

# SINAMICS G120

Converter

with the Control Units

CU240B-2

CU240B-2 DP

CU240E-2

CU240E-2 DP

CU240E-2 F

CU240E-2 DP-F

CU240E-2 PN

CU240E-2 PN-F

Operating Instructions · 01/2013



## SINAMICS

Answers for industry.

**SIEMENS**





## SINAMICS

### SINAMICS G120 Converters with the CU240B-2 and CU240E-2 Control Units

#### Operating Instructions

#### Changes in this manual

<b>Safety notes</b>	<b>1</b>
<b>Introduction</b>	<b>2</b>
<b>Description</b>	<b>3</b>
<b>Installing</b>	<b>4</b>
<b>Commissioning</b>	<b>5</b>
<b>Adapt terminal strip</b>	<b>6</b>
<b>Configuring the fieldbus</b>	<b>7</b>
<b>Setting functions</b>	<b>8</b>
<b>Backing up data and series commissioning</b>	<b>9</b>
<b>Corrective maintenance</b>	<b>10</b>
<b>Alarms, faults and system messages</b>	<b>11</b>
<b>Technical data</b>	<b>12</b>
<b>Appendix</b>	<b>A</b>

Edition 01/2013, Firmware V4.6

Original instructions  
01/2013, FW V4.6

A5E02299792B AD

## Legal information

### Warning notice system

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

 <b>DANGER</b>
---

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

 <b>WARNING</b>
--

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

 <b>CAUTION</b>
--

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

<b>NOTICE</b>
---------------

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

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

### Qualified Personnel

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

### Proper use of Siemens products

Note the following:

 <b>WARNING</b>
--

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

### Trademarks

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

### Disclaimer of Liability

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

# Changes in this manual

## Important changes with respect to the Manual, Edition 04/2012

New Power Modules	In Chapter
<ul style="list-style-type: none"><li>• Power Module PM230 FSD ... FSF in IP20 degree of protection</li><li>• Power Module PM230 FSD ... FSF in push through design</li><li>• Enable operation of the CU240B/E-2 Control Unit with the PM340 1AC Power Module</li></ul>	Installing the Power Module (Page 40)

New functions in firmware V4.6	In Chapter
Skip frequency band for analog inputs	Analog inputs (Page 94)
Firmware update of the Control Unit	Upgrading the firmware (Page 303) Firmware downgrade (Page 305)
EtherNet/IP	Communication via EtherNet/IP (Page 133)

An overview of all new and modified functions in Firmware V4.6 can be found in section Firmware version 4.6 (Page 360).

Revised descriptions	In Chapter
Summary of the general safety notes has been supplemented	Safety notes (Page 15)
Ramp-function generator <ul style="list-style-type: none"><li>• Rounding times have been added</li><li>• Changing the ramp-up and ramp-down times in operation.</li></ul>	Ramp-function generator (Page 191)
Accepting the safety function Safe Torque Off (STO)	Approval - completing commissioning (Page 265)
PROFenergy functionality of the inverter has been supplemented	PROFenergy profile for PROFINET (Page 130)
"Energy-saving display" inverter function has been supplemented	Energy-saving display (Page 218)



# Table of contents

	Changes in this manual .....	5
<b>1</b>	<b>Safety notes .....</b>	<b>15</b>
<b>2</b>	<b>Introduction .....</b>	<b>19</b>
2.1	About this manual.....	19
2.2	Guide through this manual.....	20
<b>3</b>	<b>Description .....</b>	<b>21</b>
3.1	Identifying the converter .....	21
3.2	Overview of Control Units.....	22
3.3	Power Module .....	23
3.3.1	Accessories for installation and shielding.....	25
3.4	System components for the Power Modules .....	27
3.4.1	Line filter .....	27
3.4.2	Line reactor.....	28
3.4.3	Output reactor .....	29
3.4.4	Sine-wave filter.....	31
3.4.5	Braking resistor .....	33
3.4.6	Brake Relay .....	34
3.5	Tools to commission the converter .....	35
<b>4</b>	<b>Installing .....</b>	<b>37</b>
4.1	Overview of the inverter installation .....	37
4.2	Installing reactors, filters and braking resistors.....	38
4.3	Installing the Power Module.....	40
4.3.1	Dimensions, hole drilling templates, minimum clearances, tightening torques .....	41
4.3.2	Dimension drawings PT.....	43
4.3.3	Connecting the line supply, motor, and inverter components.....	44
4.4	Installing Control Unit .....	50
4.4.1	Interfaces, connectors, switches, terminal blocks and LEDs of the CU .....	51
4.4.2	Terminal strips on CU240B-2 Control Units.....	52
4.4.3	Terminal strips on CU240E-2 Control Units.....	53
4.4.4	Finding a suitable setting for the interfaces .....	55
4.4.4.1	Pre-assignments and wiring of the inverter with CU240B-2 Control Units.....	55
4.4.4.2	Pre-assignments and wiring of the inverter with CU240E-2 Control Units.....	57
4.4.5	Wiring the terminal strip.....	61
4.4.6	Fieldbus interface allocation .....	62
4.5	Connecting inverters in compliance with EMC .....	63
4.5.1	EMC-compliant connection of the converter.....	63
4.5.2	Avoid electromagnetic interference (EMI) .....	63
<b>5</b>	<b>Commissioning .....</b>	<b>67</b>

5.1	Commissioning guidelines.....	67
5.2	Preparing for commissioning .....	68
5.2.1	Wiring examples for the factory settings .....	69
5.2.2	Does the motor match the converter? .....	71
5.2.3	Factory setting of the inverter control.....	72
5.2.4	V/f control or vector control (speed/torque)? .....	73
5.2.5	Defining additional requirements for the application .....	74
5.3	Restoring the factory setting .....	75
5.4	Basic commissioning .....	76
5.4.1	Basic commissioning with the BOP-2 operator panel .....	76
5.4.2	Basic commissioning with STARTER .....	81
5.4.2.1	Adapting interfaces .....	82
5.4.2.2	Generating a STARTER project.....	84
5.4.2.3	Go online and start wizard for basic commissioning.....	84
5.4.2.4	Carry-out basic commissioning.....	85
5.4.2.5	Identifying motor data.....	86
<b>6</b>	<b>Adapt terminal strip.....</b>	<b>89</b>
6.1	Digital inputs .....	90
6.2	Fail-safe input .....	92
6.3	Digital outputs .....	93
6.4	Analog inputs .....	94
6.5	Analog outputs .....	99
<b>7</b>	<b>Configuring the fieldbus .....</b>	<b>103</b>
7.1	Communication via PROFINET .....	104
7.1.1	What do you need for communication via PROFINET?.....	104
7.1.2	Connect the converter to PROFINET.....	105
7.1.3	Configuring communication to the control.....	106
7.1.4	Select telegram – procedure.....	106
7.1.5	Activating diagnostics via the control .....	107
7.2	Communication via PROFIBUS .....	107
7.2.1	What do you need for communication via PROFIBUS?.....	107
7.2.2	Connect the frequency inverter to PROFIBUS .....	108
7.2.3	Configuring communication to the control .....	109
7.2.4	Setting the address .....	109
7.2.5	Select telegram – procedure.....	110
7.3	PROFIdrive profile for PROFIBUS and PROFINET.....	111
7.3.1	Cyclic communication.....	111
7.3.1.1	Control and status word 1.....	113
7.3.1.2	Control and status word 3.....	116
7.3.1.3	Extend telegrams and change signal interconnection.....	118
7.3.1.4	Data structure of the parameter channel.....	119
7.3.1.5	Slave-to-slave communication.....	124
7.3.2	Acyclic communication .....	125
7.4	PROFInergy profile for PROFINET .....	130
7.4.1	PROFInergy.....	130

7.5	Communication via EtherNet/IP .....	133
7.5.1	Connect converter to Ethernet/IP .....	133
7.5.2	What do you need for communication via Ethernet/IP? .....	134
7.5.3	Communication settings for Ethernet/IP .....	134
7.5.4	Additional settings if you are working with the AC/DC profile .....	135
7.5.5	Supported objects .....	136
7.5.6	Create generic I/O module .....	145
7.6	Communication via RS485 .....	146
7.6.1	Integrating inverters into a bus system via the RS485 interface .....	146
7.6.2	Communication via USS .....	147
7.6.2.1	Basic settings for communication .....	147
7.6.2.2	Telegram structure .....	148
7.6.2.3	User data range of the USS telegram .....	149
7.6.2.4	USS parameter channel .....	150
7.6.2.5	USS process data channel (PZD) .....	155
7.6.2.6	Time-out and other errors .....	156
7.6.3	Communication over Modbus RTU .....	158
7.6.3.1	Basic settings for communication .....	159
7.6.3.2	Modbus RTU telegram .....	161
7.6.3.3	Baud rates and mapping tables .....	161
7.6.3.4	Write and read access via FC 03 and FC 06 .....	165
7.6.3.5	Communication procedure .....	167
<b>8</b>	<b>Setting functions .....</b>	<b>169</b>
8.1	Overview of the inverter functions .....	169
8.2	Inverter control .....	171
8.2.1	Switching the motor on and off .....	171
8.2.2	Inverter control using digital inputs .....	173
8.2.3	Two-wire control: method 1 .....	174
8.2.4	Two-wire control, method 2 .....	175
8.2.5	Two-wire control, method 3 .....	176
8.2.6	Three-wire control, method 1 .....	177
8.2.7	Three-wire control, method 2 .....	178
8.2.8	Running the motor in jog mode (JOG function) .....	179
8.2.9	Switching over the inverter control (command data set) .....	180
8.3	Setpoints .....	182
8.3.1	Overview .....	182
8.3.2	Analog input as setpoint source .....	183
8.3.3	Specifying the motor speed via the fieldbus .....	183
8.3.4	Motorized potentiometer as setpoint source .....	184
8.3.5	Fixed speed as setpoint source .....	186
8.4	Setpoint calculation .....	188
8.4.1	Overview of setpoint processing .....	188
8.4.2	Invert setpoint .....	188
8.4.3	Inhibit direction of rotation .....	189
8.4.4	Minimum speed .....	189
8.4.5	Maximum speed .....	190
8.4.6	Ramp-function generator .....	191
8.5	Motor control .....	196
8.5.1	V/f control .....	196

8.5.1.1	Characteristics of U/f control.....	197
8.5.1.2	Selecting the U/f characteristic .....	198
8.5.1.3	Optimizing with a high break loose torque and brief overload.....	199
8.5.2	Closed-loop speed control.....	201
8.5.2.1	Properties of the sensorless vector control .....	201
8.5.2.2	Select motor control .....	202
8.5.2.3	Re-optimize the speed controller .....	203
8.5.2.4	Torque control.....	205
8.6	Protection functions.....	206
8.6.1	Inverter temperature monitoring.....	206
8.6.2	Motor temperature monitoring using a temperature sensor .....	207
8.6.3	Protecting the motor by calculating the motor temperature.....	210
8.6.4	Overcurrent protection.....	210
8.6.5	Limiting the maximum DC link voltage .....	211
8.7	Application-specific functions.....	213
8.7.1	Unit changeover.....	213
8.7.1.1	Changing over the motor standard.....	215
8.7.1.2	Changing over the unit system .....	216
8.7.1.3	Changing over process variables for the technology controller.....	216
8.7.1.4	Switching units with STARTER.....	217
8.7.2	Energy-saving display .....	218
8.7.3	Braking functions of the inverter .....	220
8.7.3.1	Electrical braking methods .....	220
8.7.3.2	DC braking.....	222
8.7.3.3	Compound braking.....	225
8.7.3.4	Dynamic braking .....	226
8.7.3.5	Braking with regenerative feedback to the line.....	230
8.7.3.6	Motor holding brake.....	230
8.7.4	Automatic restart and flying restart .....	236
8.7.4.1	Flying restart – switching on while the motor is running.....	236
8.7.4.2	Automatic switch-on .....	237
8.7.5	PID technology controller .....	241
8.7.5.1	Overview.....	241
8.7.5.2	Setting the controller .....	242
8.7.5.3	Optimizing the controller.....	243
8.7.6	Monitor the load torque (system protection).....	245
8.7.7	Speed and load failure via digital input.....	247
8.7.8	Logical and arithmetic functions using function blocks .....	249
8.8	Safe Torque Off (STO) safety function.....	253
8.8.1	Function description .....	253
8.8.2	Prerequisite for STO use.....	254
8.8.3	Commissioning STO .....	254
8.8.3.1	Commissioning tool.....	254
8.8.3.2	Protection of the settings from unauthorized changes.....	255
8.8.3.3	Resetting the safety function parameters to the factory setting.....	255
8.8.3.4	Changing settings .....	256
8.8.3.5	Interconnecting the "STO active" signal.....	257
8.8.3.6	Setting the filter for fail-safe inputs.....	258
8.8.3.7	Setting forced dormant error detection.....	261
8.8.3.8	Activate settings.....	263
8.8.3.9	Checking the assignment of the digital inputs .....	264

8.8.3.10	Approval - completing commissioning.....	265
8.9	Switchover between different settings.....	270
<b>9</b>	<b>Backing up data and series commissioning.....</b>	<b>273</b>
9.1	Backing up and transferring settings using a memory card.....	274
9.1.1	Saving setting on memory card .....	275
9.1.2	Transferring the setting from the memory card.....	277
9.1.3	Safely remove the memory card .....	279
9.2	Backing up and transferring settings using STARTER .....	282
9.3	Saving settings and transferring them using an operator panel .....	284
9.4	Other ways to back up settings.....	285
9.5	Write and know-how protection.....	286
9.5.1	Write protection .....	288
9.5.2	Know-how protection .....	289
9.5.2.1	Settings for the know-how protection .....	290
9.5.2.2	Creating an exception list for the know-how protection.....	292
9.5.2.3	Replacing devices with active know-how protection .....	293
<b>10</b>	<b>Corrective maintenance.....</b>	<b>295</b>
10.1	Overview of replacing converter components.....	295
10.2	Replacing a Control Unit with enabled safety function.....	296
10.3	Replacing the Control Unit without the safety functions enabled.....	299
10.4	Replacing the Control Unit without data backup .....	300
10.5	Replacing a Power Module with enabled safety function .....	301
10.6	Replacing a Power Module without the safety function being enabled .....	302
10.7	Upgrading the firmware .....	303
10.8	Firmware downgrade.....	305
10.9	Correcting an unsuccessful firmware upgrade or downgrade .....	307
10.10	If the converter no longer responds .....	308
<b>11</b>	<b>Alarms, faults and system messages .....</b>	<b>311</b>
11.1	Operating states indicated on LEDs.....	311
11.2	System runtime .....	313
11.3	Alarms.....	314
11.4	Faults.....	317
11.5	List of alarms and faults.....	322
<b>12</b>	<b>Technical data .....</b>	<b>331</b>
12.1	Technical data, CU240B-2 Control Unit .....	331
12.2	Technical data, CU240E-2 Control Unit .....	333
12.3	Technical data, Power Modules .....	336
12.3.1	Technical data, PM230 IP20.....	338

12.3.1.1	General data, PM230 - IP20 .....	338
12.3.1.2	Power-dependent data, PM230, IP20 .....	339
12.3.2	Technical data, PM240 .....	345
12.3.2.1	General data, PM240 .....	345
12.3.2.2	Power-dependent data, PM240 .....	346
12.3.3	Technical data, PM240-2 .....	351
12.3.3.1	General data, PM240-2 .....	351
12.3.3.2	Power-dependent data PM240-2 .....	352
12.3.4	Technical data, PM250 .....	354
12.3.4.1	Power-dependent data, PM250 .....	355
12.3.5	Technical data, PM260 .....	357
12.3.5.1	Power-dependent data, PM260 .....	358
<b>A</b>	<b>Appendix.....</b>	<b>359</b>
A.1	New and extended functions .....	359
A.1.1	Firmware version 4.5 .....	359
A.1.2	Firmware version 4.6 .....	360
A.2	Star-delta motor connection and application examples .....	361
A.3	Parameter .....	362
A.4	Handling the BOP 2 operator panel .....	364
A.4.1	Changing settings using BOP-2 .....	365
A.4.2	Changing indexed parameters .....	366
A.4.3	Directly entering the parameter number and value .....	366
A.4.4	A parameter cannot be changed .....	367
A.5	Handling STARTER .....	368
A.5.1	Change settings .....	368
A.5.2	Optimize the drive using the trace function .....	369
A.6	Interconnecting signals in the inverter .....	372
A.6.1	Fundamentals .....	372
A.6.2	Example .....	374
A.7	Application Examples .....	376
A.7.1	Configuring PROFIBUS communication in STEP 7 .....	376
A.7.1.1	Precondition .....	376
A.7.1.2	Creating a STEP 7 project and network .....	376
A.7.1.3	Inserting the inverter into the project .....	377
A.7.2	Configuring PROFINET communication in STEP 7 .....	379
A.7.2.1	Configuring the controller and converter in HW Config .....	379
A.7.2.2	Create a reference for STARTERS .....	382
A.7.2.3	Call the STARTER and go online .....	383
A.7.2.4	Activate diagnostic messages via STEP 7 .....	383
A.7.3	STEP 7 program examples .....	384
A.7.3.1	STEP 7 program example for cyclic communication .....	385
A.7.3.2	STEP 7 program example for acyclic communication .....	387
A.7.4	Configuring slave-to-slave communication in STEP 7 .....	391
A.7.5	Connecting fail-safe digital inputs .....	393
A.8	Documentation for accepting the safety functions .....	394
A.8.1	Machine documentation .....	394
A.8.2	Log the settings for the basic functions, firmware V4.4 ... V4.6 .....	396

A.9	Additional information on the inverter.....	397
A.10	Mistakes and improvements .....	399
<b>Index.....</b>		<b>401</b>



## Safety notes

### 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 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

## 2.1 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?



1 An operating instruction starts here.



This concludes the operating instruction.



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



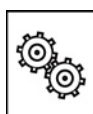
The following text applies if you are using a PC with STARTER.



Examples for the symbols of the inverter functions.

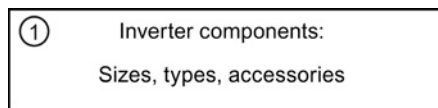
The description of the corresponding inverter function starts with one of these symbols.

See also: Overview of the inverter functions (Page 169).



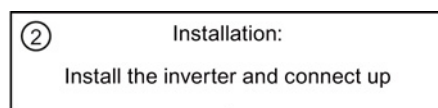
## 2.2 Guide through this manual

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

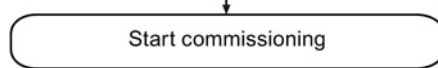


- ① Here you will find information about the hardware of your inverter and the commissioning tools:

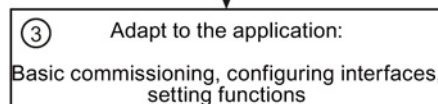
- Identifying the converter (Page 21)



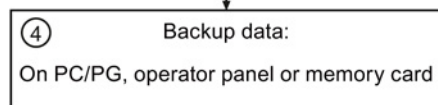
- ② • Overview of the inverter installation (Page 37)



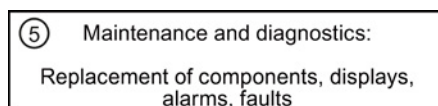
All information relating to the commissioning of your inverter is located in the following chapters:



- ③ • Basic commissioning (Page 76)  
• Adapt terminal strip (Page 89)  
• Configuring the fieldbus (Page 103)  
• Setting functions (Page 169)

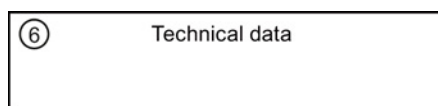


- ④ • Backing up data and series commissioning (Page 273)



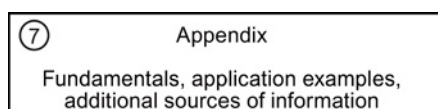
- ⑤ Information regarding the maintenance and diagnostics of your inverter is located in the following chapters:

- Corrective maintenance (Page 295)
- Alarms, faults and system messages (Page 311)



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

- Technical data (Page 331)



- ⑦ The appendix contains some background information and explanatory examples:

- Appendix (Page 359)

## 3

## Description

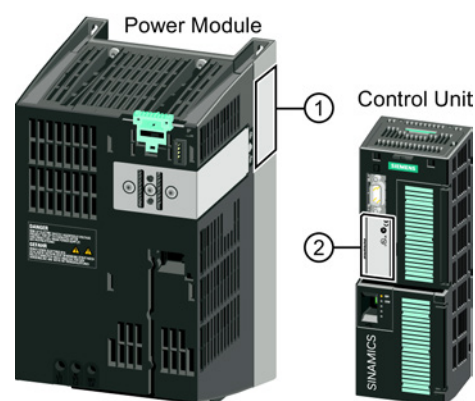
All power data refer to rated values or to power for operation with low overload (LO).

### 3.1 Identifying the converter

#### Main components of the converter

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

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



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

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

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

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

#### Additional converter components

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

- Line filter (Page 27)
- Line reactor (Page 28)
- Output reactor (Page 29)
- Sine-wave filter (Page 31)
- Braking resistor (Page 33)
- Brake Relay to control a motor holding brake (Page 34).


## 3.2 Overview of Control Units



Table 3- 1 Control Units CU240B-2 ...

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

Table 3- 2 Control Units CU240E-2 ...

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

### Shield connection kit for the Control Unit

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

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

Table 3- 3 Order numbers

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

## 3.3 Power Module

Which Power Module can I use with the Control Unit?

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

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



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



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

**PM230, 3 AC 400 V - Pump and fan applications**

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

Range of order numbers:

- IP20: 6SL3210-1NE...
- Push through 6SL3211-1NE...

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

**PM340, 1 AC 200 V - Standard areas of application**

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

Order number range: 6SL3210-1SB1...

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW)	0.12 ... 0.7 5	--	--	--	--	--	---

**PM240, 3 AC 400 V - Standard areas of application**

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

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

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

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

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

Range of order numbers:

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

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW), IP20	0.55 ... 3	--	--	--	--	--	--
Power range (kW), PT	2.2 ... 3	--	--	--	--	--	--

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

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

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

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW)	---	---	7,5 ... 15	18,5 ... 30	37 ... 45	55 ... 90	---

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

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

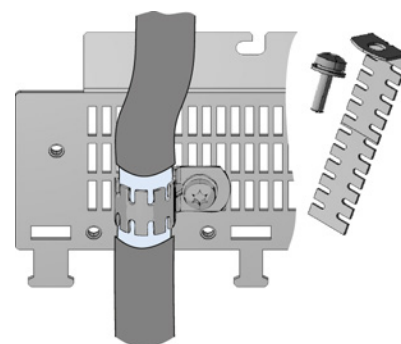
Order number range, IP20: 6SL3225-0BH...

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW)	---	---	---	11 ... 18.5	---	30 ... 55	---

## 3.3.1 Accessories for installation and shielding

### Shield connection kit

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



#### Note

For Power Modules PM230 and PM240-2, the shield connection kit is included in the scope of delivery.

For the PM240, PM250 and PM260 Power Modules, the shield connection kit is an optional component.

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

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

**Order numbers for shield connection kit and DIN rail mounting adapter**

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

## 3.4 System components for the Power Modules

### 3.4.1 Line filter

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



Footprint line filter for Power Module PM240 FSA

Examples:



Line filter for Power Module PM240 FSGX

#### External line filters for PM240

Table 3- 5 Class A according to EN 55011: 2009

PM240, order number 6SL3224-...		Power	Line filter, class A
FSA	...0BE13-7UA0, ...0BE15-5UA0, ...0BE17-5UA0, ...0BE21-1UA0, ...0BE21-5UA0	0.37 kW ... 1.5 kW	6SE6400-2FA00-6AD0
FSF	...0BE38-8UA0, ...0BE41-1UA0	110 kW ... 132 kW	6SL3203-0BE32-5AA0
FSGX	...0XE41-3UA0, ...0XE41-6UA0	160 kW ... 200 kW	6SL3000-0BE34-4AA0
	...0XE42-0UA0	250 kW	6SL3000-0BE36-0AA0

Table 3- 6 Class B according to EN 55011: 2009

PM240, order number 6SL3224-...		Power	Line filter, class B
FSA	...0BE13-7UA0, ...0BE15-5UA0, ...0BE17-5UA0, ...0BE21-1UA0, ...0BE21-5UA0	0.37 kW ... 1.5 kW	6SE6400-2FB00-6AD0
FSB	...0BE22-2AA0, ...0BE23-0AA0, ...0BE24-0AA0	2.2 kW ... 4.0 kW	6SL3203-0BE21-6SA0
FSC	...0BE25-5UA0, ...0BE27-5UA0, ...0BE31-1UA0	7.5 kW ... 15.0 kW	6SL3203-0BD23-8SA0

#### External line filters for PM250

Table 3- 7 Class B according to EN 55011: 2009

PM250, order number 6SL3225-...		Power	Line filter, class B
FSC	...0BE25-5AA0, ...0BE27-5AA0, ...0BE31-1AA0	7.5 kW ... 15.0 kW	6SL3203-0BD23-8SA0

### 3.4.2 Line reactor

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

#### NOTICE

##### Damage to inverter as a result of a missing line reactor

The following cases are possible, depending on the inverter type and the line conditions:

- You must install a line reactor, if the Power Module is subsequently listed, and the relative short-circuit voltage of the line is below 1%
- You can install a line reactor, if the Power Module is subsequently listed, and you do not know the relative short-circuit voltage of the line
- It is not permissible that you install a line reactor, if the Power Module is not subsequently listed.

#### Line reactors for PM240



PM240, order number 6SL3224-...		Power	Line reactor
FSA	...0BE13-7UA0, ...0BE15-5UA0	0.37 kW ... 0.55 kW	6SE6400-3CC00-2AD3
	...0BE17-5UA0, ...0BE21-1UA0	0.75 kW ... 1.1 kW	6SE6400-3CC00-4AD3
	...0BE21-5UA0	1.5 kW	6SE6400-3CC00-6AD3
FSB	...0BE22-2□A0, ...0BE23-0□A0	2.2 kW ... 3.0 kW	6SL3203-0CD21-0AA0
	...0BE24-0□A0	4.0 kW	6SL3203-0CD21-4AA0
FSC	...0BE25-5□A0, ...0BE27-5□A0	7.5 kW ... 11.0 kW	6SL3203-0CD22-2AA0
	...0BE31-1□A0	15.0 kW	6SL3203-0CD23-5AA0
FSD	...0BE31-5□A0, ...0BE31-8□A0	18.5 kW ... 22 kW	6SL3203-0CJ24-5AA0
	...0BE32-2□A0	30 kW	6SL3203-0CD25-3AA0
FSE	...0BE33-0□A0, ...0BE33-7□A0	37 kW ... 45 kW	6SL3203-0CJ28-6AA0
FSF	...0BE34-5□A0, ...0BE35-5□A0	55 kW ... 75 kW	6SE6400-3CC11-2FD0
	...0BE37-5□A0	90 kW	6SE6400-3CC11-7FD0
	...0BE38-8UA0	110 kW	6SL3000-0CE32-3AA0
	...0BE41-1UA0	132 kW	6SL3000-0CE32-8AA0
FSGX	...0XE41-3UA0	160 kW	6SL3000-0CE33-3AA0
	...0XE41-6UA0, ...0XE42-0UA0	200 kW ... 250 kW	6SL3000-0CE35-1AA0

## Line reactors for PM240-2



Order number 6SL321□-...		Power	Line reactor
FSA	...1PE11-8□L0, ...1PE12-3□L0, ...1PE13-2□L0, ...1PE14-3□L0	0.55 kW ... 1.5 kW	6SL3203-0CE13-2AA0
	...1PE16-1□L0, ...1PE18-0□L0	2.2 kW ... 3.0 kW	6SL3203-0CE21-0AA0

## Line reactors for PM340 1AC

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

## 3.4.3 Output reactor

## Output reactors for the PM240 Power Module and the PM250 Power Module

Output reactors reduce the voltage stress on the motor windings. Further, they reduce the inverter load as a result of capacitive recharging currents in the cables.

For motor cables longer than 50 m, shielded or 100 m unshielded, an output reactor is required.

Examples:



Footprint output reactors for  
Power Modules PM240 FSA and  
FSB



Output reactor for  
Power Module PM240  
FSGX

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

Table 3- 8 Output reactors for PM240 Power Module

PM240, order number 6SL3224-...		Power	Output reactor
FSA	...0BE13-7UA0, ...0BE15-5UA0, ...0BE17-5UA0, ...0BE21-1UA0, ...0BE21-5UA0	0.37 kW ... 1.5 kW	6SE6400-3TC00-4AD2
FSB	...0BE22-2□A0, ...0BE23-0□A0, ...0BE24-0□A0	2.2 kW ... 4.0 kW	6SL3202-0AE21-0CA0
FSC	...0BE25-5□A0, ...0BE27-5□A0, ...0BE31-1□A0	7.5 kW ... 15.0 kW	6SL3202-0AJ23-2CA0

## 3.4 System components for the Power Modules

PM240, order number 6SL3224-...		Power	Output reactor
FSD	...0BE31-5□A0	18.5 kW	6SE6400-3TC05-4DD0
	...0BE31-8□A0	22 kW	6SE6400-3TC03-8DD0
	...0BE32-2□A0	30 kW	6SE6400-3TC05-4DD0
FSE	...0BE33-0□A0	37 kW	6SE6400-3TC08-0ED0
	...0BE33-7□A0	45 kW	6SE6400-3TC07-5ED0
FSF	...0BE34-5□A0	55 kW	6SE6400-3TC14-5FD0
	...0BE35-5□A0	75 kW	6SE6400-3TC15-4FD0
	...0BE37-5□A0	90 kW	6SE6400-3TC14-5FD0
	...0BE38-8UA0	110 kW	6SL3000-2BE32-1AA0
	...0BE41-1UA0	132 kW	6SL3000-2BE32-6AA0
FSGX	...0XE41-3UA0	160 kW	6SL3000-2BE33-2AA0
	...0XE41-6UA0	200 kW	6SL3000-2BE33-8AA0
	...0XE42-0UA0	250 kW	6SL3000-2BE35-0AA0

Table 3- 9 Output reactors for PM250 Power Module

PM250, order number 6SL3225-...		Power	Output reactor
FSC	...0BE25-5□A0, ...0BE27-5□A0, ...0BE31-1□A0	7.5 kW ... 15.0 kW	6SL3202-0AJ23-2CA0
FSD	...0BE31-5□A0	18.5 kW	6SE6400-3TC05-4DD0
	...0BE31-8□A0	22 kW	6SE6400-3TC03-8DD0
	...0BE32-2□A0	30 kW	6SE6400-3TC05-4DD0
FSE	...0BE33-0□A0	37 kW	6SE6400-3TC08-0ED0
	...0BE33-7□A0	45 kW	6SE6400-3TC07-5ED0
FSF	...0BE34-5□A0	55 kW	6SE6400-3TC14-5FD0
	...0BE35-5□A0	75 kW	6SE6400-3TC15-4FD0
	...0BE37-5□A0	90 kW	6SE6400-3TC14-5FD0

### 3.4.4 Sine-wave filter

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



Example: Sine-wave filter for inverter with frame size FSF

The following applies when using a sine-wave filter:

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

Table 3- 10 Sine-wave filter for PM240 Power Module

PM240, order number 6SL3224-...		Power	Sine-wave filter
FSA	...0BE13-7UA0, ...0BE15-5UA0, ...0BE17-5UA0	0.37 kW ... 0.75 kW	6SL3202-0AE20-3SA0
	...0BE21-1UA0, ...0BE21-5UA0	1.1 kW ... 1.5 kW	6SL3202-0AE20-6SA0
FSB	...0BE22-2□A0, ...0BE23-0□A0	2.2 kW ... 3.0 kW	6SL3202-0AE21-1SA0
	...0BE24-0□A0	4.0 kW	6SL3202-0AE21-4SA0
FSC	...0BE25-5□A0	7.5 kW	6SL3202-0AE22-0SA0
	...0BE27-5□A0, ...0BE31-1□A0	11.0 kW ... 15.0 kW	6SL3202-0AE23-3SA0
FSD	...0BE31-5□A0, ...0BE31-8□A0	18.5 kW ... 22 kW	6SL3202-0AE24-6SA0
	...0BE32-2□A0	30 kW	6SL3202-0AE26-2SA0
FSE	...0BE33-0□A0, ...0BE33-7□A0	37 kW ... 45 kW	6SL3202-0AE28-8SA0
FSF	...0BE34-5□A0, ...0BE35-5□A0	55 kW ... 75 kW	6SL3202-0AE31-5SA0
	...0BE37-5□A0	90 kW	6SL3202-0AE31-8SA0
	...0BE38-8UA0, ...0BE41-1UA0	110 kW ... 132 kW	6SL3000-2CE32-3AA0
FSGX	...0XE41-3UA0	160 kW	6SL3000-2CE32-8AA0
	...0XE41-6UA0	200 kW	6SL3000-2CE33-3AA0
	...0XE42-0UA0	250 kW	6SL3000-2CE34-1AA0

## 3.4 System components for the Power Modules

Table 3- 11 Sine-wave filter for PM250 Power Module

PM250, order number 6SL3225-...		Power	Sine-wave filter
FSC	...0BE25-5□A0	7.5 kW	6SL3202-0AE22-0SA0
	...0BE27-5□A0, ...0BE31-1□A0	11.0 kW ... 15.0 kW	6SL3202-0AE23-3SA0
FSD	...0BE31-5□A0, ...0BE31-8□A0	18.5 kW ... 22 kW	6SL3202-0AE24-6SA0
	...0BE32-2□A0	30 kW	6SL3202-0AE26-2SA0
FSE	...0BE33-0□A0, ...0BE33-7□A0	37 kW ... 45 kW	6SL3202-0AE28-8SA0
FSF	...0BE34-5□A0, ...0BE35-5□A0	55 kW ... 75 kW	6SL3202-0AE31-5SA0
	...0BE37-5□A0	90 kW	6SL3202-0AE31-8SA0

### 3.4.5 Braking resistor

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

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

#### Braking resistors for PM240



For frame size FSGX there is an optional pluggable braking module (order number 6SL3300-1AE32-5AA0).

Order number 6SL3224-...		Power	Braking resistor
FSA	...0BE13-7UA0, ...0BE15-5UA0	0.37 kW ... 0.55 kW	6SE6400-4BD11-0AA0
	...0BE17-5UA0, ...0BE21-1UA0	0.75 kW ... 1.1 kW	
	...0BE21-5UA0	1.5 kW	
FSB	...0BE22-2□A0, ...0BE23-0□A0	2.2 kW ... 3.0 kW	6SL3201-0BE12-0AA0
	...0BE24-0□A0	4.0 kW	
FSC	...0BE25-5□A0, ...0BE27-5□A0	7.5 kW ... 11.0 kW	6SE6400-4BD16-5CA0
	...0BE31-1□A0	15.0 kW	
FSD	...0BE31-5□A0, ...0BE31-8□A0	18.5 kW ... 22 kW	6SE6400-4BD21-2DA0
	...0BE32-2□A0	30 kW	
FSE	...0BE33-0□A0, ...0BE33-7□A0	37 kW ... 45 kW	6SE6400-4BD22-2EA1
FSF	...0BE34-5□A0, ...0BE35-5□A0	55 kW ... 75 kW	6SE6400-4BD24-0FA0
	...0BE37-5□A0	90 kW	
	...0BE38-8UA0	110 kW	6SE6400-4BD26-0FA0
	...0BE41-1UA0	132 kW	
FSGX	...0XE41-3UA0	160 kW	6SL3000-1BE31-3AA0
	...0XE41-6UA0, ...0XE42-0UA0	200 kW ... 250 kW	6SL3000-1BE32-5AA0

#### Braking resistors for PM240-2



Order number 6SL321□-...		Power	Braking resistor
FSA	...1PE11-8□L0, ...1PE12-3□L0, ...1PE13-2□L0, ...1PE14-3□L0	0.55 kW ... 1.5 kW	6SL3201-0BE14-3AA0
	...1PE16-1□L0, ...1PE18-0□L0	2.2 kW ... 3.0 kW	

#### Braking resistors for PM340, 1AC



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

### 3.4.6 Brake Relay



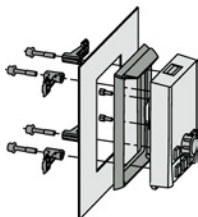

The brake relay has a switch contact (NO contact) to control the motor brake coil.

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





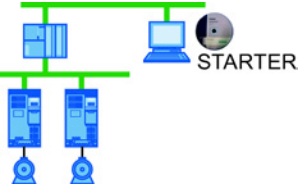

## 3.5 Tools to commission the converter

### 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 <ul style="list-style-type: none"> <li>• Copying of drive parameters</li> <li>• Two-line display</li> <li>• Guided basic commissioning</li> </ul>	6SL3255-0AA00-4CA1
	IOP (Intelligent Operator Panel) - for snapping onto the frequency inverter <ul style="list-style-type: none"> <li>• Copying of drive parameters</li> <li>• Plain text display</li> <li>• Menu-based operation and application wizards</li> </ul>	6SL3255-0AA00-4JA0
	Door mounting kit for IOP/BOP-2 <ul style="list-style-type: none"> <li>• For installation of the BOP-2 or IOP in a control cabinet door.</li> <li>• Degree of protection with IOP: IP54 or UL Type 12</li> <li>• Degree of protection with BOP-2: IP55</li> </ul>	6SL3256-0AP00-0JA0
	For mobile use of the IOP: IOP handheld with IOP housing, power supply unit and rechargeable batteries as well as RS232 connecting cable If you are using your own connecting cable, carefully note the maximum permissible length of 5 m.	6SL3255-0AA00-4HA0

## Description

### 3.5 Tools to commission the converter

PC tools for commissioning, diagnostics and controlling 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 ( <a href="http://support.automation.siemens.com/WW/view/en/10804985/133200">http://support.automation.siemens.com/WW/view/en/10804985/133200</a> )	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

## 4.1 Overview of the inverter installation

### Installing the inverter

#### Precondition

Before installation, please check:

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

#### Procedure

To install the inverter, proceed as follows:

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

See also Installing reactors, filters and braking resistors (Page 38).

2. Install the Power Module.

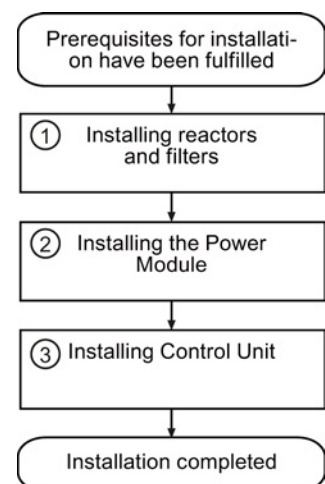
See also Installing the Power Module (Page 40).

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

3. Install the Control Unit.

See also Installing Control Unit (Page 50).

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



## 4.2 Installing reactors, filters and braking resistors

### Installing reactors, filters and braking resistors

The installation of reactors, filters and braking resistors is described in the documentation provided. See also Section: Additional information on the inverter (Page 397).

### Installing base components

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

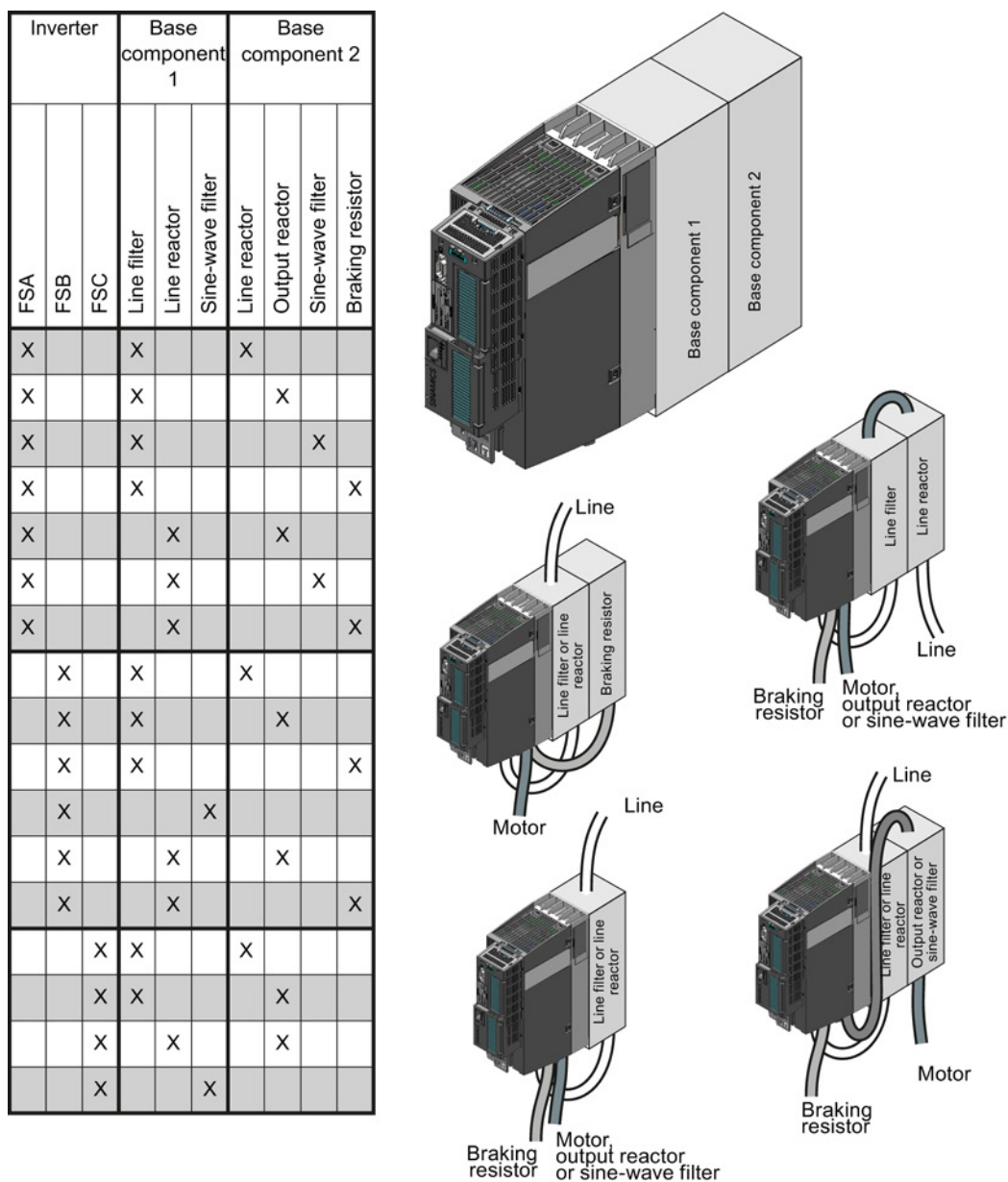


Figure 4-1 Permissible combination of base components

**Electrical connections of the line reactor and line filter**

- Line connection via terminals
- Inverter connection via a prefabricated cable

**Electrical connections of the output reactor and sine-wave filter**

- Inverter connection via a prefabricated cable
- Motor connection via terminals

## 4.3 Installing the Power Module

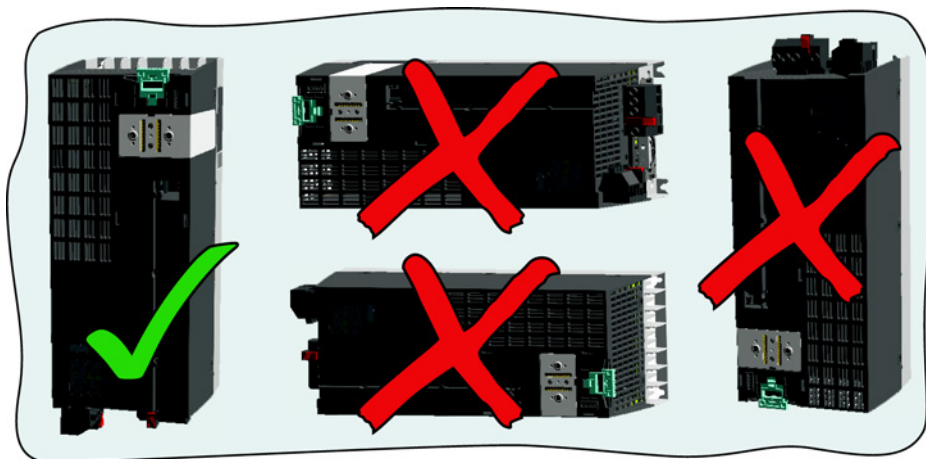
### WARNING

#### 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.

### Installing Power Modules with degree of protection IP20



- Mount the Power Module vertically on a mounting plate in a control cabinet. For frame sizes FSA and FSB, an adapter is available for mounting on DIN rails.
- When installing, observe the minimum clearances to other components in the control cabinet. These minimum clearances are necessary to ensure adequate cooling of the inverter.
- Do not cover the ventilation openings of the inverter.

