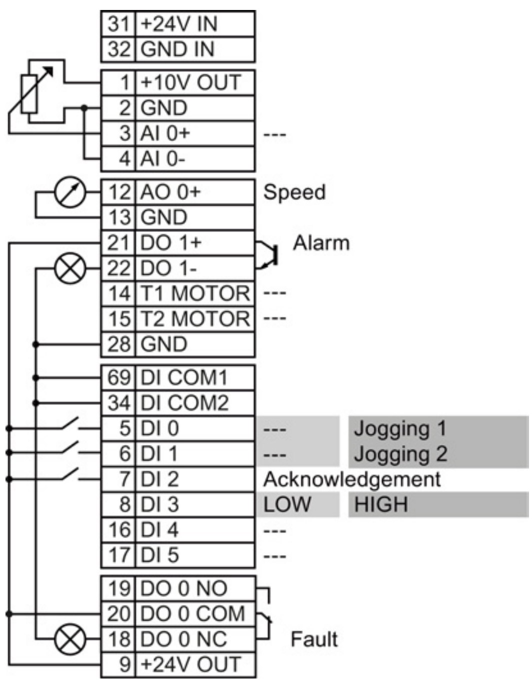


Figure 5-1 Motor data of the rating plate

5.2.2 Wiring examples for the factory setting

If you wish to use the factory setting of your converter, then you must wire the terminal strip of your converter as shown in the following examples.

Pre-assignment of the terminal strip for G120C USS and G120C CAN	**Pre-assignment of the terminal strip for G120C DP and G120C PN**
	DI 3 = LOW: PROFIdrive telegram 1 DI 3 = HIGH: Jogging 

5.2.3 Does the motor match the converter?

The converter is preset on a motor at the factory as shown in the figure below.

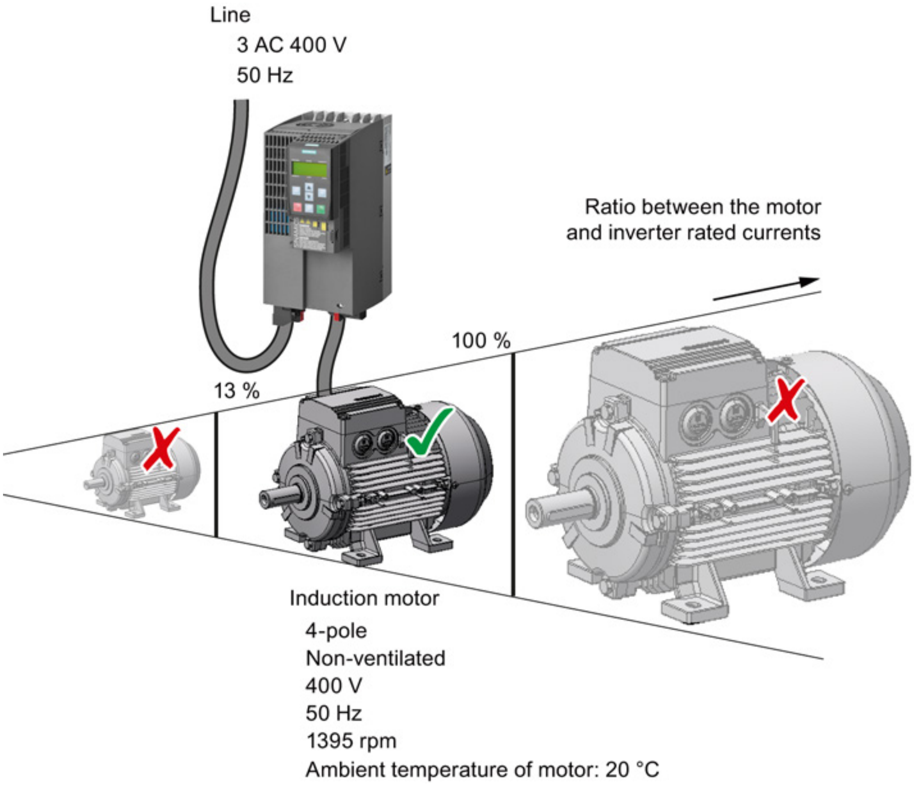


Figure 5-2 Motor data factory settings

The rated current of the motor must be in the range 13% to 100% of the rated converter current.
Example: With a converter with the rated current 10.2 A, you may operate induction motors whose rated currents are in the range 1.3 A to 10.2 A.

5.2.4 Factory setting of the inverter control

Switching the motor on and off

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

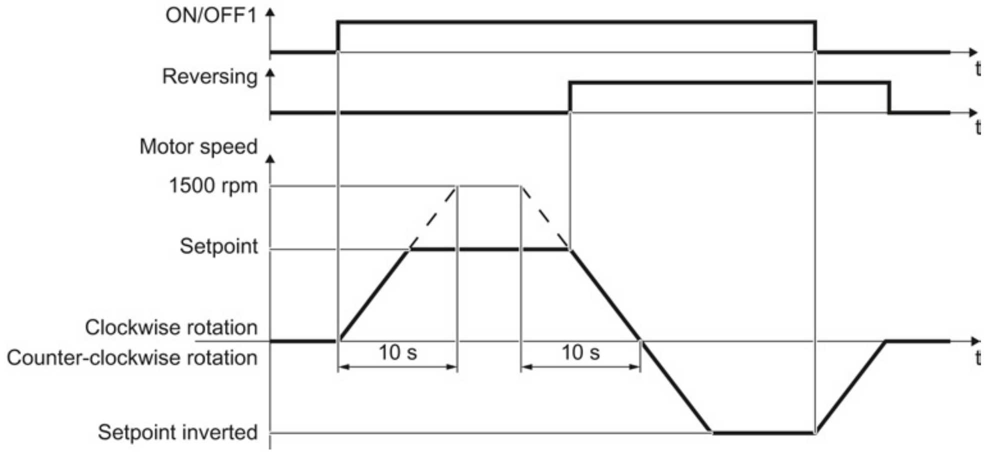


Figure 5-3 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

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

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

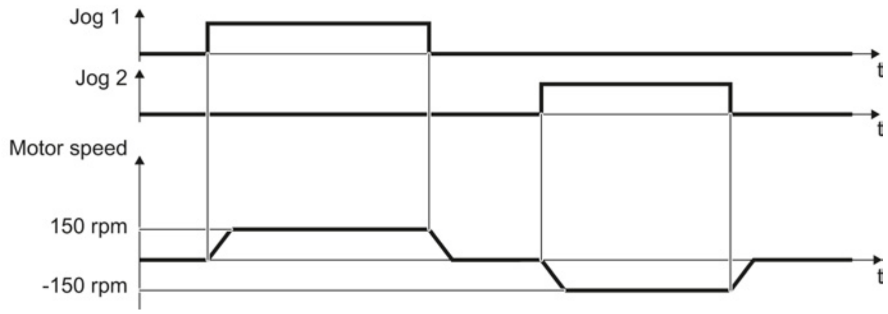


Figure 5-4 Jogging the motor in the factory setting

For induction motors, there are two different open-loop control or closed-loop control techniques:

- V/f control (calculation of the motor voltage using a characteristic curve)
- Closed-loop speed control (also: field-oriented control or vector control)

Criteria for selecting either V/f control or vector control

In many applications, the V/f control suffices to change the speed of induction motors. Examples of typical applications for V/f control include:

- Pumps
- Fans
- Compressors
- Horizontal conveyors

When compared to V/f control, vector control offers the following advantages:

- The speed is more stable for motor load changes.
- Shorter accelerating times when the setpoint changes.
- Acceleration and braking are possible with an adjustable maximum torque.
- Improved protection of the motor and the driven machine as a result of the adjustable torque limiting.
- Full torque is possible at standstill.

Examples of typical applications in which speed control is used:

- Hoisting gear and vertical conveyors
- Winders
- Extruders

It is not permissible to use vector control in the following cases:

- If the motor is too small in comparison to the converter (the rated motor power must not be less than one quarter of the rated converter power)
- When you operate several motors on one converter
- If a power contactor is used between the converter and motor, and is opened while the motor is powered up
- When the maximum motor speed exceeds the following values:

Converter pulse frequency	2 kHz			4 kHz and higher		
Pole number of the motor	2-pole	4-pole	6-pole	2-pole	4-pole	6-pole
Maximum motor speed [rpm]	9960	4980	3320	14400	7200	4800

5.2.5 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 converter limits the motor speed to this value.

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

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

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

5.3 Restoring the factory setting

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

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

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

Resetting the safety functions to the factory settings

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

Procedure

Proceed as follows to restore the safety function settings in the inverter to the factory settings:

	
1. Go online 2. Call the safety functions screen form 3. In the "Safety Integrated" screen form, press the button for restoring the factory setting.	1. Set p0010 = 30 Activate reset settings. 2. p9761 = … Enter the password for the safety functions 3. Start the reset with p970 = 5 When the inverter has reset the settings, p0970 = 0.
4. Switch off the inverter power supply.	
5. Wait until all LEDs on the inverter go dark.	
6. Switch on the inverter power supply again.	

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

Restoring the inverter to the factory setting

Procedure

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

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

You have restored the inverter factory settings.

5.4 Basic commissioning

5.4.1 Basic commissioning with Operator Panel BOP-2

Installing the basic operator panel BOP-2

Procedure

For installing the BOP-2 operator panel you have to proceed as follows:

1. Remove the blind cover from the converter.
2. Place the bottom edge of the BOP-2 casing into the lower recess of the converter housing.
3. Push the BOP-2 towards the converter until the release-catch clicks into place on the converter housing.

The BOP-2 is installed. When you supply the voltage to the converter, the operator panel BOP-2 is ready to operate.

5.4.1.1 Basic commissioning

Setting the basic commissioning data

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

Prerequisite

SP [1/min] [1/min]

You have inserted the BOP-2 operator panel on the inverter and connected the inverter to a power supply.

The Operator Panel has powered up and displays setpoints and actual values.

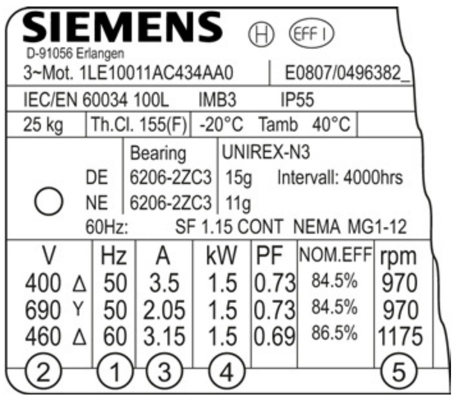
Procedure

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

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

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

   The control modes are described in the operating instructions of your inverter.
6. Transfer the data from the motor rating plate to the inverter:
   - 6.1. EUR/USA P100 (OK) — Motor standard
     - KW 50HZ — IEC
     - HP 60HZ — NEMA
     - KW 60HZ — IEC 60 Hz
   - 6.2. MOT VOLT P304 (OK) — Rated voltage
   - 6.3. MOT CURR P305 (OK) — Rated current
   - 6.4. MOT POW P307 (OK) — IEC power (kW) NEMA (HP)
   - 6.5. MOT RPM P311 (OK) — Rated speed



7. MOT ID P1900 (OK)

Motor data identification

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

OFF — No measurement of motor data.

STIL ROT — Recommended setting: Measure the motor data at standstill and with the motor rotating.

STILL — Measure the motor data at standstill.

Select this setting if one of the following cases is applicable:

- You have selected the control mode "SPD N EN". However, the motor cannot rotate freely – for example, if the traversing range is mechanically limited.
- You have selected V/f control as a control mode, e.g. "VF LIN" or "VF QUAD".

ROT — Measuring the motor data while it is rotating.

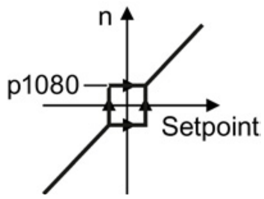
8. MAc PAr P15 (OK)

Select the configuration for the interfaces of the inverter that is suitable for your application. You can find possible configurations in Section: Finding a suitable setting for the interfaces (Page 43)

coN 2 SP	Macro 1	Std ASPS	Macro 13
coN SAFE	Macro 2	Proc FB	Macro 14
coN 4 SP	Macro 3	Proc	Macro 15
coN Fb	Macro 4	2-wire 1	Macro 17
coN Fb S	Macro 5	2-wire 2	Macro 18
Fb SAFE	Macro 6	3-wire 1	Macro 19
Fb cdS	Macro 7	3-wire 2	Macro 20
MoP SAFE	Macro 8	USS	Macro 21
Std MoP	Macro 9	CAN	Macro 22
Std ASP	Macro 12		

9. MIN RPM P1080 (OK)

Set the minimum speed of the motor.

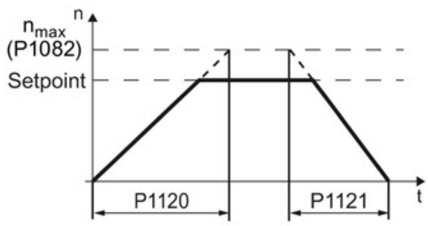


10. RAMP UP P1120 (OK)

Set the ramp-up time of the motor.

11. RAMP DWN P1121 (OK)

Set the ramp-down time of the motor.



12. FINISH (OK)

Complete the basic commissioning:

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

12.2. Press the OK key.

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

Identifying the motor data and optimizing the closed-loop control

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

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

⚠ WARNING

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

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

Secure dangerous machine parts before starting motor data identification:

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

Preconditions

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

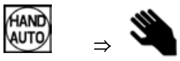
	You can recognize an active alarm from the corresponding symbol on the BOP-2.

- The motor is cooled down to the ambient temperature.

  If the motor is too hot, the motor data identification will provide incorrect values and the closed-loop speed control can become unstable.

Procedure

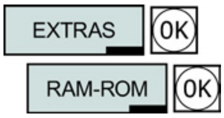
To initiate motor data identification and optimization of the motor control, proceed as follows:

1. 

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

2. 
Switch on the motor.

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

4. 

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

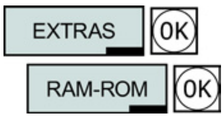

If you have also selected a rotating measurement in addition to the motor data identification, then the inverter again issues the alarm A07991.

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

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

7. 

Switch the inverter control from HAND to AUTO.

8. 

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

You have now completed motor data identification and the closed-loop speed control has been optimized.

5.4.2 Basic commissioning with STARTER

STARTER and STARTER screen forms

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

The STARTER screen forms that are shown in this manual show general examples. You may therefore find that a screen contains more or fewer setting options than are shown in these instructions. A commissioning step may also be shown using an inverter other than the one you are using.

Overview: Commission the inverter in the online mode

We recommend that you commission the inverter using STARTER in the online mode. STARTER offers two options of going online with an inverter:

- Via the USB interface
- Via PROFIBUS or PROFINET

Precondition

You require the following to commission the inverter using STARTER:

- A pre-installed drive (motor and inverter)
- A computer with Windows XP or Windows 7, on which STARTER V4.3 or higher is installed.

  You can find updates for STARTER in the Internet under: Download STARTER (http://support.automation.siemens.com/WW/view/en/10804985/133100)

Procedure

Proceed as follows to carry out the basic commissioning of the inverter online using STARTER:

1. Adapt the inverter and PC interfaces:
   - Go online via USB:Adapting the USB interface (Page 72)
   - Go online via PROFINET:

     Adapting the PROFINET interface (Page 73)

     Configure the communication between inverter and PC: Configuring the PROFINET communication with STEP 7 (Page 376).
2. Create a STARTER project (Page 74).
3. Go online and commission the inverter using the wizards (Page 74).

This means that you have completed the basic commissioning.

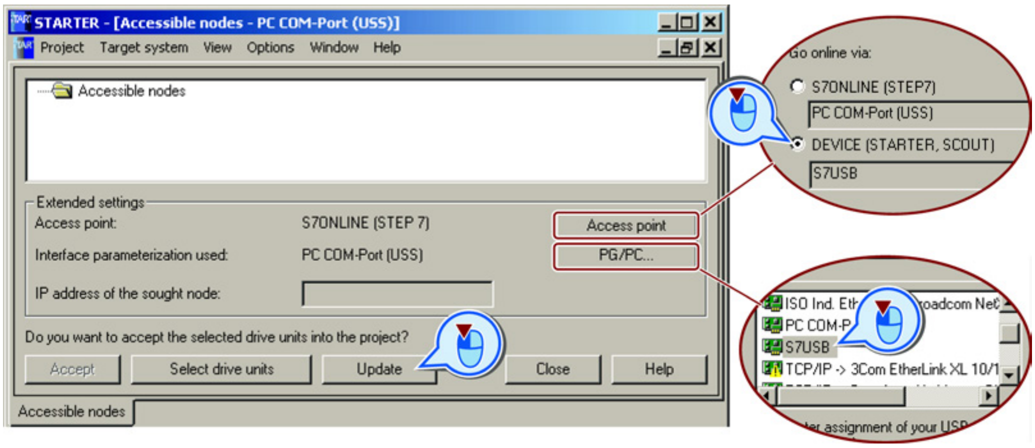
5.4.2.1 Adapt the interfaces

Adapting the USB interface

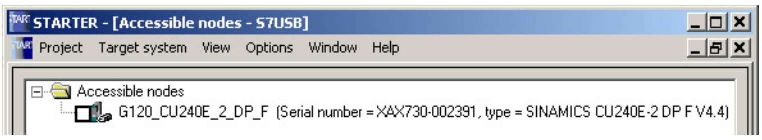
Procedure

Proceed as follows to set the USB interface:

1. Switch on the converter power supply and connect the converter to the PC via USB.
2. The USB drivers are installed if you are connecting the converter and PC together for the first time. Windows 7 automatically installs the drivers without you having to take any action. For older Windows versions, acknowledge the corresponding screen forms with OK.
3. Start the STARTER commissioning software.
4. If you are using STARTER for the first time, you must check the USB interface setting. To do this, click in STARTER on ("Accessible nodes").
   If the interface is appropriately set, then the "Accessible nodes" screen form lists the converters, which are connected via the USB interface. In this case, go to Point 7.
   If incorrectly set, then the "No additional nodes found" message is displayed.
5. Acknowledge this message, and set the "Access point" to "DEVICE (STARTER, Scout)" and the "PG/PC interface" to "S7USB".



6. Then click on "Update". The connected converters are now displayed in "Accessible nodes".



7. Close this screen form without selecting the converter(s) that has/have been found.
8. Create your STARTER project (Page 74).

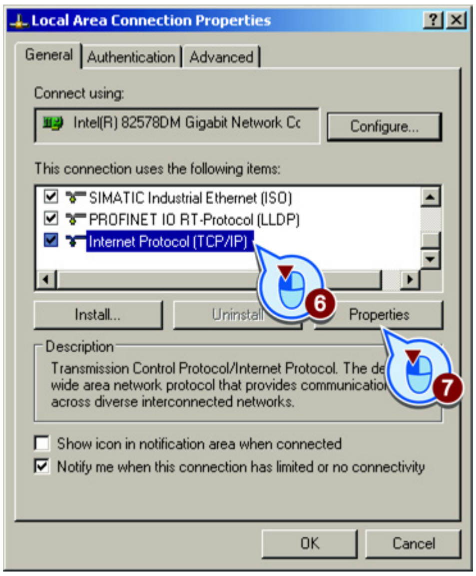
You have set the USB interface.

Adapting the PROFINET interface

If you commission the inverter with STARTER via PROFINET, then you must correctly address your PC and allocate STARTER the interface via which it goes online with the inverter.

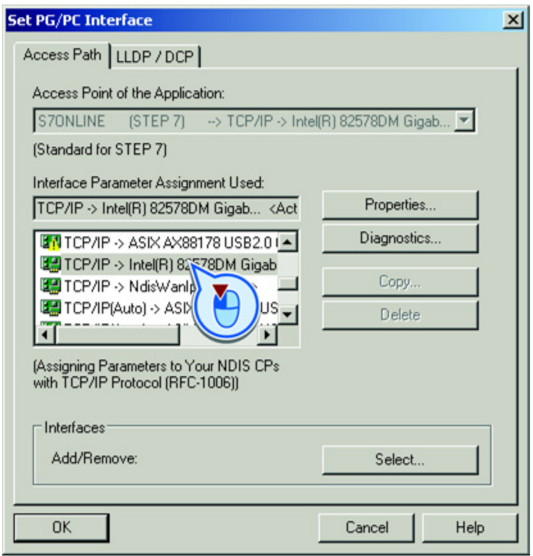
Procedure

To address the inverter, proceed as follows:



1. Establish the bus connection.

   See Section Communication via PROFINET (Page 92))
2. From the control panel, assign the IP address and the subnet mask address to your computer:
3. Go to "Start/Settings/Control Panel".
4. Select "Network Connections".
5. Right-click to open the properties window of the LAN connection.
6. In this window, select "Internet Protocol (TCP/IP)".
7. Select "Properties".



8. Set 192.168.0.100 as the IP address of the supervisor and 255.255.255.0 as subnet mask.

   In the company network it is possible that the IP address and the subnet mask have different values. You can obtain these values from your network administrator.
9. Open the SIMATIC Manager.
10. Assign the TCP/IP interface to "Intel(R) PRO/100 VE Network Connection" via "Tools/PG/PC interface".

You have allocated your computer the IP address and the address of the subnet mask, and defined the PC interface via which STARTER goes online with the inverter.

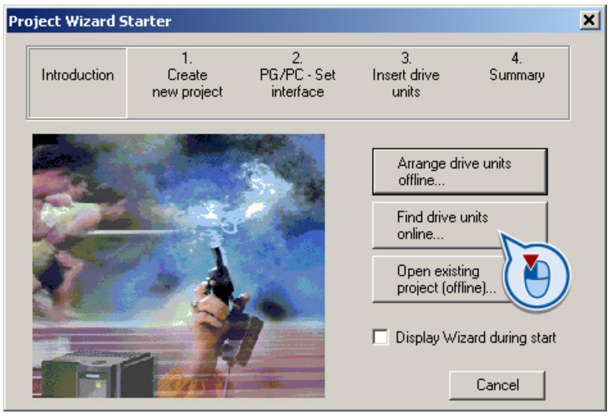
5.4.2.2 Generating a STARTER project

Creating a STARTER project using project wizards

Procedure

To create a project with the STARTER project Wizards, proceed as follows:

1. Using "Project / New with wizard" create a new project.
2. To start the wizard, click on "Search online for drive units ...".
3. Follow the instructions of the Wizard, and set everything that you require for your particular project.



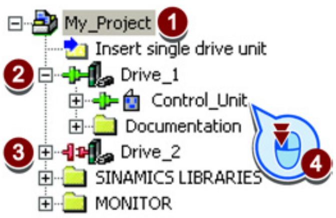
You have created your STARTER project.

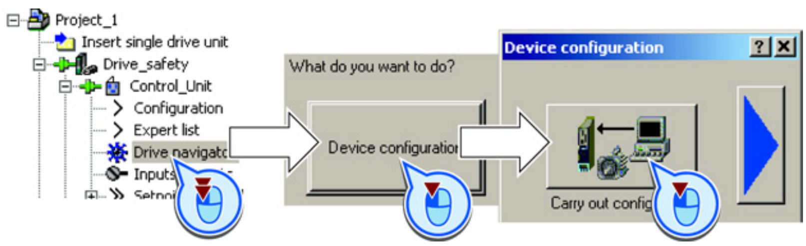
5.4.2.3 Go online and start wizard for basic commissioning

Procedure

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

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





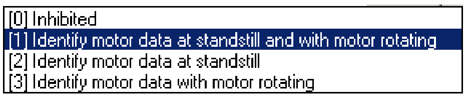
You are online and have started basic commissioning.

5.4.2.4 Carry-out basic commissioning

Procedure

Proceed as follows to carry out basic commissioning:

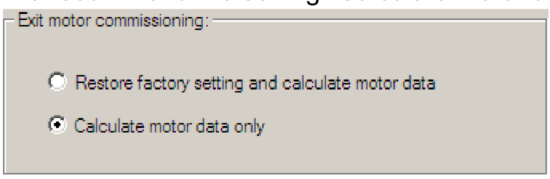
1. ☑ Control structure — Select the control mode.
   See also Section: U/f control or speed control? (Page 62)
2. ☑ Defaults of the setpoin — Select the default setting of the converter interfaces.
   See also Section: Finding a suitable setting for the interfaces (Page 43).
3. ☑ Drive setting — Select the application for the converter:
   Low overload for applications that only require a low dynamic performance, e.g. pumps or fans.
   High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4. ☑ Motor — Select your motor.
5. ☑ Motor data — Enter the motor data according to the rating plate of your motor.
   If you have selected a motor based on its order number, the data has already been entered.
6. ☑ Drive functions — If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".

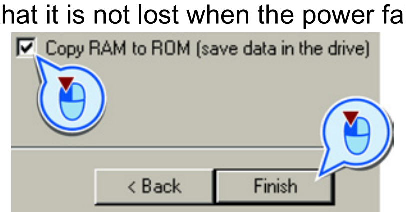
   With this setting, the converter optimizes its speed controller.

   If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":

   - 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.
7. ☑ Important parameters — Set the most important parameters to suit your application.
8. ☑ Calculation of the motc — We recommend the setting "Calculate motor data only".

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

   Exit basic commissioning.

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

5.4.2.5 Identifying motor data

Preconditions

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

  If the motor is too hot, the motor data identification will provide incorrect values and the closed-loop speed control will become unstable.

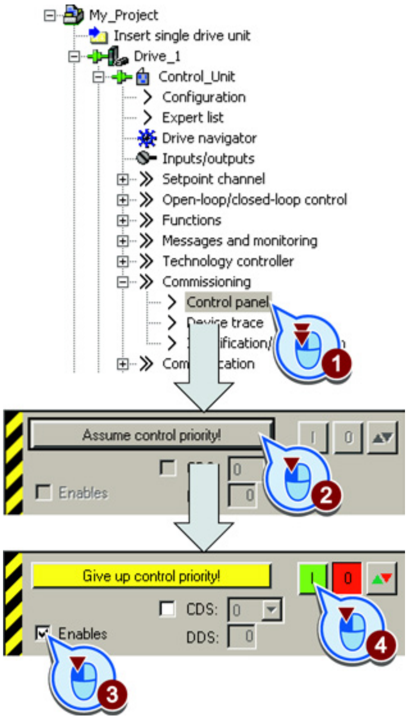
⚠ DANGER
Risk of injury or material damage as a result of machine movements when switching on the motor Switching on the motor for identification purposes may result in hazardous machine movements. Secure dangerous machine parts before starting motor data identification: • Before switching on, check that no parts are loose on the machine or can be spun out. • Before switching on, ensure that nobody is working on the machine or located within its working area. • Secure the machine's work area against unintended access. • Lower hanging/suspended loads to the floor.

Procedure

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

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

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



You have now completed motor data identification.

Self-optimization of the closed-loop control

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

6 Adapting the terminal strip

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

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

See also the following chapter:

- Basic commissioning (Page 66)
- Finding a suitable setting for the interfaces (Page 43)
- Interconnecting signals in the converter (Page 369)

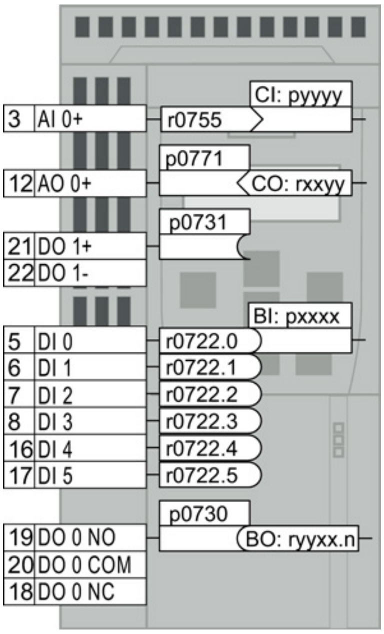
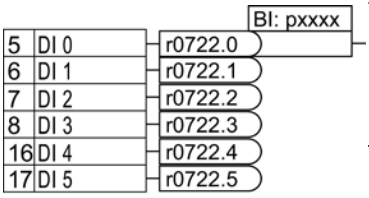


Figure 6-1 Internal connection of the inputs and outputs

6.1 Digital inputs



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.

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.

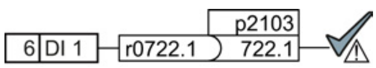
Changing the function of a digital input

Example

You want to acknowledge inverter fault messages using digital input DI 1.

Procedure

Proceed as follows to acknowledge faults using digital input DI 1:

		
	1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p2103 = 722.1	1. Go online. 2. Select "Inputs/outputs". 3. Change the input function via the corresponding screen form.

You have interconnected digital input DI 1 with the command to acknowledge faults.

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

When required, you can use the analog input as additional digital input.

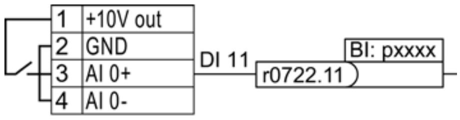


Figure 6-2 Additional digital input

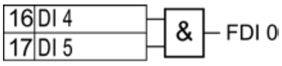
6.2 Fail-safe input

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

Specifying the fail-safe input

If you use the STO safety function, then you must configure the terminal strip during the basic commissioning for a fail-safe input, e.g. with p0015 = 2 (see Section Finding a suitable setting for the interfaces (Page 43)).

The inverter combines digital inputs DI 4 and DI 5 to form a fail-safe input.



You must enable STO to select the STO safety function via FDI 0.

See also Section: Fail-safe function Safe Torque Off (STO) (Page 261).

What devices can be connected?

The fail-safe input is designed for the following devices:

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

Signal states at the fail-safe input

The inverter expects signals with the same state at its fail-safe input:

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

Special measures for wiring of a fail-safe input

The inverter evaluates deviations in the two signals of the fail-safe 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

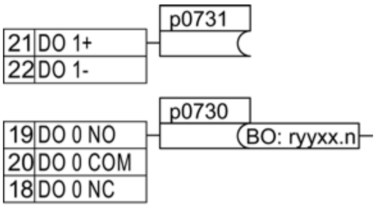
You have the following options to reduce the risk of damaged cables during operation of your machine or plant:

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

These special types of cable routing are normally required only if the cables are laid over larger distances, e.g. between remote control cabinets.

Examples of connecting a fail-safe input can be found in Section: Connecting fail-safe digital inputs (Page 391).

6.3 Digital outputs



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

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.

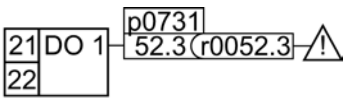
Changing the function of a digital output

Example

You want to output inverter fault messages using digital output DO 1.

Procedure

Proceed as follows to interconnect digital output DO 1 with the fault message:

		
	1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p0731 = 52.3	1. Go online. 2. Select "Inputs/outputs". 3. Change the output function via the corresponding screen form.

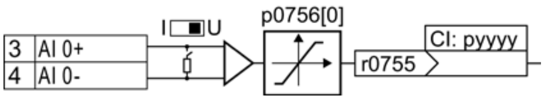
You have interconnected digital output DO 1 with the fault message.

Advanced settings

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

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

6.4 Analog input



Proceed as follows to change the function of an analog input:

1. Define the analog input type.
2. Adapt the characteristic of the analog input.
3. Adapt the internal interconnection of the analog input.

Define the analog input type

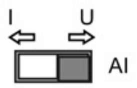
Procedure

Proceed as follows to define the analog input type:

1. Set p0756 to the appropriate value.

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

2. Set the switch associated with the analog input. The switch is on the converter behind the upper front door.

• Voltage input: Switch position U (factory setting) • Current input: Switch position I	

You have now defined the analog input type.

Characteristics of the analog input

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.

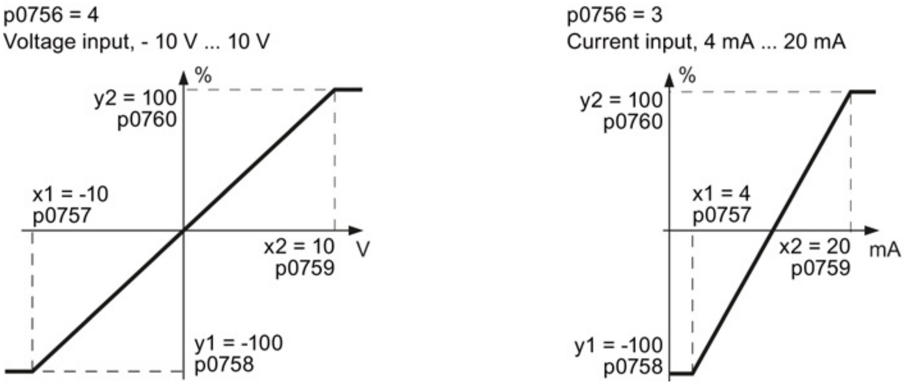


Figure 6-3 Examples for scaling characteristics

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

Adapting the characteristic of the analog input

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.

Procedure

1
2

Proceed as follows to adapt the characteristic to match the example:

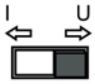
1. Set p0756[0] = 3

   You have defined analog input 0 as current input with wire break monitoring.

   After the change p0756 = 3, the inverter sets the scaling characteristic to the following values (see the example above for the scaling characteristic):

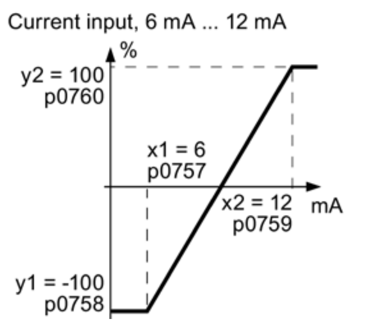
   p0757[0] = 4,0; p0758[0] = 0,0; p0759[0] = 20; p0760[0] = 100

2. Set DIP switch for AI 0 to current input ("I"):



3. Adapt the characteristic:

p0757[0] = 6.0	**Analog inputs, characteristic (x_1, y_1)**
p0758[0] = -100.0	6 mA corresponds to -100 %
p0759[0] = 12.0	**Analog inputs, characteristic (x_2, y_2)**
p0760[0] = 100.0	12 mA corresponds to 100 %



You have adapted the characteristic of the analog input to match the example.

Internal interconnection of the 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 via 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.

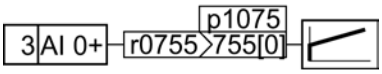
Adapting the internal interconnection of the analog input

Example

The inverter should receive the additional setpoint via analog input AI 0.

Procedure

Proceed as follows to interconnect the analog input with the additional setpoint:

		
	1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p1075 = 755[0]	1. Go online. 2. Select "Inputs/outputs". 3. Change the input function via the corresponding screen form.

You have interconnected the analog input with the additional setpoint.

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.

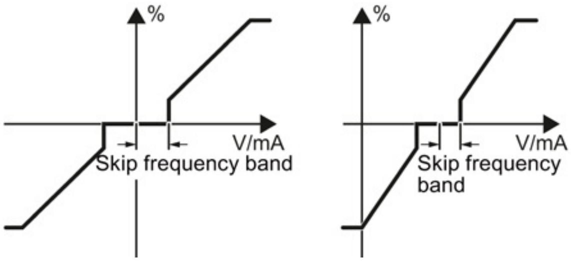
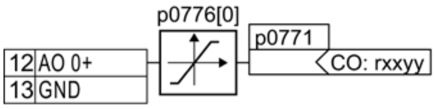


Figure 6-4 Skip frequency band of the analog input

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

6.5 Analog output



Proceed as follows to change the function of an analog output:

1. Define the analog output type.
2. Set the characteristic of the analog output.
3. Adapt the internal interconnection of the analog output.

Define the analog output type

Procedure

Proceed as follows to define the analog output type:

Set parameter p0776 to the appropriate value:

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

You have now defined the analog output type.

Characteristics of the analog output

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).

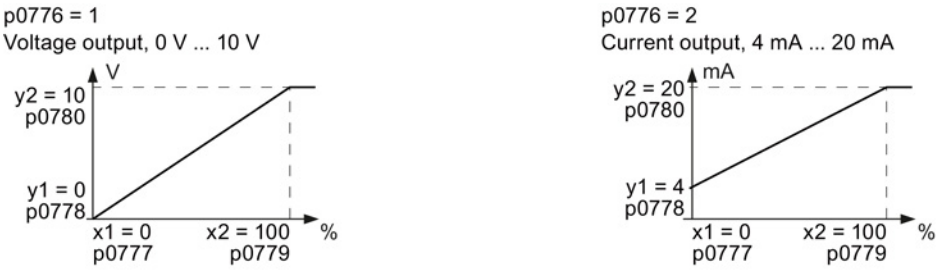


Figure 6-5 Examples for scaling characteristics

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 of the analog output

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

Example:

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

Procedure

Proceed as follows to adapt the characteristic to match the example:

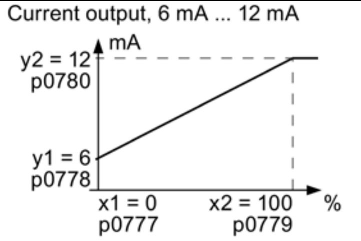
1. Set p0776[0] = 2.

   You have defined analog output 0 as current output.

   After changing p0776 = 2, the inverter sets the scaling characteristic parameters to the following values:

   p0777[0] = 0.0; p0778[0] = 4.0; p0779[0] = 100.0; p0780[0] = 20.0

2. Adapt the characteristic:

p0777[0] = 0.0	**Analog output, characteristic (x_1, y_1)**	
p0778[0] = 6.0	0.0% corresponds to 6 mA	
p0779[0] = 100.0	**Analog output, characteristic (x_2, y_2)**	
p0780[0] = 12.0	100% corresponds to 12 mA	

You have adapted the characteristic of the analog output to match the example.

Internal interconnection of the analog output

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

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

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

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

For more information, please see the parameter list and the function block diagrams 9572 f of the List Manual.

Adapting the internal interconnection of the analog output

Example

You wish to output the inverter output current via analog output 0.

Procedure

Proceed as follows to interconnect analog output 0 with the signal for the output current:

		
12 AO 0+ p0771 27 r0027 |i|	1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p0771 = 27	1. Go online. 2. Select "Inputs/outputs". 3. Change the output function via the corresponding screen form.

You have interconnected analog output 0 with the signal for the output current.

Advanced settings

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

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

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

7 Configuring the fieldbus

Fieldbus interfaces of the 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 95)	SUB D female connector	PROFIdrive and PROFIsafe [1]
PROFINET IO (Page 92)	Two RJ45 connectors	-
EtherNet/IP (Page 118)	Two RJ45 connectors	-
USS (Page 132)	RS485 connector	-
Modbus RTU (Page 143)	RS485 connector	-
CANopen (Page 154)	SUB D male connector	-
	[1] You find information on PROFIsafe in the Function Manual Safety Integrated, see also section: Manuals for your inverter (Page 395).	

7.1 Communication via PROFINET

The Control Unit provides the following functions

• IRT without isochronous mode	
• MRP	Media redundancy, not bumpless with 200 ms Precondition: Ring topology
• MRPD	Media redundancy, bumpless Precondition: IRT and the ring topology created in the control
• Diagnostic alarms	According to error classes specified in the PROFIdrive profile. See Activate diagnostic messages via STEP 7 (Page 380).
• Device replacement without removable data storage medium	Precondition: Topology created in the control
• Shared Device	Only for Control Units with fail-safe functions (see Safety Function Manual)

The Control Units have two RJ45 sockets, which you can use to implement a line topology. You can implement all topologies by using switches.

Additional information on PROFINET in the Internet

General information about PROFINET can be found at Industrial Communication (http://support.automation.siemens.com/WW/view/en/19292127).

The configuration of the functions is described in the PROFINET system description (http://www.automation.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx) manual.

7.1.1 What do you need for communication via PROFINET?

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

Questions	Answer/description	Example
Is the converter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 93)	
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 94)	See Configuring the controller and converter in HW Config (Page 376)
Is the same telegram set in the converter as in the higher-level controller?	Set the telegram in the converter, see: Select telegram – procedure (Page 94)	See: Configuring the controller and converter in HW Config (Page 376)
Are the signals that the converter and the controller exchange via PROFINET correctly interconnected?	PROFIdrive-compliant interconnection in the converter, see: PROFIdrive profile for PROFIBUS and PROFINET (Page 99)	See: STEP 7 programming examples (Page 382)

7.1.2 Connect the converter to PROFINET

Connecting up

Connect the inverter (IO device) and your PG/PC (IO supervisor) via PROFINET cables with the control. The maximum permissible cable length is 100 m.

See also Section: Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).

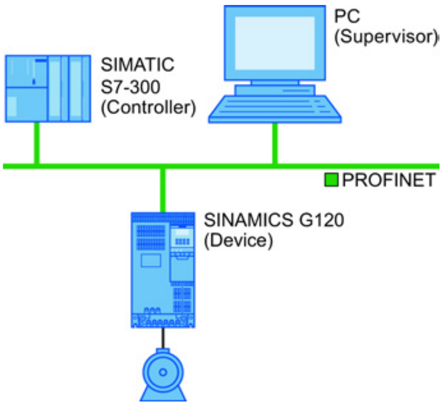


Figure 7-1 Example: PROFINET in a line topology

Recommended PROFINET connectors and pin assignment

We recommend the following connector with order number: 6GK1901-1BB10-2Ax0 for connecting the PROFINET cable.

Instructions for assembling the SIMATIC NET Industrial Ethernet FastConnect RF45 Plug 180 can be found on the Internet under product information " "Assembly instructions for SIMATIC NET Industrial Ethernet FastConnect RJ45 Plug (http://support.automation.siemens.com/WW/view/en/37217116/133300)".

Laying and shielding the PROFINET cable

Information can be found on the Internet: PROFIBUS user organization installation guidelines (http://www.profibus.com/downloads/installation-guide/).

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

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

In the case of short interruptions of the 24 V voltage supply, the inverter may report a fault without communications with the controller being interrupted.

7.1.3 Configuring communication to the control

Loading GSDML

In order to establish communication between the inverter and control system via PROFINET, you need the device file of the inverter "GSDML" for your control. You can then configure the communication.

Procedure

Proceed as follows to load the GSDML of the inverter:

Load the GSDML of the inverter into the PROFINET-Controller, i.e. into your control system. You can load the GSDML of your inverter in two ways:

- You can find the GSDML of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
- The GSDML is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the GSDML will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card as a compressed file (PNGSD.ZIP).

  Unpack the GSDML before you use the device file.

You have loaded the GSDML of the inverter.

7.1.4 Select telegram – procedure

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Finding a suitable setting for the interfaces (Page 43).

Procedure

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

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

You have set a specific telegram in the inverter.

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram. See also the section: Finding a suitable setting for the interfaces (Page 43).	
p0922	**PROFIdrive Telegram selection** Set the send and receive telegram, see also Cyclic communication (Page 99)	
	1: 20: 352 353: 354: 999:	Standard telegram 1, PZD-2/2 (factory setting) 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 See Extend telegrams and change signal interconnection (Page 103).

7.1.5 Activating diagnostics via the control

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

The functionality must be selected in the higher-level control (see example ofSTEP 7 (Page 380)) and activated by powering up.

7.2 Communication via PROFIBUS

7.2.1 What do you need for communication via PROFIBUS?

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

Questions	Description	Examples
Is the inverter correctly connected to the PROFIBUS?	See Section: Connect the frequency inverter to PROFIBUS (Page 96).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring communication to the control (Page 96)	See also Section: Configuring the PROFIBUS communication with STEP 7 (Page 372).
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 97).	
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram – procedure (Page 98).	
Are the signals that the inverter and the controller exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the controller to the inverter. For the PROFIdrive-compliant interconnection in the inverter, see also Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 99).	See also Section: STEP 7 programming examples (Page 382).

7.2.2 Connect the frequency inverter to PROFIBUS

Permissible cable lengths, routing and shielding the PROFIBUS cable

For a data transfer rate of 1 Mbit/s, the maximum permissible cable length is 100 m.

You will find additional information on this topic in the Internet:

- Product support (http://support.automation.siemens.com/WW/view/en/1971286)
- PROFIBUS user organization installation guidelines (http://www.profibus.com/downloads/installation-guide/)

Recommended PROFIBUS connectors

We recommend connectors with the following order numbers for connecting the PROFIBUS cable:

- 6GK1500-0FC00
- 6GK1500-0EA02

Pin assignment at the inverter

For the pin assignment at the inverter refer to Section Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).

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

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

In the case of short interruptions of the 24 V voltage supply, the inverter may report a fault without communications with the controller being interrupted.

7.2.3 Configuring communication to the control

To configure communication between the inverter and control system, you generally require the description file GSD of the inverter.

When STEP 7 and STARTER are installed, you do not need GSD.

Procedure

Proceed as follows to configure communication to the control system using GSD:

1. Obtain the GSD file of the inverter.
   You have two options:
   - You can find the GSD of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   - The GSD is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the inverter writes the GSD to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.

2. Import the GSD into the configuring tool of your control system.
3. Configure the communication between the control and the inverter in your control.

   See also Section: Configuring the PROFIBUS communication with STEP 7 (Page 372).

You have configured the communication to the control system.

7.2.4 Setting the address

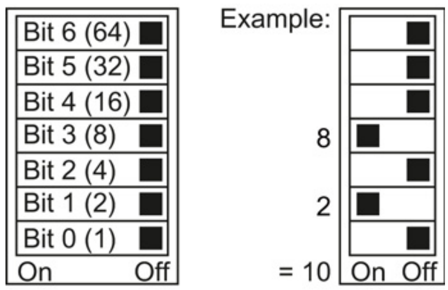
You set the PROFIBUS address of the inverter using the address switch on the Control Unit, using parameter p0918 or in STARTER.

Using parameter p0918 (factory setting: 126) or using 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 using 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: Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - using the address switches
   - with an operator panel using p0918
   - in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p0918
2. Switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

This means that you have changed the bus address.

7.2.5 Select telegram – procedure

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Finding a suitable setting for the interfaces (Page 43).

Procedure

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

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

You have set a specific telegram in the inverter.

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram. See also the section: Finding a suitable setting for the interfaces (Page 43).	
p0922	**PROFIdrive Telegram selection** Set the send and receive telegram, see also Cyclic communication (Page 99)	
	1:	Standard telegram 1, PZD-2/2 (factory setting)
	20:	Standard telegram 20, PZD-2/6
	352	SIEMENS telegram 352, PZD-6/6
	353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4
	354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4
	999:	See Extend telegrams and change signal interconnection (Page 103).

7.3 PROFIdrive profile for PROFIBUS and PROFINET

7.3.1 Cyclic communication

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

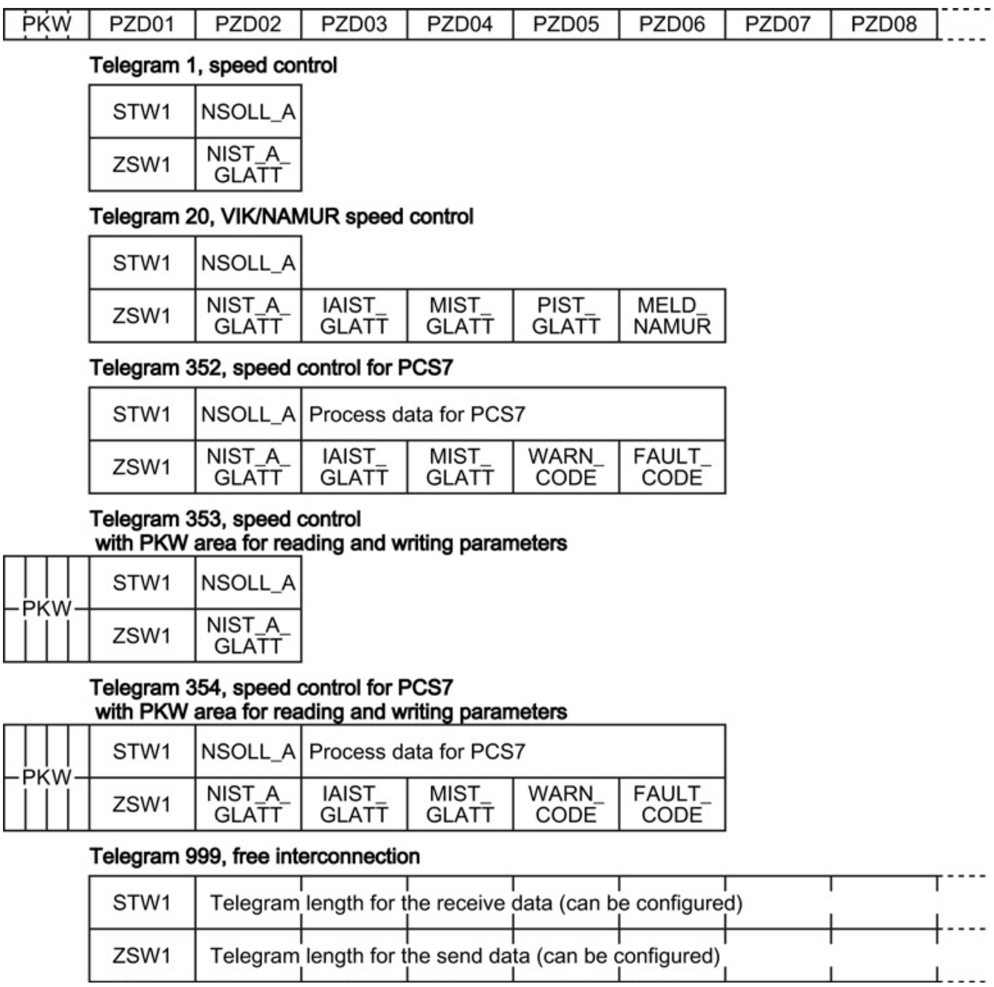


Figure 7-2 Telegrams for cyclic communication

Table 7- 1 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
STW1/2	Control word 1/2	PIST_GLATT	Actual active power
ZSW1/2	Status word 1/2	M_LIM	Torque limit
NSOLL_A	Speed setpoint	FAULT_CODE	Fault number
NIST_A_GLATT	Smoothed actual speed value	WARN_CODE	Alarm number
IAIST_GLATT	Smoothed actual current value	MELD_NAMUR	Fault word according to the VIK-NAMUR definition
MIST_GLATT	Actual torque		

Interconnection of the process data

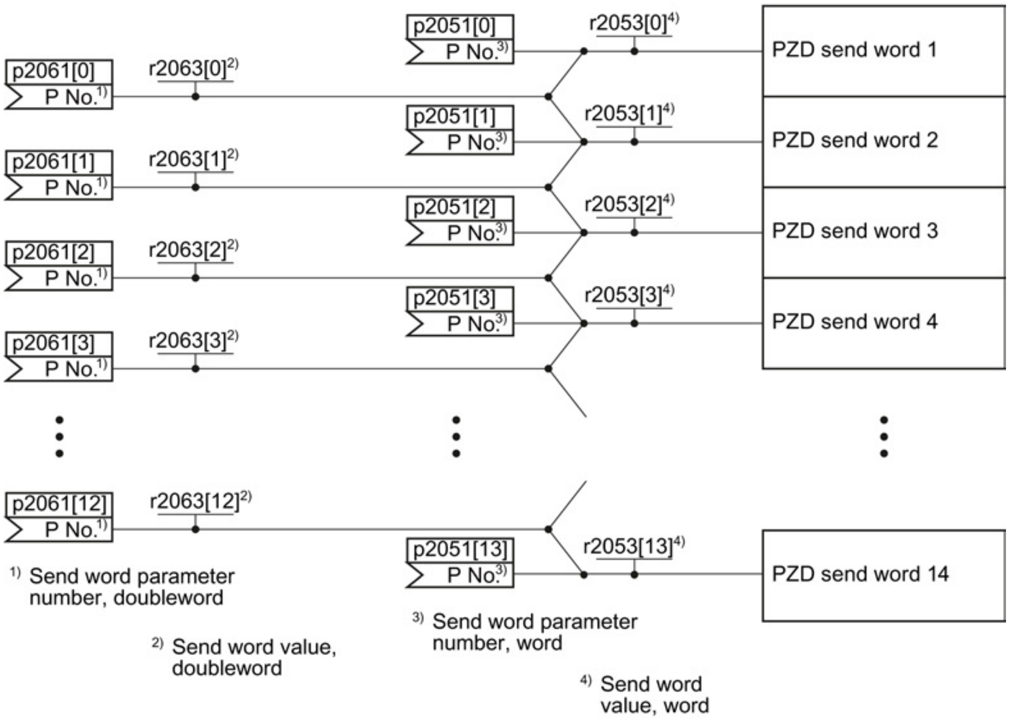


Figure 7-3 Interconnection of the send words

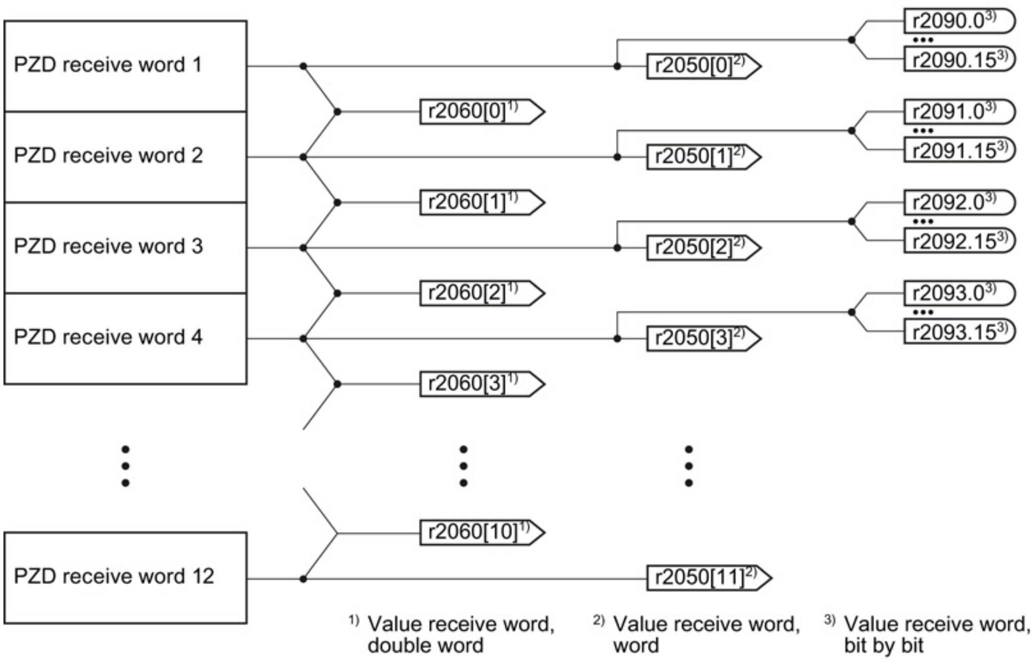


Figure 7-4 Interconnection of the receive words

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.

7.3.1.1 Control and status word 1

The control and status words fulfill the specifications of PROFIdrive profile version 4.1 for the "closed-loop speed controlled" mode.

Control word 1 (STW1)

Control word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter).

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

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

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

Status word 1 (ZSW1)

Status word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter).

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	0 = I, M or P limit reached		Comparison value for current, torque or power has been reached or exceeded.	p2080[11] = r1407.7

Bit	Significance		Comments	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
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.

7.3.1.2 Extend telegrams and change signal interconnection

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

Parameter	Description
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…11]	**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.

Parameters	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…11]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

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

7.3.1.3 Structure of the parameter channel

Structure of the parameter channel

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

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

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

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

Request and response IDs

Bits 12 to 15 of the first word of the parameter channel contain the request and response identifier. The possible identifiers and further explanations can be found in the following tables.

Overview of the request identifiers controller → 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.

Overview of the response identifiers inverter → controller

The response identifier depends on the request identifier.

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 (with error number)
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).

Overview of the error numbers in response identifier 7 (inverter cannot process the request)

For response identifier 7, the inverter sends one of the following error numbers in the highest word of the parameter channel to the controller.

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")

No.	Description
6B hex	**No change access for a controller that is enabled**. (operating status of the inverter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating status of the inverter prevents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (example: a parameter value is too large for the inverter power)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

Offset and page index of the parameter numbers

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

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

Indexed parameters

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

Parameter contents

Parameter contents can be parameter values or connector parameters. For interconnecting connector parameters please see section: Interconnecting signals in the converter (Page 369).

Enter the parameter value, right-justified, as follows in the 4th word of the parameter channel:

- 8-bit values: 4. Word, bit 0 … 7,
  bits 8 … 15 of the 4th word and the 3rd word are zero.
- 16-bit values: 4. Word, bits 0 … 15,
  The 3rd word is zero.
- 32-bit values: 3. and 4th word

Enter a connector parameter as follows:

- Number of the connector parameter: 3. Word
- Drive object of the connector parameter: 4. Word, bits 10 … 15
- The index or bit field number of the connector parameter: 4. Word, bits 0 … 9

Telegram examples

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

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

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

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

Figure 7-5 Telegram for a read request from p7841[2]

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

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

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

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

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

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						
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word
15 ... 12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 0
AK		Parameter number	Subindex	Page index	Parameter value (bit 16 ... 31)	Parameter value (bit 0 ... 15)
0 1 1 1	0	1 0 0 1 0 1 1 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0

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

Other application examples

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

7.3.1.4 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.