### Installing additional components

Depending on the application, the following additional components, for example, may be required (also refer to Section Identifying the converter (Page 21)):

- Line reactors
- Filter
- Braking resistors
- Brake Relay

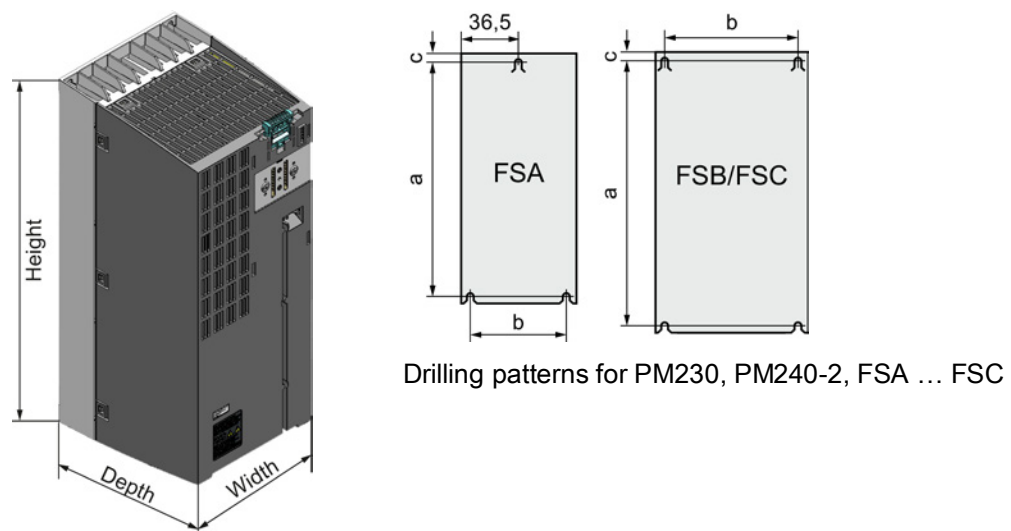
Information about mounting these components is also provided in the relevant instructions that are provided with each component.

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

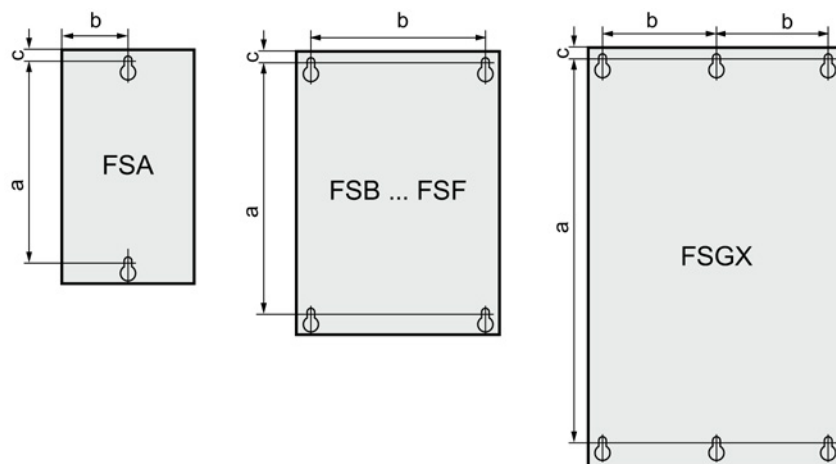
#### Note

The total depth of the converter increases – with the exception of frame sizes FSGX (160 kW ... 250 kW) – by 39 mm as a result of the Control Unit – and an additional 12 mm or 27 mm respectively, if you use a BOP or IOP.

#### Dimensions and drilling patterns for Power Modules PM230, PM240, PM250, PM260 - protection type IP20



Drilling patterns for PM230, PM240-2, FSA ... FSC



Drilling patterns for PM230 FSD ... FSF and for PM240, PM250 and PM260

Table 4- 1 Dimensions and clearances for PM230 and PM240-2 - degree of protection IP20, frame sizes FSA ... FSC

## 4.3 Installing the Power Module

Frame size	Dimensions (mm)						Clearances (mm)		
	Height <sup>1)</sup>	Width	Depth	a	b	c	Top	Bottom	Lateral
FSA	196	73	165	186	62,3	6	80	100	0 <sup>2)</sup>
FSB	292	100	165	281	80	6	80	100	0 <sup>2)</sup>
FSC	355	140	165	343	120	6	80	100	0 <sup>2)</sup>
<b>Fixing:</b>	FSA/FSB: M4 screws, 2.5 Nm				FSC: M5 screws, 2.5 Nm				

1) With shield connection kit: FSA: + 80 mm; FSB: + 78 mm; FSC: + 77 mm

2) For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

Table 4- 2 Dimensions and clearances for PM240 and PM250 - degree of protection IP20, frame sizes FSA ... FSC

Frame size	Dimensions (mm)						Clearances (mm)		
	Height <sup>1)</sup>	Width	Depth	a	b	c	Top	Bottom	Lateral
FSA	173	73	145	160	36,5	--	100	100	30 <sup>2)</sup>
FSB	270	153	165	258	133	--	100	100	40 <sup>2)</sup>
FSC	355	140	165	343	120	6	80	100	50 <sup>2)</sup>
<b>Fixing:</b>	FSA/FSB: M4 screws, 2.5 Nm				FSC: M5 screws, 2.5 Nm				

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

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

Table 4- 3 Dimensions and clearances for PM230, PM240, PM250 and PM260 - IP20 degree of protection, frame sizes FSD ... FSGX

Frame size	Dimensions (mm)						Clearances (mm)		
	Height <sup>1)</sup>	Width	Depth	a	b	c	Top	Bottom	Lateral
FSD without filter	419	275	204	325	235	11	300	300	0 <sup>2)</sup>
FSD with filter	512	275	204	419	235	11	300	300	0 <sup>2)</sup>
FSE without filter	499	275	204	405	235	11	300	300	0 <sup>2)</sup>
FSE with filter	635	275	204	541	235	11	300	300	0 <sup>2)</sup>
FSF without filter	634	350	316	598	300	11	350	350	0 <sup>2)</sup>
FSF with filter	934	350	316	899	300	11	350	350	0 <sup>2)</sup>
FSGX	1533	326	547	1506	125	14,5	250	150	50
<b>Fixing:</b>	FSD/FSE: M6 screws, 6 Nm				FSF/FSGX: M8 screws, 13 Nm				

1) With shield connection kit: FSD, FSE, FSF: +123 mm

2) For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

### 4.3.2 Dimension drawings PT

Dimensions and drilling patterns for PM230 and PM240 Power Modules with push through technology

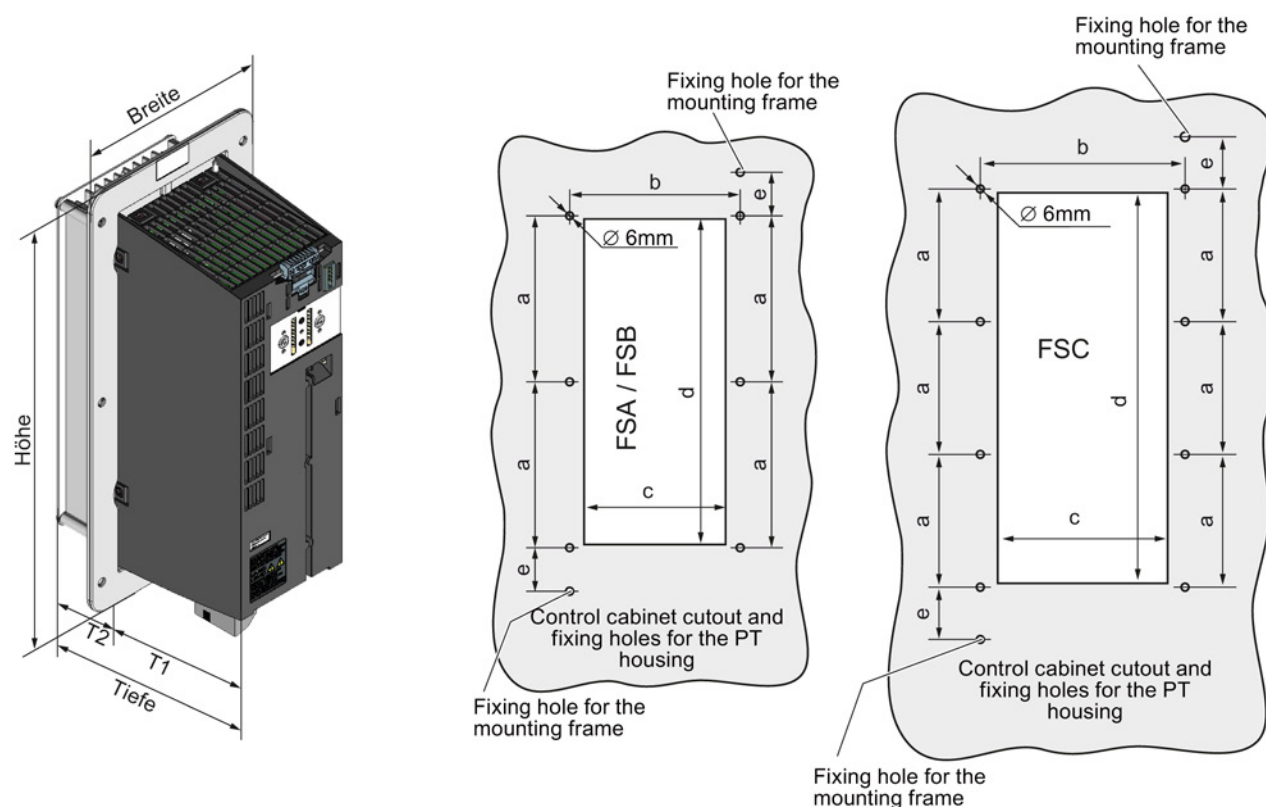


Table 4- 4 Dimensions and clearances for PM230 and PM240-2 in push through technology, frame sizes FSA ... FSC

Frame size	Dimensions (mm)										Clearances (mm)		
	Height <sup>1)</sup>	Width	Depth	T1	T2	a	b	c	d	e	Top	Bottom	Lateral
FSA	238	125,9	171	117,7	53,1	103	106	88	198	27	80	100	0 <sup>2)</sup>
FSB	345	153,9	171	117,7	53,1	147,5	134	116	304	34,5	80	100	0 <sup>2)</sup>
FSC	410,5	200	171	117,7	53,1	123	174	156	365	30,5	80	100	0 <sup>2)</sup>
<b>Fixing:</b>	FSA/FSB/FSC: M5 screws, 3 Nm												

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

<sup>2)</sup> The Power Modules can be mounted side by side. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

### 4.3.3 Connecting the line supply, motor, and inverter components

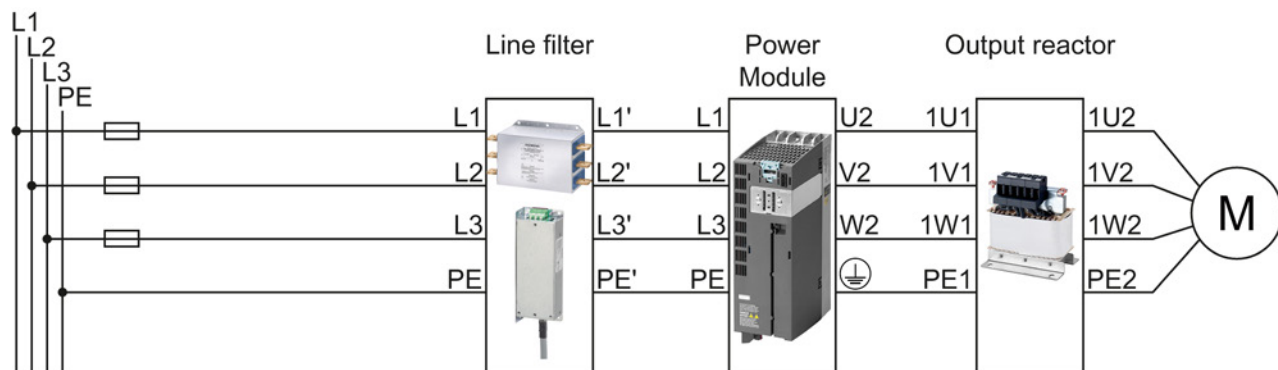


Figure 4-2 Connecting the PM230 IP20 and push-through Power Module

The line filter of the PM230 Power Module complies with Class A. For increased EMC requirements, you require an external Class B line filter.

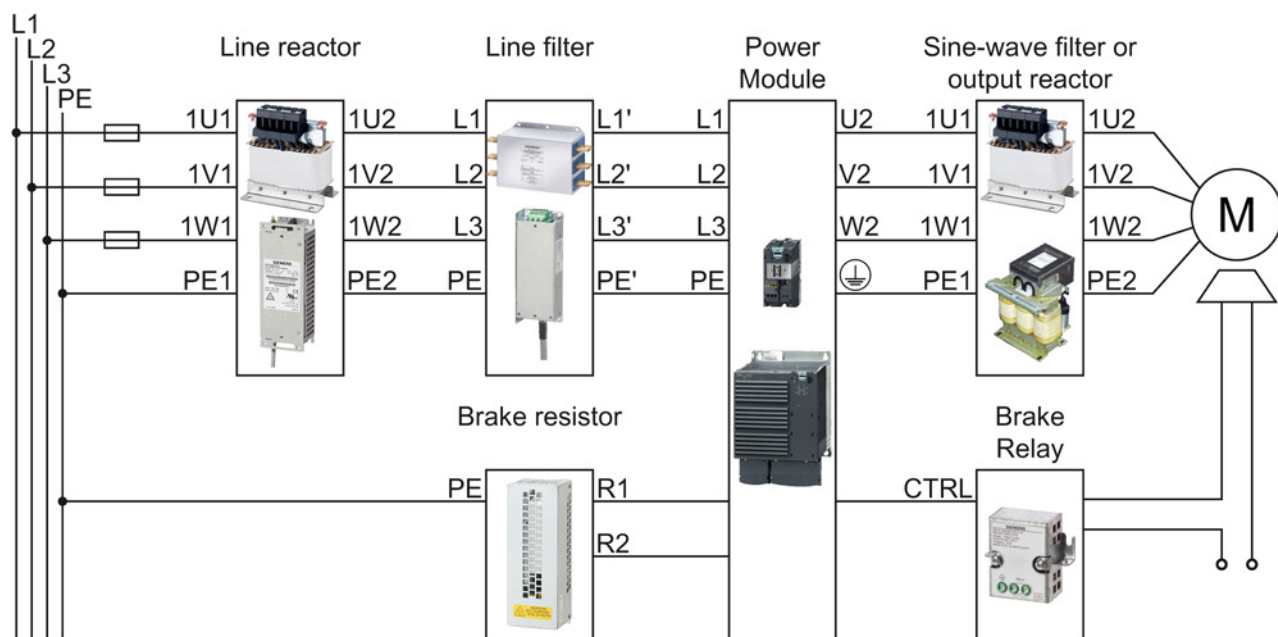


Figure 4-3 Connecting the PM240, PM240-2 IP20 and push-through Power Modules

PM240 and PM240-2 Power Modules are available with and without integrated Class A line filters. You require an external Class B line filter for increased EMC requirements.

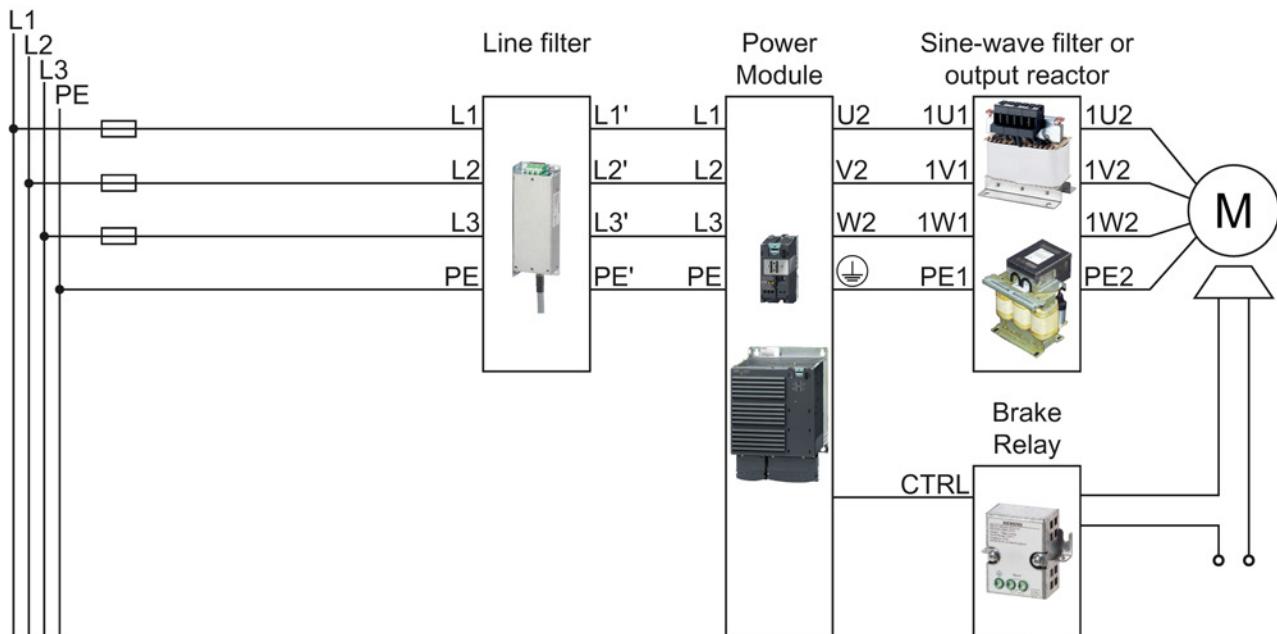


Figure 4-4 Connecting the PM250 Power Module

PM250 Power Modules are available with and without integrated class A line filters. You require an external Class B line filter for increased EMC requirements.

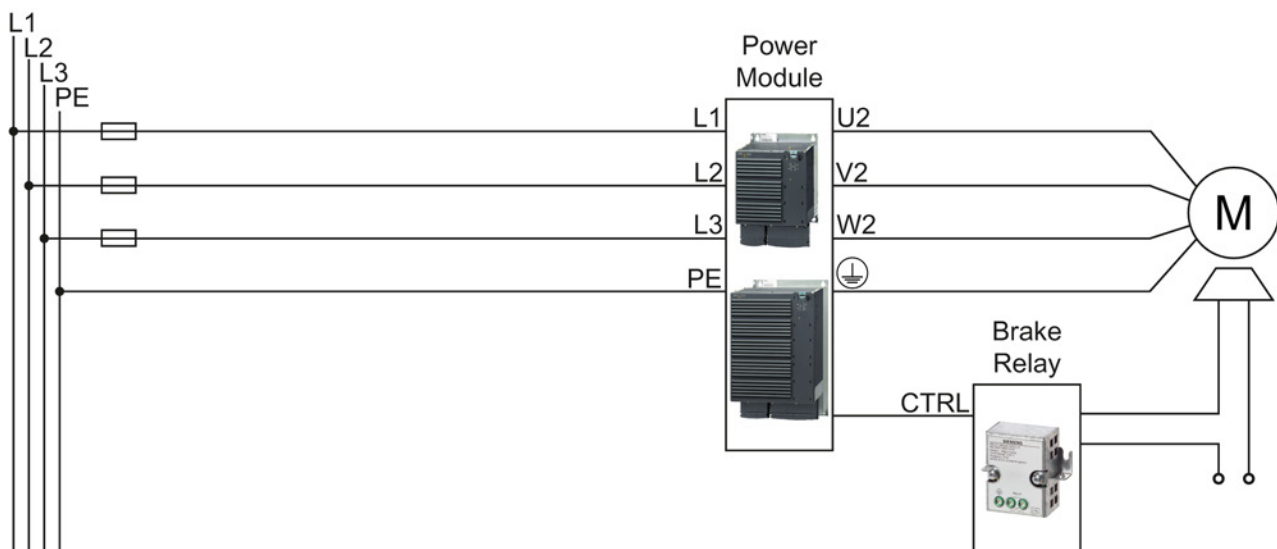


Figure 4-5 Connecting the PM260 Power Module

PM260 Power Modules are available with and without integrated class A line filters. You require an external Class B line filter for increased EMC requirements.

## 4.3 Installing the Power Module

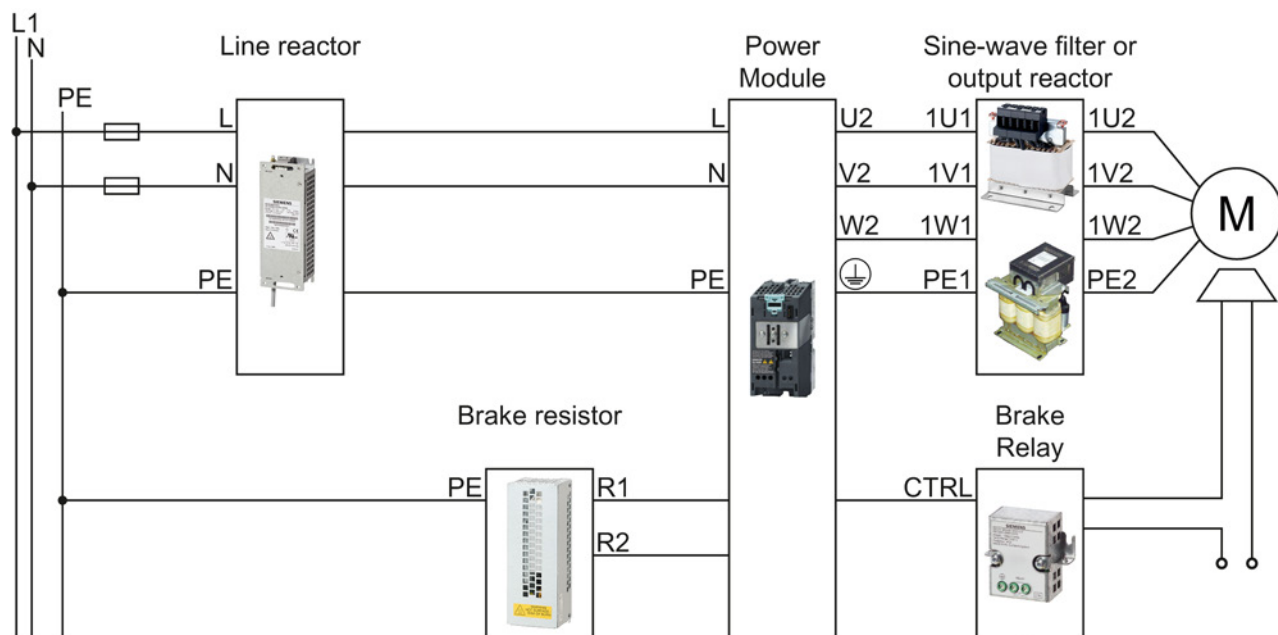


Figure 4-6 Connecting the PM340 1AC Power Module

PM340 Power Modules are available with and without integrated Class A line filters. You require an external Class B line filter for increased EMC requirements.

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

Table 4- 5 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.

 **WARNING**

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

The inverter conducts high leakage currents  $> 3.5 \text{ mA}$  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  $\geq 10 \text{ mm}^2 \text{ Cu}$ .
  - In a multi-core cable the protective conductor has a cross-section of  $\geq 2.5 \text{ mm}^2 \text{ Cu}$ .
  - 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.



 **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.

**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.

**Connecting the line supply cable to the converter**



**Procedure**

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

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




You have connected the line supply cable to the converter.

**Connecting the motor cable to the converter**



**Procedure**

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

1. If available, open the terminal covers of the converter.
2. Connect the motor to terminals U2, V2, and W2.  
Carefully observe the regulations for EMC-compliant wiring:  
Connecting inverters in compliance with EMC (Page 63)
3. Connect the protective conductor of the motor to the  terminal of the converter.
4. If available, close the terminal covers of the converter.



You have therefore connected the motor line to the converter.

### **Connect motor line to motor**

Connect the motor in either the star or delta connection according to your particular application. Additional information on this is provided in the Section Star-delta motor connection and application examples (Page 361).

### **Permissible cable lengths**

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

---

#### **Note**

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

## 4.4 Installing Control Unit

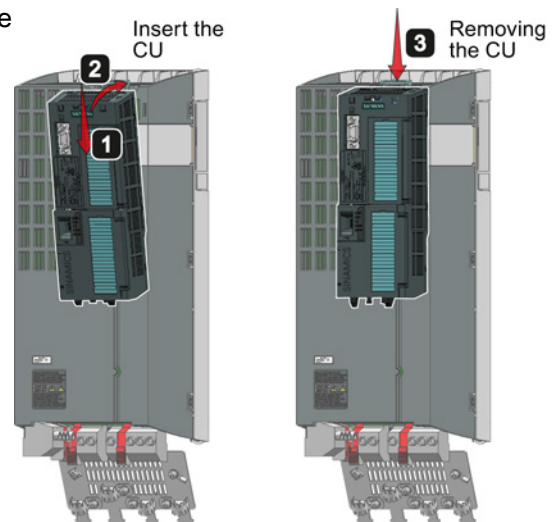
### Installing the Control Unit on an IP20 Power Module



#### Procedure

Proceed as follows to connect Power Modules and Control Units:

1. Locate the rear of the Control Unit in the matching recesses of the Power Module.
2. Press the Control Unit onto the Power Module until you hear the latching mechanism engage.



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

If you want to remove the Control Unit, press the release button ③ and withdraw the Control Unit from the Power Module.

### 4.4.1 Interfaces, connectors, switches, terminal blocks and LEDs of the CU

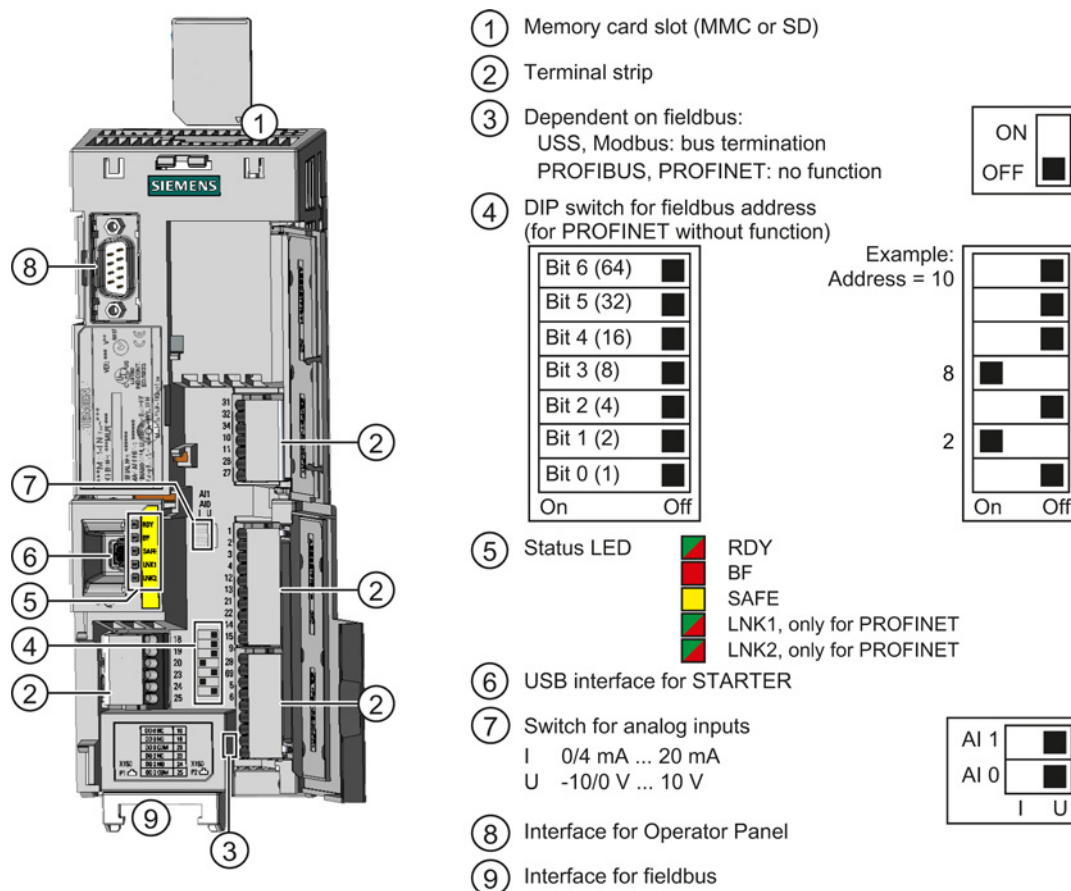
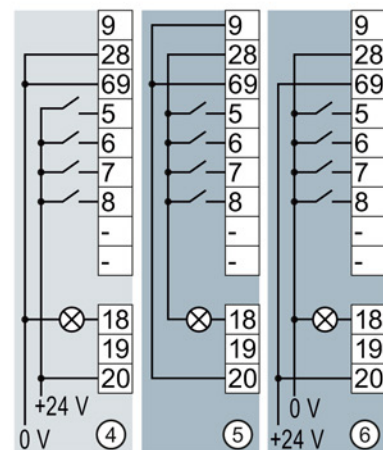
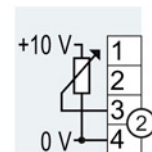
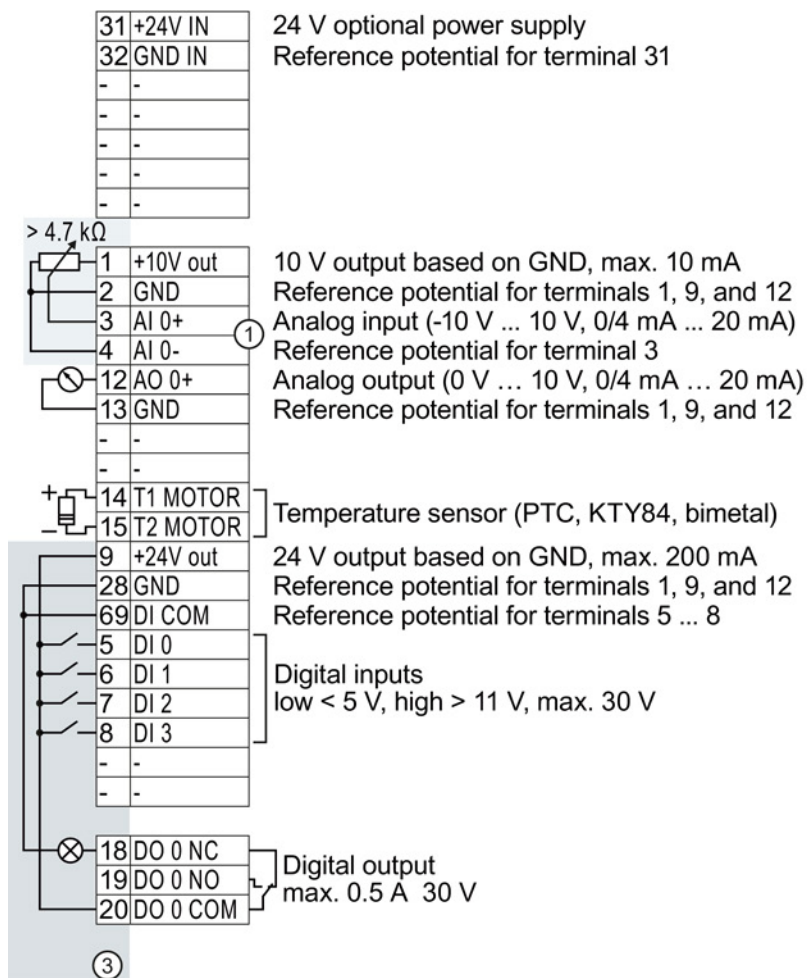


Figure 4-7 Design of the Control Unit using the example of the CU240E-2

## 4.4.2 Terminal strips on CU240B-2 Control Units



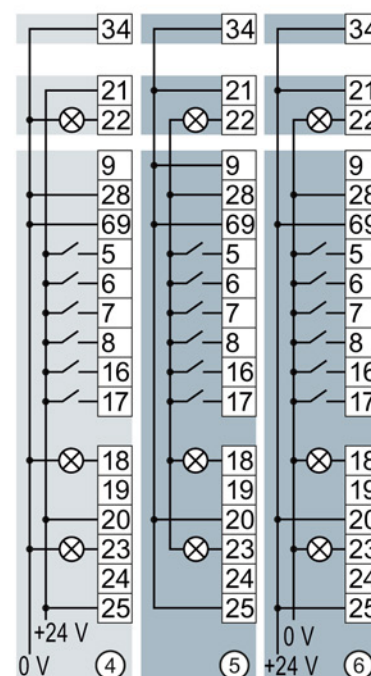
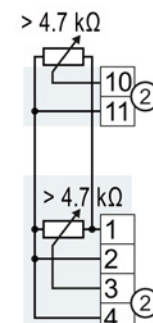
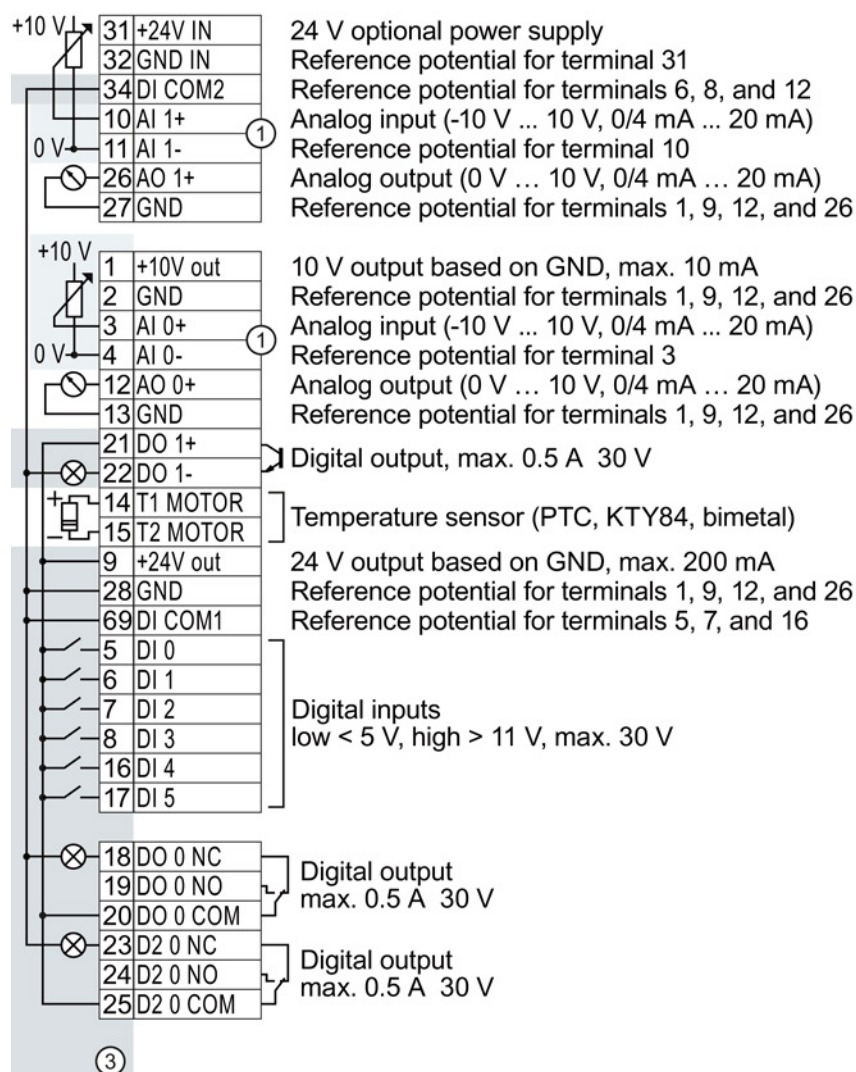
- ① The analog input is supplied from the internal 10 V voltage.
- ② The analog input is supplied from an external 10 V voltage.
- ③ Wiring when using the internal power supplies. Connection of a contact switching to P potential.
- ④ Wiring when using external power supplies. Connection of a contact switching to P potential.
- ⑤ Wiring when using the internal power supplies. Connection of a contact switching to M potential.
- ⑥ Wiring when using external power supplies. Connection of a contact switching to M potential.

**CAUTION**

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240B-2 Control Unit (Page 331).

Define the meanings of the inputs and outputs during basic commissioning. Further information can be found in section Finding a suitable setting for the interfaces (Page 55).

### 4.4.3 Terminal strips on CU240E-2 Control Units



- ① The analog inputs are supplied from an external 10 V source.
- ② The analog inputs are supplied from the internal 10 V voltage.
- ③ Wiring when using the internal power supplies. Connection of a contact switching to P potential.
- ④ Wiring when using external power supplies. Connection of a contact switching to P potential.
- ⑤ Wiring when using the internal power supplies. Connection of a contact switching to M potential.
- ⑥ Wiring when using external power supplies. Connection of a contact switching to M potential.

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

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

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

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

**Note**

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240E-2 Control Unit (Page 333).

Define the meanings of the inputs and outputs during basic commissioning. Additional information is available in Section: Finding a suitable setting for the interfaces (Page 55).

For a fail-safe input, you require two "standard" digital inputs.

Terminals	Designation	Fail-safe input
16	DI4	F-DI0
17	DI5	

If you wish to use several fail-safe inputs of the inverter, this is described in the Safety Integrated Function Manual. See also Section: Additional information on the inverter (Page 397).

Further information on fail-safe inputs can be found in Section Fail-safe input (Page 92).

#### 4.4.4 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.

##### 4.4.4.1 Pre-assignments and wiring of the inverter with CU240B-2 Control Units

The converter with CU240B-2 and CU240B-2 DP Control Units offers the following default settings for its interfaces:

Macro 7: Switch over between fieldbus and jogging via DI 3 Factory setting for inverters with PROFIBUS interface		Macro 9: Motorized potentiometer (MOP)
PROFIdrive telegram 1		
5 DI 0 ---	5 DI 0 Jog 1	5 DI 0 ON/OFF1
6 DI 1 ---	6 DI 1 Jog 2	6 DI 1 MOP raise
7 DI 2 Acknowledge	7 DI 2 Acknowledge	7 DI 2 MOP lower
8 DI 3 LOW	8 DI 3 HIGH	8 DI 3 Acknowledge
3 AI 0 ---	3 AI 0 ---	3 AI 0 ---
4 ---	4 ---	4 ---
18 DO 0 Fault	18 DO 0 Fault	18 DO 0 Fault
19 ---	19 ---	19 ---
20 ---	20 ---	20 ---
12 AO 0 Speed	12 AO 0 Speed	12 AO 0 Speed
13 0 V ... 10 V	13 0 V ... 10 V	13 0 V ... 10 V

Macro 12: Two-wire control with method 1 Factory setting for inverters with USS interface	Macro 17: Two-wire control with method 2 Macro 18: Two-wire control with method 3	Macro 19: Three-wire control with method 1
<div>5 DI 0 ON/OFF1</div> <div>6 DI 1 Reversing</div> <div>7 DI 2 Acknowledge</div> <div>8 DI 3 ---</div> <div>3 AI 0 Setpoint</div> <div>4 I U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div>	<div>5 DI 0 ON/OFF1 right</div> <div>6 DI 1 ON/OFF1 left</div> <div>7 DI 2 Acknowledge</div> <div>8 DI 3 ---</div> <div>3 AI 0 Setpoint</div> <div>4 I U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div>	<div>5 DI 0 Enable/OFF1</div> <div>6 DI 1 ON right</div> <div>7 DI 2 ON left</div> <div>8 DI 3 Acknowledge</div> <div>3 AI 0 Setpoint</div> <div>4 I U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div>

Macro 20: Three-wire control with method 2	Macro 21: Fieldbus USS	
<div>5 DI 0 Enable/OFF1</div> <div>6 DI 1 ON</div> <div>7 DI 2 Reversing</div> <div>8 DI 3 Acknowledge</div> <div>3 AI 0 Setpoint</div> <div>4 I U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div>	<div>USS setting: 38,400 baud, 2 PZD, PKW variable</div> <div>5 DI 0 ---</div> <div>6 DI 1 ---</div> <div>7 DI 2 Acknowledge</div> <div>8 DI 3 ---</div> <div>3 AI 0 ---</div> <div>4</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div>	

#### 4.4.4.2 Pre-assignments and wiring of the inverter with CU240E-2 Control Units

The inverter with CU240E-2, CU240E-2 F, CU240E-2 DP, and CU240E-2 DP F Control Units offers the following default settings for its interfaces:

Macro 1: Two fixed speeds	Macro 2: Two fixed speeds with safety function	Macro 3: Four fixed speeds																																																																																																																																																														
<table> <tr><td>5</td><td>DI 0</td><td>ON/OFF1 right</td></tr> <tr><td>6</td><td>DI 1</td><td>ON/OFF1 left</td></tr> <tr><td>7</td><td>DI 2</td><td>Acknowledge</td></tr> <tr><td>8</td><td>DI 3</td><td>---</td></tr> <tr><td>16</td><td>DI 4</td><td>Fixed speed 3</td></tr> <tr><td>17</td><td>DI 5</td><td>Fixed speed 4</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table> <p>DI 4 and DI 5 = high: The inverter adds both fixed speeds.</p>	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	26	AO 1	Current	27		0 V ... 10 V	<table> <tr><td>5</td><td>DI 0</td><td>ON/OFF1</td></tr> <tr><td></td><td></td><td>Fixed speed 1</td></tr> <tr><td>6</td><td>DI 1</td><td>Fixed speed 2</td></tr> <tr><td>7</td><td>DI 2</td><td>Acknowledge</td></tr> <tr><td>8</td><td>DI 3</td><td>---</td></tr> <tr><td>16</td><td>DI 4</td><td rowspan="2">Reserved for safety function</td></tr> <tr><td>17</td><td>DI 5</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table>	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 safety function	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	26	AO 1	Current	27		0 V ... 10 V	<table> <tr><td>5</td><td>DI 0</td><td>ON/OFF1</td></tr> <tr><td></td><td></td><td>Fixed speed 1</td></tr> <tr><td>6</td><td>DI 1</td><td>Fixed speed 2</td></tr> <tr><td>7</td><td>DI 2</td><td>Acknowledge</td></tr> <tr><td>8</td><td>DI 3</td><td>---</td></tr> <tr><td>16</td><td>DI 4</td><td>Fixed speed 3</td></tr> <tr><td>17</td><td>DI 5</td><td>Fixed speed 4</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table> <p>Multiple DIs = high: The inverter adds the corresponding fixed speeds.</p>	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	26	AO 1	Current	27		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	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																																																																																																																																																														
26	AO 1	Current																																																																																																																																																														
27		0 V ... 10 V																																																																																																																																																														
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 safety function																																																																																																																																																														
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																																																																																																																																																														
26	AO 1	Current																																																																																																																																																														
27		0 V ... 10 V																																																																																																																																																														
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																																																																																																																																																														
26	AO 1	Current																																																																																																																																																														
27		0 V ... 10 V																																																																																																																																																														



Macro 4: PROFIBUS or PROFINET	Macro 5: PROFIBUS or PROFINET with safety function	Macro 6: PROFIBUS or PROFINET with two safety functions																																																																																																																																																						
<p>PROFIdrive telegram 352</p> <table> <tr><td>5</td><td>DI 0</td><td>---</td></tr> <tr><td>6</td><td>DI 1</td><td>---</td></tr> <tr><td>7</td><td>DI 2</td><td>Acknowledge</td></tr> <tr><td>8</td><td>DI 3</td><td>---</td></tr> <tr><td>16</td><td>DI 4</td><td>---</td></tr> <tr><td>17</td><td>DI 5</td><td>---</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table>	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	26	AO 1	Current	27		0 V ... 10 V	<p>PROFIdrive telegram 1</p> <table> <tr><td>5</td><td>DI 0</td><td>---</td></tr> <tr><td>6</td><td>DI 1</td><td>---</td></tr> <tr><td>7</td><td>DI 2</td><td>Acknowledge</td></tr> <tr><td>8</td><td>DI 3</td><td>---</td></tr> <tr><td>16</td><td>DI 4</td><td rowspan="2">Reserved for safety function</td></tr> <tr><td>17</td><td>DI 5</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table>	5	DI 0	---	6	DI 1	---	7	DI 2	Acknowledge	8	DI 3	---	16	DI 4	Reserved for safety function	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	26	AO 1	Current	27		0 V ... 10 V	<p>PROFIdrive telegram 1</p> <table> <tr><td>5</td><td>DI 0</td><td rowspan="2">Reserved for Safety function 1</td></tr> <tr><td>6</td><td>DI 1</td></tr> <tr><td>7</td><td>DI 2</td><td>---</td></tr> <tr><td>8</td><td>DI 3</td><td>Acknowledge</td></tr> <tr><td>16</td><td>DI 4</td><td rowspan="2">Reserved for Safety function 2</td></tr> <tr><td>17</td><td>DI 5</td></tr> <tr><td>3</td><td>AI 0</td><td>---</td></tr> <tr><td>4</td><td></td><td></td></tr> <tr><td>18</td><td>DO 0</td><td>Fault</td></tr> <tr><td>19</td><td></td><td></td></tr> <tr><td>20</td><td></td><td></td></tr> <tr><td>21</td><td>DO 1</td><td>Alarm</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td>12</td><td>AO 0</td><td>Speed</td></tr> <tr><td>13</td><td></td><td>0 V ... 10 V</td></tr> <tr><td>26</td><td>AO 1</td><td>Current</td></tr> <tr><td>27</td><td></td><td>0 V ... 10 V</td></tr> </table> <p>Only with Control Units CU240E-2 F, CU240E-2 DP-F, and CU240E-2 PN-F.</p>	5	DI 0	Reserved for Safety function 1	6	DI 1	7	DI 2	---	8	DI 3	Acknowledge	16	DI 4	Reserved for Safety function 2	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	26	AO 1	Current	27		0 V ... 10 V
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																																																																																																																																																						
26	AO 1	Current																																																																																																																																																						
27		0 V ... 10 V																																																																																																																																																						
5	DI 0	---																																																																																																																																																						
6	DI 1	---																																																																																																																																																						
7	DI 2	Acknowledge																																																																																																																																																						
8	DI 3	---																																																																																																																																																						
16	DI 4	Reserved for safety function																																																																																																																																																						
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																																																																																																																																																						
26	AO 1	Current																																																																																																																																																						
27		0 V ... 10 V																																																																																																																																																						
5	DI 0	Reserved for Safety function 1																																																																																																																																																						
6	DI 1																																																																																																																																																							
7	DI 2	---																																																																																																																																																						
8	DI 3	Acknowledge																																																																																																																																																						
16	DI 4	Reserved for Safety function 2																																																																																																																																																						
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																																																																																																																																																						
26	AO 1	Current																																																																																																																																																						
27		0 V ... 10 V																																																																																																																																																						

Macro 7: Switch over between fieldbus and jogging via DI 3 Factory setting for inverters with PROFIBUS or PROFINET interface		Macro 8: Motorized potentiometer (MOP) with safety function
PROFIdrive telegram 1		
5 DI 0 ---	5 DI 0 Jog 1	5 DI 0 ON/OFF1
6 DI 1 ---	6 DI 1 Jog 2	6 DI 1 MOP raise
7 DI 2 Acknowledge	7 DI 2 Acknowledge	7 DI 2 MOP lower
8 DI 3 LOW	8 DI 3 HIGH	8 DI 3 Acknowledge
16 DI 4 ---	16 DI 4 ---	16 DI 4 } Reserved for
17 DI 5 ---	17 DI 5 ---	17 DI 5 } safety function
3 AI 0 ---	3 AI 0 ---	3 AI 0 ---
4	4	4
18 DO 0 Fault	18 DO 0 Fault	18 DO 0 Fault
19	19	19
20	20	20
21 DO 1 Alarm	21 DO 1 Alarm	21 DO 1 Alarm
22	22	22
12 AO 0 Speed	12 AO 0 Speed	12 AO 0 Speed
13 0 V ... 10 V	13 0 V ... 10 V	13 0 V ... 10 V
26 AO 1 Current	26 AO 1 Current	26 AO 1 Current
27 0 V ... 10 V	27 0 V ... 10 V	27 0 V ... 10 V

Macro 9: Motorized potentiometer (MOP)	Macro 12: Two-wire control with method 1 Factory setting for inverters without PROFIBUS or PROFINET interface.	Macro 13: Setpoint via analog input with safety function
5 DI 0 ON/OFF1	5 DI 0 ON/OFF1	5 DI 0 ON/OFF1
6 DI 1 MOP raise	6 DI 1 Reversing	6 DI 1 Reversing
7 DI 2 MOP lower	7 DI 2 Acknowledge	7 DI 2 Acknowledge
8 DI 3 Acknowledge	8 DI 3 ---	8 DI 3 ---
16 DI 4 ---	16 DI 4 ---	16 DI 4 } Reserved for
17 DI 5 ---	17 DI 5 ---	17 DI 5 } safety function
3 AI 0 ---	3 AI 0 Setpoint	3 AI 0 Setpoint
4	4 I □ U -10 V ... 10 V	4 I □ U -10 V ... 10 V
18 DO 0 Fault	18 DO 0 Fault	18 DO 0 Fault
19	19	19
20	20	20
21 DO 1 Alarm	21 DO 1 Alarm	21 DO 1 Alarm
22	22	22
12 AO 0 Speed	12 AO 0 Speed	12 AO 0 Speed
13 0 V ... 10 V	13 0 V ... 10 V	13 0 V ... 10 V
26 AO 1 Current	26 AO 1 Current	26 AO 1 Current
27 0 V ... 10 V	27 0 V ... 10 V	27 0 V ... 10 V

Macro 14: Switch over between fieldbus and motorized potentiometer (MOP) via DI 3			
PROFIdrive telegram 1			
5 DI 0 ---	5 DI 0 ON/OFF1		
6 DI 1 External fault	6 DI 1 External fault		
7 DI 2 Acknowledge	7 DI 2 Acknowledge		
8 DI 3 LOW	8 DI 3 HIGH		
16 DI 4 ---	16 DI 4 MOP raise		
17 DI 5 ---	17 DI 5 MOP lower		
3 AI 0 ---	3 AI 0 ---		
4	4		
18 DO 0 Fault	18 DO 0 Fault		
19	19		
20	20		
21 DO 1 Alarm	21 DO 1 Alarm		
22	22		
12 AO 0 Speed	12 AO 0 Speed		
13 0 V ... 10 V	13 0 V ... 10 V		
26 AO 1 Current	26 AO 1 Current		
27 0 V ... 10 V	27 0 V ... 10 V		

Macro 15: Switch over between analog setpoint and motorized potentiometer (MOP) via DI 3		Macro 17: Two-wire control with method 2	Macro 18: Two-wire control with method 3
5 DI 0 ON/OFF1	5 DI 0 ON/OFF1	5 DI 0 ON/OFF1 right	5 DI 0 ON/OFF1 right
6 DI 1 External fault	6 DI 1 External fault	6 DI 1 ON/OFF1 left	6 DI 1 ON/OFF1 left
7 DI 2 Acknowledge	7 DI 2 Acknowledge	7 DI 2 Acknowledge	7 DI 2 Acknowledge
8 DI 3 LOW	8 DI 3 HIGH	8 DI 3 ---	8 DI 3 ---
16 DI 4 ---	16 DI 4 MOP raise	16 DI 4 ---	16 DI 4 ---
17 DI 5 ---	17 DI 5 MOP lower	17 DI 5 ---	17 DI 5 ---
3 AI 0 Setpoint	3 AI 0 ---	3 AI 0 Setpoint	3 AI 0 Setpoint
4 I U -10 V ... 10 V	4	4 I U -10 V ... 10 V	4 I U -10 V ... 10 V
18 DO 0 Fault	18 DO 0 Fault	18 DO 0 Fault	18 DO 0 Fault
19	19	19	19
20	20	20	20
21 DO 1 Alarm	21 DO 1 Alarm	21 DO 1 Alarm	21 DO 1 Alarm
22	22	22	22
12 AO 0 Speed	12 AO 0 Speed	12 AO 0 Speed	12 AO 0 Speed
13 0 V ... 10 V	13 0 V ... 10 V	13 0 V ... 10 V	13 0 V ... 10 V
26 AO 1 Current	26 AO 1 Current	26 AO 1 Current	26 AO 1 Current
27 0 V ... 10 V	27 0 V ... 10 V	27 0 V ... 10 V	27 0 V ... 10 V

Macro 19: Three-wire control with method 1	Macro 20: Three-wire control with method 2	Macro 21: Fieldbus USS
<div>5 DI 0 Enable/OFF1</div> <div>6 DI 1 ON right</div> <div>7 DI 2 ON left</div> <div>8 DI 3 Acknowledge</div> <div>16 DI 4 ---</div> <div>17 DI 5 ---</div> <div>3 AI 0 Setpoint</div> <div>4 I  U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>21 DO 1 Alarm</div> <div>22</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div> <div>26 AO 1 Current</div> <div>27 0 V ... 10 V</div>	<div>5 DI 0 Enable/OFF1</div> <div>6 DI 1 ON</div> <div>7 DI 2 Reversing</div> <div>8 DI 3 Acknowledge</div> <div>16 DI 4 ---</div> <div>17 DI 5 ---</div> <div>3 AI 0 Setpoint</div> <div>4 I  U -10 V ... 10 V</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>21 DO 1 Alarm</div> <div>22</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div> <div>26 AO 1 Current</div> <div>27 0 V ... 10 V</div>	<div>USS setting: 38400 baud, 2 PZD, PKW variable</div> <div>5 DI 0 ---</div> <div>6 DI 1 ---</div> <div>7 DI 2 Acknowledge</div> <div>8 DI 3 ---</div> <div>16 DI 4 ---</div> <div>17 DI 5 ---</div> <div>3 AI 0 ---</div> <div>4</div> <div>18 DO 0 Fault</div> <div>19</div> <div>20</div> <div>21 DO 1 Alarm</div> <div>22</div> <div>12 AO 0 Speed</div> <div>13 0 V ... 10 V</div> <div>26 AO 1 Current</div> <div>27 0 V ... 10 V</div>

### 4.4.5 Wiring the terminal strip



#### **! WARNING**

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

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

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

#### **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 mm<sup>2</sup> (21 AWG) to 1.5 mm<sup>2</sup> (16 AWG).  
When completely connecting up the unit, we recommend cables with a cross-section of 1 mm<sup>2</sup> (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 55).
- 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.

**4.4.6 Fieldbus interface allocation**

The converter's fieldbus interface is on the bottom of the Control Unit.

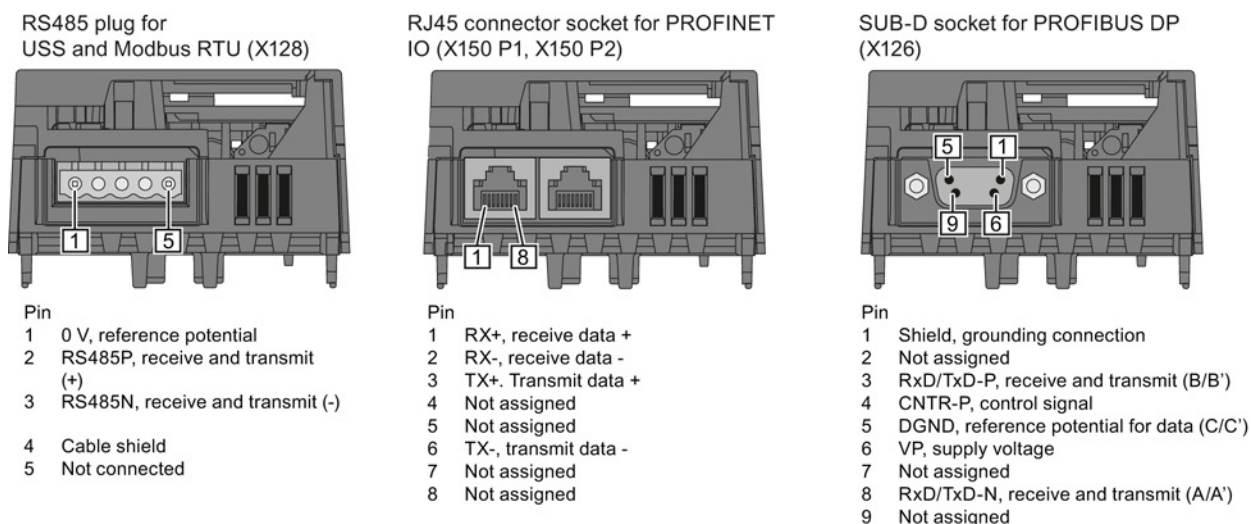


Figure 4-8 Fieldbus interface allocation

## 4.5 Connecting inverters in compliance with EMC

### 4.5.1 EMC-compliant connection of the converter

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

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

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

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

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

### 4.5.2 Avoid electromagnetic interference (EMI)

The inverters are designed to operate in an industrial environment where a high level of EMI can be expected. Safe, reliable and disturbance-free operation is only guaranteed if the devices are professionally installed.

#### Control cabinet design

- Connect the metal parts and components of the control cabinet to the control cabinet frame through a good electrical connection:
  - Side panels
  - Rear panels
  - Roof
  - Base plates
- Using the highest possible surface area or a high number of individual screw connections.
- Connect the PE bar and the EMC shield bar to the control cabinet frame through a good electrical connection established through a large surface area.
- Connect the metal enclosures of the devices in the cabinet, e.g. converter or line filter, to the control cabinet frame through a good electrical connection through the largest possible surface area.

We recommend to mount these devices on a bare metal mounting plate with good conducting characteristics.

- Choose one of the following methods to establish a conducting contact for screw connections on painted or anodized surfaces:
  - Use special contact (serrated) washers that cut through the
  - Remove the insulating surface at the contact locations
- Equip the following devices with interference suppression elements:
  - Coils of contactors
  - Relays
  - Solenoid valves
  - Motor holding brakes

Interference suppression elements are RC elements or varistors with AC coils and free-wheeling diodes or varistors for DC coils.

Connect the interference suppression elements directly at the coil.

### Cable routing and shielding

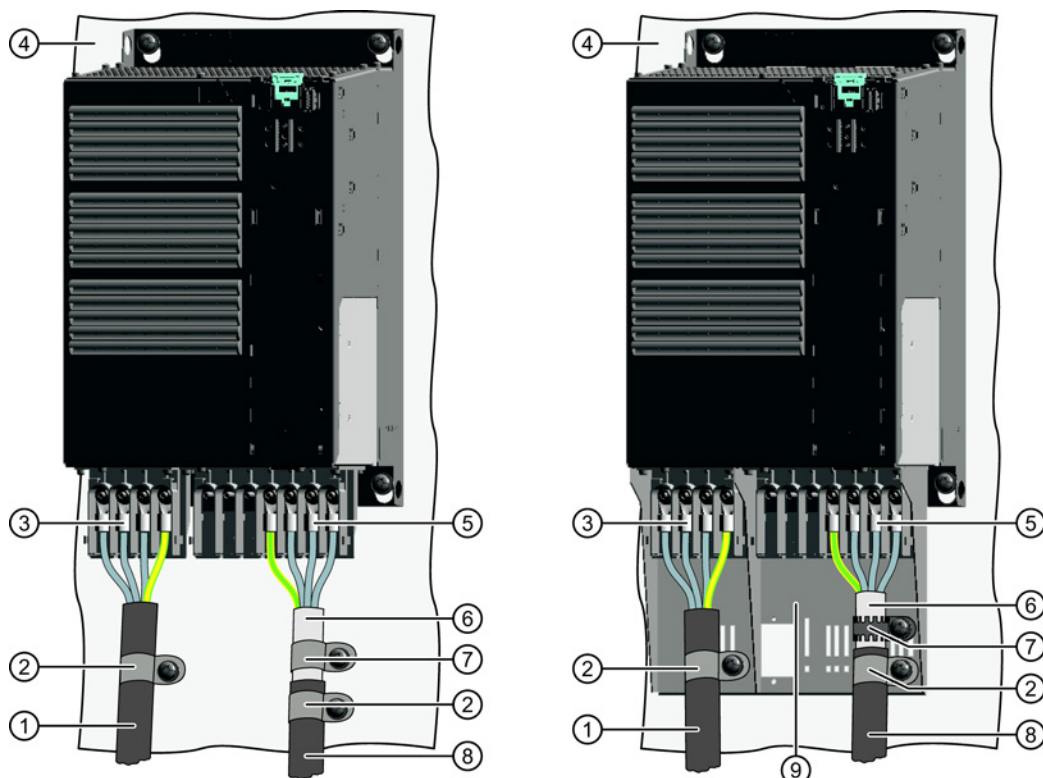
- Rout all inverter power cables (line supply cables, cables between the braking chopper and the associated braking resistance as well as the motor cables) separately from signal and data cables. Keep the minimum clearance to 25 cm. If the cables can not be separated use metal partitions with a good connection to the mounting plate.
- Rout the cables from the line supply to the line filter separately away from the following cables:
  - Cables between the line filter and converter
  - Cables between the braking chopper and the associated braking resistor
  - Motor cables.
- Signal and data cables as well as filtered line supply cables may only cross non-filtered power cables at right angles.
- Keep all cables as short as possible.
- Rout signal and data cables and the associated equipotential bonding always in parallel with the smallest possible clearance between them.
- Use shielded motor cables.
- Route the shielded motor cable separately away from the cables to the motor temperature sensors (PTC/KTY).
- Shield signal and data cables.
- Connect shields at both ends to the grounded enclosures through a good electrical connection and through a large surface area.
- Connect cable shields as close as possible to where the cable enters the cabinet.
- Use EMC shield bars for power cables.

Use the shield support elements provided in the converter for signal and data cables.

- Do not interrupt the cable shields by intermediate terminals.
- Use appropriate EMC clamps for the cable shields.

The EMC clamps connect the cable shield to the EMC shield bar or the shield support element through a large conductive area.

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



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

- ① Line connection cable (unshielded) for Power Modules with integrated line filter.  
If you use an external line filter, you will need a shielded cable between the line filter and the Power Module.
- ② Strain relief
- ③ Line supply connection
- ④ Metal mounting plate (unpainted and with a good electrical conductivity)
- ⑤ Motor connection
- ⑥ Cable shield
- ⑦ Cable clamps for establishing the connection between the shield and the mounting plate through a large surface area
- ⑧ Motor connection cable (shielded)
- ⑨ Shield plate (option). Use the shield plate for EMC-compliant installation of the PM240-2 and PM230 power Modules (FSA ... FSC); connect the shield of the control cable at the shield plate of the CU as well as at the shield plate of the Power Module.

Figure 4-9 EMC-compliant wiring of a Power Module frame size E as example

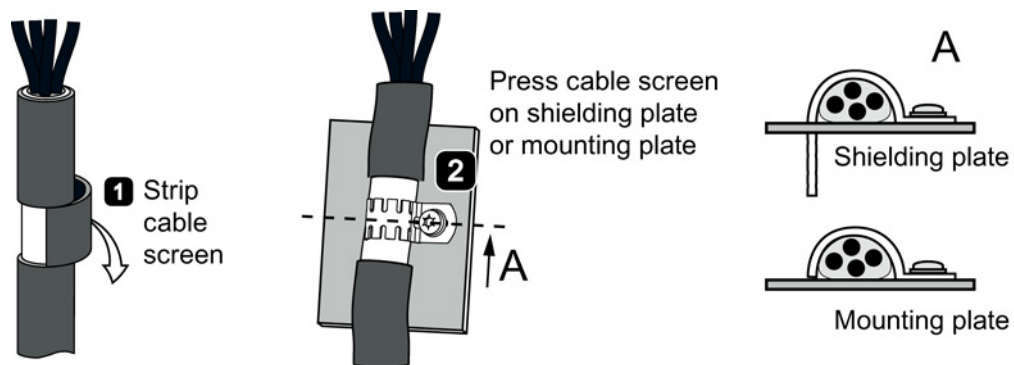


Figure 4-10 Shield connection - detail

Shielding with shield plate:

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

Shielding without shield plate:

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

Braking resistor connection:

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

# Commissioning

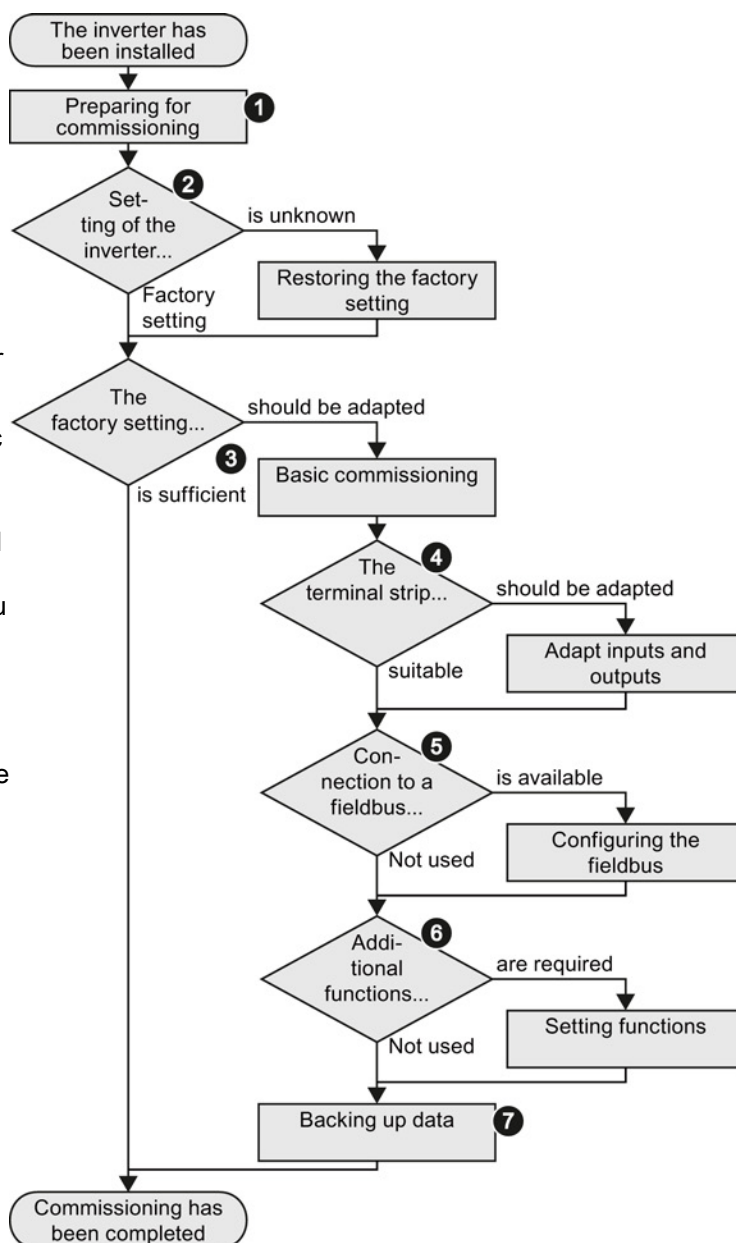
## 5.1 Commissioning guidelines



### Procedure

Proceed as follows to commission the inverter:

1. Define the requirements of your application placed on the drive.  
→ (Page 68) .
2. Reset the inverter when required to the factory setting.  
→ (Page 75) .
3. Check whether the factory setting of the inverter is appropriate for your application.  
If not, start with the basic commissioning.  
→ (Page 76).
4. Check whether you need to adapt the functions of the terminal strip that you specify in the basic commissioning.  
→ (Page 89).
5. If necessary, adapt the communications interface in the inverter.  
→ (Page 103) .
6. If necessary, set further functions in the inverter.  
→ (Page 169) .
7. Save your settings.  
→ (Page 273) .



You have commissioned the inverter.

## 5.2 Preparing for commissioning

### Overview

Before starting commissioning, you must answer the following questions:

- What data does my converter have?  
→ Identifying the converter (Page 21).
- What is the data for the connected motor?  
→ Preparing for commissioning (Page 68).
- Which interfaces of the converter are active?  
→ Wiring examples for the factory settings (Page 69).
- Via which converter interfaces does the higher-level controller operate the drive?
- How is my converter set?  
→ Factory setting of the inverter control (Page 72).
- What technological requirements must the drive fulfill?  
→ V/f control or vector control (speed/torque)? (Page 73).  
→ Defining additional requirements for the application (Page 74).

#### **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 [ $\Delta$ ]). 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.

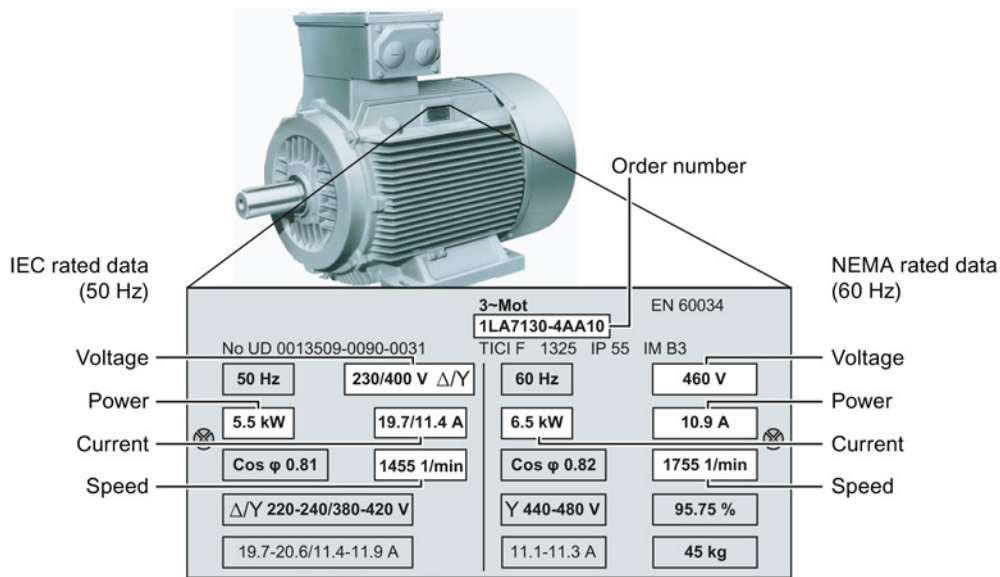


Figure 5-1 Motor data of the rating plate

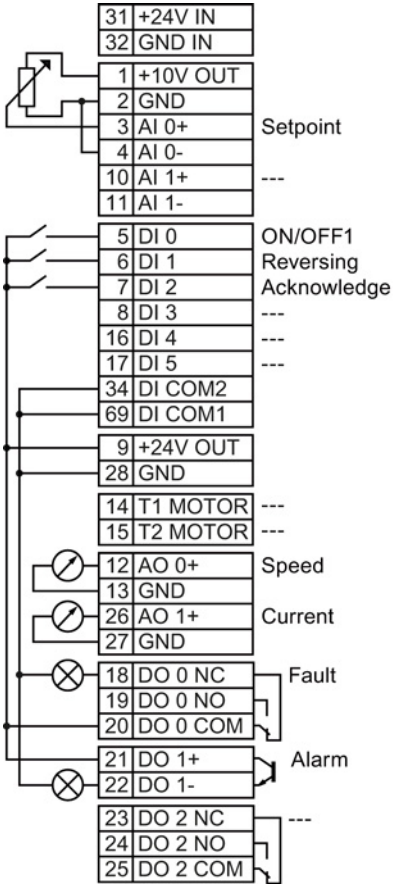
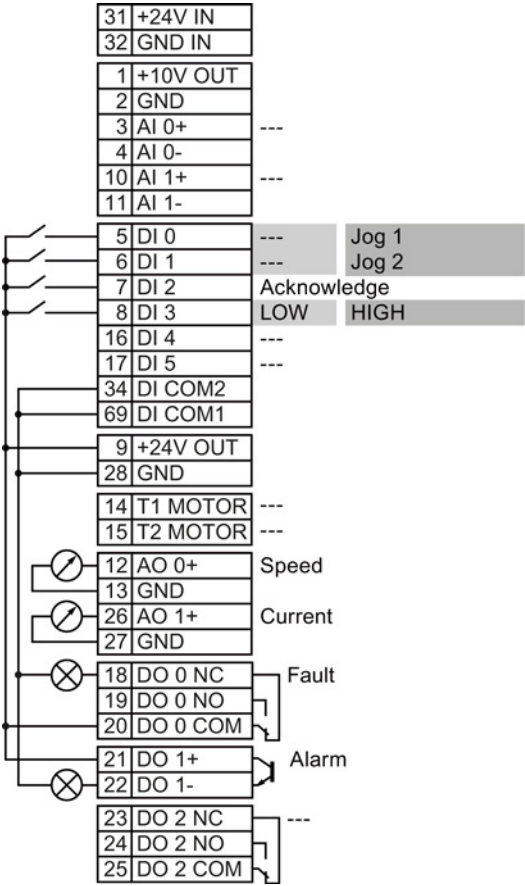
### 5.2.1 Wiring examples for the factory settings

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

#### Wiring the terminal strip for CU240B-2 Control Units

Wiring for Control Units without PROFIBUS or PROFINET interface.	Wiring for Control Units with PROFIBUS or PROFINET interface.
<p>31 +24V IN 32 GND IN 1 +10V OUT 2 GND 3 AI 0+ Setpoint 4 AI 0- 5 DI 0 ON/OFF1 6 DI 1 Reversing 7 DI 2 Acknowledge 8 DI 3 --- 69 DI COM 9 +24V OUT 28 GND 14 T1 MOTOR --- 15 T2 MOTOR --- 12 AO 0+ Speed 13 GND 18 DO 0 NC Fault 19 DO 0 NO 20 DO 0 COM</p>	<p>DI 3 = LOW: PROFIdrive telegram 1 DI 3 = HIGH: Jogging</p> <p>31 +24V IN 32 GND IN 1 +10V OUT 2 GND 3 AI 0+ --- 4 AI 0- 5 DI 0 --- Jog 1 6 DI 1 --- Jog 2 7 DI 2 Acknowledge 8 DI 3 LOW HIGH 69 DI COM 9 +24V OUT 28 GND 14 T1 MOTOR --- 15 T2 MOTOR --- 12 AO 0+ Speed 13 GND 18 DO 0 NC Fault 19 DO 0 NO 20 DO 0 COM</p>

## Wiring the terminal strip for CU240E-2 Control Units

Wiring for Control Units without PROFIBUS or PROFINET interface.	Wiring for Control Units with PROFIBUS or PROFINET interface.
	<p>DI 3 = LOW: PROFIdrive telegram 1 DI 3 = HIGH: Jogging</p> 

### 5.2.2 Does the motor match the converter?

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

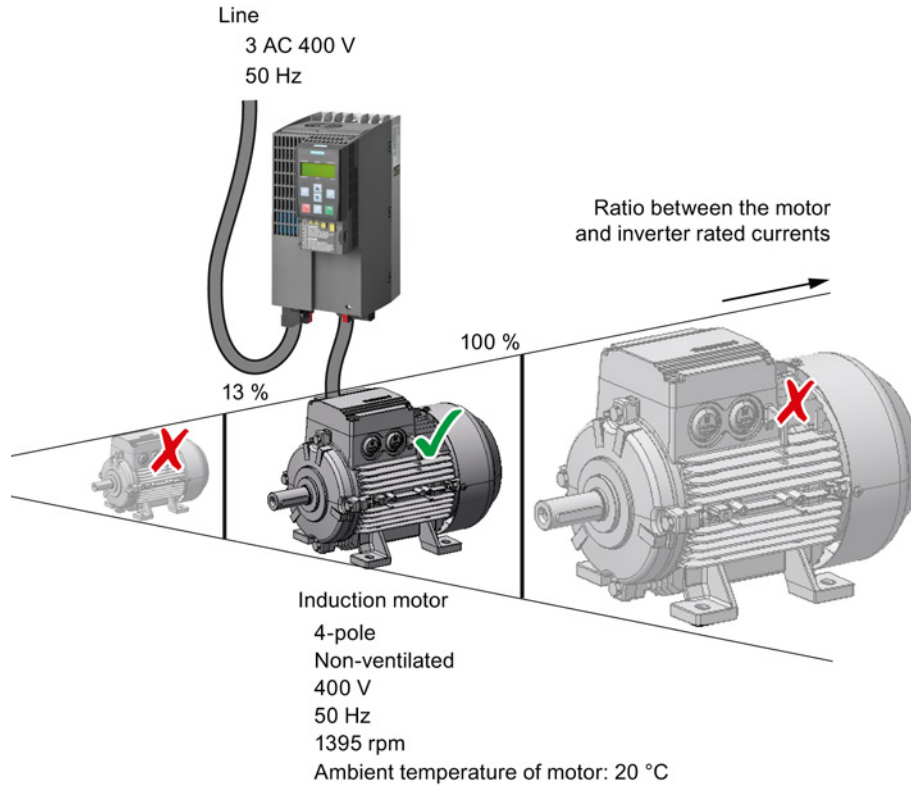


Figure 5-2 Motor data factory settings

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.

### 5.2.3 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.

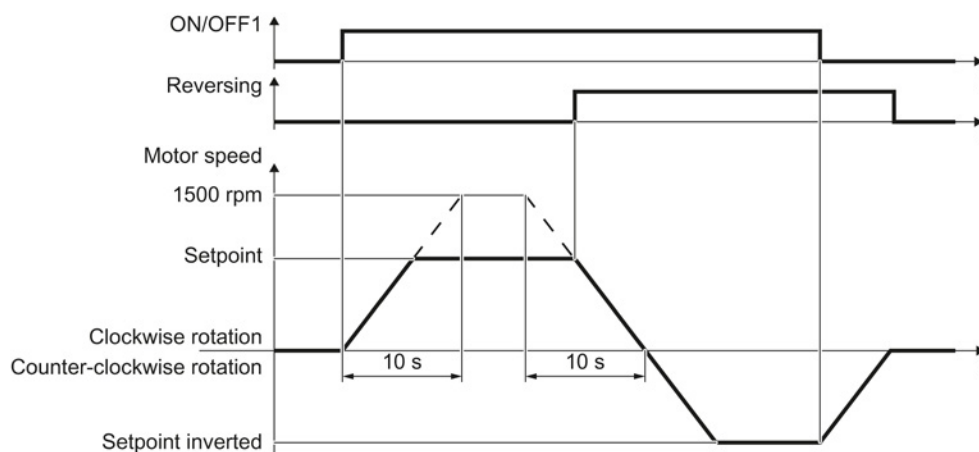


Figure 5-3 Switching on and switching off the motor and reversing in the factory setting

#### 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  $\pm 150$  rpm. The ramp-up and ramp-down times are also 10 seconds, referred to 1500 rpm.

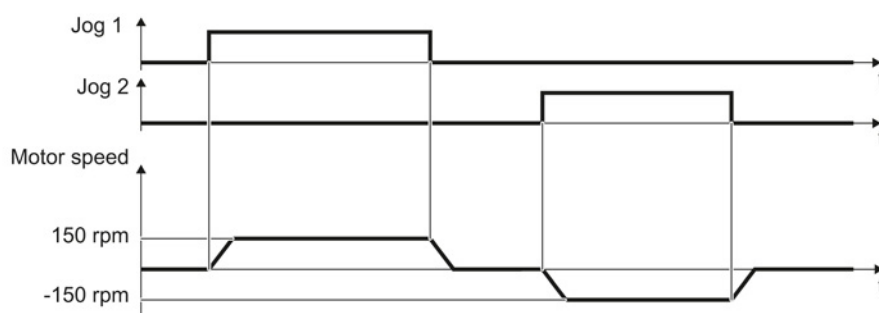


Figure 5-4 Jogging the motor in the factory setting

## 5.2.4 V/f control or vector control (speed/torque)?

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:



	
<ol style="list-style-type: none"> <li>1. Go online</li> <li>2. Call the safety functions screen form</li> <li>3. In the "Safety Integrated" screen form, press the button for restoring the factory setting.</li> </ol>	<ol style="list-style-type: none"> <li>1. Set p0010 = 30 Activate reset settings.</li> <li>2. p9761 = ... Enter the password for the safety functions</li> <li>3. Start the reset with p970 = 5 When the inverter has reset the settings, p0970 = 0.</li> </ol>
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:



	
<ol style="list-style-type: none"> <li>1. Go online</li> <li>2. Click the  key.</li> </ol>	<ol style="list-style-type: none"> <li>1. In the "Options" menu, select the "DRVRESET" entry</li> <li>2. Confirm the reset using the OK key</li> </ol>



You have restored the inverter factory settings.

## 5.4 Basic commissioning

### 5.4.1 Basic commissioning with the BOP-2 operator panel

#### Installing the BOP-2 Basic Operator Panel



##### Procedure

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

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



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

#### Setting the basic commissioning data

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

##### 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.


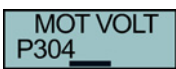






## Procedure

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

1.  Press the ESC key.
2.  Press one of the arrow keys until the BOP-2 displays the "SETUP" menu.
3.  In the "SETUP" menu, press the OK key to start basic commissioning.
4.  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.  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.  Motor standard  
KW 50HZ IEC  
HP 60HZ NEMA  
KW 60HZ IEC 60 Hz
  - 6.2.  Rated voltage
  - 6.3.  Rated current
  - 6.4.  IEC power (kW)  
NEMA (HP)
  - 6.5.  Rated speed

<b>SIEMENS</b>					
D-91056 Erlangen					
3~Mot. 1LE10011AC434AA0				E0807/0496382	
IEC/EN 60034 100L			IMB3		IP55
25 kg	Th.Cl. 155(F)		-20°C		Tamb 40°C
	Bearing		UNIREX-N3		
	DE	6206-2ZC3	15g	Intervall: 4000hrs	
	NE	6206-2ZC3	11g		
	60Hz:		SF 1.15 CONT NEMA MG1-12		
V	Hz	A	kW	PF	NOM.EFF
400 Δ	50	3.5	1.5	0.73	84.5%
690 Y	50	2.05	1.5	0.73	84.5%
460 Δ	60	3.15	1.5	0.69	86.5%
(2)	(1)	(3)	(4)	(5)	

7.  

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.

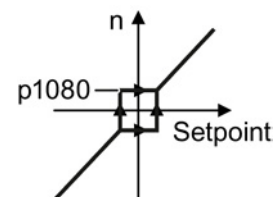
8.  

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 55)

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.  

Set the minimum speed of the motor.

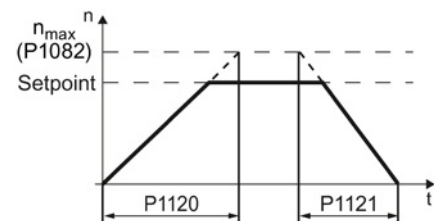



10.  

Set the ramp-up time of the motor.

11.  

Set the ramp-down time of the motor.



12.  

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.











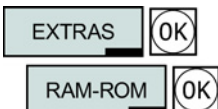
You can recognize an active alarm from the corresponding symbol on the BOP-2.

- 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.
5.  If you have also selected a rotating measurement in addition to the motor data identification, then the inverter again issues the alarm A07991. 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: Update download path for 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 82)
  - Go online via PROFINET:  
Adapting the PROFINET interface (Page 83)  
Configure the communication between inverter and PC: Configuring PROFINET communication in STEP 7 (Page 379).
2. Create a STARTER project (Page 84).
3. Go online and commission the inverter using the wizards (Page 84).




This means that you have completed the basic commissioning.

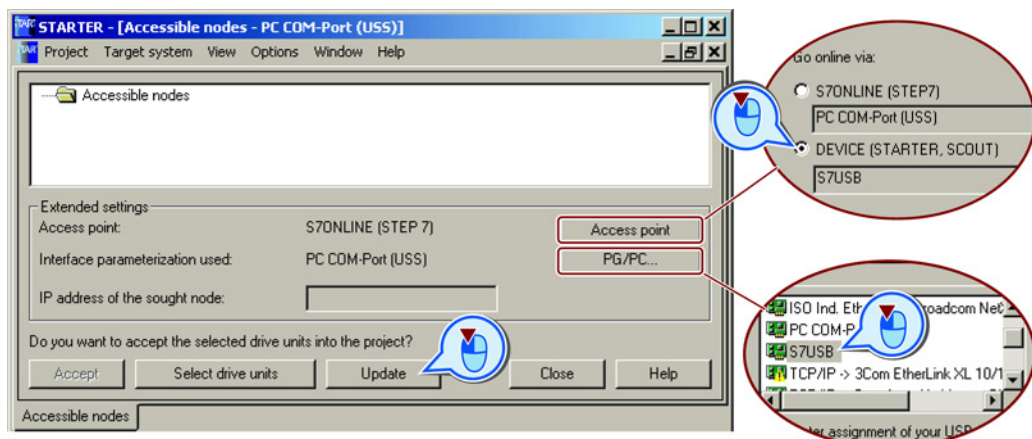
## 5.4.2.1 Adapting interfaces

## Adapting the USB interface

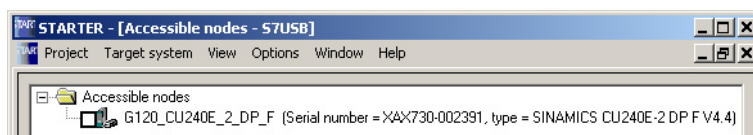
**Procedure**

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 84).

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

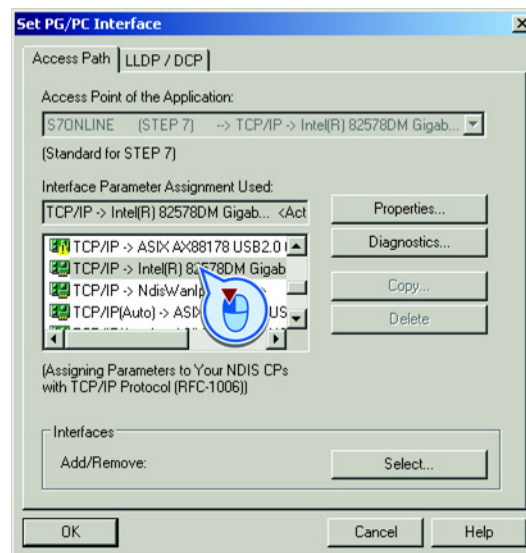
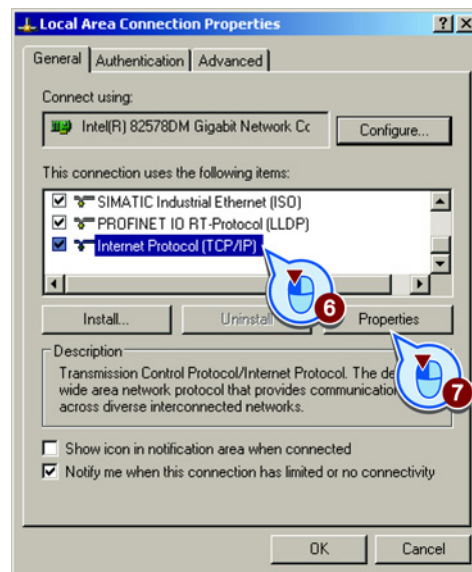
To address the inverter, proceed as follows:



1. Establish the bus connection.  
See Section Communication via PROFINET (Page 104))
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

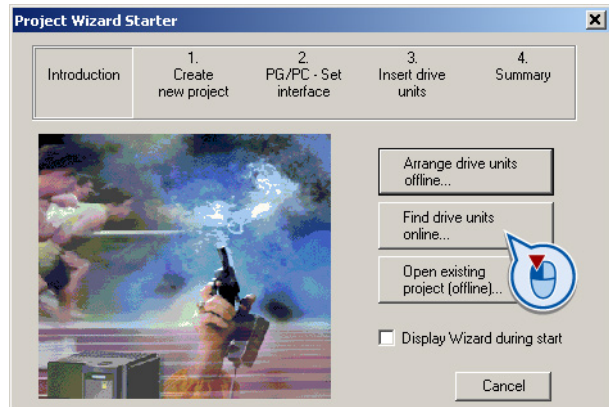
#### Creating a STARTER project using project wizards



##### 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.

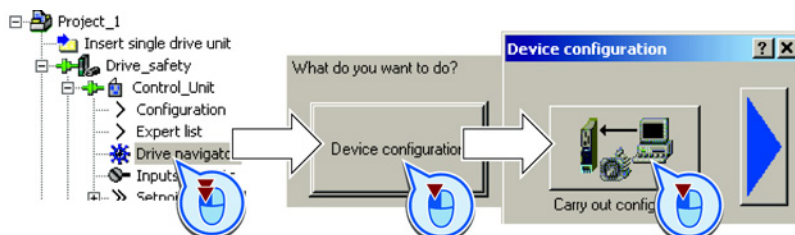
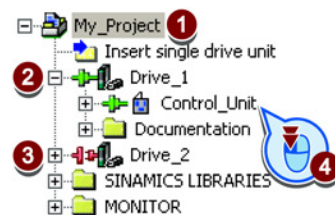
### 5.4.2.3 Go online and start wizard for basic commissioning



##### 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.

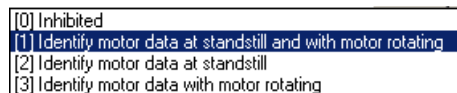
#### 5.4.2.4 Carry-out basic commissioning



##### 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 73)
2. ☒ Defaults of the setpoint Select the default setting of the converter interfaces.  
See also Section: Finding a suitable setting for the interfaces (Page 55).
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".

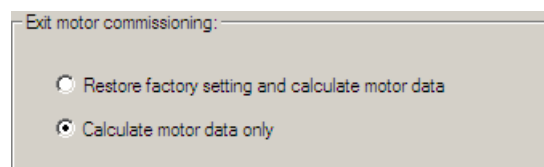


With this setting, the converter optimizes its speed controller.

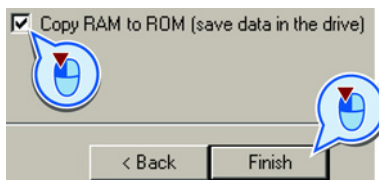
If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":

- 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 motor data 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.




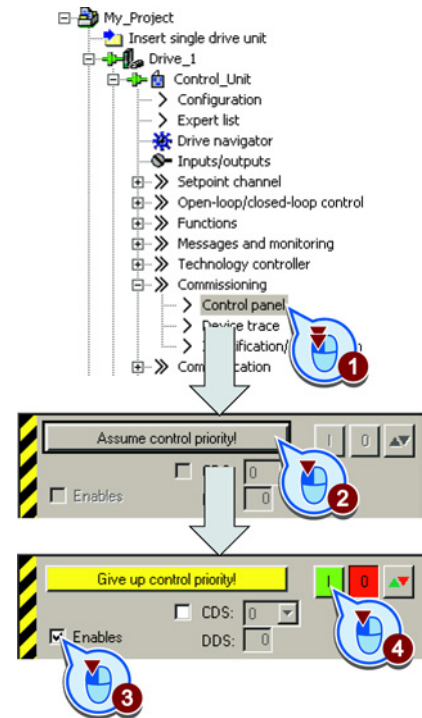
### Procedure

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 and optimization.