Example: An inverter uses the actual speed value of another inverter as its speed setpoint.

Definitions

- **Publisher:** Slave, which sends data for direct data exchange.
- **Subscriber:** Slave, which receives the data for direct data exchange from the publisher.
- **Links and access points** define the data that is used for direct data exchange.

Restrictions

- Direct data exchange in the current firmware version is only possible for inverters with PROFIBUS communication.
- A maximum of 12 PZDs are permissible for each drive.
- To a publisher, a maximum of 4 links are possible.

Procedure

To configure direct data exchange, proceed as follows:

1. In the control, define:
   - Which inverters operate as publisher (sender) or subscriber (receiver)?
   - Which data or data areas do you use for direct data exchange?
2. In the inverter, define:

   How does the subscriber process the data transferred using direct data exchange?

You have configured direct data exchange.

See also Section: Configuring slave-to-slave communication in STEP 7 (Page 389).

7.3.2 Acyclic communication

You can communicate with the inverter both cyclically and acyclically via PROFIBUS and PROFINET.

The inverter supports the following types of acyclic communication:

- Reading and writing parameters via "data set 47" (up to 240 bytes per write or read request)
- Reading-out profile-specific parameters
- Data exchange with a SIMATIC panel (**H**uman **M**achine **I**nterface)

You can find a STEP 7 program example for acyclic data transfer in Section Application examples (Page 372).

Reading parameter values

Table 7- 2 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**Attribute** *10 hex:* Parameter value *20 hex:* Parameter description	**Number of indexes** *00 hex ... EA hex* (for parameters without index: 00 hex)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0000 hex ... FFFF hex* (for parameters without index: 0000 hex)		8
	…		…
Address, parameter 2	…		…
…	…		…
Address, parameter m	…		…

Table 7- 3 Inverter response to a read request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a read request)	**01 hex**: Inverter has executed the read request. **81 hex**: Inverter was not able to completely execute the read request.	0
	01 hex	**Number of parameters (m)** (identical to the read request)	2
Values, parameter 1	**Format** 02 hex: Integer8 03 hex: Integer16 04 hex: Integer32 05 hex: Unsigned8 06 hex: Unsigned16 07 hex: Unsigned32 08 hex: FloatingPoint 10 hex OctetString 13 hex TimeDifference 41 hex: Byte 42 hex: Word 43 hex: Double word 44 hex: Error	**Number of index values** or - for a negative response - **number of error values**	4
	Value of the 1st index or - for a negative response - **error value 1** You can find the error values in a table at the end of this section.		6
	…		…
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Changing parameter values

Table 7- 4 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex ... EA hex* (00 hex and 01 hex have the same significance)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0001 hex ... FFFF hex*		8
	…		…
Address, parameter 2	…		
…	…		…
Address, parameter m	…		
Values, parameter 1	**Format** *02 hex:* Integer 8 *03 hex:* Integer 16 *04 hex:* Integer 32 *05 hex:* Unsigned 8 *06 hex:* Unsigned 16 *07 hex:* Unsigned 32 *08 hex:* Floating Point *10 hex* Octet String *13 hex* Time Difference *41 hex:* Byte *42 hex:* Word *43 hex:* Double word	**Number of index values** *00 hex ... EA hex*	
	Value of the 1st index		
	…		
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Table 7- 5 Response, if the inverter has executed the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**02 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2

Table 7- 6 Response if the inverter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex or 02 hex	4
	Only for "Error" - **error value 1** You can find the error values in the table at the end of this section.		6
	Only for "Error" - **error value 2** Error value 2 is either zero, or it contains the number of the first index where the error occurred.		8
Values, parameter 2	...		
...	…		…
Values, parameter m	...		

Table 7- 7 Error value in the parameter response

Error value 1	Significance
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 parameter index 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 that cannot be changed)
09 hex	**Description data not available** (access to a description that does not exist, parameter value is available)
0B hex	**No master control** (change request but with no master control)
0F hex	**Text array does not exist** (although the parameter value is available, the request is made to a text array that does not exist)
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)
15 hex	**Response too long** (the length of the actual response exceeds the maximum transfer length)
16 hex	**Illegal parameter address** *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)*
17 hex	**Illegal format** (change request for an illegal or unsupported format)
18 hex	**Number of values not consistent** *(number of values of the parameter data to not match the number of elements in the parameter address)*
19 hex	**Drive object does not exist** (access to a drive object that does not exist)

Error value 1	Significance
6B hex	No change access for a controller that is enabled.
6C hex	Unknown unit.
6E hex	Change request is only possible when the motor is being commissioned (p0010 = 3).
6F hex	Change request is only possible when the power unit is being commissioned (p0010 = 2).
70 hex	Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).
71 hex	Change request is only possible if the inverter is ready (p0010 = 0).
72 hex	Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).
73 hex	Change request possible only during commissioning of the safety functions (p0010 = 95).
74 hex	Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).
75 hex	Change request is only possible in a commissioning state (p0010 ≠ 0).
76 hex	Change request is not possible for internal reasons (p0010 = 29).
77 hex	Change request is not possible at download.
81 hex	Change request is not possible at download.
82 hex	Transfer of the control authority (master) is inhibited by BI: p0806.
83 hex	Desired interconnection is not possible (the connector output does not supply a float value although the connector input requires a float value)
84 hex	Inverter does not accept a change request (inverter is busy with internal calculations. See parameter r3996 in the inverter List Manual. See also Section: Manuals for your inverter (Page 395))
85 hex	No access methods defined.
86 hex	Write access only during commissioning of the data records (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)

Other application examples

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

7.4 PROFIenergy profile for PROFINET

7.4.1 PROFIenergy

The non-proprietary PROFIenergy profile provides the following functions:

- switches off plant or plant sections in non-operational periods
- monitors the energy flow
- signals the plant or system state

PROFIenergy functions of the inverter

The higher-level control transfers commands to the inverter acyclically. The following commands and queries are available for the control:

Control commands

- Start_Pause
  Signal for the start and duration of a pause
- End_Pause
  Signal for the return into the productive state

Status queries

- PEM_Status
  Actual device status: Energy-saving mode or productive state
- Query_Measurement
  Energy usage

Basic settings in the inverter

Parameter p5611 defines the responses to the PROFIenergy command "Start_Pause".

Enabling PROFIenergy	p5611.0 = 0	Yes	
	p5611.0 = 1		No
For "Start_Pause", the drive initiates OFF1	p5611.1= 0		No
	p5611.1= 1	Yes	
Transition into the energy-saving mode from S4	p5611.2 = 0		No
	p5611.2 = 1	Yes	

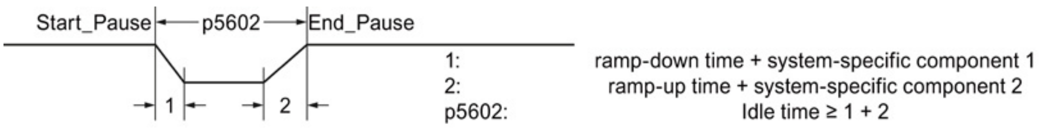
Table 7- 8 Dependency on the settings of p5611.0 … p5611.2

Bit 0	Bit 1	Bit 2	
0	0	0	Energy-saving mode enabled. • Display in r5613 • no additional "automatic" responses. • Set the responses to PROFIenergy commands on the inverter side.
1	0/1	0/1	Energy-saving mode not enabled. No response to PROFIenergy commands from the control
0	1	0	Energy-saving mode enabled with the following responses: • Display in r5613 • OFF1 is set if the "Start_Pause" command is received from the control. – The command is immediately effective in the inverter states "switching on inhibited" (S1) or "ready to start" (S2). – In the "operation" state (S4), OFF1 only becomes effective if the inverter has been brought into the "switching on inhibited" (S1) or "ready to start" (S2) state as a result of other commands, either from the control or inverter side. • The inverter cannot be switched on as long as the "Start_Pause" command is present. The OFF1 command is withdrawn with "End_Pause".
0	1	1	Energy-saving mode enabled with the following responses: • Display in r5613 • OFF1 is set if the "Start_Pause" command is received from the control. The command is immediately effective in the inverter states "switching on inhibited" (S1), "ready to start" (S2), "ready" (S3) and operation (S4). • With the "End_Pause" command, the pulses are re-enabled and the motor starts, if one of the states "ready" (S3) or "operation" (S4) is present.

Additional settings and displays

Settings

- Minimum pause time: p5602
  is the time that the machine requires to change into the energy-saving mode and back into the production mode.



- Maximum pause time: p5606
- Signal source to set the inverter into state S1 (switching on inhibited): p5614
  (e.g. p5614 = 722.0, means that you bring the inverter into the "switching-on inhibited" state via DI0).
- Reset the energy usage display to 0: p0040

Displaying

Display value	in the inverter	in the PROFIenergy profile
Power output at the motor shaft	r0032 in kW	ID 34 in W
Power factor	r0038	ID166
Balance from the energy drawn and fed back	r0039[1], in kWh	ID 200 in Wh
Interconnectable display of the PROFIenergy state	r5613	---
Energy saved - with respect to the adjustable characteristic (p3320 … p3329)	r0041	---

7.5 Communication via EtherNet/IP

Via EtherNet/IP you can enter commands and setpoints, read-out status information and actual values, change parameter values and reset faults.

Process data (setpoints, actual values, etc.) are transferred in EtherNet/IP using assemblies. In addition to the assemblies, there are objects that you can use to set the communication. The objects and assemblies supported by the inverter are described in Section Supported objects (Page 121)

7.5.1 Connect converter to Ethernet/IP

The Control Units have two RJ45 sockets for connection to the control system, which you can use to implement a line topology. You can implement all topologies by using switches.

We recommend the following connector with order number: 6GK1901-1BB10-2Ax0 for connecting an EtherNet cable.

Instructions for assembling the SIMATIC NET Industrial Ethernet FastConnect RF45 Plug 180 can be found on the Internet under product information " "Assembly instructions for SIMATIC NET Industrial Ethernet FastConnect RJ45 Plug (http://support.automation.siemens.com/WW/view/en/37217116/133300)".

Procedure

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

1. Connect the inverter to the control system via an Ethernet cable.
2. Either
   create a generic I/O module (Page 130) in your control system for cyclic data exchange between the control system and the inverter
   or
   load the EDS file of the ODVA into the control system. You can find the file in the internet at:
   (http://www.odva.org/Home/CIPPRODUCTCOMPLIANCE/DeclarationsofConformity/EtherNetIPDOCs/tabid/159/lng/en-US/Default.aspx) .

You have connected the inverter to the control system via EtherNet/IP.

See also Section: Interfaces, connectors, switches, control terminals and LEDs on the CU (Page 41).

Routing and shielding the Ethernet cable

Information can be found on the Internet: EtherNet/IP guidelines (http://www.odva.org/Home/ODVATECHNOLOGIES/EtherNetIP/EtherNetIPLibrary/tabid/76/lng/en-US/Default.aspx).

Commissioning the inverter in an EtherNet/IP network

To commission the inverter, using STARTER you must access the inverter via the USB interface. To do this, connect the computer to the inverter via the USB interface. See also Basic commissioning with STARTER (Page 71).

7.5.2 What do you need for communication via Ethernet/IP?

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

- Is the inverter correctly connected to the EtherNet/IP?
- Is the EDS file (http://support.automation.siemens.com/WW/view/en/48351511) installed in your control system?
- Have the bus interface and IP address been correctly set?
- Have the signals that the inverter and the control system exchange been correctly interconnected?

7.5.3 Communication settings for Ethernet/IP

General communication settings

In order to be able to communicate with a higher-level control system via EtherNet/IP, you must set parameter p2030 = 10.

Further, you must set the following data:

• IP address	in p8921	currently valid value in r8931
• Subnet mask	in p8923	currently valid value in r8933
• Default gateway	in p8922	currently valid value in r8932
• Name of station	in p8920	currently valid value in r8930

These parameters apply if p2030 = 10 is set, for EtherNet/IP, even if the parameter name indicates PROFINET.

Modified addresses only become effective if you switch-off the inverter and switch it on again; this includes any external 24 V supply that is being used.

Additional settings for communication via EtherNet/IP

Setting the communication profile

The inverter has two communication profiles

- p8980 = 0: SINAMICS profile (factory setting)
  A drive profile defined by Siemens for EtherNet/IP based on PROFIdrive
- p8980 = 1: ODVA AC/DC drive profile
  A drive profile defined by the ODVA organization

Telegram selection

You select the telegram using p0922.

You can select any of the listed telegrams if you are working with the SINAMICS profile.

If you use the AC/DC profile of the ODVA, select the standard telegram, p0922 = 1. You cannot work with the EDS file if you wish to use the assemblies described in Section Supported objects (Page 121). In this case, you must integrate the inverter into your control system.

Setting the bus monitoring time

You set the bus monitoring using parameter p8840 in the inverter.

If you set this parameter to 0, the inverter continues to operate even if the bus develops a fault condition. If you set a time ≠ 0, then the inverter switches off with F08501 "Setpoint timeout" if the control system does not issue any signals within this time.

7.5.4 Additional settings if you are working with the AC/DC profile

If you change the following settings in the inverter by accessing the appropriate parameters, you must switch-off the inverter and switched it on again in order that these changes become effective. The changes become immediately effective when making the changes via the control system with objects 90 hex or 91 hex.

Setting the off response for the motor

You set the standard off response for the inverter using parameter p8981:

- p8981 = 0: OFF1 (factory setting), also corresponds to the setting in the SINAMICS profile
- p8981 = 1: OFF2

You can find details on OFF1 and OFF2 in section Switching the motor on and off (Page 193)

Setting the speed and torque scaling

You scale the speed and torque display using parameter p8982 or p8983. Setting range: 2^5 to 2^{-5}.

Displaying the maximum process data that can be transferred (PZD)

- r2067[0] maximum interconnected PZD length - receiving
- p2067[1] maximum interconnected PZD length - sending

7.5.5 Supported objects

EtherNet/IP objects supported by the G120

Object class		Object name	Objects required	ODVA objects	SINAMICS objects
hex	dec				
1 hex	1	Identity object	x		
4 hex	4	Assembly object	x		
6 hex	6	Connection Manager object	x		
28 hex	30	Motor Data Object		x	
29 hex	31	Supervisor Object		x	
2A hex	42	Drive Object		x	
32C hex	44	Siemens Drive Object			x
32D hex	45	Siemens Motor Data Object			x
90 hex	144	Parameter object			x
91 hex	145	Parameter object free access (DS47)			x
F5 hex	245	TCP/IP Interface object [1)]	x		
F6 hex	246	Ethernet Link object 1)	x		
401 hex … 43E hex	1025 … 1086	Parameter object			x

1) these objects are part of the EtherNet/IP system management.

ODVA AC/DC assembly

Number		required/ optional	Type	Name
hex	dec			
14 hex	20	Required	Sending	Basic Speed Control Output
15 hex	21	Optional	Sending	Extended Speed Control Output
16 hex	22	Optional	Sending	Speed and Torque Control Output
17 hex	23	Optional	Sending	Extended Speed and Torque Control Output
18 hex	24	Optional	Sending	Process Control Output
19 hex	25	Optional	Sending	Extended Process Control Output
46 hex	70	Required	Receiving	Basic Speed Control Input
47 hex	71	Optional	Receiving	Extended Speed Control Input
48 hex	72	Optional	Receiving	Speed and Torque Control Input
49 hex	73	Optional	Receiving	Extended Speed and Torque Control Input
4A hex	74	Optional	Receiving	Process Control Input
4B hex	75	Optional	Receiving	Extended Process Control Input

Assembly Basic Speed Control, Instance Number: 20, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

Assembly Basic Speed Control, Instance Number: 70, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

Assembly Basic Speed Control with parameter assembly, Instance Number: 120, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Data Out 1 Value (Low Byte)							
5	Data Out 1 Value (High Byte)							
6	Data Out 2 Value (Low Byte)							
7	Data Out 2 Value (High Byte)							
8	Data Out 3 Value (Low Byte)							
9	Data Out 3 Value (High Byte)							
10	Data Out 4 Value (Low Byte)							
11	Data Out 4 Value (High Byte)							
12	Data Out 5 Value (Low Byte)							
13	Data Out 5 Value (High Byte)							
14	Data Out 6 Value (Low Byte)							
15	Data Out 6 Value (High Byte)							
16	Data Out 7 Value (Low Byte)							
17	Data Out 7 Value (High Byte)							
18	Data Out 8 Value (Low Byte)							
19	Data Out 8 Value (High Byte)							
20	Data Out 9 Value (Low Byte)							
21	Data Out 9 Value (High Byte)							
22	Data Out 10 Value (Low Byte)							
23	Data Out 10 Value (High Byte)							

Assembly Basic Speed Control with parameter assembly, Instance Number: 170, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Data In 1 Value (Low Byte)							
5	Data In 1 Value (High Byte)							
6	Data In 2 Value (Low Byte)							
7	Data In 2 Value (High Byte)							
8	Data In 3 Value (Low Byte)							
9	Data In 3 Value (High Byte)							
10	Data In 4 Value (Low Byte)							
11	Data In 4 Value (High Byte)							
12	Data In 5 Value (Low Byte)							
13	Data In 5 Value (High Byte)							
14	Data In 6 Value (Low Byte)							
15	Data In 6 Value (High Byte)							
16	Data In 7 Value (Low Byte)							
17	Data In 7 Value (High Byte)							
18	Data In 8 Value (Low Byte)							
19	Data In 8 Value (High Byte)							
20	Data In 9 Value (Low Byte)							
21	Data In 9 Value (High Byte)							
22	Data In 10 Value (Low Byte)							
23	Data In 10 Value (High Byte)							

Assembly Extended Speed Control, Instance Number: 21, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							

Assembly Extended Speed Control, Instance Number: 71, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							

Assembly Extended Speed Control with parameter assembly, Instance Number: 121, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Data Out 1 Value (Low Byte)							
5	Data Out 1 Value (High Byte)							
6	Data Out 2 Value (Low Byte)							
7	Data Out 2 Value (High Byte)							
8	Data Out 3 Value (Low Byte)							
9	Data Out 3 Value (High Byte)							
10	Data Out 4 Value (Low Byte)							
11	Data Out 4 Value (High Byte)							
12	Data Out 5 Value (Low Byte)							
13	Data Out 5 Value (High Byte)							
14	Data Out 6 Value (Low Byte)							
15	Data Out 6 Value (High Byte)							
16	Data Out 7 Value (Low Byte)							
17	Data Out 7 Value (High Byte)							
18	Data Out 8 Value (Low Byte)							
19	Data Out 8 Value (High Byte)							
20	Data Out 9 Value (Low Byte)							
21	Data Out 9 Value (High Byte)							
22	Data Out 10 Value (Low Byte)							
23	Data Out 10 Value (High Byte)							

Assembly Extended Speed Control with parameter assembly, Instance Number: 171, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Ref From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Data In 1 Value (Low Byte)							
5	Data In 1 Value (High Byte)							
6	Data In 2 Value (Low Byte)							
7	Data In 2 Value (High Byte)							
8	Data In 3 Value (Low Byte)							
9	Data In 3 Value (High Byte)							
10	Data In 4 Value (Low Byte)							
11	Data In 4 Value (High Byte)							
12	Data In 5 Value (Low Byte)							
13	Data In 5 Value (High Byte)							
14	Data In 6 Value (Low Byte)							
15	Data In 6 Value (High Byte)							
16	Data In 7 Value (Low Byte)							
17	Data In 7 Value (High Byte)							
18	Data In 8 Value (Low Byte)							
19	Data In 8 Value (High Byte)							
20	Data In 9 Value (Low Byte)							
21	Data In 9 Value (High Byte)							
22	Data In 10 Value (Low Byte)							
23	Data In 10 Value (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 22, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 72, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		RUN Forward
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly , Instance Number: 122, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly , Instance Number: 172, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

Extended Speed and Torque Control, Instance Number: 23, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Extended Speed and Torque Control, Instance Number: 73, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 123, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 173, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
21	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

7.5.6 Create generic I/O module

For certain control systems, you cannot use the EDS file provided by the ODVA. In these cases, you must create a generic I/O module in the control system for the cyclic communication.

Procedure

Proceed as follows to create a generic I/O module:

1. In your control system, via "New module" create a new "I/O module", "Generic" type.
2. In the control system, enter the lengths for the process data for cyclic communication, which you have selected in STARTER, r2067[0] (input), r2067[1] (output), for example: Standard telegram 2/2.
3. In STARTER, set the same values for IP address, Subnet Mask, Default Gateway and the Name of Station as in the control system (see Communication settings for Ethernet/IP (Page 119))

You have created a generic I/O module for cyclic communication with the inverter.

7.6 Communication via RS485

7.6.1 Integrating inverters into a bus system via the RS485 interface

Connecting to a network via RS485

Connect the inverter to your fieldbus via the RS485 interface. Position and assignment of the RS485 interface can be found in Section Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41). This connector has short-circuit proof, isolated pins.

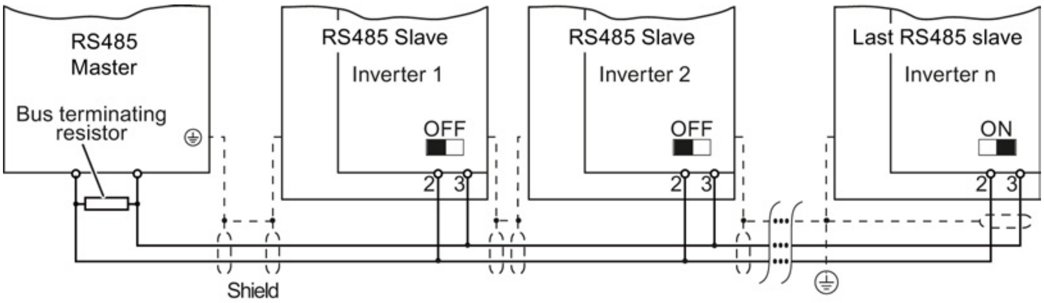


Figure 7-8 Communication network via RS485

You must switch-in the bus-terminating resistor for the first and last nodes. The position of the bus-terminating resistor can be found in Section Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).

Note

During bus operation the first and last bus subscriber must be constantly supplied with power as otherwise the communication with the other subscribers is broken.

With the exception of the first or last slave, when required you can remove slaves from the bus. To do this, withdraw the bus connector. When doing this, communication to the other nodes (stations) is not interrupted.

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

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

In the case of short interruptions of the 24 V voltage supply, the inverter may report a fault without communications with the controller being interrupted.

7.6.2 Communication via USS

The USS protocol is a serial-data connection between one master and one or more slaves. A master is, for example:

- A programmable logic controller (e.g. SIMATIC S7-200)
- A PC

The inverter is always a slave.

A maximum of 31 slaves is possible.

The maximum cable length is 100 m.

Information about how to connect the inverter to the USS fieldbus is provided in Section Integrating inverters into a bus system via the RS485 interface (Page 131).

7.6.2.1 Basic settings for communication

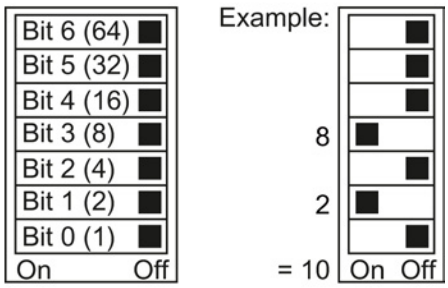
Setting the address

You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Valid address range: 1 … 30

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 0) will not be able to be changed.

The positions of the address switches are described in Section: Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – using the address switches
   – with an operator panel using p2021
   – in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p2021
2. Switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

This means that you have changed the bus address.

Additional settings

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td>p0015 = 21</td><td colspan="4">Macro drive device
Select the I/O configuration</td></tr>
<tr><td rowspan="7">p2020</td><td colspan="4">Setting the baud rate</td></tr>
<tr><td>Value</td><td>Baud rate</td><td>Value</td><td>Baud rate</td></tr>
<tr><td>4</td><td>2400</td><td>9</td><td>57600</td></tr>
<tr><td>5</td><td>4800</td><td>10</td><td>76800</td></tr>
<tr><td>6</td><td>9600</td><td>11</td><td>93750</td></tr>
<tr><td>7</td><td>19200</td><td>12</td><td>115200</td></tr>
<tr><td>8</td><td>38400</td><td>13</td><td>187500</td></tr>
<tr><td>p2022</td><td colspan="4">Fieldbus interface USS PZD number
Sets the number of 16-bit words in the PZD part of the USS telegram
Setting range: 0… 8 (0 … 8 words)</td></tr>
<tr><td>p2023</td><td colspan="4">Fieldbus interface USS PIV number
Sets the number of 16-bit words in the PIV part of the USS telegram
Setting range:
• 0, 3, 4: 0, 3 or 4 words
• 127: variable length</td></tr>
<tr><td>p2040</td><td colspan="4">Fieldbus interface monitoring time [ms]
Sets the monitoring time to monitor the process data received via the fieldbus. If no process data is received within this time, an appropriate message is output</td></tr>
</table>

7.6.2.2 Telegram structure

Overview

A USS telegram comprises a series of elements with a defined sequence. Each element contains 11 bits.

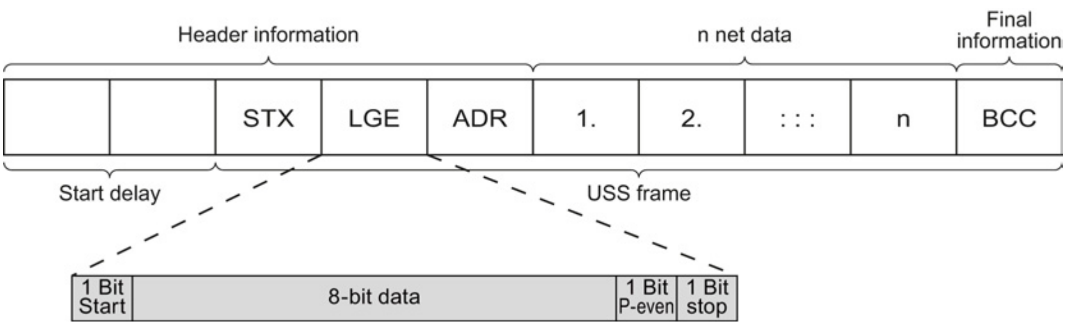
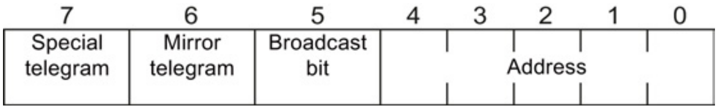


Figure 7-9 Structure of a USS telegram

Telegram part	Description
Start delay / response delay	There is always a start and/or response delay between two telegrams (see alsoTime-out and other errors (Page 141))
STX	An ASCII character (02 hex) indicates the beginning of the message.
LGE	The telegram length "LGE" is calculated as follows: LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte)
ADR	 • Bit 7 = 0: Normal data exchange. Bit 7 =1, to transfer telegrams that require a net data structure different from the device profile. • Bit 6 = 0: Normal data exchange. Bit 6 = 1: Testing the bus connection: The converter returns the telegram unchanged to the master. • Bit 5 = 0: Normal data exchange. (Bit 5 = 1: Not supported in the converter.) • Bits 0 ... 4: Address of the converter.
Net data	See section User data range of the USS telegram (Page 134).
BCC	Checksum (exclusive or) across all telegram bytes – with the exception of BCC.

7.6.2.3 User data range of the USS telegram

The user data area consists of the following elements:

- Parameter channel (PIV) for writing and reading parameter values
- Process data (PZD) for controlling the drive.

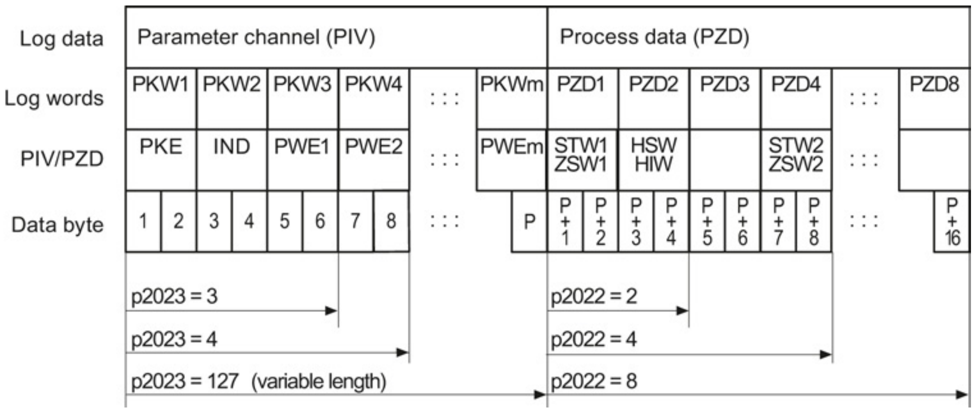


Figure 7-10 USS telegram - user data structure

Parameter channel

In parameter p2023 you specify the parameter channel length.

Parameter channel with fixed and variable length

- p2023 = 0
  With this setting, no parameter values are transferred.
- p2023 = 3
  You can select this setting if you only want to read or write 16-bit data or alarm signals.
- p2023 = 4:
  If you want to read or write 32-bit values (for example indexed parameters or bit parameters, e.g. r0722.2), then this setting is required. In this case, the send or receive telegram always contains four words, even if only three would be required. The values are enter right-justified in the 4th word.
- p2023 = 127:
  If you set p2023 = 27 (variable length), the send and response telegrams are as long as the task actually requires.

Process data

Parameter p2022 defines the length for the process data. You can transfer up to eight process data items in one telegram (p2022 = 0 … 8). For p2022 = 0, no process data is transferred.

7.6.2.4 USS parameter channel

Structure of the parameter channel

Depending on the setting in p2023, the parameter channel has a fixed length of three or four words, or a variable length, depending on the length of the data to be transferred.

1. and 2nd word contain the parameter number and index as well as the type of job (read or write). The other words of the parameter channel contain parameter contents. The parameter contents can be 8-bit values, 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters). The parameter contents are entered right justified in the word with the highest number. Words that are not required are assigned 0.

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

The diagram shows a parameter channel that is four words long.

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

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

Request and response IDs

Bits 12 to 15 of the first word of the parameter channel contain the request and response identifier. The possible identifiers and further explanations can be found in the following tables.

Overview of the request identifiers controller → 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.

Overview of the response identifiers inverter → controller

The response identifier depends on the request identifier.

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 (with error number)
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).

Overview of the error numbers in response identifier 7 (inverter cannot process the request)

For response identifier 7, the inverter sends one of the following error numbers in the highest word of the parameter channel to the controller.

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

Parameter number

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 15 … 8).

Table 7- 9 Offset and page index of the parameter numbers

Parameter number	Offset	Page index								
		Hex	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
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 7 … 0).

Parameter contents

Parameter contents can be parameter values or connector parameters. You require two words for connector parameters. For interconnecting connector parameters please see Section Interconnecting signals in the converter (Page 369).

Enter the parameter value in the parameter channel right-justified as follows:

- 8-bit values: Low word, bit 0 ... 7,
  bits 8 … 15 are zero.
- 16-bit values: Low word, bits 0 … 15,
- 32-bit values: Low word and high word

Enter a connector parameter right-justified as follows:

- Number of the connector parameter: High word
- Drive object of the connector parameter: Low word, bits 10 … 15
- The index or bit field number of the connector parameter: Low word, bits 0 … 9

Telegram examples, parameter channel length = 4

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 (page index): = 90 hex** (offset 6000 ≙ 90 hex)
- **IND, bit 0 … 7 (subindex): = 2** (Index of the parameter)
- 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							
PKE (1st word)			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 ... 12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	1 0 0 1 0 0 0 0	0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 7-11 Telegram for a read request from p7841[2]

Write request: Changing the automatic restart mode (p1210)

Parameter p1210 defines the automatic restart mode:

- **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 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **IND, bit 0 … 7 (subindex): = 0 hex** (parameter is not indexed)
- **PWE1, bit 0 … 15: = 0 hex**
- **PWE2, bit 0 … 15: = 1A hex** (26 = 1A hex)

Parameter channel						
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word
15 ... 12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 0
AK		Parameter number	Page index	Subindex	Parameter value (bit 16 ... 31)	Parameter value (bit 0 ... 15)
0 1 1 1	0	1 0 0 1 0 1 1 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0

Figure 7-12 Telegram, to activate the automatic restart with p1210 = 26

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

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

- **PKE, bit 12 … 15 (AK): = 7 hex** (change, parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)
- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 ≙ 0 hex)
- **IND bit 0 … 7 (subindex): = 1 hex** (command data set, CDS1 = index1)
- **PWE1, bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)
- **PWE2, bit 10 … 15: = 3f hex** (drive object - for SINAMICS G120, always 63 = 3f hex)
- **PWE2, bit 0 … 9: = 2 hex** (index or bit number of the parameter: DI 2 = r0722.2)

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

Figure 7-13 Telegram, to assign DI 2 with ON/OFF1

7.6.2.5 USS process data channel (PZD)

Description

The process data channel (PZD) contains the following data depending on the transmission direction:

- Control words and setpoints for the slave
- Status words and actual values for the master.

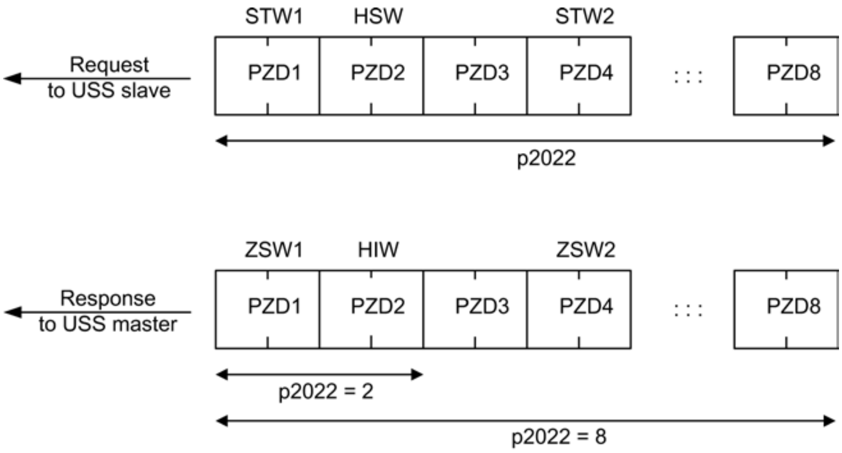


Figure 7-14 Process data channel

The first two words are:

- Control 1 (STW1) and main setpoint (HSW)
- Status word 1 (ZSW1) and main actual value (HIW)

If p2022 is greater than or equal to 4, then the converter receives the additional control word (STW2).

You define the sources of the PZD using parameter p2051.

For further information, please refer to the List Manual.

7.6.2.6 Time-out and other errors

You require the telegram runtimes in order to set the telegram monitoring. The character runtime is the basis of the telegram runtime:

Table 7- 10 Character runtime

Baud rate in bit/s	Transmission time per bit	Character run time (= 11 bits)
9600	104.170 µs	1.146 ms
19200	52.084 µs	0.573 ms
38400	26.042 µs	0.286 ms
115200	5.340 µs	0.059 ms

The telegram runtime is longer than just purely adding all of the character runtimes (=residual runtime). You must also take into consideration the character delay time between the individual characters of the telegram.

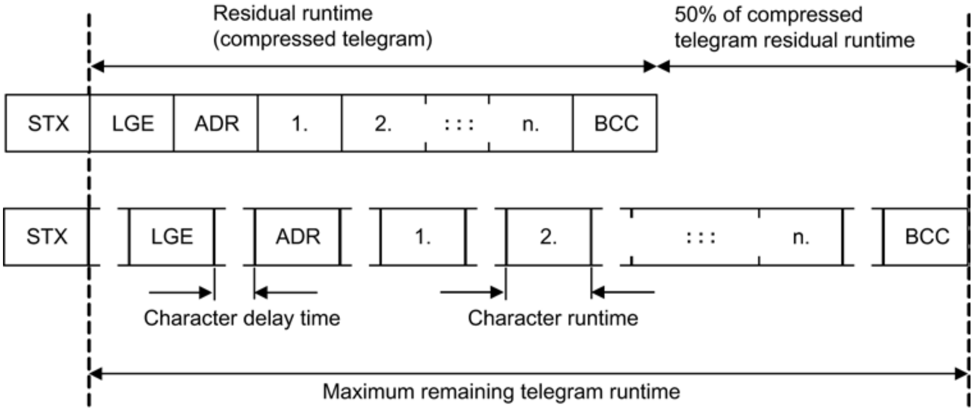


Figure 7-15 Telegram runtime as the sum of the residual runtime and character delay times

The total telegram runtime is always less than 150% of the pure residual runtime.

Before each request telegram, the master must maintain the start delay. The start delay must be > 2 × character runtime.

The slave only responds after the response delay has expired.

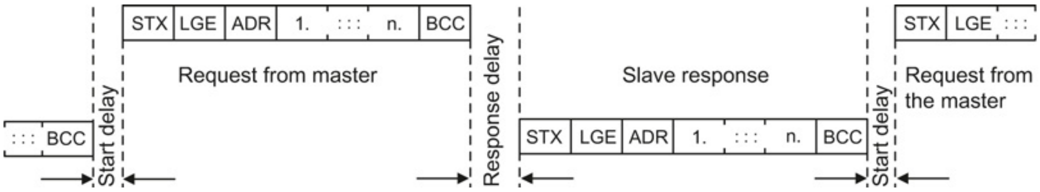


Figure 7-16 Start delay and response delay

The duration of the start delay must at least be as long as the time for two characters and depends on the baud rate.

Table 7- 11 Duration of the start delay

Baud rate in bit/s	Transmission time per character (= 11 bits)	Min. start delay
9600	1.146 ms	> 2.291 ms
19200	0.573 ms	> 1.146 ms
38400	0.286 ms	> 0.573 ms
57600	0.191 ms	> 0.382 ms
115200	0.059 ms	> 0.117 ms

Note: The character delay time must be shorter than the start delay.

Telegram monitoring of the master

With your USS master, we recommend that the following times are monitored:

- Response delay: Response time of the slave to a request from the master

  The response delay must be < 20 ms, but longer than the start delay
- Telegram runtime: Transmission time of the response telegram sent from the slave

Telegram monitoring of the converter

The converter monitors the time between two requests of the master. Parameter p2040 defines the permissible time in ms. If a time p2040 ≠ 0 is exceeded, then the converter interprets this as telegram failure and responds with fault F01910.

150% of the residual runtime is the guide value for the setting of p2040, i.e. the telegram runtime without taking into account the character delay times.

For communication via USS, the converter checks bit 10 of the received control word 1. If the bit is not set when the motor is switched on ("Operation"), the converter responds with fault F07220.

7.6.3 Communication over Modbus RTU

Overview of communication using Modbus

The Modbus protocol is a communication protocol with linear topology based on a master/slave architecture.

Modbus offers three transmission modes:

- **Modbus ASCII**
  Data in ASCII code. The data throughput is lower compared to RTU.
- **Modbus RTU (RTU: Remote Terminal Unit)**
  Data in binary format. The data throughput is greater than in ASCII code.
- **Modbus TCP**
  Data as TCP/IP packets. TCP port 502 is reserved for Modbus TCP. Modbus TCP is currently undergoing definition as a standard (IEC PAS 62030 (pre-standard)).

The Control Unit supports Modbus RTU as a slave with even parity.

1 Bit Start	8 bits of data	1 Bit P-even	1 Bit stop

Communication settings

- Communication using Modbus RTU takes place over the RS485 interface with a maximum of 247 slaves.
- The maximum cable length is 100 m.
- Two 100 kΩ resistors are provided to polarize the receive and send cables.

Note

It is not permitted to change over the units

The "Unit changeover (Page 232)" function is not permissible with this bus system!

7.6.3.1 Basic settings for communication

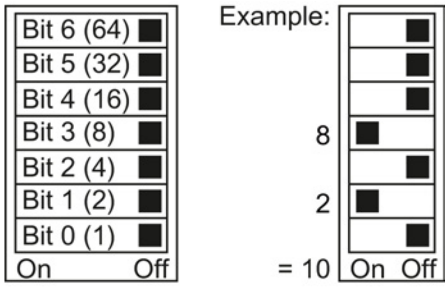
You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Using parameter p2021 (factory setting: 1) or using STARTER, you can only set the address, if all address switches are set to "OFF" (0).

Valid address range: 1 … 247

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 1) will not be able to be changed.

The positions of the address switches are described in Section: Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - using the address switches
   - with an operator panel using p2021
   - in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p2021
2. Switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

This means that you have changed the bus address.

Additional settings

Parameter	Description
p0015 = 21	**Macro drive unit** Selecting the I/O configuration
p2030 = 2	**Fieldbus protocol selection** 2: Modbus
p2020	**Fieldbus baud rate** Factory setting = 19200 bit/s
p2024	**Modbus timing** (see Section "Baud rates and mapping tables (Page 146)") • **Index 0: Maximum slave telegram processing time:** The time after which the slave must have sent a response to the master. • **Index 1: Character delay time:** Character delay time: Maximum permissible delay time between the individual characters in the Modbus frame (Modbus standard processing time for 1.5 bytes). • **Index2: Inter-telegram delay:** Maximum permissible delay time between Modbus telegrams (Modbus standard processing time for 3.5 bytes).
p2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface
p2040	**Process data monitoring time** Determines the time after which an alarm is generated if no process data is transferred **Note:** You must adapt the time depending on the number of slaves and the baud rate is set on the bus (factory setting = 100 ms).

7.6.3.2 Modbus RTU telegram

Description

For Modbus, there is precisely one master and up to 247 slaves. The master always starts the communication. The slaves can only transfer data at the request of the master. Slave-to-slave communication is not possible. The Control Unit always operates as slave.

The following figure shows the structure of a Modbus RTU telegram.

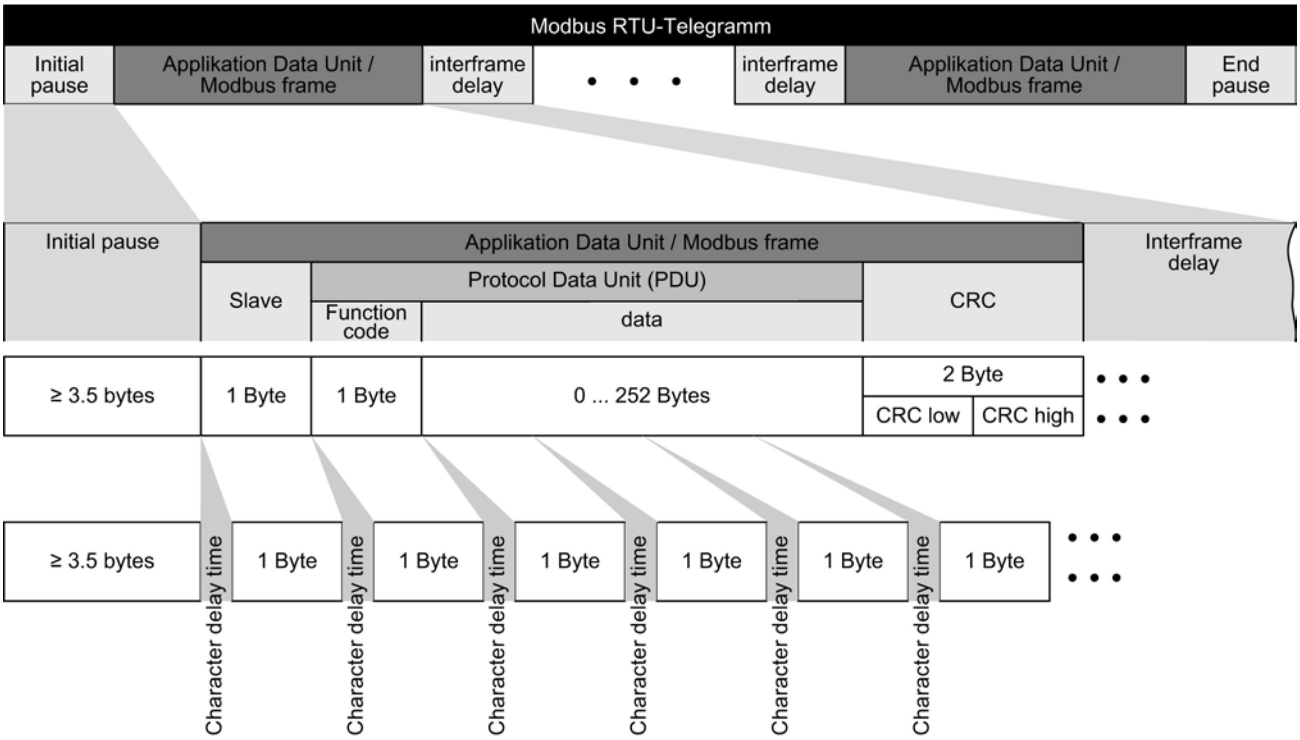


Figure 7-17 Modbus with delay times

The data area of the telegram is structured according to the mapping tables.

7.6.3.3 Baud rates and mapping tables

Permissible baud rates and telegram delay

The Modbus RTU telegram requires pauses for the following cases:

- Start detection
- Between the individual frames
- End detection

Minimum duration: Processing time for 3.5 bytes (can be set via p2024[2]).

A character delay time is also permitted between the individual bytes of a frame. Maximum duration: Processing time for 1.5 bytes (can be set via p2024[1]).

Table 7- 12 Baud rates, transmission times, and delays

Baud rate in bit/s (p2020)	Transmission time per character (11 bits)	Minimum pause between two telegrams (p2024[2])	Maximum pause between two bytes (p2024[1])
4800	2.292 ms	≥ 8.021 ms	≤ 3.438 ms
9600	1.146 ms	≥ 4.010 ms	≤ 1.719 ms
19200 (factory setting)	0.573 ms	≥ 1.75 ms	≤ 0.859 ms
38400	0.286 ms	≥ 1.75 ms	≤ 0.75 ms
57600	0.191 ms	≥ 1.75 ms	≤ 0.556 ms
76800	0.143 ms	≥ 1.75 ms	≤ 0.417 ms
93750	0.117 ms	≥ 1.75 ms	≤ 0.341 ms
115200	0.095 ms	≥ 1.75 ms	≤ 0.278 ms
187500	0.059 ms	≥ 1.75 ms	≤ 0.171 ms

Note

The factory setting for p2024[1] and p2024[2] is 0. The converter specifies the associated values depending on the protocol selection (p2030) or the baud rate.

Modbus register and Control Unit parameters

The Modbus protocol contains register or bit numbers for addressing memory. You must assign the appropriate control words, status words and parameters to these registers in the slave.

The converter supports the following addressing ranges:

Addressing range	Remark
40001 … 40065	Compatible with Micromaster MM436
40100 … 40522	

The valid holding register addressing range extends from 40001 to 40522. Access to other holding registers generates the fault "Exception Code".

The registers 40100 to 40111 are described as process data.

Note

R"; "W"; "R/W" in the column Modbus access stands for read (with FC03); write (with FC06); read/write.

Table 7- 13 Assigning the Modbus register to the parameters of the Control Unit

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Process data							
Control data							
40100	Control word	R/W	--	1			Process data 1
40101	Main setpoint	R/W	--	1			Process data 2
Status data							
40110	Status word	R	--	1			Process data 1
40111	Main actual value	R	--	1			Process data 2
Parameter data							
Digital outputs							
40200	DO 0	R/W	--	1	HIGH	LOW	p0730, r747.0, p748.0
40201	DO 1	R/W	--	1	HIGH	LOW	p0731, r747.1, p748.1
40202	DO 2	R/W	--	1	HIGH	LOW	p0732, r747.2, p748.2
Analog outputs							
40220	AO 0	R	%	100	-100.0 … 100.0		r0774.0
40221	AO 1	R	%	100	-100.0 … 100.0		r0774.1
Digital inputs							
40240	DI 0	R	--	1	HIGH	LOW	r0722.0
40241	DI 1	R	--	1	HIGH	LOW	r0722.1
40242	DI 2	R	--	1	HIGH	LOW	r0722.2
40243	DI 3	R	--	1	HIGH	LOW	r0722.3
40244	DI 4	R	--	1	HIGH	LOW	r0722.4
40245	DI 5	R	--	1	HIGH	LOW	r0722.5
Analog inputs							
40260	AI 0	R	%	100	-300.0 … 300.0		r0755 [0]
40261	AI 1	R	%	100	-300.0 … 300.0		r0755 [1]
40262	AI 2	R	%	100	-300.0 … 300.0		r0755 [2]
40263	AI 3	R	%	100	-300.0 … 300.0		r0755 [3]
Converter identification							
40300	Powerstack number	R	--	1	0 … 32767		r0200
40301	Converter firmware	R	--	0.0001	0.00 … 327.67		r0018
Converter data							
40320	Rated power of the power unit	R	kW	100	0 … 327.67		r0206
40321	Current limit	R/W	%	10	10.0 … 400.0		p0640
40322	Ramp-up time	R/W	s	100	0.00 … 650.0		p1120
40323	Ramp-down time	R/W	s	100	0.00 … 650.0		p1121
40324	Reference speed	R/W	RPM	1	6.000 … 32767		p2000

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Converter diagnostics							
40340	Speed setpoint	R	RPM	1	-16250 … 16250		r0020
40341	Actual speed value	R	RPM	1	-16250 … 16250		r0022
40342	Output frequency	R	Hz	100	- 327.68 … 327.67		r0024
40343	Output voltage	R	V	1	0 … 32767		r0025
40344	DC-link voltage	R	V	1	0 … 32767		r0026
40345	Actual current value	R	A	100	0 … 163.83		r0027
40346	Actual torque value	R	Nm	100	- 325.00 … 325.00		r0031
40347	Actual active power	R	kW	100	0 … 327.67		r0032
40348	Energy consumption	R	kWh	1	0 … 32767		r0039
40349	Control priority	R	--	1	HAND	AUTO	r0807
Fault diagnostics							
40400	Failure number, index 0	R	--	1	0 … 32767		r0947 [0]
40401	Failure number, index 1	R	--	1	0 … 32767		r0947 [1]
40402	Failure number, index 2	R	--	1	0 … 32767		r0947 [2]
40403	Failure number, index 2	R	--	1	0 … 32767		r0947 [3]
40404	Failure number, index 3	R	--	1	0 … 32767		r0947 [4]
40405	Failure number, index 4	R	--	1	0 … 32767		r0947 [5]
40406	Failure number, index 5	R	--	1	0 … 32767		r0947 [6]
40407	Failure number, index 6	R	--	1	0 … 32767		r0947 [7]
40408	Alarm number	R	--	1	0 …32767		r2110 [0]
40499	PRM ERROR code	R	--	1	0 …99		--
Technology controller							
40500	Technology controller enable	R/W	--	1	0 … 1		p2200, r2349.0
40501	Technology controller MOP	R/W	%	100	-200.0 … 200.0		p2240
Technology controller adjustment							
40510	Time constant for actual-value filters of the technology controller	R/W	--	100	0.00 … 60.0		p2265
40511	Scaling factor for actual value of the technology controller	R/W	%	100	0.00 … 500.00		p2269
40512	Proportional amplification of the technology controller	R/W	--	1000	0.000 … 65.000		p2280
40513	Integral time of the technology controller	R/W	s	1	0 … 60		p2285
40514	Time constant D-component of the technology controller	R/W	--	1	0 … 60		p2274
40515	Max. limit of technology controller	R/W	%	100	-200.0 … 200.0		p2291
40516	Min. limit technology controller	R/W	%	100	-200.0 … 200.0		p2292
PID diagnostics							
40520	Effective setpoint acc. to internal technology controller MOP ramp-function generator	R	%	100	-100.0 … 100.0		r2250
40521	Actual value of technology controller after filter	R	%	100	-100.0 … 100.0		r2266
40522	Output signal technology controller	R	%	100	-100.0 … 100.0		r2294

7.6.3.4 Write and read access via FC 03 and FC 06

Function codes used

For data exchange between the master and slave, predefined function codes are used for communication via Modbus.

The Control Unit uses the Modbus function code 03, FC 03 (read holding registers) for reading, and the Modbus function code 06, FC 06 (preset single register) for writing.

Structure of a read request via Modbus function code 03 (FC 03)

Any valid register address is permitted as the start address.

The controller can access more than one register via FC 03 with a request. The number of addressed registers is contained in bytes 4 and 5 of the read request.

Table 7- 14 Invalid read requests

Read request	Converter response
Invalid register address	Exception code 02 (invalid data address)
Read a write-only register	Telegram in which all values are set to 0.
Read a reserved register	
Controller addresses more than 125 registers	Exception code 03 (invalid data value)
The start address and the number of registers of an address are located outside of a defined register block	Exception code 02 (invalid data address)

Table 7- 15 Structure of a read request for slave number 17

Example		
	Byte	Description
11 h	0	Slave address
03 h	1	Function code
00 h	2	Register start address "High" (register 40110)
6D h	3	Register start address "Low"
00 h	4	Number of registers "High" (2 registers: 40110; 40111)
02 h	5	Number of registers "Low"
xx h	6	CRC "Low"
xx h	7	CRC "High"

The response returns the corresponding data set:

Table 7- 16 Slave response to the read request

Example		
	Byte	Description
11 h	0	Slave address
03 h	1	Function code
04 h	2	Number of bytes (4 bytes are returned)
11 h	3	Data of first register "High"
22 h	4	Data of first register "Low"
33 h	5	Data of second register "High"
44 h	6	Data of second register "Low"
xx h	7	CRC "Low"
xx h	8	CRC "High"

Structure of a write request via Modbus function code 06 (FC 06)

Start address is the holding register address.

Using FC 06, precisely one register can always be addressed with one request. The value to be written to the addressed register is contained in bytes 4 and 5 of the write request.

Table 7- 17 Write request and response of the converter

Write request	Converter response
Incorrect address (a holding register address does not exist)	Exception code 02
Write to a "read-only" register	Modbus error telegram (exception code 04 - device failure)
Write to a reserved register	

If an incorrect address is entered (a holding register address does not exist), exception code 02 (invalid data address) is returned. An attempt to write to a "read-only" register or a reserved register is replied to with a Modbus error telegram (exception code 4 - device failure). In this instance, the detailed internal error code that occurred on the last parameter access via the holding registers can be read out via holding register 40499.

Table 7- 18 Structure of a write request for slave number 17

Example		
	Byte	Description
11 h	0	Slave address
06 h	1	Function code
00 h	2	Register start address "High" (write register 40100)
63 h	3	Register start address "Low"
55 h	4	Register data "High"
66 h	5	Register data "Low"
xx h	6	CRC "Low"
xx h	7	CRC "High"

The response returns the register address (bytes 2 and 3) and the value (bytes 4 and 5) that was written by the higher-level controller to the register.

Table 7- 19 Slave response to the write request

Example		
	Byte	Description
11 h	0	Slave address
06 h	1	Function code
00 h	2	Register start address "High"
63 h	3	Register start address "Low"
55 h	4	Register data "High"
66 h	5	Register data "Low"
xx h	6	CRC "Low"
xx h	7	CRC "High"

7.6.3.5 Communication procedure

Procedure for communication in a normal case

Normally, the master sends a telegram to a slave (address range 1 ... 247). The slave sends a response telegram to the master. This response telegram mirrors the function code; the slave enters its own address in the telegram and so the slave identifies itself with the master.

The slave only processes orders and telegrams which are directly addressed to it.

Communication errors

If the slave detects a communication error on receipt (parity, CRC), it does not send a response to the master (this can lead to "setpoint timeout").

Logical error

If the slave detects a logical error within a request, it responds to the master with an "exception response". In this case, the slave sets the highest bit in the function code to 1 in the response. If, for example, it receives an unsupported function code from the master, the slave responds with an "exception response" with code 01 (illegal function code).

Table 7- 20 Overview of exception codes

Exception code	Modbus name	Remark
01	Illegal function code	An unknown (unsupported) function code was sent to the slave.
02	Illegal Data Address	An invalid address was requested.
03	Illegal data value	An invalid data value was detected.
04	Server failure	Slave has terminated during processing.

Maximum processing time, p2024[0]

The slave-response time is the time in which the Modbus master expects a response to a request. Set the same slave-response time (p2024 [0] in the inverter) in the master and slave.

Process data monitoring time (setpoint timeout), p2040

The alarm "Setpoint timeout" (F1910) is issued by the Modbus if p2040 is set to a value > 0 ms and no process data is requested within this time period.

The alarm "Setpoint timeout" only applies for access to process data (40100, 40101, 40110, 40111). The alarm "Setpoint timeout" is not generated for parameter data (40200 … 40522).

Note

Adjust the time (factory setting = 100 ms) depending on the number of slaves and the baud rate set on the bus.