### 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.



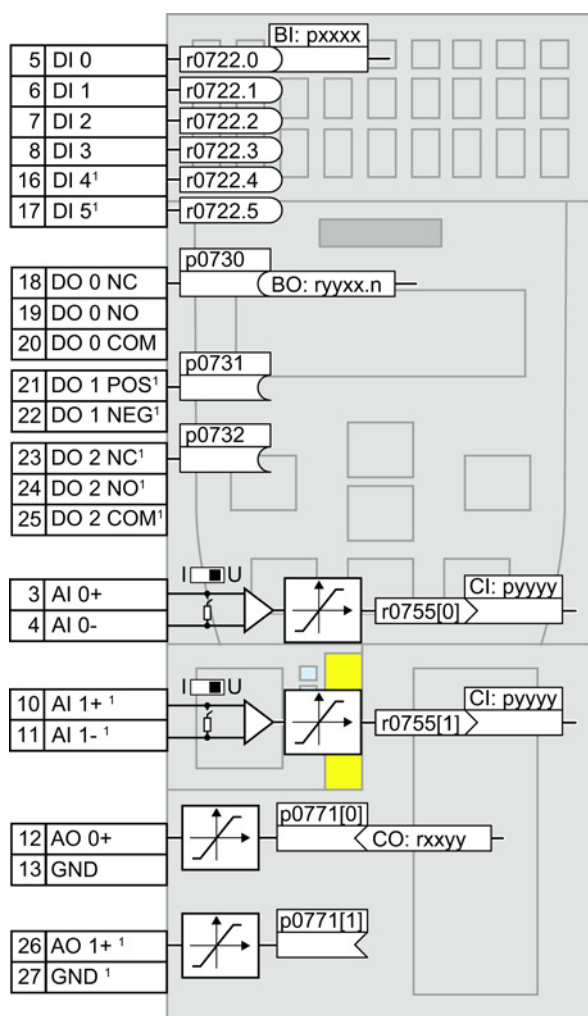
## Adapt terminal strip

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:

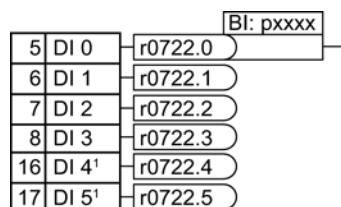
- Basic commissioning (Page 76)
- Finding a suitable setting for the interfaces (Page 55)
- Interconnecting signals in the inverter (Page 372)



<sup>1</sup> Not available with Control Units CU240B-2 and CU240B-2 DP

Figure 6-1 Internal interconnection of the inputs and outputs

## 6.1 Digital inputs



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.

<sup>1</sup>Not available with CU240B-2 and CU240B-2 DP Control Units

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

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

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

## Changing the function of a digital input



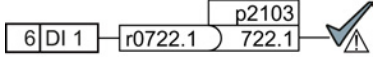
### Example

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

### Procedure

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



		
	<ol style="list-style-type: none"> <li>1. Go into the menu "PARAMS".</li> <li>2. As parameter filter, select "EXPERT".</li> <li>3. Set p2103 = 722.1</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online.</li> <li>2. Select "Inputs/outputs".</li> <li>3. Change the input function via the corresponding screen form.</li> </ol>



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 inputs as digital inputs

When required, you can use analog inputs as additional digital inputs.

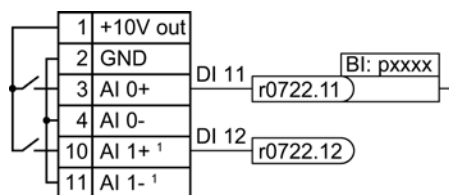


Figure 6-2 Additional digital inputs

<sup>1</sup>Not available with CU240B-2 and CU240B-2 DP Control Units

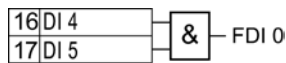
## 6.2 Fail-safe input

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 55)).

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: Safe Torque Off (STO) safety function (Page 253).

### 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.

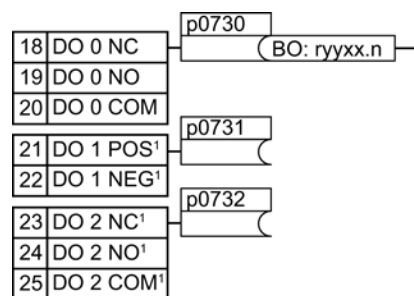
These special types of cable routing are normally required only if the cables are laid over larger distances, e.g. between remote control cabinets.

Examples of connecting a fail-safe input can be found in Section: Connecting fail-safe digital inputs (Page 393).

#### Note

Control Units CU240B-2 and CU240B-2 DP do not have a fail-safe digital input.

## 6.3 Digital outputs



<sup>1</sup>Not available with CU240B-2 and CU240B-2 DP Control Units

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



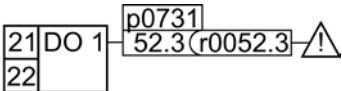
### Example

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:



		
	<ol style="list-style-type: none"> <li>1. Go into the menu "PARAMS".</li> <li>2. As parameter filter, select "EXPERT".</li> <li>3. Set p0731 = 52.3</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online.</li> <li>2. Select "Inputs/outputs".</li> <li>3. Change the output function via the corresponding screen form.</li> </ol>

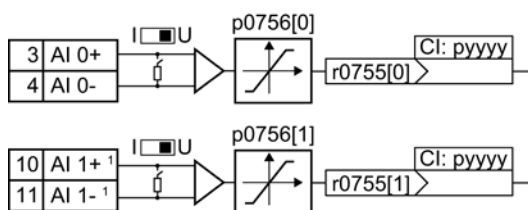
You have interconnected digital output DO 1 with the fault message.

## 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 inputs



<sup>1</sup>Not available with CU240B-2 and CU240B-2 DP Control Units

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

2. Set the switch associated with the analog input. You can find the switch on the Control Unit behind the lower front door.

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

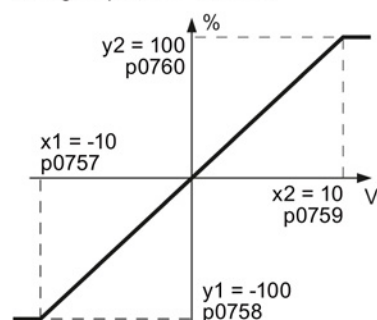


You have now defined the analog input type.

## 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.

p0756 = 4  
Voltage input, -10 V ... 10 V



p0756 = 3  
Current input, 4 mA ... 20 mA

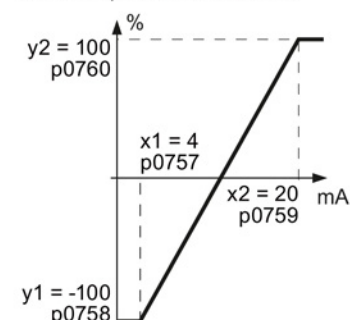


Figure 6-3 Examples for scaling characteristics

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

### 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

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	<b>Analog inputs, characteristic (x<sub>1</sub>, y<sub>1</sub>)</b>	Current input, 6 mA ... 12 mA 
p0758[0] = -100.0	6 mA corresponds to -100 %	
p0759[0] = 12.0	<b>Analog inputs, characteristic (x<sub>2</sub>, y<sub>2</sub>)</b>	
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



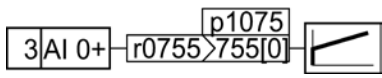
### Example

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:



		
	<ol style="list-style-type: none"> <li>1. Go into the menu "PARAMS".</li> <li>2. As parameter filter, select "EXPERT".</li> <li>3. Set p1075 = 755[0]</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online.</li> <li>2. Select "Inputs/outputs".</li> <li>3. Change the input function via the corresponding screen form.</li> </ol>

You have interconnected the analog input with the additional setpoint.

## Advanced settings

### Signal smoothing

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

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

### Skip frequency band

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

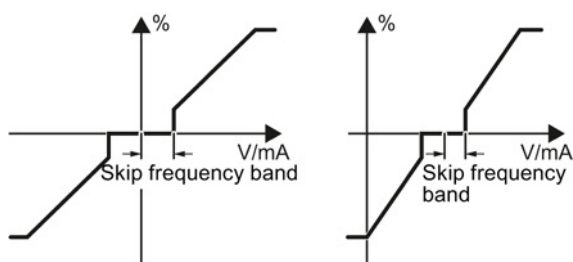
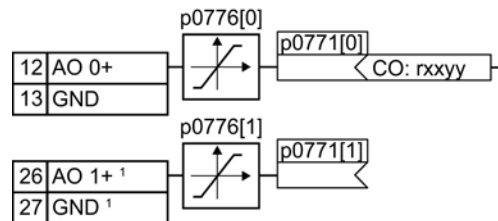


Figure 6-4 Skip frequency band of the analog input

p0764[0]	<b>Skip frequency band of the analog input AI 0</b> (factory setting: 0)
p0764[1]	<b>Skip frequency band of the analog input AI 1</b> (factory setting: 0)

## 6.5 Analog outputs

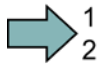


<sup>1</sup>Not available with CU240B-2 and CU240B-2 DP Control Units

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.

### Defining the analog output type



#### Procedure

Proceed as follows to define the analog output type:

Set parameter p0776 to the appropriate value:

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

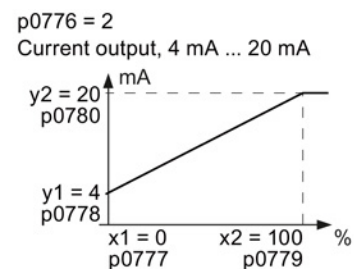
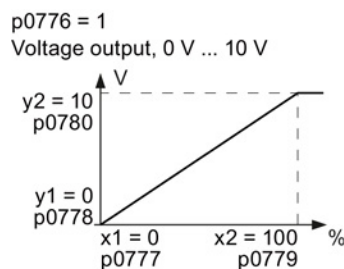


Figure 6-5 Examples for scaling characteristics

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

### 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	<b>Analog output, characteristic (x<sub>1</sub>, y<sub>1</sub>)</b>	
p0778[0] = 6.0	0.0% corresponds to 6 mA	
p0779[0] = 100.0	<b>Analog output, characteristic (x<sub>2</sub>, y<sub>2</sub>)</b>	
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



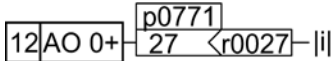
### Example

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:



		
	<ol style="list-style-type: none"> <li>Go into the menu "PARAMS".</li> <li>As parameter filter, select "EXPERT".</li> <li>Set p0771 = 27</li> </ol>	<ol style="list-style-type: none"> <li>Go online.</li> <li>Select "Inputs/outputs".</li> <li>Change the output function via the corresponding screen form.</li> </ol>



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.



## Configuring the fieldbus

### Fieldbus interfaces of the Control Units

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

Fieldbus	Profile	Control Unit	Interface
PROFIBUS (Page 107)	PROFIdrive and PROFIsafe <sup>1</sup>	CU240B-2 DP CU240E-2 DP CU240E-2 DP-F	Sub D socket
PROFINET (Page 104)		CU240E-2 PN CU240E-2 PN-F	Two RJ45 connectors
USS (Page 147)	-	CU240B-2	RS485 connector
Modbus RTU (Page 158)	-	CU240E-2 CU240E-2 F	
	<sup>1</sup> Information on PROFIsafe can only be found in the Safety Integrated Function Manual, see also Section: Additional information on the inverter (Page 397).		

## 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 Activating diagnostics via the control (Page 107).
- 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 105)	
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 106)	See Configuring the controller and converter in HW Config (Page 379)
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 106)	See: Configuring the controller and converter in HW Config (Page 379)
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 111)	See: STEP 7 program examples (Page 384)

## 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 CU (Page 51).

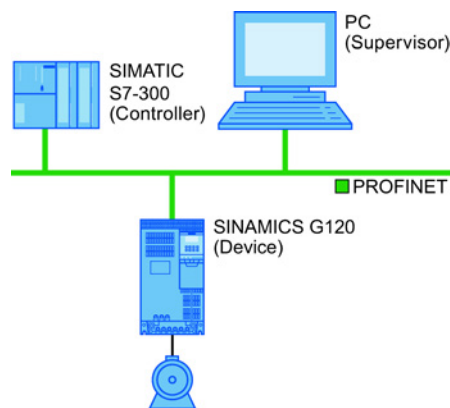


Figure 7-1 Example: PROFINET in a line topology

### 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: Basic commissioning (Page 76).

##### 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.

The following telegrams are available:

Parameter	Description
p0015	<b>Macro drive unit</b> Configure the interface in basic commissioning, and select a telegram.
p0922	<b>PROFIdrive Telegram selection</b> Set the send and receive telegram, also see Cyclic communication (Page 111)
1:	Standard telegram 1, PZD-2/2 (factory setting)
20:	Standard telegram 20, PZD-2/6
350:	SIEMENS telegram 350, PZD-4/4
352:	SIEMENS telegram 352, PZD-6/6
353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4
354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4
999:	Extend telegrams and change signal interconnection (Page 118)

### 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 of STEP 7 (Page 383)) 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 108).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring communication to the control (Page 109)	See also Section: Configuring PROFIBUS communication in STEP 7 (Page 376).
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 109).	
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 110).	
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 111).	See also Section: STEP 7 program examples (Page 384).

## 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 CU (Page 51).

### 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 PROFIBUS communication in STEP 7 (Page 376).



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 CU (Page 51).

Bit 6 (64)	<input type="checkbox"/>
Bit 5 (32)	<input type="checkbox"/>
Bit 4 (16)	<input type="checkbox"/>
Bit 3 (8)	<input type="checkbox"/>
Bit 2 (4)	<input type="checkbox"/>
Bit 1 (2)	<input type="checkbox"/>
Bit 0 (1)	<input type="checkbox"/>
On	Off

Example:	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
8	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
= 10	<input checked="" type="checkbox"/>
	On Off



### 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: Basic commissioning (Page 76).

### 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.

The following telegrams are available:

Parameter	Description														
p0015	<b>Macro drive unit</b> Configure the interface in basic commissioning, and select a telegram.														
p0922	<b>PROFIdrive Telegram selection</b> Set the send and receive telegram, also see Cyclic communication (Page 111) <table border="1"> <tr> <td>1:</td><td>Standard telegram 1, PZD-2/2 (factory setting)</td></tr> <tr> <td>20:</td><td>Standard telegram 20, PZD-2/6</td></tr> <tr> <td>350:</td><td>SIEMENS telegram 350, PZD-4/4</td></tr> <tr> <td>352:</td><td>SIEMENS telegram 352, PZD-6/6</td></tr> <tr> <td>353:</td><td>SIEMENS telegram 353, PZD-2/2, PKW-4/4</td></tr> <tr> <td>354:</td><td>SIEMENS telegram 354, PZD-6/6, PKW-4/4</td></tr> <tr> <td>999:</td><td>Extend telegrams and change signal interconnection (Page 118)</td></tr> </table>	1:	Standard telegram 1, PZD-2/2 (factory setting)	20:	Standard telegram 20, PZD-2/6	350:	SIEMENS telegram 350, PZD-4/4	352:	SIEMENS telegram 352, PZD-6/6	353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4	354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4	999:	Extend telegrams and change signal interconnection (Page 118)
1:	Standard telegram 1, PZD-2/2 (factory setting)														
20:	Standard telegram 20, PZD-2/6														
350:	SIEMENS telegram 350, PZD-4/4														
352:	SIEMENS telegram 352, PZD-6/6														
353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4														
354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4														
999:	Extend telegrams and change signal interconnection (Page 118)														

## 7.3 PROFIdrive profile for PROFIBUS and PROFINET

### 7.3.1 Cyclic communication

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

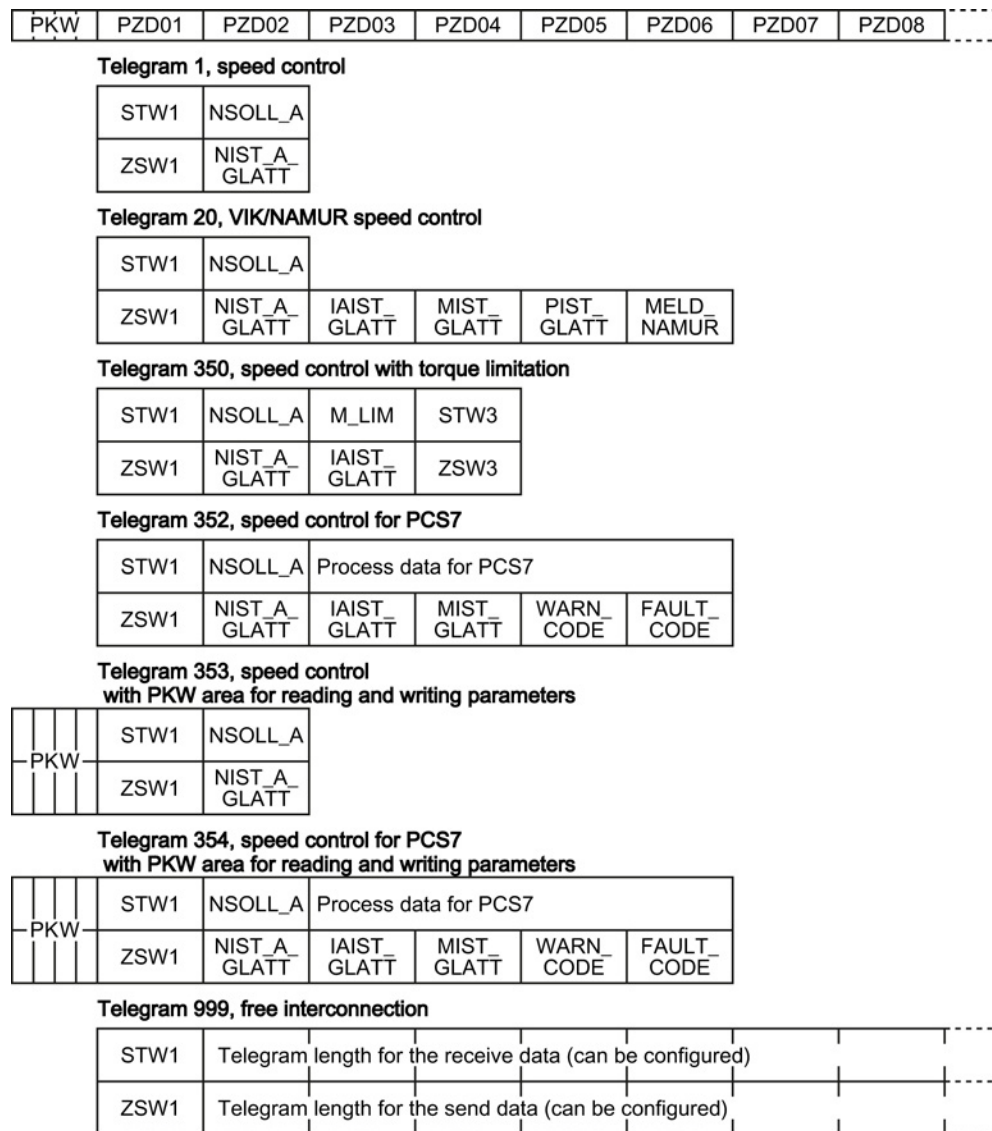


Figure 7-2 Telegrams for cyclic communication

Table 7- 1 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
STW1	Control word 1	MIST_GLATT	Current torque
ZSW1	Status word 1	PIST_GLATT	Current active power
STW3	Control word 3	M_LIM	Torque limit value
ZSW3	Status word 3	FAULT_CODE	Fault number
NSOLL_A	Speed setpoint	WARN_CODE	Alarm number
NIST_A_GLATT	Smoothed actual speed value	MELD_NAMUR	Fault word according to VIK-NAMUR definition
IAIST_GLATT	Smoothed actual current value		

## Interconnection of the process data

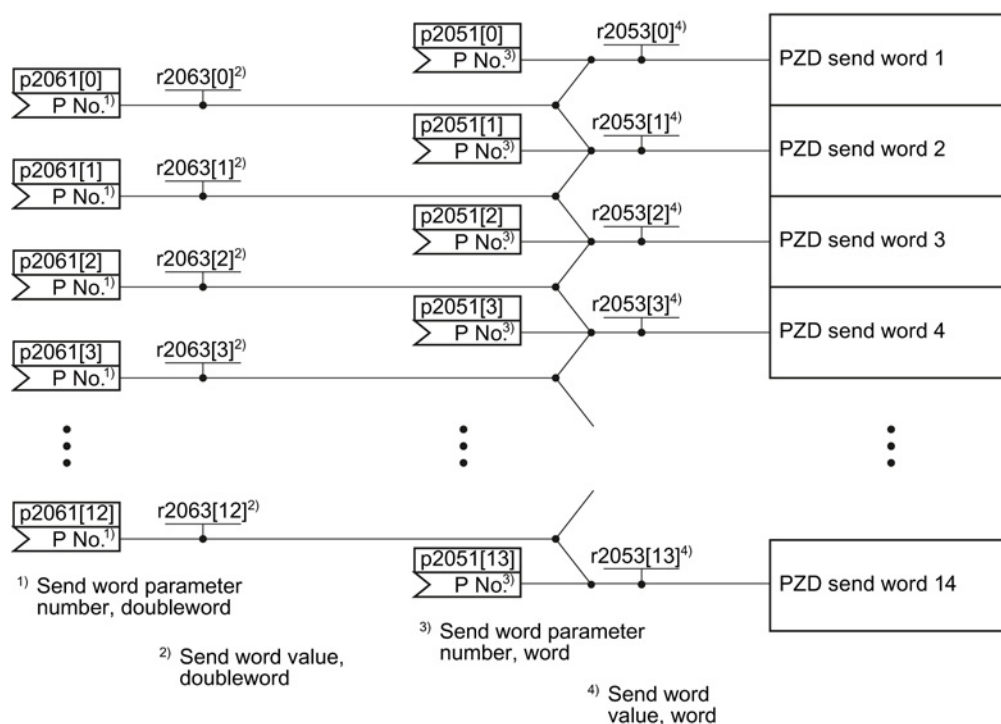


Figure 7-3 Interconnection of the send words

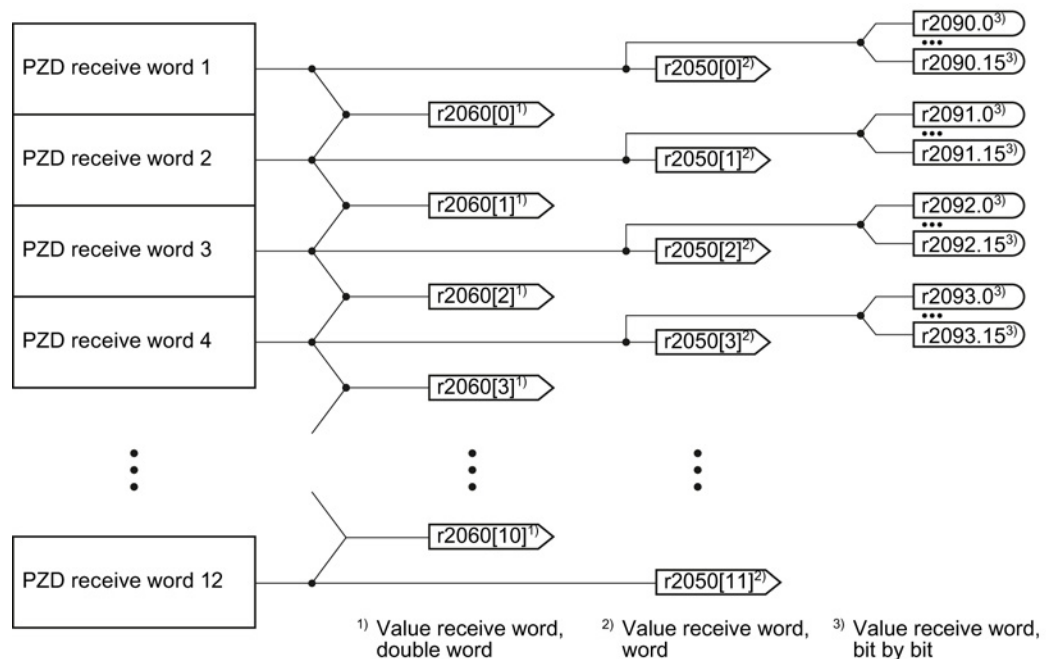


Figure 7-4 Interconnection of the receive words

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

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

### 7.3.1.1 Control and status word 1

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

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG		The inverter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the inverter switches to "closing lockout" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Inverter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, inverter accepts the process data from the fieldbus.	
11	--- <sup>1)</sup>	0 = Direction reversal	Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Not used			
13	--- <sup>1)</sup>	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	--- <sup>1)</sup>	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

<sup>1)</sup> 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
12	--- <sup>1)</sup>	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

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

### 7.3.1.2 Control and status word 3

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

#### Control word 3 (STW3)

Control word 3 has the following default assignment. You can change the signal interconnection.

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

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

**Status word 3 (ZSW3)**

Status word 3 has the following standard assignment.

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

### 7.3.1.3 Extend telegrams and change signal interconnection

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

#### Extend telegram

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

##### Procedure

Proceed as follows to extend a telegram:

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

You have extended the telegram.

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

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

### Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

#### Procedure

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

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

You have freely interconnected the signals transferred in the telegram.

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

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

### 7.3.1.4 Data structure of the parameter channel

#### Structure of the parameter channel

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

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

Parameter channel							
PKE (1st word)		IND (2nd word)		PWE (3rd and 4th word)			
15 ... 12	11	10 ... 0		15 ... 8	7 ... 0	15 ... 0	15 ... 0
AK	S P M	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 <sup>1)</sup>	3	7 / 8
6 <sup>2)</sup>	Request parameter value (field) <sup>1)</sup>	4 / 5	7 / 8
7 <sup>2)</sup>	Change parameter value (field, word) <sup>1)</sup>	4	7 / 8
8 <sup>2)</sup>	Change parameter value (field, double word) <sup>1)</sup>	5	7 / 8
9	Request number of field elements	6	7 / 8

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

<sup>2)</sup> 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 <sup>1)</sup>
4	Transfer parameter value (field, word) <sup>2)</sup>
5	Transfer parameter value (field, double word) <sup>2)</sup>
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

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

<sup>2)</sup> 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	<b>Illegal parameter number</b> (access to a parameter that does not exist)
01 hex	<b>Parameter value cannot be changed</b> (change request for a parameter value that cannot be changed)
02 hex	<b>Lower or upper value limit exceeded</b> (change request with a value outside the value limits)
03 hex	<b>Incorrect subindex</b> (access to a subindex that does not exist.)
04 hex	<b>No array</b> (access with a subindex to non-indexed parameters)
05 hex	<b>Incorrect data type</b> (change request with a value that does not match the data type of the parameter)
06 hex	<b>Setting not permitted, only resetting</b> (change request with a value not equal to 0 without permission)
07 hex	<b>Descriptive element cannot be changed</b> (change request to a descriptive element error value that cannot be changed)
0B hex	<b>No master control</b> (change request but with no master control, see also p0927.)
0C hex	<b>Keyword missing</b>
11 hex	<b>Request cannot be executed due to the operating state</b> (access is not possible for temporary reasons that are not specified)
14 hex	<b>Inadmissible value</b> (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	<b>Parameter number is currently deactivated</b> (depending on the mode of the inverter)
66 hex	<b>Channel width is insufficient</b> (communication channel is too small for response)
68 hex	<b>Illegal parameter value</b> (parameter can only assume certain values)
6A hex	<b>Request not included / task is not supported</b> (the valid request identifications can be found in table "Request identifications controller → inverter")
6B hex	<b>No change access for a controller that is enabled.</b> (operating status of the inverter prevents a parameter change)
86 hex	<b>Write access only for commissioning (p0010 = 15)</b> (operating status of the inverter prevents a parameter change)
87 hex	<b>Know-how protection active, access locked</b>
C8 hex	<b>Change request below the currently valid limit</b> (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	<b>Change request above the currently valid limit</b> (example: a parameter value is too large for the inverter power)
CC hex	<b>Change request not permitted</b> (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 inverter (Page 372).

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  $\pm$  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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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

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

### Write request: Change restart mode (p1210)

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

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

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	1	1	0	1	0

Figure 7-6 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 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  $\triangleq$  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	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0

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

**Other application examples**

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

**7.3.1.5 Slave-to-slave communication**

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

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 391).

### 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 (Human Machine Interface)

You can find a STEP 7 program example for acyclic data transfer in Section STEP 7 program example for acyclic communication (Page 387).

### Reading parameter values

Table 7-2 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	<b>Reference</b> 01 hex ... FF hex	<b>01 hex:</b> Read request	0
	<b>01 hex</b>	<b>Number of parameters (m)</b> 01 hex ... 27 hex	2
Address, parameter 1	<b>Attribute</b> 10 hex: Parameter value 20 hex: Parameter description	<b>Number of indexes</b> 00 hex ... EA hex (for parameters without index: 00 hex)	4
	<b>Parameter number</b> 0001 hex ... FFFF hex		6
	<b>Number of the 1st index</b> 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	<b>Reference</b> (identical to a read request)	<b>01 hex:</b> Inverter has executed the read request. <b>81 hex:</b> Inverter was not able to completely execute the read request.	0
	<b>01 hex</b>	<b>Number of parameters (m)</b> (identical to the read request)	2
Values, parameter 1	<b>Format</b> 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	<b>Number of index values</b> or - for a negative response - <b>number of error values</b>	4
	<b>Value of the 1st index</b> or - for a negative response - <b>error value 1</b> 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	<b>Reference</b> 01 hex ... FF hex	<b>02 hex:</b> Change request	0
	<b>01 hex</b>	<b>Number of parameters (m)</b> 01 hex ... 27 hex	2
Address, parameter 1	<b>10 hex:</b> Parameter value	<b>Number of indexes</b> 00 hex ... EA hex (00 hex and 01 hex have the same significance)	4
	<b>Parameter number</b> 0001 hex ... FFFF hex		6
	<b>Number of the 1st index</b> 0001 hex ... FFFF hex		8
	...		...
Address, parameter 2	...		
...	...		...
Address, parameter m	...		
Values, parameter 1	<b>Format</b> 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	<b>Number of index values</b> 00 hex ... EA hex	
	<b>Value of the 1st index</b>		
	...		
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	<b>Reference</b> (identical to a change request)	<b>02 hex</b>	0
	<b>01 hex</b>	<b>Number of parameters</b> (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	<b>Reference</b> (identical to a change request)	<b>82 hex</b>	0
	<b>01 hex</b>	<b>Number of parameters</b> (identical to a change request)	2
Values, parameter 1	<b>Format</b> 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	<b>Number of error values</b> 00 hex or 02 hex	4
	Only for "Error" - <b>error value 1</b> You can find the error values in the table at the end of this section.		6
	Only for "Error" - <b>error value 2</b> 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	<b>Illegal parameter number</b> (access to a parameter that does not exist)
01 hex	<b>Parameter value cannot be changed</b> (change request for a parameter value that cannot be changed)
02 hex	<b>Lower or upper value limit exceeded</b> (change request with a value outside the value limits)
03 hex	<b>Incorrect subindex</b> (access to a parameter index that does not exist)
04 hex	<b>No array</b> (access with a subindex to non-indexed parameters)
05 hex	<b>Incorrect data type</b> (change request with a value that does not match the data type of the parameter)
06 hex	<b>Setting not permitted, only resetting</b> (change request with a value not equal to 0 without permission)
07 hex	<b>Descriptive element cannot be changed</b> (change request to a descriptive element that cannot be changed)
09 hex	<b>Description data not available</b> (access to a description that does not exist, parameter value is available)
0B hex	<b>No master control</b> (change request but with no master control)
0F hex	<b>Text array does not exist</b> (although the parameter value is available, the request is made to a text array that does not exist)
11 hex	<b>Request cannot be executed due to the operating state</b> (access is not possible for temporary reasons that are not specified)
14 hex	<b>Inadmissible value</b> (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	<b>Response too long</b> (the length of the actual response exceeds the maximum transfer length)
16 hex	<b>Illegal parameter address</b> ( <i>illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these</i> )
17 hex	<b>Illegal format</b> (change request for an illegal or unsupported format)
18 hex	<b>Number of values not consistent</b> ( <i>number of values of the parameter data to not match the number of elements in the parameter address</i> )

Error value 1	Significance
19 hex	<b>Drive object does not exist</b> (access to a drive object that does not exist)
6B hex	<b>No change access for a controller that is enabled.</b>
6C hex	<b>Unknown unit.</b>
6E hex	<b>Change request is only possible when the motor is being commissioned (p0010 = 3).</b>
6F hex	<b>Change request is only possible when the power unit is being commissioned (p0010 = 2).</b>
70 hex	<b>Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).</b>
71 hex	<b>Change request is only possible if the inverter is ready (p0010 = 0).</b>
72 hex	<b>Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).</b>
73 hex	<b>Change request possible only during commissioning of the safety functions (p0010 = 95).</b>
74 hex	<b>Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).</b>
75 hex	<b>Change request is only possible in a commissioning state (p0010 ≠ 0).</b>
76 hex	<b>Change request is not possible for internal reasons (p0010 = 29).</b>
77 hex	<b>Change request is not possible at download.</b>
81 hex	<b>Change request is not possible at download.</b>
82 hex	<b>Transfer of the control authority (master) is inhibited by BI: p0806.</b>
83 hex	<b>Desired interconnection is not possible</b> (the connector output does not supply a float value although the connector input requires a float value)
84 hex	<b>Inverter does not accept a change request</b> (inverter is busy with internal calculations. See parameter r3996 in the inverter List Manual. See also Section: Additional information on the inverter (Page 397))
85 hex	<b>No access methods defined.</b>
86 hex	<b>Write access only during commissioning of the data records (p0010 = 15)</b> (operating status of the inverter prevents a parameter change.)
87 hex	<b>Know-how protection active, access locked</b>
C8 hex	<b>Change request below the currently valid limit</b> (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	<b>Change request above the currently valid limit</b> (example: a parameter value is too large for the inverter power)
CC hex	<b>Change request not permitted</b> (change is not permitted as the access code is not available)

## Other application examples

See also: Reading and writing parameters acyclically  
(<http://support.automation.siemens.com/WW/view/en/29157692>).

## 7.4 PROFlenergy profile for PROFINET

### 7.4.1 PROFlenergy

The non-proprietary PROFlenergy 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

#### PROFlenergy 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 PROFlenergy command "Start\_Pause".

Enabling PROFlenergy	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

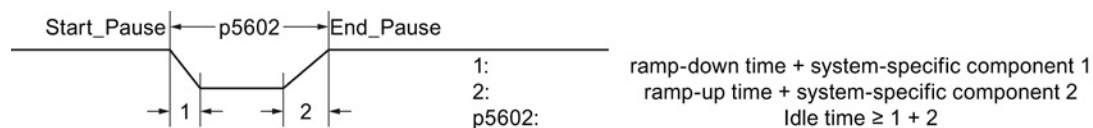
Table 7- 8     Dependency on the settings of p5611.0 ... p5611.2

Bit 0	Bit 1	Bit 2	
0	0	0	Energy-saving mode enabled. <ul style="list-style-type: none"> <li>• Display in r5613</li> <li>• no additional "automatic" responses.</li> <li>• Set the responses to PROFlenergy commands on the inverter side.</li> </ul>
1	0/1	0/1	Energy-saving mode not enabled. No response to PROFlenergy commands from the control
0	1	0	Energy-saving mode enabled with the following responses: <ul style="list-style-type: none"> <li>• Display in r5613</li> <li>• OFF1 is set if the "Start_Pause" command is received from the control.               <ul style="list-style-type: none"> <li>– The command is immediately effective in the inverter states "switching on inhibited" (S1) or "ready to start" (S2).</li> <li>– 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.</li> </ul> </li> <li>• The inverter cannot be switched on as long as the "Start_Pause" command is present.</li> </ul> The OFF1 command is withdrawn with "End_Pause".
0	1	1	Energy-saving mode enabled with the following responses: <ul style="list-style-type: none"> <li>• Display in r5613</li> <li>• 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).</li> <li>• 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.</li> </ul>

## 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 PROFlenergy 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 PROFlenergy 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 136)

### 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 RJ45 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 145) 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/Inq/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 51).

#### 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/Inq/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 81).

### 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 (Page 133) 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 136). 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  $\neq 0$ , 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 171)

### 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 <sup>1)</sup>	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 CtrlL			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	Ctrl 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 134))

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 CU (Page 51). This connector has short-circuit proof, isolated pins.

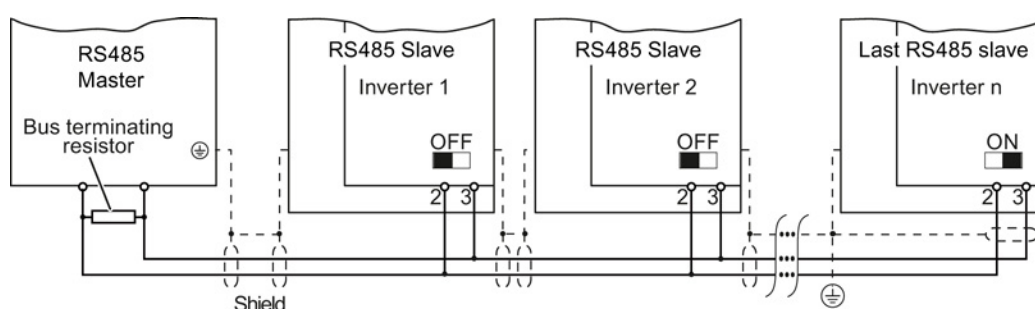


Figure 7-8 Communication network via RS485

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 CU (Page 51).

#### 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 146).

### 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 CU (Page 51).

Bit 6 (64)	<input type="checkbox"/>
Bit 5 (32)	<input type="checkbox"/>
Bit 4 (16)	<input type="checkbox"/>
Bit 3 (8)	<input type="checkbox"/>
Bit 2 (4)	<input type="checkbox"/>
Bit 1 (2)	<input type="checkbox"/>
Bit 0 (1)	<input type="checkbox"/>
On	Off

Example:	<input type="checkbox"/>
	<input type="checkbox"/>
	<input type="checkbox"/>
8	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>
	<input type="checkbox"/>
= 10	<input checked="" type="checkbox"/>
	On Off

#### 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	<b>Macro drive device</b> Select the I/O configuration			
p2020	<b>Setting the baud rate</b>			
	Value	Baud rate	Value	Baud rate
	4	2400	9	57600
	5	4800	10	76800
	6	9600	11	93750
	7	19200	12	115200
8	38400	13	187500	
p2022	<b>Fieldbus interface USS PZD number</b> Sets the number of 16-bit words in the PZD part of the USS telegram Setting range: 0... 8 (0 ... 8 words)			
p2023	<b>Fieldbus interface USS PIV number</b> Sets the number of 16-bit words in the PIV part of the USS telegram Setting range: <ul style="list-style-type: none"><li>0, 3, 4: 0, 3 or 4 words</li><li>127: variable length</li></ul>			
p2040	<b>Fieldbus interface monitoring time [ms]</b> 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			

## 7.6.2.2 Telegram structure

## Overview

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

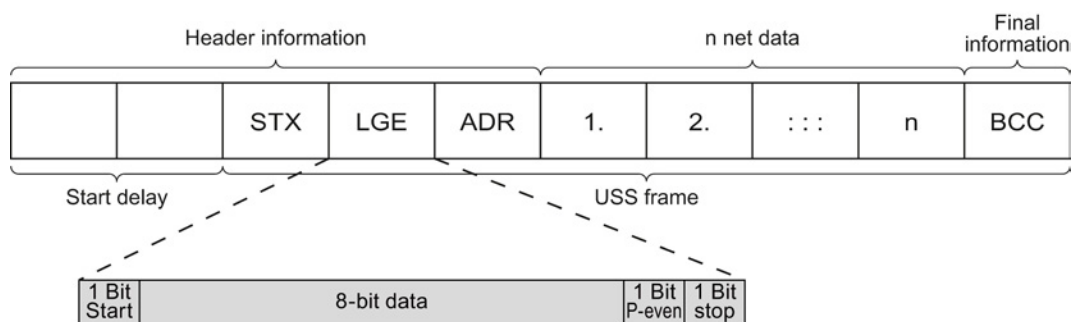


Figure 7-9 Structure of a USS telegram

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 156))																
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	<table><tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr><tr><td>Special telegram</td><td>Mirror telegram</td><td>Broadcast bit</td><td></td><td></td><td>Address</td><td></td><td></td></tr></table> <ul style="list-style-type: none"><li>• Bit 7 = 0: Normal data exchange. Bit 7 =1, to transfer telegrams that require a net data structure different from the device profile.</li><li>• Bit 6 = 0: Normal data exchange. Bit 6 = 1: Testing the bus connection: The converter returns the telegram unchanged to the master.</li><li>• Bit 5 = 0: Normal data exchange. (Bit 5 = 1: Not supported in the converter.)</li><li>• Bits 0 ... 4: Address of the converter.</li></ul>	7	6	5	4	3	2	1	0	Special telegram	Mirror telegram	Broadcast bit			Address		
7	6	5	4	3	2	1	0										
Special telegram	Mirror telegram	Broadcast bit			Address												
Net data	See section User data range of the USS telegram (Page 149).																
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.

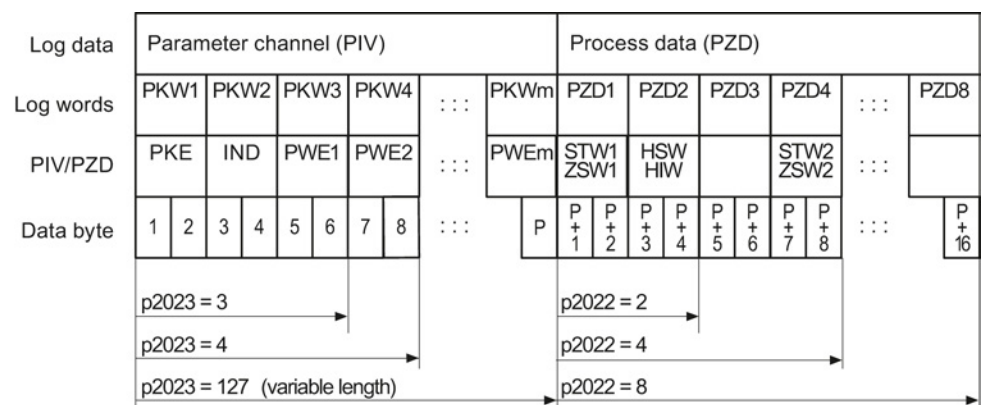


Figure 7-10 USS telegram - user data structure

## 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 entered 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

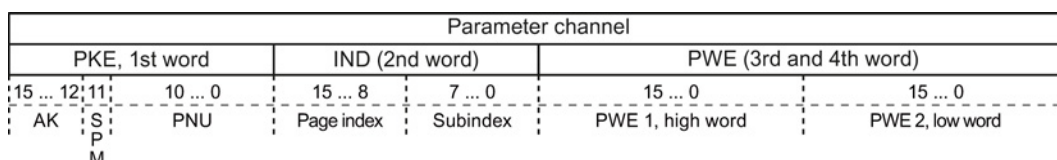
#### Structure of the parameter channel

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.



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 <sup>1)</sup>	3	7 / 8
6 <sup>2)</sup>	Request parameter value (field) <sup>1)</sup>	4 / 5	7 / 8
7 <sup>2)</sup>	Change parameter value (field, word) <sup>1)</sup>	4	7 / 8
8 <sup>2)</sup>	Change parameter value (field, double word) <sup>1)</sup>	5	7 / 8
9	Request number of field elements	6	7 / 8

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

<sup>2)</sup> 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 <sup>1)</sup>
4	Transfer parameter value (field, word) <sup>2)</sup>
5	Transfer parameter value (field, double word) <sup>2)</sup>
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

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

<sup>2)</sup> 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	<b>Illegal parameter number</b> (access to a parameter that does not exist)
01 hex	<b>Parameter value cannot be changed</b> (change request for a parameter value that cannot be changed)
02 hex	<b>Lower or upper value limit exceeded</b> (change request with a value outside the value limits)
03 hex	<b>Incorrect subindex</b> (access to a subindex that does not exist.)
04 hex	<b>No array</b> (access with a subindex to non-indexed parameters)
05 hex	<b>Incorrect data type</b> (change request with a value that does not match the data type of the parameter)
06 hex	<b>Setting not permitted, only resetting</b> (change request with a value not equal to 0 without permission)
07 hex	<b>Descriptive element cannot be changed</b> (change request to a descriptive element error value that cannot be changed)
0B hex	<b>No master control</b> (change request but with no master control, see also p0927.)
0C hex	<b>Keyword missing</b>
11 hex	<b>Request cannot be executed due to the operating state</b> (access is not possible for temporary reasons that are not specified)
14 hex	<b>Inadmissible value</b> (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	<b>Parameter number is currently deactivated</b> (depending on the mode of the inverter)
66 hex	<b>Channel width is insufficient</b> (communication channel is too small for response)
68 hex	<b>Illegal parameter value</b> (parameter can only assume certain values)
6A hex	<b>Request not included / task is not supported</b> (the valid request identifications can be found in table "Request identifications controller → inverter")
6B hex	<b>No change access for a controller that is enabled.</b> (operating status of the inverter prevents a parameter change)
86 hex	<b>Write access only for commissioning (p0010 = 15)</b> (operating status of the inverter prevents a parameter change)
87 hex	<b>Know-how protection active, access locked</b>
C8 hex	<b>Change request below the currently valid limit</b> (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	<b>Change request above the currently valid limit</b> (example: a parameter value is too large for the inverter power)
CC hex	<b>Change request not permitted</b> (change is not permitted as the access code is not available)

Parameter numbers < 2000	<p>PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).</p>
Parameter numbers ≥ 2000	<p>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).</p>

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 inverter (Page 372).

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, length of the parameter channel = 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  $\triangleq$  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	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	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  $\triangleq$  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	1	0	0	0	0	0	1	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.

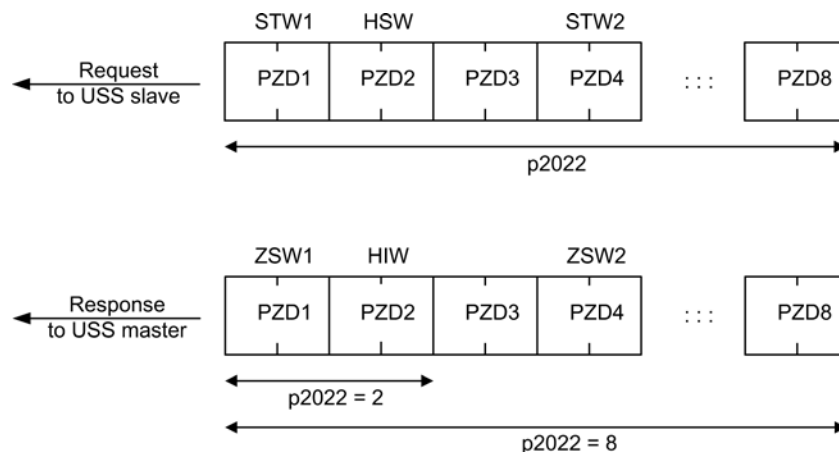


Figure 7-14 Process data channel

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 $\mu$ s	1.146 ms
19200	52.084 $\mu$ s	0.573 ms
38400	26.042 $\mu$ s	0.286 ms
115200	5.340 $\mu$ s	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.

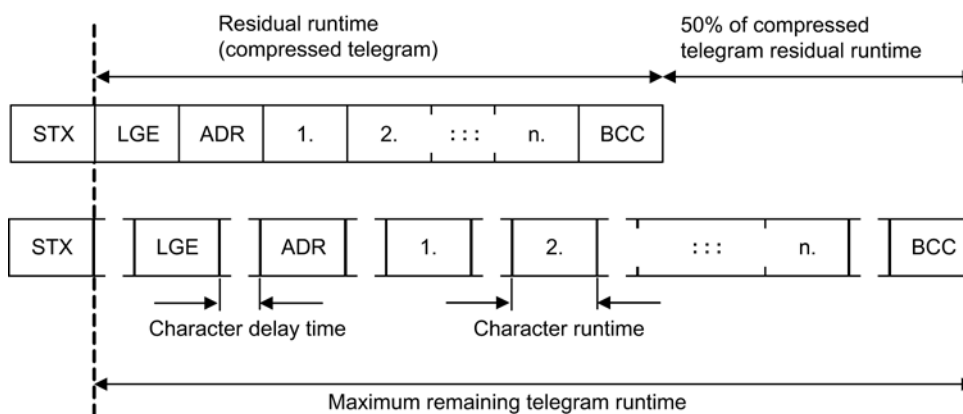


Figure 7-15 Telegram runtime as the sum of the residual runtime and character delay times

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  $> 2 \times$  character runtime.

The slave only responds after the response delay has expired.

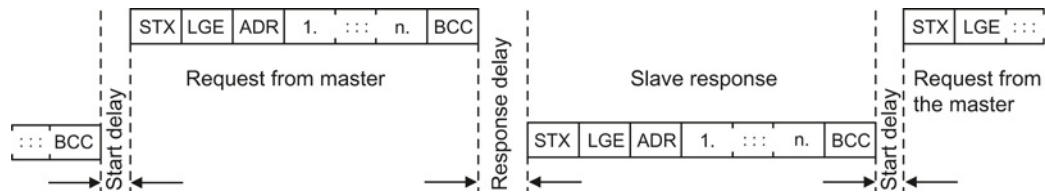


Figure 7-16 Start delay and response delay

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

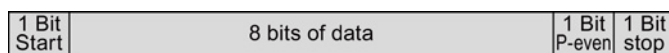
#### Overview of communication using Modbus

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.



#### 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 213)" 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 CU (Page 51).

Bit 6 (64)	<input type="checkbox"/>
Bit 5 (32)	<input type="checkbox"/>
Bit 4 (16)	<input type="checkbox"/>
Bit 3 (8)	<input type="checkbox"/>
Bit 2 (4)	<input type="checkbox"/>
Bit 1 (2)	<input type="checkbox"/>
Bit 0 (1)	<input type="checkbox"/>
On	Off

Example:

	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>
8	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>
= 10	<input checked="" type="checkbox"/>
On	Off

#### Procedure



To change the bus address, proceed as follows:

- 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
- 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.



This means that you have changed the bus address.

## Additional settings

Parameter	Description
p0015 = 21	<b>Macro drive unit</b> Selecting the I/O configuration
p2030 = 2	<b>Fieldbus protocol selection</b> 2: Modbus
p2020	<b>Fieldbus baud rate</b> Factory setting = 19200 bit/s
p2024	<b>Modbus timing</b> (see Section "Baud rates and mapping tables (Page 161)") <ul style="list-style-type: none"> <li>• <b>Index 0: Maximum slave telegram processing time:</b> The time after which the slave must have sent a response to the master.</li> <li>• <b>Index 1: Character delay time:</b> Character delay time: Maximum permissible delay time between the individual characters in the Modbus frame (Modbus standard processing time for 1.5 bytes).</li> <li>• <b>Index2: Inter-telegram delay:</b> Maximum permissible delay time between Modbus telegrams (Modbus standard processing time for 3.5 bytes).</li> </ul>
p2029	<b>Fieldbus fault statistics</b> Displays receive faults on the fieldbus interface
p2040	<b>Process data monitoring time</b> Determines the time after which an alarm is generated if no process data is transferred <b>Note:</b> 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.

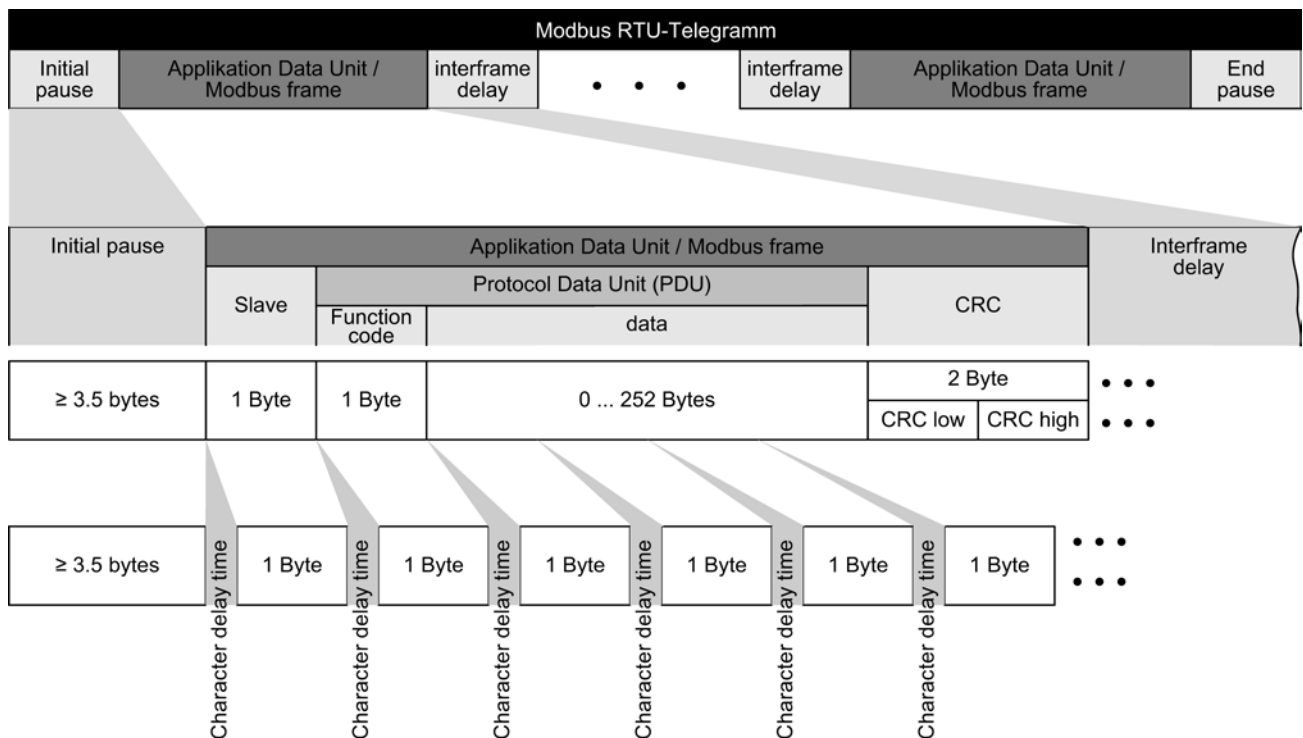


Figure 7-17 Modbus with delay times

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 accesses	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

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.

---

## 8

## Setting functions

## 8.1 Overview of the inverter functions

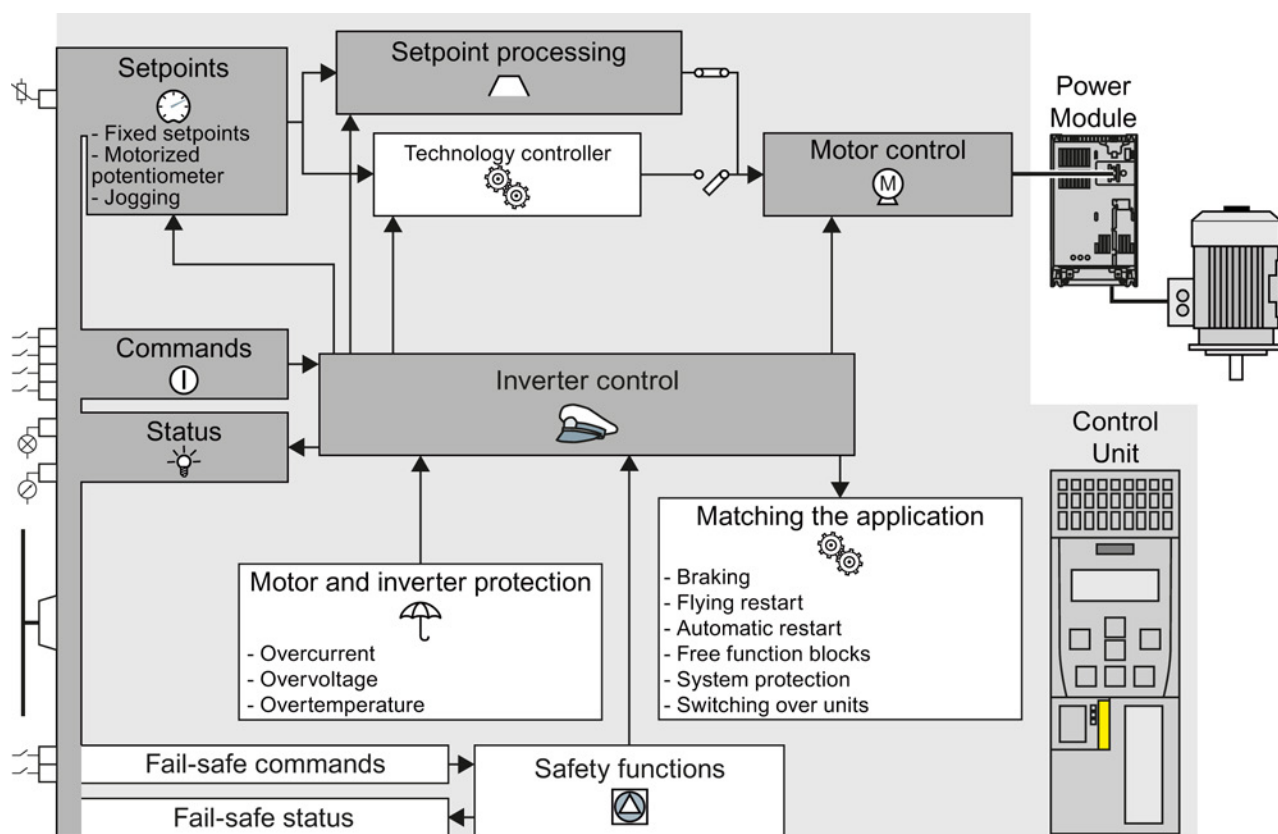





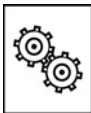





Figure 8-1 Overview of inverter functions

Functions relevant to all applications		Functions required in special applications only	
<p>The functions that you require in each application are shown in a dark color in the function overview above.</p> <p>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.</p>		<p>The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.</p>	
	<p><b>Inverter control</b> is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to commands from the higher-level control system.</p> <p>Inverter control (Page 171)</p>		<p>The <b>protection functions</b> prevent damage to the motor, inverter and driven load, e.g. using temperature monitoring or torque monitoring.</p> <p>Protection functions (Page 206)</p>
	<p>The <b>commands</b> from the higher-level control are sent to the inverter via digital inputs or the fieldbus.</p> <p>Adapt terminal strip (Page 89)</p> <p>Configuring the fieldbus (Page 103)</p>		<p>The <b>status signals</b> provide signals at the outputs of the Control Unit via the fieldbus, e.g. the actual motor speed or the inverter fault signal.</p> <p>Adapt terminal strip (Page 89)</p> <p>Configuring the fieldbus (Page 103)</p>
	<p>You must define a <b>setpoint</b>, which defines the motor speed, for example.</p> <p>Setpoints (Page 182)</p>		<p>Functions <b>suitable for the application</b> permit, for example, a motor holding brake to be controlled, a higher-level closed-loop pressure or temperature control to be implemented using the technology controller.</p> <p>Application-specific functions (Page 213)</p>
	<p>The <b>setpoint processing</b> uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value.</p> <p>Setpoint calculation (Page 188)</p>		<p>The <b>safety functions</b> fulfill increased requirements regarding the functional safety of the drive.</p> <p>Safe Torque Off (STO) safety function (Page 253)</p>
	<p>The <b>motor closed-loop control</b> ensures that the motor follows the speed setpoint. You can select either closed-loop speed control or U/f control.</p> <p>Motor control (Page 196)</p>		

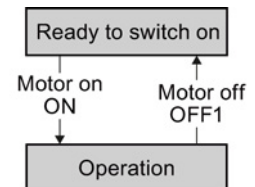
## 8.2 Inverter control

### 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.

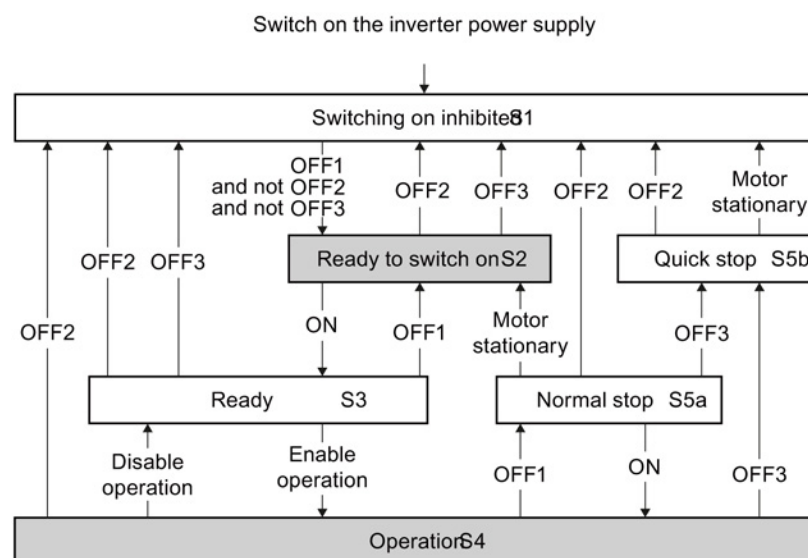


Figure 8-2 State overview of the inverter

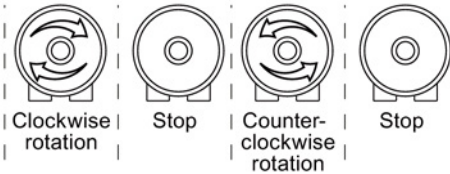
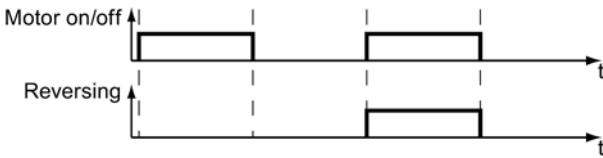
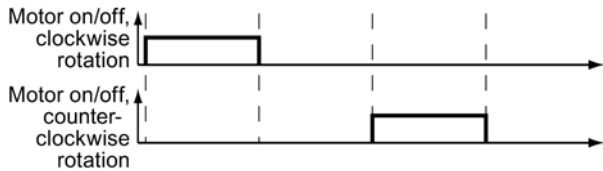
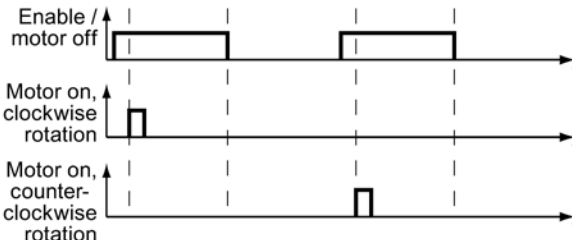
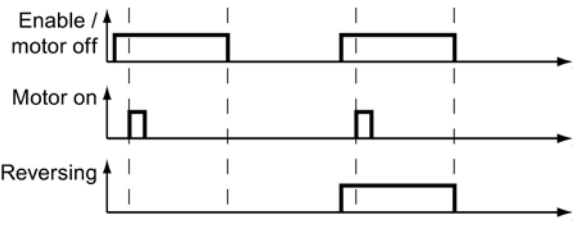
Table 8- 1 Explanation of the inverter states

State	Explanation
Switching on inhibited (S1)	<p>In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions:</p> <ul style="list-style-type: none"> <li>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.</li> <li>OFF2 or OFF3 is selected.</li> </ul>
Ready to switch on (S2)	This state is required to switch on the motor.
Ready (S3)	<p>The inverter waits for the operating enable.</p> <p>If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit.</p> <p>If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.</p>
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.

## 8.2.2 Inverter control using digital inputs

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
 <p>Clockwise rotation   Stop   Counter-clockwise rotation   Stop</p>			
		<b>Two-wire control, method 1</b> <ol style="list-style-type: none"> <li>1. Switching the motor on and off (ON/OFF1).</li> <li>2. Reverse the motor direction of rotation.</li> </ol>	Local control in conveyor systems.
		<b>Two-wire control, method 2 and two-wire control, method 3</b> <ol style="list-style-type: none"> <li>1. Switch the motor on and off (ON/OFF1), clockwise rotation.</li> <li>2. Switch the motor on and off (ON/OFF1), counter-clockwise rotation.</li> </ol>	Traction drives with control via joystick
		<b>Three-wire control, method 1</b> <ol style="list-style-type: none"> <li>1. Enable signal for switching the motor on and off (OFF1).</li> <li>2. Switch on the motor (ON), clockwise rotation.</li> <li>3. Switch on the motor (ON), counter-clockwise rotation.</li> </ol>	Traction drives with control via joystick
		<b>Three-wire control, method 2</b> <ol style="list-style-type: none"> <li>1. Enable signal for switching the motor on and off (OFF1).</li> <li>2. Switch on motor (ON).</li> <li>3. Reverse the motor direction of rotation.</li> </ol>	-

### 8.2.3 Two-wire control: method 1

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

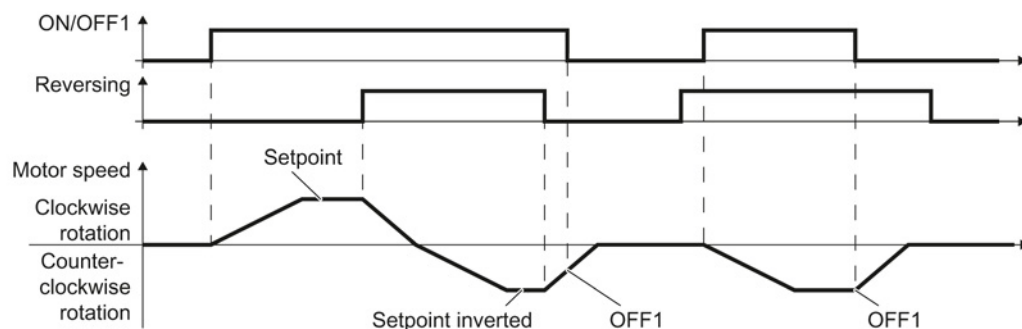


Figure 8-3 Two-wire control, method 1

Table 8-3 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.

Parameter	Description		
p0015 = 12	<b>Macro drive unit</b> (factory setting for inverters without PROFIBUS interface)		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1	Reversing
<b>Advanced setting</b>			
Interconnecting control commands with digital inputs of your choice (DI x).			
p0840[0 ... n] = 722.x	<b>BI: ON/OFF1</b> (ON/OFF1)		
p1113[0 ... n] = 722.x	<b>BI: Setpoint inversion</b> (reversing)		
<b>Example</b>			
p0840 = 722.3	DI 3: ON/OFF1 Also see section Digital inputs (Page 90).		

## 8.2.4 Two-wire control, method 2

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

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

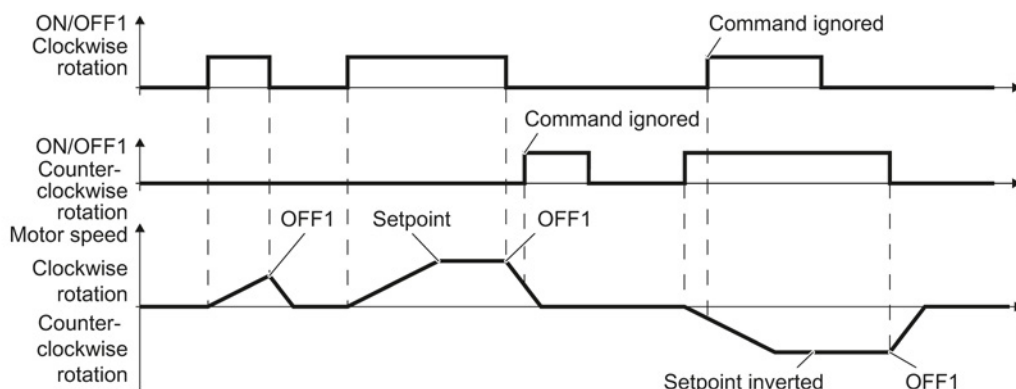


Figure 8-4 Two-wire control, method 2

Table 8- 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	<b>Macro drive unit</b>		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation
<b>Advanced setting</b>			
Interconnecting control commands with digital inputs of your choice (DI x).			
p3330[0 ... n] = 722.x	<b>BI: 2-3-WIRE control command 1</b> (ON/OFF1 clockwise rotation)		
p3331[0 ... n] = 722.x	<b>BI: 2-3-WIRE control command 2</b> (ON/OFF1 counter-clockwise rotation)		
<b>Example</b>			
p3331 = 722.0	DI 0: ON/OFF1 counter-clockwise rotation Also see section Digital inputs (Page 90).		

### 8.2.5 Two-wire control, method 3

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

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

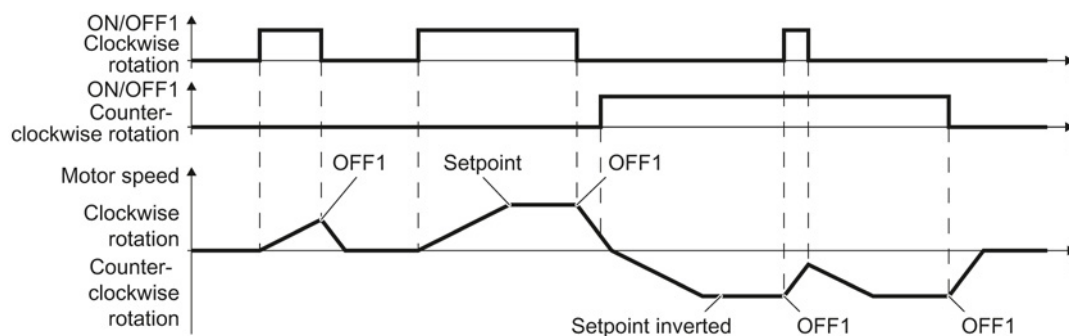


Figure 8-5 Two-wire control, method 3

Table 8- 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.

Parameter	Description		
p0015 = 18	<b>Macro drive unit</b>		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation
<b>Advanced setting</b>			
Interconnecting control commands with digital inputs of your choice (DI x).			
p3330[0 ... n] = 722.x	<b>BI: 2-3-WIRE control command 1</b> (ON/OFF1 clockwise rotation)		
p3331[0 ... n] = 722.x	<b>BI: 2-3-WIRE control command 2</b> (ON/OFF1 counter-clockwise rotation)		
<b>Example</b>			
p3331[0 ... n] = 722.2	DI 2: ON/OFF1 counter-clockwise rotation Also see section Digital inputs (Page 90).		

## 8.2.6 Three-wire control, method 1

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

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

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

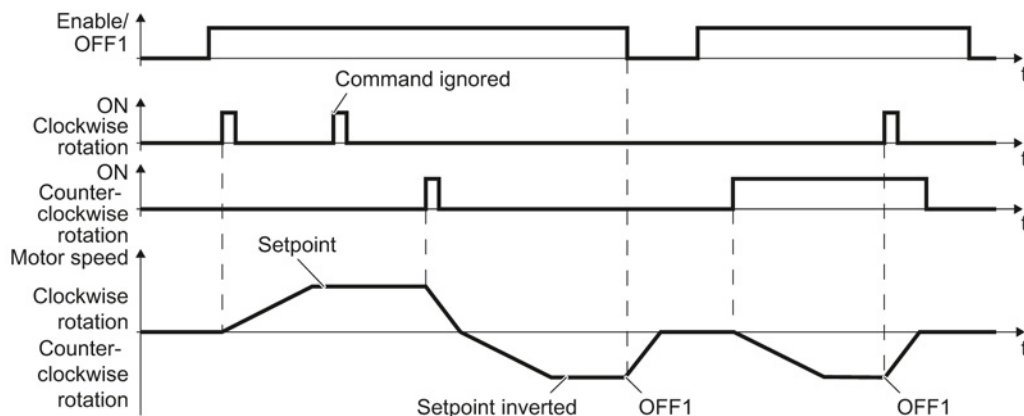


Figure 8-6 Three-wire control, method 1

Table 8- 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.

Parameter	Description			
p0015 = 19	Macro drive unit			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable / OFF1	ON clockwise rotation	ON clockwise rotation
Advanced setting				
Interconnecting control commands with digital inputs of your choice (DI x).				
p3330[0 ... n] = 722.x	BI: 2-3-WIRE control command 1 (enable/ OFF1)			
p3331[0 ... n] = 722.x	BI: 2-3-WIRE control command 2 (ON clockwise rotation)			
p3332[0 ... n] = 722.x	BI: 2-3-WIRE control command 3 (ON counter-clockwise rotation)			
Example				
p3332 = 722.0	DI 0: ON counter-clockwise rotation. Also see section Digital inputs (Page 90).			

### 8.2.7 Three-wire control, method 2

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

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

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

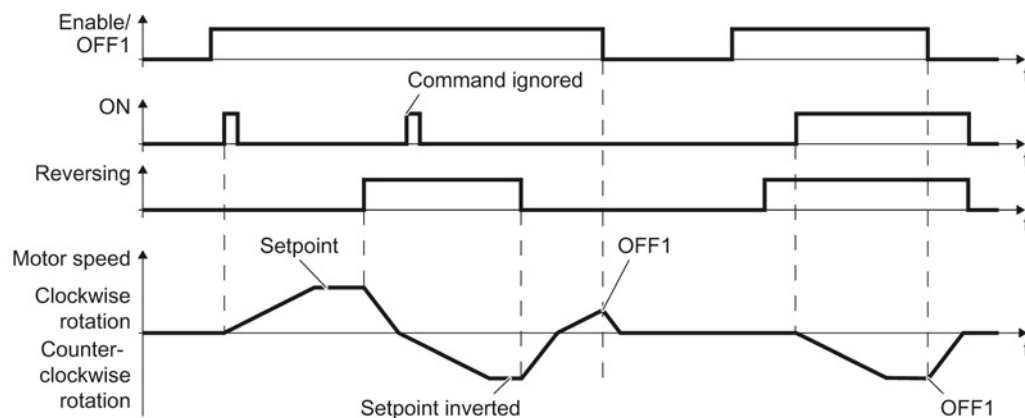


Figure 8-7 Three-wire control, method 2

Table 8-7 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.

Parameter	Description			
p0015 = 20	Macro drive unit			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable / OFF1	ON	Reversing
<b>Advanced setting</b>				
Interconnecting control commands with digital inputs of your choice (DI x).				
p3330[0 ... n] = 722.x	BI: 2-3-WIRE control command 1 (enable/ OFF1)			
p3331[0 ... n] = 722.x	BI: 2-3-WIRE control command 2 (ON)			
p3332[0 ... n] = 722.x	BI: 2-3-WIRE Control Command 3 (reversing)			
<b>Example</b>				
p3331 = 722.0	DI 0: ON Also see section Digital inputs (Page 90).			

## 8.2.8 Running the motor in jog mode (JOG function)

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

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

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

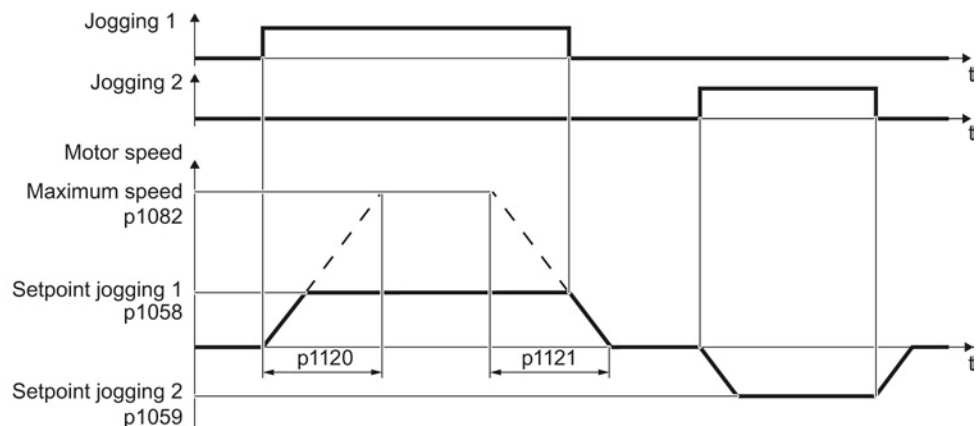
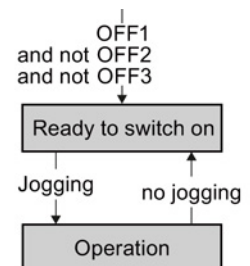


Figure 8-8 Behavior of the motor when "jogging"

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



### Setting jogging

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

### 8.2.9 Switching over the inverter control (command data set)

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

#### Example: Switchover from automatic to manual operation

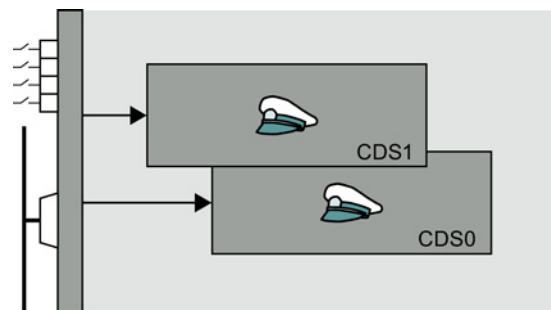
You control the motor either from a central control system, via fieldbus or from a local control panel.

#### 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.

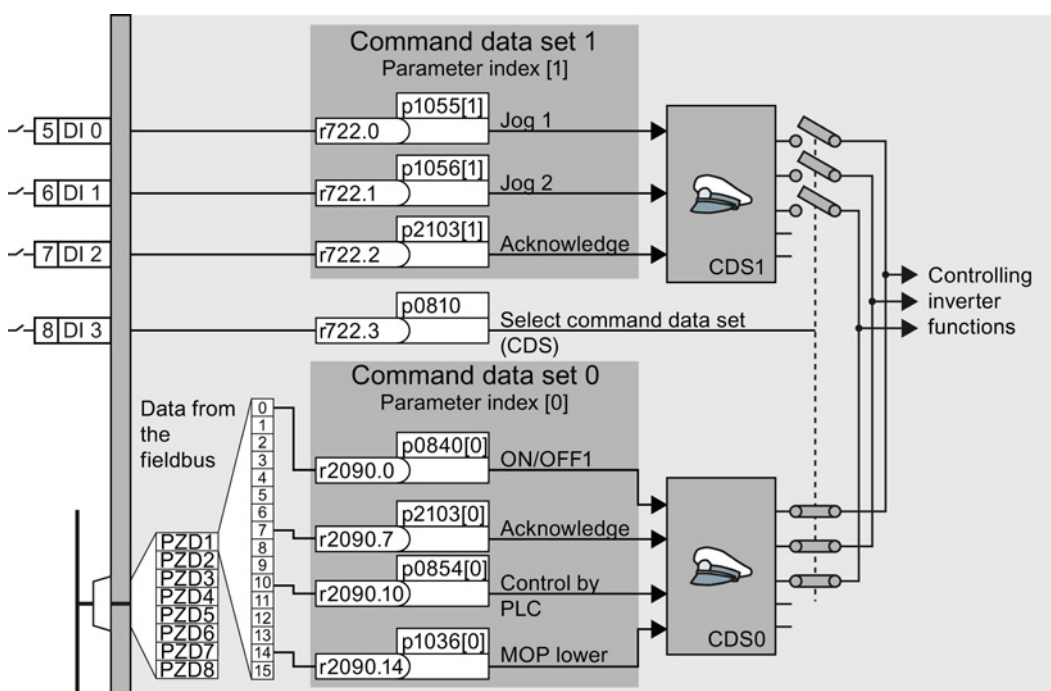


Figure 8-10 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

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 55).

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

#### Note

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

## Advanced settings

If you require more than two command data sets, then define the number of command data sets (2, 3 or 4) using parameter p0170.

Table 8- 8 Defining the number of command data sets

Parameter	Description
p0010 = 15	<b>Drive commissioning: Data sets</b>
p0170	<b>Number of command data sets</b> (factory setting 2) p0170 = 2, 3 or 4
p0010 = 0	<b>Drive commissioning: Ready</b>
r0050	<b>Displaying the number of the CDS that is currently active</b>

You require two bits to be able to make a clear selection for more than two command data sets.

Table 8- 9 Selecting a command data set

Parameter	Description
p0810	<b>Command data set selection CDS bit 0</b>
p0811	<b>Command data set selection CDS bit 1</b>
r0050	<b>Displaying the number of the CDS that is currently active</b>

A copy function is available making it easier to commission more than one command data set.

Table 8- 10 Parameters for copying the command data sets

Parameter	Description
p0809[0]	<b>Number of the command data set to be copied (source)</b>
p0809[1]	<b>Number of the command data set to which the data is to be copied (target)</b>
p0809[2] = 1	<b>Copying is started</b> Once copying has been completed, the converter sets p0809[2] to 0.

## 8.3 Setpoints

### 8.3.1 Overview



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

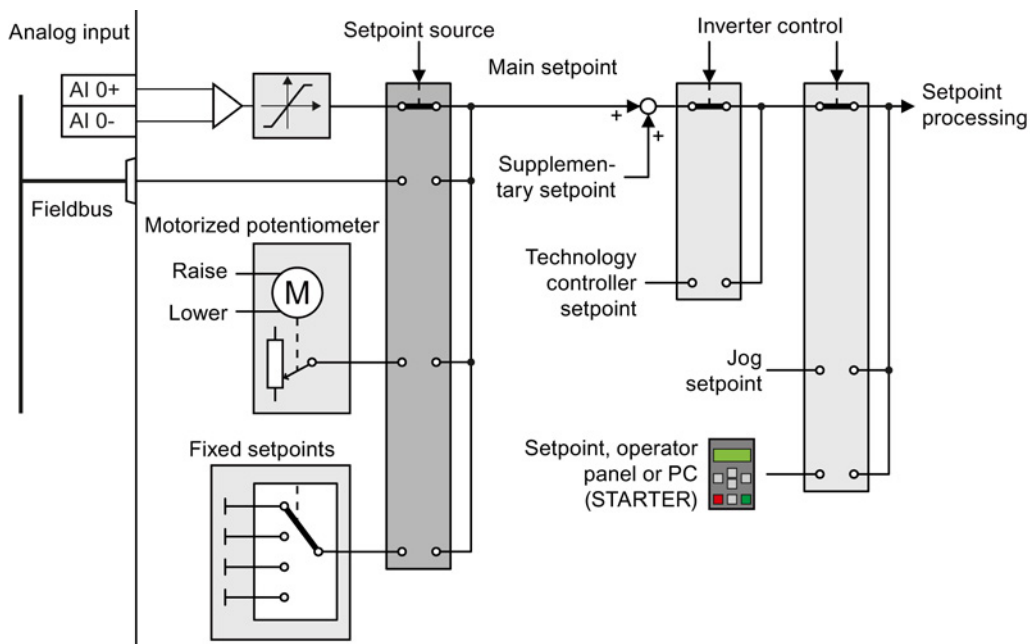


Figure 8-11 Setpoint sources for the converter

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, its 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 55).

However, you can change this setting. On the following pages, you will find a more detailed description of the setpoint sources.

## 8.3.2 Analog input as setpoint source

### Interconnecting an analog input

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

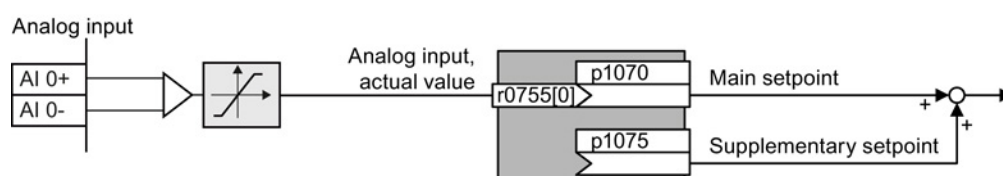


Figure 8-12 Example: Analog input 0 as setpoint source

Table 8- 11 Setting with analog input 0 as setpoint source

Parameter	Remark
p1070 = 755[0]	<b>Main setpoint</b> Interconnect the main setpoint with analog input 0
p1075 = 755[0]	<b>Additional setpoint</b> Interconnect the additional setpoint with analog input 0

You must adapt the analog input to the connected signal, e.g.  $\pm 10$  V or 4 ... 20 mA. You will find additional information in the section: Analog inputs (Page 94).

## 8.3.3 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 103).

### Interconnecting the fieldbus with the main setpoint

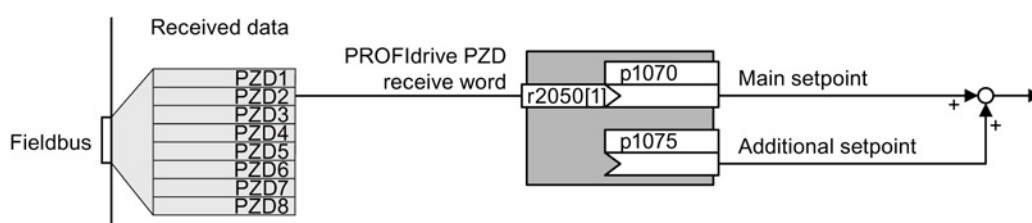


Figure 8-13 Fieldbus as setpoint source

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

Table 8- 12 Setting the fieldbus as setpoint source

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

### 8.3.4 Motorized potentiometer as setpoint source

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

#### Interconnecting the motorized potentiometer (MOP) with the setpoint source

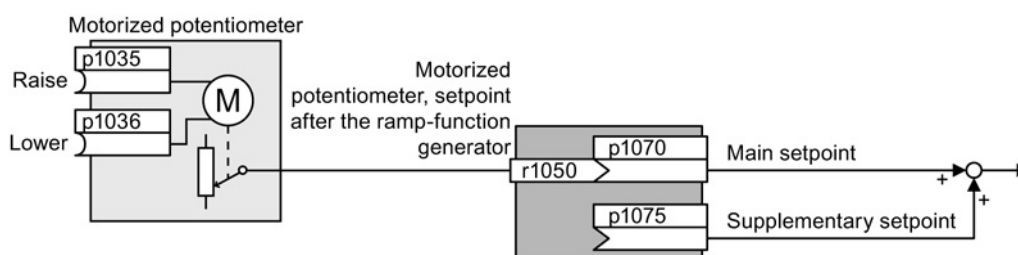


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 13 Basic setup of motorized potentiometer

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

Table 8- 14 Setting the MOP as setpoint source

Parameter	Remark
p1070 = 1050	<b>Main setpoint</b> Interconnecting the main setpoint with MOP.
p1035	<b>Motorized potentiometer, increase setpoint</b> (factory setting 0) Interconnect this signal, for example with a digital input of your choice: p1035 = 722.1 (digital input 1)
p1036	<b>Motorized potentiometer, decrease setpoint</b> (factory setting 0) Interconnect this signal, for example with a digital input of your choice.

## Adapting the behavior of the motorized potentiometer

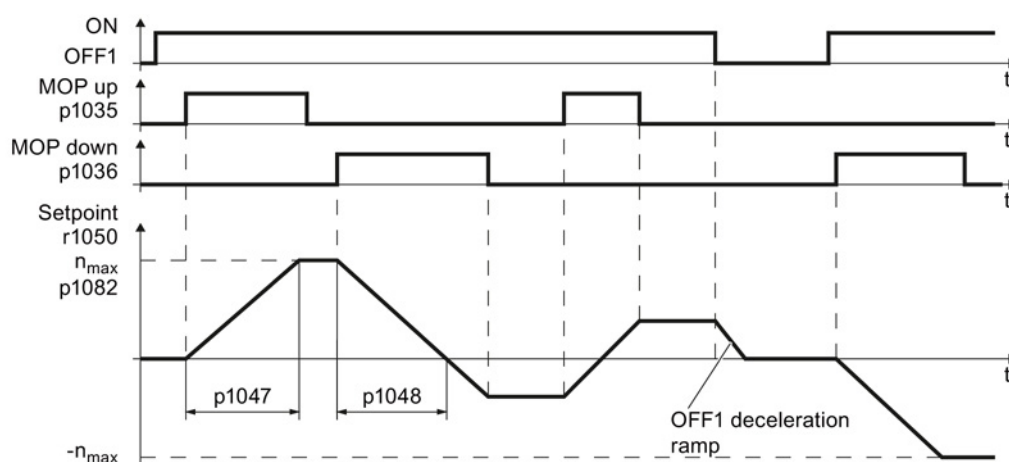


Figure 8-15 Function chart of motorized potentiometer

Table 8- 15 Extended setup of motorized potentiometer

Parameter	Description
p1030	<b>MOP configuration</b> (factory setting 00110 bin) <b>Parameter value with four independently adjustable bits 00 ... 03</b> <b>Bit 00:</b> 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 <b>Bit 01:</b> 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 <b>Bit 02:</b> 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 <b>Bit 03:</b> 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) <b>Bit 04:</b> Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: The setpoint is calculated independent of the pulse enable.
p1037	<b>MOP maximum speed</b> (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1038	<b>MOP minimum speed</b> (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1044	<b>MOP setting value</b> (factory setting 0) Signal source for the setting value.

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

### 8.3.5 Fixed speed as setpoint source

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

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

#### Interconnecting the fixed speeds with a main setpoint

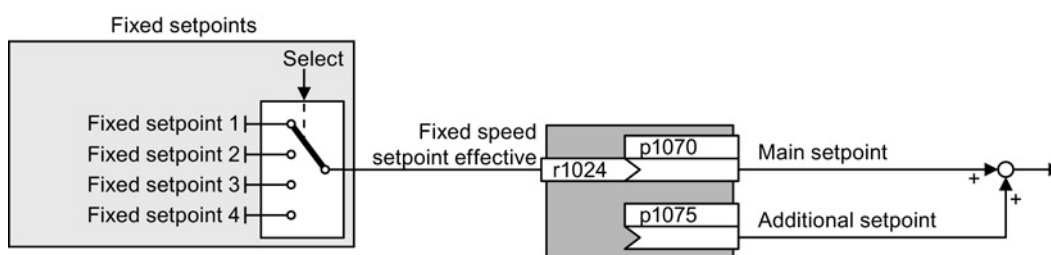


Figure 8-16 Fixed speeds as setpoint source

Table 8- 16 Setting the fixed speed as a setpoint source

Parameter	Remark
p1070 = 1024	<b>Main setpoint</b> Interconnecting the main setpoint with fixed speeds.
p1075 = 1024	<b>Additional setpoint</b> 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.

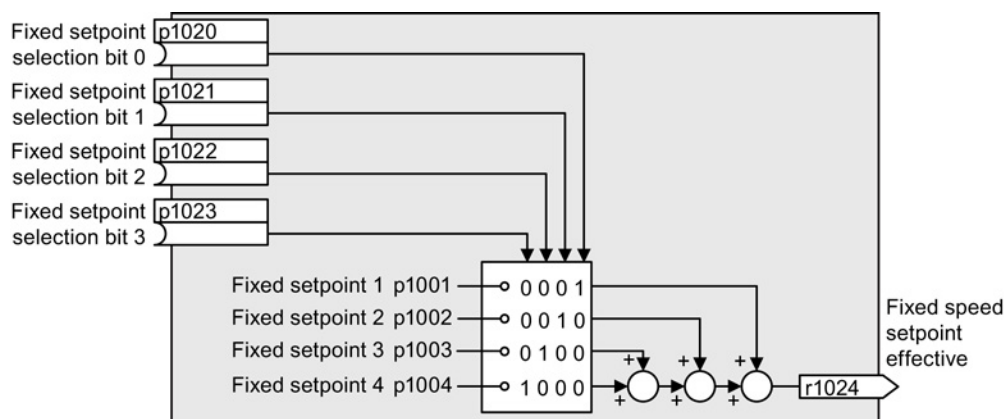


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

### 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- 17 Settings for the example

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

Table 8- 18 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 calculation

### 8.4.1 Overview of setpoint processing



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

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- 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.