7.7 Communication via CANopen

General information on CAN

You can find general information on CAN in the CAN Internet pages (http://www.can-cia.org); you can obtain an explanation of CAN terminology in the CANdictionary under CAN downloads (http://www.can-cia.org/index.php?id=6).

Integrating a converter in a CANopen network

To integrate a converter in a CANopen network, we recommend the EDS file on the Internet (http://support.automation.siemens.com/WW/view/en/48351511). This file is the description file of the SINAMICS G120 converter for CANopen networks. In this way, you can use the objects of the DSP 402 device profile.

7.7.1 CANopen Converter functions

CANopen is a CAN-based communication protocol with linear topology that operates on the basis of communication objects (COB).

There are two ways you can setup the communication between the inverter and the controller:

- Via the Predefined connection set (Page 167)
- Via Free PDO mapping (Page 169)

Communication objects (COB)

The inverter operates with communication objects from the following profiles:

- CANopen communication profile CiA 301
- Device profile CiA 402 (Drives And Motion Control)
- Indicator profile DR 303-3

Specifically, these are:

- NMT Network management (NMT service) (Page 155)
  Network management objects for controlling CANopen communication and for monitoring the individual nodes on the basis of a master-slave relationship
- SDO SDO services (Page 158)
  Service data objects for reading and changing parameters
- PDO PDO and PDO services (Page 163)
  Process data objects to transfer process data; TPDO to send, RPDO to receive
- SYNC
  Synchronization objects
- EMCY
  Time stamp and fault messages

COB ID

A communication object contains the data to be transferred and a unique 11-bit COB ID. The COB ID also defines the priority for processing the communication objects. The communication object with the lowest COB ID always has the highest priority.

COB ID for individual communication objects

You will find the specifications for the COB IDs of the individual communication objects below:

• **COB ID$_{NMT}$ = 0**	Cannot be changed
• **COB ID$_{SYNC}$ = free**	Pre-assigned with 80 hex
• **COB ID$_{EMCY}$ = free**	80 hex + node ID = COB ID $_{EMCY}$
• **COB ID$_{TPDO}$ = free**	In the free PDO mapping *)
• **COB ID$_{RPDO}$ = free**	In the free PDO mapping *)
• **COB ID$_{TSDO}$ =** 580 + node ID	
• **COB ID$_{RSDO}$ =** 600 + node ID	
• **COB ID$_{Node\ Guarding/Heartbeat}$** = 700 + node ID	

*) In the "Predefined Connection Set", see SectionPredefined connection set (Page 167) .

7.7.1.1 Network management (NMT service)

Network management (NMT) is node-oriented and has a master-slave topology.

The NMT services can be used to initialize, start, monitor, reset, or stop nodes. Two data bytes follow each NMT service. All NMT services have the fixed COB ID = 0.

The SINAMICS converter is an NMT slave and can adopt the following states in CANopen:

- Initializing
  The converter initializes itself after power on. In the factory setting, the converter then enters the "Pre-Operational" state, which also corresponds to the CANopen standard. Using p8684, you can set that after the bus has booted, the converter does not go into the "Pre-Operational" state, but instead, into the "Stopped" or "Operational" state.
- Pre-Operational
  In this state, the node cannot process any process data (PDO). However, the controller can use SDO parameters to change or operate the converter, which means that you can also enter setpoints via SDO.

- Operational
  In this state, the node can process both SDO and PDO.
- Stopped
  In this state, the node cannot process either PDO or SDO. The "Stopped" state terminates one of the following commands:
  – Enter Pre-Operational
  – Start Remote Node
  – Reset Node
  – Reset Communication

The NMT recognizes the following transitional states:

- Start Remote Node:
  Command for switching from the "Pre-Operational" communication state to "Operational". The drive can only transmit and receive process data (PDO) in "Operational" state.
- Stop Remote Node:
  Command for switching from "Pre-Operational" or "Operational" to "Stopped". The node only processes NMT commands in the "Stopped" state.
- Enter Pre-Operational:
  Command for switching from "Operational" or "Stopped" to "Pre-Operational". In this state, the node cannot process any process data (PDO). However, the controller can use SDO parameters to change or operate the converter, which means that you can also enter setpoints via SDO.
- Reset Node:
  Command for switching from "Operational", "Pre-Operational" or "Stopped" to "Initialization". When the Reset Node command is issued, the converter resets all the objects (1000 hex - 9FFF hex) to the state that was present after "Power On".
- Reset Communication:
  Command for switching from "Operational", "Pre-Operational" or "Stopped" to "Initialization". When the Reset Communication command is issued, the converter resets all the communication objects (1000 hex - 1FFF hex) to the state that was present after "Power On".

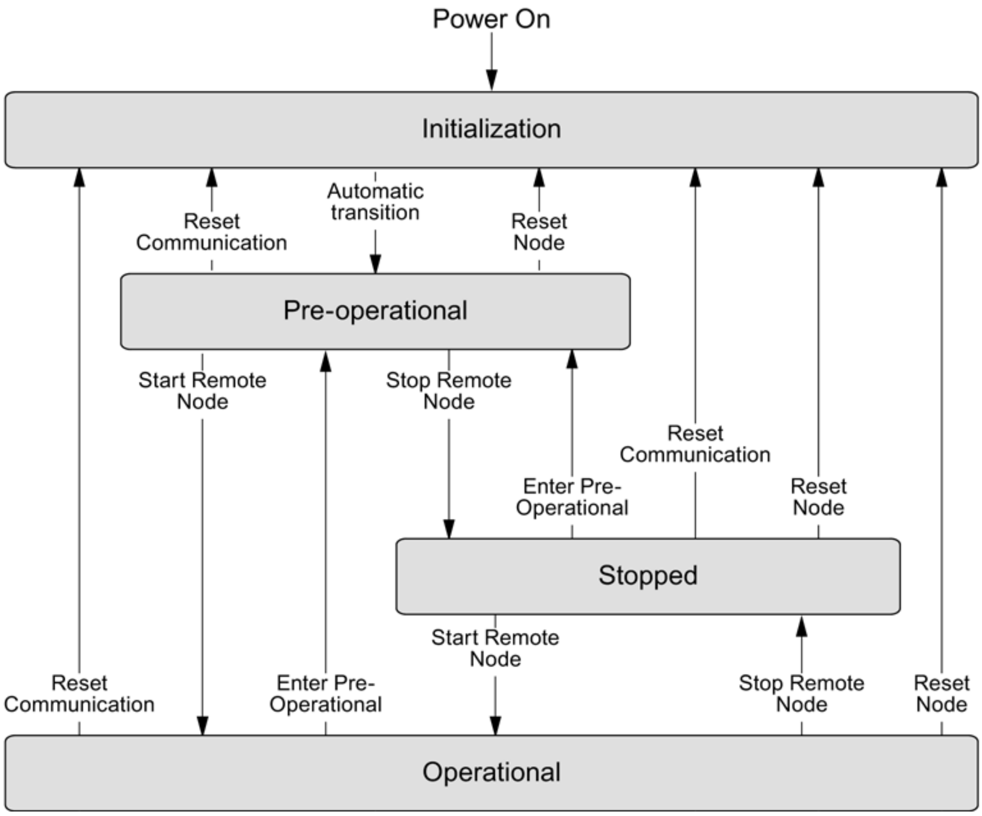


Figure 7-18 CANopen state diagram

Command specifier and Node_ID indicate the transition states and addressed nodes:

Overview of NMT commands

NMT master - request → NMT slave - message		
Command	**Byte 0 (command specifier, CS)**	**Byte 1**
Start	1 (01hex)	Node ID of the addressed node
Stop	2 (02hex)	Node ID of the addressed node
Enter Pre-Operational	128 (80hex)	Node ID of the addressed node
Reset Node	129 (81hex)	Node ID of the addressed node
Reset Communication	130 (82 hex)	Node ID of the addressed node

The NMT master can simultaneously direct a request to one or more slaves. The following is applicable:

- Requirement of a slave:
  The controller accesses the slave with its node ID (1 - 127).
- Requirement for all slaves:
  Node ID = 0

The current state of the node is displayed via p8685. It can also be changed directly using this parameter:

- p8685 = 0 Initializing (display only)
- p8685 = 4 Stopped
- p8685 = 5 Operational
- p8685 = 127 Pre-Operational (factory setting)
- p8685 = 128 Reset Node
- p8685 = 129 Reset Communication

You can also change the NMT state in STARTER via "Control_Unit / Communication / CAN" under the "Network-Management" tab.

7.7.1.2 SDO services

You can access the object directory of the connected drive unit using the SDO services. An SDO connection is a peer-to-peer coupling between an SDO client and a server.

The drive unit with its object directory is an SDO server.

The identifiers for the SDO channel of a drive unit are defined according to CANopen as follows.

Receiving:	Server ⇐ client:	COB ID = 600 hex + node ID
Transmitting:	Server ⇒ client:	COB ID = 580 hex + node ID

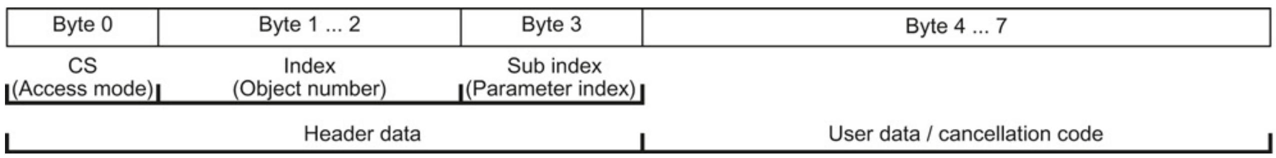
Properties

The SDOs have the following properties:

- An SDO connection exists only in the Pre-Operational and Operational states
- Transmission is confirmed
- Asynchronous transmission (matches the acyclical communication via PROFIBUS DB)
- Transmission of values > 4 bytes (normal transfer)
- Transmission of values ≤ 4 bytes (expedited transfer)
- All drive unit parameters can be addressed via SDO

Structure of the SDO protocols

The basic structure of the SDO protocols is shown below:



Byte 0 (CS = command specifier) contains the access type of the protocol:

- 2F hex: Write 4 bytes
- 2B hex: Write 3 bytes
- 27 hex: Write 2 bytes
- 23 hex: Write 1 byte
- 40 hex: Read request
- 4F hex: Read 4 bytes
- 4B hex: Read 3 bytes
- 47 hex: Read 2 bytes
- 43 hex: Read 1 byte
- 60 hex: Write confirmation
- 80 hex: Error

7.7.1.3 Access to SINAMICS parameters via SDO

If you wish to change converter parameters in CANopen using the controller, use the SDO service.

You also configure RPDO and TPDO telegrams via SDO. You can find the objects that are available to do this in Section List of objects (Page 173).

Object numbers for SDO jobs

In CAN, access the converter parameters with the SDO service via manufacturer-specific objects in the range from 2000 hex to 470F hex of the CANopen object directory.

Because you cannot directly address all of the parameters using this area, you require for an SDO job always the parameter number itself and the offset dependent on the parameter number.

Selection of parameter range and the associated offset

Parameter range	Offset	Offset value
0 < parameter number < 10000	p8630[2] = 0	0
10000 ≤ parameter number < 20000	p8630[2] = 1	10000
20000 ≤ parameter number < 20000	p8630[2] = 2	20000
30000 ≤ parameter number < 20000	p8630[2] = 3	30000

Calculate object number for an SDO job

The object number for the SDO job is calculated as follows:
object number hex = (number of the converter parameter - offset value) hex + 2000 hex

Examples of object numbers

Parameter number	Number of the converter parameter - offset value		Object number
	Decimal	Hexadecimal	
• p0010:	10 dec	A hex	⇒ 200A hex
• p11000:	1000 dec	3E8 hex	⇒ 23E8 hex
• r20001:	1 dec	1 hex	⇒ 2001 hex
• p31020:	1020 dec	3FC hex	⇒ 23FC hex

Selection, index range

A CANopen object can contain a maximum of 255 indexes. For parameters with more than 255 indexes, you must create additional CANopen objects via p8630[1]. Overall, 1024 indexes are possible.

- P8630[1] = 0: 0 … 255
- P8630[1] = 1: 256 … 511
- P8630[1] = 2: 512 … 767
- P8630[1] = 3: 768 … 1023

Switch-on access to objects of the converter parameters

Access to objects of the converter parameters is activated via p8630[0], where:

- p8630[0] = 0: only access to CANopen objects (SDO, PDO, ...)
- p8630[0] = 1: access to virtual CANopen objects (converter parameters)
- p8630[0] = 2: not relevant for G120 converters

A selection of important manufacturer-specific objects is included in the EDS file.

7.7.1.4 Access PZD objects via SDO

Access to mapped PZD objects

When you access objects mapped via transmit or receive telegrams, you can access the process data without additional settings.

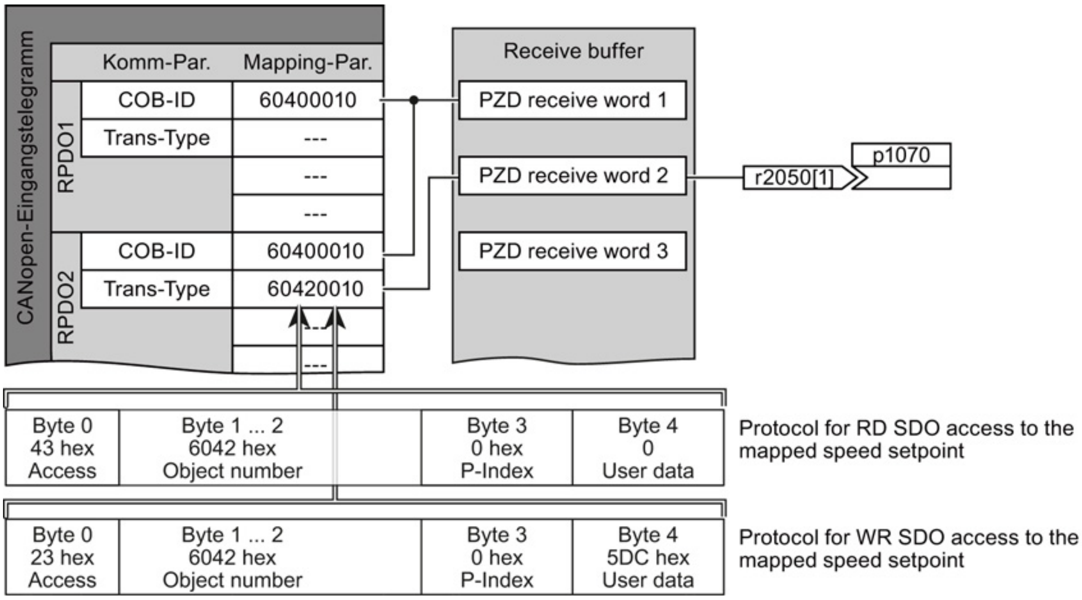


Figure 7-19 Access to the process data

Access to non-mapped PZD objects

When you access objects that are not interconnected via the receive or transmit telegram, you must also establish the interconnection with the corresponding CANopen parameters.

There follows an example for switching the control word with the CANopen parameters:

ON/OFF1	p840[0] = r8795.0
No coast down activated	p0844[0] = r8795.1
No fast stop activated	p0848[0] = r8795.2
Enable operation	p0852[0] = r8795.3
Enable ramp-function generator	p1140[0] = r8795.4
Continue ramp-function generator	p1141[0] = r8795.5
Enable speed setpoint	p1142[0] = r8795.6
Acknowledge fault	p2103[0] = r8795.7
Stop	p8791 = r8795.8

SDO abort codes

Abort code	Description
0503 0000 hex	Toggle bit not alternated Toggle bit has not changed
0504 0000 hex	SDO protocol timed out Timeout for the SDO protocol
0504 0001 hex	Client/server command specifier not valid or unknown Client/server command not valid or unknown
0504 0002 hex	Invalid block size (block mode only) Invalid block size
0504 0003 hex	Invalid sequence number (block mode only) Invalid sequence number
0504 0004 hex	CRC error (block mode only) CRC error
0504 0005 hex	Out of memory. Memory overflow
0601 0000 hex	Unsupported access to an object. Access to an object that is not supported
0601 0001 hex	Attempt to read a write only object. Attempt to read a "write-only object"
0601 0002 hex	Attempt to write a read only object. Attempt to write a "read-only object"
0602 0000 hex	Object does not exist in the object dictionary. Object does not exist in the object dictionary
0604 0041 hex	Object cannot be mapped to the PDO. Object cannot be linked with the PDO
0604 0042 hex	The number and length of the objects to be mapped would exceed PDO length. The number and length of the linked objects exceeds the PDO length
0604 0043 hex	General parameter incompatibility reason. Basic parameter incompatibility
0604 0047 hex	General internal incompatibility in the device. Basic incompatibility in the device
0606 0000 hex	Access failed due to an hardware error. Access failed due to a hardware fault
0607 0010 hex	Data type does not match, length of service parameter does not match. Data type and length of the service parameter do not match
0607 0012 hex	Data type does not match, length of service parameter too high. Data type is not correct, service parameter is too long
0607 0013 hex	Data type does not match, length of service parameter too low. Data type is not correct, service parameter is too short
0609 0011 hex	Subindex does not exist. Subindex does not exist
0609 0030 hex	Value range of parameter exceeded (only for write access). Value range of the parameter exceeded (only for write access)
0609 0031 hex	Value of parameter written too high. Subindex does not exist

Abort code	Description
0609 0032 hex	Value of parameter written too low. Value of written parameter too small
0609 0036 hex	Maximum value is less than minimum value. Maximum value is less than the minimum value
060A 0023 hex	Resource not available: SDO connection. Source does not exist: SDO connection
0800 0000 hex	General error. General error
0800 0020 hex	Data cannot be transferred or stored to the application. Data cannot be transferred or saved in the application
0800 0021 hex	Data cannot be transferred or stored to the application because of local control. Data cannot be transferred or saved because of the local controller
0800 0022 hex	Data cannot be transferred or stored to the application because of the current device state. Data cannot be transferred or saved because of the device condition
0800 0023 hex	Object dictionary dynamic generation failed or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error). Dynamic creation of the object dictionary failed or no object dictionary exists (e.g. object directory was generated from a defective file)

7.7.1.5 PDO and PDO services

Process data objects (PDO)

CANopen transfers the process data using "Process Data Objects" (PDO). There are send PDOs (TDPO) and receive PDOs (RPDO). CAN controller and inverter each exchange eight TPDOs and RPDOs.

PDO communication parameters and PDO mapping parameters define a PDO.

Link the PDO with the elements of the object directory that contain the process data. You can use Free PDO mapping (Page 169) or the Predefined connection set (Page 167) to do this.

Parameter area for PDO	**RPDO**		**TPDO**	
	In the inverter	In CANopen	In the inverter	In CANopen
Communication parameters	p8700 … p8707	1400 hex … 1407 hex	p8720 … p8727	1800 hex … 1807 hex
Mapping parameters	p8710 … p8717	1600 hex … 1607 hex	p8730 … p8737	1A00 hex …1A07 hex

Structure of the PDO

A PDO consists of communication and mapping parameters. Examples for the structure of the TPDO and RPDO follow.

The values for communication parameters can be found in the tables in Section List of objects (Page 173)

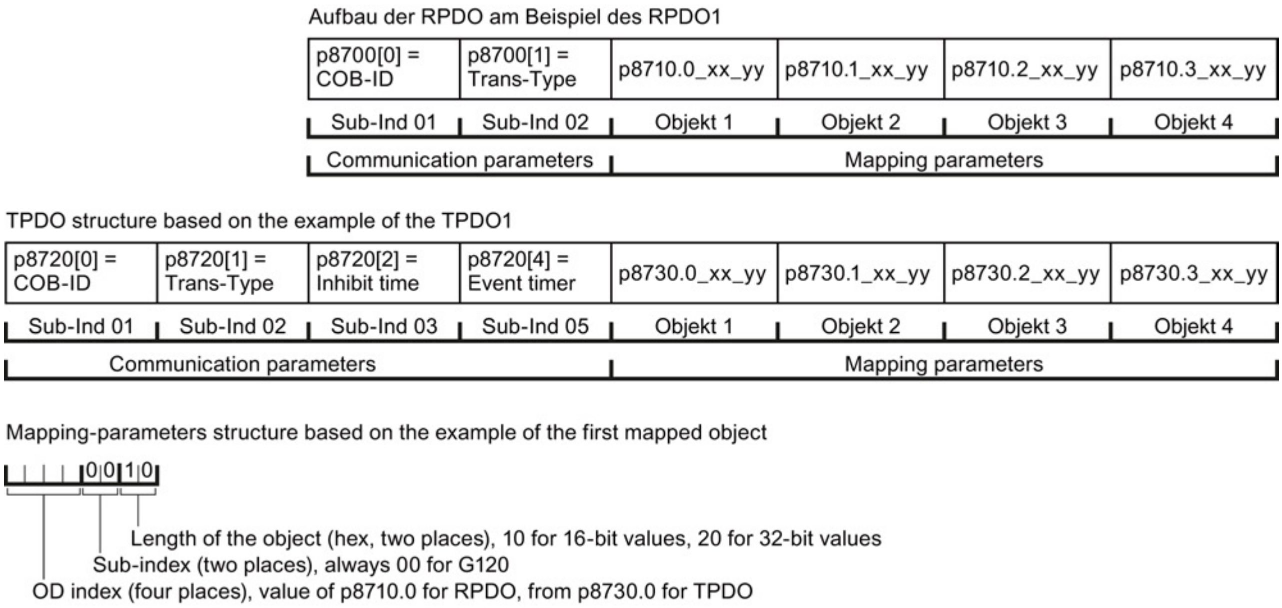


Figure 7-20 Structure of the RPDO and TPDO communication objects

COB ID

An overview of the COB IDs can be found in Section CANopen Converter functions (Page 154). Section Predefined connection set (Page 167) explains how the COB IDs are calculated.

Transmission type

For process data objects, the following transmission types are available, which you set in index 1 of the communication parameter (p8700[1] … p8707[1] / p8720[1] … p8727[1]) in the inverter:

- Cyclic synchronous (value range: 1 … 240)
  - TPDO after each n-th SYNC
  - RPDO after each n-th SYNC
- Acyclic synchronous (value: 0)
  - TPDO when a SYNC is received and a process data has changed in the telegram.

- Cyclic asynchronous (values: 254, 255 + event time)
  – TPDO when a process data has changed in the telegram.
- Acyclic asynchronous (values: 254, 255)
  – TPDO when a process data has changed in the telegram.
  – The controller accepts the RPDO immediately.

Inhibit time

The inhibit time defines the minimum interval between two transmissions.

Synchronous data transmission

A periodic synchronization object (SYNC object) ensures that the devices on the CANopen bus remain synchronized during transmission.

Each PDO transferred as synchronization object must include a "transmission type" 1 ... n:

- Transmission type 1: PDO in each SYNC cycle
- Transmission type n: PDO in every n-th SYNC cycle

The following diagram shows the principle of synchronous and asynchronous transmission:

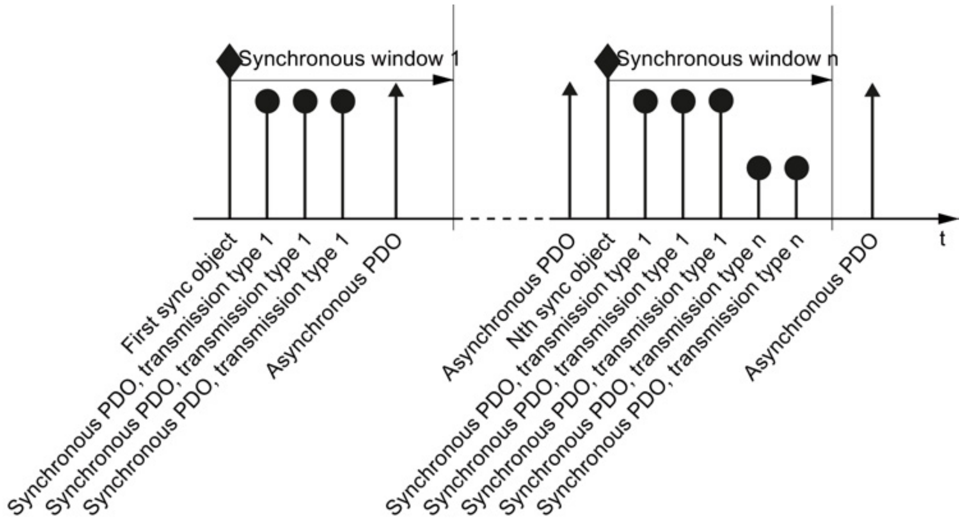


Figure 7-21 Principle of synchronous and asynchronous transmission

For synchronous TPDOs, the transmission mode also identifies the transmission rate as a factor of the SYNC object transmission intervals.

The CAN controller transfers data from synchronous RPDOs that it received after a SYNC signal only after the next SYNC signal to the inverter.

Note

The SYNC signal synchronizes only the communication on the CANopen bus and not functions in the inverter, e.g. the clock times of the speed control.

PDO services

The PDO services can be subdivided as follows:

- Write PDO
- Read PDO
- SYNC service

Write PDO

The "Write PDO" service is based on the "push" model. The PDO has exactly one producer. There can be no consumer, one consumer, or multiple consumers.

Via Write PDO, the producer of the PDO sends the data of the mapped application object to the individual consumer.

Read PDO

The "Read PDO" service is based on the "pull" model. The PDO has exactly one producer. There can be one consumer or multiple consumers.

Via Read PDO, the consumer of the PDO receives the data of the mapped application object from the producer.

SYNC service

The SYNC object is sent periodically from the SYNC producer. The SYNC signal represents the basic network cycle. The standard "Communication cycle time" parameter sets the time interval between two SYNC signals in the master.

In order to ensure CANopen accesses in real-time, the SYNC object has a high priority, which is defined using the COB ID. It can be changed via p8602 (factory setting = 80 hex). The service runs unconfirmed.

Note

Set the COB ID of the SYNC object to the same value for all nodes of a bus that should respond to the SYNC telegram from the master.

The COB ID of the SYNC object is defined in object 1005h (p8602).

7.7.1.6 Predefined connection set

If you integrate the converter using the factory setting in CANopen, the converter receives the control word and the speed setpoint from the controller. The converter returns the status word and the actual speed value to the controller. These are the settings stipulated in the Predefined Connection Set.

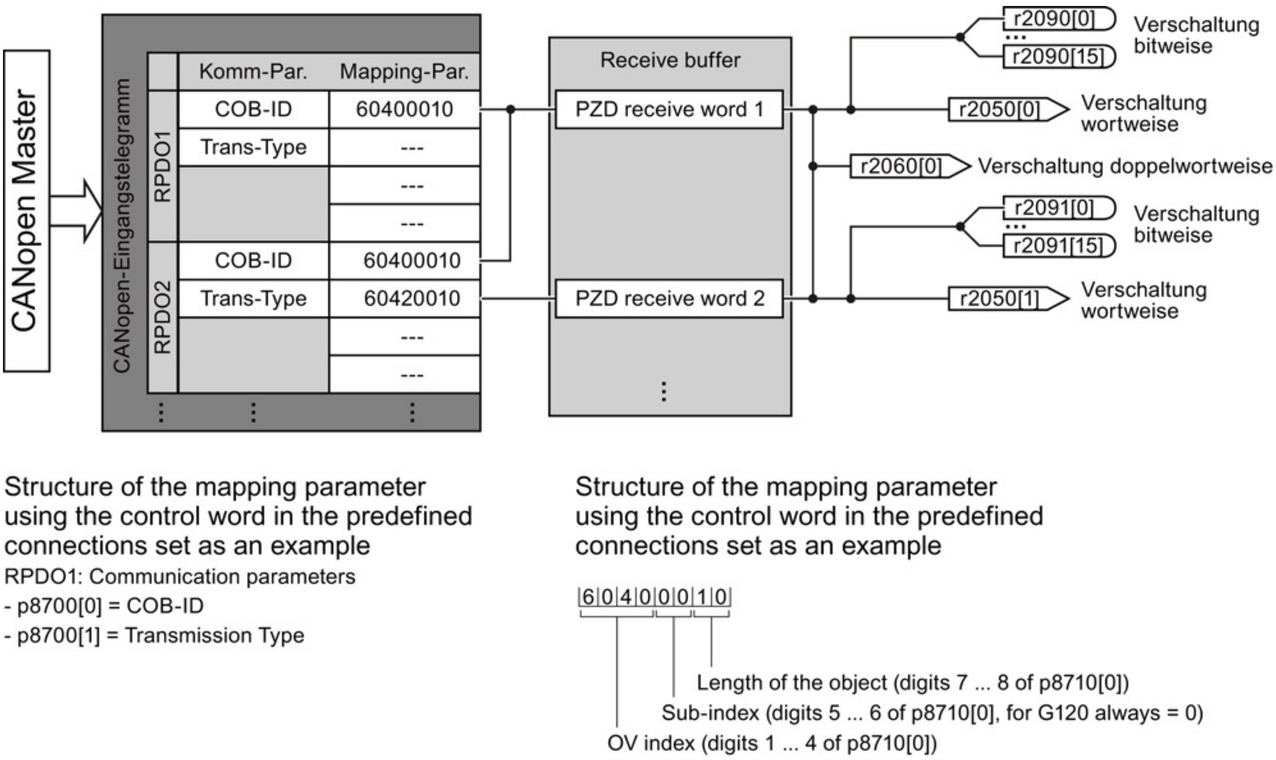


Figure 7-22 RPDO mapping with the Predefined Connection Set

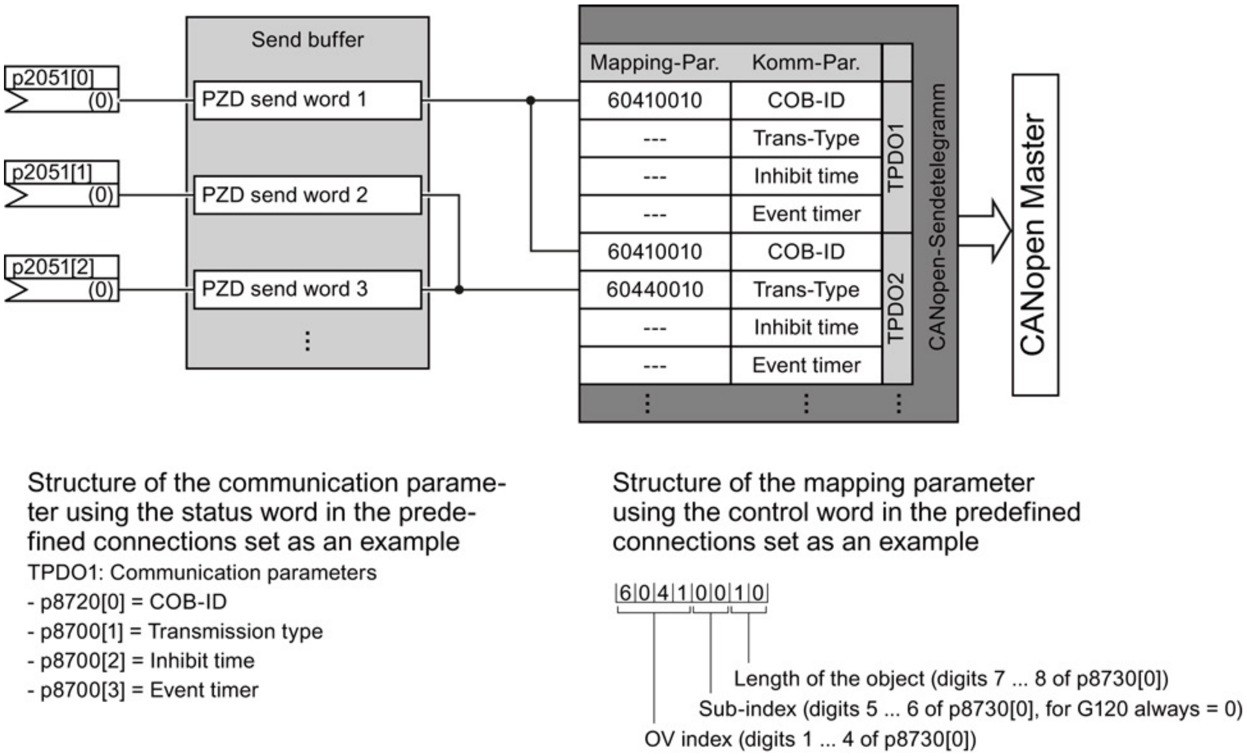


Figure 7-23 TPDO mapping with the Predefined Connection Set

Calculate the COB IDs using the following formula and enter the results in the p8700, p8701, p8720 and p8721 parameters.

COB ID for TPDO and RPDO in the Predefined Connection Set

- **COB ID**$_{TPDO}$ = 180 hex + node ID + ((TPDO no. - 1) * 100 hex)

  Example: For p8721[0] = COB-ID from TPDO 2, the following value results with the Node ID = C hex:

  180 hex + C hex + ((2 - 1)*100 hex) = 18C hex + 100 hex = 28C hex

- **COB ID**$_{RPDO}$ = 200 hex + node ID + ((RPDO no. - 1) * 100 hex)

  Example: For p8700[0] = COB-ID from RPDO 1, the following value results with the Node ID = C hex:

  200 hex + C hex + ((1 - 1) * 100 hex) = 20C hex + 0 hex = 20C hex

7.7.1.7 Free PDO mapping

Using the free PDO mapping, you configure and interconnect any process data as required as follows:

- as free objects, or
- as objects of drive profile CiA 402, corresponding to the requirements of your system for the PDO service

This requires that the inverter is set to a free PDO mapping (p8744 = 2) (factory setting).

Interconnecting process data via a free PDO mapping

Procedure

To interconnect process data, proceed as follows:

1. Define process data, examples:
   - Send actual current value (r0068) from the inverter to the controller (TPDO - Transmit Process Data Object)
   - Send additional speed setpoint from the controller to the inverter (RPDO - Receive Process Data Object) and write in p1075
2. Specify objects for transmission of the process data
   - TPDO1 for the actual current value
   - RPDO1 for additional speed setpoint
3. Set communication parameters for RPDO and TPDO
   - Define the communication parameters for RPDO, see RPDO communication parameters (Page 176)
   - Define the communication parameters for TPDO, see TPDO communication parameters (Page 179)
4. Select the OD index for the mapping parameters:
   - Mapping parameters for RPDO, see RPDO mapping parameters (Page 177)
   - Mapping parameters for TPDO, see TPDO mapping parameters (Page 180)
5. Write OV index into the SINAMICS mapping parameters
   - p8710 … p8717 for RPDO
   - p8730 … p8737 for TPDO
   - You will find the OD index in the free objects (Page 182) or in the objects of the CiA 402 drive profile (Page 173)

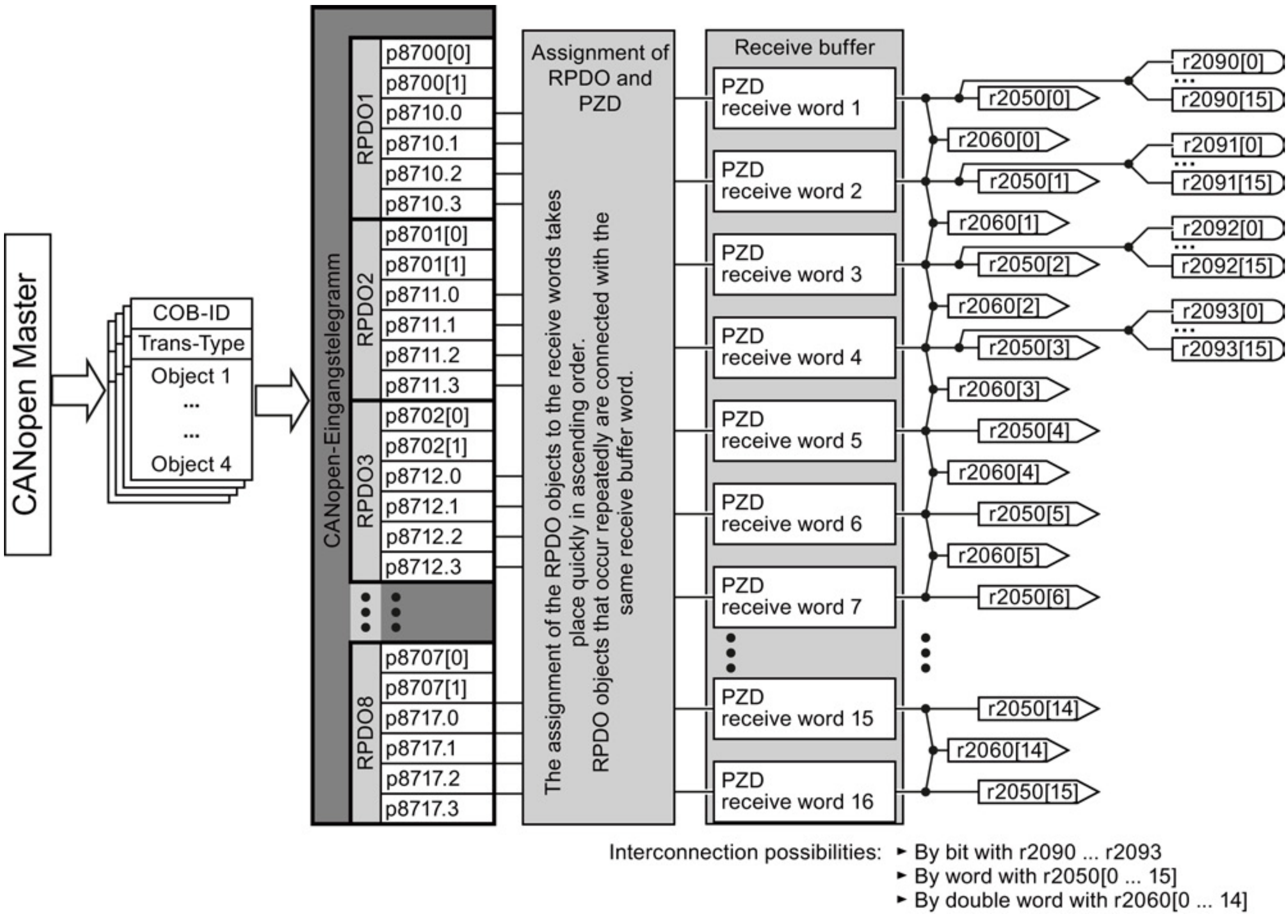
Note

Requirement for changing the OD indexes of the SINAMICS mapping parameters

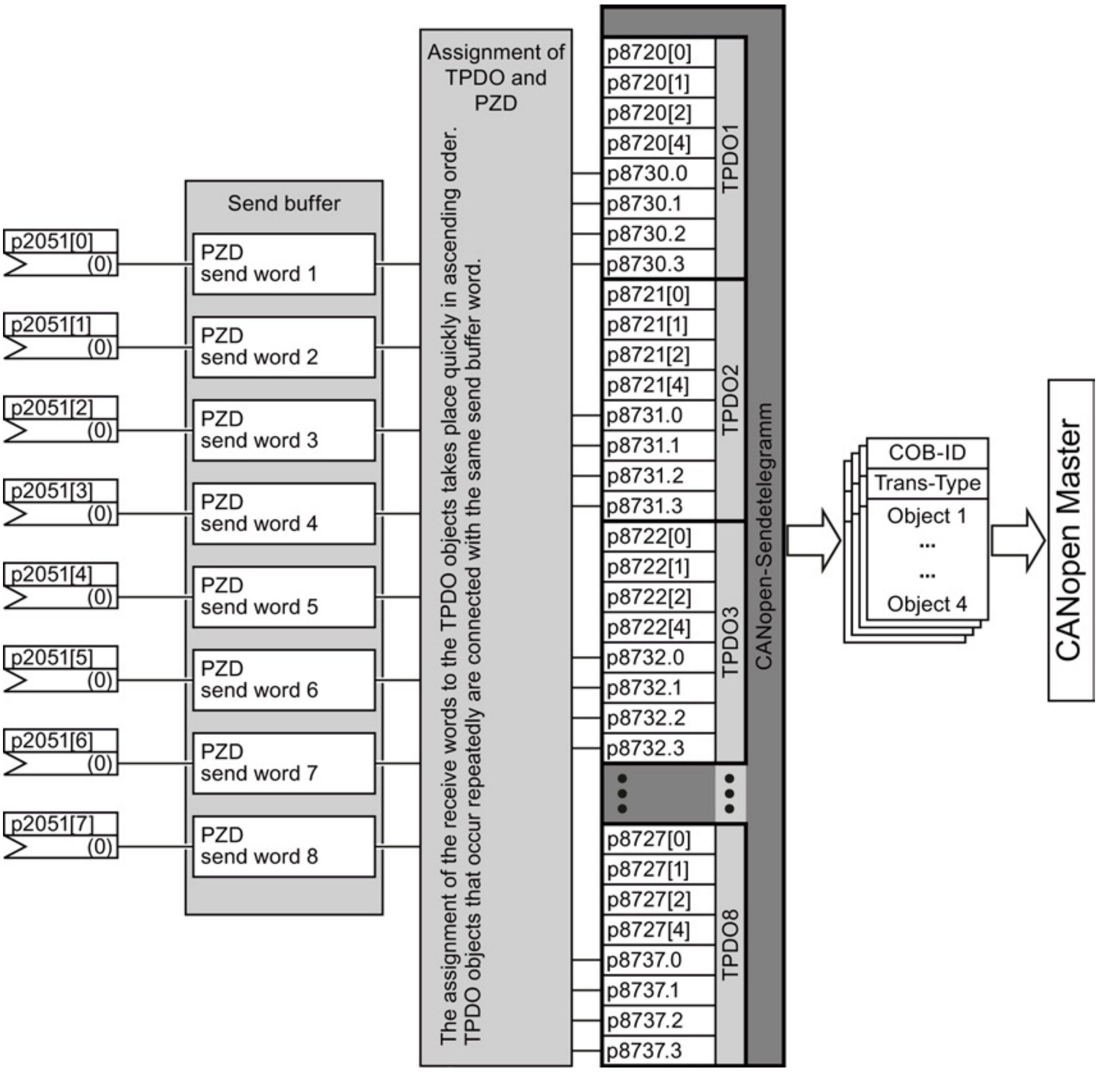
To allow you to change the values of the mapping parameters, you must set the COB ID of the corresponding parameter to invalid. Add the value 80000000 hex to the COB ID. If you have changed the mapping parameter, you must reset the COB ID to the valid value.

You have interconnected the process data.

Free RPDO mapping - Overview



Free TPDO mapping - Overview



7.7.1.8 Interconnect objects from the receive and transmit buffers

Procedure

Proceed as follows to configure the CANopen PDO:

1. Create a telegram:
   create PDO (parameterize the PDO Com. Parameter and PDO mapping parameters), see Predefined connection set (Page 167) and Free PDO mapping (Page 169)
2. Interconnect the parameters:
   Interconnect the parameters of the PZD buffer (p2050/p2060, p2051) corresponding to the mapping of point "Create telegram" using the mapping table r8750/r8760 or r8751/r8761. The mapping table indicates the position of a mapped CANopen object in the PZD buffer.

You have configured the CANopen PDO.

Interconnecting the receive buffer

The inverter writes the received data in the receive buffer:

- PZD receive word 1 … PZD receive word 12 double word in r2060[0] … r2060[10].
- PZD receive word 1 … PZD receive word 12 word in r2050[0] … r2050[11].
- PZD 1 … PZD 4 bit-by-bit in r2090.0 … r2090.15 to r2093.0 … r2093.15

The position of the mapped objects in the receive buffer is displayed in:

- r8760 for double word switching
- r8750 for word switching

Examples

Object	Mapped receive objects	Receive word r2050	
Control word	r8750[0] = 6040 hex (PZD1)	Interconnect r2050[0] (PZD1) with control word 1)	p0840.0 = 2090.0 p0844.0 = 2090.1 p0844.0 = 2090.2 p0852.0 = 2090.3 p2130.0 = 2090.7
Torque limit	r8750[1] = 5800 hex (PZD2)	Link r2050[1] (PZD2) with torque limit:	p1522 = 2050[1]
Speed setpoint	r8750[2] = 6042 hex (PZD3)	Link r2050[2] (PZD3) with speed setpoint:	p1070 = 2050[2]

1) see also p8790, "Automatic CAN control word interconnection"

Interconnecting the send buffer

The inverter sends the data from the send buffer as follows:

- p2051[0] … p2051[13] in PZD 1 … PZD 14 (indication of the actual link in r2053[0 … 13])
- p2061[0] … p2061[12] in PZD 1 … PZD 14 (indication of the actual link in r2063[0 … 12])

Examples

Object	Mapped send objects	Send word p2051	
Status word	r8751[0] = 6041 hex (PZD1)	Interconnect p2051[0] with PZD1	p2051[0] = r8784
Actual current value	r8751[1] = 5810 hex (PZD2)	Link PZD2 with actual current value	p2051[1] = r68[1]
Actual speed value	r8751[2] = 6044 hex (PZD3)	Link PZD3 with actual speed value	p2051[2] = r63[0]

7.7.1.9 CANopen operating modes

The converter has the following CANopen operating modes

- Profile Velocity Mode:
  Closed-loop speed control with encoder with the objects relevant for this purpose.
- Velocity Mode:
  Simple speed control with ramps with the objects relevant for this purpose. It is preferably used for converters with V/f and I/f control.
- Profile Torque Mode:
  Torque control with the objects relevant for this purpose.

You can also use parameters from other CANopen operating modes, independently from the current effective CANopen operating mode.

		Switching of	
	velocity mode	Profile velocity mode	Profile torque mode
Up velocity mode		p1300 < 20 V/f control	p1300 < 20 V/f control
Up Profile velocity mode	p1300 = 20 / 21 Speed control		p1500 = 0 (via BiCo) Speed control
Up Profile torque mode	p1300 = 22 / 23 Speed control	p1500 = 1 (via BiCo) Torque control	

Parameter access via SDO   Parameter change via PDO

Figure 7-24 Switching the CANopen operating modes

7.7.2 List of objects

7.7.2.1 General objects from the CiA 301 communication profile

Overview

The following table lists the drive-independent communication objects. The "SINAMICS parameters" column shows the parameter numbers assigned in the converter.

Table 7- 21 Drive-independent communication objects

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmission	Data type	Default values	Can be read/ written
1000		Device type	r8600	SDO	U32	–	r
1001		Error register	r8601	SDO	U8	–	r
1003	0...52 hex	Predefined error field	p8611[0...82]	SDO	U32	0	r/w
	0	Number of errors	p8611.0	SDO	U32	0	rw
	1	Number of module	p8611.1	SDO	U32	0	r
	2	Number of errors: module 1	p8611.2	SDO	U32	0	r

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmis sion	Data type	Default values	Can be read/ written
	3-A	Standard error field: module 1	p8611.3- p8611.10	SDO	U32	0	r
	B	Number of errors: module 2	p8611.11	SDO	U32	0	r
	C-13	Standard error field: module 2	p8611.12-p8611.19	SDO	U32	0	r
	14	Number of errors: module 3	p8611.20	SDO	U32	0	r
	15-1C	Standard error field: module 3	p8611.21-p8611.28	SDO	U32	0	r
	1D	Number of errors: module 4	p8611.29	SDO	U32	0	r
	1E-25	Standard error field: module 4	p8611.30-p8611.37	SDO	U32	0	r
	26	Number of errors: module 5	p8611.38	SDO	U32	0	r
	27-2E	Standard error field: module 5	p8611.39-p8611.46	SDO	U32	0	r
	2F	Number of errors: module 6	p8611.47	SDO	U32	0	r
	30-37	Standard error field: module 6	p8611.48-p8611.55	SDO	U32	0	r
	38	Number of errors: module 7	p8611.56	SDO	U32	0	r
	39-40	Standard error field: module 7	p8611.57-p8611.64	SDO	U32	0	r
	41	Number of errors: module 8	p8611.65	SDO	U32	0	r
	42-49	Standard error field: module 8	p8611.66-p8611.73	SDO	U32	0	r
	4A	Number of Control Unit faults	p8611.74	SDO	U32	0	r
	4B-52	Field Control Unit standard error	p8611.75-p8611.82	SDO	U32	0	r
1005		SYNCH COB ID	p8602	SDO	U32	128	rw
1008		Manufacturer device name		SDO			
100A		Manufacturer software version	r0018	SDO	U32	–	r
100C		Guard time	p8604.0	SDO	U16	0	rw
100D		Lifetime factor	p8604.1	SDO	U16	0	rw
1010		Store parameters	p0977	SDO	U16	0	rw
	0	Largest subindex supported		SDO			
	1	Save all parameters	p0977	SDO	U16	0	rw

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmis sion	Data type	Default values	Can be read/ written
	2	Save communication parameters (0x1000-0x1fff)	p0977	SDO	U16	0	rw
	3	Save application-related parameters (0x6000-0x9fff)	p0977	SDO	U16	0	rw
1011		Restore default parameters	p0976	SDO	U16	0	rw
	0	Largest subindex supported		SDO			
	1	Restore all default parameters	p0976	SDO	U16	0	rw
	2	Restore communication default parameters (0x1000-0x1fff)	p0976	SDO	U16	0	rw
	3	Restore application default parameters (0x6000-0x9fff)	p0976	SDO	U16	0	rw
1014		COB ID emergency	p8603	SDO	U32	0	rw
1017		Producer heartbeat time	p8606	SDO	U16	0	rw
1018		Identy Object	r8607[0...3]		U32	–	r
	0	Number of entries		SDO			
	1	Vendor ID	r8607.0	SDO	U32	–	r
	2	Product code	r8607.1	SDO	U32	–	r
	3	Revision number	r8607.2	SDO	U32	–	r
	4	Serial number	r8607.3	SDO	U32	0	r
1027		Module list					
	0	Number of entries	r0102	SDO	U16	–	r
	1-8	Module ID	p0107[0...15]	SDO	I16	0	rw
1029		Error behavior					
	0	Number of error classes		SDO			
	1	Communication Error	p8609.0	SDO	U32	1	rw
	2	Device profile or manufacturer-specific error	p8609.1	SDO	U32	1	rw
1200		1st server SDO parameter					
	0	Number of entries		SDO			
	1	COB ID client -> server (rx)	r8610.0	SDO	U32	–	r
	2	COB ID server -> client (tx)	r8610.1	SDO	U32	–	r

RPDO configuration objects

The following tables list the communication and mapping parameters together with the indexes for the individual RPDO configuration objects. The configuration objects are established via SDO. The "SINAMICS parameters" column shows the parameter numbers assigned in the converter.

Table 7- 22 RPDO configuration objects - communication parameters

OD Index (hex)	Subi ndex (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written to
1400		**Receive PDO 1 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8700.0	U32	200 hex + node ID	r/w
	2	Transmission type	p8700.1	U8	FE hex	r/w
1401		**Receive PDO 2 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8701.0	U32	300 hex + node ID	r/w
	2	Transmission type	p8701.1	U8	FE hex	r/w
1402		**Receive PDO 3 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8702.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8702.1	U8	FE hex	r/w
1403		**Receive PDO 4 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8703.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8703.1	U8	FE hex	r/w
1404		**Receive PDO 5 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8704.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8704.1	U8	FE hex	r/w
1405		**Receive PDO 6 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8705.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8705.1	U8	FE hex	r/w
1406		**Receive PDO 7 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8706.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8706.1	U8	FE hex	r/w
1407		**Receive PDO 8 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8707.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8707.1	U8	FE hex	r/w

Table 7- 23 RPDO configuration objects - mapping parameters

OD index (hex)	Subi ndex (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written to
1600		**Receive PDO 1 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	1	r
	1	PDO mapping for the first application object to be mapped	p8710.0	U32	6040 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8710.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8710.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8710.3	U32	0	r/w
1601		**Receive PDO 2 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	2	r
	1	PDO mapping for the first application object to be mapped	p8711.0	U32	6040 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8711.1	U32	6042 hex	r/w
	3	PDO mapping for the third application object to be mapped	p8711.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8711.3	U32	0	r/w
1602		**Receive PDO 3 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8712.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8712.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8712.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8712.3	U32	0	r/w
1603		**Receive PDO 4 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8713.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8713.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8713.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8713.3	U32	0	r/w
1604		**Receive PDO 5 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r

OD index (hex)	Subi ndex (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written to
	1	PDO mapping for the first application object to be mapped	p8714.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8714.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8714.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8714.3	U32	0	r/w
1605		**Receive PDO 6 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8715.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8715.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8715.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8715.3	U32	0	r/w
1606		**Receive PDO 7 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8716.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8716.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8716.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8716.3	U32	0	r/w
1607		**Receive PDO 8 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8717.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8717.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8717.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8717.3	U32	0	r/w

TPDO configuration objects

The following tables list the communication and mapping parameters together with the indexes for the individual TPDO configuration objects. The configuration objects are established via SDO. The "SINAMICS parameters" column shows the parameter numbers assigned in the converter.

Table 7- 24 TPDO configuration objects - communication parameters

OD index (hex)	Subi ndex (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1800		**Transmit PDO 1 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8720.0	U32	180 hex + node ID	r/w
	2	Transmission type	p8720.1	U8	FE hex	r/w
	3	Inhibit time	p8720.2	U16	0	r/w
	4	Reserved	p8720.3	U8	---	r/w
	5	Event timer	p8720.4	U16	0	r/w
1801		**Transmit PDO 2 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8721.0	U32	280 hex + node ID	r/w
	2	Transmission type	p8721.1	U8	FE hex	r/w
	3	Inhibit time	p8721.2	U16	0	r/w
	4	Reserved	p8721.3	U8	---	r/w
	5	Event timer	p8721.4	U16	0	r/w
1802		**Transmit PDO 3 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8722.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8722.1	U8	FE hex	r/w
	3	Inhibit time	p8722.2	U16	0	r/w
	4	Reserved	p8722.3	U8	---	r/w
	5	Event timer	p8722.4	U16	0	r/w
1803		**Transmit PDO 4 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8723.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8723.1	U8	FE hex	r/w
	3	Inhibit time	p8723.2	U16	0	r/w
	4	Reserved	p8723.3	U8	---	r/w
	5	Event timer	p8723.4	U16	0	r/w
1804		**Transmit PDO 5 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8724.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8724.1	U8	FE hex	r/w

OD index (hex)	Subi ndex (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	3	Inhibit time	p8724.2	U16	0	r/w
	4	Reserved	p8724.3	U8	---	r/w
	5	Event timer	p8724.4	U16	0	r/w
1805		**Transmit PDO 6 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8725.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8725.1	U8	FE hex	r/w
	3	Inhibit time	p8725.2	U16	0	r/w
	4	Reserved	p8725.3	U8	---	r/w
	5	Event timer	p8725.4	U16	0	r/w
1806		**Transmit PDO 7 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8726.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8726.1	U8	FE hex	r/w
	3	Inhibit time	p8726.2	U16	0	r/w
	4	Reserved	p8726.3	U8	---	r/w
	5	Event timer	p8726.4	U16	0	r/w
1807		**Transmit PDO 8 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8727.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8727.1	U8	FE hex	r/w
	3	Inhibit time	p8727.2	U16	0	r/w
	4	Reserved	p8727.3	U8	---	r/w
	5	Event timer	p8727.4	U16	0	r/w

Table 7- 25 TPDO configuration objects - mapping parameters

OD index (hex)	Subind ex (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1A00		**Transmit PDO 1 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	1	r/w
	1	PDO mapping for the first application object to be mapped	p8730.0	U32	6041 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8730.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8730.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8730.3	U32	0	r/w
1A01		**Transmit PDO 2 mapping parameter**				

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	0	Number of mapped application objects in PDO		U8	2	r/w
	1	PDO mapping for the first application object to be mapped	p8731.0	U32	6041 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8731.1	U32	6044 hex	r/w
	3	PDO mapping for the third application object to be mapped	p8731.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8731.3	U32	0	r/w
1A02		**Transmit PDO 3 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8732.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8732.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8732.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8732.3	U32	0	r/w
1A03		**Transmit PDO 4 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8733.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8733.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8733.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8733.3	U32	0	r/w
1A04		**Transmit PDO 5 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8734.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8734.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8734.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8734.3	U32	0	r/w
1A05		**Transmit PDO 6 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8735.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8735.1	U32	0	r/w

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	3	PDO mapping for the third application object to be mapped	p8735.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8735.3	U32	0	r/w
1A06		**Transmit PDO 7 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8736.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8736.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8736.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8736.3	U32	0	r/w
1A07		**Transmit PDO 8 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8737.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8737.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8737.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8737.3	U32	0	r/w

7.7.2.2 Free objects

You can interconnect any process data objects of the receive and transmit buffer using receive and transmit double words.

- Scaling the process data of the free objects:
  - 16-bit (word): 4000 hex ≙ 100%
  - 32-bit (doubleword) 4000000 hex ≙ 100%
  - For temperature values: 16-bit (word): 4000 hex ≙ 100° C
  - For temperature values: 32-bit (doubleword): 4000000 hex ≙ 100° C

The "SINAMICS parameters" column shows the parameter numbers assigned in the converter. The assignment applies to the case in which an object which is not mapped in any PDO is to be accessed via SDO.

OD index (hex)	Description	Data type per PZD	Default values	Can be read/ written	SINAMICS parameters
5800 … 580F	16 freely-interconnectable receive process data	I16	0	r/w	r8745[0 … 15]
5810 … 581F	16 freely-interconnectable transmit process data	I16	0	r	r8746[0 … 15]
5820 … 5827	8 freely-interconnectable receive process data	I32	0	r/w	r8747[0 … 7]
5828 … 582F	Reserved				
5830 … 5837	8 freely-interconnectable transmit process data	I32	0	r	r8748[0 … 7]
5828 … 582F	Reserved				

7.7.2.3 Objects from the CiA 402 drive profile

The following table lists the object directory with the index of the individual objects for the drives. The "SINAMICS parameters" column shows the parameter numbers assigned in the converter.

OD index (hex)	Subi ndex (hex)	Name of the object	SINAMICS parameters	Transmi ssion	Data type	Default setting	Can be read/ written
Predefinitions							
67FF		Single device type		SDO	U32		r
Common entries in the object dictionary							
6007		Abort connection option code	p8641	SDO	I16	3	r/w
6502		Supported drive modes		SDO	I32		r
6504		Drive manufacturer		SDO	String	SIEME NS	r
Device control							
6040		Control word	r8795	PDO/S DO	U16	–	r/w
6041		Status word	r8784	PDO/S DO	U16	–	r
605D		Halt option code	p8791	PDO/S DO	I16	–	r/w
6060		Modes of operation	p1300	SDO	I8	–	r/w
6061		Modes of operation display	p1300	SDO	I8	–	r
Factor group							
6094		Velocity encoder factor		SDO	U8	-	r
	01	velocity encoder factor numerator	p8798[1]	SDO	U32	1	r/w
	02	velocity encoder factor denumerator	p8798[2]	SDO	U32	1	r/w
Profile Velocity Mode 3)							

OD index (hex)	Subi ndex (hex)	Name of the object	SINAMICS parameters	Transmi ssion	Data type	Default setting	Can be read/ written
6063		Actual position value	r0482	SDO/PDO	I32	–	r
6069		Velocity sensor actual value	r0061	SDO/PDO	I32	–	r
606B		Velocity demand value	r1170	SDO/PDO	I32	–	r
606C		Velocity actual value Actual velocity	r0063	SDO/PDO	I32	–	r
6083		Profile acceleration	p1082/p1120	SDO	I32	–	r/w
6084		Profile deceleration	p1082/p1121	SDO	I32	0	r/w
6085		Quick stop deceleration	p1082/p1135	SDO	I32	0	r/w
6086		Motion profile type	p1115/p1134	SDO	I32	0	r/w
60FF		**Target** velocity Set velocity	p1155[0] 1) p1072 2)	SDO/PDO	I32	0	r/w
Profile Torque Mode 3)							
6071		Target torque torque setpoint	r8797	SDO/PDO	I16	–	r/w
6072		Max. torque	p1520	SDO	0	0	
6074		Torque demand value overall torque setpoint	r0079	SDO/PDO	I16	–	r
6077		Torque actual value	r0080	SDO/PDO	I16	–	r
Velocity mode							
6042		vl target velocity	r8792	SDO/PDO	I16	–	r/w
6043		vl velocity demand	r1170	SDO/PDO	I16	–	r
6044		vl velocity actual value	r0063	SDO/PDO	I16	–	r
6046	0	vl velocity min./max. amount		SDO	U8	–	r
	1	vl velocity min. amount	p1080	SDO	U32	–	r/w
	2	vl velocity max. amount	p1082	SDO	U32	–	r/w
6048	0	vl velocity acceleration		SDO	U8	–	r
	1	Delta speed	p1082	SDO	U32	–	r/w
	2	Delta time	p1120	SDO	U16	–	r/w

1) Without ramp-function generator

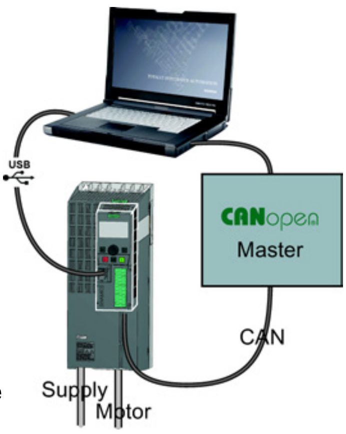
2) With ramp-function generator

3) The converter processes the objects of profile velocity mode and profile torque mode. But they cannot be set nor selected in converters.

7.7.3 Integrating the converter into CANopen

Commissioning

Precondition



- STARTER ≥ version 4.2, is installed on the computer used to commission the system.
- The inverter is connected to a CANopen master.
- The EDS (Electronic Data Sheet) (http://support.automation.siemens.com/WW/view/en/48351511)is installed on your CANopen master.
- In the basic commissioning you have set the inverter interfaces to the CANopen fieldbus.

  See also Finding a suitable setting for the interfaces (Page 43).

  This means that the following signals in the inverter are interconnected corresponding to the Predefined Connection Sets:
  - Speed setpoint and control word
  - Speed actual value and status word

Procedure

Proceed as follows to commission the CANopen interface:

1. Integrating the converter into CANopen (Page 185)
2. Set the node ID, baud rate and the monitoring of the communication.
   Also see "Setting the baud rate (Page **Fehler! Textmarke nicht definiert.**)" as well as "Setting the monitoring of the communication (Page 187)"
3. Interconnecting additional process data
   Set p8744 = 2. You can now interconnect additional process data.

See also "Free PDO mapping (Page 169)"

4. Signal interconnection of the links created in free PDO mapping.

See also Interconnect objects from the receive and transmit buffers (Page 171).

5. Exiting commissioning
   Select the "Operational" status in the "Network management" tab in the "Control Unit/Communication/CAN" STARTER screen form and exit the commissioning.

You have commissioned the CANopen interface.

More information about configuring the communication is provided in Sections List of objects (Page 173) and CANopen Converter functions (Page 154).

7.7.3.1 Connecting the converter to CANopen

Connect the converter to the fieldbus via the 9-pin SUB-D pin connector.

The connections of this pin connector are short-circuit proof and isolated. If the converter forms the first or last slave in the CANopen network, then you must switch-in the bus-terminating resistor.

For additional information on the SUB-D pin connector and on the bus-terminating resistor, please refer to Section Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).

7.7.3.2 Setting the node ID and baud rate

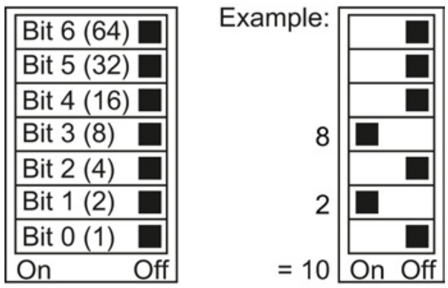
Setting the node ID

You set the node ID of the inverter using the address switches on the Control Unit, using parameter p8620 or in STARTER.

Valid address range: 1 … 127

If you have specified a valid node ID using the address switches, this node ID will always be the one that takes effect, and parameter p8620 (factory setting: 0) will not be able to be changed.

The positions of the address switches are described in Section: Interfaces, connectors, switches, terminal blocks and LEDs of the converter (Page 41).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – using the address switches
   – with an operator panel using p8620
   – in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p8620
2. Switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

This means that you have changed the bus address.

Setting the data transfer rate

You set the data transfer rate using parameter p8622 or in the STARTER "Control Unit/Communication/CAN" screen form under the "CAN interface" tab.

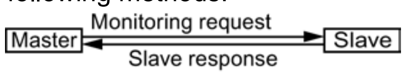
Setting range: 10 kbit/s … 1 Mbit/s. The maximum permissible cable length for1 Mbit/s is 40 m.

In order that a newly set or modified data transfer rate becomes effective, switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit. Switch on the voltages again after all LEDs at the inverter have gone dark.

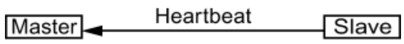
7.7.3.3 Setting the monitoring of the communication

To monitor the communication, use one of the following methods:

- Node guarding / life guarding



- Heartbeat



Node guarding / life guarding

Principle of operation

- Node guarding:
  Is always active if heartbeat is not activated (p8606 = 0). Node guarding means the master sends monitoring queries to the converter which then answers.

  The converter does not monitor the communication. Set the responses to a bus failure in the master.

- Life guarding:
  is active if you use p8604.0 and p8604.1 to set a lifetime ≠ 0.
  Life Guarding means that the converter monitors the master's monitoring query and reports fault F8700 (A) with fault value 2, if a life guarding protocol (life guarding event) is not received within the lifetime. Set additional responses to a bus failure in the master.

  Calculate value for lifetime

  Life time = guard time in milliseconds (p8604.0) * life time factor (p8604.1)

Heartbeat

Principle of operation

The slave periodically sends heartbeat messages. Other slaves and the master can monitor this signal. In the master, set the responses for the case that the heartbeat does not come.

Setting value for heartbeat

Set in p8606 the cycle time for the heartbeat in milliseconds.

Converter behavior with a bus fault

With a bus fault, the CAN master goes to the "Bus OFF" status. In the converter set the response via the p8641 parameter. Factory setting: p8641 = 3 (AUS3). When you have resolved the bus fault, you can confirm the error as follows:

- via OFF/ON: this enables you to remove the Bus OFF state and start communication again.
- via the DI 2 or direct via p3981: the converter remains in the Bus OFF state. To start the communication again, set p8608 = 1.

⚠ WARNING
Stopping the motor after a bus error If the converter does not enter into a fault for a bus fault (p8641 = 0), the motor cannot be stopped via the controller. For this case, wire an additional OFF command via terminals. To stop the motor from the controller, you must resolve the bus fault and restart the communication via p8608 = 1.

7.7.4 Free PDO mapping for example of the actual current value and torque limit

Free PDO mapping for example of the actual current value and torque limit

You integrate the actual current value and torque limit into the communication via the free PDO mapping.

The actual current value and the torque setpoint are transferred in TPDO1 and RPDO1, respectively. TPDO1 and RPDO1 have already been specified by the Predefined Connection Set.

Mapping the actual current value (r0068) with TPDO1

Procedure

Proceed as follows to accept the current actual value as send object in the communication:

1. Set the OV index for the actual current value:
   first free OV index from the send data from the "Free objects" 5810 table
2. Map the OV index for the actual current value with PZD2:
   - Set the COB-ID of TPDO1 to "invalid":
     p8720[0] = 800001B2 hex
   - Link the mapping parameter object 2 of TPDO1 (p8730.1) with the OV index for the actual current value:
     p8730.1 = 58100010 hex (5810 = OV index, 00 = fixed value, 10 ≙ 16 bit value)
   - Set the COB-ID of TPDO1 to "valid":
     p8720[0] = 400001B2 hex

   r8751 shows which object is matched to which PZD:
   PZD2 (r8751[1]) = 5810 (actual current value)
3. link the PZD send word 2 in the send word (p2051) with the actual current value:
   p2051[1] = r0086[0]

This means you have transferred the actual current value into the communication as the send object.

Mapping the torque limit (p1520) with RPDO1

Procedure

Proceed as follows to accept the torque limit value in the communication:

1. Set the OV index for the torque limit:
   first free OV index from the receive data from the "Free objects" 5800 table
2. Map the OV index for the torque limit with PZD2
   - Set the COB-ID of RPDO1 to "invalid":
     p8700[0] = 80000232 hex
   - Link the mapping parameter object 2 of RPDO1 (p8710.1) with the OV index for the torque limit:
     p8710.1 = 58000010 hex (5800 = OV index, 00 = fixed value, 10 ≙ 16 bit value)
   - Set the COB-ID of RPDO1 to "valid":
     p8700[0] = 40000232 hex

   r8750 shows which object is mapped to which PZD:
   PZD2 (r8750[1]) = 5800 (torque limit)
3. Link the PZD receive word 2 in the receive word (p2050) with the torque limit:
   p2050[1] = p1520[0]

This means you have transferred the value for the torque limit into the communication.

Setting functions

8

Complete the following commissioning steps before you set the converter functions:

- Basic commissioning (Page 66)
- If necessary: Adapting the terminal strip (Page 79)
- If necessary: Configuring the fieldbus (Page 91)

8.1 Overview of the inverter functions

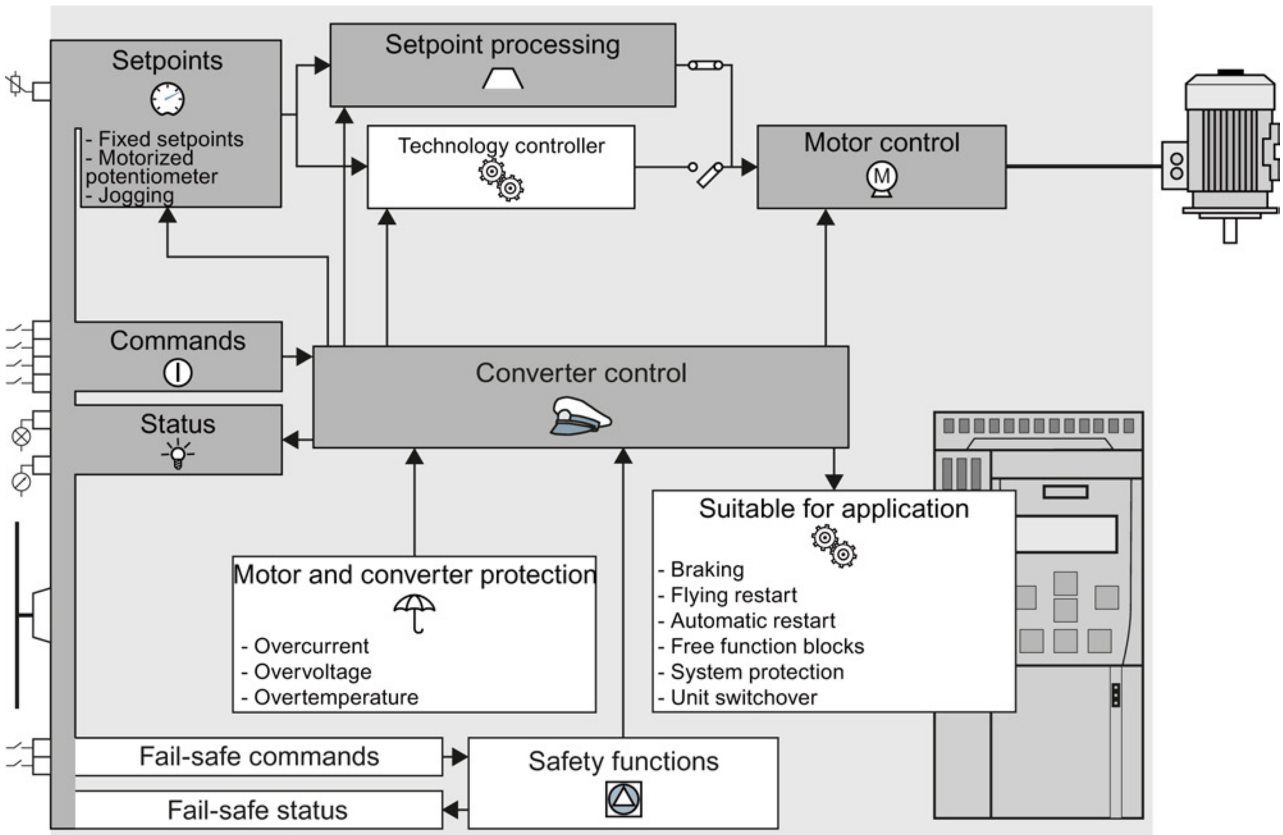
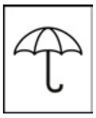
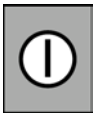
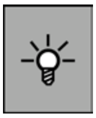
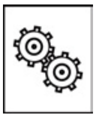
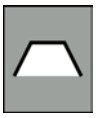
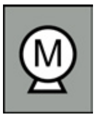
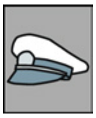


Figure 8-1 Overview of inverter functions

Functions relevant to all applications		**Functions required in special applications only**	
The functions that you require in each application are shown in a dark color in the function overview above. You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.		The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.	
	**Converter control** is responsible for all of the other converter functions. Among other things, it defines how the converter responds to commands from the higher-level control system. Converter control (Page 193)		The **protection functions** prevent damage to the motor, converter, and driven load, e.g. using temperature monitoring or torque monitoring. Protection functions (Page 225)
	The **commands** from the higher-level control are sent to the converter via digital inputs or the fieldbus. Adapting the terminal strip (Page 79) Configuring the fieldbus (Page 91)		The **status signals** provide signals at the outputs of the Control Unit via the fieldbus, e.g. the actual motor speed or the converter fault signal. Adapting the terminal strip (Page 79) Configuring the fieldbus (Page 91)
	You must define a **setpoint**, which defines the motor speed, for example. Setpoint sources (Page 204)		Functions **suitable for the application** permit, for example, a motor holding brake to be controlled or higher-level closed-loop pressure or temperature control to be implemented using the technology controller. Application-specific functions (Page 231)
	The **setpoint processing** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value. Setpoint preparation (Page 210)		The **safety function** fulfills increased requirements regarding the functional safety of the drive. Fail-safe function Safe Torque Off (STO) (Page 261)
	The **motor closed-loop control** ensures that the motor follows the speed setpoint. You can select either closed-loop speed control or U/f control. Motor control (Page 216)		

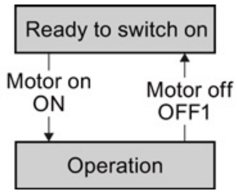
8.2 Converter control

8.2.1 Switching the motor on and off



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

- The inverter switches on the motor with the ON command. The inverter changes to the "Operation" state.
- After the OFF1 command, the inverter brakes the motor with the ramp-down time of the ramp-function generator. The inverter switches off the motor once standstill has been reached. The inverter is again "ready to start".



Inverter states and commands for switching the motor on and off

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

- OFF2 - the inverter immediately switches off the motor without first braking it.
- OFF3 - this command means "quick stop". After OFF3, the inverter brakes the motor with the OFF3 ramp-down time. After reaching standstill, the inverter 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.

The following diagram shows the internal sequence control of the inverter when switching the motor on and off.

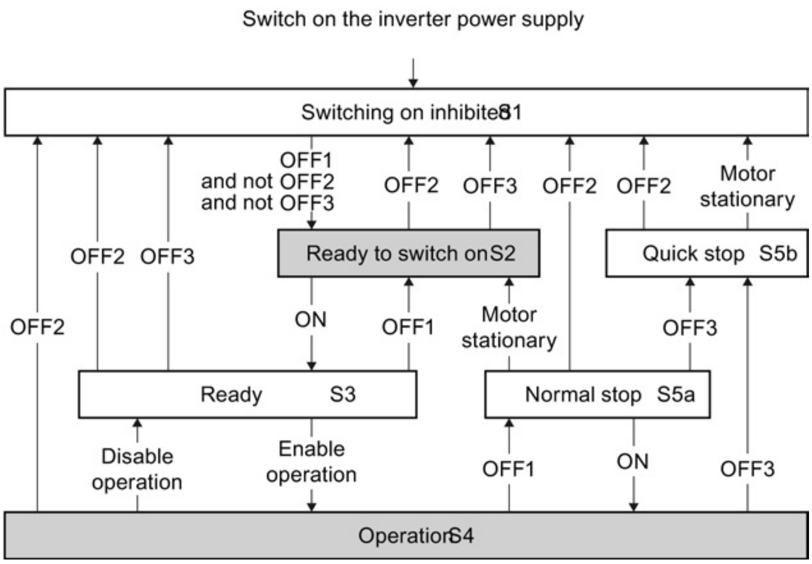


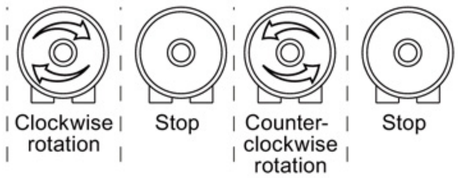
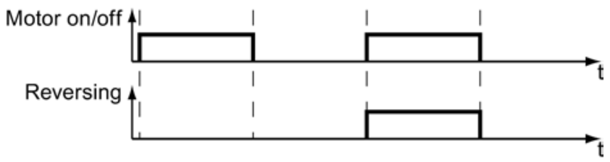
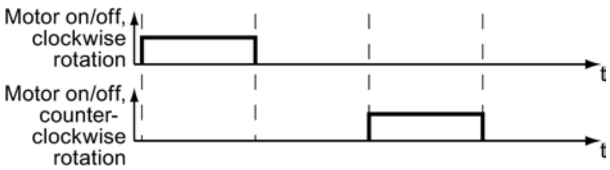
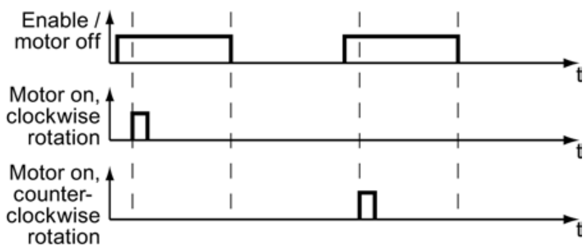
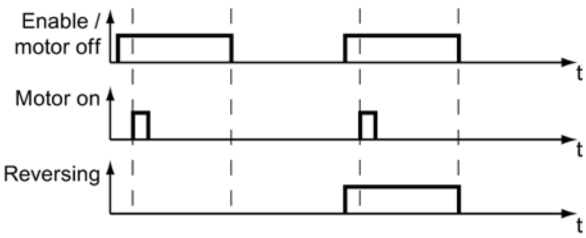
Figure 8-2 State overview of the inverter

Table 8- 1 Explanation of the inverter states

State	Explanation
Switching on inhibited (S1)	In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions: • ON was active when switching on the inverter. Exception: When the automatic start function is active, ON must be active after switching on the power supply. • OFF2 or OFF3 is selected.
Ready to switch on (S2)	This state is required to switch on the motor.
Ready (S3)	The inverter waits for the operating enable. If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit. If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.
Operation (S4)	The motor is switched on.
Normal stop (S5a)	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
Fast stop (S5b)	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time.

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

Table 8- 2 Two-wire control and three-wire control

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

8.2.2 Two-wire control: method 1

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

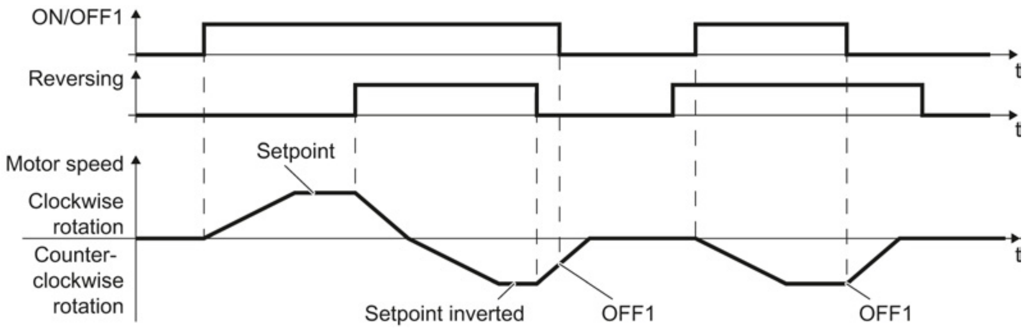


Figure 8-3 Two-wire control, method 1

Table 8- 3 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.

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 12</td><td colspan="3">Macro drive unit (factory setting for inverters without PROFIBUS interface)</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1</td><td>Reversing</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p0840[0 … n] = 722.x</td><td colspan="3">BI: ON/OFF1 (ON/OFF1)</td></tr>
<tr><td>p1113[0 … n] = 722.x</td><td colspan="3">BI: Setpoint inversion (reversing)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p0840 = 722.3</td><td colspan="3">DI 3: ON/OFF1
Also see section Digital inputs (Page 80).</td></tr>
</table>

8.2.3 Two-wire control, method 2

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

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

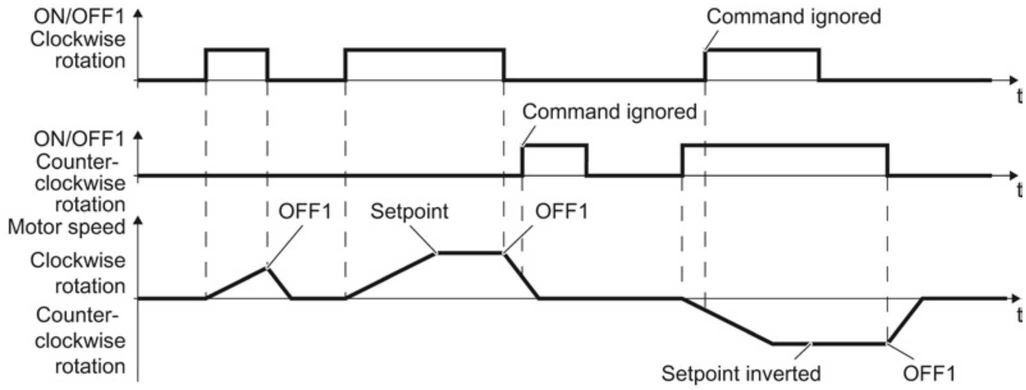


Figure 8-4 Two-wire control, method 2

Table 8- 4 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	OFF1: The motor stops.
1	0	ON: Clockwise motor rotation.
0	1	ON: Counter-clockwise motor rotation.
1	1	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 (DI x).			
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 = 722.0	DI 0: ON/OFF1 counter-clockwise rotation Also see section Digital inputs (Page 80).		

8.2.4 Two-wire control, method 3

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

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

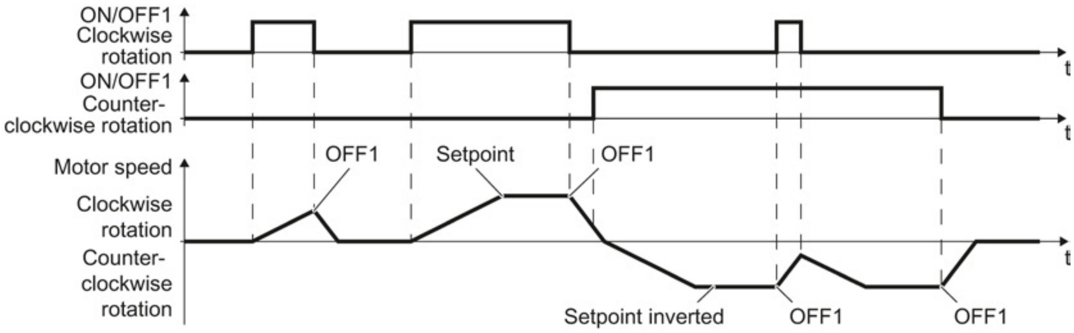


Figure 8-5 Two-wire control, method 3

Table 8- 5 Function table

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.

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 18</td><td colspan="3">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1 clockwise rotation</td><td>ON/OFF1 counter-clockwise rotation</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2-3-WIRE control command 1 (ON/OFF1 clockwise rotation)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2-3-WIRE control command 2 (ON/OFF1 counter-clockwise rotation)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p3331[0 … n] = 722.2</td><td colspan="3">DI 2: ON/OFF1 counter-clockwise rotation
Also see section Digital inputs (Page 80).</td></tr>
</table>

8.2.5 Three-wire control, method 1

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

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

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

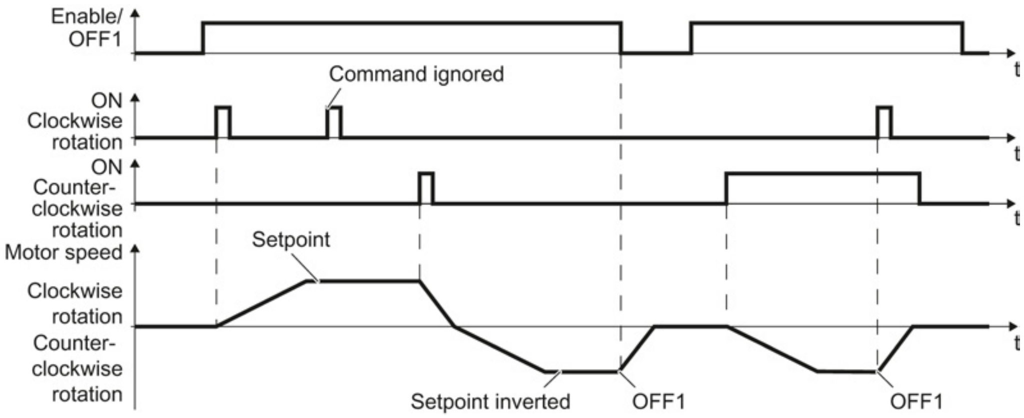


Figure 8-6 Three-wire control, method 1

Table 8- 6 Function table

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

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 19</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON clockwise rotation</td><td>ON clockwise rotation</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE control command 1 (enable/ OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE control command 2 (ON clockwise rotation)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE control command 3 (ON counter-clockwise rotation)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3332 = 722.0</td><td colspan="4">DI 0: ON counter-clockwise rotation.
Also see section Digital inputs (Page 80).</td></tr>
</table>

8.2.6 Three-wire control, method 2

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

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

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

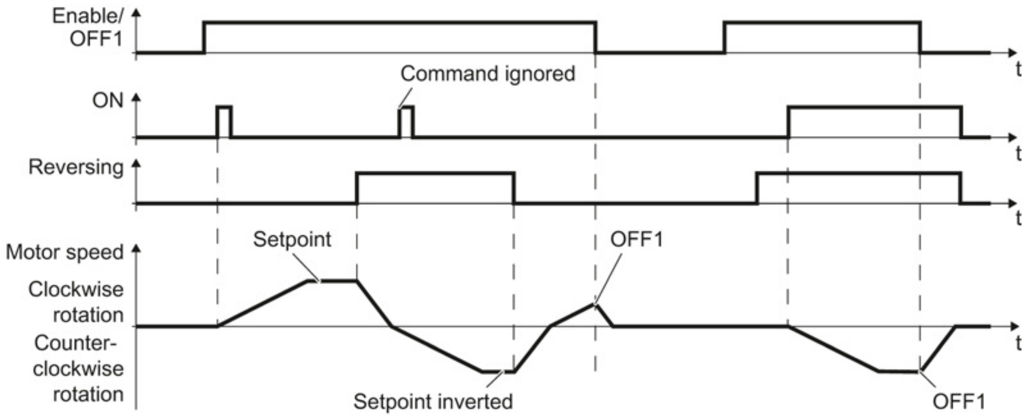


Figure 8-7 Three-wire control, method 2

Table 8- 7 Function table

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

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 20</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON</td><td>Reversing</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE control command 1 (enable/ OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE control command 2 (ON)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 3 (reversing)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3331 = 722.0</td><td colspan="4">DI 0: ON
Also see section Digital inputs (Page 80).</td></tr>
</table>

8.2.7 Running the motor in jog mode (JOG function)

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

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

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

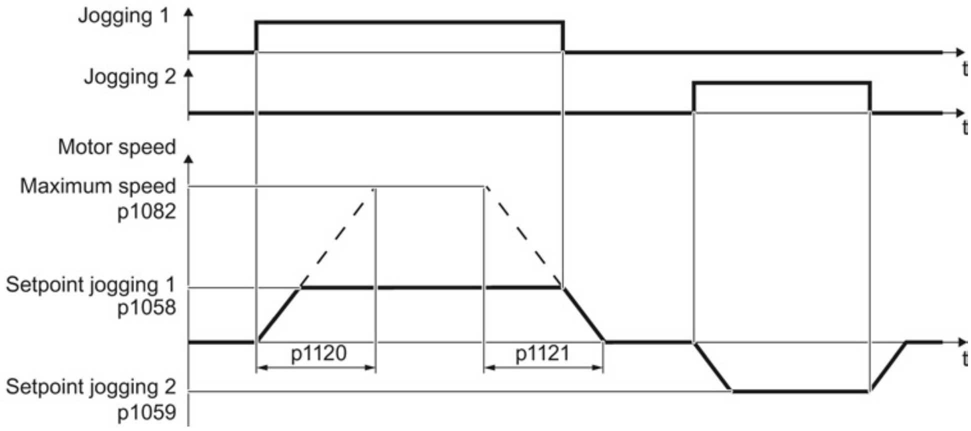
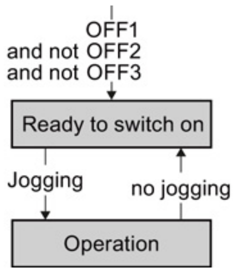


Figure 8-8 Behavior of the motor when "jogging"

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



Setting jogging

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

8.2.8 Switching over the inverter control (command data set)

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

Example: Switchover from automatic to manual operation

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

Command data set (CDS)

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

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

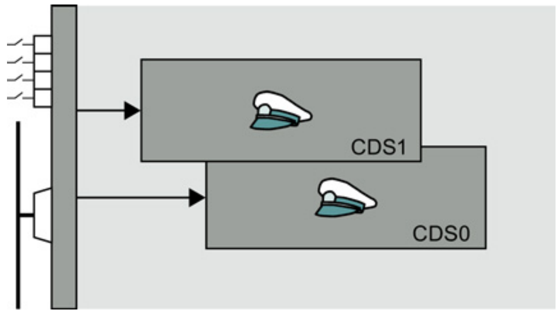


Figure 8-9 Different inverter control using several command data sets (CDS)

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

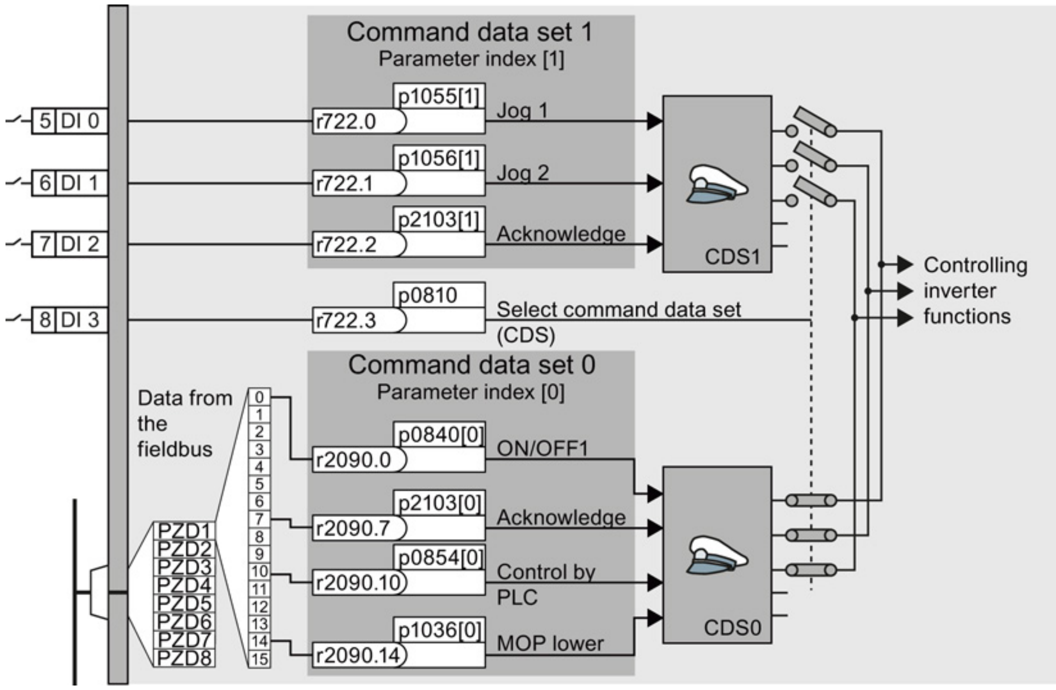


Figure 8-10 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

You obtain the interconnection as in the example above, if you configured the interfaces of the inverter with p0015 = 7 in the basic commissioning, also see Section Finding a suitable setting for the interfaces (Page 43).

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.

8.3 Setpoint sources

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

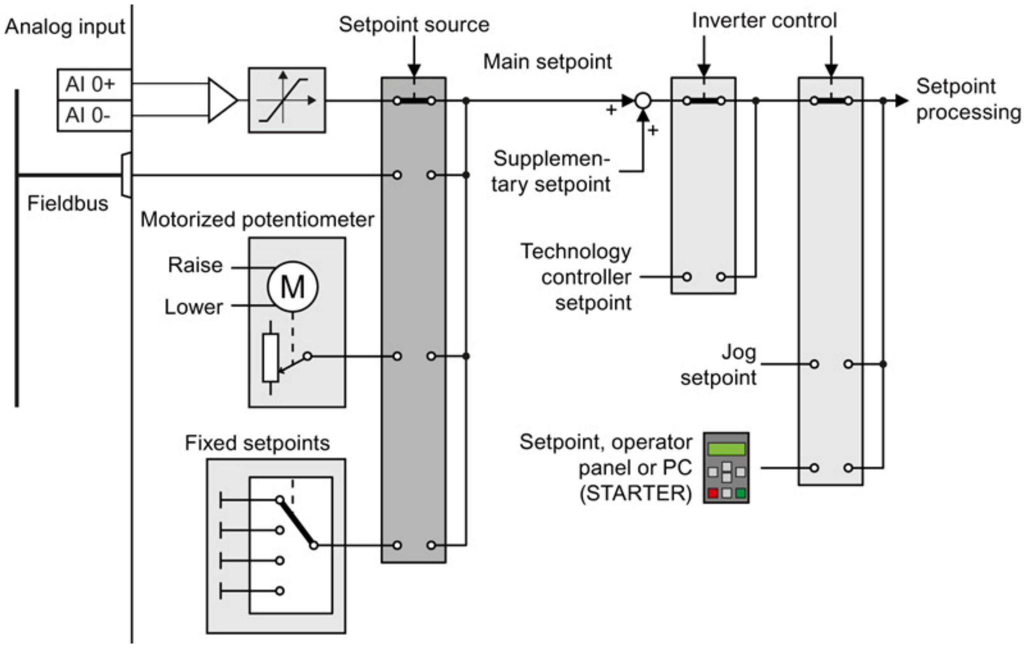


Figure 8-11 Setpoint sources for the converter

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

- Converter analog input.
- Converter fieldbus interface.
- Motorized potentiometer simulated in the converter.
- Fixed setpoints saved in the converter.

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

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

- When the technology controller is active, it's output specifies the motor speed.
- When jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

In the basic commissioning, you have already selected a setpoint source. Refer also to Section: Finding a suitable setting for the interfaces (Page 43).

However, you can change this setting. On the following pages, you will find a more detailed description of the setpoint sources.

8.3.1 Analog input as setpoint source

Interconnecting an analog input

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

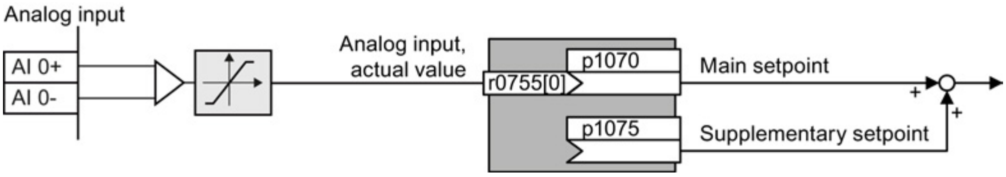


Figure 8-12 Example: Analog input 0 as setpoint source

Table 8- 8 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 84).

8.3.2 Specifying the motor speed via the fieldbus

If you enter the setpoint via a fieldbus, you must connect the converter to a higher-level control. For additional information, see Section Configuring the fieldbus (Page 91).

Interconnecting the fieldbus with the main setpoint

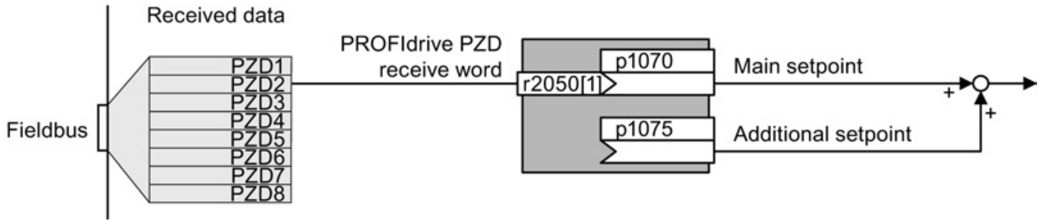


Figure 8-13 Fieldbus as setpoint source

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

Table 8- 9 Setting the fieldbus as setpoint source

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

8.3.3 Motorized potentiometer as setpoint source

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

Interconnecting the motorized potentiometer (MOP) with the setpoint source

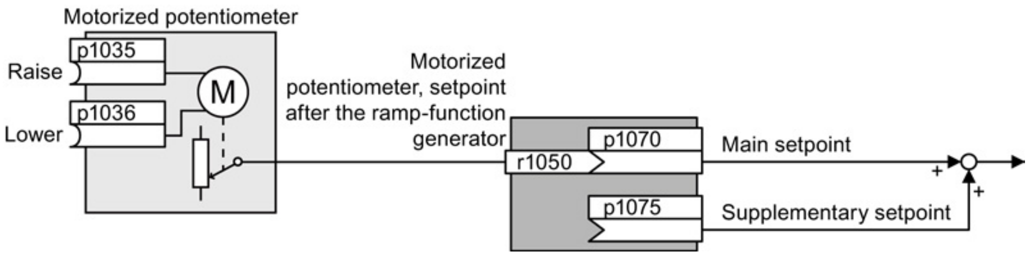


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 10 Basic setup of motorized potentiometer

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

Table 8- 11 Setting the MOP as setpoint source

Parameter	Remark
p1070 = 1050	**Main setpoint** Interconnecting the main setpoint with MOP.
p1035	**Motorized potentiometer, increase setpoint** (factory setting 0) Interconnect this signal, for example with a digital input of your choice: p1035 = 722.1 (digital input 1)
p1036	**Motorized potentiometer, decrease setpoint** (factory setting 0) Interconnect this signal, for example with a digital input of your choice.

Adapting the behavior of the motorized potentiometer

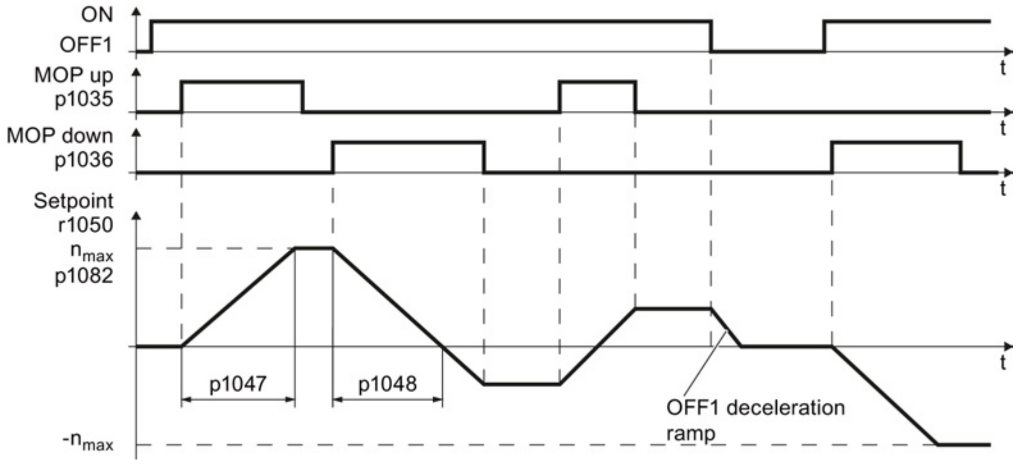


Figure 8-15 Function chart of motorized potentiometer

Table 8- 12 Extended setup of motorized potentiometer

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

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

8.3.4 Fixed speed as setpoint source

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

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

Interconnecting the fixed speeds with a main setpoint

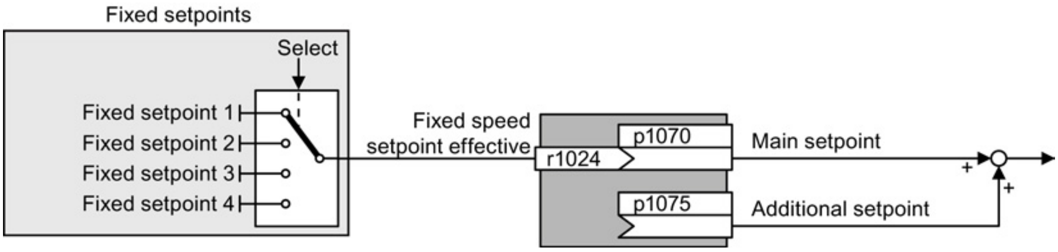


Figure 8-16 Fixed speeds as setpoint source

Table 8- 13 Setting the fixed speed as a setpoint source

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

Select direct or binary fixed setpoint

The inverter has up to 16 different fixed setpoints. The superior controller selects the appropriate fixed setpoints via digital inputs or the field bus.

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

1. Direct selection:
   You set four different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.
   Direct selection is the most suitable method for controlling the inverter via the digital inputs.

   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 fixed setpoints by a combination of four selection bits.
   The binary selection is the suitable method of controlling the inverter via a field bus.
   Additional information about binary selection can be found in function diagram 3010 of the List Manual.

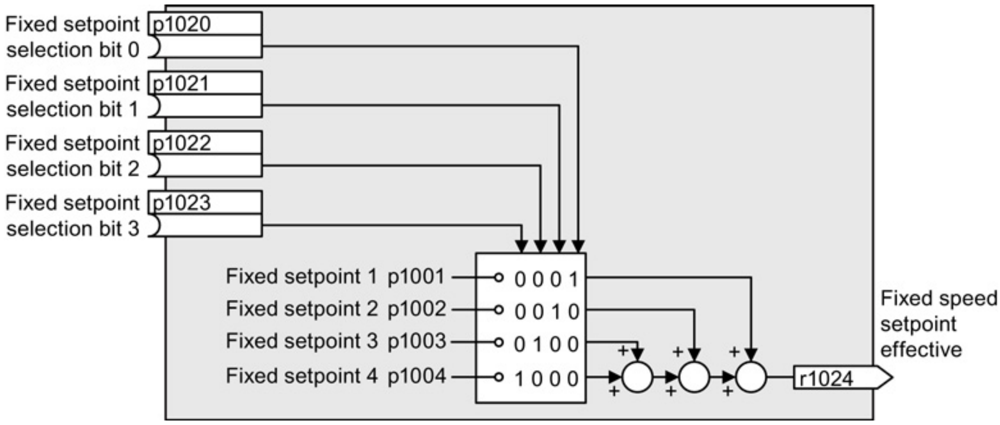


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

Example: Select two fixed setpoints directly

The motor is to operate at two 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.

Table 8- 14 Settings for the example

Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** in [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** in [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	**Fixed speed setpoint selection bit 0:** Interconnect fixed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnect fixed setpoint 2 with DI 1.
p1016 = 1	**Fixed speed setpoint mode:** Select direct selection of the fixed setpoints.

Table 8- 15 Resulting fixed setpoints for the example above

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

8.4 Setpoint preparation

8.4.1 Overview of setpoint processing

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

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Minimum speed to avoid standstill when the motor is switched on.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

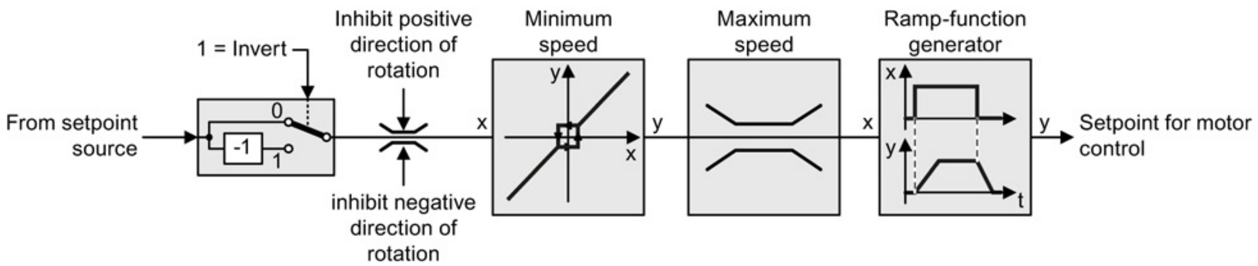


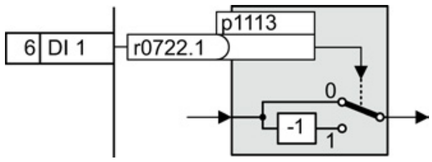
Figure 8-18 Setpoint processing in the inverter

8.4.2 Invert setpoint

Procedure

Proceed as follows to invert the setpoint:

Interconnect parameter p1113 with a binary signal, e.g. digital input 1.



You have inverted the setpoint.

Table 8- 16 Examples of settings to invert the setpoint

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

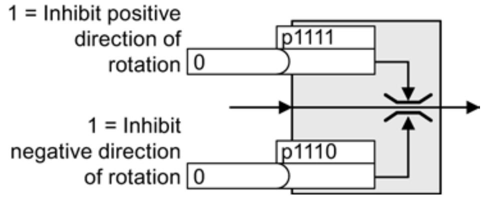
8.4.3 Inhibit direction of rotation

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

Procedure

Proceed as follows to permanently lock a direction of rotation:

Set the corresponding parameter to a value = 1.



You have permanently locked the appropriate direction of rotation.

Table 8- 17 Examples of settings to inhibit the direction of rotation

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

8.4.4 Minimum speed

Function

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

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

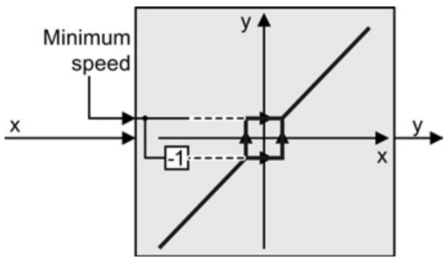


Table 8- 18 Setting the minimum speed

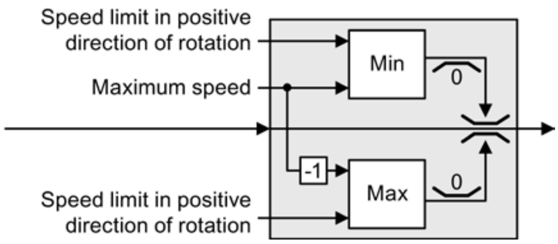
Parameter	Description
p1080	Minimum speed

8.4.5 Maximum speed

Function

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.



The maximum speed also acts as a reference value for several other functions, e.g. the ramp-function generator.

If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 8- 19 Parameters for minimum and maximum speed

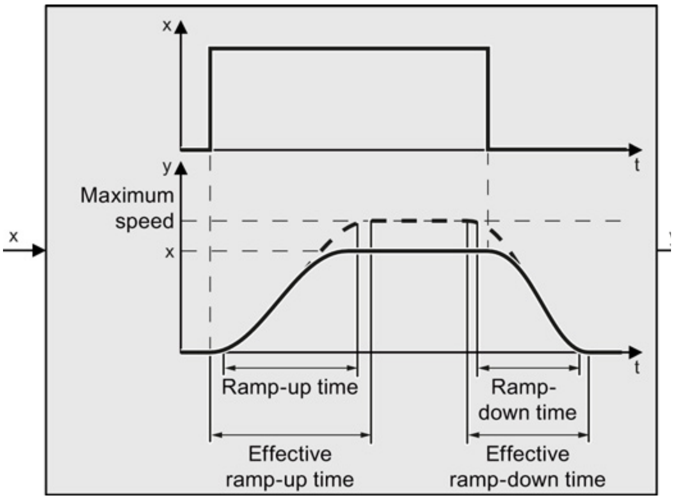
Parameter	Description
p1082	**Maximum speed** (factory setting 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting 210,000 rpm)
p1086	**Speed limit, negative direction of rotation** (factory setting -210,000 rpm)

8.4.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

The ramp-function generator is not active if the technology controller in the inverter specifies the speed setpoint.

Extended ramp-function generator



The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimum times that you select depend on your particular application in question and can range from just a few 100 ms (e.g. for belt conveyor drives) to several minutes (e.g. for centrifuges).

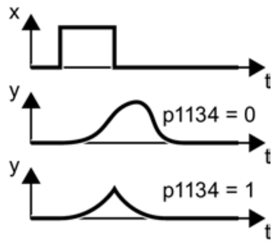
Initial and final rounding permit smooth, jerk-free acceleration and braking.

The ramp-up and ramp-down times of the motor are increased by the rounding times:

- Effective ramp-up time = p1120 + 0.5 × (p1130 + p1131).
- Effective ramp-down time = p1121 + 0.5 × (p1130 + p1131).

Table 8- 20 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting 10 s) braking time in seconds from the maximum speed down to standstill
p1130	**Ramp-function generator initial rounding time** (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1131	**Ramp-function generator final rounding time** (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.

Parameter	Description
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.

     An excessively short ramp-down time means that the motor will temporarily not be able to follow the speed setpoint. Depending on the Power Module being used, the reason for this is that either the motor current limit has been reached, or there is a risk of an excessively high inverter DC link voltage.

     In any case, the drive exceeds the set time.
   - If the motor decelerates too quickly, then extend the ramp-down time.
6. Repeat steps 1 … 5, until you are satisfied with your drive response.

You have set the extended ramp-function generator.

Changing the ramp-up and ramp-down times in operation

Using a scaling factor, the ramp-up and ramp-down times of the ramp-function generator can be changed in operation. You have the following options of entering a scaling value:

- Using an analog input
- Using a fieldbus

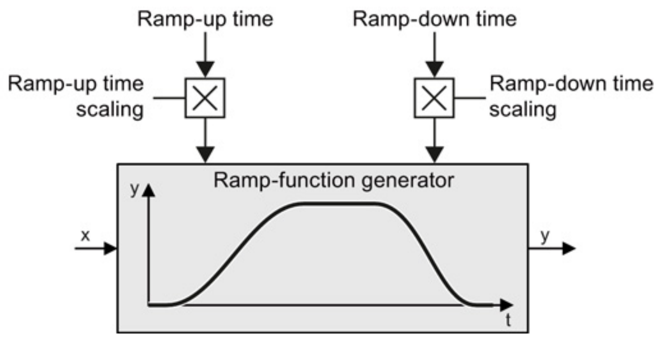


Table 8- 21 Parameters for setting the scaling

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

Example

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

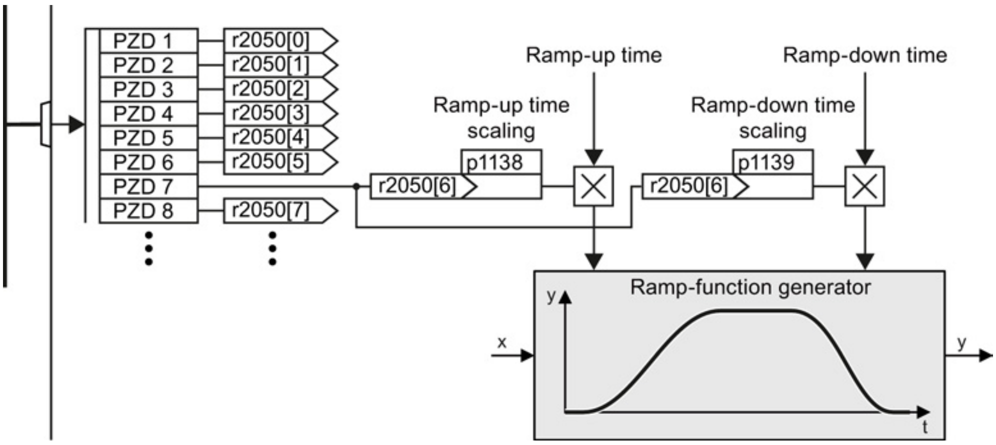


Figure 8-19 Example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system. See also Section: Extend telegrams and change signal interconnection (Page 103).
- The controller sends the scaling value to the inverter in PZD 7.

Procedure

To interconnect the scaling of the ramp-up and ramp-down times with PZD receive word 7 from the fieldbus in the inverter, proceed as follows:

1. Set p1138 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 7.
2. Set p1139 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-down time with PZD receive word 7.

The inverter receives the value for scaling the ramp-up and ramp-down times via PZD receive word 7.

8.5 Motor control

Decision-making criteria for the control mode that is suitable for your application is provided in Section Factory setting of the inverter control (Page 62)

8.5.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

The inverter provides the two most important characteristics (linear and square-law). User-defined characteristic curves are also supported.