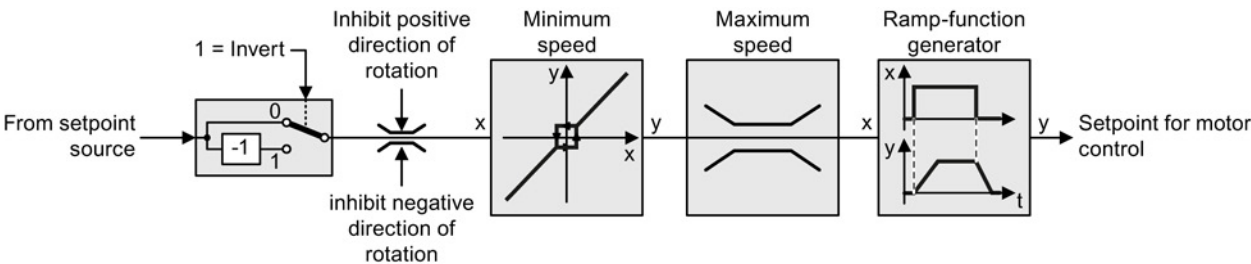


Figure 8-18 Setpoint processing in the inverter

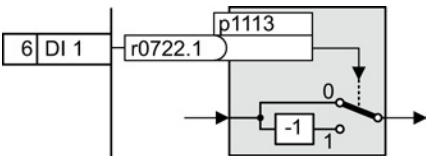
### 8.4.2 Invert setpoint



#### 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- 19 Examples of settings to invert the setpoint

Parameter	Remark
p1113 = 722.1	<b>Setpoint inversion</b> 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.

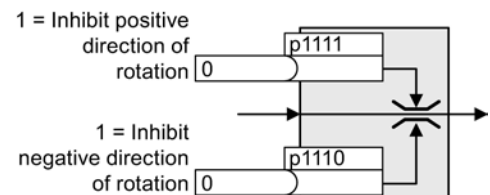
### 8.4.3 Inhibit direction of rotation

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- 20 Examples of settings to inhibit the direction of rotation

Parameter	Remark
p1110 = 1	<b>Inhibit negative direction</b> Negative direction is permanently inhibited.
p1110 = 722.3	<b>Inhibit negative direction</b> 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.

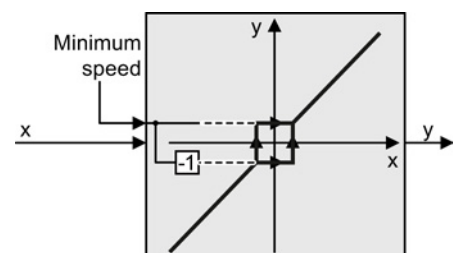


Table 8- 21 Setting the minimum speed

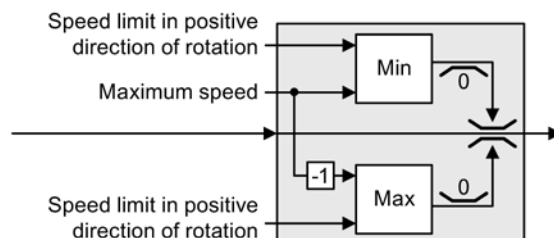
Parameter	Description
p1080	Minimum speed

### 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- 22 Parameters for minimum and maximum speed

Parameter	Description
p1082	<b>Maximum speed</b> (factory setting 1500 rpm)
p1083	<b>Speed limit, positive direction of rotation</b> (factory setting 210,000 rpm)
p1086	<b>Speed limit, negative direction of rotation</b> (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.

You can select between two different ramp-function generator types:

- Extended ramp-function generator

The extended ramp-function generator limits acceleration and jerk.

- Basic ramp-function generator

The basic ramp-function generator limits the acceleration, however not the rate the acceleration changes (jerk).

#### Extended ramp-function generator

The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimum times that you select depend on your particular application in question and can range from just a few 100 ms (e.g. for belt conveyor drives) to several minutes (e.g. for centrifuges).

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

The ramp-up and ramp-down times of the motor are increased by the rounding times:

- Effective ramp-up time =  $p1120 + 0.5 \times (p1130 + p1131)$ .
- Effective ramp-down time =  $p1121 + 0.5 \times (p1130 + p1131)$ .

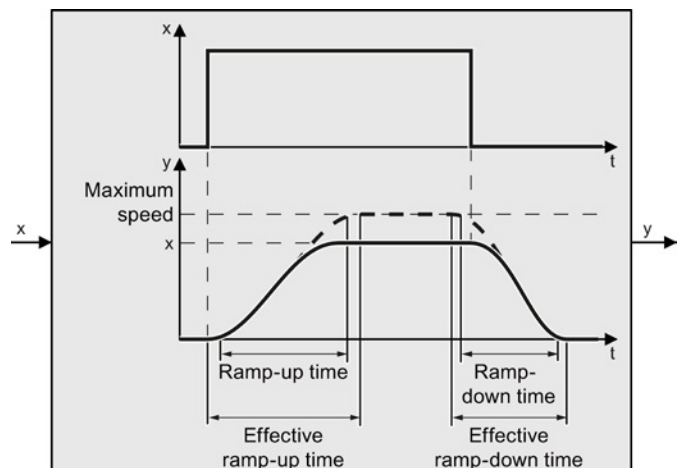
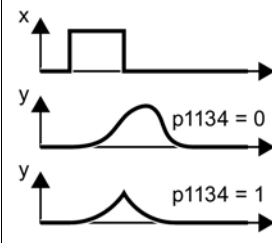


Table 8- 23 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	<b>Ramp-function generator selection</b> (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	<b>Ramp-function generator, ramp-up time</b> (factory setting 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	<b>Ramp-function generator, ramp-down time</b> (factory setting 10 s) braking time in seconds from the maximum speed down to standstill
p1130	<b>Ramp-function generator initial rounding time</b> (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1131	<b>Ramp-function generator final rounding time</b> (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1134	<b>Ramp-function rounding type</b> (factory setting: 0) 0: Continuous smoothing 1: Discontinuous smoothing
p1135	<b>OFF3 ramp-down time</b> (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.
p1136	<b>OFF3 initial rounding time</b> (factory setting: 0 s) Initial rounding for OFF3 for the extended ramp-function generator.
p1137	<b>OFF3 final rounding time</b> (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.

## Basic ramp-function generator

When compared to the extended ramp-function generator, the basic ramp-function generator has no rounding times.

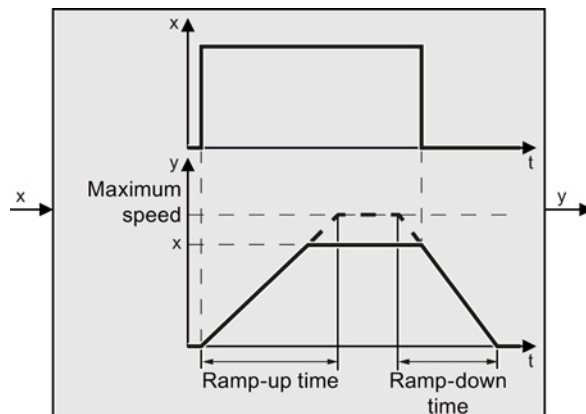


Table 8- 24 Parameters for setting the ramp-function generator

Parameter	Description
p1115 = 0	<b>Ramp-function generator selection</b> (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	<b>Ramp-function generator, ramp-up time</b> (factory setting 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	<b>Ramp-function generator, ramp-down time</b> (factory setting 10 s) braking time in seconds from the maximum speed down to standstill
p1135	<b>OFF3 ramp-down time</b> (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.

## 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

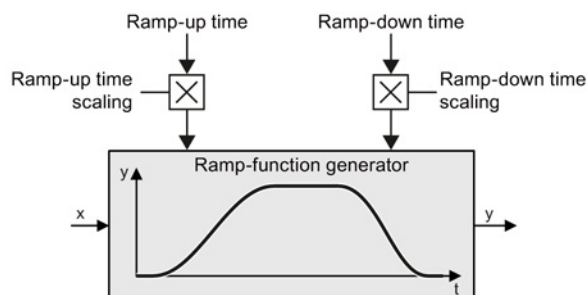


Table 8- 25 Parameters for setting the scaling

Parameter	Description
p1138	<b>Up ramp scaling</b> (factory setting: 1) Signal source for scaling the up ramp.
p1139	<b>Down ramp scaling</b> (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.

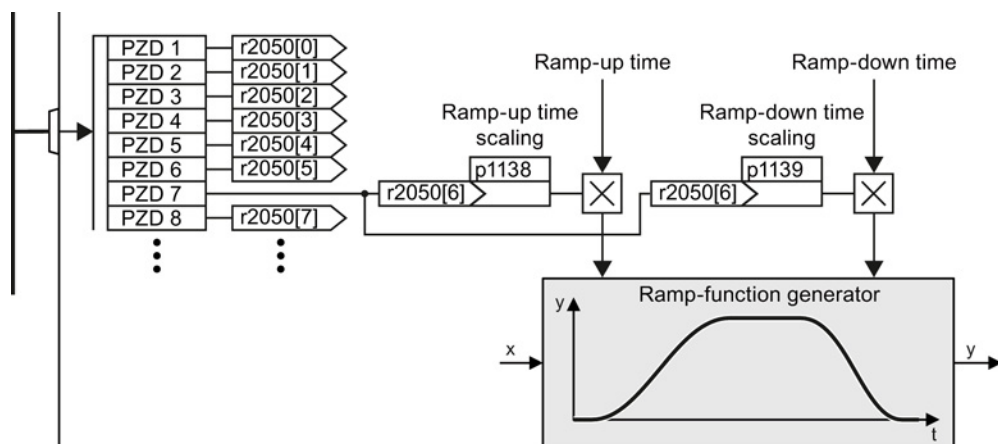


Figure 8-19 Example for changing the ramp-function generator times in operation

### 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 118).
- 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 V/f control or vector control (speed/torque)? (Page 73)

### 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 ( $f = n * \text{number of pole pairs} / 60$ , in particular:  $f_{\max} = p1082 * \text{number of pole pairs} / 60$ ).

The inverter provides the two most important characteristics (linear and square-law). User-defined characteristic curves are also supported.

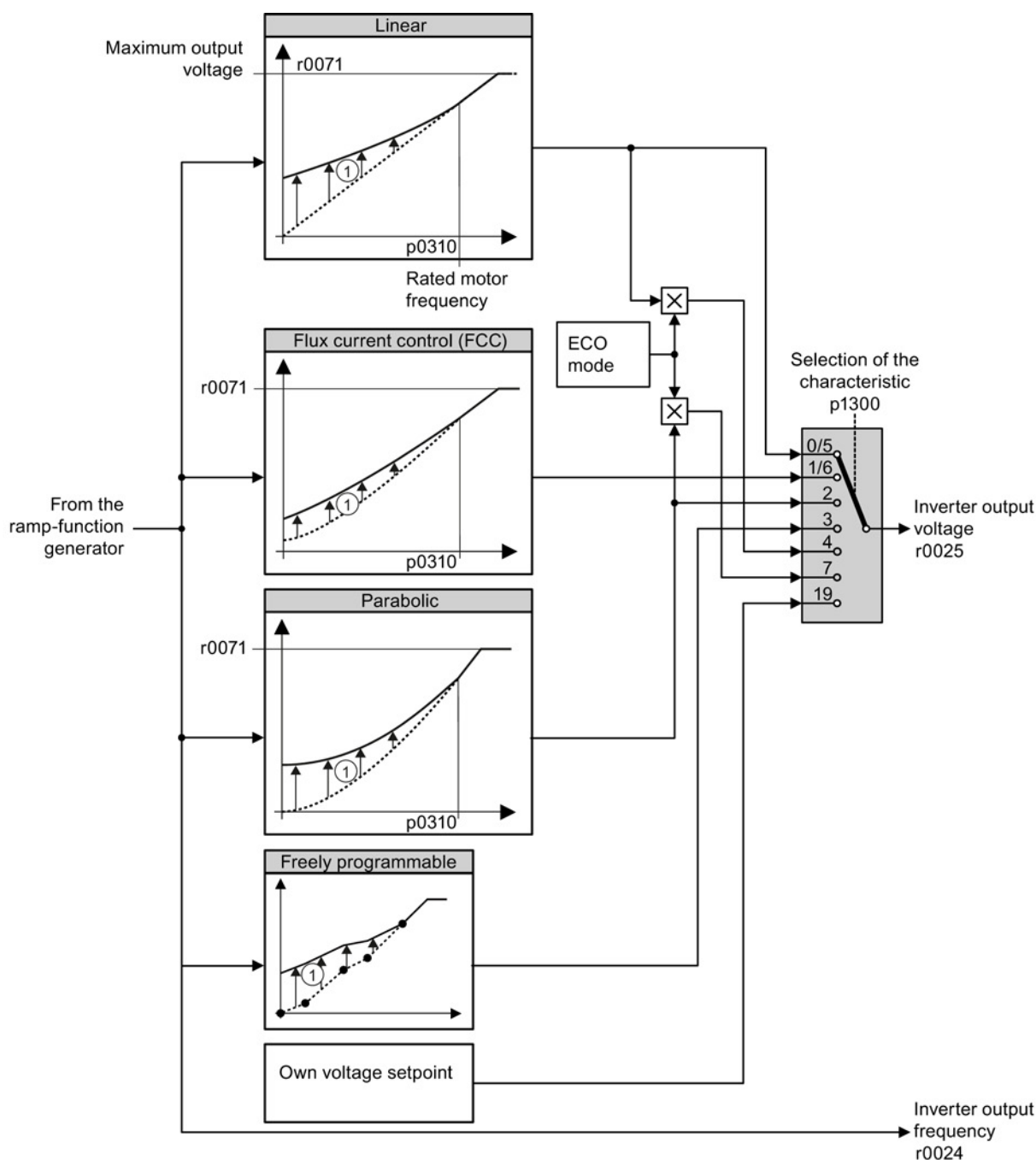
U/f control is not a high-precision method of controlling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

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 331).

### 8.5.1.2 Selecting the U/f characteristic



#### Procedure

Proceed as follows to select a U/f characteristic:

	
<ol style="list-style-type: none"> <li>1. Go into the menu "PARAMS".</li> <li>2. As parameter filter, select "EXPERT".</li> <li>3. Set p1300 to the appropriate value.</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online.</li> <li>2. Select the U/f characteristic curve in one of the screen forms "speed controller" or "U/f control".</li> </ol>



You have selected a U/f characteristic.

Table 8- 26 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- 27 Characteristics for special applications

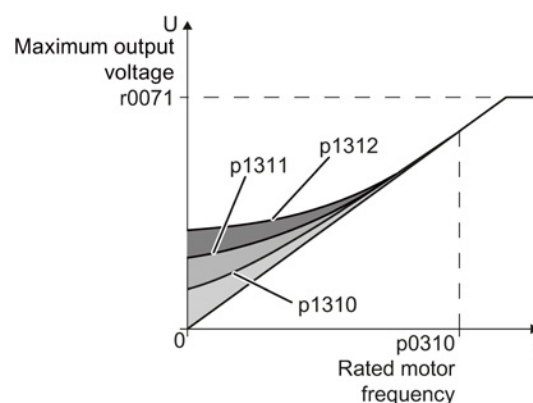
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic.  If the speed setpoint is reached and 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	<b>Permanent voltage boost</b> (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	<b>Voltage boost when accelerating</b> (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	<b>Voltage boost when starting</b> (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 Closed-loop speed 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".

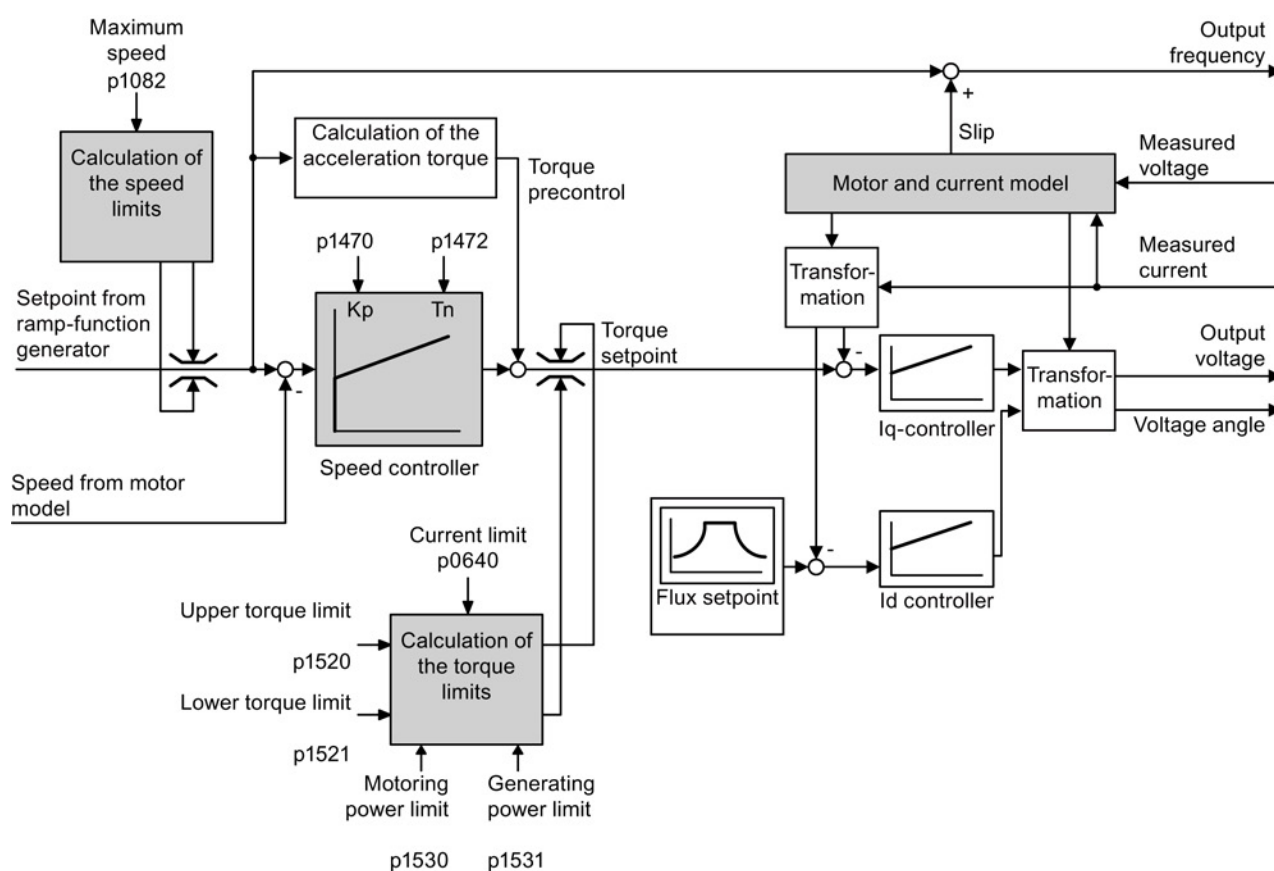


Figure 8-21 Simplified function diagram of sensorless vector control

### 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:

	
<ol style="list-style-type: none"> <li>1. In the "Parameters" menu, go to p1300</li> <li>2. Set p1300 = 20.</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online</li> <li>2. Select speed control without encoder in the "Speed controller" or "U/f control" mask.</li> </ol>



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

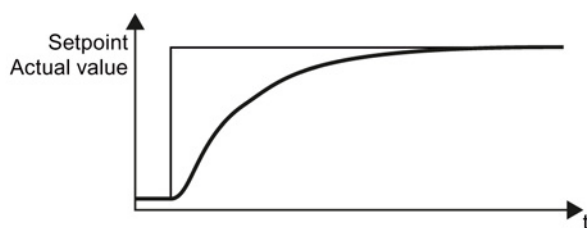


To manually optimize the speed controller, proceed as follows:

	
<ol style="list-style-type: none"> <li>1. Set the ramp-up and ramp-down times of the ramp-function generator <math>p1120 = 0</math> and <math>p1121 = 0</math>.</li> <li>2. Set the pre-control of the speed controller <math>p1496 = 0</math>.</li> <li>3. Enter a setpoint step and observe the associated actual value.</li> <li>4. Optimize the speed controller by changing controller parameters <math>K_P</math> and <math>T_N</math> until the drive runs optimally (see the diagrams below). <ul style="list-style-type: none"> <li>– <math>K_P = p1470</math></li> <li>– <math>T_N = p1472</math></li> </ul> </li> <li>5. Set the ramp-up and ramp-down times of the ramp-function generator <math>p1120</math> and <math>p1121</math> back to their original value.</li> <li>6. Set the pre-control of the speed controller <math>p1496 = 100\%</math>.</li> </ol>	<ol style="list-style-type: none"> <li>1. Go online, and in the "Ramp-function generator" screen form, set the times = 0 .</li> <li>2. Go online, and in the "Speed controller" screen form, set the pre-control = 0 .</li> <li>3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.</li> <li>4. Go online and optimize the controller in the "Speed controller" screen form by changing the controller parameters <math>K_P</math> and <math>T_N</math> until the drive runs optimally (refer to the diagrams below).</li> <li>5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.</li> <li>6. Set the pre-control of the speed controller back to 100%.</li> </ol>

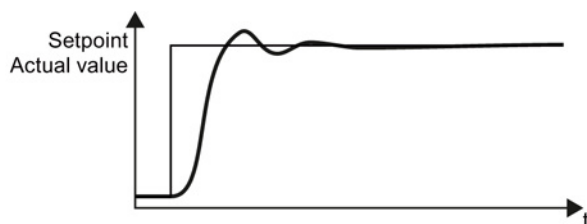


You have optimized the speed controller.



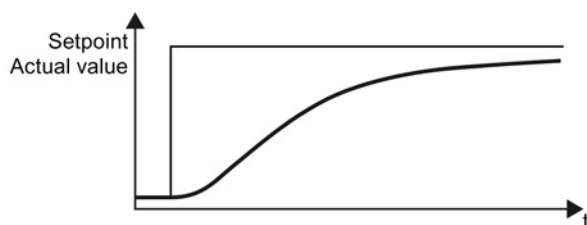
**Optimum control response for applications that do not permit any overshoot.**

The actual value approaches the setpoint, without any significant overshoot.



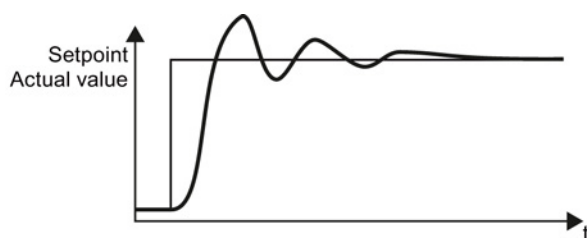
**Optimum control response for fast correction and quick compensation of noise components.**

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  $T_N$ .

### 8.5.2.4 Torque control

Torque control is part of the vector control and normally receives its setpoint from the speed controller output. By deactivating the speed controller and directly entering the torque setpoint, the closed-loop speed control becomes closed-loop torque control. The inverter then no longer controls the motor speed, but the torque that the motor generates.

#### Typical applications for torque control

The torque control is used in applications where the motor speed is specified by the connected driven load. Examples of such applications include:

- Load distribution between master and slave drives:  
The master drive is speed controlled, the slave drive is torque controlled.
- Winding machines

#### Commissioning the torque control

The torque control only functions error-free if, during the basic commissioning, you correctly set the motor data and performed the motor data identification with the motor in the cold state.

You can find the basic commissioning in the following sections:

- Basic commissioning with the BOP-2 operator panel (Page 76)
- Basic commissioning with STARTER (Page 81)

Table 8- 28 The most important torque control parameters

Parameter	Description
p1300 = ...	<b>Control mode:</b> 20: Vector control without speed encoder 22: Torque control without speed encoder
p0300 ... p0360	<b>Motor data</b> is transferred from the rating plate during basic commissioning and calculated with the motor data identification
p1511 = ...	<b>Additional torque</b>
p1520 = ...	<b>Upper torque limit</b>
p1521 = ...	<b>Lower torque limit</b>
p1530 = ...	<b>Motoring power limit</b>
p1531 = ...	<b>Regenerative power limit</b>

Additional information about this function is provided in the parameter list and in function diagrams 6030 onwards in the List Manual.

## 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<sup>2</sup>t monitoring** (alarm A07805, fault F30005)  
The I<sup>2</sup>t 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	<b>Power unit overload response</b> (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	<b>Power unit temperature warning threshold</b> (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.

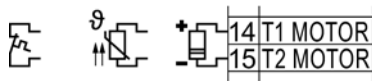


Figure 8-22 Connecting the motor temperature sensor at the inverter

### 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  $\geq 100 \Omega$  as being an opened temperature switch and responds according to the setting for p0610.

## PTC sensor

The inverter interprets a resistance  $> 1650 \Omega$  as being an overtemperature and responds according to the setting for p0610.

The inverter interprets a resistance  $< 20 \Omega$  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  $-48^{\circ}\text{C}$  ...  $+248^{\circ}\text{C}$ .  
Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):  
- motor temperature  $> \text{p0604}$  and  $\text{p0610} = 0$
  - Overtemperature fault (F07011):  
The inverter switches off with fault in the following cases:  
- motor temperature  $> \text{p0605}$   
- motor temperature  $> \text{p0604}$  and  $\text{p0610} \neq 0$
- Sensor monitoring (A07015 or F07016):
  - Wire-break:  
The inverter interprets a resistance  $> 2120 \Omega$  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  $< 50 \Omega$  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	<b>Specify the motor cooling</b> 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	<b>Motor-temperature sensor type</b> 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	<b>Motor temperature alarm threshold</b> (factory setting 130° C)
p0605	<b>Motor temperature fault threshold</b> (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	<b>Motor-overtemperature response</b> 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	<b>Current limit</b> (input in A)

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

### 8.6.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode ( $p1300 \geq 20$ ) and functions by calculating a thermal motor model.

Table 8- 29 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description
p0621= 1	<b>Motor-temperature acquisition after restart</b> 0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on
p0622	<b>Magnetization time of the motor for temperature measurement after starting</b> ( <i>set automatically as the result of motor data identification</i> )
p0625 = 20	<b>Ambient motor temperature</b> Enter the ambient motor temperature in °C at the instant that the motor data is acquired (factory setting: 20° C). The difference between the motor temperature and motor environment (p0625) must lie within a tolerance range of approx. $\pm 5^\circ \text{C}$ .

### 8.6.4 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- 30 I-max controller parameters

Parameter	Description
p0305	<b>Rated motor current</b>
p0640	<b>Motor current limit</b>
p1340	<b>Proportional gain of the I-max controller for speed reduction</b>
p1341	<b>Integral time of the I-max controller for speed reduction</b>
r0056.13	<b>Status: I-max controller active</b>
r1343	<b>Speed output of the I-max controller</b> 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.

### 8.6.5 Limiting the maximum DC link voltage

#### How does the motor generate overvoltage?

An induction motor operates as a generator if it is driven by the connected load. A generator converts mechanical power into electrical power. The electrical power flows back into the inverter and causes  $V_{DC}$  in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before harmful voltages occur, the inverter switches off the connected motor with the fault

"DC-link overvoltage".

#### Protecting the motor and inverter against overvoltage

To the extent the application permits, the  $V_{dc\_max}$  control prevents the DC-link voltage from reaching critical levels. The  $V_{dc\_max}$  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  $V_{dc\_max}$  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 220).

There are two different groups of parameters for the  $V_{dc\_max}$  control, depending on whether the motor is being operated with U/f control or vector control.

Table 8- 31 Parameters of the Vdc\_max control

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	<b>Vdc_max control Vdc monitoring configuration</b> (factory setting: 1)1: Enable Vdc_max control
r1282	r1242	<b>Vdc_max control activation level</b> Shows the value of the DC link voltage above which the Vdc_max control is active
p1283	p1243	<b>Vdc_max control dynamic factor</b> (factory setting: 100 %) scaling of the control parameters p1290, p1291 and p1292
p1290	p1250	<b>Vdc_max control proportional gain</b> (factory setting: 1)
p1291	p1251	<b>Vdc_max control integral time</b> (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1292	p1252	<b>Vdc_max control rate time</b> (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
p1294	p1254	<b>Vdc_max control automatic sensing ON level</b> (factory setting p1294: 0, factory setting p1254: 1) Activates or deactivates automatic detection of the switch-on levels of the Vdc_max control. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	<b>Unit supply voltage</b> If p1254 or p1294 = 0, the converter uses this parameter to calculate the switch-in thresholds of the Vdc_max control. Set this parameter to the actual value of the input voltage.

For more information about this function, see the List Manual (function diagrams 6320 and 6220).

## 8.7 Application-specific functions



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

- Switching over units
- Braking functions
- Automatic restart and flying restart
- Basic process control functions
- Logical and arithmetic functions using function blocks that can be freely interconnected
- Energy-saving display for pumps and fans

Refer to the following sections for detailed descriptions.

### 8.7.1 Unit changeover

#### Description

With the unit changeover function, you can adapt the inverter to the line supply (50/60 Hz) and also select US units or SI units as base units.

Independent of this, you can define the units for process variables or change over to percentage values.

Specifically, you have the following options:

- Changing over the motor standard (Page 215) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 216)
- Changing over process variables for the technology controller (Page 216)

---

#### 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 217).

---

---

**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
p2005	Reference angle
p2007	Reference acceleration

### 8.7.1.1 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the changeover.

Table 8- 32 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 <sup>2</sup>	lb ft <sup>2</sup>	kgm <sup>2</sup>
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm <sup>2</sup>	lb ft <sup>2</sup>	kgm <sup>2</sup>

\*) Factory setting

### 8.7.1.2 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units
- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

---

#### Note

##### Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which changeover to % is not possible, the following applies:  
p0505 = 1  $\triangleq$  p0505 = 2 and p0505 = 3  $\triangleq$  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  $\triangleq$  p0505 = 3 and p0505 = 2  $\triangleq$  p0505 = 4.

##### Parameters affected by changeover

The parameters affected by changing over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

---

### 8.7.1.3 Changing over process variables for the technology controller

---

#### Note

We recommend that the units and reference values of the technology controller are coordinated and harmonized with one another during commissioning.

Subsequent modification in the reference variable or the unit can result in incorrect calculations or displays.

---

### Changing over process variables of the technology controller

You change over the process variables of the technology controller using p0595. For physical values, you define the reference variable in p0596.

The parameters affected by changing over units of the technology controller belong to unit group 9\_1. For details, please refer to the section titled "Unit group and unit choice" in the List Manual.

### 8.7.1.4 Switching units with STARTER

#### Precondition

The inverter must be in the offline mode in order to change over the units.

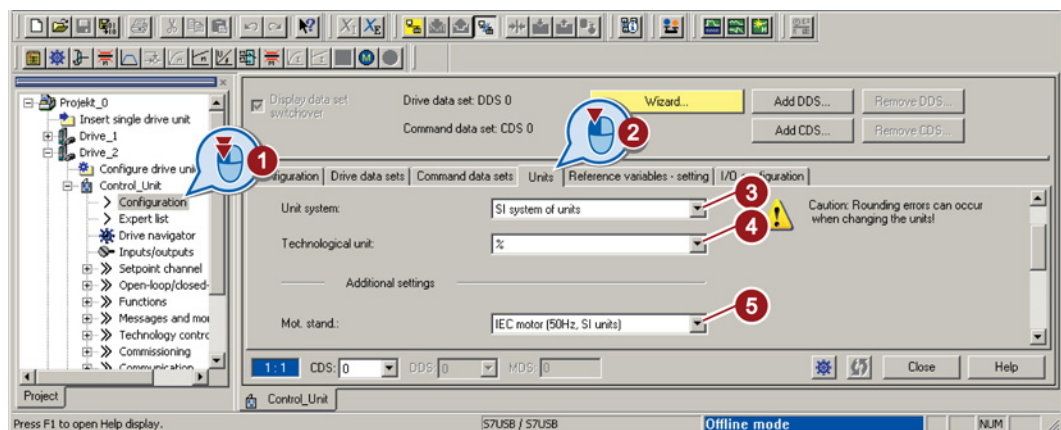
STARTER shows whether you change settings online in the inverter or change offline in the PC (**Online mode** / **Offline mode**).

You switch over the mode using the adjacent buttons in the menu bar.



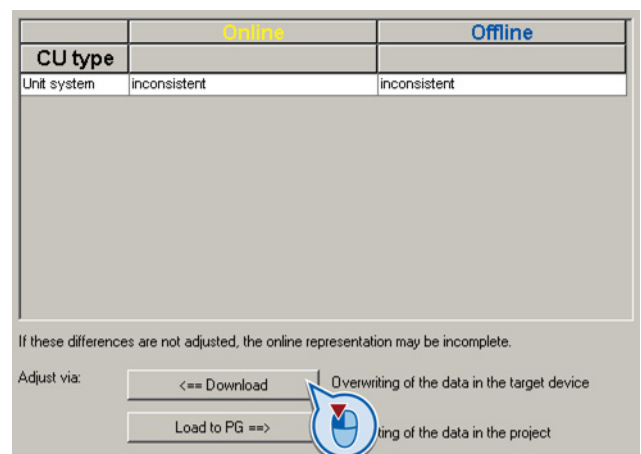
#### Procedure

1. 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 technological 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.



## 8.7.2 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 completely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

The inverter controls the flow rate or the pressure by varying the speed of the fluid flow machine. As a consequence, over its complete operating range, a fluid-flow machine operates close to its maximum efficiency – and especially in partial load operation, uses less energy than for valve and throttle-based controls.

### Function

The 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- 33 Operating characteristic set in the factory

	Point 1	Point 2	Point 3	Point 4	Point 5
<b>Power</b>	p3320 = 25 %	p3322 = 50 %	p3324 = 77 %	p3326 = 92 %	p3328 = 100 %
<b>Speed</b>	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.



### 8.7.3 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 230).
- 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.

#### 8.7.3.1 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)

Depending on the Power Module used, 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 222)  
for Power Modules **PM230**, **PM240**, **PM340**, **PM250** and **PM260**
- Compound braking (Page 225)  
for Power Modules **PM240** and **PM340**
- Dynamic braking (Page 226)  
for Power Modules **PM240** and **PM340**
- Braking with regenerative feedback to the line (Page 230)  
for Power Modules **PM250** and **PM260**

## Main features of the braking functions

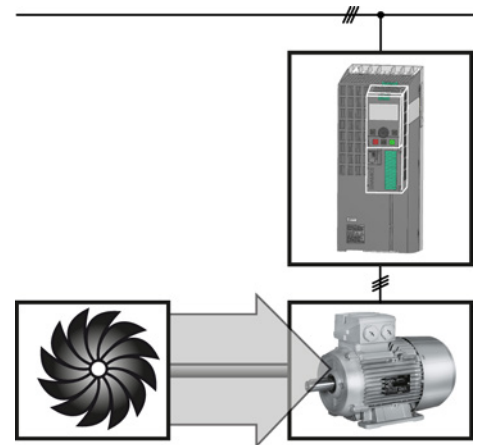
### DC braking

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

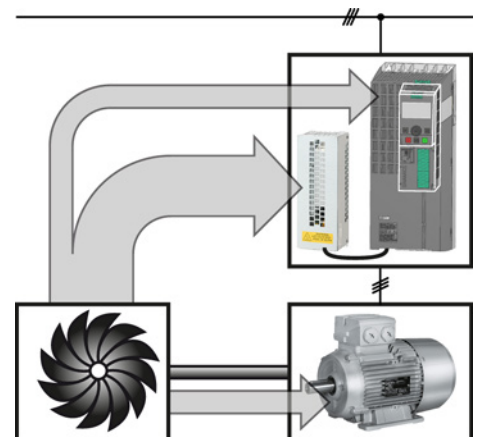
A version of DC braking in which the motor is braked defined. All other properties are identical to DC braking.



### Dynamic braking

The inverter converts the regenerative power into heat using a braking resistor.

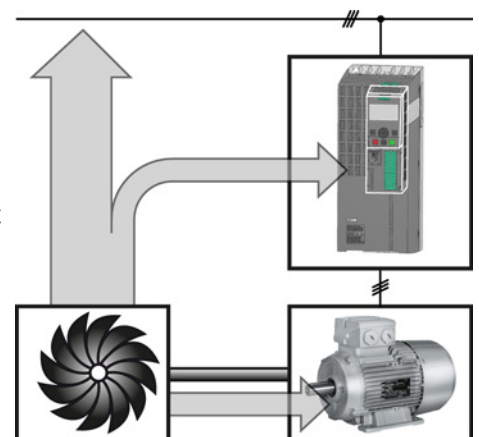
- *Advantages:* Defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* Braking resistor required; regenerative power is dissipated as heat



### Braking with regenerative feedback into the line supply

The converter feeds the regenerative power back into the line supply.

- *Advantages:* Constant braking torque; the regenerative power is not converted into heat, but is regenerated into the line supply; can be used in all applications; continuous regenerative operation is possible - e.g. when lowering a crane load
- *Disadvantage:* Does not function when power fails



Braking with regenerative feedback into the line supply

### What braking method is suitable for what application?

Application examples	Electrical braking methods	Power Modules that can be used
Pumps, fans, mixers, compressors, extruders	Not required	PM240, PM340, PM250, PM260
Grinding machines, conveyor belts	DC braking, compound braking	PM240, PM340
Centrifuges, vertical conveyors, hoisting gear, cranes, winders	Dynamic braking	PM240, PM340
	Braking with regenerative feedback into the line supply	PM250, PM260

#### 8.7.3.2 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

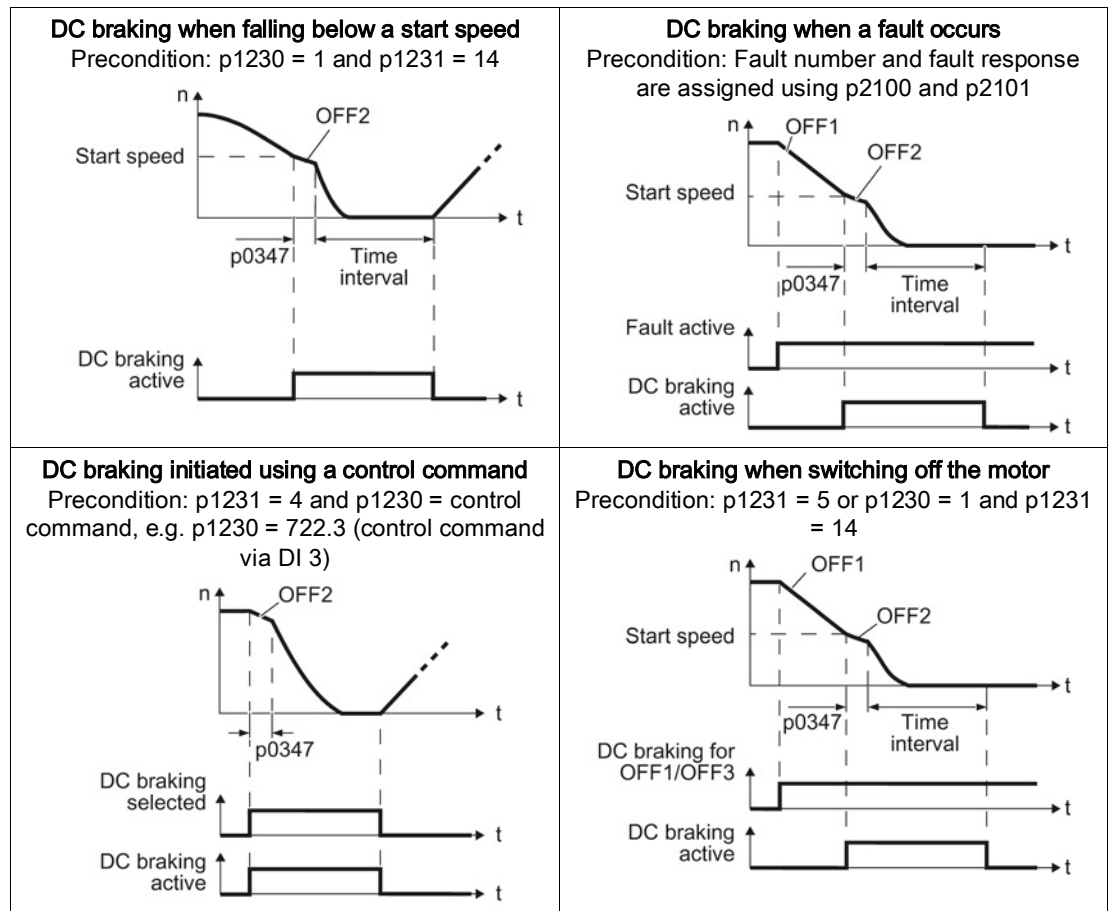
##### Motor damage caused by overheating

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 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	<b>Motor de-excitation time</b> (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	<b>DC braking activation</b> (factory setting: 0) Signal source to activate DC braking <ul style="list-style-type: none"> <li>• 0 signal: Deactivated</li> <li>• 1 signal: Active</li> </ul>										
p1231	<b>Configuring DC braking</b> (factory setting: 0) <table> <tr> <td>0</td><td>No DC braking</td></tr> <tr> <td>4</td><td>General release for DC braking</td></tr> <tr> <td>5</td><td>DC braking for OFF1/OFF3</td></tr> <tr> <td>14</td><td>DC braking below the starting speed</td></tr> </table>	0	No DC braking	4	General release for DC braking	5	DC braking for OFF1/OFF3	14	DC braking below the starting speed		
0	No DC braking										
4	General release for DC braking										
5	DC braking for OFF1/OFF3										
14	DC braking below the starting speed										
p1232	<b>DC braking braking current</b> (factory setting 0 A)										
p1233	<b>DC braking duration</b> (factory setting 1 s)										
p1234	<b>DC braking start speed</b> (factory setting 210000 rpm)										
r1239	<b>DC braking status word</b> <table> <tr> <td>.08</td><td>DC braking active</td></tr> <tr> <td>.10</td><td>DC braking ready</td></tr> <tr> <td>.11</td><td>DC braking selected</td></tr> <tr> <td>.12</td><td>DC braking selection internally locked</td></tr> <tr> <td>.13</td><td>DC braking for OFF1/OFF3</td></tr> </table>	.08	DC braking active	.10	DC braking ready	.11	DC braking selected	.12	DC braking selection internally locked	.13	DC braking for OFF1/OFF3
.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- 34 Configuring DC braking when faults occur

Parameter	Description
p2100	<b>Set fault number for fault response</b> (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	<b>Fault response setting</b> (factory setting 0) Assigning the fault response: p2101[3] = 6.
<p>The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response.</p> <p>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.</p>	

### 8.7.3.3 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

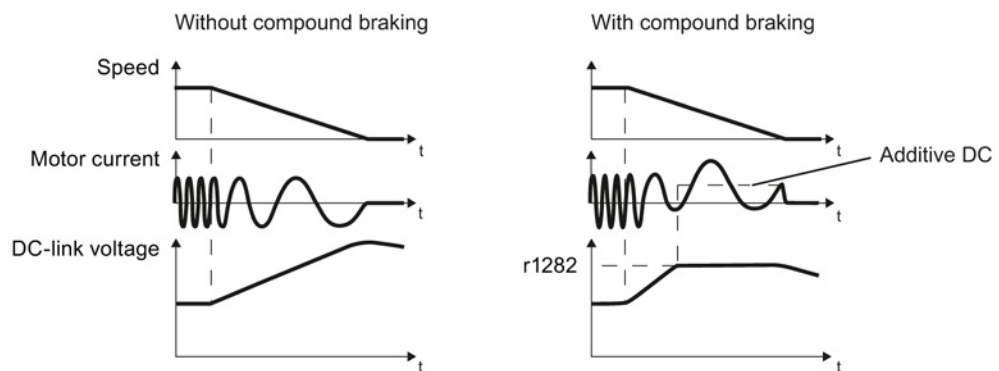


Figure 8-23 Motor brakes with and without active compound braking

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	<b>Compound braking current (%)</b> 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: $p3856 < 100\% \times (r0209 - r0331) / p0305 / 2$
r3859.0	<b>Compound-braking status word</b> r3859.0 = 1: Compound braking is active

**NOTICE****Motor damage from overheating with compound braking**

The motor will overheat if braking lasts too long or the motor is braked too often. This may damage the motor.

Monitor the motor temperature. If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

## 8.7.3.4 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  $U_{DC\ link, \ max}$ .

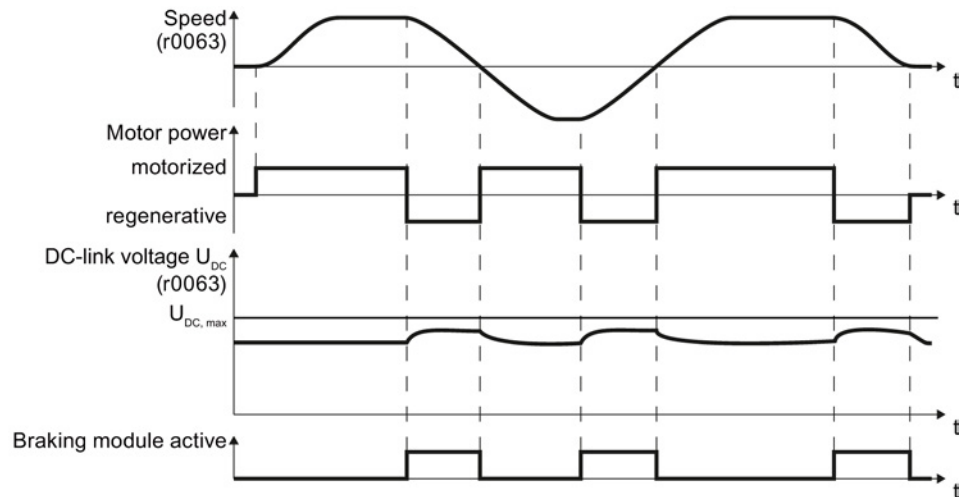


Figure 8-24 Simplified representation of dynamic braking with respect to time

## Connecting a braking resistor

### WARNING

#### Injuries from smoke gases when using an unsuitable braking resistor

An unsuitable braking resistor may result in a fire during operation. The following risks exist as a result:

- Smoke gas development
- Expansion of the fire due to open flames

Remedy:

- Only use the specified braking resistors.
- Maintain an appropriate distance from the other components around the braking resistor.
- Ensure adequate ventilation.

**Procedure**

To connect a braking resistor to the inverter, proceed as follows:

1. Connect the braking resistor to terminals R1 and R2 of the Power Module
2. Ground the braking resistor directly to the control cabinet's grounding bar. It is not permissible that the braking resistor is grounded via the PE terminals on the Power Module.
3. If you must observe the EMC guidelines, pay special attention to the shielding.
4. Evaluate the braking resistor's temperature monitoring (terminals T1 and T2) such that the inverter outputs a fault when the resistor has an overtemperature condition. You can do this in the following two ways:
  - Use a contactor to disconnect the inverter from the line as soon as the temperature monitoring responds.
  - Connect the contact of the temperature monitoring function of the braking resistor with a free digital input of your choice on the inverter.

Define the function of this digital input as external fault, e.g. for a digital input DI 3: p2106 = 722.3.

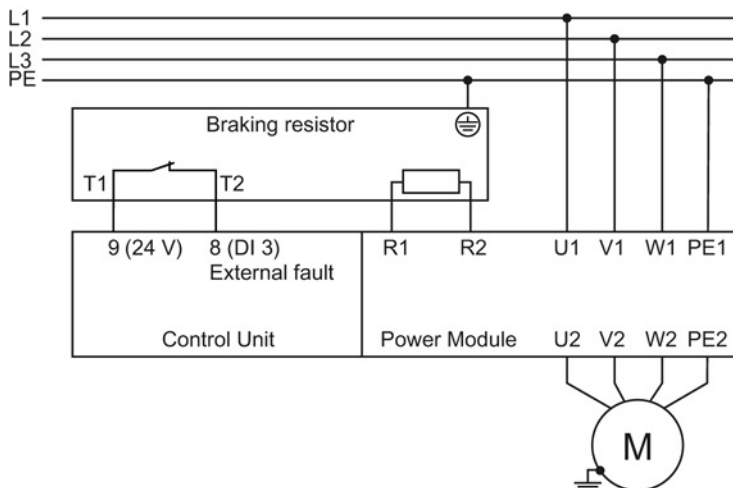


Figure 8-25 Braking resistor connection (as example: Temperature monitoring via digital input DI 3)

You have connected the braking resistor to the inverter.

You will find more information about the braking resistor in the installation instructions for Power Module PM240

(<http://support.automation.siemens.com/WW/view/en/30563173/133300>).

## 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- 35 Parameter

Parameter	Description		
p0219	<p><b>Braking power of the braking resistor</b> (factory setting: 0 kW) Set the maximum braking power that the braking resistor must handle in your particular application.</p> <p>Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor.</p> <p><b>Example:</b> 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 <math>1 \text{ kW} \times 2 \text{ s} / 10 \text{ s} = 0.2 \text{ kW}</math> and set the maximum braking power to: p0219 = 1 (kW).</p>		
p0844	<p><b>No coast down/coast down (OFF2) signal source 1</b></p> <table border="1"> <tr> <td>p0844 = 722.x</td><td>Monitor the overtemperature of the braking resistor with digital input x of the inverter.</td></tr> </table>	p0844 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the inverter.
p0844 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the inverter.		

### 8.7.3.5 Braking with regenerative feedback to the line

Typical applications for braking with energy recovery (regenerative feedback into the line supply):

- Centrifuges
- Unwinders
- Cranes and hoisting gear

For these applications, the motor must brake frequently or for longer periods of time.

Pre-requisite for regenerative braking is the Power Module PM250 or PM260.

The inverter can feed back up to 100% of its power into the line supply (referred to "High Overload" base load, see Section Technical data, Power Modules (Page 336)).

### Setting the braking with regenerative feedback to the line

Parameter	Description
<b>Limiting the regenerative feedback for U/f control (p1300 &lt; 20)</b>	
p0640	<b>Motor overload factor</b> Limiting the regenerative power is not directly possible with U/f control, but can be achieved indirectly by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault F07806.
<b>Limiting feedback with vector control (p1300 ≥ 20)</b>	
p1531	<b>Regenerative power limit</b> The maximum regenerative load is entered as negative value via p1531. (-0.01 ... -100000.00 kW). Values higher than the rated value of the power unit (r0206) are not possible.

### 8.7.3.6 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.

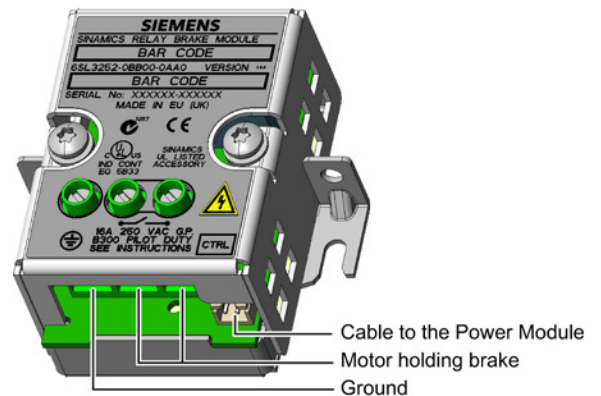
The inverter-internal control of the motor holding brake is suitable typically for horizontal, inclined and vertical conveyors.

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.

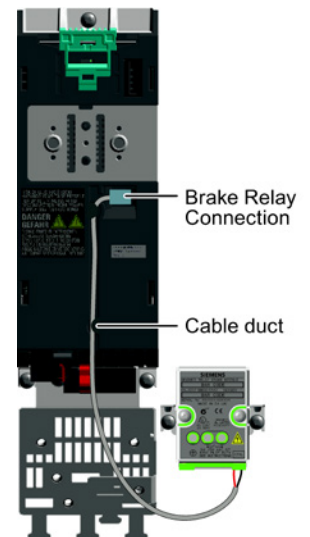
## Connecting a Brake Relay and a motor holding brake

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

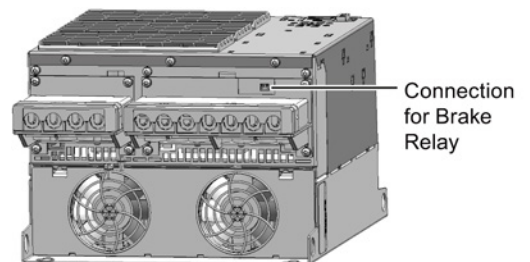
The Brake Relay can be mounted on a mounting plate, the cabinet wall or the converter's shield connection kit. For additional information, please refer to the associated installation instructions: Installation instructions for the Brake Relay (<http://support.automation.siemens.com/WW/view/en/23623179>).



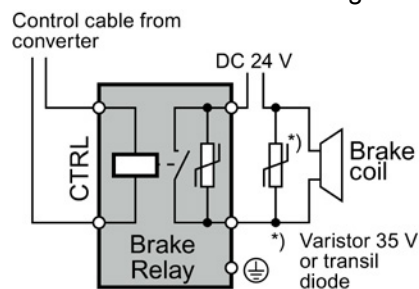
- Connect the Brake Relay to the Power Module using the cable form provided.
- Power Modules FSA ... FSC:
  - Connect the Brake Relay at the connector on the front of the Power Module.
  - Route the control cable in the guide on the Power Module.



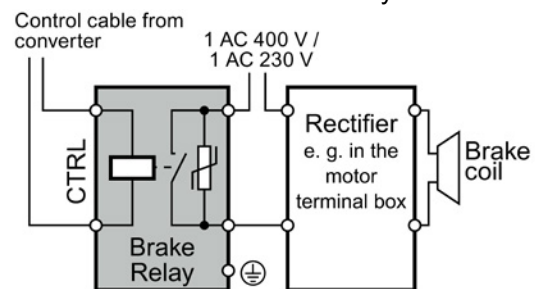
- Power Modules FSD ... FSF:
  - Connect the Brake Relay at the connector on the lower side of the Power Module.



- Connect the motor holding brake to the terminals of the Brake Relay:



24 V brake connection



440V brake connection

### Function after OFF1 and OFF3 command

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

- After the ON command (to switch on motor), the inverter magnetizes the motor.
- After the magnetizing time (p0346), the inverter issues the command to open the brake.
- The inverter keeps the motor at a standstill up until the end of the time in p1216. The motor holding brake must open within this time.
- At the end of the brake opening time the motor accelerates to the speed setpoint.
- After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
- When braking, the inverter compares the speed setpoint and the actual speed with the speed threshold p1226:

If the speed setpoint falls below the threshold p1226, the inverter starts the time p1227.

If the actual speed falls below the threshold p1226, the inverter starts the time p1228.

- As soon as the first of the two times (p1227 or p1228) has elapsed, the inverter issues the command to close the brake.

The motor comes to a standstill but remains switched on.

- After the brake closing time p1217, the inverter switches off the motor.  
The motor holding brake must close within this time.

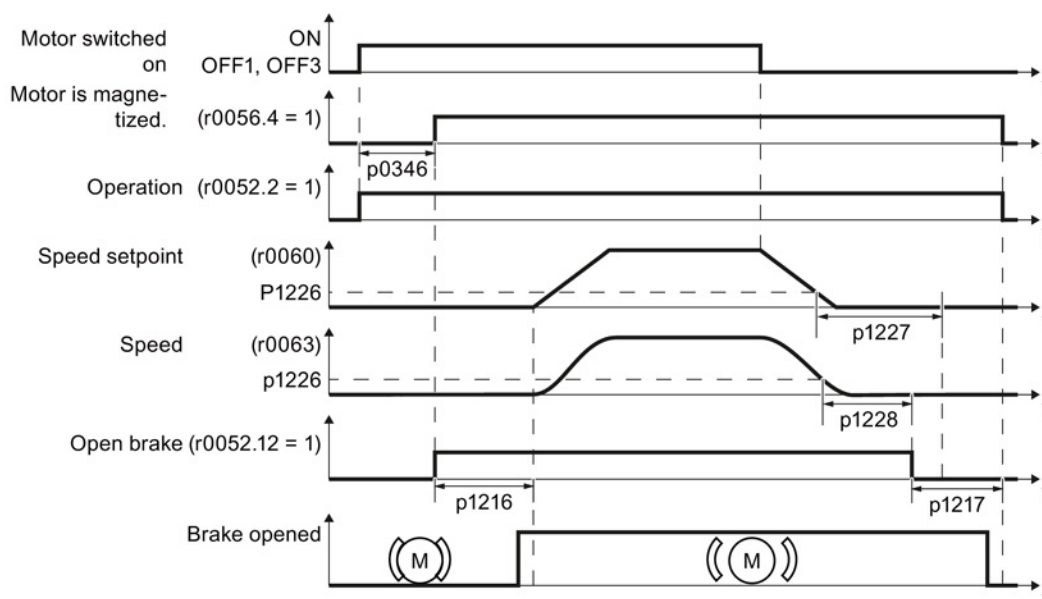


Figure 8-26 Controlling the motor holding brake when the motor is switched on and off

## 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.

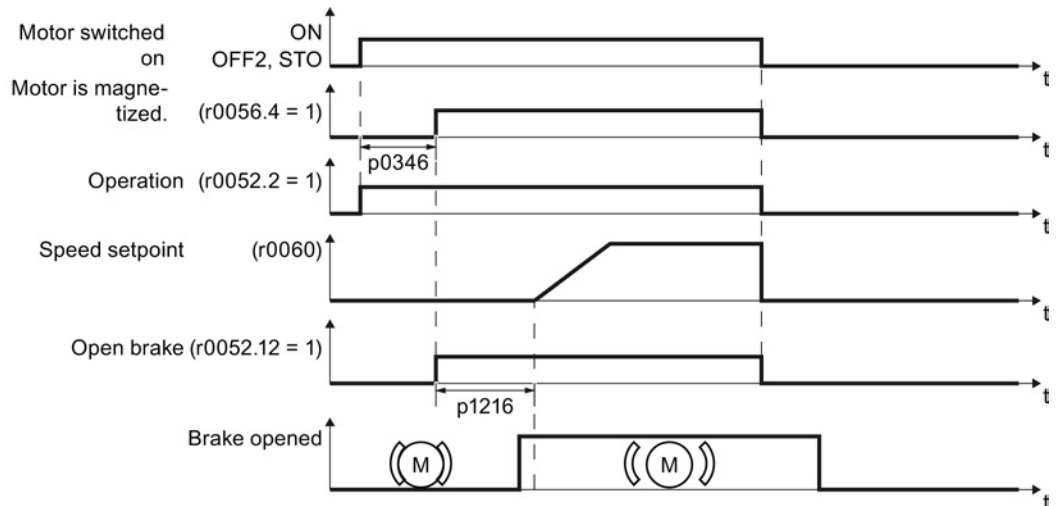


Figure 8-27 Controlling the motor holding brake after an OFF2 command or selecting STO

## 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  $\leq$  p1216.
  - Closing time  $\leq$  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  $\geq$  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- 36 Setting the control logic of the motor holding brake

Parameter	Description
p1215 = 1	<b>Enable motor holding brake</b> 0 Motor holding brake locked (factory setting) 1 Motor holding brake just like the sequence control 2: Motor holding brake permanently open 3: Motor holding brake just like the sequential control, connected via BICO
p1216	<b>Motor holding brake opening time</b> (factory setting 0.1 s) p1216 > braking signal relay runtimes + brake release time
p1217	<b>Motor holding brake closing time</b> (factory setting 0.1 s) p1217 > braking signal relay runtimes + brake closing time
r0052.12	<b>"Open motor holding brake" command</b>

Table 8- 37 Advanced settings

Parameter	Description
p0346	<b>Magnetizing time</b> (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.
p0855	<b>Open motor holding brake (imperative)</b> (factory setting 0)
p0858	<b>Close motor holding brake (imperative)</b> (factory setting 0)
p1226	<b>Stationary state detection speed threshold</b> (factory setting 20 rpm) When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started
p1227	<b>Stationary state detection monitoring time</b> (factory setting 300 s)
p1228	<b>Pulse deletion delay time</b> (factory setting 0.01 s)
p1351	<b>Starting frequency, motor holding brake</b> (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	<b>Starting frequency for motor holding brake</b> (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	<b>Speed controller torque set value for motor holding brake</b> (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

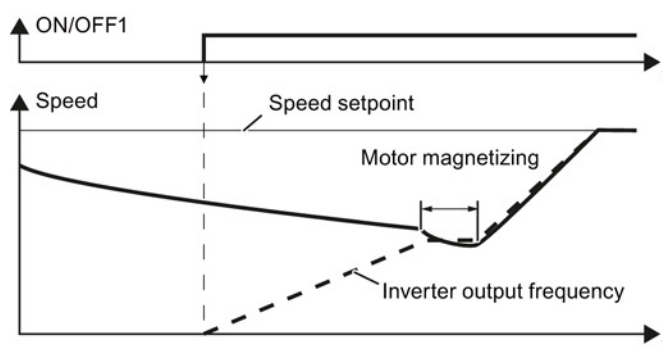
## 8.7.4 Automatic restart and flying restart

### 8.7.4.1 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- 38 Basic setting

Parameter	Description
p1200	<b>Flying restart operating mode</b> (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- 39 Advanced settings

Parameter	Description
p1201	<b>Flying restart enable signal source</b> (factory setting 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
p1202	<b>Flying restart search current</b> (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	<b>Flying restart search speed factor</b> (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).

#### 8.7.4.2 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.



##### **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 236).

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

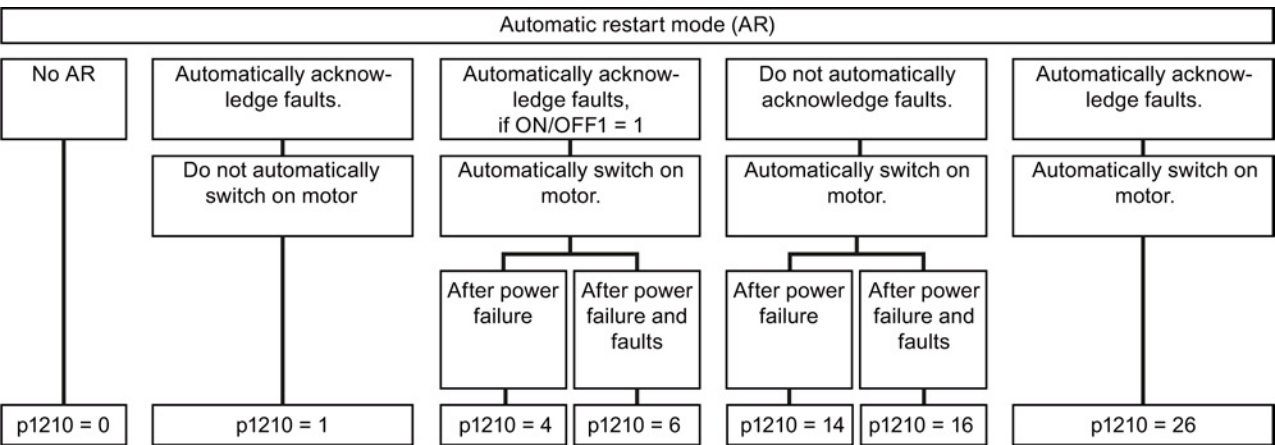
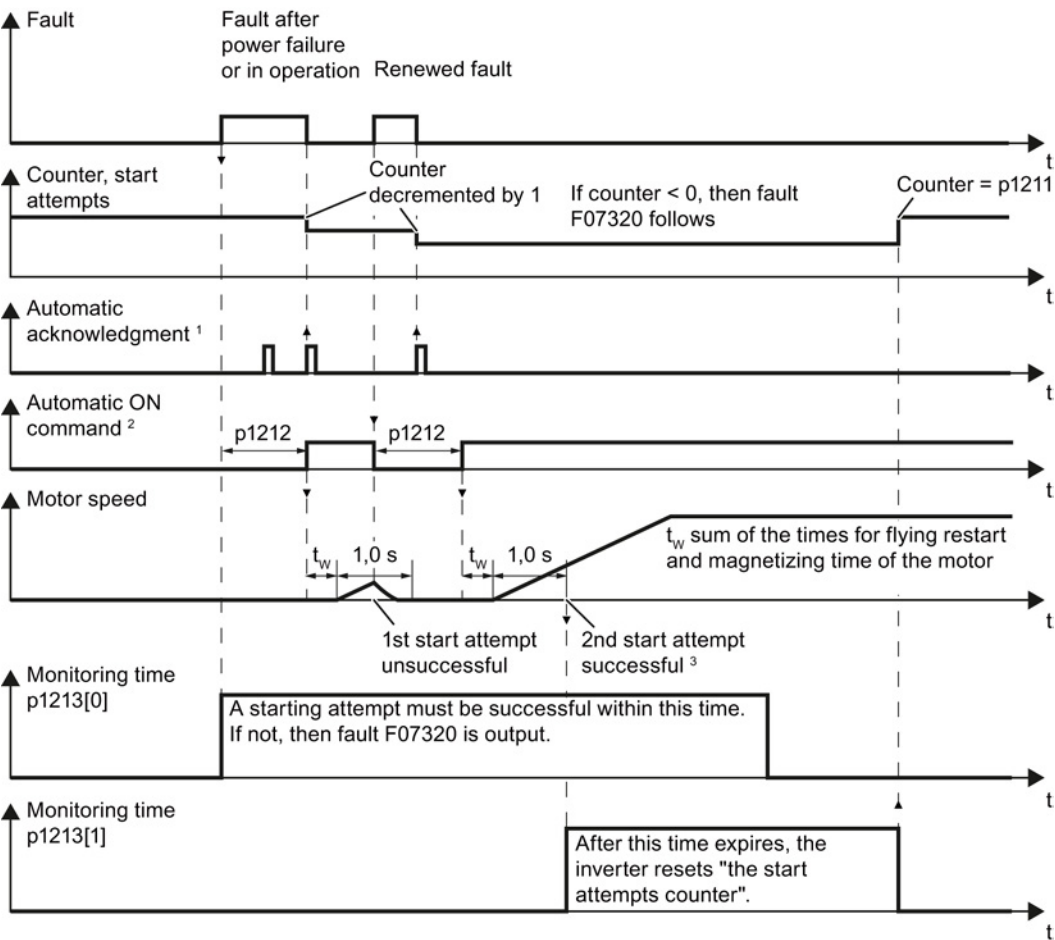


Figure 8-28 Selecting the automatic restart mode

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.



- <sup>1</sup> 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.
- <sup>2</sup> 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).
- <sup>3</sup> If no fault has occurred one second after flying restart and magnetizing (r0056.4 = 1), the start attempt was successful.

Figure 8-29 Time response of the automatic restart



You have commissioned the automatic restart function.

#### Parameter for setting the automatic restart

Parameter	Explanation
p1210	<b>Automatic restart mode</b> (factory setting 0) <ul style="list-style-type: none"> <li>0: Disable automatic restart.</li> <li>1: Acknowledge all faults without restarting.</li> <li>4: Restart after power failure without further restart attempts.</li> <li>6: Restart after fault with further restart attempts.</li> <li>14: Restart after power failure after manual acknowledgement.</li> <li>16: Restart after fault after manual acknowledgement.</li> <li>26: Acknowledgement of all faults and restart with ON/OFF1 = 1 command.</li> </ul>
p1211	<b>Automatic restart start attempts</b> (factory setting 3) <p>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.</p> <p>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.</p> <p>For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts.</p> <p>The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled:</p> <ul style="list-style-type: none"> <li>• After a successful start attempt, the time in p1213[1] has expired.</li> <li>• After fault F07320, switch off the motor (OFF1) and acknowledge the fault.</li> <li>• You change the start value p1211 or the mode p1210.</li> </ul>

Parameter	Explanation
p1212	<p><b>Automatic restart wait time start attempt</b> (factory setting 1.0 s)</p> <p>This parameter is only effective for the settings p1210 = 4, 6, 26.</p> <p>Examples for setting this parameter:</p> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> </ol>
p1213[0]	<p><b>Automatic restart monitoring time for restart</b> (factory setting 60 s)</p> <p>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.</p> <p>With this monitoring function, you limit the time in which the inverter may attempt to automatically switch-on the motor again.</p> <p>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.</p> <p>Set the monitoring time longer than the sum of the following times:</p> <ul style="list-style-type: none"> <li>+ p1212</li> <li>+ Time that the inverter requires to start the motor on the fly.</li> <li>+ Motor magnetizing time (p0346)</li> <li>+ 1 second</li> </ul> <p>You deactivate the monitoring function with p1213 = 0.</p>
p1213[1]	<p><b>Automatic restart monitoring time to reset the fault counter</b> (factory setting 0 s)</p> <p>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.</p> <p>Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time.</p> <p>The monitoring function starts with a successful start attempt and ends after the monitoring time has expired.</p> <p>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.</p>

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

## Advanced settings

If you wish 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  $\Rightarrow$  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).

## 8.7.5 PID technology controller

### 8.7.5.1 Overview

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

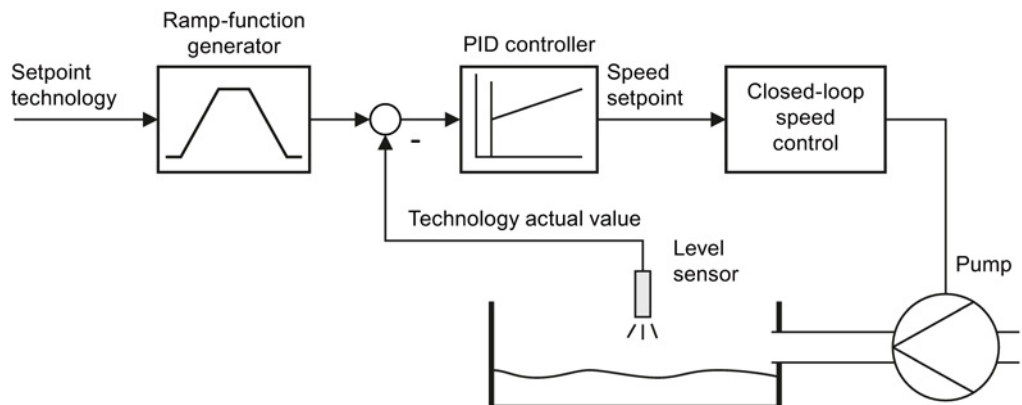


Figure 8-30 Example: technology controller as a level controller

## 8.7.5.2 Setting the controller

## Simplified representation of the technology controller

The technology controller is implemented as PID controller (controller with proportional, integral and differential component) and so can be adapted very flexibly.

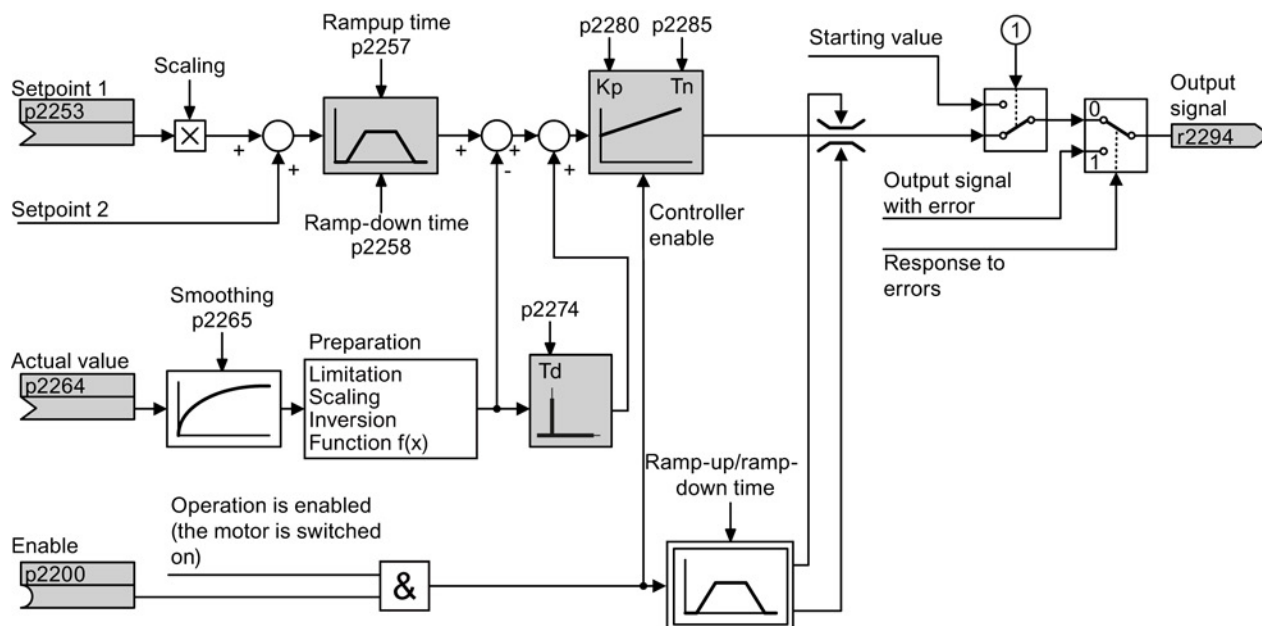


Figure 8-31 Simplified representation of the technology controller

## 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.

Parameter	Remark
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
<b>Limiting the output of the technology controller</b>	
In the factory setting, the output of the technology controller is limited to $\pm$ 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
<b>Manipulating the actual value of the technology controller</b>	
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.

## 8.7.5.3 Optimizing the controller

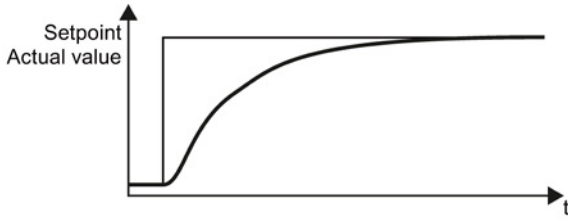
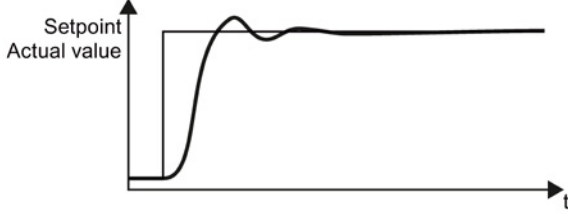
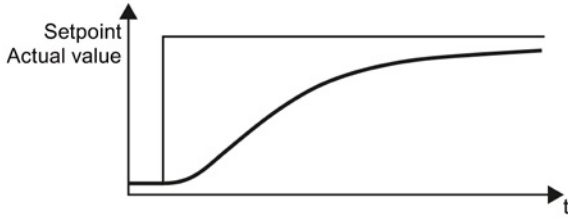
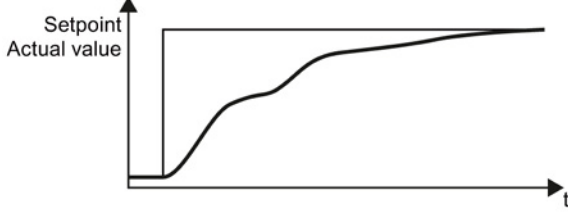
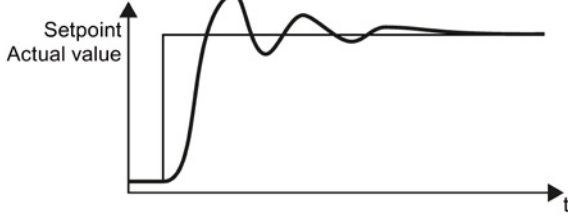
### Setting the technology controller from a practical perspective



#### Procedure

Proceed as follows to set the technology controller:

- Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
- 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.

	<p><b>Optimum controller response for applications that do not permit any overshoot.</b></p> <p>The actual value approaches the setpoint without any significant overshoot.</p>
	<p><b>Optimum controller behavior for fast correction and quick compensation of noise components.</b></p> <p>The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).</p>
	<p><b>The actual value only slowly approaches the setpoint.</b></p> <ul style="list-style-type: none"> <li>• Increase the proportional component <math>K_P</math> and reduce the integration time <math>T_N</math>.</li> </ul>
	<p><b>Actual value only slowly approaches the setpoint with slight oscillation.</b></p> <ul style="list-style-type: none"> <li>• Increase the proportional component <math>K_P</math> and reduce the rate time <math>T_D</math> (differentiating time).</li> </ul>
	<p><b>The actual value quickly approaches the setpoint, but overshoots too much</b></p> <ul style="list-style-type: none"> <li>• Decrease the proportional component <math>K_P</math> and increase the integration time <math>T_N</math>.</li> </ul>

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



You have now set the technology controller.

## 8.7.6 Monitor the load torque (system protection)

In many applications, it is advisable to monitor the motor torque:

- Applications where the load speed can be indirectly monitored by means of the load torque. For example, in fans and conveyor belts with too low a torque indicates that the drive belt is torn.
- Applications that are to be protected against overload or locking (e.g. extruders or mixers).
- Applications in which no-load operation of the motor represents an impermissible situation (e.g. pumps).

### Load torque monitoring functions

The inverter monitors the motor torque in different ways:

- No-load monitoring  
The inverter generates a message if the motor torque is too low.
- Blocking protection  
The inverter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.
- Stall protection:  
The inverter generates a message if the inverter control has lost the orientation of the motor.
- Speed-dependent torque monitoring  
The inverter measures the actual torque and compares it with a set speed/torque characteristic.

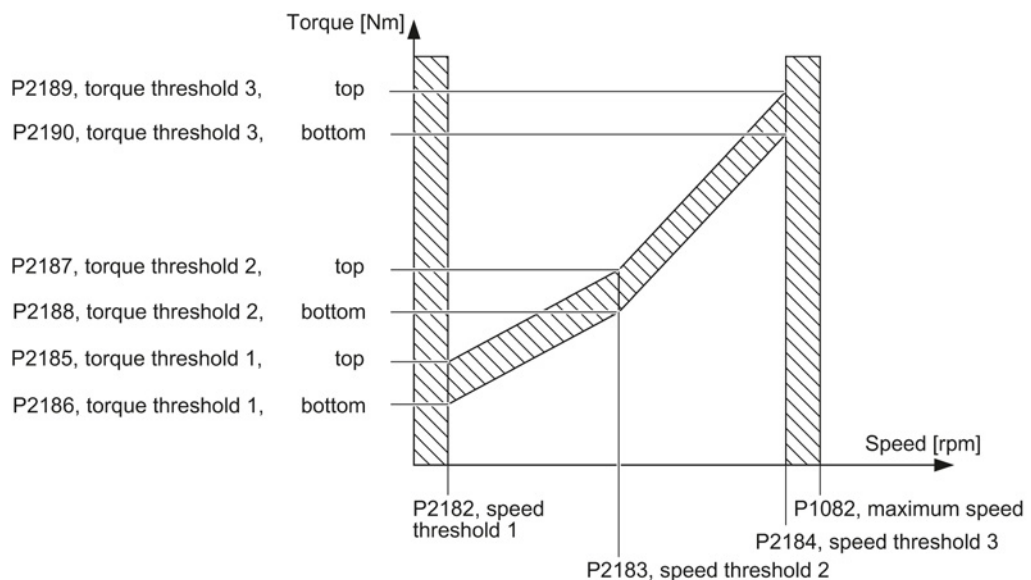


Figure 8-32 Parameters for the load torque monitoring

Table 8- 40 Parameterizing the monitoring functions

Parameter	Description
<b>No-load monitoring</b>	
p2179	<b>Current limit for no-load detection</b> If the inverter current is below this value, the message "no load" is output.
p2180	<b>Delay time for the "no load" message</b>
<b>Blocking protection</b>	
p2177	<b>Delay time for the "motor locked" message</b>
<b>Stall protection</b>	
p2178	<b>Delay time for the "motor stalled" message</b>
p1745	<b>Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated</b> This parameter is only evaluated as part of encoderless vector control.
<b>Speed-dependent torque monitoring</b>	
p2181	<b>Load monitoring, response</b> Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
p2182	<b>Load monitoring, speed threshold 1</b>
p2183	<b>Load monitoring, speed threshold 2</b>
p2184	<b>Load monitoring, speed threshold 3</b>
p2185	<b>Load monitoring, torque threshold 1, upper</b>
p2186	<b>Load monitoring, torque threshold 1, lower</b>
p2187	<b>Load monitoring, torque threshold 2, upper</b>
p2188	<b>Load monitoring, torque threshold 2, lower</b>
p2189	<b>Load monitoring, torque threshold 3, upper</b>
p2190	<b>Load monitoring torque threshold 3, lower</b>
p2192	<b>Load monitoring, delay time</b> Delay time for the message "Leave torque monitoring tolerance band"

For more information about these functions, see the List Manual (function diagram 8013 and the parameter list).

## 8.7.7 Speed and load failure via digital input

The function monitors the speed or velocity of a machine component, e.g.:

- Gearbox monitoring for traction drives and hoisting gear
- Drive belt monitoring for fans and conveyor belts
- Blocking protection

### Monitoring

There are two ways of monitoring speed or velocity in your application:

- Load failure:

The inverter evaluates whether an encoder signal is present.

- Speed deviation:

The inverter calculates a speed from the signal of the connected encoder and compares it with the motor speed.

A sensor (e.g. a proximity switch) is required for speed monitoring. The inverter evaluates the sensor signal via a digital input.

### Load failure

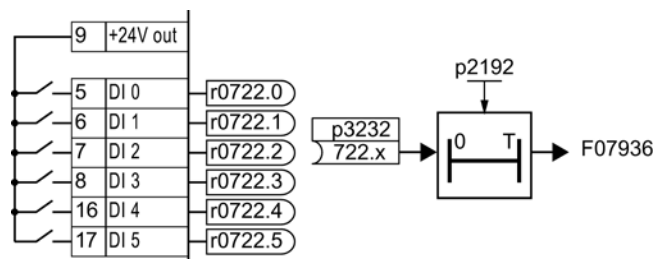


Figure 8-33 Load failure monitoring by means of a digital input

Parameter	Description
p2192	<b>Load monitoring delay time</b> (factory setting 10 s) After the motor is switched on, if the "LOW" signal is present on the associated digital input for longer than this time, the inverter signals a load failure (F07936).
p2193 = 1 to 3	<b>Load monitoring configuration</b> (factory setting: 1) 0: Monitoring is deactivated 1: Torque monitoring (see Monitor the load torque (system protection) (Page 245)) and load failure 2: Speed deviation monitoring (see below) and load failure 3: Load failure monitoring
p3232 = 722.x	<b>Load monitoring failure detection</b> (factory setting: 1) Interconnect the load monitoring with a digital input of your choice.

For more information, see the List Manual (the parameter list and function diagram 8013).

## Speed deviation

This function is only available for CU240E-2... Control Units. The monitoring sensor must be connected to digital input 3.

The inverter can process a pulse sequence of up to 32 kHz.

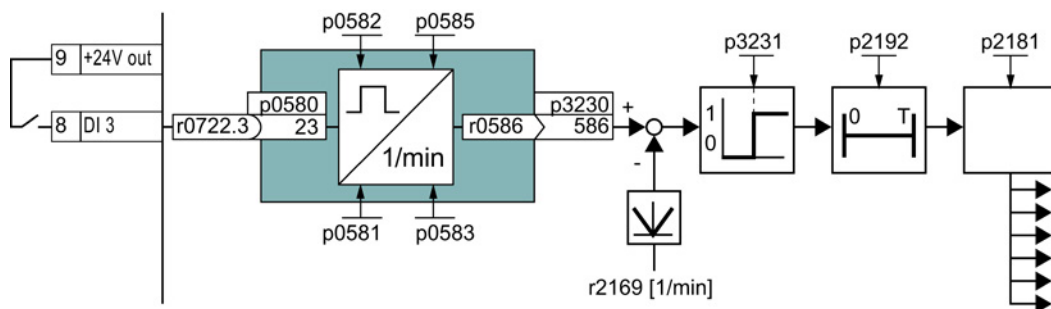


Figure 8-34 Speed deviation monitoring

The speed is calculated from the pulse signal of the digital input in the "probe".

The inverter compares the calculated speed with the speed actual value r2169. The inverter response if the deviation is too high, can be adjusted using p2181.

Parameter	Description
p0490	<b>Invert probe</b> (factory setting 0000bin) The 3rd bit of the parameter value inverts the input signals of digital input 3 for the probe.
p0580 = 23	<b>Probe input terminal</b> (factory setting 0) Interconnect the probe input with DI 3.
p0581	<b>Probe edge</b> (factory setting 0) Edge for evaluation of the probe signal to measure actual speed value 0: 0/1 edge 1: 1/0 edge
p0582	<b>Probe pulses per revolution</b> (factory setting 1) Number of pulses per revolution.
p0583	<b>Maximum probe measuring time</b> (factory setting 10 s) Maximum measuring time for the probe. If there is no new pulse before the maximum measuring time elapses, the inverter sets the actual speed value in r0586 to zero. The time is restarted with the next pulse.
p0585	<b>Probe gear factor</b> (factory setting 1) The inverter multiplies the measured speed by the gear factor and then displays it in r0586.
p2181	<b>Load monitoring response</b> (factory setting 0) Response for evaluating load monitoring.
	0 Load monitoring disabled
	1 A07920 for speed too low
	2 A07921 for speed too high
	3 A07922 for speed outside tolerance
	4 F07923 for speed too low
	5 F07924 for speed too high
	6 F07925 for speed outside tolerance

Parameter	Description
p2192	<b>Load monitoring delay time</b> (factory setting 10 s) Delay time for evaluating load monitoring.
p2193 = 2	<b>Load monitoring configuration</b> (factory setting: 1) 2: Speed deviation and load failure monitoring.
p3230 = 586	<b>Load monitoring actual speed value</b> (factory setting 0) Result of the speed calculation with the evaluation of the speed monitoring.
p3231	<b>Load monitoring speed deviation</b> (factory setting 150 rpm) Permissible speed deviation of load monitoring.

For more information, see the List Manual (the parameter list and function diagram 8013).

### 8.7.8 Logical and arithmetic functions using function blocks

The free function blocks permit additional signal interconnections within the inverter. In order to use the free function blocks, you must interconnect the inputs and outputs of the function blocks with the appropriate signals.

Among others, the following free function blocks are available:

- Logic modules AND, OR, XOR, NOT
- Arithmetic blocks ADD, SUB, MUL, DIV, AVA (device for forming absolute values), NCM (numeric comparator), PLI (polyline)
- Time modules MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), PST (pulse stretching)
- Memories RSR (RS flip-flop), DSR (D flip-flop)
- Switches NSW (numeric change-over switch) BSW (binary change-over switch)
- Controllers LIM (limiter), PT1 (smoothing element), INT (integrator), DIF (differentiating element)
- Limit value monitoring LVM

You will find an overview of all of the free function blocks and their parameters in the List Manual, in Chapter "Function diagrams" in Section "Free function blocks" (function diagrams 7210 ff).

## Enabling free modules

None of the free function blocks in the inverter are used in the factory setting.

### Procedure



Proceed as follows to activate the free blocks:

1. In the parameter list, select the function block from the function diagrams - there you will find all parameters that you require to interconnect the block.
2. Assign the block to a runtime group.
3. Define the run sequence within the runtime group - this is only required if you have assigned several blocks to the same runtime group
4. Interconnect the block's inputs and outputs with the corresponding signals on the inverter



You have activated the free blocks.

The runtime groups are calculated at different intervals (time slices). Refer to the following table to see which free function blocks can be assigned to which time slices.

Table 8- 41 Runtime groups and possible assignments of the free function blocks

Free function blocks	Runtime groups 1 ... 6 with associated time slices					
	1	2	3	4	5	6
	8 ms	16 ms	32 ms	64 ms	128 ms	256 ms
Logic modules AND, OR, XOR, NOT	✓	✓	✓	✓	✓	✓
Arithmetic blocks ADD, SUB, MUL, DIV, AVA, NCM, PLI	-	-	-	-	✓	✓
Time modules MFP, PCL, PDE, PDF, PST	-	-	-	-	✓	✓
Memories RSR, DSR	✓	✓	✓	✓	✓	✓
Switches NSW	-	-	-	-	✓	✓
Switches BSW	✓	✓	✓	✓	✓	✓
Controllers LIM, PT1, INT, DIF	-	-	-	-	✓	✓
Limit value monitoring LVM	-	-	-	-	✓	✓

✓: The block can be assigned to the runtime group

-: The block cannot be assigned to this runtime group

## Normalizing analog signals

If you interconnect a physical quantity, e.g. speed or voltage to the input of a free function block, then the signal is automatically scaled to a value of 1. The analog output signals of the free function blocks are also available as scaled quantities ( $0 \triangleq 0\%$ ,  $1 \triangleq 100\%$ ).

As soon as you have interconnected the scaled output signal of a free function block to functions that require physical input quantities, then the inverter converts the signal into the physical quantity. An example of this is the signal source for the upper torque limit (p1522).

The quantities with their associated scaling parameters are listed in the following:

- |                  |       |                           |                        |
|------------------|-------|---------------------------|------------------------|
| • Speeds         | p2000 | Reference speed           | ( $\triangleq 100\%$ ) |
| • Voltage values | p2001 | Reference voltage         | ( $\triangleq 100\%$ ) |
| • Current values | p2002 | Reference current         | ( $\triangleq 100\%$ ) |
| • Torque values  | p2003 | Reference torque          | ( $\triangleq 100\%$ ) |
| • Power values   | p2004 | Reference power           | ( $\triangleq 100\%$ ) |
| • Angle          | p2005 | Reference angle           | ( $\triangleq 100\%$ ) |
| • Acceleration   | p2007 | Reference acceleration    | ( $\triangleq 100\%$ ) |
| • Temperature    |       | 100° C $\triangleq 100\%$ |                        |

### Scaling examples

- Speed:  
Reference speed p2000 = 3000 rpm, actual speed 2100 rpm. As a consequence, the following applies to the scaled input quantity:  $2100 / 3000 = 0,7$ .
- Temperature:  
Reference quantity is 100° C. For an actual temperature of 120° C, the input value is obtained from  $120^\circ \text{C} / 100^\circ \text{C} = 1.2$ .

---

### Note

Enter limits within the function blocks as scaled values. Calculation of the normalized value: Scaled limit value = physical limit value / value of the reference parameter.

The assignment to reference parameters is provided in the parameter list in the individual parameter descriptions.

---

**Example: Logic combination of two digital inputs**

You want to switch on the motor via digital input 0 and also via digital input 1.

**Procedure**

Proceed as follows to logically interconnect two digital inputs:

1. Activate a free OR block by assigning it to a runtime group, and define the run sequence.
2. Interconnect the status signals of the two digital inputs DI 0 and DI 1 with the two inputs of the OR block.
3. Finally, interconnect the OR block output with the internal ON command (p0840).

You have logically interconnected two digital inputs.

Parameter	Description
p20048 = 1	<b>Assignment of block OR 0 to runtime group 1</b> (factory setting 9999) The block OR 0 is calculated in the time slice with 8 ms
p20049 = 60	<b>Definition of run sequence within runtime group 1</b> (factory setting 60) Within one runtime group, the block with the smallest value is calculated first.
p20046[0] = 722.0	<b>Interconnection of first OR 0 input (factory setting 0)</b> The first OR 0 input is linked to digital input 0 (r0722.0)
p20046[1] = 722.1	<b>Interconnection of second OR 0 input (factory setting 0)</b> The second OR 0 input is linked to digital input 1 (r0722.1)
p0840 = 20047	<b>Interconnection of OR 0 output (factory setting 0)</b> The OR 0 output (r20047) is connected with the motor's ON command

**Example: AND operation**

An example of an AND logic operation, explained in detail, including the use of a time block is provided in the Example (Page 374)chapter.