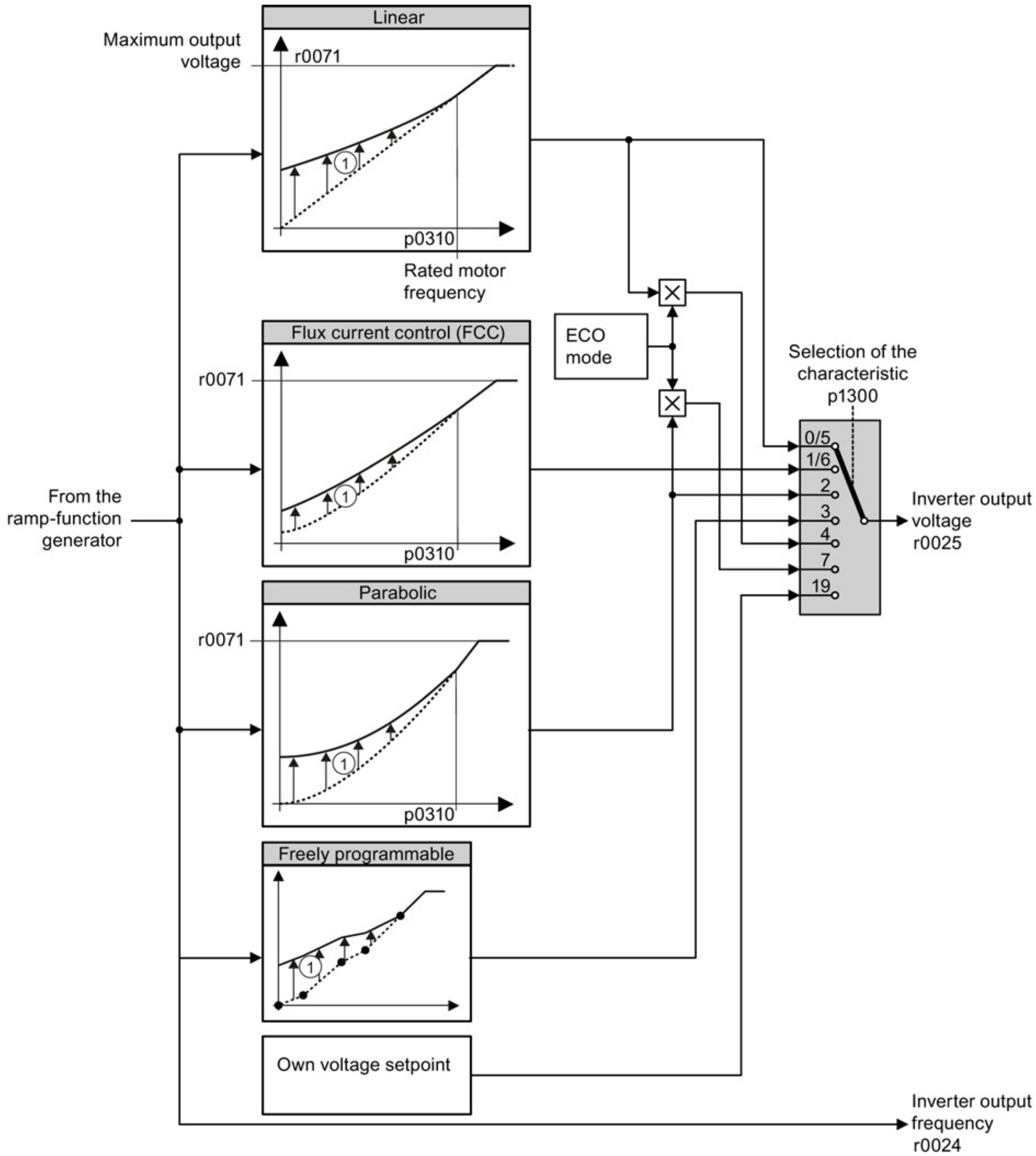
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

8.5.1.1 Characteristics of U/f control

The inverter has several U/f characteristics. Based on the characteristic, as the frequency increases, the inverter increases the voltage at the motor.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective for frequencies < rated frequency

Figure 8-20 U/f characteristics of the inverter

The inverter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum inverter output voltage.

If the inverter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the motor voltage at the rated motor frequency also depends on the following variables:

- Ratio between the inverter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible motor voltage as a function of the input voltage is provided in the technical data, also see Section Technical data (Page 339).

8.5.1.2 Selecting the U/f characteristic

Procedure

Proceed as follows to select a U/f characteristic:

	
1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p1300 to the appropriate value.	1. Go online. 2. Select the U/f characteristic curve in one of the screen forms "speed controller" or "U/f control".

You have selected a U/f characteristic.

Table 8- 22 Linear and parabolic characteristics

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 8- 23 Characteristics for special applications

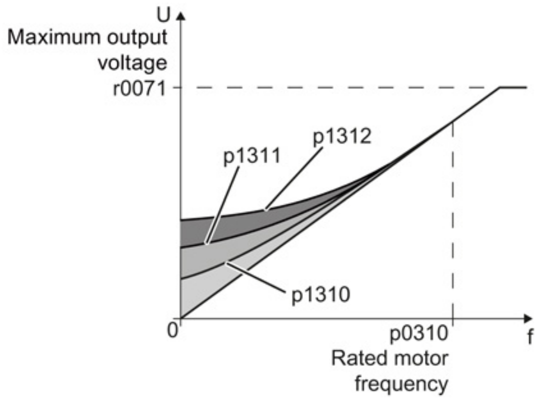
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage.	ECO mode	p1300 = 4 or p1300 = 7
The inverter must keep the motor speed constant under all circumstances.	Drives in the textile sector	When the maximum current limit is reached, the inverter only reduces the stator voltage but not the speed.	Precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	Operating the inverter with a synchronous motor	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

8.5.1.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.



Procedure

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Voltage boost when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

8.5.2 Vector control

8.5.2.1 Properties of the sensorless vector control

Sensorless vector control

Using a motor model, the speed control calculates the load and the motor slip. As a result of this calculation, the inverter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Speed control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

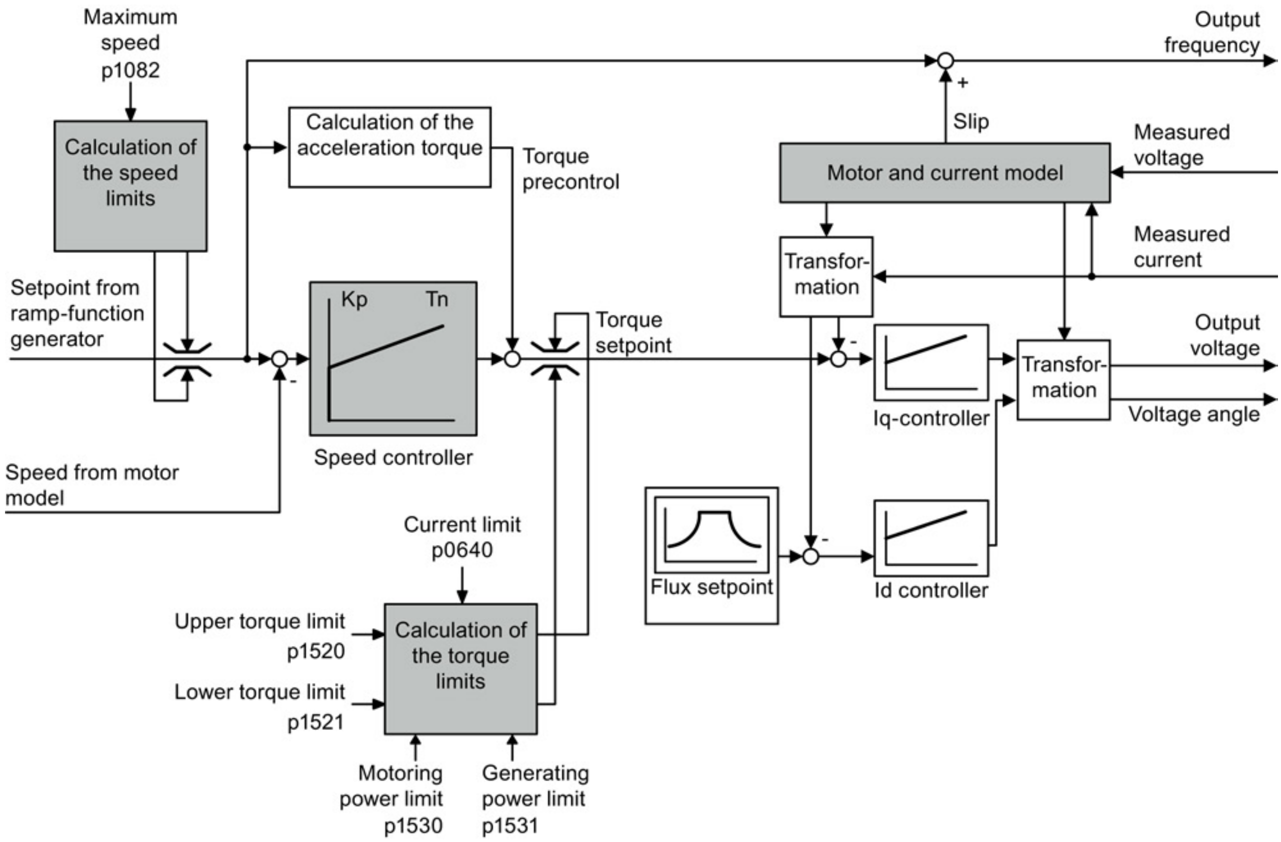


Figure 8-21 Simplified function diagram of sensorless vector control

8.5.2.2 Select motor control

Speed control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected speed control as control mode in the basic commissioning, you will already have set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement).
If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Procedure

Proceed as follows to select encoderless vector control:

	
1. In the "Parameters" menu, go to p1300 2. Set p1300 = 20.	1. Go online 2. Select speed control without encoder in the "Speed controller" or "U/f control" mask.

You have selected encoderless vector control.

8.5.2.3 Re-optimize the speed controller

In the following cases you will need to manually optimize the speed controller:

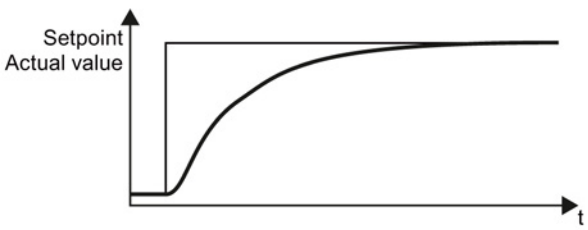
- Your application does not permit self-optimization because the motor cannot rotate freely.
- You are dissatisfied with the result of the inverter self-optimization.
- The inverter interrupted the self-optimization with a fault.

Procedure

To manually optimize the speed controller, proceed as follows:

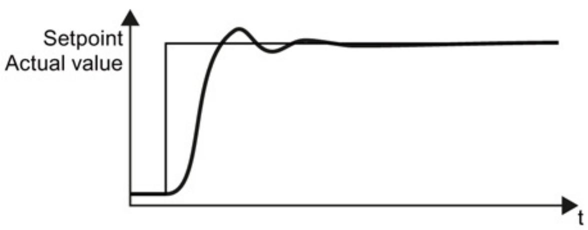
	
1. Set the ramp-up and ramp-down times of the ramp-function generator p1120 = 0 and p1121 = 0. 2. Set the pre-control of the speed controller p1496 = 0. 3. Enter a setpoint step and observe the associated actual value. 4. Optimize the speed controller by changing controller parameters K_P and T_N until the drive runs optimally (see the diagrams below). – K_P = p1470 – T_N = p1472 5. Set the ramp-up and ramp-down times of the ramp-function generator p1120 and p1121 back to their original value. 6. Set the pre-control of the speed controller p1496 = 100%.	1. Go online, and in the "Ramp-function generator" screen form, set the times = 0 . 2. Go online, and in the "Speed controller" screen form, set the pre-control = 0 . 3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER. 4. Go online and optimize the controller in the "Speed controller" screen form by changing the controller parameters K_P and T_N until the drive runs optimally (refer to the diagrams below). 5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value. 6. Set the pre-control of the speed controller back to 100%.

You have optimized the speed controller.



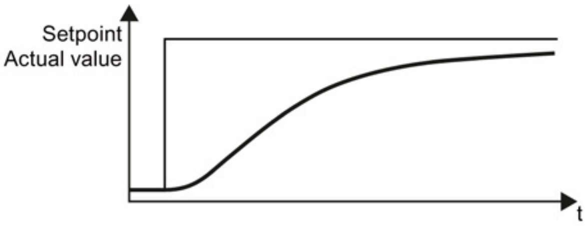
Optimum control response for applications that do not permit any overshoot.

The actual value approaches the setpoint, without any significant overshoot.



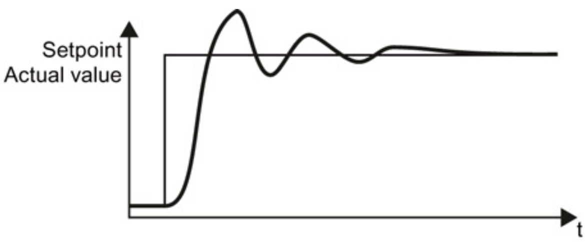
Optimum control response for fast correction and quick compensation of noise components.

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).



The actual value only slowly approaches the setpoint.

- Increase the proportional component K_P and reduce the integration time T_N.



The actual value quickly approaches the setpoint, but overshoots too much

- Decrease the proportional component K_P and increase the integration time T_N.

8.6 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.

8.6.1 Inverter temperature monitoring

The inverter protects itself against overtemperature with different monitoring functions:

- I^2t monitoring (alarm A07805, fault F30005)
  The I^2t monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a %. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
- Monitoring the chip temperature of the power unit (alarm A05006 - fault F30024)
  The inverter monitors the difference in temperature between the power chip (IGBT) and the heat sink. The measured values are in r0037[1] [°C].
- Heat sink monitoring (alarm A05000, fault F30004)
  The inverter monitors the heat sink temperature of the Power Module. The values are in r0037[0] [°C].

Inverter response

The inverter temperature is essentially defined by the following effects:

- the ohmic losses of the output current
- the switching losses that occur when the motor is pulsed

Parameter p0290 defines how the inverter responds to an excessively high temperature.

Parameter	Description
p0290	**Power unit overload response** (factory setting for SINAMICS G120 inverters with Power Module PM260: 0; factory setting for all other inverters: 2) Setting the reaction to a thermal overload of the power unit: 0: Reduce output current (in vector control mode) or speed (in U/f mode) 1: No reduction, shutdown when overload threshold is reached (F30024) 2: Reduce pulse frequency and output current (in vector control mode) or pulse frequency and speed (in U/f mode) 3: Reduce pulse frequency
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.

8.6.2 Motor temperature monitoring using a temperature sensor

Connecting the temperature sensor

You can 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.

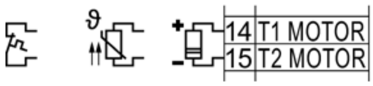


Figure 8-22 Connecting the motor temperature sensor at the inverter

Set response to excess motor temperature

If you use a temperature switch or PTC sensor, set the response to excess motor temperature via P0610 as follows:

- p0610 = 0
  - Warning A07910,
  - No shutdown
- p0610 = 1, p0610 = 2, p0610 = 12
  - Warning A07910
  - Shutdown with fault F07011

If you use a KTY84 sensor, set the temperature for the warning or fault threshold via p0604 or p0605.

- Monitoring via p0604: Response as per the setting in p0610
- Monitoring via p0605: Shutdown with fault as soon as the set threshold is exceeded.

For details, please refer to the List Manual.

Temperature switch

The inverter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

PTC sensor

The inverter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The inverter 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 inverter shuts down with fault F07016.

KTY84 sensor

Use a KTY sensor to monitor the motor temperature and the sensor itself for wire-break or short-circuit.

NOTICE
Motor destruction through overheating
If a KTY sensor is connected with the incorrect polarity, the motor can be destroyed due to overheating, as the inverter cannot detect a motor overtemperature condition.
Connect the KTY sensor with the correct polarity.

- Temperature monitoring:
  The inverter 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 inverter 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 inverter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter 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** Determines the response when the motor temperature reaches the alarm threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); current limit is reduced and timer is started. Shutdown with fault (F07011). 2: Alarm (A07910); timer is started. Shutdown with fault (F07011). 12: As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0640	**Current limit** (input in A)

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

8.6.3 Overcurrent protection

During vector control, the motor current remains within the torque limits set there.

During V/f control, the maximum current controller (I-max controller) protects the motor and converter against overload by limiting the output current.

I-max controller operation

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, (i.e. it is being driven by the connected machine), the I-max controller increases the speed and stator voltage of the motor to reduce the current.

Note

The converter load is only reduced if the motor torque decreases at lower speeds (e.g. for fans).

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

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 it is shut down due to overcurrent.

Table 8- 24 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 1690 in the List Manual.

8.6.4 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 power into electrical power. The electrical power flows back into the inverter and causes V_{DC} in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before harmful voltages occur, the inverter switches off the connected motor with the fault

"DC-link overvoltage".

Protecting the motor and inverter against overvoltage

To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Braking functions of the inverter (Page 238).

There are two different groups of parameters for the Vdc_max control, depending on whether the motor is being operated with U/f control or vector control.

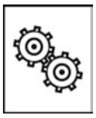
Table 8- 25 V_{DCmax} controller parameters

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).

8.7 Application-specific functions

8.7.1 Functions that match the application



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

- Unit changeover
- Braking functions
- Automatic restart and flying restart
- Basic process control functions

Please refer to the following sections for detailed descriptions.

8.7.2 Unit changeover

Description

With the unit changeover function, you can adapt the inverter to the line supply (50/60 Hz) and also select US units or SI units as base units.

Independent of this, you can define the units for process variables or change over to percentage values.

Specifically, you have the following options:

- Changing over the motor standard (Page 233) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 234)
- Changing over units for the technology controller (Page 234)

Note

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

The procedure is described in Section Switching units with STARTER (Page 235).

Note

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 a multiple 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

8.7.2.1 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the changeover.

Table 8- 26 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm^2	$lb\ ft^2$	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm^2	$lb\ ft^2$	kgm^2

*) Factory setting

8.7.2.2 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units
- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

Note

Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which changeover to % is not possible, the following applies:
p0505 = 1 ≙ p0505 = 2 and p0505 = 3 ≙ p0505 = 4.

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

The parameters affected by changing over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

8.7.2.3 Changing over units for the technology controller

Note

We recommend that the units and reference values of the technology controller are coordinated and harmonized with one another during commissioning.

Subsequent modification in the reference variable or the unit can result in incorrect calculations or displays.

Changing over process variables of the technology controller

You change over the process variables of the technology controller using p0595. For physical values, you define the reference variable in p0596.

The parameters affected by changing over units of the technology controller belong to unit group 9_1. For details, please refer to the section titled "Unit group and unit choice" in the List Manual.

8.7.2.4 Switching units with STARTER

Precondition

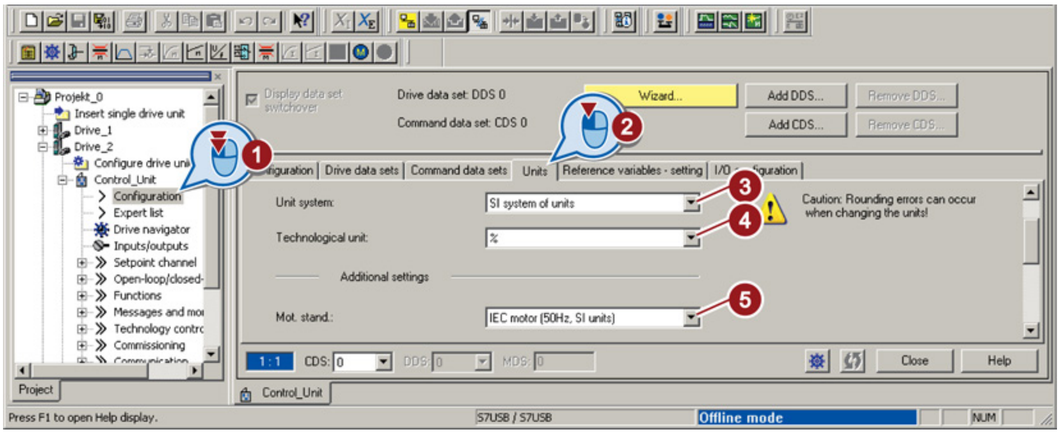
The inverter must be in the offline mode in order to change over the units.

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.

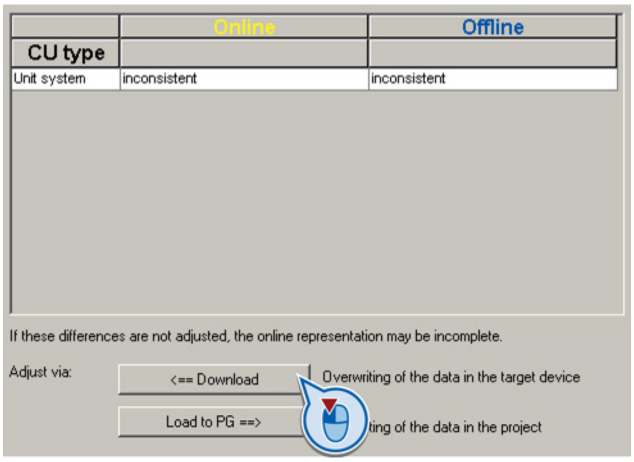
Procedure

1. 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



You have changed over the units.

- Save your settings and go online. In this case, the converter detects that other units or process variables have been set offline than are actually in the converter; the converter displays this in the following screen form:
- Accept these settings in the converter.



8.7.3 Energy-saving display

Background

Conventionally-controlled fluid flow machines control the flow rate using valves or throttles. In so doing, the drive operates constantly at the rated speed. The efficiency of the system decreases if the flow rate is reduced using valves or throttles. The efficiency is the lowest when valves or throttles are ompletely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

The inverter controls the flow rate or the pressure by varying the speed of the fluid flow machine. As a consequence, over its complete operating range, a fluid-flow machine operates close to its maximum efficiency – and especially in partial load operation, uses less energy than for valve and throttle-based controls.

Function

The energy-saving display calculates the energy saved when operating fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors. The energy saving display compares inverter operation with direct on line operation and throttle control.

The inverter indicates the energy saved in parameter r0041 in kWh, referred to the last 100 operating hours.

For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.

The inverter calculates the energy-saving based on the operating characteristic that has been saved.

Table 8- 27 Operating characteristic set in the factory

	Point 1	Point 2	Point 3	Point 4	Point 5
Power	p3320 = 25 %	p3322 = 50 %	p3324 = 77 %	p3326 = 92 %	p3328 = 100 %
Speed	p3321 = 0 %	p3323 = 25 %	p3325 = 50 %	p3327 = 75 %	p3329 = 100 %

If you require a precise value for the energy saving, then you must adapt the operating characteristic set in the factory.

Additional parameters for the energy usage display:

r0039.0: Energy usage since the last reset

r0039.1: Energy drawn since the last reset

r0039.2: Energy fed back since the last reset

p0040: Parameter to reset parameters r0039 and r0041.

r0041: Displays the saved energy since the last reset, referred to the operating characteristic, defined by parameters p3320 …p3329.

Adapting the operating characteristic

Precondition

You require the following data to calculate the system-specific operating characteristic:

- Operating characteristics of the manufacturer
  - for pumps: Delivery height and power as a function of the flow rate
  - for fans: Total pressure increase and power as a function of the flow rate
- System characteristics for 5 different flow rates.

Procedure

Proceed as follows to adapt the operating characteristic:

1. For the 5 different flow rates, calculate the delivery height requirement, referred to a pump, which is directly connected to the line supply (n = 100 %).

   To do this, set the formula for the system characteristic the same as the formula for the operating characteristic of the delivery height.

   For a correspondingly lower delivery height, you only require a correspondingly low speed.
2. Enter the speeds into parameters p3321, p3323, p3325, p3327 and p3329.
3. Based on the flow rates and the associated operating characteristic of the manufacturer, calculate the power that the pump requires for the various flow rates when connected directly to the line supply.
4. Enter the values into parameters p3320, p3322, p3324, p3326 and p3328.

You have adapted the operating characteristic, and you now obtain a precise result for the energy saving.

8.7.4 Braking functions of the inverter

A differentiation is made between mechanically braking and electrically braking a motor:

- Mechanical brakes are generally motor holding brakes that are closed when the motor is at a standstill. Mechanical operating brakes, that are closed while the motor is rotating are subject to a high wear and are therefore often only used as an emergency brake.
  If your motor is equipped with a motor holding brake, then you should use the inverter functions to control this motor holding brake, see Section Motor holding brake (Page 247).
- The motor is electrically braked by the inverter. An electrical braking is completely wear-free. Generally, a motor is switched off at standstill in order to save energy and so that the motor temperature is not unnecessarily increased.

8.7.4.1 Electrical braking methods

Regenerative power

If an induction motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it operates as a generator. The motor converts mechanical power into electrical power. Examples of applications, in which regenerative operation briefly occurs, include:

- Grinding disk drives
- Fans

For certain drive applications, the motor can operate in the regenerative mode for longer periods of time, e.g.:

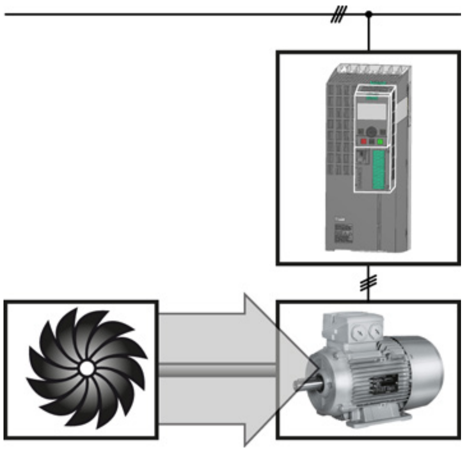
- Centrifuges
- Hoisting gear and cranes
- Conveyor belts with downward movement of load (vertical or inclined conveyors)

The inverter offers the following options to convert the regenerative power of the motor into heat or to feed it back into the line:

- DC braking (Page 240)
- Compound braking (Page 243)
- Dynamic braking (Page 244)

Main features of the braking functions

DC braking



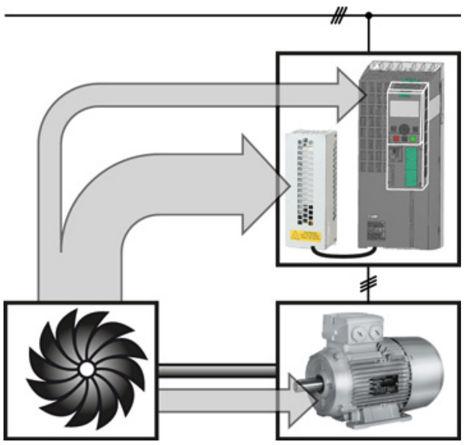
The motor converts the regenerative power into heat.

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

Compound braking

A version of DC braking in which the motor is braked defined. All other properties are identical to DC braking.

Dynamic braking



The inverter converts the regenerative power into heat using a braking resistor.

- *Advantages:* Defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* Braking resistor required; regenerative power is dissipated as heat

Braking method depending on the application

Table 8- 28 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

8.7.4.2 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

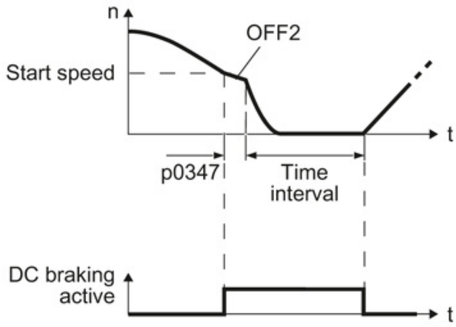
Function

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.

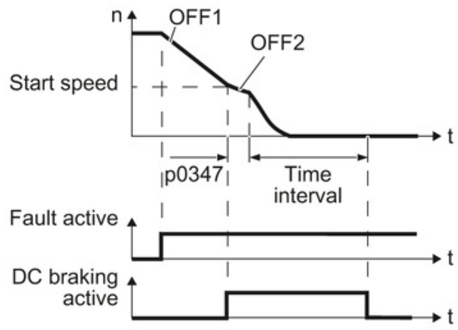
With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

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

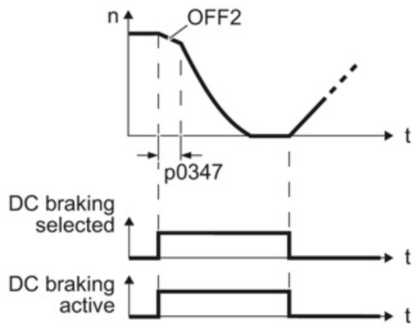
DC braking when falling below a start speed
Precondition: p1230 = 1 and p1231 = 14



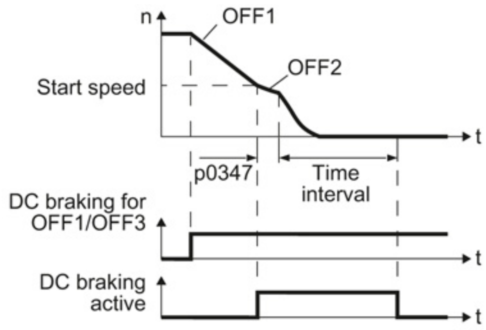
DC braking when a fault occurs
Precondition: Fault number and fault response are assigned using p2100 and p2101



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 No DC braking 4 General release for DC braking 5 DC braking for OFF1/OFF3 14 DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)
p1233	**DC braking duration** (factory setting 1 s)
p1234	**DC braking start speed** (factory setting 210000 rpm)
r1239	**DC braking status word** .08 DC braking active .10 DC braking ready .11 DC braking selected .12 DC braking selection internally locked .13 DC braking for OFF1/OFF3

Table 8- 29 Configuring DC braking when faults occur

Parameter	Description
p2100	**Set fault number for fault response** (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	**Fault response setting** (factory setting 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response. The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault.	

See also

Flying restart – switching on while the motor is running (Page 252)

8.7.4.3 Compound braking

Typical applications for compound braking include:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

For these applications, the motor is normally operated with a constant speed, and is only braked down to standstill after longer periods of time.

Principle of operation

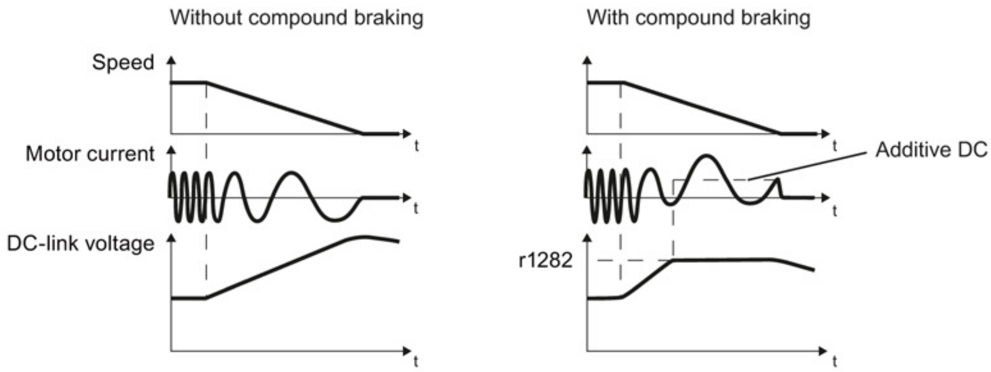


Figure 8-23 Motor brakes with and without active compound braking

Compound braking prevents the DC-link voltage increasing above a critical value. The inverter activates compound braking depending on the DC-link voltage. Above a DC-link voltage threshold (r1282), the inverter adds a DC current to the motor current. The DC current brakes the motor and prevents an excessive increase in the DC-link voltage.

Note

Compound braking is possible only with the U/f control.

Compound braking does not operate in the following cases:

- The "flying restart" function is active
- DC braking is active
- Vector control is selected

Setting and enabling compound braking

Parameter	Description
p3856	**Compound braking current (%)** With the compound braking current, the magnitude of the DC current is defined, which is additionally generated when stopping the motor for operation with U/f control to increase the braking effect. p3856 = 0 Compound braking locked p3856 = 1 … 250 Current level of the DC braking current as a % of the rated motor current (p0305) Recommendation: p3856 < 100% × (r0209 - r0331) / p0305 / 2
r3859.0	**Compound-braking status word** r3859.0 = 1: Compound braking is active

NOTICE

Motor damage from overheating with compound braking

The motor will overheat if braking lasts too long or the motor is braked too often. This may damage the motor.

Monitor the motor temperature. If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

8.7.4.4 Dynamic braking

Typical applications for dynamic braking include:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

For these applications, dynamic motor behavior with different speeds or continuous change of direction is required.

Principle of operation

CAUTION

Burns when touching a hot braking resistor

A braking resistor reaches high temperatures during operation. Touching the braking resistor may result in burns.

- Do not touch a braking resistor during operation.

The inverter controls the braking chopper depending on its DC-link voltage. The DC-link voltage increases as soon as the inverter absorbs the regenerative power when braking the motor. The braking chopper converts this power into heat in the braking resistor. This prevents the DC-link voltage from increasing above the limit value $U_{DC\ link,\ max}$.

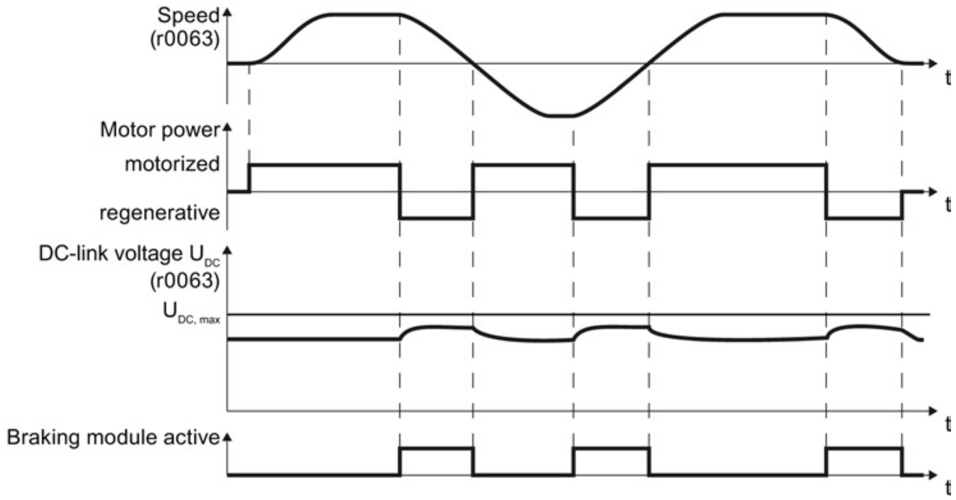


Figure 8-24 Simplified representation of dynamic braking with respect to time

Mounting the braking resistor

You find the mounting instructions in the section: Mounting the braking resistor (Page 30).

Connecting the braking resistor

1. Connect the braking resistor to terminals R1 and R2 on the converter.
2. Ground the braking resistor directly to the control cabinet's grounding bar. The braking resistor must not be grounded using the PE terminals on the converter.
3. If you have to comply with EMC requirements, observe the rules for shielding.
4. Connect the braking resistor's temperature monitoring (terminals T1 and T2 on the braking resistor) with a free digital input of your choice on the converter. Set the function of this digital input to the OFF2 command.

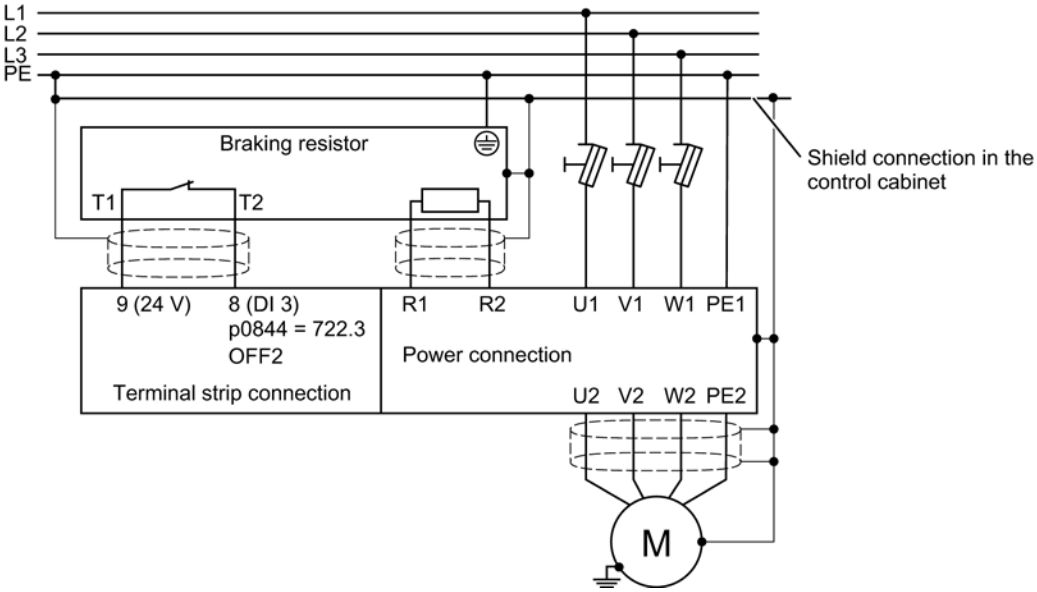


Figure 8-25 Braking resistor connections (Example: temperature monitoring via DI 3)

NOTICE
Without temperature monitoring the resistor might get damaged.

WARNING

Risk of fire, severe personal and property damage

If an unsuitable braking resistor is used, this could result in a fire and severely damage, people, property and equipment. It is essential that not only the correct braking resistor is used, but it is installed correctly according to the instructions delivered with the braking resistor.

The temperature of braking resistors increases significantly during operation. For this reason, avoid coming into direct contact with braking resistors. Maintain sufficient clearances around the braking resistor and ensure that there is adequate ventilation.

Procedure: Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 8- 30 Parameter

Parameter	Description	
p0219	**Braking power of the braking resistor** (factory setting: 0 kW) Set the maximum braking power that the braking resistor must handle in your particular application. Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor. **Example**: In your particular application, the motor brakes every 10 seconds. In so doing, the braking resistor must handle a braking power of 1 kW for 2 s. Use a braking resistor with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the maximum braking power to: p0219 = 1 (kW).	
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.

8.7.4.5 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The inverter has internal logic to optimally control a motor holding brake.

The inverter-internal control of the motor holding brake is suitable typically for horizontal, inclined and vertical conveyors.

A motor holding brake can also be useful in several applications for pumps or fans to ensure that the powered-down motor does not rotate in the wrong direction through a liquid or air flow.

Connecting the motor holding brake

You have to define which of the digital outputs is to be used for controlling the motor holding brake function.

There are two digital outputs to choose from, for example, the motor holding brake can be connected to the converter using digital output 0 (DO 0) on terminals 19 and 20.

The converter supplies the control for the motor holding brake.

You have to supply the following equipment:

- A motor holding brake suitable for the attached motor and the purposes of the application.
- A power supply for the motor holding brake.
- A relay to allow the digital output to enable or disable the motor holding brake.

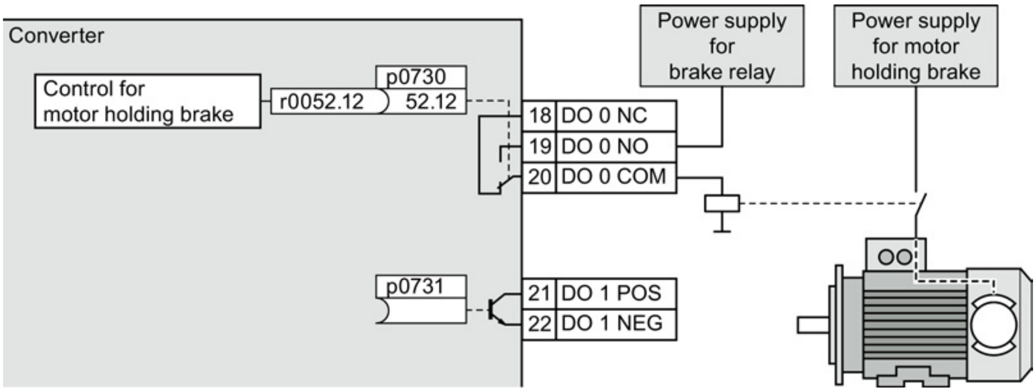


Figure 8-26 Simplified diagram of motor holding brake connected to DO 0 of the converter

Function after OFF1 and OFF3 command

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

1. After the ON command (switch on motor), the converter 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. After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
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.

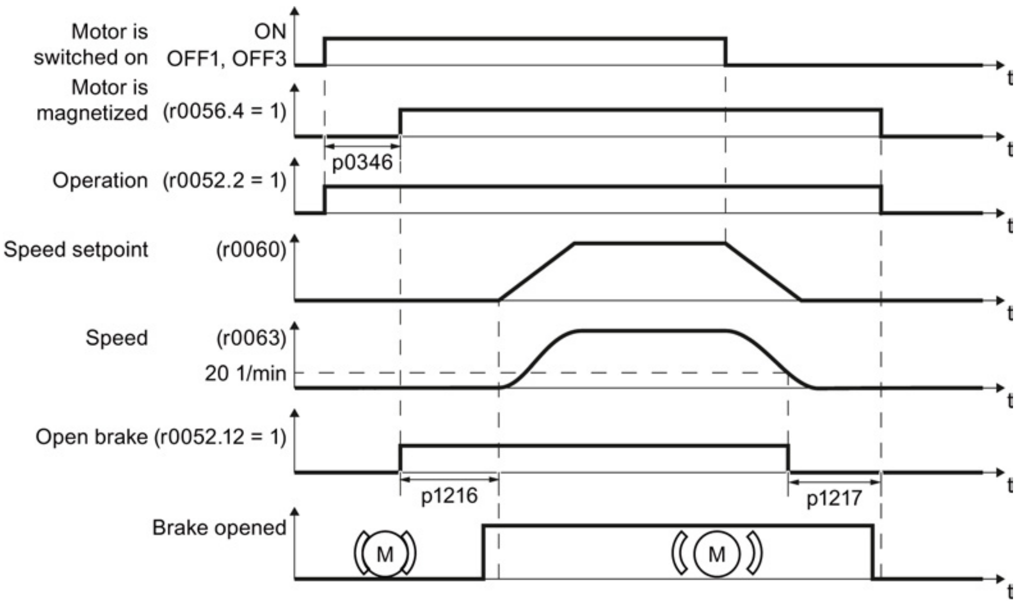


Figure 8-27 Controlling the motor holding brake when the motor is switched on and off

Function after OFF2 – or the selection of the "Safe Torque Off" (STO) safety function

For the following signals, the brake closing time is not taken into account:

- OFF2 command
- After selecting the "Safe Torque Off" (STO) safety function

After these control commands, the inverter issues the signal to immediately close the motor holding brake, independent of the motor speed.

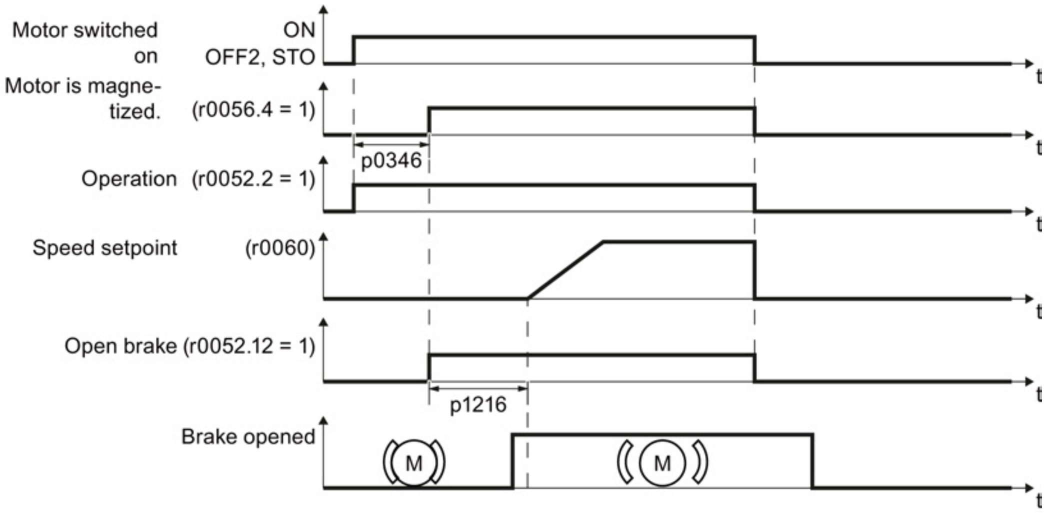


Figure 8-28 Controlling the motor holding brake after an OFF2 command or selecting STO

Commissioning a motor holding brake

DANGER

Danger to life due to falling loads

For applications such as lifting equipment, cranes or elevators, there is a danger to life if the "Motor holding brake" function is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any dangerous loads, e.g. by applying the following measures:
  - Lower the load down to the floor
  - Cordon off the hazardous area so that nobody can enter it

Precondition

The motor holding brake is connected to the inverter.

Procedure

Proceed as follows to commission the "Motor holding brake" function using an operator panel.

1. Set p1215 = 1.

   The "Motor holding brake" function" is enabled.
2. Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero.
3. Take the opening and closing times of the connected brake from the technical data for the motor holding brake.
   - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
   - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
4. Set the following parameters in the inverter to match the opening and closing times of the brake:
   - Opening time ≤ p1216.
   - Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   - If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.

     In this case, increase the opening time p1216.
   - After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   - U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   - Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   - If the brake closes too late, the load briefly sags before the brake closes.

     In this case, increase the closing time p1217.
   - After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.

You have commissioned the "Motor holding brake" function.

Table 8- 31 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 8- 32 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.

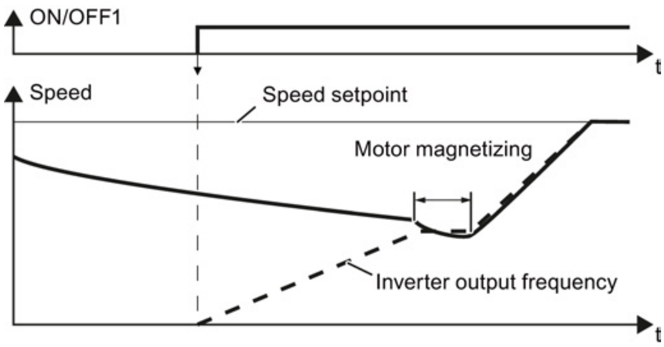
8.7.5 Automatic restart and flying restart

8.7.5.1 Flying restart – switching on while the motor is running

If you switch on the motor while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (overcurrent fault F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

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

After the ON command, the "flying restart" function initially synchronizes the converter output frequency to the motor speed and then accelerates the motor up to the setpoint.



If the converter simultaneously drives several motors, then you must only use the "flying restart" function if the speed of all of the motors is always the same (group drive with a mechanical coupling).

Table 8- 33 Basic setting

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

Table 8- 34 Advanced settings

Parameter	Description
p1201	**Flying restart enable signal source** (factory setting 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
p1202	**Flying restart search current** (factory setting 100%) Defines the search current with respect to the motor magnetizing current (r0331), which flows in the motor while the flying restart function is being used.
p1203	**Flying restart search speed factor** (factory setting 100%) The value influences the speed with which the output frequency is changed during the flying restart. A higher value results in a longer search time. If the converter does not find the motor, reduce the search speed (increase p1203).

8.7.5.2 Automatic switch-on

The automatic restart includes two different functions:

- The inverter automatically acknowledges faults.
- After a fault occurs or after a power failure, the inverter automatically switches-on the motor again.

The inverter interprets the following events as power failure:

- The inverter signals fault F30003 (DC-link undervoltage), as the line supply voltage of the inverter has briefly failed.
- The inverter power supply has failed for a long enough time so that the inverter has been switched-off.

WARNING

Injuries from the automated machine restart

When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. The movements that the machine executes may result in serious injuries.

- Block the machine to prevent unintentional access.
- Before working on the machine switch the automatic restart mechanism off.

Commissioning the automatic restart

Procedure

Proceed as follows to commission the automatic restart:

1. 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 252).
2. Using p1210, select the automatic restart mode that best suits your application.

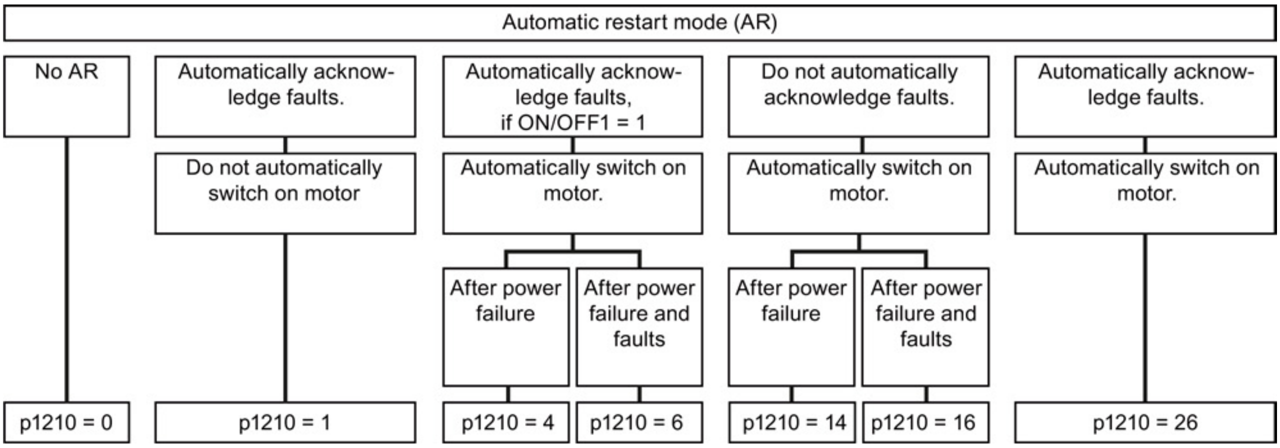
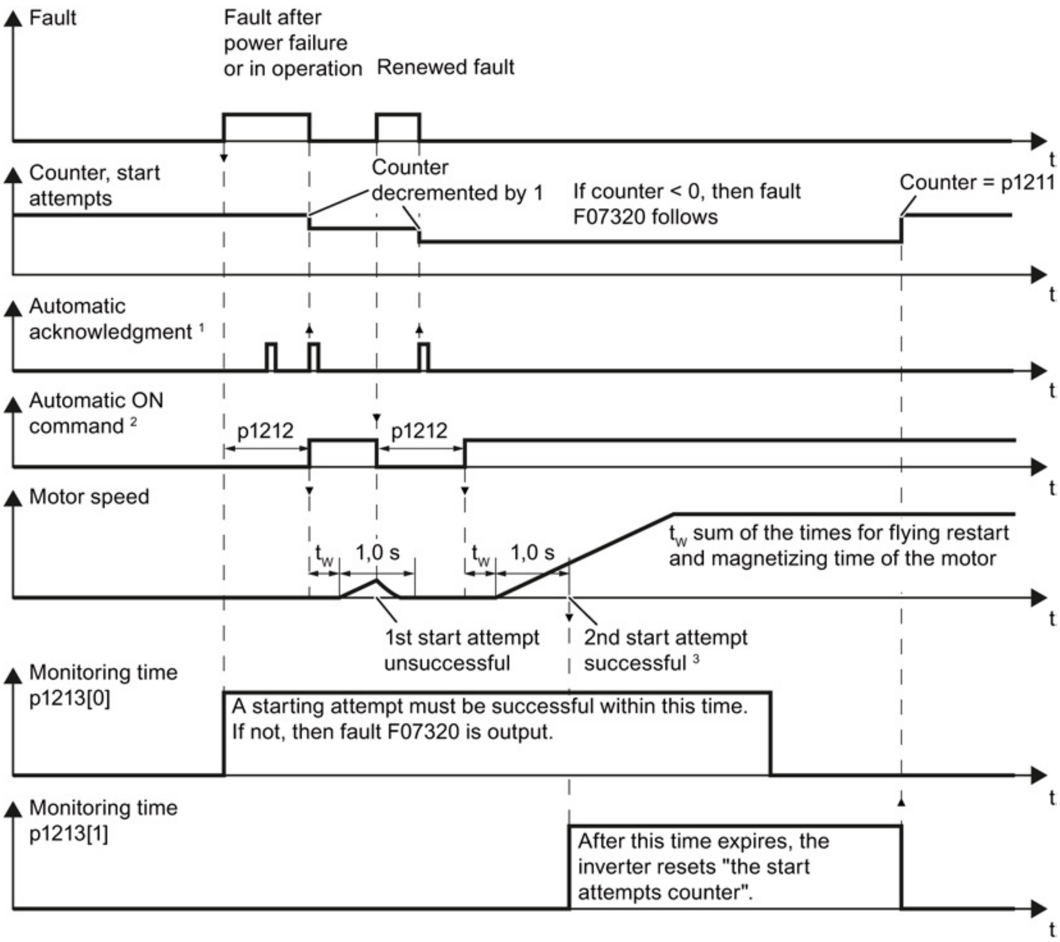


Figure 8-29 Selecting the automatic restart mode

3. Set the parameters of the automatic restart function.
   The method of operation of the parameters is explained in the following diagram and in the table.



[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-on the motor under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).

[3] If no fault has occurred one second after flying restart and magnetizing (r0056.4 = 1), the start attempt was successful.

Figure 8-30 Time response of the automatic restart

You have commissioned the automatic restart function.

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.
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. For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts. The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled: • After a successful start attempt, the time in p1213[1] has expired. • After fault F07320, switch off the motor (OFF1) and acknowledge the fault. • You change the start value p1211 or the mode p1210.
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.

Parameter	Explanation
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 the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch on the motor again, you must acknowledge the fault and set ON/OFF1 = 1.

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**

Personal injury and property damage

In the case of communication via the fieldbus interface, the motor restarts with the setting p1210 = 6 even if the communication link is interrupted. This means that the controller cannot stop the motor. To avoid this dangerous situation, you must enter the fault code of the communications fault in parameter p1206.

Example: A communication failure via PROFIBUS is signaled using fault code F01910. You should therefore set p1206[n] = 1910 (n = 0 … 9).

8.7.6 PID technology controller

8.7.6.1 Overview

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

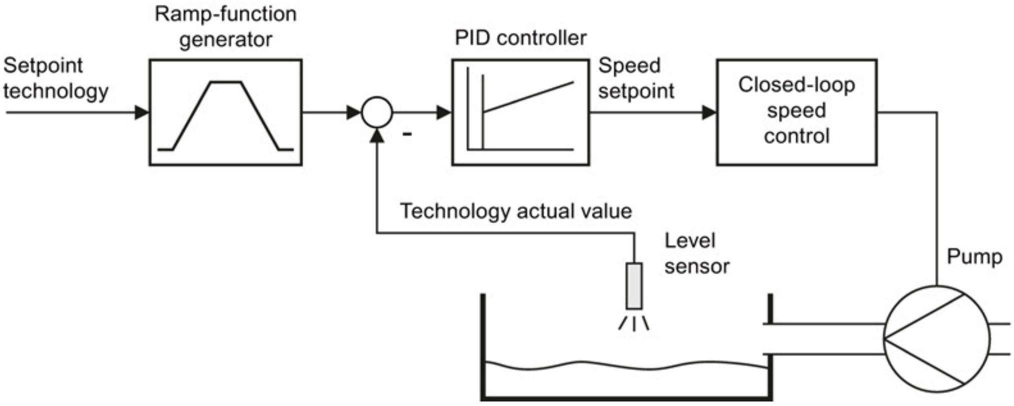


Figure 8-31 Example: technology controller as a level controller

8.7.6.2 Setting the controller

Simplified representation of the technology controller

The technology controller is implemented as PID controller (controller with proportional, integral and differential component) and so can be adapted very flexibly.

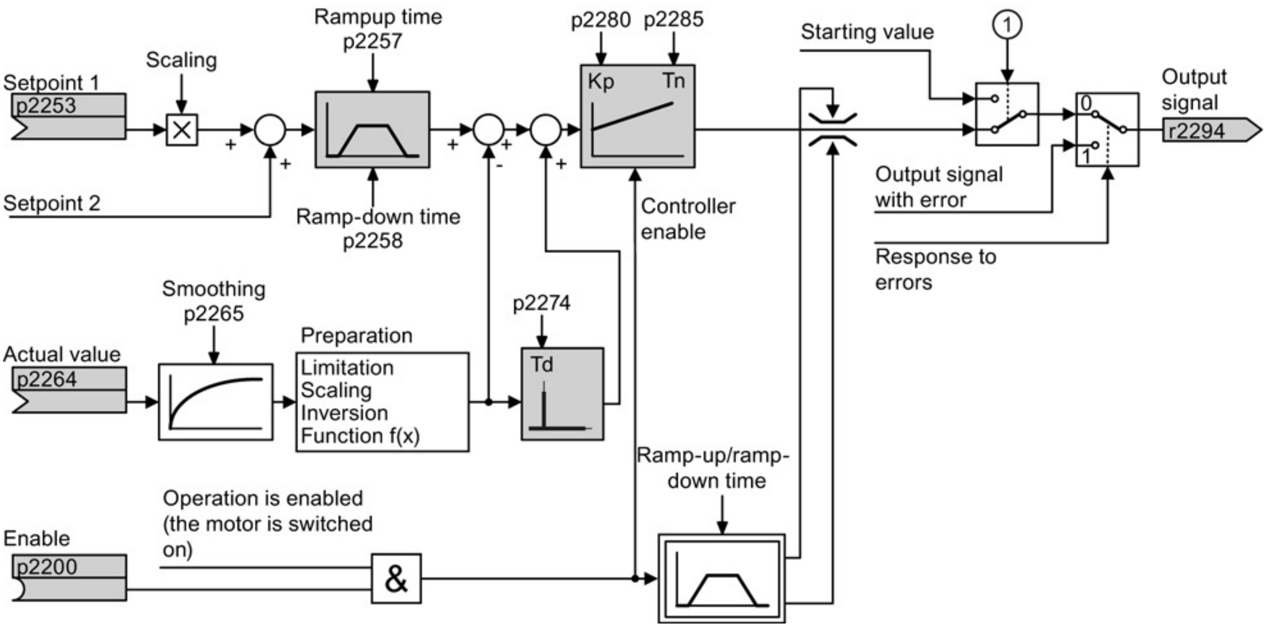


Figure 8-32 Simplified representation of the technology controller

Setting the technology controller

Parameter	Remark
p2200 = 1	Enable technology controller.
p1070 = 2294	Interconnect the main speed setpoint with the output of the technology controller.
p2253 = …	Define the setpoint for the technology controller. Example: p2253 = 2224: The converter interconnects the fixed setpoint p2201 with the setpoint of the technology controller. p2220 = 1: The fixed setpoint p2201 is selected.
p2264 = …	Define the actual value for the technology controller. Example: For p2264 = 755[0], analog input 0 is the source for the actual value.
p2257, p2258	Define the ramp-up and ramp-down times [s]
p2274	Differentiation time constant [s] The differentiation improves the rise time characteristics for very slow controlled variables, e.g. a temperature control. p2274 = 0: The differentiation is switched off.
p2280	Proportional gain K_P
p2285	Integral time T_N [s] Without an integral time, the controller cannot completely equalize deviations between the setpoint and actual value. p2285 = 0: The integral time is switched off.

Advanced settings

Parameter	Remark
Limiting the output of the technology controller In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application. Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.	
p2297 = 2291	Interconnect the upper limit with p2291.
p2298 = 2292	Interconnect the lower limit with p2292.
p2291	Upper limit for the technology controller output e.g.: p2291 =100
p2292	Lower limit for the technology controller output e.g.: p2292 = 0
Manipulating the actual value of the technology controller	
p2267, p2268	Limit the actual value
p2269	Scale the actual value
p2271	Invert the actual value
p2270	Actual value

You can find additional information in function block diagram 7958 of the List Manual.

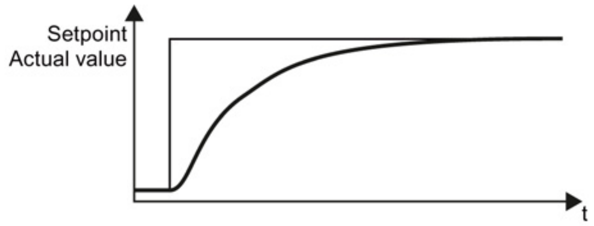
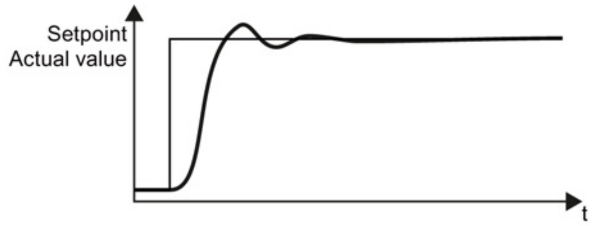
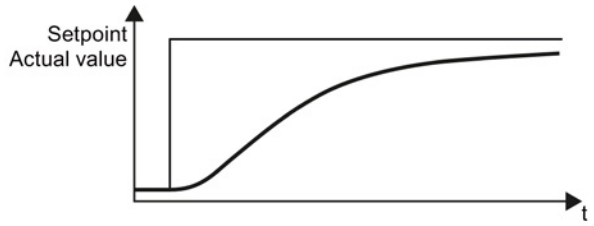
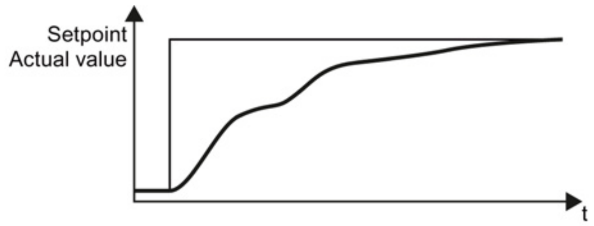
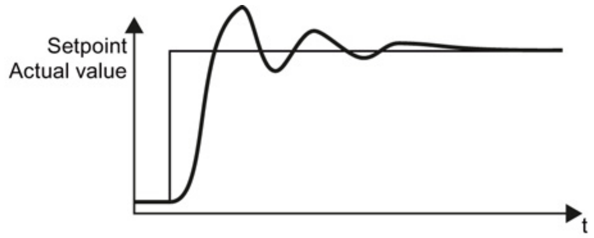
8.7.6.3 Optimizing the controller

Setting the technology controller from a practical perspective

Procedure

Proceed as follows to set the technology controller:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

	**Optimum controller response for applications that do not permit any overshoot.** The actual value approaches the setpoint without any significant overshoot.
	**Optimum controller behavior for fast correction and quick compensation of noise components.** The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).
	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**Actual value only slowly approaches the setpoint with slight oscillation.** • Increase the proportional component K_P and reduce the rate time T_D (differentiating time).
	**The actual value quickly approaches the setpoint, but overshoots too much** • Decrease the proportional component K_P and increase the integration time T_N.

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

You have now set the technology controller.

8.8 Fail-safe function Safe Torque Off (STO)

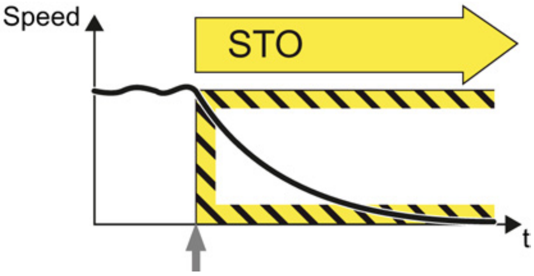
These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Further information on your inverter (Page 395).

8.8.1 Functional description

Definition according to 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)."



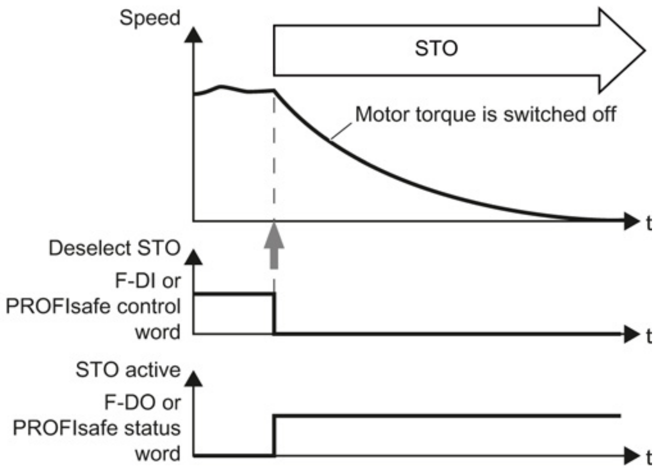
Application examples

Example	Possible solution
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	• Wire the Emergency Stop button with a fail-safe input. • Select STO via the fail-safe input.
A central Emergency Stop button ensures that several drives cannot unintentionally start.	• Evaluate the Emergency Stop button in a central control. • Select STO via PROFIsafe.

How does STO function in detail?

The inverter recognizes the selection ofSTO via a fail-safe input or via the safe communicationPROFIsafe.

The inverter then safely switches off the torque of the connected motor.



If no motor holding brake is present, the motor coasts to a standstill.

If you use a motor holding brake, the inverter closes the brake immediately after selecting STO.

8.8.2 Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

8.8.3 Commissioning STO

8.8.3.1 Commissioning tool

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

If you use STARTER for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 35 STARTER commissioning tool (PC software)

Download	Order number
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3255-0AA00-2CA0 PC Connection Kit, includes STARTER DVD and USB cable

8.8.3.2 Protection of the settings from unauthorized changes

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

Table 8- 36 Parameter

No.	Description
p9761	**Entering a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

See also

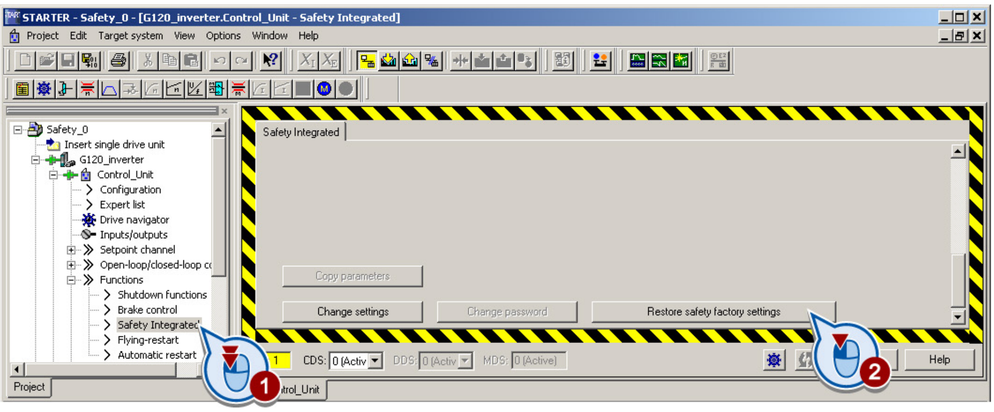
Product Support (Page 396)

8.8.3.3 Resetting the safety function parameters to the factory setting

Procedure

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

1. Go online with STARTER
2. Open the screen form for the safety functions ①.



3. Press the button to restore the factory settings ②.
4. Enter the password,for the safety functions.
5. Confirm saving parameters (RAM to ROM).
6. Go offline with STARTER .
7. Switch off the inverter supply voltage.
8. Wait until all of the LED on the inverter go dark. Now switch on the inverter power supply again (power on reset).

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

Parameters	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	95	Safety Integrated commissioning
p0970	**Reset drive parameters**	
	0	Inactive
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Confirm password**	

8.8.3.4 Changing settings

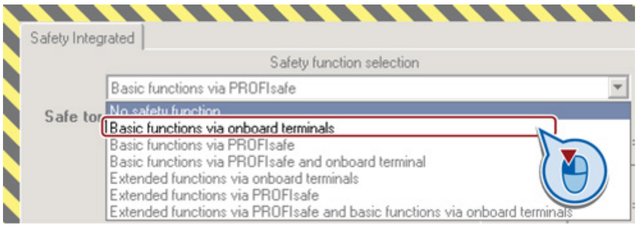
Procedure

To start commissioning the safety functions, proceed as follows:

1. Go online with STARTER.
2. In STARTER, select the fail-safe functions.
3. Select "Change settings".

Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

4. Selecting "STO via terminal":



You have completed the following commissioning steps:

- You have started to commission the safety functions.
- You have selected the basic functions via onboard terminals of the inverter.

Table 8- 37 Parameter

Parameter	Description	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
	p9601 = 0	Safety functions integrated in the drive inhibited
	p9601 = 1	Enable basic functions via onboard terminals

The other selection options are described in the "Safety Integrated Function Manual". See also Section: Manuals for your inverter (Page 395).

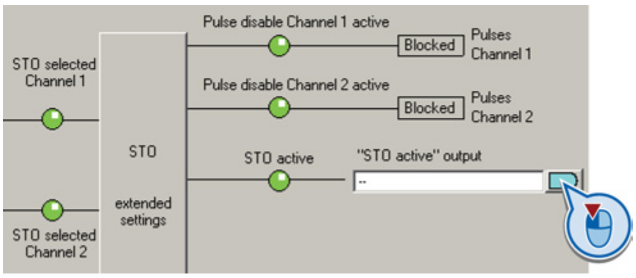
8.8.3.5 Interconnecting the "STO active" signal

If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.



2. In the following selection menu, select the appropriate setting for your particular application.

You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

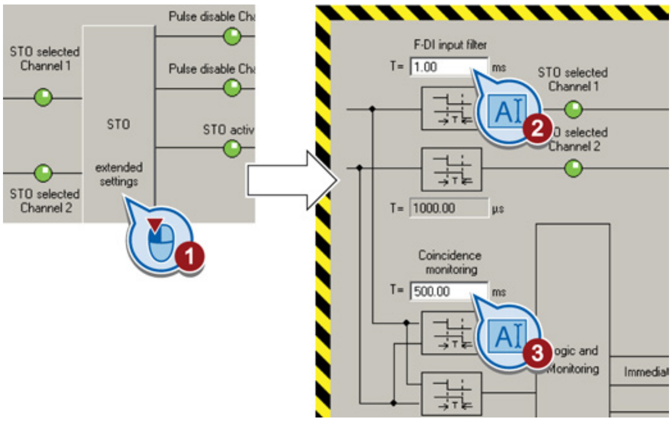
Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

8.8.3.6 Setting the filter for fail-safe inputs

Procedure

To set the input filter and monitoring for simultaneous operation for a fail-safe input, proceed as follows:

1. Select the advanced settings for STO.



2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the fail-safe input.

Description of the signal filter

The following are available for the signal processing of the fail-safe inputs:

- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a fail-safe input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

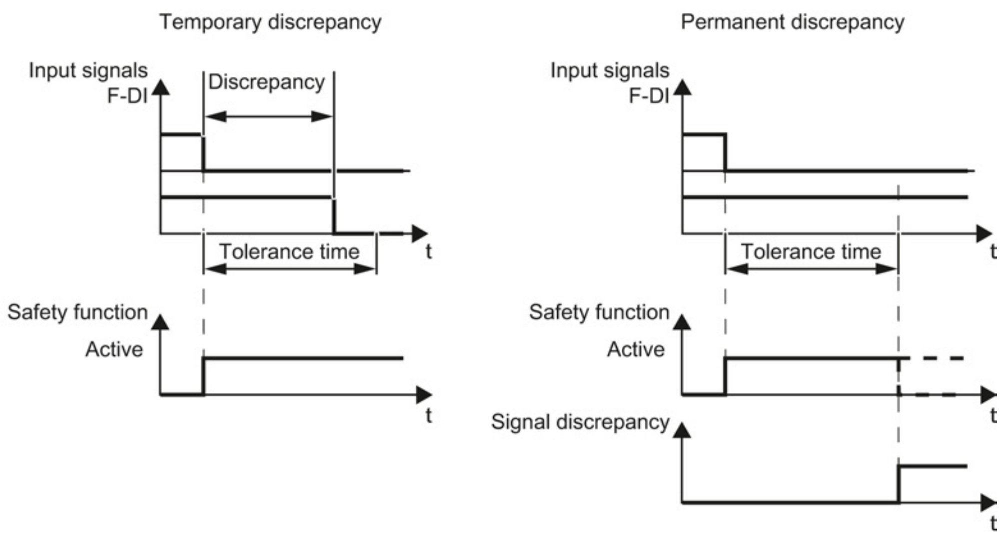


Figure 8-33 Tolerance regarding discrepancy

Filter to suppress short signals

The inverter normally responds immediately to signal changes at its fail-safe inputs. This is not required in the following cases:

- When you interconnect a fail-safe 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 fail-safe outputs using bit pattern tests (on/off tests), in order to identify faults due to either short-circuit or cross-circuit faults. When you interconnect a fail-safe input of the inverter with a fail-safe 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 fail-safe input signals too many signal changes within a certain time, then the inverter responds with a fault.

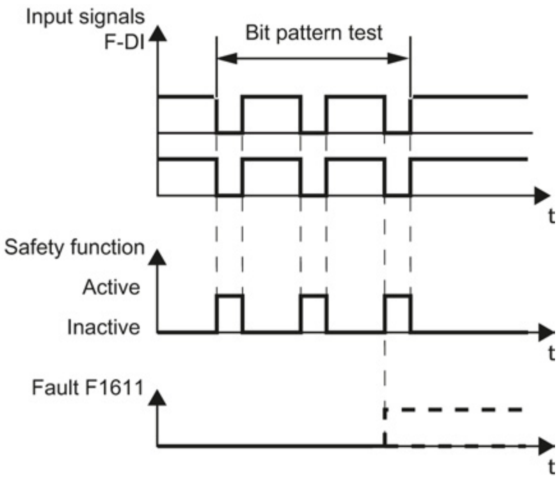


Figure 8-34 Inverter response to a bit pattern test

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

The filter increases the inverter response time. The inverter only selects its safety function after the debounce time has elapsed.

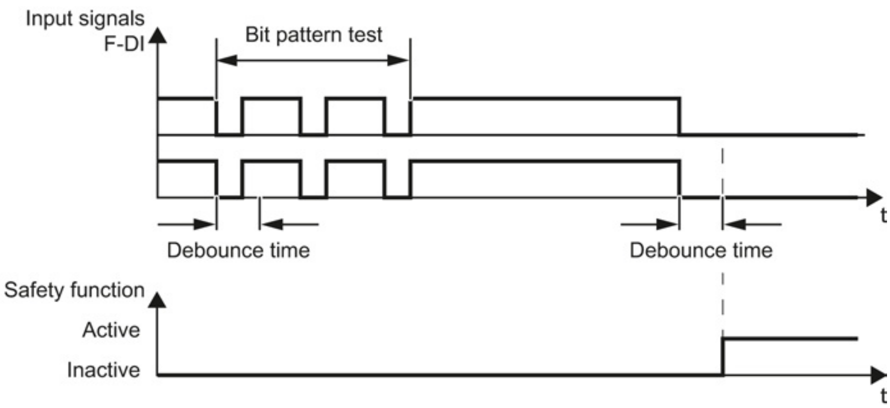


Figure 8-35 Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

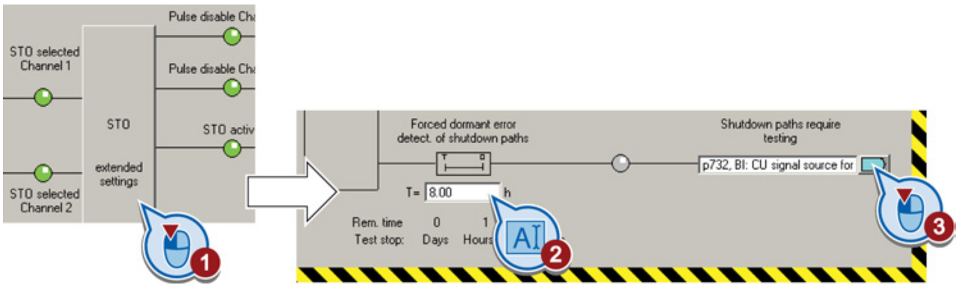
If you use an input as a fail-safe input, set the debounce time as described above.

8.8.3.7 Setting forced dormant error detection

Procedure

To set forced dormant error detection of the basic functions, proceed as follows:

1. Select the advanced settings for STO.



2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced dormant error detection is required.

   Interconnect this signal - for example - with a digital output of your choice.

You have set the forced dormant error detection for the basic functions.

Description of the forced dormant error detection

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the inverter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

Forced dormant error detection of the basic functions

The forced dormant error detection of the basic functions is the regular self-test of the inverter that causes the inverter to check its circuits to switch-off the torque. If you use the Safe Brake Relay, for a forced dormant error detection, the inverter also checks the circuits of this option module.

The inverter executes a forced dormant error detection under the following circumstances:

- every time the supply voltage is connected.
- every time after the STOfunction has been selected.

The inverter monitors the regular forced dormant error detection.

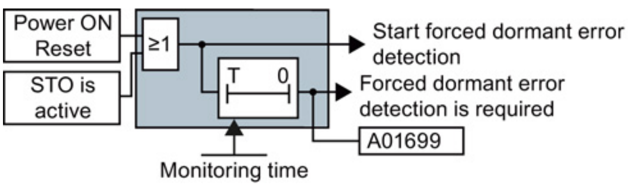


Figure 8-36 Triggering and monitoring the forced dormant error detection

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.

Time of the forced dormant error detection

In the case of warning A01699 , you must initiate a forced dormant error detection at the next opportunity. These alarms do not affect the operation of your machine.

- Switch off the motor.
- Select function STO or switch off the inverter supply voltage temporarily and on again.

Examples for the times when forced dormant error detection is performed:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent).

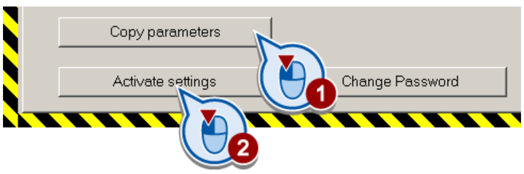
8.8.3.8 Activate settings

Activate settings

Procedure

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.



2. Press the "Activate settings" button.
3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
4. Confirm the prompt for saving your settings (copy RAM to ROM).
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark (no voltage condition).
7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	**Confirm data change** (factory setting: 0)Confirm data change overall.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p9761	**Enter a password** (factory setting 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

See also

Protection of the settings from unauthorized changes (Page 263)

8.8.3.9 Checking the assignment of the digital inputs

Checking the assignment of the digital inputs

If you control the safety functions in the inverter using digital inputs, then you must check as to whether these digital inputs have been assigned other functions.

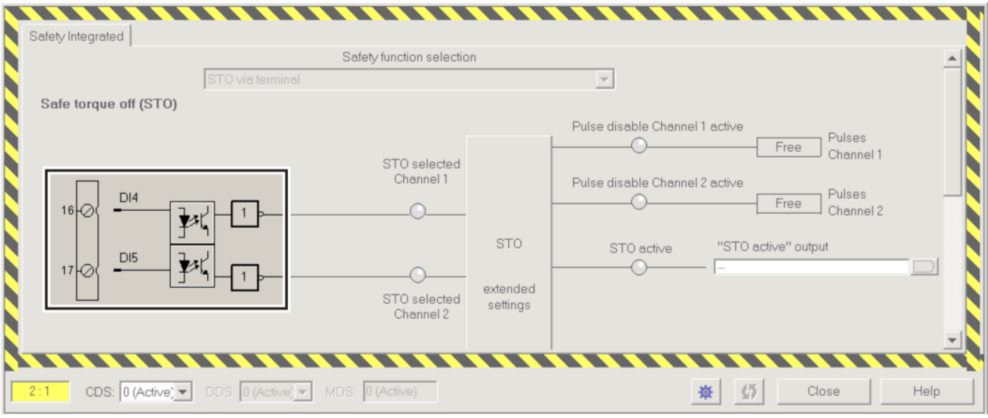


Figure 8-37 Example: Assignment of digital inputs DI 4 and DI 5 with STO

Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the drive.

Procedure

To check the assignment of the digital inputs, proceed as follows:

1. In STARTER, select the screen form for the terminals of the digital inputs.
2. Remove all signal interconnections of the digital inputs that you wish to use as fail-safe input F-DI:

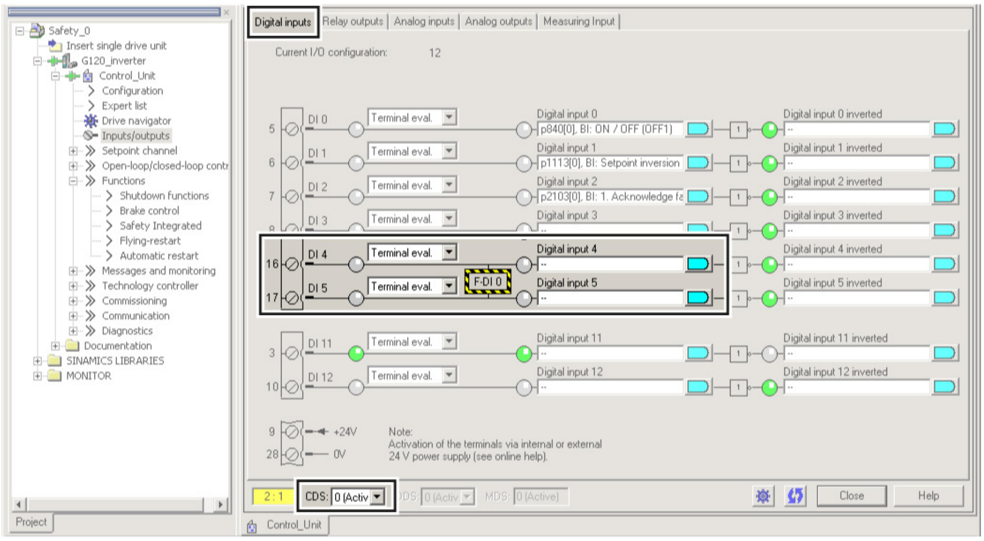


Figure 8-38 Remove pre-assignment of digital inputs DI 4 and DI 5

3. When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

You have ensured that the fail-safe inputs of the safety functions do not control other functions in the inverter.

8.8.3.10 Acceptance test

Why is acceptance required?

The EC Machinery Directive and ISO 13849-1 stipulate:

- You must check safety-related functions and machine parts after commissioning.
  → Acceptance test.
- You must create an "acceptance report" showing the test results.
  → Documentation.

Acceptance test

The acceptance test comprises two parts:

- Checking whether the safety functions in the inverter are correctly set:
  - Does the speed control handle the configured application cases in the machine?
  - Do the set interface, times and monitoring functions match the configuration of the machine?
- Checking whether the safety-relevant functions in the plant or machine function correctly.
  This part of the acceptance test goes beyond the inverter acceptance test:
  - 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 correctly respond to the safety-relevant feedback signals of the inverter?
  - Do the inverter settings match the configured safety-relevant function in the machine?

Documentation

The documentation consists of the following parts:

- Description of the safety-relevant components and functions of the machine or plant.
- Report of the acceptance test results.
- Report of the settings of the safety functions.
- Countersigned documentation.

Authorized persons

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 carry out an acceptance.

Reduced acceptance test

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

- The reduced acceptance test is only required for the part of the machine that has been changed as a result of replacement, update, or function expansion.
- The acceptance test is only required for the safety functions that you actually use.

Table 8- 38 Reduced scope acceptance test for function expansions

Measure	Acceptance test	
	Acceptance test	**Documentation**
Replace the inverter.	No. Only check the direction of rotation of the motor.	• Supplement inverter data • Log the new checksums • Countersignature
Replacing the motor.		No change.
Replacing the gearbox.		
Replace the safety-related peripherals (e.g. Emergency Off switch).	No. Only check the control of the safety functions that are influenced by the components that have been replaced.	No change.
Inverter firmware update.	No.	• Supplement firmware version in the inverter data • Log the new checksums • Countersignature.
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement inverter data • Supplement function table • Supplement limit values • Log the new checksums • Countersignature
Transfer of converter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	• Supplement machine description • Check checksums • Check firmware versions

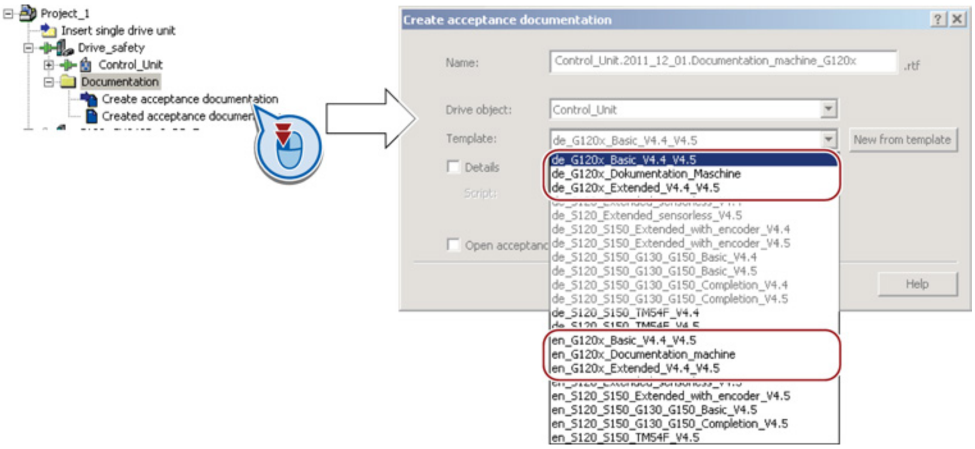
Documents for the acceptance test

The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

Procedure

Proceed as follows to create the acceptance documentation for the drive using STARTER:

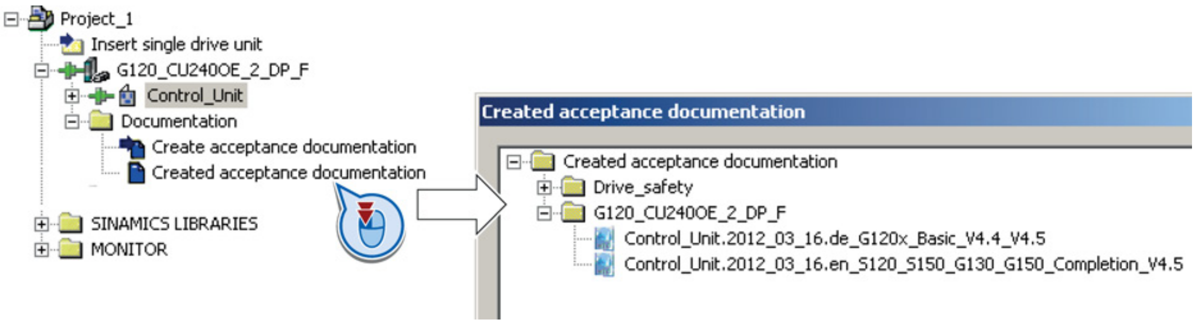
1. In STARTER, select "Create acceptance documentation":



   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: Documentation for acceptance of safety functions (Page 392).

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

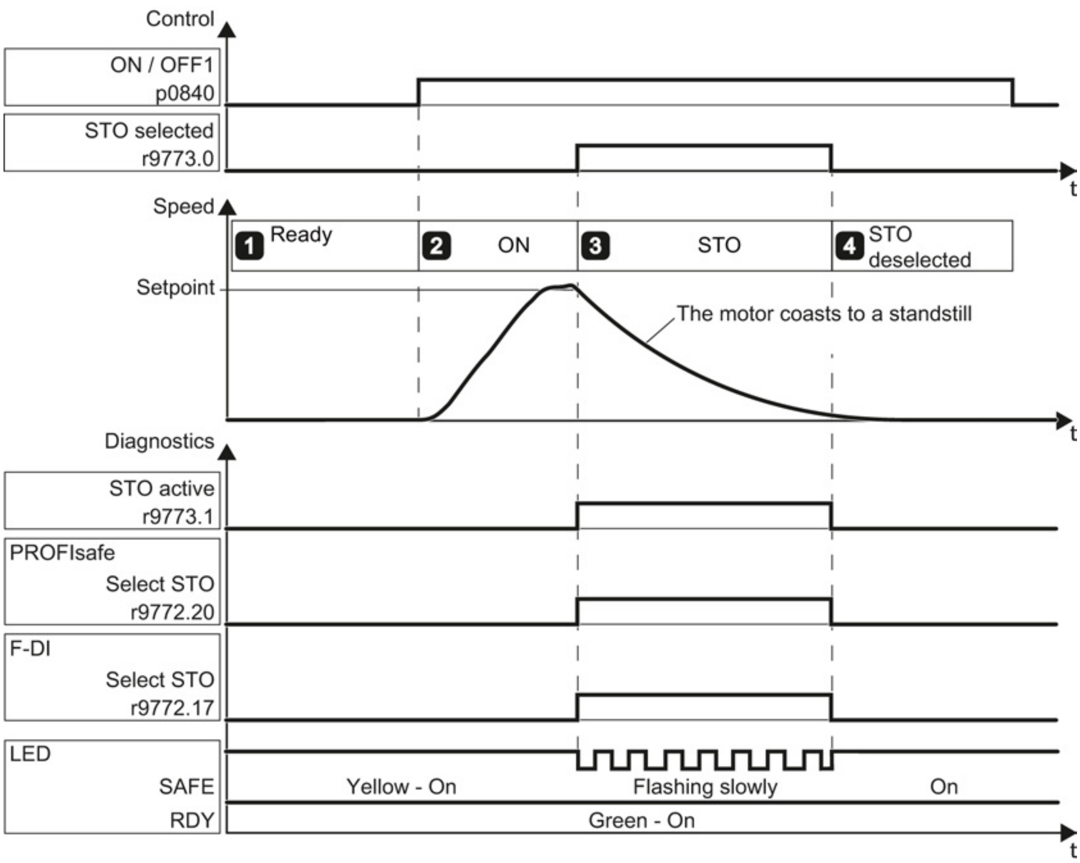


Figure 8-39 Acceptance test for STO (basic functions)

Procedure

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

				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.		
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 by PROFIsafe	For control via terminal	
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 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 a 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.

8.9 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.

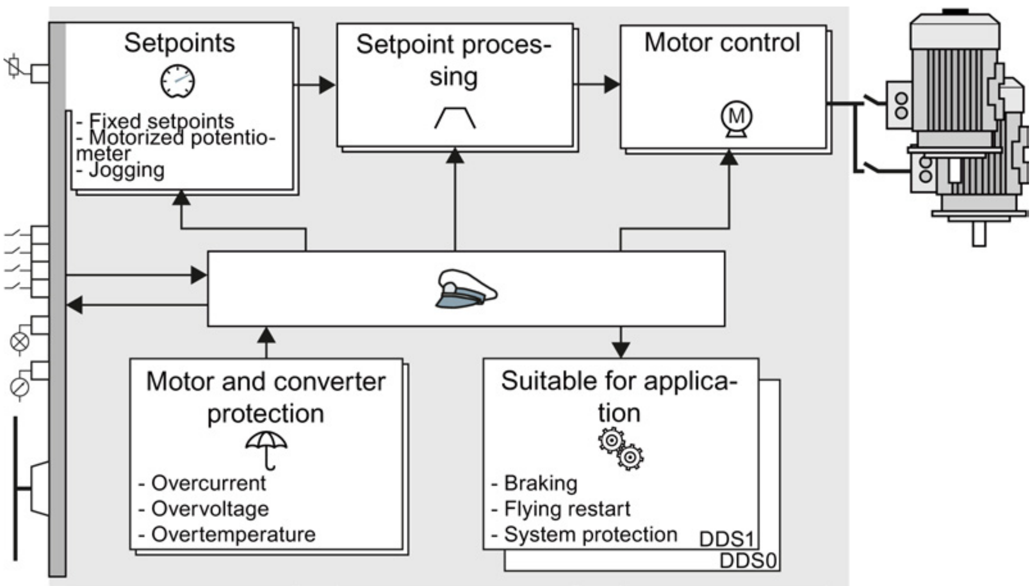


Figure 8-40 DDS switchover in the inverter

You can use parameter p0180 to define the number of drive data sets (1 or 2).

Table 8- 39 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0180	**Drive data sets (DDS) number**(factory setting: 1)
p0010 = 0	**Drive commissioning:** Ready

Table 8- 40 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 8- 41 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).

Backup data and series commissioning 9

External data backup

After commissioning, your settings are saved in the inverter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the inverter. Without backup, your settings could be lost if the inverter developed a defect (see also Overview of how to replace an inverter (Page 303)).

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

NOTICE
Data backup using operator panels with USB connection with the PG/PC is not possible
If the inverter is connected to a PG/PC via a USB cable, you can save any data on the MMC via the operator panels. To allow you to save data on the MMC using an operator panel, you must release the USB connection between PG/PC and inverter.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Procedure

You must proceed as follows to carry out series commissioning:

1. Commission the first inverter.
2. Back up the settings of the first inverter to an external storage medium.
3. Transfer the settings of the first inverter to another inverter via the storage medium.

Note

The control unit to which the settings are transferred must have the same order number and the same or a higher firmware version as the source control unit.

You have carried out series commissioning.

9.1 Backing up and transferring settings using memory card

What memory cards do we recommend?

You will find the recommended memory cards in Section: Commissioning tools, page 23.

SDHC cards (SD High Capacity) are not possible.

Using memory cards from other manufacturers

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 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

Note

Limited function with memory cards from other manufacturers

Under certain circumstances, third-party memory cards do not support all functions (e.g. download). You use these cards at your own risk.

9.1.1 Saving setting on memory card

We recommend that you insert the memory card before switching on the inverter. The inverter always also backs up its settings on an inserted card.

If you wish to backup the inverter settings on a memory card, you have two options:

Automatically backing up

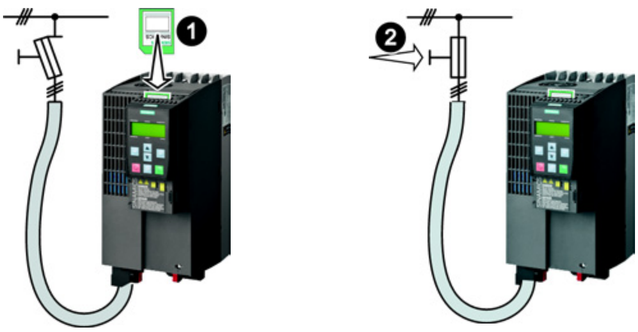
Preconditions

- The inverter power supply has been switched off.
- No USB cable is inserted in the inverter.

Procedure

Proceed as follows to automatically backup your settings:

1. Insert an empty memory card into the inverter.
2. Then switch-on the inverter power supply.



After it has been switched on, the frequency inverter copies its settings to the memory card.

Note

If the memory card is not empty, then the inverter accepts the data from the memory card. This deletes the old setting in the inverter.

Only use empty memory cards for automatic data backup.

Manually backing up

Preconditions

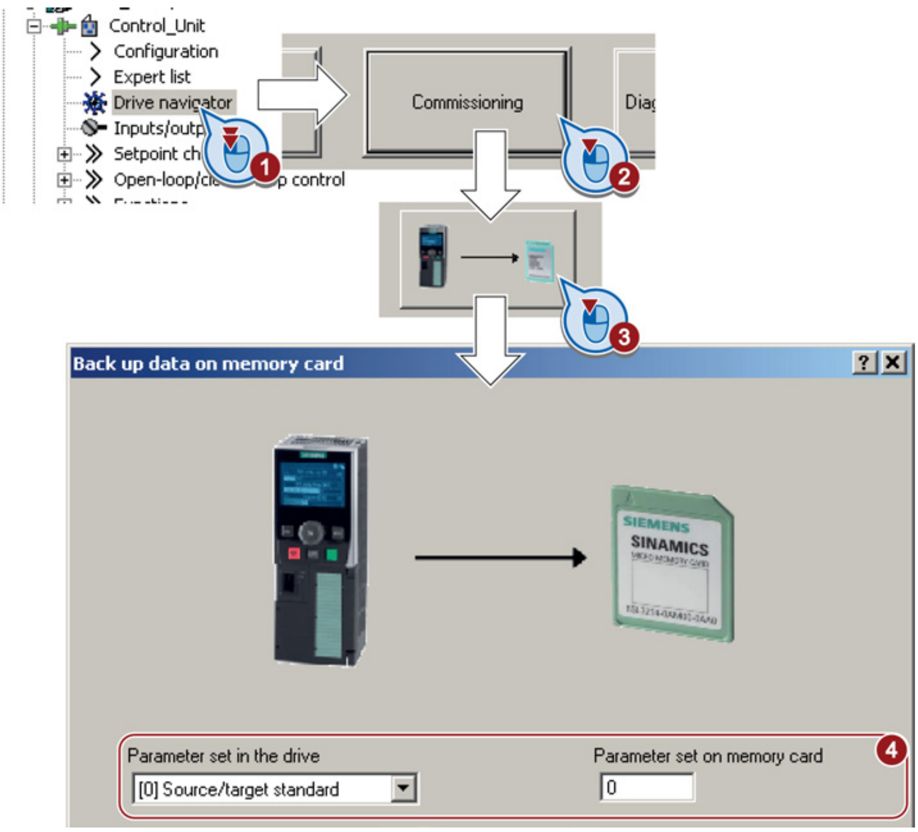
- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

Procedure using STARTER

Proceed as follows to manually back up your settings on a memory card:

1. Go online with STARTER, e.g. via a USB cable.

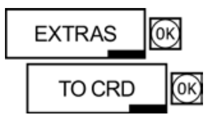
   In your drive, select "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.



You have manually backed up the settings on the memory card.

Procedure with the BOP-2

Proceed as follows to manually back up your settings on a memory card:



1. Remove the USB cable if one is inserted in the inverter.
2. Plug a BOP-2 onto the inverter.
3. Go to the menu level "EXTRAS".
4. In the menu, select "EXTRAS" - "TO CRD".

You have manually backed up the settings on the memory card.

9.1.2 Transferring the setting from the memory card

Automatically transferring

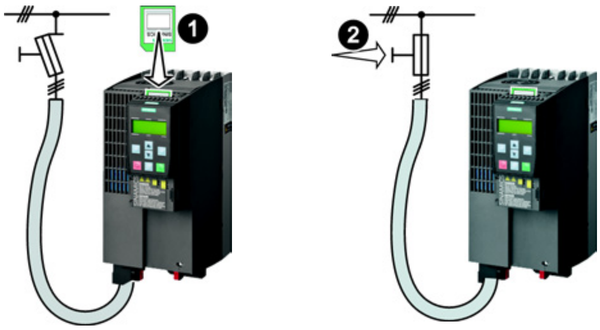
Precondition

The inverter power supply has been switched off.

Procedure

Proceed as follows to automatically transfer your settings:

1. Insert the memory card into the inverter.
2. Then switch on the inverter power supply.



If there is valid parameter data on the memory card, then the inverter accepts the data from the memory card.

Manually transferring

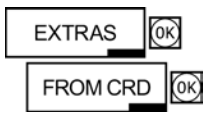
Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

Procedure with the BOP-2

Proceed as follows to manually transfer your settings from a memory card:

1. Remove the USB cable if one is inserted in the inverter.
2. Attach the BOP-2 operator panel to the inverter.
3. Go to the menu level "EXTRAS".
4. Start data transfer in the menu "EXTRAS" - "FROM CRD".
5. Switch off the inverter power supply.
6. Wait until all LED on the inverter go dark.
7. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.

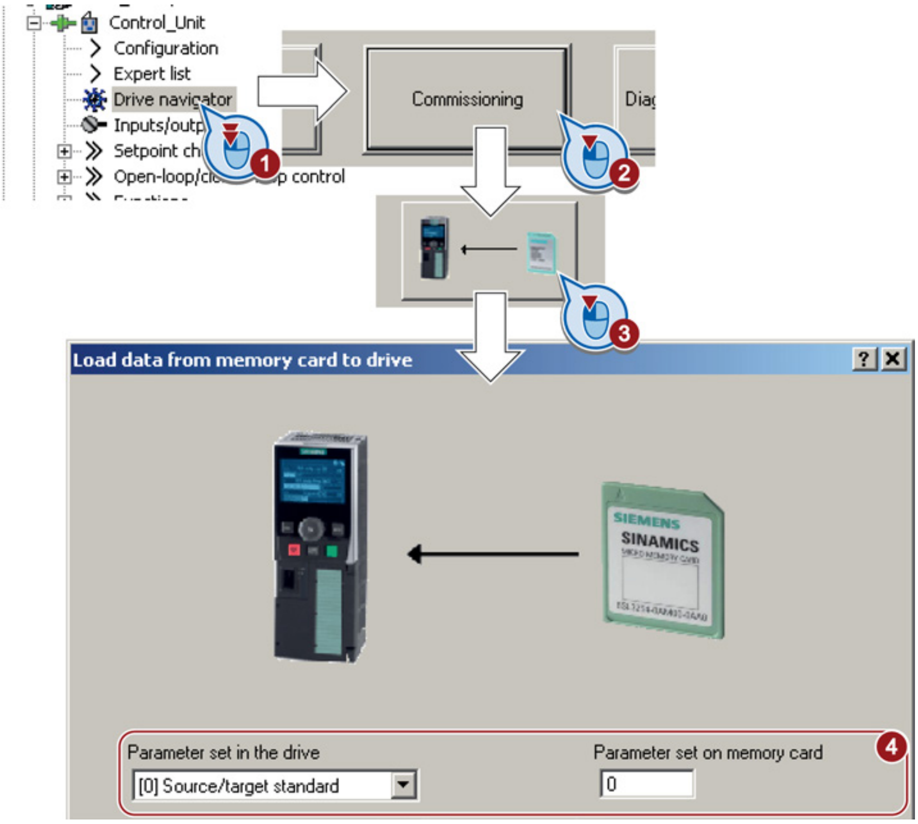


You have manually transferred the settings from the memory card.

Procedure using STARTER

Proceed as follows to manually transfer your settings from a memory card:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.
6. Go offline with STARTER.
7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.



You have manually transferred the settings from the memory card.

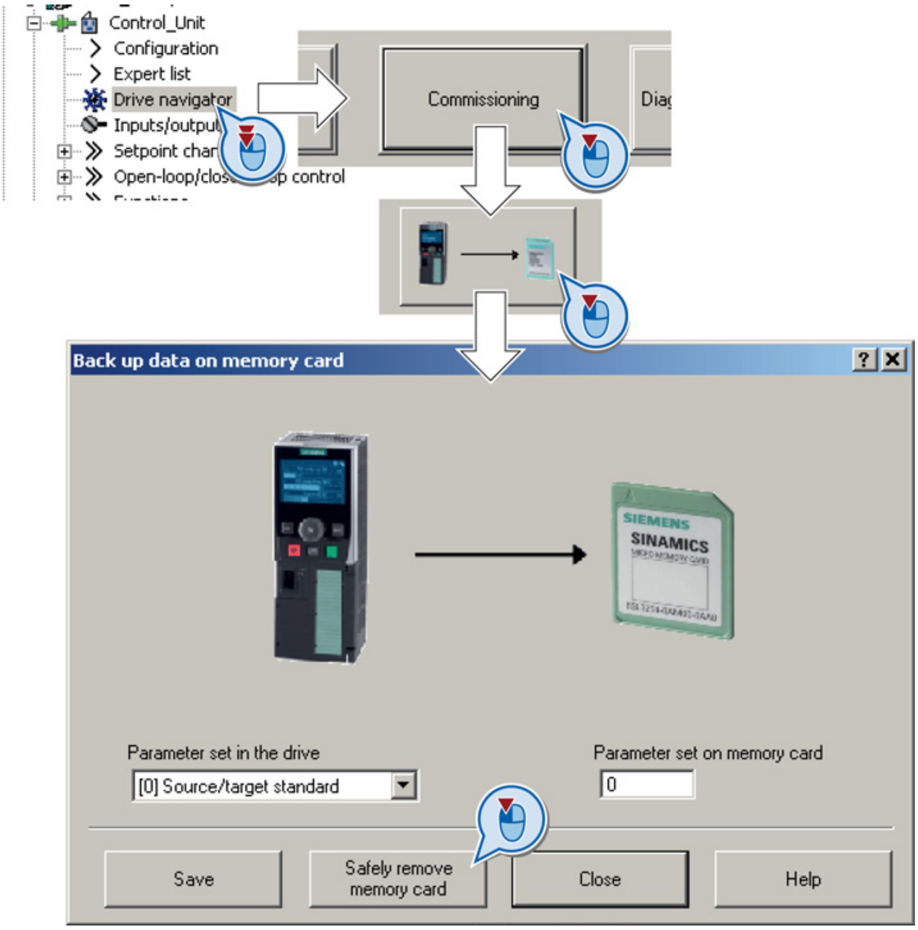
9.1.3 Safely remove the memory card

NOTICE
Destruction of files on the memory card when the memory card is removed
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 memory card will then no longer function.
Only remove the memory card using the "safe removal" function.

Procedure using STARTER

To safely remove the memory card, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



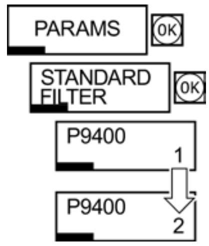
2. Click on the button to safely remove the memory card.
3. You may remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card.

Procedure with the BOP-2

To safely remove the memory card, proceed as follows:

1. Go to parameter p9400. If a memory card is correctly inserted, then p9400 = 1.
2. Set p9400 = 2 The BOP-2 displays "BUSY" for several seconds and then jumps to either p9400 = 3 or p9400 = 100.
3. For Bei p9400 = 3 you may remove the memory card.
4. For p9400 = 100, you may not remove the memory card at the moment.
   In this case, try again by setting p9400 = 2.



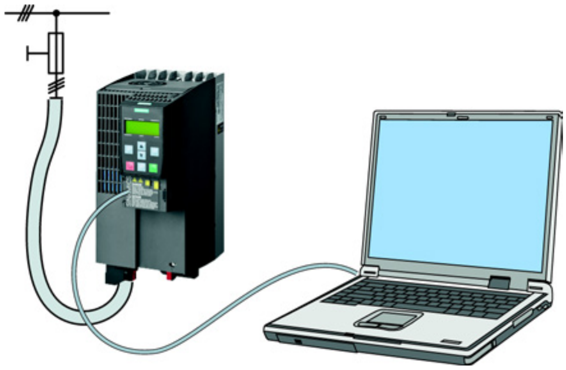
You have now safely removed the memory card.

9.2 Backing up and transferring settings using STARTER

Precondition

With the supply voltage switched on, you can transfer the inverter settings from the inverter to a PG/PC, or the data from a PG/PC to the inverter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.



You will find additional information about STARTER in Section Commissioning tools (Page 23).

Inverter → PC/PG

Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

Procedure PC/PG → Converter

The procedure depends on whether you also transfer settings of safety functions or not.

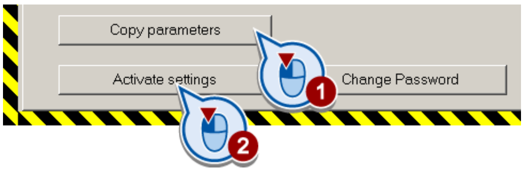
Converter without safety functions:

- Go online with STARTER : .
- Select the button "Download project to target system": .
- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .

Converter with safety functions:

- ① Go online with STARTER : .
- ② Select the button "Download project to target system": .
- ③ Open the STARTER screen for the safety functions.

- ① Copy the safety function parameters.
- ② Activate the settings.



- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

9.3 Saving settings and transferring them using an operator panel

Precondition

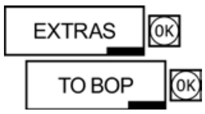
When the power supply is switched on, you can transfer the settings of the inverter to the BOP-2 or, vice versa, transfer the data from the BOP-2 to the inverter.

Inverter → BOP-2

Procedure

To back up the settings, proceed as follows:

Start data transfer in the menu "EXTRAS" - "TO BOP".



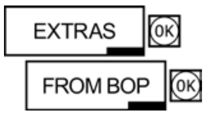
You have backed up the settings.

BOP-2 → inverter

Procedure

To transfer the settings, proceed as follows:

1. Start data transfer in the menu "EXTRAS" - "FROM BOP".
2. Switch off the inverter power supply.
3. Wait until all LED on the inverter go dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.



You have transferred the settings.

9.4 Other ways to back up settings

Description

In addition to the default setting, the converter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

Table 9- 1 Backing up settings in the converter

Parameter	Description
p0970	**Reset drive parameters** Load backed-up setting (number 10, 11 or 12). The load overwrites the current setting.
p0971	**Save parameters** Back up the setting (10, 11 or 12).

Table 9- 2 Backing up additional settings on the memory card

Parameter	Description
p0802	**Data transfer with memory card as source/target** (factory setting 0) Default setting: p802 = 0 Further settings: p802 = 1 … 99
p0803	**Data transfer with device memory as source/target** (factory setting 0) Default setting: p803 = 0 Further settings: p803 = 10, 11 or 12

Table 9- 3 Operation on the BOP-2

	Description	
	EXTRAS OK TO CRD OK	The converter writes its setting 0, 10, 11 or 12 to the memory card in accordance with p0802. The file on the memory card is assigned the number according to p0802.
	EXTRAS OK FROM CRD OK	The converter loads the setting with the number according to p0802 from the memory card and thus overwrites its setting 0, 10, 11 or 12.

9.5 Write and know how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

Write protection - overview

Write protection is primarily used to prevent inverter settings from being inadvertently changed. No password is required for write protection, your settings remain unencrypted.

The following functions are excluded from the write protection:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Access to service parameters (p3950) - only for service personnel, a password is required
- Restoring the factory setting
- Upload
- Acknowledging alarms and faults
- Switching over to the control panel
- Trace
- Function generator
- Measuring functions
- Reading out diagnostic buffer

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".

Know-how protection - overview

The know-how protection is used, for example, so that machine manufacturers can encrypt their configuration know-how and protect it against changes or copying.

The know-how protection is available in the following versions:

- **Know-how protection without copy protection** (possible with or without memory card)
- **Know-how protection with copy protection** (possible only with Siemens memory card)

A password is required for the know-how protection.

In case of active know-how protection, the STARTER dialog screens are locked. The expert list in STARTER shows only display parameters.

Actions that are also possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Displaying the alarm 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, which are accessible even though know-how protection is active)

Actions that are not possible during active know-how protection

- Download
- Export/import
- Trace
- Function generator
- Measuring functions
- Automatic controller setting
- Stationary/rotating measurement
- Deleting the alarm history

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".

9.5.1 Write protection

Set write protection

Precondition

In order that you can set write protection, your inverter must be connected online with STARTER.

Activate and deactivate write protection

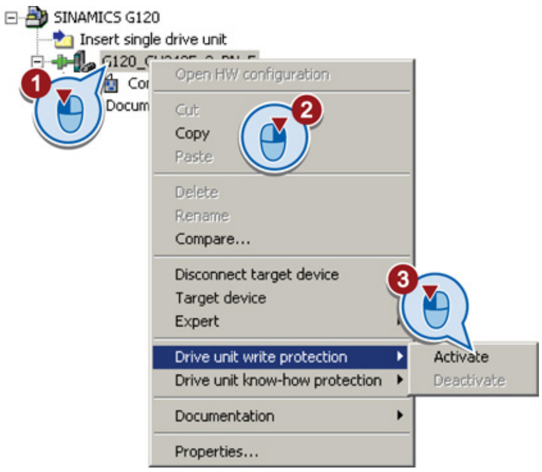
Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the inverter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate write protection.

   Deactivation is executed in analog.

   To make this setting permanent, you need to select "Copy RAM to ROM". Otherwise, your settings will be lost when the inverter is switched off.



You have activated or deactivated write protection.

Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.

The confirmation prompt is not issued, if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

9.5.2 Know-how protection

When the inverter is operated with know-how protection, please take note of the following information:

Note

Support provided by technical support for active know-how protection

In the case of active know-how protection, support by the technical support is only possible with the consent of the machine manufacturer.

Know-how protection can only be activated online.

If you have created a project offline on your computer, you must download it to the inverter and go online. Only then can you activate the know-how protection.

You cannot activate know-how protection in the project on the computer.

Know-how protection with copy protection is only possible with a Siemens memory card.

For "know-how protection with copy protection", a Siemens memory card must be plugged in!

If you try to activate the "know-how protection with copy protection" without a memory card, or with a different memory card, the message "Know-how protection for the drive unit could not be activated" is displayed.

Password check for know-how protection and Windows language settings

Please note that if the Windows language settings are changed, after activating know-how protection, faults can occur when subsequently checking the password. Therefore, only use characters from the ASCII character set for your password.

Commissioning the inverter with know-how protection

Procedure

Proceed as follows to commission an inverter with know-how protection:

1. Commission the inverter.
2. Create the exception list (Page 299).
3. Activate the know-how protection (Page 297).
4. Save the settings in the inverter 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.

You have commissioned the inverter with know-how protection.

9.5.2.1 Settings for the know-how protection

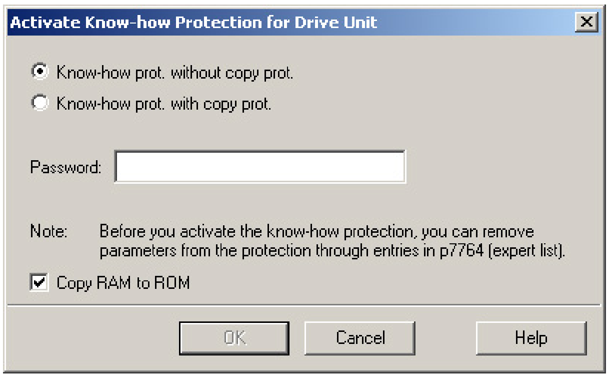
Activating know-how protection

Procedure

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 295)).
2. Enter your password, and confirm with OK.

   The password must consist of at least one character and can be no longer than 30 characters. All characters are permissible.

3. In this screen form "Copy RAM to ROM" has been selected in the factory. This will ensure that your settings are permanently stored.

   If "Copy RAM to ROM" is not selected, then your know-how protection settings are only saved in the volatile memory, and will no longer be available the next time the system is switched on.

You have activated know-how protection.

Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

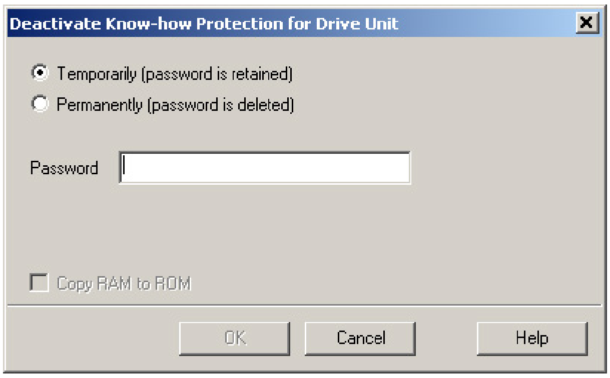
To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

Deactivate know-how protection, delete password

Procedure

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
3. Enter the password and exit the screen form with OK.



You have deactivated know-how protection.

Note

Permanently or temporarily deactivating know-how protection

Temporarily deactivating know-how protection means that know-how protection is active again after switching off and switching on. Permanently deactivating means that know-how protection is no longer active after switching off and switching on again.

Deactivating know-how protection temporarily

To temporarily deactivate the know-how protection means that you can change the settings in the inverter until you switch the inverter off and on again, or until you reactivate the know-how protection.

Finally deactivating know-how protection (delete password)

Finally deactivating the know-how protection means that you delete the password

- Immediately and finally, if you select "Copy RAM to ROM"
- Until the next OFF/ON if you do not select "Copy RAM to ROM"

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

9.5.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ( ).
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

9.5.2.3 Replacing devices during know-how protection

Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the converter settings can be transferred to another converter using a memory card.

See also:

- Saving setting on memory card (Page 283)
- Transferring the setting from the memory card (Page 285)

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the inverter cannot be replaced as described in "Overview of how to replace an inverter (Page 303)".

However, to allow the inverter to be replaced, you must use a Siemens memory card, and the machine manufacturer must have an identical machine that he uses as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 297)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the inserted memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 297)
  - 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 MMC

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 297)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the customer's memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 297)
  - 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).

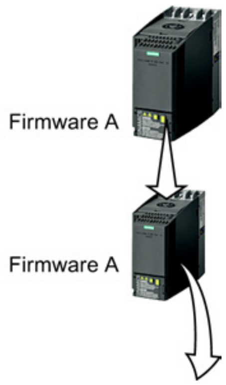
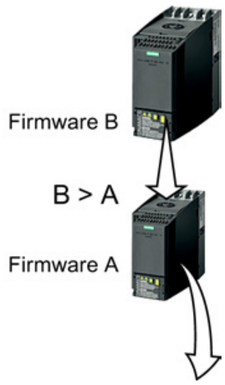
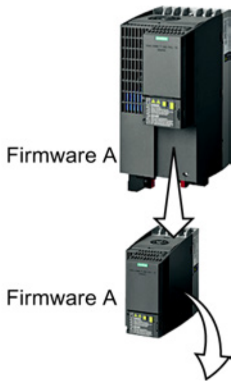
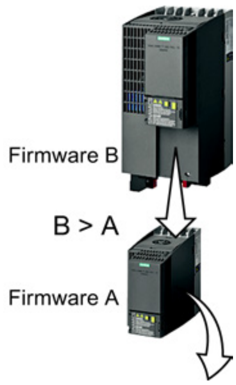
Repair 10

10.1 Overview of how to replace an inverter

You must replace the inverter if it continually malfunctions.

Overview

In the following cases you will need to replace the inverter:

Replacement: • Same fieldbus interface • Same power rating • Same firmware version	Replacement: • Same fieldbus interface • Same power rating • *Higher* firmware version (e.g. replace FW V4.2 by FW V4.3)	Replacement: • Same fieldbus interface • *Higher* power rating • Same firmware version	Replacement: • Same fieldbus interface • *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**
>
> **Physical injury or material damage as a result of unexpected drive behavior**
>
> Replacing inverters of different types can result in an unpredictable drive response.
>
> - In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, using the environment detection, you can replace a defective inverter by a new device of the same type and with the identical software release without having to recommission the system.

You can either load the inverter settings into the inverter using the memory card or – if you are using a SIMATIC S7 controller with DriveES – using DriveES.

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).

DANGER

Danger to life when live parts are touched

Touching live parts can result in death or severe injury.

Note the following:

- Only work on electrical equipment if you are qualified to do so.
- When carrying out any work, always comply with the country-specific safety rules.

Follow the six steps to ensure safety:

1. Prepare for shutdown and inform team members who will be affected by the procedure.
2. Switch off the machine so that it is in a no-voltage state:
   - 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 that all auxiliary circuits are also in a no-voltage state.
   - Ensure that the motor 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. Lock out all energy sources to prevent reclosing.
6. Make sure that the machine is completely locked out ... and that you have the right machine!

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

10.2 Replacing a converter with enabled safety function

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.

DANGER
Death as a result of electric shock! After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous. • Check the voltage at the inverter connections before you carry out any installation work.

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.

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 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:
   Perform a **reduced** acceptance test.
     The reduced acceptance test is described in Section Reduced acceptance test (Page 274).

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 the PC

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.

⚠DANGER
Death as a result of electric shock!
After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous. • Check the voltage at the inverter connections before you carry out any installation work.

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.

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.

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 project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC into the inverter by pressing the button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. 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 LED on the inverter go dark.
15. Switch on the inverter power supply again (power on reset).
16. Perform a **reduced** acceptance test, see the section Reduced acceptance test ((G120C)) (Page 274).

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.

DANGER
Death as a result of electric shock!
After the power supply has been switched off, it takes up to 5 minutes until the capacitors in the inverter have discharged enough for the residual voltage to be non-hazardous. • Check the voltage at the inverter connections before you carry out any installation work.

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.

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.

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.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
10. Switch off the inverter power supply.
11. Wait until all LED on the inverter go dark.
12. Switch on the inverter power supply again (power on reset).
13. Perform a **reduced** acceptance test, see the section Reduced acceptance test ((G120C)) (Page 274).

You have replaced the inverter and transferred the safety function settings from the operator panel to the new inverter.

10.3 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.

10.4 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.

10.5 Replacing the heat sink fan

When do you have to replace the fan?

A defect fan involves an over temperature of the converter. Indications for a defective fan are e. g. the following alarms and faults:

- A05002 (Air intake overtemperature)
- A05004 (Rectifier overtemperature)
- F30004 (Overtemperature heat sink)
- F30024 (Overtemperature thermal model)
- F30025 (Chip overtemperature)
- F30035 (Air intake overtemperature)
- F30037 (Rectifier overtemperature)

Preparatory steps

Prodedure

1. Power-down the converter
2. Disconnect all the cable connectors for line, motor and braking resistor.
3. Remove the screening plate.

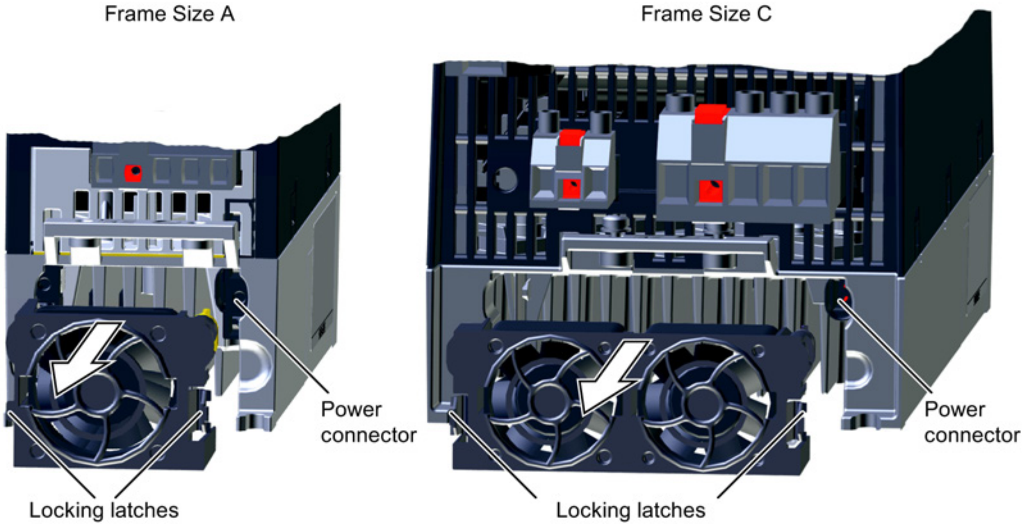
You prepared the fan replacement.

Removal

The heat sink fan of the converter is situated at the bottom of the converter below the detachable connectors.

Prodedure

1. Using your fingers, press the locking latches to release the fan module.
2. Pull the fan module out from the fan module housing.



You removed the fan.

Installation

Prodedure

1. Ensure the fan module is correctly orientated (see figure below).
2. Gently push the fan module into the fan module housing, ensuring that the power connections are aligned correctly.
3. The fan module will click into place as the locking latches are engaged correctly.
4. Re-assemble the converter by following the preparatory steps in reverse.

You installed the fan.

10.6 Replacing the internal fan

When do you have to replace the fan?

A defective fan involves an over temperature of the converter. Indications for a defective fan are e. g. the following alarms and faults:

- A30034 (Internal overtemperature)
- F30036 (Internal overtemperature)
- A30049 (Internal fan faulty)
- F30059 (Internal fan faulty)

Removal

The fan is situated at the top of the converter.

Procedure

1. Power-down the converter

⚠ DANGER
Death of electric shock Hazardous voltage is still present for up to 5 minutes after the power supply has been switched off. Do not remove the fan before this time has expired!

2. Using a screw driver, bend the locking latches to release the fan.
3. Pull the fan out.

You removed the internal fan.

Installation

Procedure

1. Gently push the fan module into the converter, ensuring that the power connections are aligned correctly.
2. The fan will click into place as the locking latches are engaged correctly.
3. Power-up the converter.

You installed the internal fan.

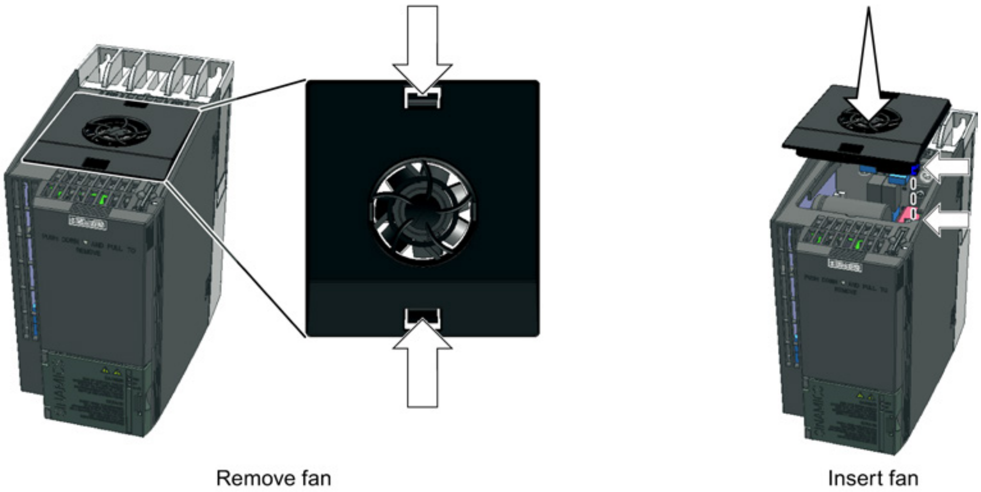


Figure 10-1 Fan replacement

10.7 Upgrading the firmware

When upgrading the firmware, you replace the inverter firmware by a later version. Only update the firmware to a later version if you require the expanded functional scope of the newer version.

Precondition

- The firmware version of your inverter is at least V4.5.
- You have the memory card with the firmware that matches the inverter.

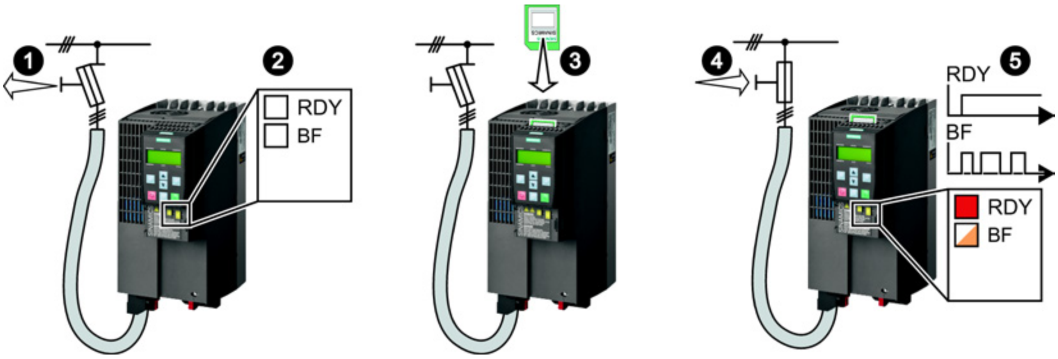
Procedure

Proceed as follows to upgrade the inverter firmware to a later version:

1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter 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.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

Note

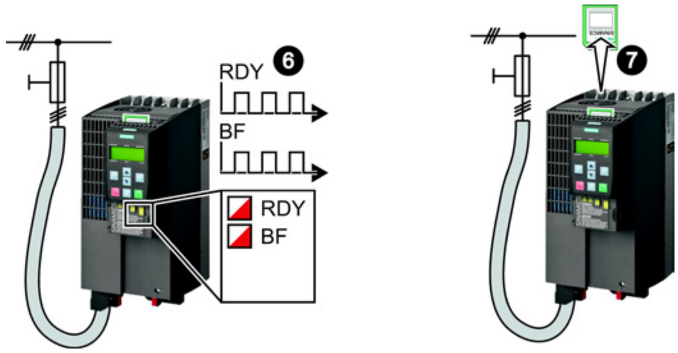
Corrupted firmware if the power supply fails during the transfer

The inverter firmware can be corrupted if the power supply fails during the transfer.

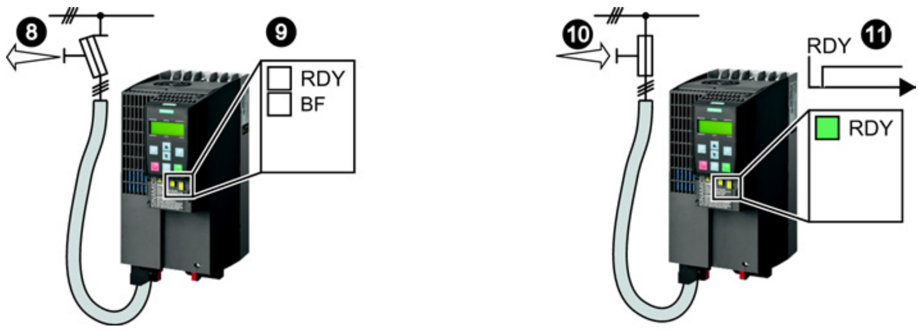
- Do not switch off the inverter power supply as long as data is being transferred.

---

7. Remove the card with the firmware from the inverter.



8. Switch off the inverter power supply.
9. Wait until all LEDs on the inverter are dark.
10. Switch on the inverter power supply.
11. If the firmware upgrade was successful, after several seconds the inverter LED RDY turns green.



You have successfully updated the firmware to a more recent version. When upgrading, your settings in the inverter are kept.

10.8 Firmware downgrade

When downgrading the firmware, you replace the inverter firmware by an older version. Only downgrade the firmware to an older version if, after replacing an inverter, you require the same firmware in all of your inverters.

Precondition

- The firmware version of your inverter is at least V4.6.
- You have the memory card with the firmware that matches the inverter.
- You have backed up your settings on the memory card, in an operator panel or in a PC.

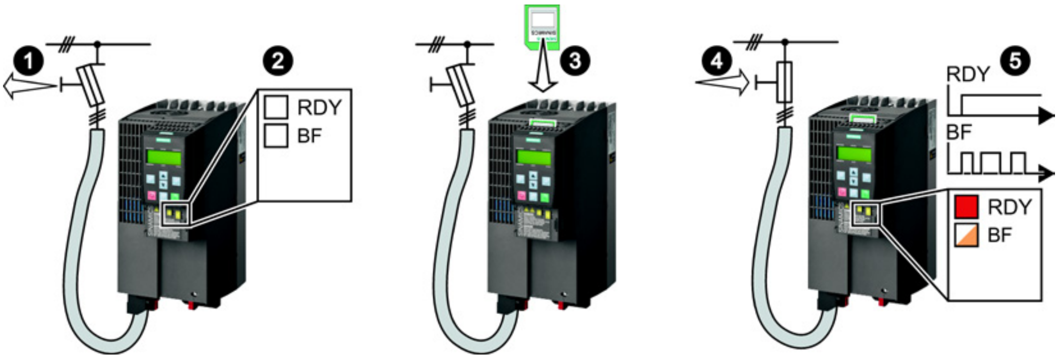
Procedure

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.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

Note

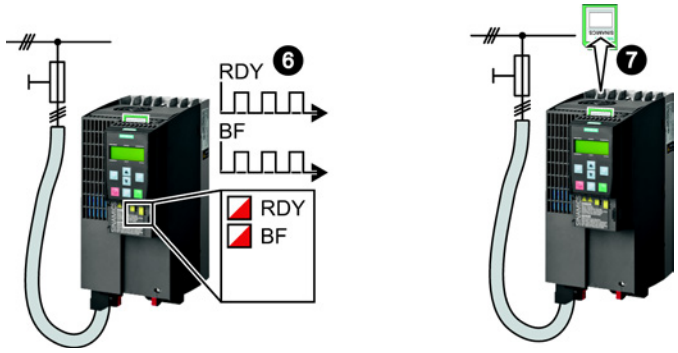
Corrupted firmware if the power supply fails during the transfer

The inverter firmware can be corrupted if the power supply fails during the transfer.

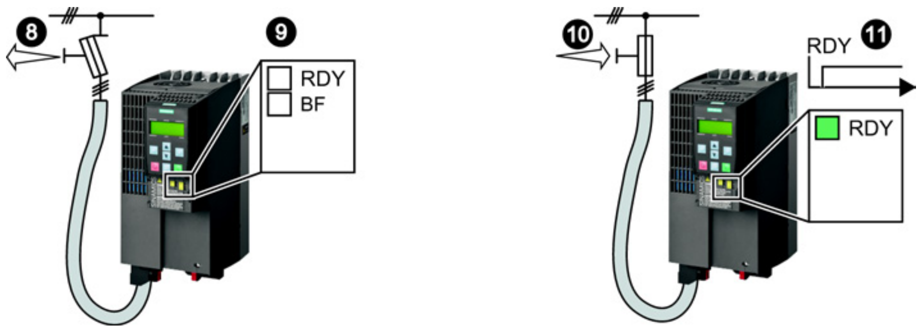
- Do not switch off the inverter power supply as long as data is being transferred.

---

7. Remove the card with the firmware from the inverter.



8. Switch off the inverter power supply.
9. Wait until all LEDs on the inverter are dark.
10. Switch on the inverter power supply.
11. If the firmware downgrade was successful, after several seconds the inverter LED RDY turns green.



After the firmware has been downgraded, the inverter has been reset to the factory settings.

12. Transfer your settings from your data backup to the inverter.

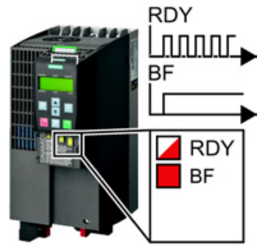
See also Section: Backup data and series commissioning (Page 281).

You have downgraded the firmware of the inverter to an older version and have transferred the backed up settings into the inverter.

10.9 Correcting an unsuccessful firmware upgrade or downgrade

How does the inverter signal an unsuccessful upgrade or downgrade?

The inverter signals an unsuccessful firmware upgrade or downgrade by a quickly flashing LED RDY and the lit LED BF.



Correcting an unsuccessful upgrade or downgrade

You can check the following to correct an unsuccessful firmware upgrade or downgrade:

- Does the firmware version of your inverter fulfill the preconditions?
  - For an upgrade, as a minimum V4.5.
  - For a downgrade, as a minimum V4.6.
- Have you correctly inserted the card?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

10.10 If the converter no longer responds

If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

Case 1

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018:
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.

You have restored the inverter factory settings.

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter factory settings.

Alarms, faults and system messages 11

The inverter has the following diagnostic types:

- LED

  The LED at the front of the inverter immediately informs you about the most important inverter states right at the inverter.

- Alarms and faults

  The inverter 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.

11.1 Operating states indicated on LEDs

The LED RDY (Ready) is temporarily orange after the power supply voltage is switched-on. As soon as the color of the LED RDY changes to either red or green, the LEDs signal the inverter state.

Signal states of the LED

In addition to the signal states "on" and "off" there are two different flashing frequencies:

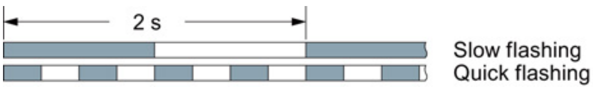


Table 11- 1 Inverter diagnostics

LED		Explanation
RDY	BF	
GREEN - on	---	There is presently no fault
GREEN - slow	---	Commissioning or reset to factory settings
GREEN - fast	---	Inverter writes data to the memory card
RED - slow	---	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	---	There is presently a fault
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update

Table 11- 2 Inverter diagnostics

LNK LED	Explanation
GREEN - on	The communication via PROFINET is in order.
GREEN - slow	Device naming is active.
Off	No communication via PROFINET.

Table 11- 3 Communication diagnostics via RS485

LED BF	Explanation
On	Receive process data
RED - slow	Bus active - no process data
RED - fast	No bus activity
YELLOW - variable frequency	Firmware update in progress

Table 11- 4 Communication diagnostics via PROFIBUS DP

LED BF	Explanation
off	Cyclic data exchange (or PROFIBUS not used, p2030 = 0)
RED - slow	Bus fault - configuration fault
RED - fast	Bus fault - no data exchange - baud rate search - no connection
YELLOW - variable frequency	Firmware update in progress

Table 11- 5 Diagnostics of the safety functions

SAFE LED	Meaning
YELLOW - on	One or more safety functions are enabled, but not active.
YELLOW - slow	One or more safety functions are active; no safety function faults have occurred.
YELLOW - rapid	The converter has detected a safety function fault and initiated a STOP response.

LED BF display for CANopen

In addition to the signal states "on" and "off" there are three different flashing frequencies:

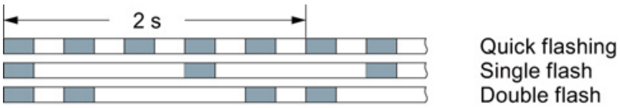


Table 11- 6 Communication diagnostics via CANopen

BF LED	Explanation
GREEN - on	Bus state "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)
YELLOW - variable frequency	Firmware update in progress

11.2 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 11-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm 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 11-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value	
1st alarm	r2122[0]	r2124[0]	r2134[0]
2nd alarm	[1]	[1]	[1]
3rd alarm	[2]	[2]	[2]
4th alarm	[3]	[3]	[3]
5th alarm	[4]	[4]	[4]
6th alarm	[5]	[5]	[5]
7th alarm	[6]	[6]	[6]
last alarm	[7]	[7]	[7]

Figure 11-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the 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.

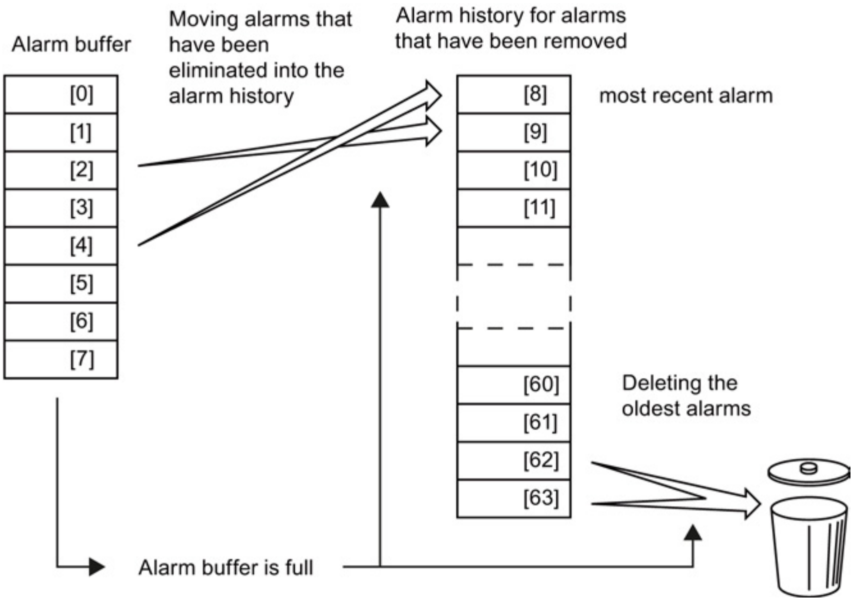


Figure 11-4 Shifting alarms that have been removed into the alarm history

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 11- 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 11- 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.

11.3 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] I32	r2133[0] Float

Figure 11-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

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 11-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value	
1st fault	r0945[0]	r0949[0]	r2133[0]
2nd fault	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]
4th fault	[3]	[3]	[3]
5th fault	[4]	[4]	[4]
6th fault	[5]	[5]	[5]
7th fault	[6]	[6]	[6]
last fault	[7]	[7]	[7]

Figure 11-7 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).

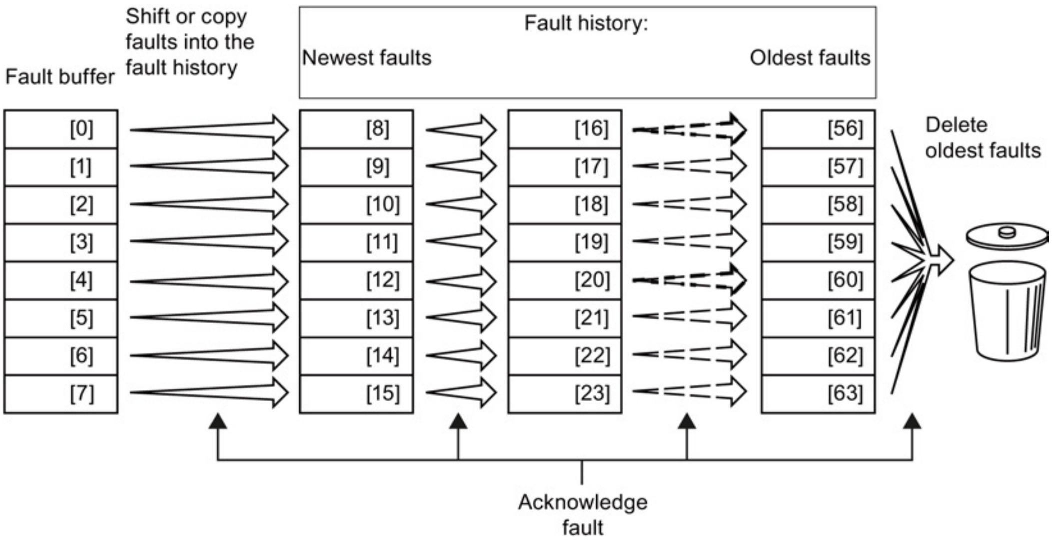


Figure 11-8 Fault history after acknowledging the faults

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 11- 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 11- 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.

11.4 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 11 The most important alarms and faults of the safety functions

<table>
<tr><th>Number</th><th>Cause</th><th colspan="2">Remedy</th></tr>
<tr><td>F01600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
<tr><td>F01650</td><td>Acceptance test required</td><td colspan="2">Carry out acceptance test and create test certificate.
Switch the Control Unit off and then on again.</td></tr>
<tr><td rowspan="5">F01659</td><td rowspan="5">Write task for parameter rejected</td><td colspan="2">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:</td></tr>
<tr><td>p0010 = 30</td><td>Parameter reset</td></tr>
<tr><td>p9761 = …</td><td>Enter password for the safety functions.</td></tr>
<tr><td>p0970 = 5</td><td>Reset Start Safety Parameter.
The converter sets p0970 = 5 if it has reset the parameters.</td></tr>
<tr><td colspan="2">Then reset the converter to the factory setting again.</td></tr>
<tr><td>A01666</td><td>Static 1 signal atF-DI for safe acknowledgment</td><td colspan="2">F-DI to a logical 0 signal.</td></tr>
<tr><td>A01698</td><td>Commissioning mode active for safety functions</td><td colspan="2">This message is withdrawn after the Safety commissioning has ended.</td></tr>
<tr><td>A01699</td><td>Shutdown path test required</td><td colspan="2">After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.</td></tr>
<tr><td>F30600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
</table>

Table 11- 12 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU.
F01001	Floating Point Exception	Switch CU off and on again.
F01015	Software fault in CU	Upgrade firmware or contact technical support.
F01018	Power-up aborted more than once	After this fault is output, the converter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the converter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 11- 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: Parameterization on the memory card has been created with a different type of module (order number, MLFB) Check the module parameters and recommission if necessary.
F01033	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.
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.

Number	Cause	Remedy
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	V/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).
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.

Number	Cause	Remedy
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.
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	

Number	Cause	Remedy
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.
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).

Number	Cause	Remedy
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	
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.

Technical data 12

12.1 Technical data of inputs and outputs

Feature	Data
Operating voltage	• Supply from the Power Module • or an external 24 V DC class 2 supply (20.4 V ... 28.8 V) via control terminals 31 and 32, a maximum of 200 VA. Use a DVC A power supply with grounded earth (DVC A = decisive voltage class A according to EN 61800-5-1:2007).
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, maximum input voltage 30 V, current consumption 5.5 mA • Response time: 5.5 ms ± 1 ms
Analog input (differential input, resolution 12 bits)	AI0: configurable as additional digital inputs 0 V … 10 V, 0 mA … 20 mA and -10 V … +10 V, Low < 1.6 V, High > 4.0 V Response time: 10 ms ± 2 ms
Digital outputs / relay outputs	• DO 0: relay output, 30 V DC / max. 0.5 A with resistive load • DO 1: transistor output, 30 V DC / max. 0.5 A with resistive load, protection against incorrect voltage polarity Update time of all DO: 2 ms
Analog output	AO 0: 0 V … 10 V or 0 mA … 20 mA, reference potential: "GND", resolution 16 bit, update time: 4 ms
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω, switching threshold 1650 Ω • KTY84 • ThermoClick sensor with dry contact
Fail-safe Input	• If you release the fail-safe function STO, then DI 4 and DI 5 form the fail-safe digital input • Maximum input voltage 30 V, 5.5 mA • Response time: – Typical: 5 ms + debounce time p9651 – Typical, if debounce time = 0: 6 ms – Worst-case scenario: 15 ms + debounce time – Worst case, if debounce time = 0: 16 ms
PFH	5 × 10E-8
USB-interface	Mini-B

12.2 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.

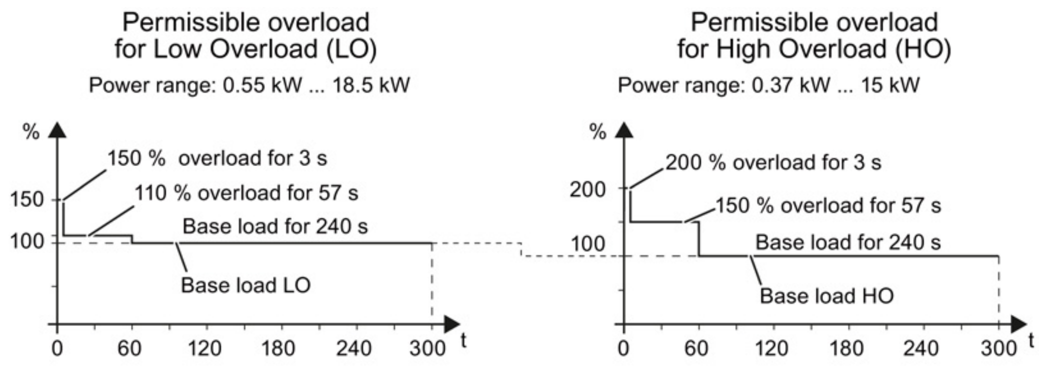


Figure 12-1 Duty cycles, "High Overload" and "Low Overload"

Note

The base load (100% power or current) of "Low Overload" is greater than the base load of "High Overload".

We recommend the "SIZER" engineering software to select the inverter based on duty cycles. See Configuring support (Page 396).

Definitions

- **LO input current** 100 % of the permissible input current for a load cycle according to Low Overload (LO base load input current).
- **LO output current** 100 % of the permissible output current for a load cycle according to Low Overload (LO base load output current).
- **LO power** Power of the inverter for LO output current.
- **HO input current** 100 % of the permissible input current for a load cycle according to High Overload (HO base load input current).
- **HO output current** 100 % of the permissible output current for a load cycle according to High Overload (HO base load output current).
- **HO power** Power of the inverter for HO output current.

If the power data comprise rated values without any further specifications they always refer to an overload capability corresponding to Low Overload.

12.3 Common technical power data

Feature	Specification		
Line voltage	3-ph. 380 V AC… 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 line 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 choke or output options at 4 kHz switching frequency	
	25 m (shielded)	To fulfil EMC Category C2 conducted emissions at 4 kHz switching frequency	
Possible braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20, cubicle mounting		
Operating temperature	-10 °C … +40 °C	Without power derating.	
	-10 °C … +55 °C	Converter with PROFINET interface.	The output power must be reduced, see also section: Temperature and voltage derating (Page 349)
	-10 °C … +60 °C	Converter with USS, MB, CANopen or PROFIBUS interface.	
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)		
Relative humidity	< 95 % RH - 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 to EN 60721-3-1 : 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2 : 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3 : 1995		
Short Circuit Current Rating (SCCR)	65 kA		

12.4 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 12- 1 G120C Frame Sizes A, 3 AC 380 V … 480 V, ± 10 % - part 1
6SL3210-…

Order No.	**Uniltered, IP20** **Filtered, IP20**	**… 1KE11-8U*1** **… 1KE11-8A*1**	**… 1KE12-3U*1** **… 1KE12-3A*1**	**… 1KE13-2U*1** **… 1KE13-2A*1**
Rated / Low Overlaod values				
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
High Overload values				
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 losses, filtered		0.041 kW	0.045 kW	0.054 kW
Power losses, unfiltered		0.040 kW	0.044 kW	0.053 kW
Fuse according to IEC		3NA3 801 (6 A)	3NA3 801 (6 A)	3NA3 801 (6 A)
Fuse according to UL		10 A class J	10 A class J	10 A class J
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable		1.0 … 2.5 mm^2 18 … 14 AWG	1.0 … 2.5 mm^2 18 … 14 AWG	1.0 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm 4.4 lbf in	0.5 Nm 4.4 lbf in	0.5 Nm 4.4 lbf in
Weight, unfiltered		1.7 kg	1.7 kg	1.7 kg
Weight, filtered		1.9 kg	1.9 kg	1.9 kg

Table 12- 2 G120C Frame Sizes A, 3 AC 380 V … 480 V, ± 10 % - part 2
6SL3210-…

Order No.	Unfiltered, IP20 Filtered, IP20	… 1KE14-3U*1 … 1KE14-3A*1	… 1KE15-8U*1 … 1KE15-8A*1	… 1KE17-5U*1 … 1KE17-5A*1
Rated / Low Overlaod values				
Rated / LO power		1.5 kW	2.2 kW	3.0 kW
Rated / LO input current		5.5 A	7.4 A	9.5 A
Rated / LO Output current		4.1 A	5.6 A	7.3 A
High Overload values				
HO power		1.1 kW	1.5 kW	2.2 kW
HO input current		4.5 A	6.0 A	8.2 A
HO output current		3.1 A	4.1 A	5.6 A
Power losses, filtered		0.073 kW	0.091 kW	0.136 kW
Power losses, unfiltered		0.072 kW	0.089 kW	0.132 kW
Fuse according to IEC		3NA3 803 (10 A)	3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A class J	10 A class J	15 A class J
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable		1.0 … 2.5 mm² 18 … 14 AWG	1.5 … 2.5 mm² 16 … 14 AWG	1.5 … 2.5 mm² 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm 4.4 lbf in	0.5 Nm 4.4 lbf in	0.5 Nm 4.4 lbf in
Weight, unfiltered		1.7 kg	1.7 kg	1.7 kg
Weight, filtered		1.9 kg	1.9 kg	1.9 kg

Table 12- 3 G120C Frame Sizes A, 3 AC 380 V … 480 V, ± 10 % - part 3
6SL3210-…

Order No.	Unfiltered, IP20 Filtered, IP20	… 1KE18-8U*1 … 1KE18-8A*1
Rated / Low Overlaod values		
Rated / LO power		4.0 kW
Rated / LO input current		11.4 A
Rated / LO Output current		8.8 A
High Overload values		
HO power		3.0 kW
HO input current		10.6 A
HO output current		7.3 A
Power losses, filtered		0.146 kW
Power losses, unfiltered		0.141 kW
Fuse according to IEC		3NA3 805 (16 A)
Fuse according to UL		15 A class J
Required cooling air flow		5 l/s
Cross section of line and motor cable		1.5 … 2.5 mm² 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm 4.4 lbf in
Weight, unfiltered		1.7 kg
Weight, filtered		1.9 kg

Table 12- 4 G120C Frame Sizes B, 3 AC 380 V … 480 V, ± 10 % - part 4
6SL3210-…

Order No.	**Uniltered, IP20** **Filtered, IP20**	**… 1KE21-3U*1** **… 1KE21-3A*1**	**… 1KE21-7U*1** **… 1KE21-7A*1**
Rated / Low Overlaod values			
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
High Overload values			
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 losses, filtered		0.177 kW	0.244 kW
Power losses, unfiltered		0.174 kW	0.24 kW
Fuse according to IEC		3NA3 807 (20 A)	3NA3 810 (25 A)
Fuse according to UL		20 A class J	25 A class J
Required cooling air flow		9 l/s	9 l/s
Cross section of line and motor cable		4.0 … 6.0 mm² 12 … 10 AWG	4.0 … 6.0 mm² 12 … 10 AWG
Tightening torque for line and motor cable		0.6 Nm 5.3 lbf in	0.6 Nm 5.3 lbf in
Weight, unfiltered		2.3 kg	2.3 kg
Weight, filtered		2.5 kg	2.5 kg

Table 12- 5 G120C Frame Sizes C, 3 AC 380 V … 480 V, ± 10 % - part 5
6SL3210-…

Order No.	**Uniltered, IP20** **Filtered, IP20**	**… 1KE22-6U*1** **… 1KE22-6A*1**	**… 1KE23-2U*1** **… 1KE23-2A*1**	**… 1KE23-8U*1** **… 1KE23-8A*1**
Rated / Low Overlaod values				
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
High Overload values				
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 losses, filtered		0.349 kW	0.435 kW	0.503 kW
Power losses, unfiltered		0.344 kW	0.429 kW	0.493 kW
Fuse according to IEC		3NA3 817 (40 A)	3NA3 820 (50 A)	3NA3 822 (63 A)
Fuse according to UL		40 A class J	50 A class J	60 A class J
Required cooling air flow		18 l/s	18 l/s	18 l/s
Cross section of line and motor cable		6.0 … 16 mm² 10 … 5 AWG	10 … 16 mm² 7 … 5 AWG	10 … 16 mm² 7 … 5 AWG
Tightening torque for line and motor cable		1.5 Nm 13.3 lbf in	1.5 Nm 13.3 lbf in	1.5 Nm 13.3 lbf in
Weight, unfiltered		4.4 kg	4.4 kg	4.4 kg
Weight, filtered		4.7 kg	4.7 kg	4.7 kg

12.5 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 61800-3:2012, in the 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 61800-3:2012 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 a rated 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 (Page 347) **observed.**

Category C1

Drive systems with a rated voltage below 1,000 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.

12.5.1 Assigning converters to EMC categories

The converters have been tested in accordance with the EMC product standard EN 61800-3:2004. You can find precise information in the Declaration of Conformity on the Internet at: Declaration of Conformity

Requirements for electromagnetic compatibility

To comply with the requirements of EN 61800-3:2004, all drives must be installed in accordance with the manufacturer's instructions and EMC directives. See also: EMC-compliant installation (Page 49).

The converter 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.

See also

Declaration of Conformity (http://support.automation.siemens.com/WW/view/en/58275445)

Second environment - category C4

The unfiltered converters 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 49).

Second environment - category C3

Immunity

With respect to their immunity, the converters are suitable for the second environment.

Emitted interference

Using a converter with an integrated line filter ensures compliance with the limit values for category C3.

If you are using unfiltered converters 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 converters are suitable for the second environment.

Emitted interference

In order for the converters to comply with the limit values for category C2 relating to emitted interference, the following conditions must be fulfilled:

- You are using a converter 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 342)
- You are using a shielded motor connection cable with low capacitance (high-frequency, radiated faults)
- If you are using a converter with frame size FSB with a PROFINET interface (order 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 348).

Contact your system operator to obtain approval for an installation in the first environment.

First environment - category C1

The converters do not correspond to category C1.

12.5.2 Harmonics

Table 12- 6 Typical harmonics in % relative to the LO input current for U_K 1%

Harmonic number	5th	7th	11th	13th	17th	19th	23rd	25th
Harmonic [%]	54	39	11	5	5	3	2	2

12.5.3 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.

12.6 Temperature and voltage derating

Operating temperature derating

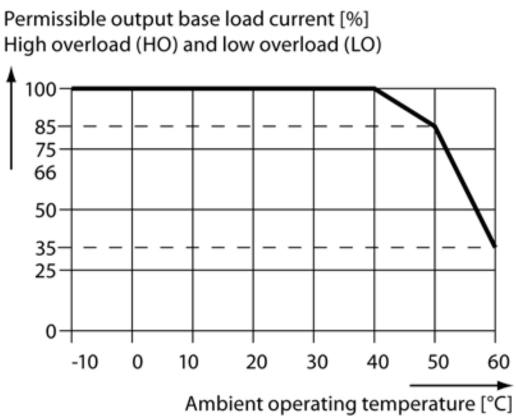


Figure 12-2 Temperature derating

Operational voltage derating

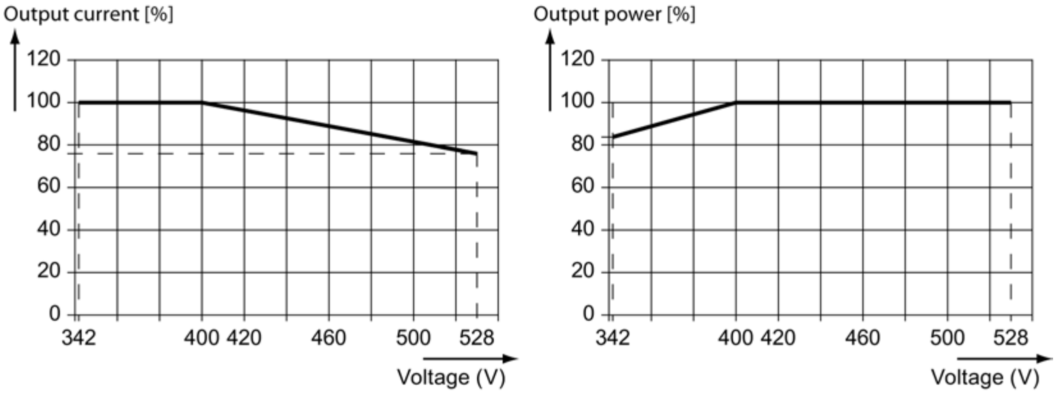


Figure 12-3 Current and Power derating required according to input voltage

12.7 Derating as a function of the installation altitude

Voltage

The clearance within the converter can isolate surge voltages in accordance with overvoltage category III in compliance with the EN 60664-1 regulation up to 2000 m above sea level.

At altitudes above 2000 m and below 4000 m above sea level, the converter has to be connected that at least one of the following conditions is fulfilled:

- It is connected to a TN-network with isolated star-point (not an external grounded connector)

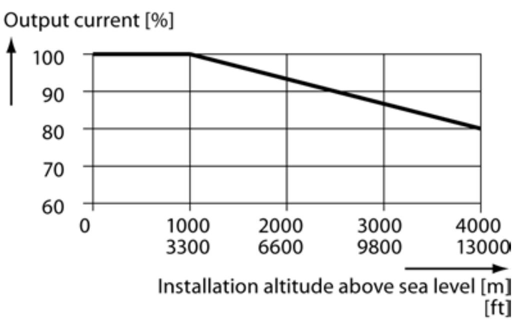
or

- it is connected through an isolating transformer that provides a TN-network with a grounded star-point.

A reduction of the line voltage is not necessary.

Note: The connected engines and power components must be considered separately.

Current



12.8 Current reduction depending on pulse frequency

Relationship between pulse frequency and output base-load current reduction

Table 12- 7 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.

12.9 Accessories

12.9.1 Line reactor

The major electrical specification of the line reactors is the same as for the suitable converter. This applies to:

- line voltage
- line frequency
- rated current

The admissible ambient conditions of the line reactors are the same as for the suitable converter. This applies to:

- storage and transport temperature
- operating temperature
- relative humidity
- shock and vibration load

Table 12- 8 Technical specifications of the line reactors

Feature	Suitable for converter with rated power of		
	0.55 kW ... 1.1 kW	1.5 kW ... 4.0 kW	5.5 kW … 7.5 kW
	FSA		FSB
Order no.	6SL3203-0CE13-2AA0	6SL3203-0CE21-0AA0	6SL3203-0CE21-8AA0
MLFB of the suitable converter	6SL3210-1KE11-8 □ □ 1 6SL3210-1KE12-3 □ □ 1 6SL3210-1KE13-2 □ □ 1	6SL3210-1KE14-3 □ □ 1 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
Cable cross section	2.5 mm² / 14 AWG	2.5 mm² / 14 AWG	6.0 mm² / 10 AWG
Tightening torque	0.6 Nm … 0.8 Nm 5 lbf in … 7 lbf in	0.6 Nm … 0.8 Nm 5 lbf in … 7 lbf in	1.5 Nm … 1.8 Nm 13 lbf in … 16 lbf in
PE connection	M4 (3 Nm / 26.5 lbf in)	M4 (3 Nm / 26.5 lbf in)	M5 (5 Nm / 44 lbf in)
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
Fixing 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 12- 9 Technical specifications of the line reactors

Feature	Suitable for converter with rated power of	
	11.0 kW … 18.5 kW	
	FSC	
Order no.	6SL3203-0CE23-8AA0	
MLFB of the suitable converter	6SL3210-1KE22-6 □ □ 1 6SL3210-1KE23-2 □ □ 1 6SL3210-1KE23-8 □ □ 1	
Inductance	0.3 mH	
Power loss at 50/60 Hz	90 W	
Cross section	16 mm² / 5 AWG	
Tightening torque	2 Nm …4 Nm 18 lbf in … 35 lbf in	
PE connection	M5 (5 Nm / 44 lbf in)	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 190 mm 220 mm 91 mm	
Fixing dimensions Width Height	 170 mm 68 mm	
Fixing screw	4 × M8 (10 Nm)	
Weight	7.8 kg	

12.9.2 Braking resistor

The admissible ambient conditions of the breaking resistors are the same as for the suitable converter. This applies to:

- storage and transport temperature
- operating temperature
- relative humidity
- shock and vibration load

Table 12- 10 Technical specifications of the breaking resistors

Feature	Suitable for converter with rated power of		
	0.55 kW ... 1.5 kW	2.2 kW ... 4.0 kW	5.5 kW … 7.5 kW
	FSA		FSB
Order no.	6SL3201-0BE14-3AA0	6SL3201-0BE21-0AA0	6SL3201-0BE21-8AA0
MLFB of the suitable converter	6SL3210-1KE11-8 □ □ 1 6SL3210-1KE12-3 □ □ 1 6SL3210-1KE13-2 □ □ 1 6SL3210-1KE14-3 □ □ 1	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
Cable cross section	2.5 mm² / 14 AWG	2.5 mm² / 14 AWG	2.5 mm² / 14 AWG
Tightening torque	0.5 Nm / 4.5 lbf in	0.5 Nm / 4.5 lbf in	0.5 Nm / 4.5 lbf in
Temperature contact	Normally closed contact	Normally closed contact	Normally closed contact
Maximum load	AC 250 V / 2,5 A	AC 250 V / 2,5 A	AC 250 V / 2,5 A
Cable cross section	2.5 mm² / 14 AWG	2.5 mm² / 14 AWG	2.5 mm² / 14 AWG
Tightening torque	0.5 Nm / 4.5 lbf in	0.5 Nm / 4.5 lbf in	0.5 Nm / 4.5 lbf in
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
Drill 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 12- 11 Technical specifications of the line reactors

Feature	Suitable for converter with rated power of	
	11.0 kW … 18.5 kW	
	FSC	
MLFB	6SL3201-0BE23-8AA0	
MLFB of the suitable converter	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	
Cable cross section	6 mm² / 10 AWG	
Tightening torque	0.6 Nm / 5.5 lbf in	
Temperature contact	Normally closed contact	
Maximum load	AC 250 V / 2,5 A	
Cable cross section	2.5 mm² / 14 AWG	
Tightening torque	0.5 Nm / 4.5 lbf in	
Degree of protection	IP20	
Overall dimensions Width Height Depth	 250 mm 490 mm 140 mm	
Drill pattern Width Height	 217 mm 460 mm	
Fixing screws	4 × M5 (6 Nm)	
Weight	6.2 kg	

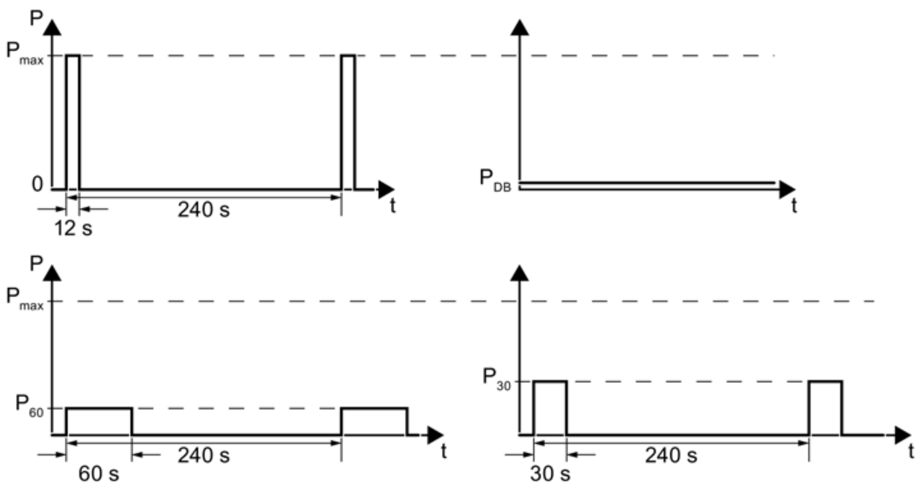


Figure 12-4 Pulse power, rated power and duty cycle examples of the braking resistor

12.10 Standards

	European Low Voltage Directive The SINAMICS G120C product range complies with the requirements of the Low Voltage Directive 2006/95/EC. The units are certified for complaince with the following standards: EN 61800-5-1 — Semiconductor converters –General requirements and line commutated converters EN 60204-1 — Safety of machinery –Electrical equipment of machines
	European Machinery Directive The SINAMICS G120C converter series does not fall under the scope of the Machinery Directive. However, the products have been fully evaluated for compliance with the essential Health & Safety requirements of the directive when used in a typical machine application. A Declaration of Incorporation is available on 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
	Underwriters Laboratories This equipment is capable of providing internal motor overload protection according to UL508C.
SEMI F47	**Specification for Semiconductor Process Equipment Voltage Sag Immunity** SINAMICS G120C Converters fulfill the requirements of the SEMI F47-0706 standard.
	ISO 9001 Siemens plc operates a quality management system, which complies with 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

A.1.1 Firmware version 4.5

Table A- 1 New functions and function changes in Firmware 4.5

	Function	SINAMICS					
			G120			G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU240D-2	CU250D-2
1	Support for the new power modules: • PM230 IP20 FSA … FSF • PM230 in a push-through FSA … FSC	-	✓	✓	✓	-	-
2	Support for the new power modules: • PM240-2 IP20 FSA • PM240-2 in push-through FSA	-	✓	✓	✓	-	-
3	New Control Units with PROFINET support	✓	✓	-	✓	✓	✓
4	Support of the PROFIenergy profile	✓	✓	-	✓	✓	✓
5	Shared device support via PROFINET	✓	✓	-	✓	✓	✓
6	Write protection	✓	✓	✓	✓	✓	✓
7	Know-how protection	✓	✓	✓	✓	✓	✓
8	Adding a second command data set (CDS0 → CDS0 … CDS1) (All other inverters have four command data sets)	✓	-	-	-	-	-
9	Position control and basic positioner	-	-	-	-	-	✓
10	Support of an HTL encoder	-	-	-	-	✓	✓
11	Support of an SSI encoder	-	-	-	-	-	✓
12	Fail-safe digital output	-	-	-	-	✓	✓

A.1.2 Firmware version 4.6

Table A- 2 New functions and function changes in Firmware 4.6

	Function	SINAMICS							
			G120					G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2 Vektor	CU250S-2 Servo	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB … FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During basic commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-	-
6	Communication via Ethernet/IP	✓	✓	-	✓	✓	✓	✓	✓
7	Skip frequency band for analog input • A symmetrical skip frequency band can be set for each analog input around the 0 V range.	✓	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) • Secure control of a motor holding brake when using the "Safe Brake Module" option	-	-	-	-	✓	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	✓	-	-
11	Straightforward selection of standard motors • Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers	✓	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓	✓
13	Safety info channel • BICO source r9734.0...14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓	✓

A.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- 3 **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- 4 **How to determine the firmware version of the Control Unit**

Parameter	Description
r0018	**The firmware version is displayed:**

Table A- 5 **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: Finding a suitable setting for the interfaces (Page 43).

Table A- 6 **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- 7 **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- 8 **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 Navigating the menu:

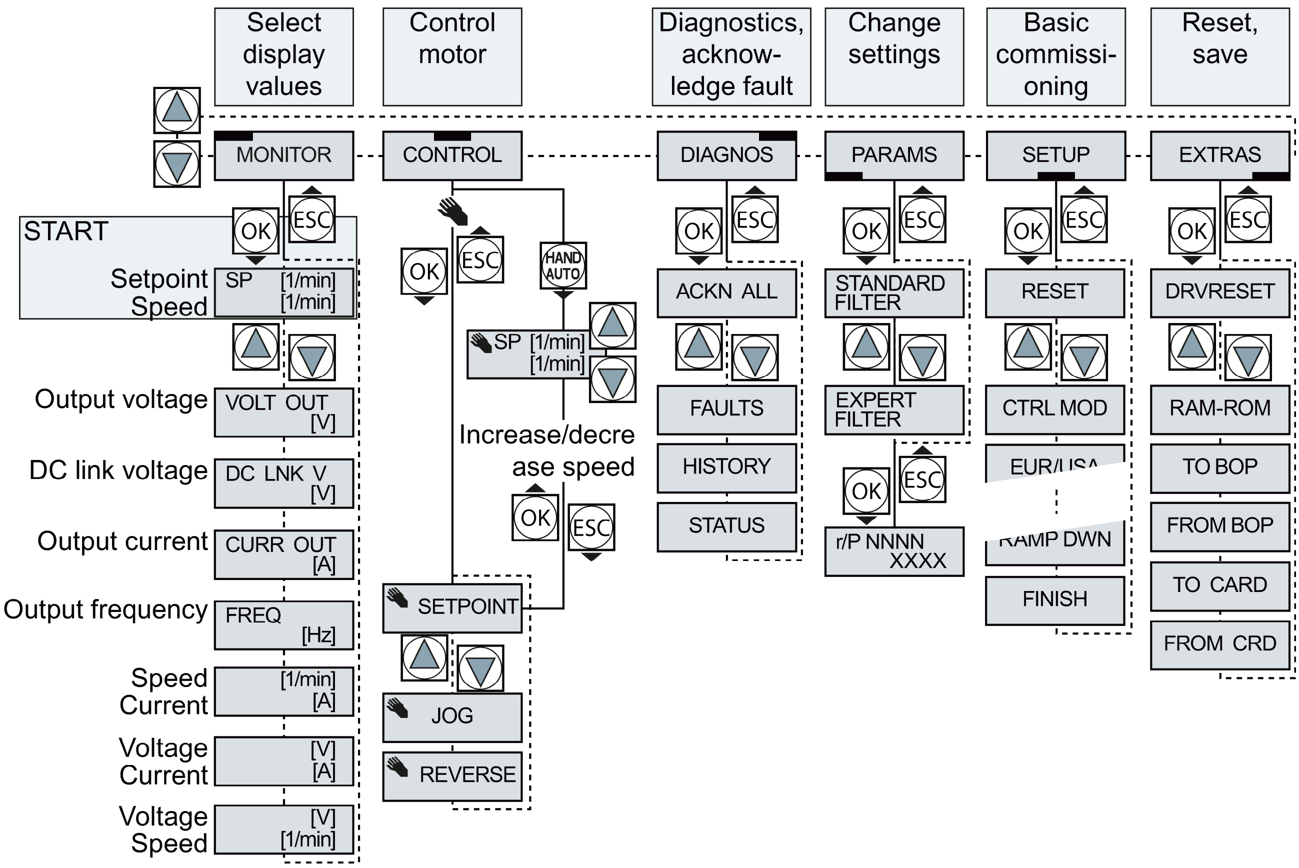


Figure A-1 Menu of the BOP-2

A.3.2 Other keys and symbols of the BOP-2 operator panel

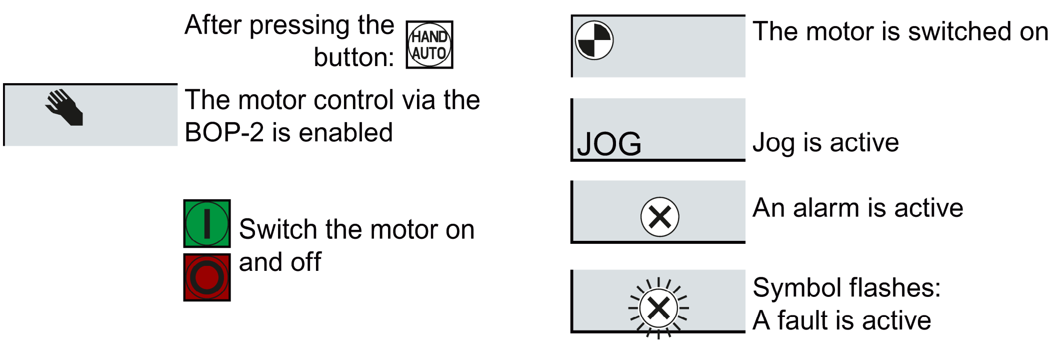


Figure A-2 Other keys and symbols of the BOP-2

A.3.3 Changing settings using BOP-2

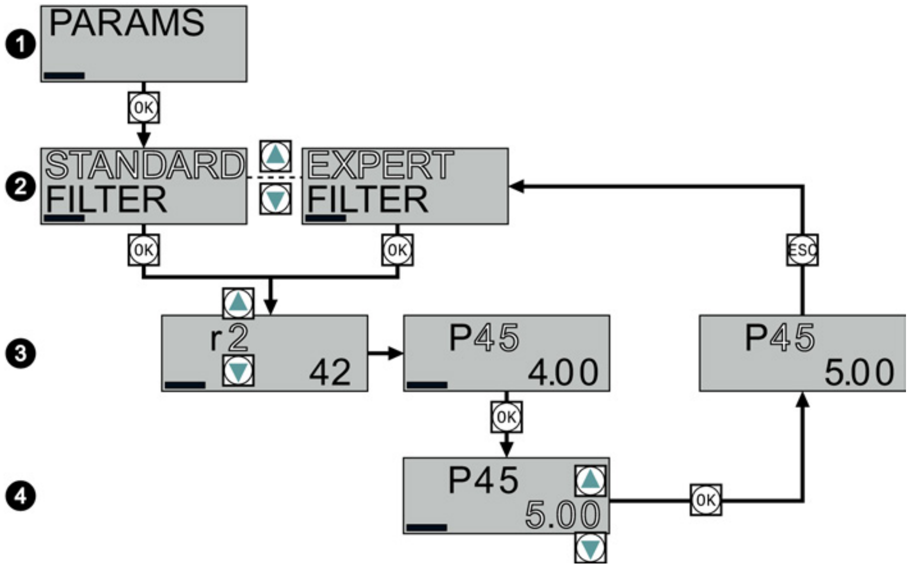
Changing settings using BOP-2

You can modify the settings of your converter by changing the values of the its parameters. The converter only permits changes to "write" parameters. Write parameters begin with a "P", e.g. P45.

The value of a read-only parameter cannot be changed. Read-only parameters begin with an "r", for example: r2.

Procedure

To change write parameters using the BOP-2, proceed as follows:



1. Select the menu to display and change parameters.
   Press the OK key.
2. Select the parameter filter using the arrow keys.
   Press the OK key.
   – STANDARD: The inverter only displays the most important parameters.
   – EXPERT: The inverter displays all of the parameters.
3. Select the required number of a write parameter using the arrow keys.
   Press the OK key.
4. Select the value of the write parameter using the arrow keys.
   Accept the value with the OK key.

You have now changed a write parameter using the BOP-2.

The converter saves all the changes made using the BOP-2 so that they are protected against power failure.

A.3.4 Changing indexed parameters

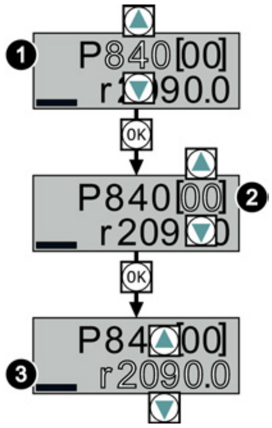
Changing indexed parameters

For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

Procedure

To change an indexed parameter, proceed as follows:

1. Select the parameter number.
2. Press the OK button and set the parameter index.
3. Press the OK button and set the parameter value for the selected index.



You have now changed an indexed parameter.

A.3.5 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.

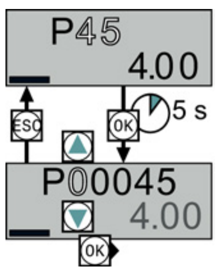
Prerequisite

The parameter number is flashing in the BOP-2 display.

Procedure

To select the parameter number directly, proceed as follows:

1. Press the OK button for longer than five seconds.
2. Change the parameter number digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter number, press the OK button.



You have now entered the parameter number directly.

Entering the parameter value directly

The BOP-2 offers the option of setting the parameter value digit by digit.

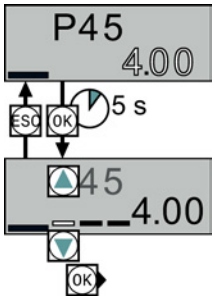
Prerequisite

The parameter value flashes in the BOP-2 display.

Procedure

To select the parameter value directly, proceed as follows:

1. Press the OK button for longer than five seconds.
2. Change the parameter value digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter value, press the OK button.

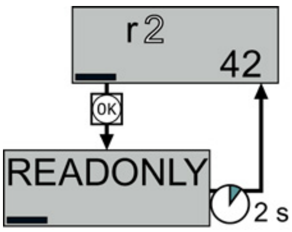


You have now entered the parameter value directly.

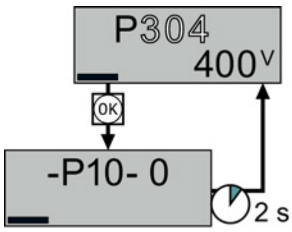
A.3.6 A parameter cannot be changed

When must you not change a parameter?

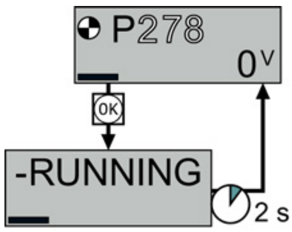
The converter indicates why it currently does not permit a parameter to be changed:



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.

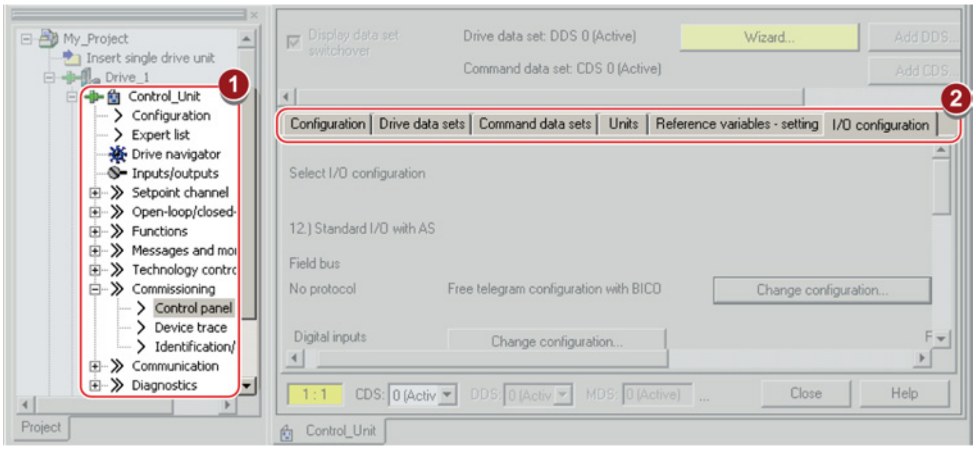
A.4 Handling STARTER

A.4.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidance (Page 57).

STARTER offers two options:

- Change the settings using the appropriate screen forms - **our recommendation.**
  ① Navigation bar: For each inverter function, select the corresponding screen form.
  ② tabs: Switch between screen forms.
  If you change the settings using screen forms you do not need to know the parameter numbers.



- You change the settings using the parameters in the expert list.
  If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.

Saving settings so that they are not lost when the power fails

The inverter initially only saves changes temporarily. You must do the following so that the inverter saves your settings securely in the event of a power failure.

Procedure

Proceed as follows to save your settings in the inverter so that they are not lost when the power fails:

1. Mark the appropriate drive in the project navigator.
2. Click the Save (RAM to ROM) button.

You have saved your settings securely in the inverter in case of a power failure.

Go offline

You can now exit the online connection after the data backup (RAM to ROM) with "Disconnect from target system".

A.4.2 Optimize the drive using the trace function

Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control_Unit/Commissioning/Device trace".

In two settings that are independent of one another, using you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with . Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ().

Mathematical function

Using the mathematical function () you can define a curve, for example the difference between the speed setpoint and the actual speed value.

Note

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

Trigger

You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the button (Start Trace). Using the button , you can define another trigger to start the measurement.

Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

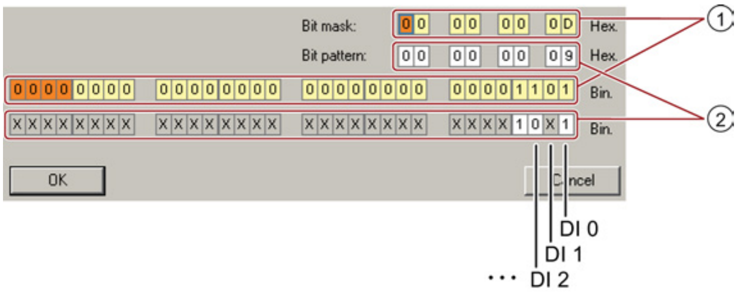
Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using , select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using , open the screen form in which you set the bits and their values for the start condition



① Select the bits for the trace trigger, upper row hex format, lower row binary format

② Define the bits for the trace trigger, upper row hex format, lower row binary format

Figure A-3 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

Display options

In this area, you can set how the measurement results are displayed.

- Measurement repetition
  This places the measurements that you wish to perform at different times above one other
- Arrange curves in tracks
  This means that you define as to whether all measured values are to be displayed with a common zero line – or whether each measured value is displayed with its own zero line.
- Measuring cursor on
  This allows you to analyze the measuring intervals in detail

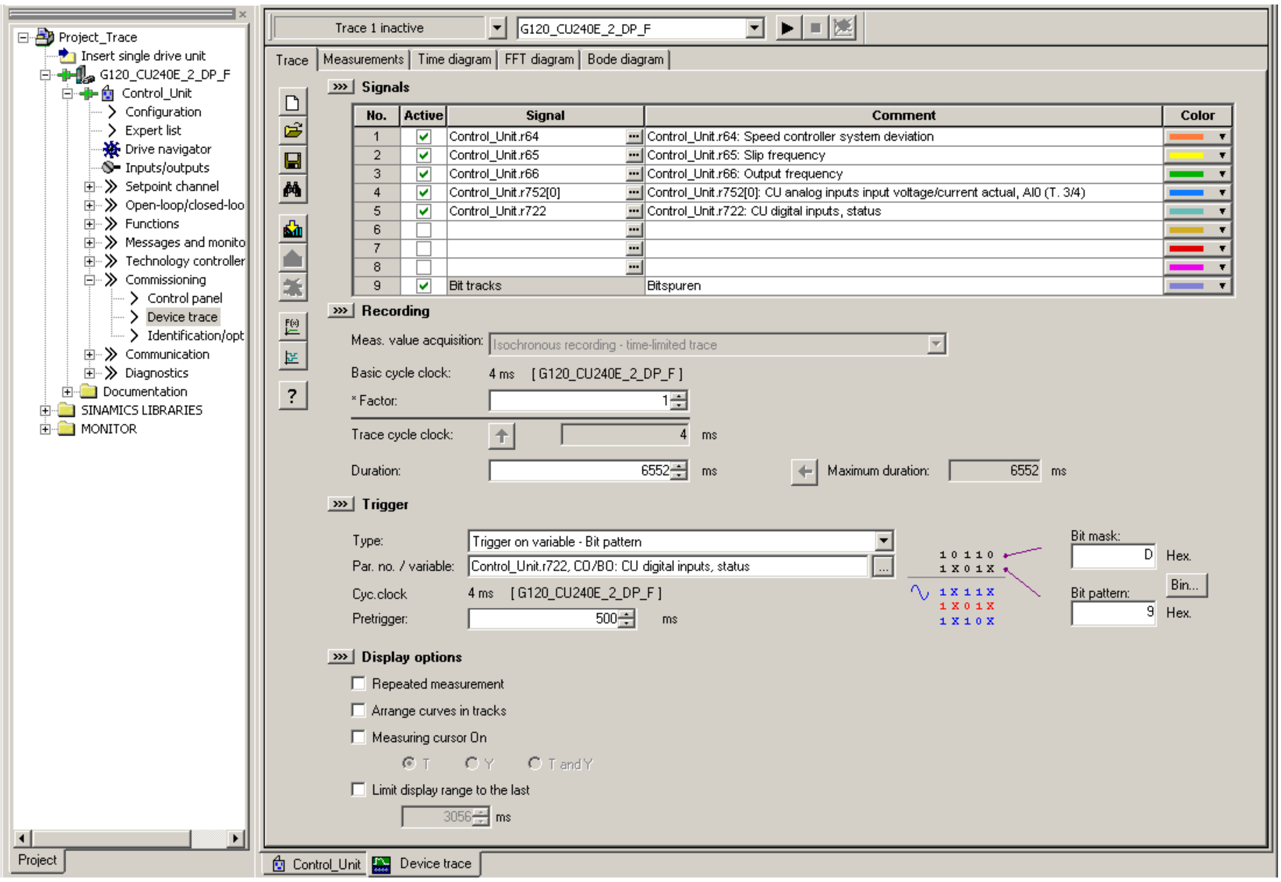


Figure A-4 Trace dialog box

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.

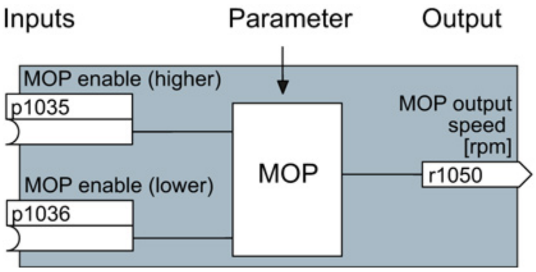


Figure A-5 Example of a block: Motorized potentiometer (MOP)

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.

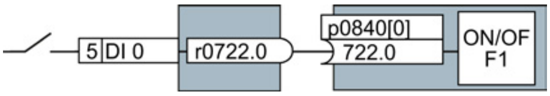


Figure A-6 Example: Signal interconnection of two blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual blocks:

- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

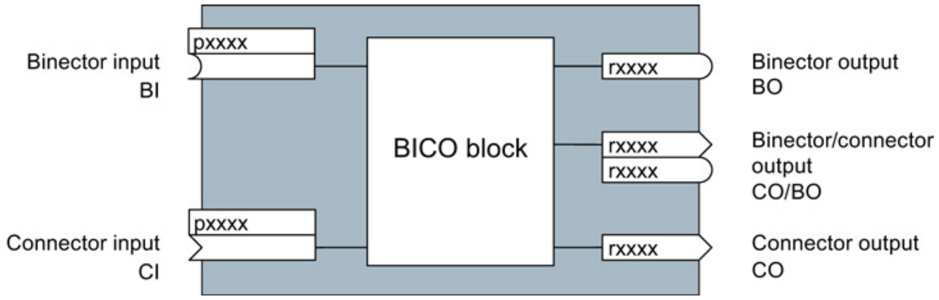


Figure A-7 Symbols for binector and connector inputs and outputs

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

Binector or connector outputs (CO, BO or CO/BO) can be used more than once.

When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

How much care is required when you change the signal interconnection?

Always take care when establishing internal signal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers signals in plain text and simplifies their interconnection.

Where can you find additional information?

- This manual is sufficient for simple signal interconnections (e.g. assigning a different function to digital inputs).
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

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 Adapting the terminal strip (Page 79).

Note

For the basic commissioning, you determine the function of the interfaces for your converter via predefined settings (p0015).

If you subsequently select a different predefined setting for the function of the interfaces, then all interconnections that you changed will be lost.

A.6 Application examples

A.6.1 Configuring the PROFIBUS communication with STEP 7

A.6.1.1 Precondition

Using a suitable example, the following section provides information on how you configure the communication of an inverter to a higher-level SIMATIC control system.

To configure the communication between an inverter and a SIMATIC control system, you require the SIMATIC STEP 7 software tool with HW Config.

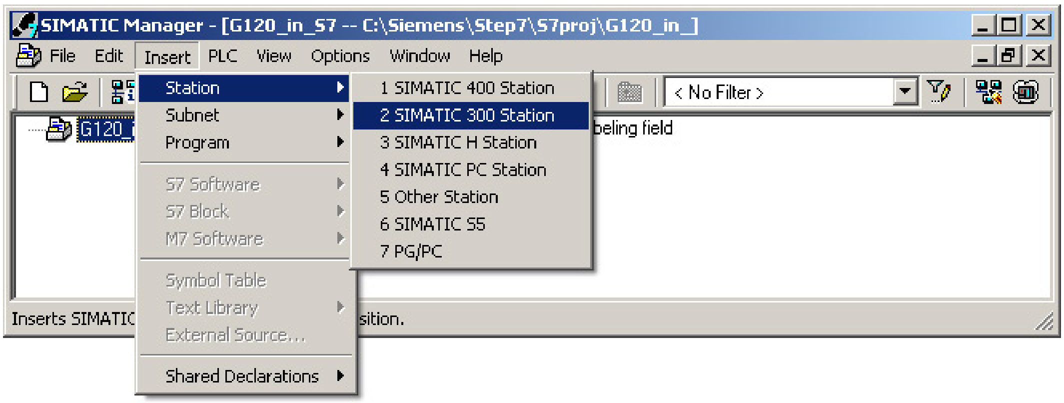
It is assumed that you are knowledgeable about working with SIMATIC control systems and that you have a sound understanding of the STEP 7 engineering tool.

A.6.1.2 Creating a STEP 7 project and network

Procedure

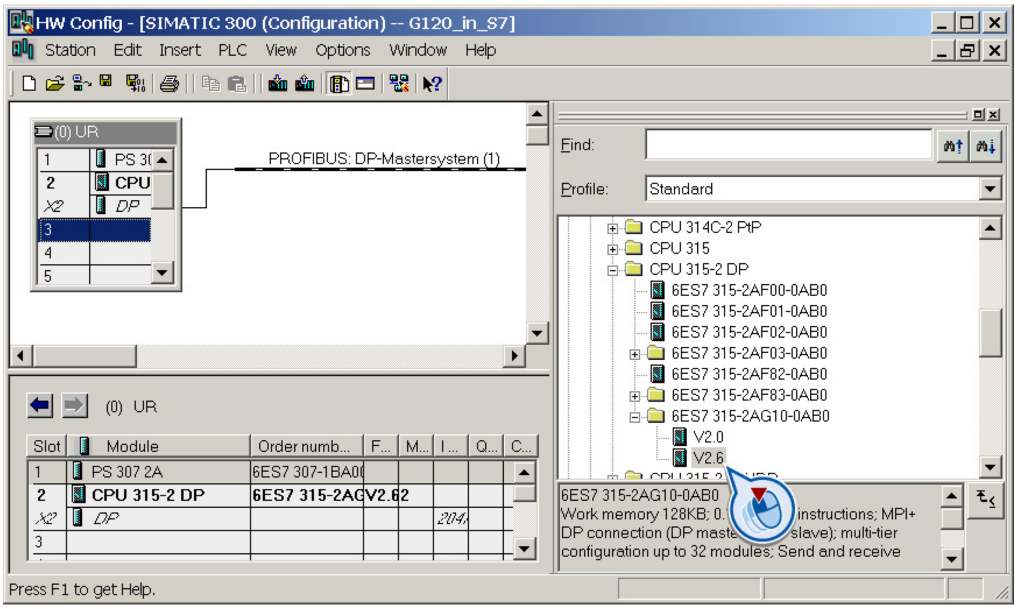
In order to create a STEP 7 project, proceed as follows:

1. Create a new STEP 7 project, e.g. "G120_in_S7".
2. Insert a SIMATIC control S7 300 CPU.



3. Select the SIMATIC 300 station in your project and open HW Config.
4. Insert an S7 300 mounting rail from the hardware catalog into your project with drag & drop.
5. Locate a power supply at slot 1 of the mounting rail and a CPU 315-2 DP control at slot 2.

   When inserting the control, HW Config opens the network setting.
6. Create a PROFIBUS DP network.



You have created a STEP 7 project with a SIMATIC control and a PROFIBUS network.

A.6.1.3 Inserting the inverter into the project

There are two ways to insert an inverter into the project:

1. Using the inverter GSD
2. Using the STEP 7 object manager

   The more user-friendly option is only available when STARTER is installed (see Section Commissioning tools (Page 23)).

Precondition

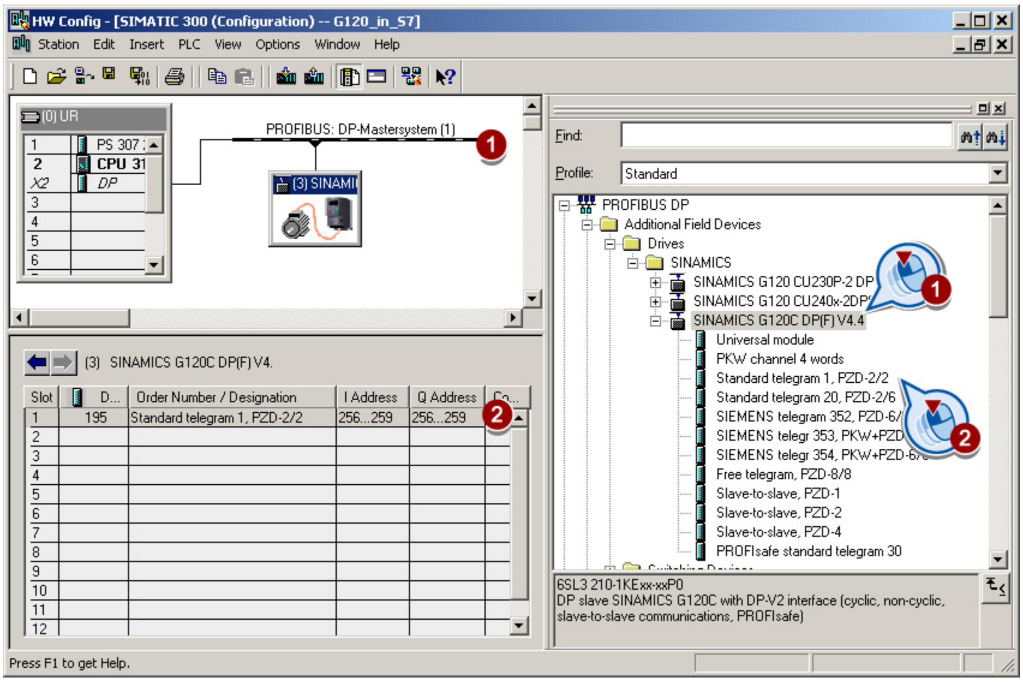
You have installed the GSD of the inverter in your PC using HW Config (menu "Options - Install GSD files").

Procedure

In order to insert an inverter into your project, proceed as follows:

1. Insert the inverter by dragging and dropping it into the PROFIBUS network.

   You can find the inverter under "PROFIBUS DP - Other field devices" in the HW Config hardware catalog.



2. Enter the PROFIBUS address set at the inverter in HW Config.
3. Select the appropriate telegram and insert the telegram into slot 1 of the inverter by dragging and dropping.

   More information on the telegram types can be found in Chapter Cyclic communication (Page 99).
4. If you wish to assign several inverter slots with telegrams, then you must comply with the permitted sequence of slot assignments.
5. Save and compile the project.
6. Download the project data to the S7-CPU.

You have inserted your project into the inverter and loaded your configuration to the CPU.

Permitted sequence for the slot assignment

1. PROFIsafe telegram, if one is being used.
   Information on connecting the inverter via PROFIsafe can be found in the "Safety Integrated Function Manual".
2. PKW channel, if one is used.
3. Standard, SIEMENS or free telegram, if one is used.
4. Direct data exchange

If you do not use one or several of the telegrams 1, 2 or 3, configure your telegrams starting with the 1st slot.

Cyclic communication to the inverter when using the universal module

A universal module with the following properties is not permitted:

- PZD length 4/4 words
- Consistency over the complete length

With these properties, the universal module has the same DP identifier (4AX) as the "PKW channel 4 words". The higher-level control does not establish cyclic communication with the inverter.

Workaround when using the universal module above:

- In the properties of the DP slave, change the PZD length to 8/8 bytes
- Change the consistency to "Unit".

A.6.2 Configuring the PROFINET communication with STEP 7

A.6.2.1 Precondition

Using a suitable example, the following section provides information on how you configure the communication of an inverter to a higher-level SIMATIC control system.

To configure the communication between an inverter and a SIMATIC control system, you require the SIMATIC STEP 7 software tool with HW Config.

It is assumed that you are knowledgeable about working with SIMATIC control systems and that you have a sound understanding of the STEP 7 engineering tool.

A.6.2.2 Configuring the controller and converter in HW Config

Using an example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2, the procedure shows how you insert the inverter into the project.

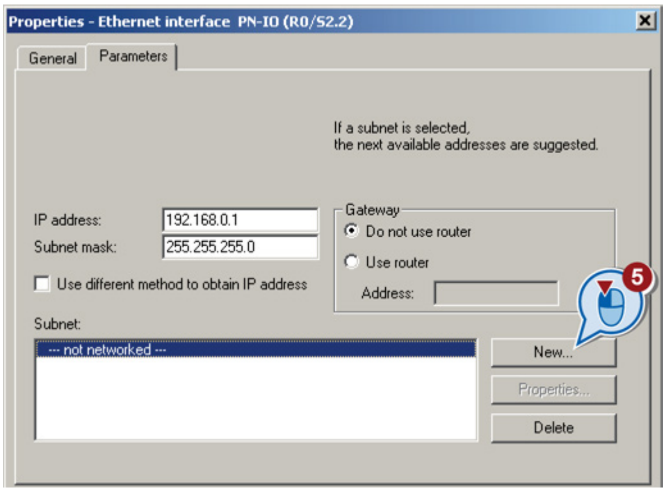
Procedure

Proceed as follows to configure communications between the inverter and the control system via PROFINET:

1. Open HW Config in STEP 7 via "Insert/[Station]", and create the components in accordance with your hardware structure. The following example is limited to the components that are absolutely required.
2. Build your station with a rack and power supply unit.
3. Insert the CPU.

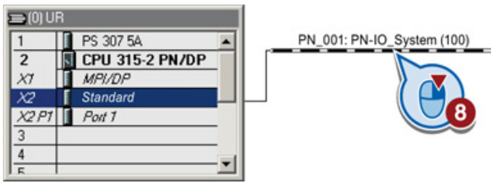
   HW Config opens a screen form with suggestions for the next free IP address and a subnet screen form.
4. If you have configured a local area network, and are not working within a larger Ethernet network, use the proposed entries.

   Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. CPU and supervisor must have the same subnet screen form.

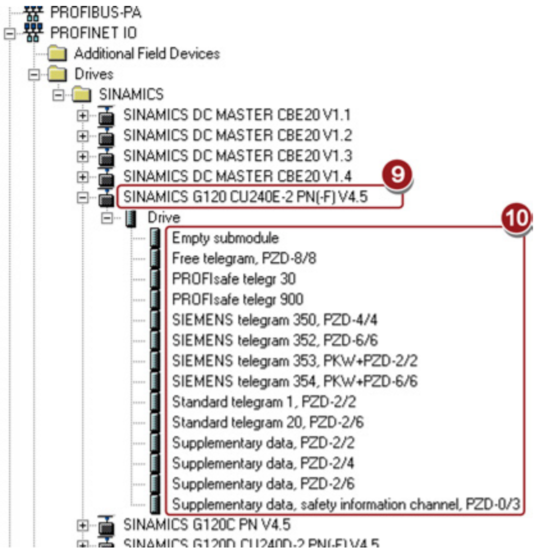


5. Use the "New" button to either create a new PROFINET subnet or select an existing one.

6. Assign a name for your PROFINET network.
7. Exit this screen form and the next one with OK.
8. Select your subnet.

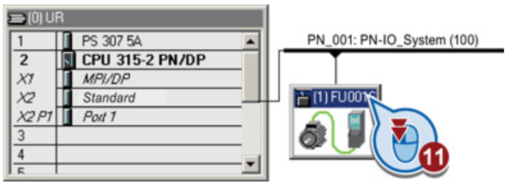


9. Using the hardware catalog, first insert the inverter using drag & drop.
10. Insert the communication telegram.



11. Open the properties window of the inverter and enter a unique and descriptive device name for the inverter.

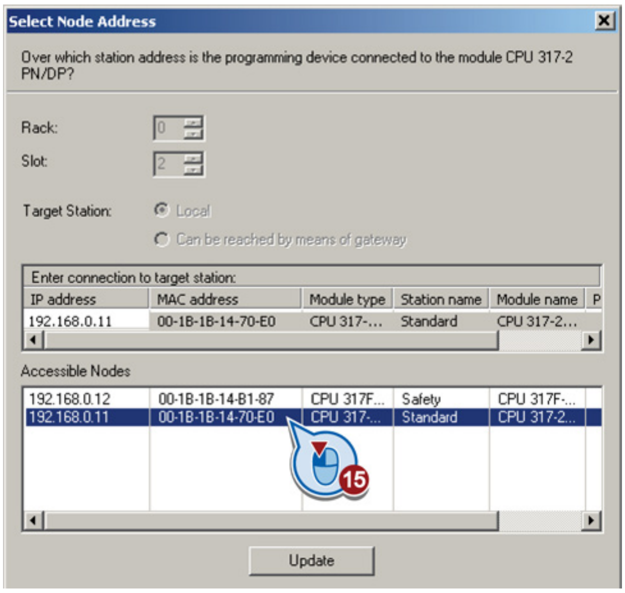
    Using the device name, the PROFINET controller assigns the IP address when starting up.



12. You will also find the proposed IP address in this screen form. If required, you can change the IP address via "Properties".
13. Save your hardware configuration with "Save and compile" ( ).
14. Load the configuration into the control unit via the button.

15.Enter the IP address of the controller.

If you do not have the IP address readily available, you can display the participants that can be reached by clicking the "Display" button. Select the control from the list of accessible participants, and exit the screen form with OK.



16.If you have installed Drive ES Basic, open the STARTER by double-clicking the inverter symbol in the Hardware Manager and configure the inverter in the STARTER.

In this case, STARTER automatically accepts the device name and IP address. The approach described in the following section is therefore superfluous.

17.If you are working with the GSDML, close HW Config now and create a reference for STARTER as described in the following section.

You have configured the communication between the inverter and the control unit using PROFINET.

See also

Connect the converter to PROFINET (Page 93)

A.6.2.3 Create a reference for STARTERS

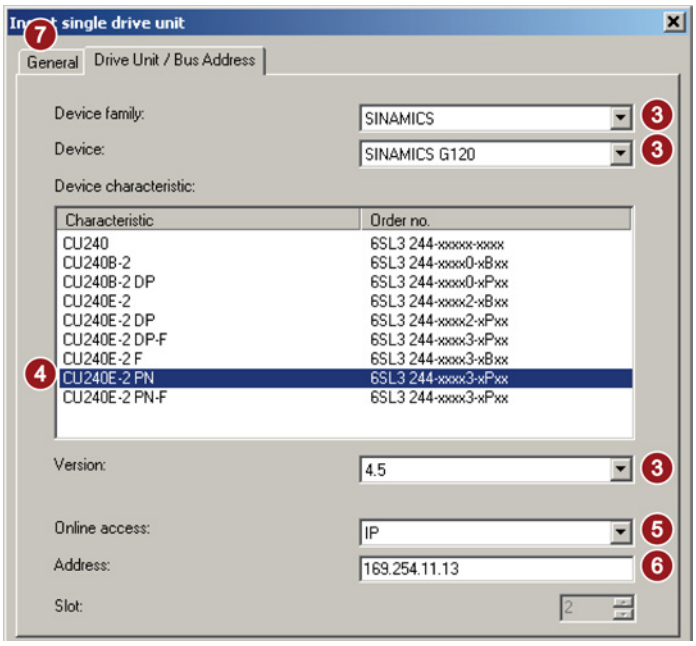
If you have configured the inverter via GSDML, in STEP 7, you must create a reference of the inverter for STARTER, so that you can call up STARTER from STEP 7.

This procedure is described using the example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2.

Procedure

Proceed as follows to create a reference of the inverter for STARTER:

1. Highlight the project in the SIMATIC manager
2. Open the "Insert single drive unit" screen form by right clicking on "Insert New Object/SINAMICS".
3. Under the "Drive device/address" tab, set the device family, device and the firmware version.
4. In the device version, select your inverter.
5. Set the online access.
6. Set the address.
7. Enter the PROFINET device name in the "General" tab.



8. Exit the screen form with OK.
9. The inverter is visible in your project.

In your project, you have created an inverter reference for STARTER. You can now call STARTER from your STEP 7 project.

A.6.2.4 Activate diagnostic messages via STEP 7

Procedure

Proceed as follows to activate the diagnostic messages of the inverter:

1. In HW Config, select the inverter.

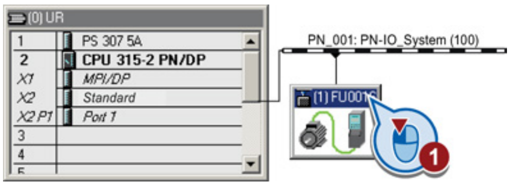
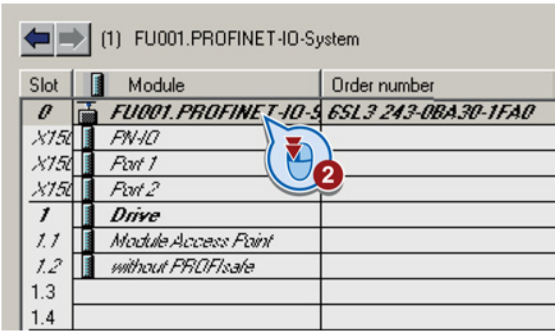
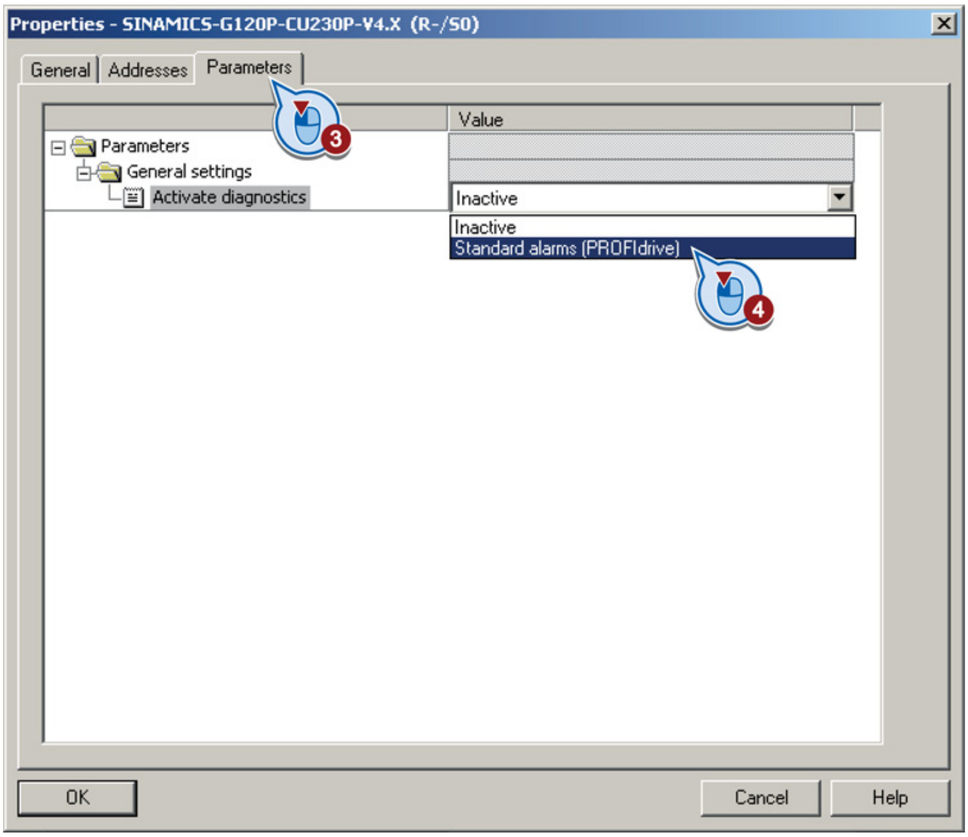


Figure A-8 Highlight inverter in HW Config

2. By double clicking on slot 0 in the station window, open the property window for the inverter's network settings.



3. Select the Parameters tab.
4. Activate the standard alarms.



You have activated the diagnosis messages.

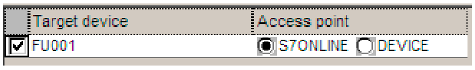
With the next ramp-up of the controller, the diagnostic messages of the inverter are then transferred to the controller.

A.6.2.5 Call the STARTER and go online

Procedure

To call STARTER from STEP 7 and establish an online connection to the inverter, proceed as follows:

1. Highlight the inverter in the SIMATIC manager with the right mouse button.
2. Open the STARTER via "Open object".
3. Configure the inverter in STARTER and click on the Online button ( ).
4. In the following window, select the inverter and then the S7ONLINE as access point.



5. Exit the screen form with OK.

You have called STARTER from STEP 7, and have established the online connection to the inverter.

A.6.3 STEP 7 programming examples

A.6.3.1 Data exchange via the fieldbus

Data exchange via the fieldbus

Analog signals

The inverter always scales signals, which are transferred via the fieldbus, to a value of 4000 hex.

Table A- 9 Signal category and associated scaling parameters

Signal category	4000 Hex ≙ …	Signal category	4000 Hex ≙ …
Speeds, frequencies	p2000	Torque	p2003
Voltage	p2001	Power	p2004
Current	p2002	Temperature	p2006

Control and status words

Control and status words consist of a higher-value and a lower-value byte. A SIMATIC control interpretes words differently than the converter: the higher-value and the lower-value byte are exchanged in each case during transmission. See also the following program example.

A.6.3.2 STEP 7 program example for cyclic communication

Network 1: Control word 1 and setpoint

Control word 1: 047E hex Setpoint: 2500 hex

```
L   W#16#47E
T   MW    1
L   W#16#2500
T   MW    3
```

Network 2: Acknowledge fault

```
U   E     0.6
=   M     2.7
```

Network 3: Switch the motor on and off

```
U   E     0.0
=   M     2.0
```

Network 4: Write process data

```
L   MW    1
T   PAW   256
L   MW    3
T   PAW   258
```

Network 4: Read process data

Status word 1: MW 5 Actual value: MW 7

```
L   PEW   256
T   MW    5
L   PEW   258
T   MW    7
```

The controller and inverter communicate via standard telegram 1. The control specifies control word 1 (STW1) and the speed setpoint, while the inverter responds with status word 1 (ZSW1) and its actual speed.

In this example, inputs E0.0 and E0.6 are linked to the ON/OFF1 bit or to the "acknowledge fault" bit of STW 1.

Control word 1 contains the numerical value 047E hex. The bits of control word 1 are listed in the following table.

The hexadecimal numeric value 2500 specifies the setpoint frequency of the inverter. The maximum frequency is the hexadecimal value 4000 (also see Configuring the fieldbus (Page 91)).

The controller cyclically writes the process data to logical address 256 of the inverter. The inverter also writes its process data to logical address 256. You define the address area in HW Config.

Table A- 10 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
E	0	0	ON/OFF1	8		0	E0.0
	1	1	OFF2	9		1	
	1	2	OFF3	10		2	
	1	3	Operation enable	11		3	
7	1	4	Ramp-function generator enable	12		4	
	1	5	Start ramp-function generator	13		5	
	1	6	Setpoint enable	14		6	
	0	7	Acknowledge fault	15		7	E0.6
4	0	8	Jog 1	0	0		
	0	9	Jog 2	1	1		
	1	10	PLC control	2	2		
	0	11	Setpoint inversion	3	3		
0	0	12	Irrelevant	4	4		
	0	13	Motorized potentiometer ↑	5	5		
	0	14	Motorized potentiometer ↓	6	6		
	0	15	Data set changeover	7	7		

A.6.3.3 STEP 7 program example for acyclic communication

OB1: Cyclic control program

Network 1: Reading and writing parameters

```
// read parameters
        O(
        U     M     9.2
        UN    M     9.1
        )
        O(
        U     M     9.0
        UN    M     9.1
        )
        R     M     9.3

        SPB   RD

// write parameters
        O(
        U     M     9.3
        UN    M     9.0
        )
        O(
        U     M     9.1
        UN    M     9.0
        )
        R     M     9.2

        SPB   WR
        BEA

RD:     NOP   0
        CALL  FC    1
        BEA
WR:     NOP   0     9.1
        CALL  FC    3
```

M9.0 Starts reading parameters

M9.1 Starts writing parameters

M9.2 Displays the read process

M9.3 Displays the write process

The number of simultaneous requests for acyclic communication is limited. More detailed information can be found under http://support.automation.siemens.com/WW/view/de/15364459 (http://support.automation.siemens.com/WW/view/en/15364459).

```
FC1:    PAR_RD

Network 1:    Parameters for reading

        L    MB       40
        T    DB1.DBB   0
        L    B#16#01
        T    DB1.DBB   1
        T    DB1.DBB   2
        L    MB       62
        T    DB1.DBB   3
  // ----------------------------------------
        L    MW       50
        T    DB1.DBW   6
        L    MB       58
        T    DB1.DBB   5
        L    MW       63
        T    DB1.DBW   8
  // ----------------------------------------
        L    MW       52
        T    DB1.DBW  12
        L    MB       59
        T    DB1.DBB  11
        L    MW       65
        T    DB1.DBW  14
  // ----------------------------------------
        L    MW       54
        T    DB1.DBW  18
        L    MB       60
        T    DB1.DBB  17
        L    MW       67
        T    DB1.DBW  10
  // ----------------------------------------
        L    MW       56
        T    DB1.DBW  24
        L    MB       61
        T    DB1.DBB  23
        L    MW       69
        T    DB1.DBW  26
```

```
Network 2:    Read request, part 1

      CALL    SFC     58
        REQ        :=M9.0
        IOID       :=B#16#54
        LADDR      :=W#16#170
        RECNUM     :=B#16#2F
        RECORD     :=P#DB1.DBX0.0 BYTE 28
        RET_VAL    :=MW10
        BUSY       :=M8.1

      U     M      8.1
      R     M      9.0
      S     M      9.2

Network 3:    Read delay after a read request

      U     M      8.1
      UN    M      9.1
      L     S5T#1s
      SS    T      1
      U     M      8.3
      R     T      1
      U     T      1
      =     M      8.2

Network 4:    Read request, part 2

      CALL    SFC     59
        REQ        :=M8.2
        IOID       :=B#16#54
        LADDR      :=W#16#170
        RECNUM     :=B#16#2F
        RET_VAL    :=MW12
        BUSY       :=M8.3
        RECORD     :=P#DB2.DBX0.0 BYTE 36

      U     M      8.3
      R     M      8.2
```

Figure A-9 Reading parameters

Note

With PROFINET standard function blocks (SFB) instead of system functions (SFC)

With acyclic communication via PROFINET, you must replace the system functions with standard function blocks as follows:

- SFC 58 → SFB 53
- SFC 59 → SFB 52

Explanation of FC 1

Table A- 11 Request to read parameters

Data block DB 1	Byte n	Bytes n + 1	n
Header	**Reference** *MB 40*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *MB 62*	2
Address, parameter 1	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 58*	4
	Parameter number *MW 50*		6
	Number of the 1st index *MW 63*		8
Address, parameter 2	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 59*	10
	Parameter number *MW 52*		12
	Number of the 1st index *MW 65*		14
Address, parameter 3	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 60*	16
	Parameter number *MW 54*		18
	Number of the 1st index *MW 67*		20
Address, parameter 4	**Attribute** *10 hex: Parameter value*	**Number of indexes** *MB 61*	22
	Parameter number *MW 56*		24
	Number of the 1st index *MW 69*		26

SFC 58 copies the specifications for the parameters to be read from DB 1 and sends them to the inverter as a read request. No other read requests are permitted while this one is being processed.

After the read request and a waiting time of one second, the controller takes the parameter values from the inverter via SFC 59 and saves them in DB 2.

```
FC3:    PAR_WR

Network 1:    Parameters for writing

        L       MB       42
        T       DB3.DBB   0
        L       B#16#02
        T       DB3.DBB   1
        L       B#16#01
        T       DB3.DBB   2
        L       MB       44
        T       DB1.DBB   3
   // -----------------------------------------
        L       MW       21
        T       DB3.DBW   6
        L       MW       23
        T       DB3.DBW   8
        L       MW       35
        T       DB3.DBW  12
        L       MB       25
        T       DB3.DBB  10
        L       MB       27
        T       DB3.DBB  11
```

```
Network 2:    Write request:

    CALL    SFC     58
      REQ          :=M9.1
      IOID         :=B#16#54
      LADDR        :=W#16#170
      RECNUM       :=B#16#2F
      RECORD       :=P#DB3.DBX0.0 BYTE 14
      RET_VAL      :=MW10
      BUSY         :=M8.1

    U       M       8.1
    R       M       9.1
    S       M       9.3
```

Figure A-10 Writing parameters

Explanation of FC 3

Table A- 12 Request to change parameters

Data block DB 3	Byte n	Bytes n + 1	n
Header	Reference *MB 42*	**02 hex**: Change request	0
	01 hex	Number of parameters *MB 44*	2
Address, parameter 1	**10 hex**: Parameter value	Number of indexes *00 hex*	4
	Parameter number *MW 21*		6
	Number of the 1st index *MW 23*		8
Values, parameter 1	Format *MB 25*	Number of index values *MB 27*	10
	Value of the 1st index*MW35*		12

SFC 58 copies the specifications for the parameters to be written from DB 3 and sends them to the inverter. The inverter blocks other write jobs while this write job is running.

A.6.4 Configuring slave-to-slave communication in STEP 7

Two drives communicate via standard telegram 1 with the higher-level controller. In addition, drive 2 receives its speed setpoint directly from drive 1 (actual speed).

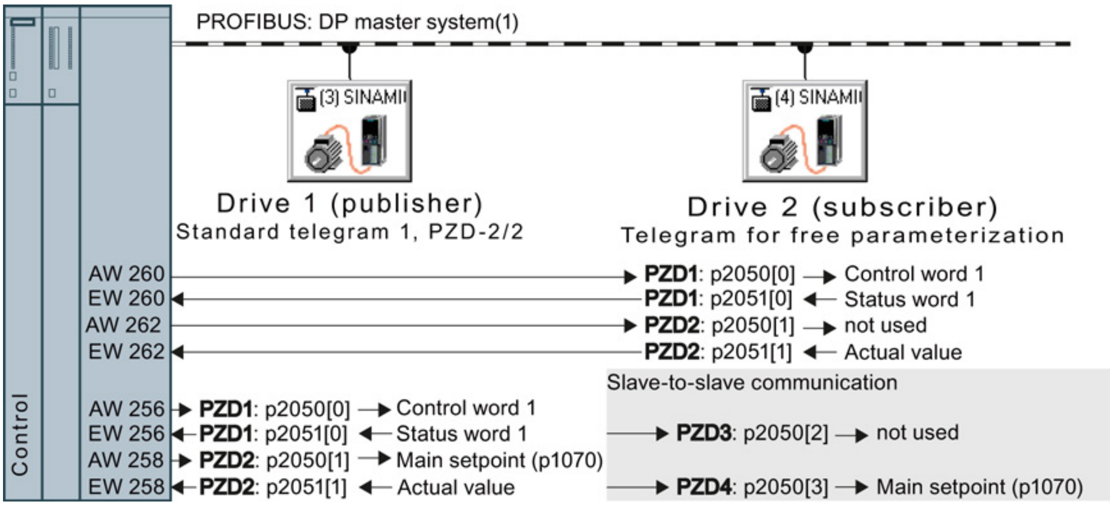


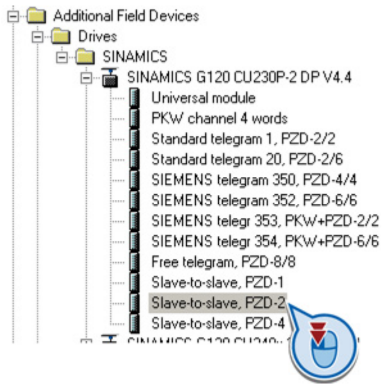
Figure A-11 Communication with the higher-level controller and between the drives with direct data exchange

Setting direct data exchange in the control

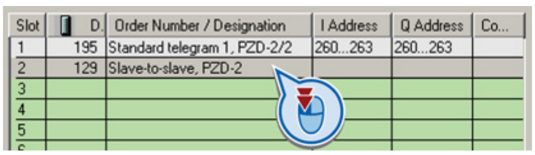
Procedure

Proceed as follows to set direct data exchange in the control:

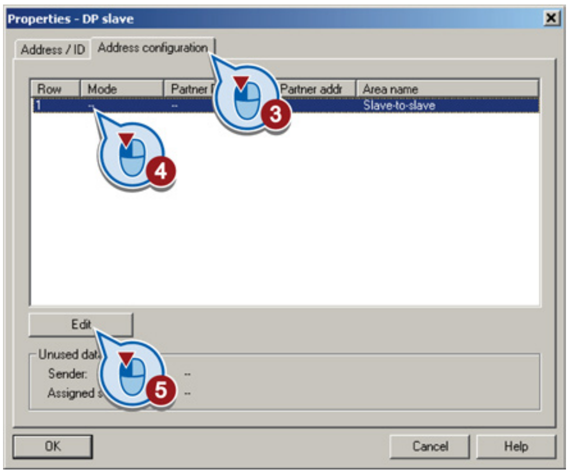
1. In HW Config in drive 2 (subscriber), insert a direct data exchange object, e.g. "Slave-to-slave, PZD2".



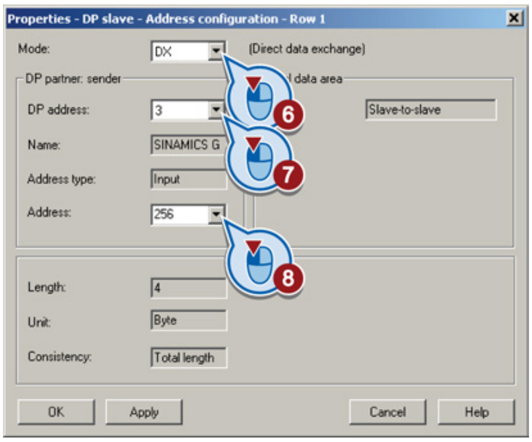
2. With a double-click, open the dialog box to make additional settings for the direct data exchange.



3. Activate the tab "Address configuration".
4. Select line 1.
5. Open the dialog box in which you define the Publisher and the address area to be transferred.



6. Select DX for direct data exchange
7. Select the address of drive 1 (publisher).
8. In the address field, select the start address specifying the data area to be received from drive 1. In the example, these are the status word 1 (PZD1) and the actual speed value with the start address 256.



9. Close both screen forms with OK.

You have now defined the value range for direct data exchange.

In the direct data exchange, drive 2 receives the sent data and writes this into the next available words, in this case, PZD3 and PZD4.

Settings in drive 2 (subscriber)

Drive 2 is preset in such a way that it receives its setpoint from the higher-level controller. In order that drive 2 accepts the actual value sent from drive 1 as setpoint, you must set the following:

- In drive 2, set the PROFIdrive telegram selection to "Free telegram configuration" (p0922 = 999).
- In drive 2, set the source of the main setpoint to p1070 = 2050.3.

The inverter indicates the inverter addresses that are configured for direct data exchange in parameter r2077.

A.6.5 Connecting fail-safe digital inputs

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.

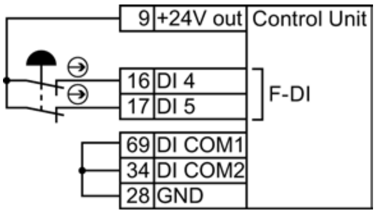


Figure A-12 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

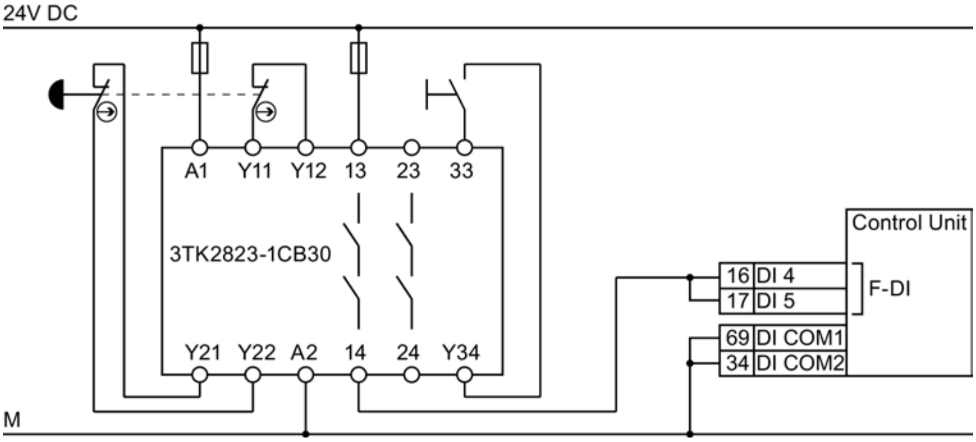


Figure A-13 Connecting a safety relay, e.g. SIRIUS 3TK28

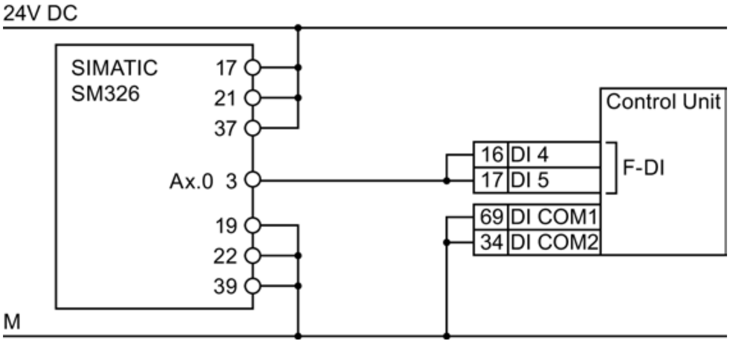


Figure A-14 Connecting an F digital output module, e.g. SIMATIC F digital output module

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 395).

A.7 Documentation for acceptance of safety functions

A.7.1 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- 13 Hardware version of the safety-related inverter

Labeling the drive	Order number and hardware version of the inverter
…	…
…	…

Function table

Table A- 14 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.7.2 Log the settings for the basic functions, firmware V4.4 ... V4.6

Drive = <pDO-NAME_v>

Table A- 15 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- 16 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 17 Checksums

Name	Number	Value
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 18 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>
SI F-DI changeover, tolerance time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>

Table A- 19 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- 20 Manuals for your converter

Depth of the information	Manual	Contents	Available languages	Download or order number
++	**Getting Started** SINAMICS G120C	Installing and commissioning the converter.	Chinese, English, French, German, Italian, Spanish, Turkish	Download (http://support.automation.siemens.com/WW/view/en/22339653/133300) **SINAMICS Manual Collection** Documentation on DVD, order number 6SL3097-4CA00-0YG0
+++	**Operating instructions**	(this manual)		
+++	**Function Manual for Safety Integrated**	Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the converter.	English, German	
+++	**List Manual** SINAMICS G120C	Complete list of all parameters, alarms and faults. Graphic function diagrams.	Chinese, English, German	
+	**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- 21 Support when configuring and selecting the converter

Manual or tool	Contents	Available languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G converters	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 (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Download engineering manual (http://support.automation.siemens.com/WW/view/en/37728795)

A.8.3 Product Support

If you have further questions

You can find additional information on the product and more in the Internet under: Product support (http://support.automation.siemens.com/WW/view/en/4000024).

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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