You can find additional information in the following manuals:

- Function Manual "Description of the Standard DCC Blocks"  
(<http://support.automation.siemens.com/WW/view/en/29193002>)
- Function Manual "Free Function Blocks"  
(<http://support.automation.siemens.com/WW/view/en/35125827>)

## 8.8 Safe Torque Off (STO) safety function



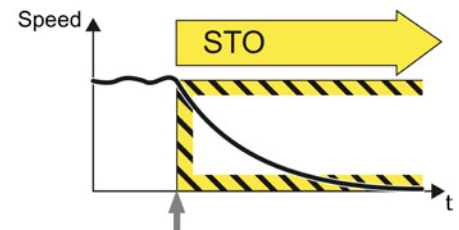
These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Additional information on the inverter (Page 397).

### 8.8.1 Function 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)."



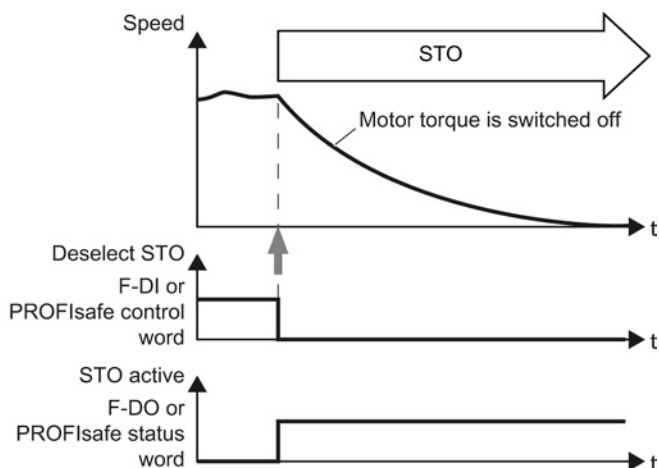
### Application examples

Example	Possible solution
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	<ul style="list-style-type: none"> <li>• Wire the Emergency Stop button with a fail-safe input.</li> <li>• Select STO via the fail-safe input.</li> </ul>
A central Emergency Stop button ensures that several drives cannot unintentionally start.	<ul style="list-style-type: none"> <li>• Evaluate the Emergency Stop button in a central control.</li> <li>• Select STO via PROFIsafe.</li> </ul>

### How does STO function in detail?

The inverter recognizes the selection of STO via a fail-safe input or via the safe communication PROFIsafe.

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- 42 STARTER commissioning tool (PC software)

Download	Order number
STARTER ( <a href="http://support.automation.siemens.com/WW/view/en/10804985/130000">http://support.automation.siemens.com/WW/view/en/10804985/130000</a> )	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- 43 Parameter

No.	Description
p9761	<b>Entering a password</b> (factory setting 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.
p9762	<b>New password</b>
p9763	<b>Confirm password</b>

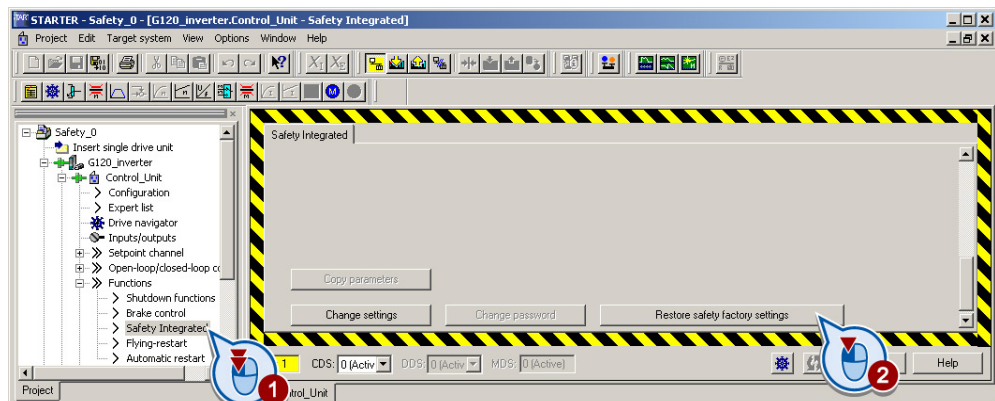
### 8.8.3.3 Resetting the safety function parameters to the factory setting

#### 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	<b>Drive, commissioning parameter filter</b>
	0 Ready
	95 Safety Integrated commissioning
p0970	<b>Reset drive parameters</b>
	0 Inactive
	5 Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.
p9761	<b>Enter a password</b> (factory setting 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.
p9762	<b>New password</b>
p9763	<b>Confirm password</b>

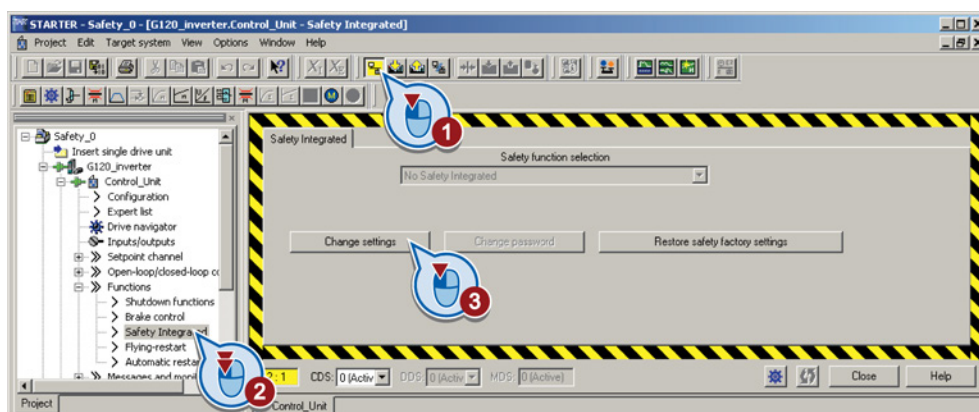
### 8.8.3.4 Changing settings

#### Procedure



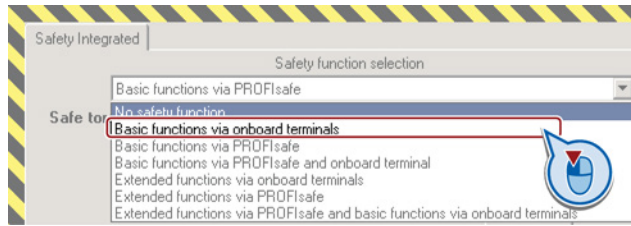
To start commissioning the safety functions, proceed as follows:

1. Go online with STARTER.
2. In STARTER, select the fail-safe functions.
3. Select "Change settings".



Parameter	Description
p0010 = 95	<b>Drive commissioning parameter filter</b> Safety Integrated commissioning
p9761	<b>Enter a password</b> (factory setting 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.
p9762	<b>New password</b>
p9763	<b>Confirm password</b>

#### 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- 44 Parameter

Parameter	Description
p9601	<b>Enable functions integrated in the drive</b> (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: Additional information on the inverter (Page 397).

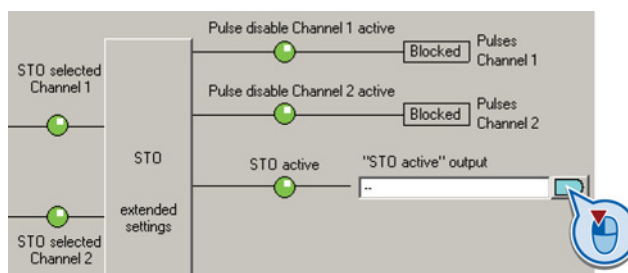
#### 8.8.3.5 Interconnecting the "STO active" signal

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	<b>1 signal:</b> STO is active in the drive

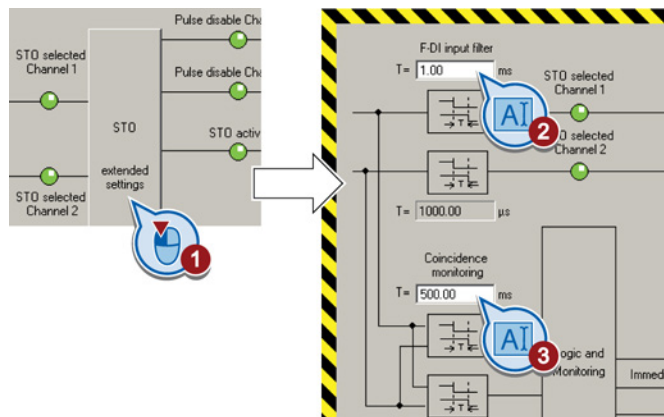
### 8.8.3.6 Setting the filter for fail-safe inputs



#### 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.

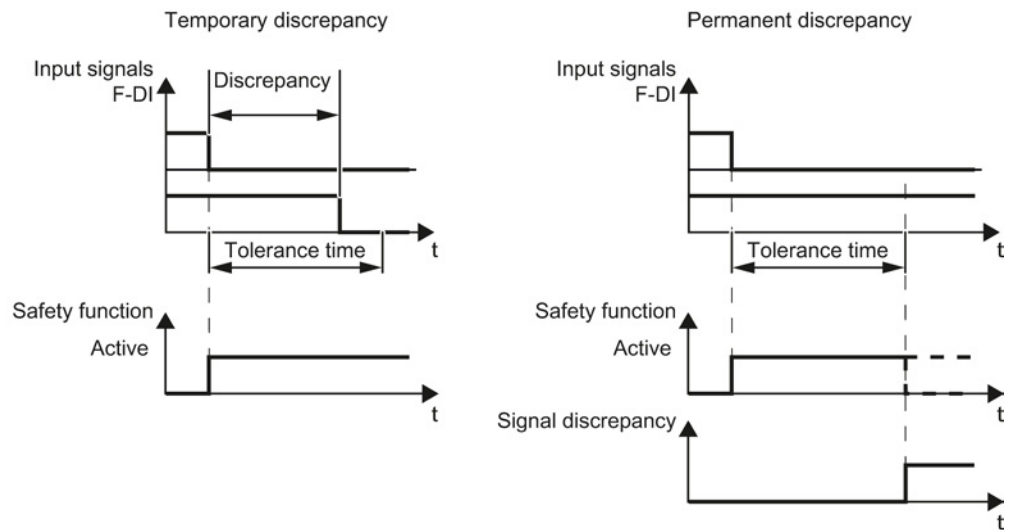


Figure 8-35 Tolerance regarding discrepancy

### 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.

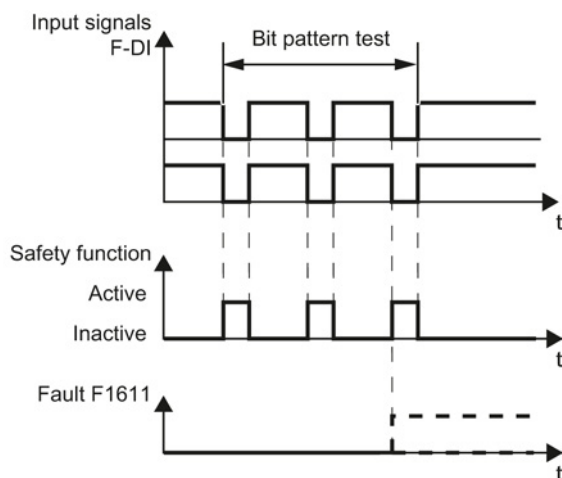


Figure 8-36 Inverter response to a bit pattern test

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.

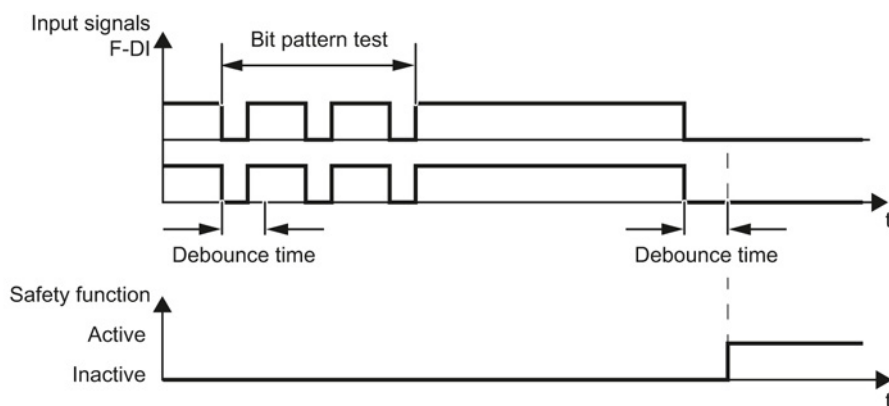


Figure 8-37 Filter for suppressing temporary signal changes

Parameter	Description
p9650	<b>F-DI changeover tolerance time</b> (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	<b>STO debounce time</b> (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.

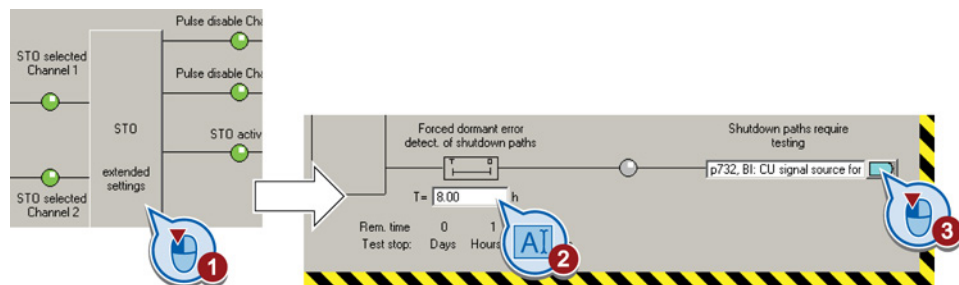
### 8.8.3.7 Setting forced dormant error detection



#### 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 STO function has been selected.

The inverter monitors the regular forced dormant error detection.

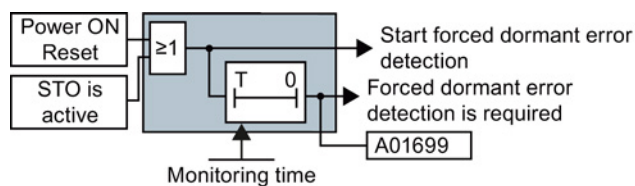


Figure 8-38 Triggering and monitoring the forced dormant error detection

Parameter	Description
p9659	<b>Forced dormant error detection timer</b> (Factory setting: 8 h) Monitoring time for the forced dormant error detection
r9660	<b>Forced dormant error detection remaining time</b> Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	<b>1 signal: Forced dormant error detection is required</b> 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

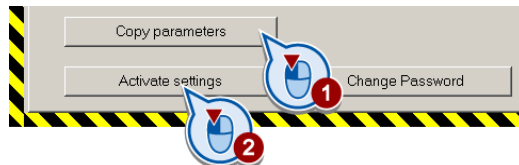
#### Activate settings



##### 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	<b>SI copy function</b> (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	<b>Confirm data change</b> (factory setting: 0) Confirm data change overall.
p0010 = 0	<b>Drive commissioning parameter filter</b> 0: Ready
p9761	<b>Enter a password</b> (factory setting 0000 hex) Permissible passwords lie in the range 1 ... FFFF FFFF.
p9762	<b>New password</b>
p9763	<b>Confirm password</b>

## 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.

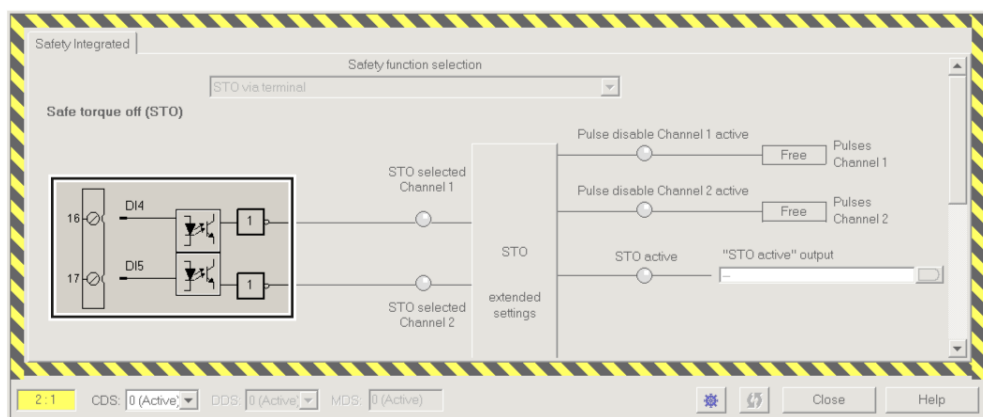


Figure 8-39 Example: Assignment of digital inputs DI 4 and DI 5 with STO

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:

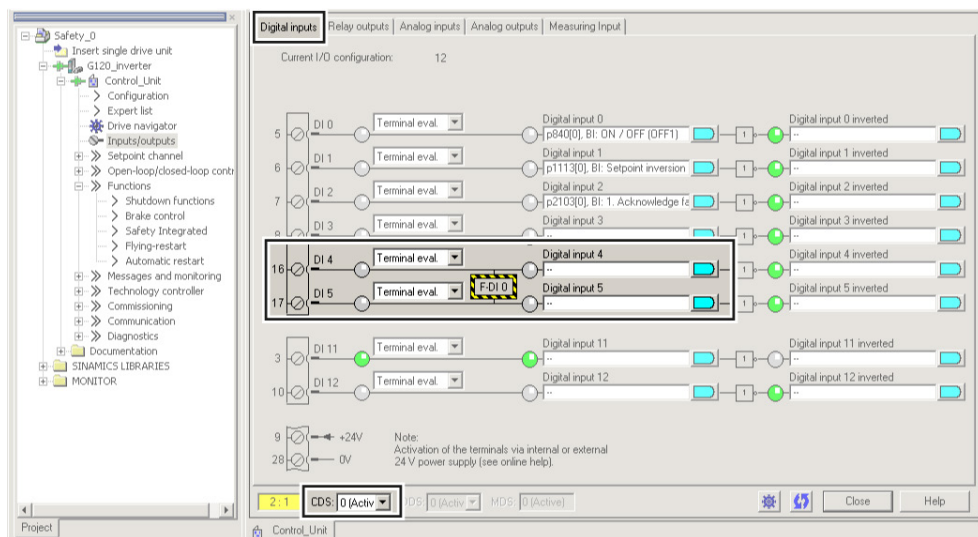


Figure 8-40 Remove pre-assignment of digital inputs DI 4 and DI 5

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 Approval - completing commissioning

#### 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- 45 Reduced scope of acceptance test for function expansions

Measure	Acceptance test	
	Acceptance test	Documentation
Replacing the Control Unit.	No. Only check the direction of rotation of the motor.	<ul style="list-style-type: none"> <li>• Supplement inverter data</li> <li>• Log the new checksums</li> <li>• Countersignature</li> </ul>
Replacing the Power Module.		Supplement the hardware version in the inverter data
Replacing the motor.		No change.
Replacing the gearbox.		No change.
Replacing safety-related peripherals (e.g. Emergency Stop switch).	No. Only check the control of the safety functions that are influenced by the components that have been replaced.	No change.
Inverter firmware update.	No.	<ul style="list-style-type: none"> <li>• Supplement firmware version in the inverter data</li> <li>• Log the new checksums</li> <li>• Countersignature.</li> </ul>
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	<ul style="list-style-type: none"> <li>• Supplement machine overview</li> <li>• Supplement inverter data</li> <li>• Add function table</li> <li>• Supplement limit values</li> <li>• Log the new checksums</li> <li>• Countersignature</li> </ul>
Transfer of inverter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	<ul style="list-style-type: none"> <li>• Add machine description</li> <li>• Check checksums</li> <li>• Check firmware versions</li> </ul>

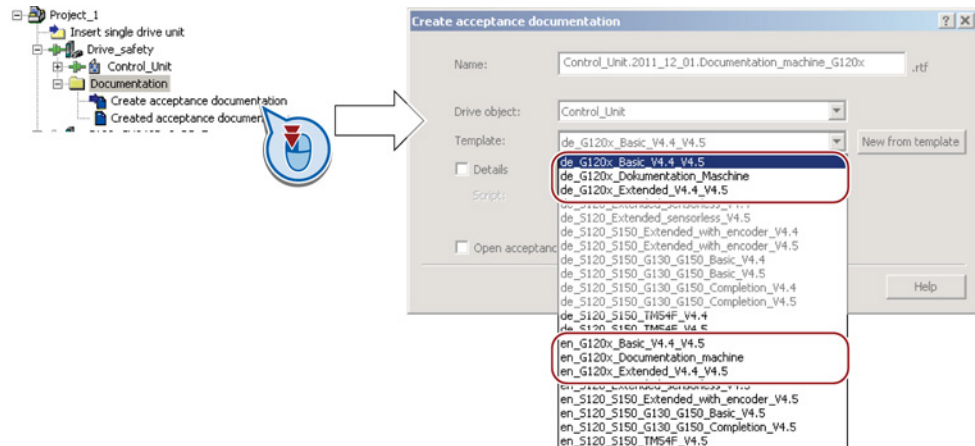
## Documents for acceptance

The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

### Procedure

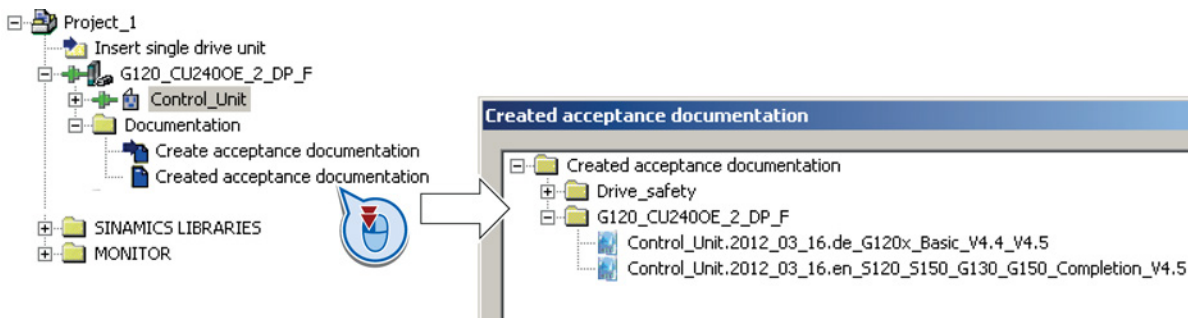
Proceed as follows to create the acceptance documentation for the drive using STARTER:

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\_Dokumentation\_Maschine: English template.
  - Report of the settings for the basic functions, from firmware version V4.4 onwards:
    - de\_G120x\_Basic\_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 accepting the safety functions (Page 394).

**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

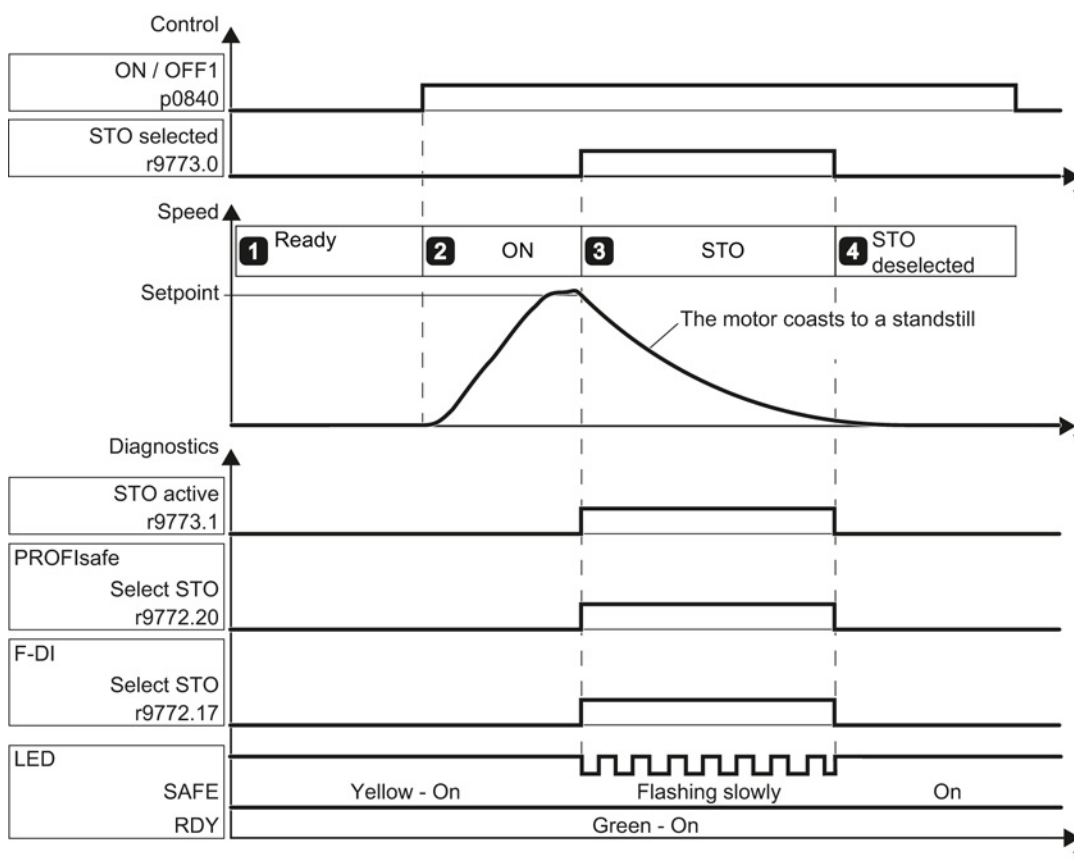


Figure 8-41 Acceptance test for STO (basic functions)

**Procedure**

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

			Status
1.	<b>The inverter is ready</b>		
	<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>		
	<ul style="list-style-type: none"> <li>STO is not active (r9773.1 = 0).</li> </ul>		
2.	<b>Switch on motor</b>		
	2.1.	Enter a speed setpoint $\neq 0$ .	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	<b>Select STO</b>		
	3.1.	Select STO while the motor is running <i>Test each configured activation, e.g. via digital inputs and PROFIsafe.</i>	
	3.2.	Check the following:	
		When controlled by PROFIsafe	For control via terminal
		<ul style="list-style-type: none"> <li>The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)</li> </ul>	<ul style="list-style-type: none"> <li>The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)</li> </ul>
		<ul style="list-style-type: none"> <li>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.</li> </ul>	
		<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	
		<ul style="list-style-type: none"> <li>The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).</li> </ul>	
4.	<b>Deselect STO</b>		
	4.1.	Deselect STO.	
	4.2.	Check the following:	
		<ul style="list-style-type: none"> <li>STO is not active (r9773.1 = 0).</li> </ul>	
		<ul style="list-style-type: none"> <li>The inverter signals neither faults nor alarms of the safety functions (r0945[0...7], r2122[0...7]).</li> </ul>	

You have performed the acceptance test of the STO function.

## 8.9 Switchover between different settings

There are applications that require different inverter settings.

### Example:

You connect different motors to one inverter. Depending on the particular motor, the inverter must operate with the associated motor data and the appropriate ramp-function generator.

### Drive data sets (DDS)

You can set several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0, 1, 2 or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the inverter with the same index are called the drive data set.

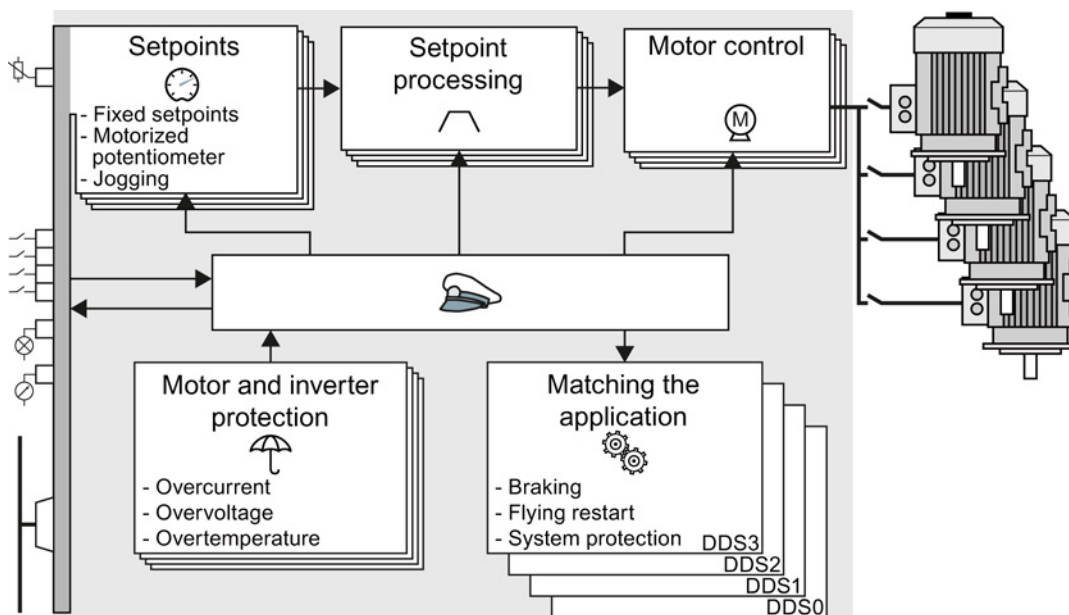


Figure 8-42 Switching over between different settings using drive data sets (DDS)

Using parameter p0180 you can define the number of drive data sets (1 ... 4).

Table 8- 46 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	<b>Drive commissioning:</b> Data sets
p0180	<b>Drive data sets (DDS) number</b> (factory setting: 1)
p0010 = 0	<b>Drive commissioning:</b> Ready

Table 8- 47 Parameters for switching the drive data sets:

Parameter	Description
p0820	<b>Drive data set selection DDS bit 0</b>
p0821	<b>Drive data set selection DDS bit 1</b>
p0826	<b>Motor changeover, motor number</b> Each drive data set is assigned a motor number: p0826[0] = motor number for drive data set 0. ... p0826[3] = motor number for drive data set 3. If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation. If you operate different motors on one inverter, then the motors must be numbered in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.
r0051	<b>Displaying the number of the DDS that is currently effective</b>

For an overview of all the parameters that belong to the drive data sets and can be switched, see the List Manual.

Table 8- 48 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	<b>Source drive data set</b>
p0819[1]	<b>Target drive data set</b>
p0819[2] = 1	<b>Start copy operation</b>

For more information, see the List Manual (the parameter list and function diagram 8565).



# Backing up data and series commissioning

## 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 Replacing a Control Unit with enabled safety function (Page 296)).

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 a memory card

### What memory cards do we recommend?

We recommend that you use one of the memory cards with the following order numbers:

- MMC (order number 6SL3254-0AM00-0AA0)
- SD (order number 6ES7954-8LB01-0AA0)

### 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

##### Precondition

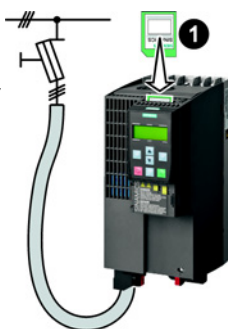
The inverter power supply has been switched off.

##### 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

##### Precondition

- The inverter power supply has been switched on.
- Insert a memory card into the inverter.

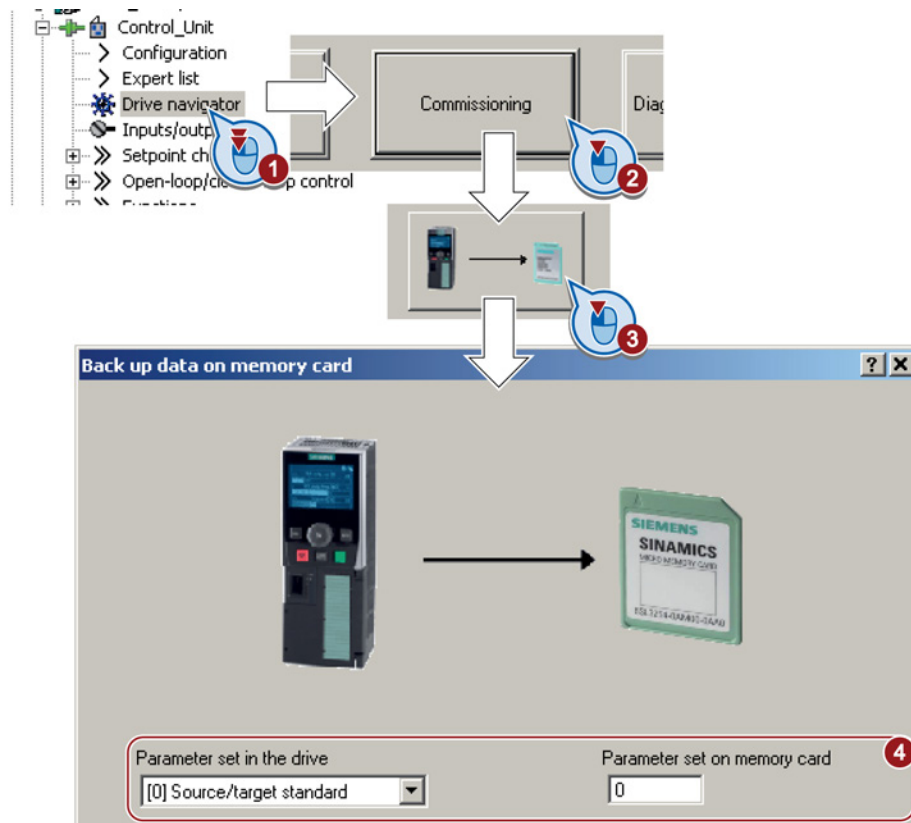


➔ 1  
2

### Procedure using STARTER

Proceed as follows to manually back up your settings on 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 settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.



■

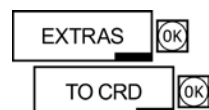
You have manually backed up the settings on the memory card.

➔ 1  
2

### Procedure with the BOP-2

Proceed as follows to manually back up your settings on a memory card:

1. Plug a BOP-2 onto the inverter.
2. Go to the menu level "EXTRAS".
3. 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

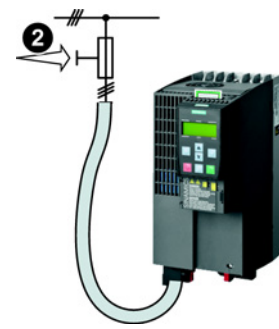
The inverter power supply has been switched off.

#### 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

#### Precondition

- The inverter power supply has been switched on.
- Insert a memory card into the inverter.

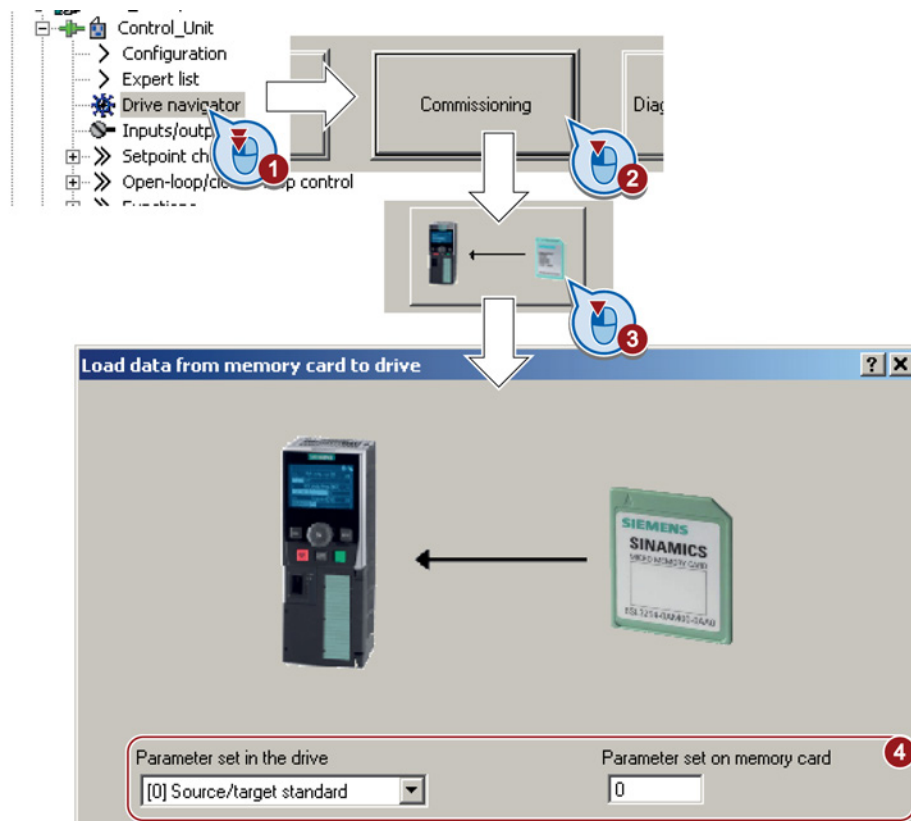




### Procedure using STARTER

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.



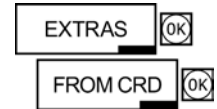
You have manually transferred the settings from the memory card.



### Procedure with the BOP-2

Proceed as follows to manually transfer your settings from a memory card:

1. Plug a BOP-2 onto the inverter.
2. Go to the menu level "EXTRAS".
3. Start data transfer in the menu "EXTRAS" - "FROM CRD".
4. Switch off the inverter power supply.
5. Wait until all LED on the inverter go dark.
6. 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.

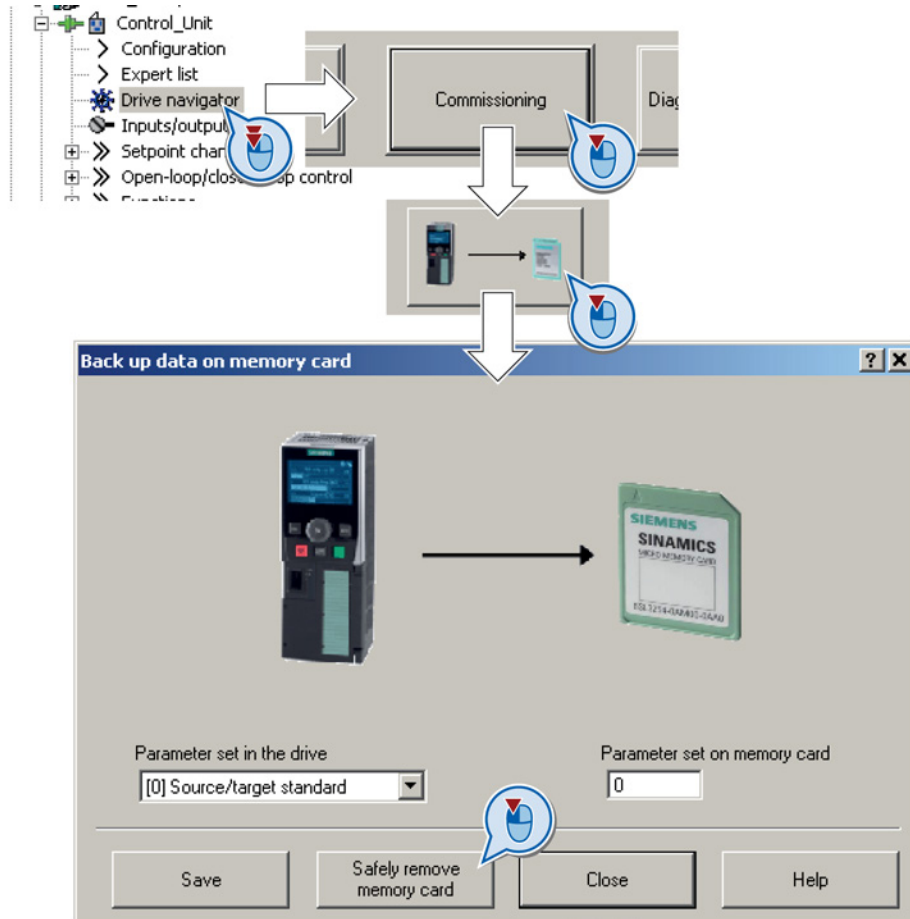
Only remove the memory card using the "safe removal" function.

➔ 1  
2

### Procedure using STARTER

To safely remove the memory card, proceed as follows:

1. In the Drive Navigator select 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.



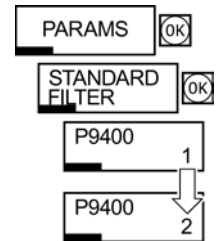
You have now safely removed the memory card.



### 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.



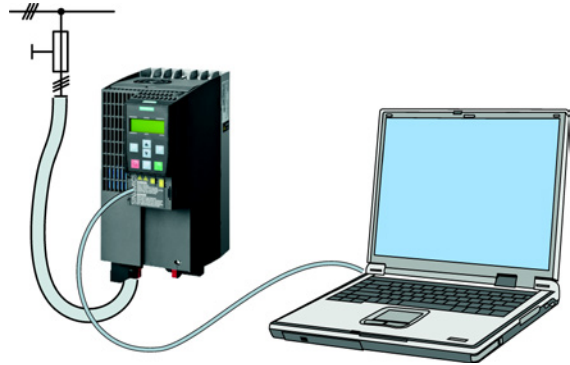
You have now safely removed the memory card.

## 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 Tools to commission the converter (Page 35).

### 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

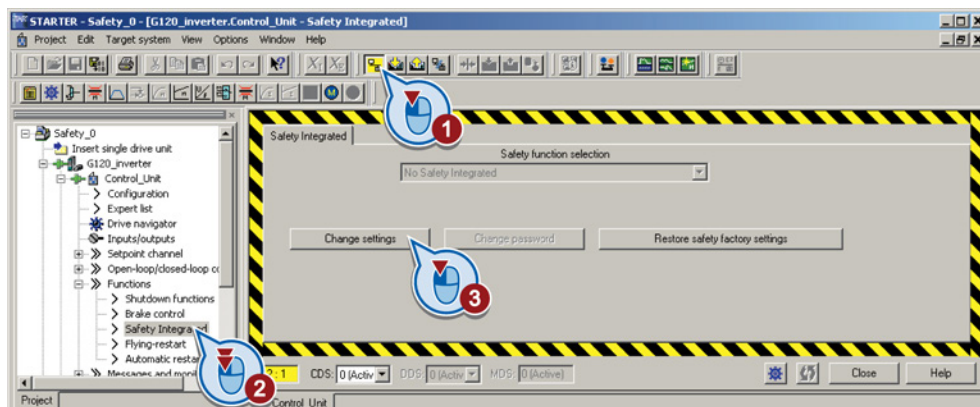
The procedure depends on whether you also transfer settings of safety functions or not.

#### Converter without safety functions:

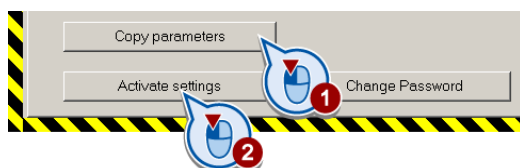
- Go online with STARTER : .
- Select the button "Download project to target system": .
- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .



#### 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.



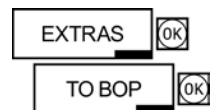
### Inverter → BOP-2



#### 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>).

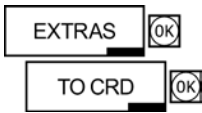

Table 9- 1 Backing up settings in the converter

Parameter	Description
p0970	<b>Reset drive parameters</b> Load backed-up setting (number 10, 11 or 12). The load overwrites the current setting.
p0971	<b>Save parameters</b> Back up the setting (10, 11 or 12).

Table 9- 2 Backing up additional settings on the memory card

Parameter	Description
p0802	<b>Data transfer with memory card as source/target</b> (factory setting 0) Default setting: p802 = 0 Further settings: p802 = 1 ... 99
p0803	<b>Data transfer with device memory as source/target</b> (factory setting 0) Default setting: p803 = 0 Further settings: p803 = 10, 11 or 12

Table 9- 3 Operation on the BOP-2

	Description
	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.
	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.

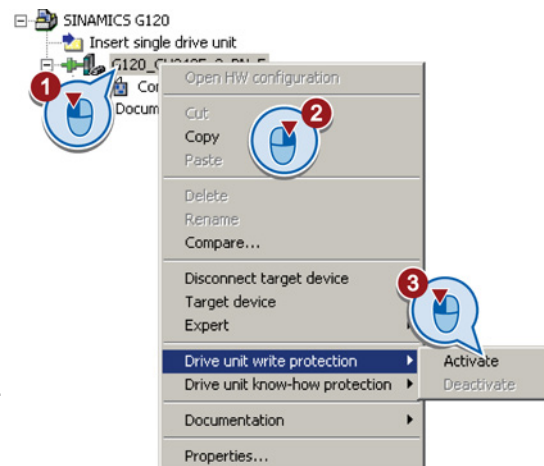
### Activate and deactivate write protection

#### 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.

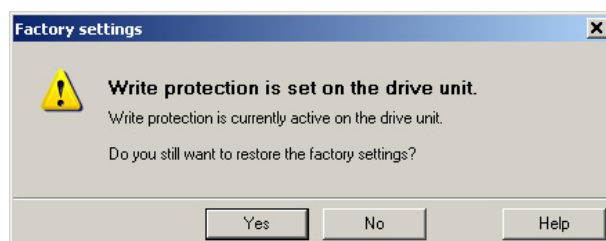
To make this setting permanent, you need to select "Copy RAM to ROM" . Otherwise, your settings will be lost when the inverter is switched off.



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 292).
3. Activate the know-how protection (Page 290).
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

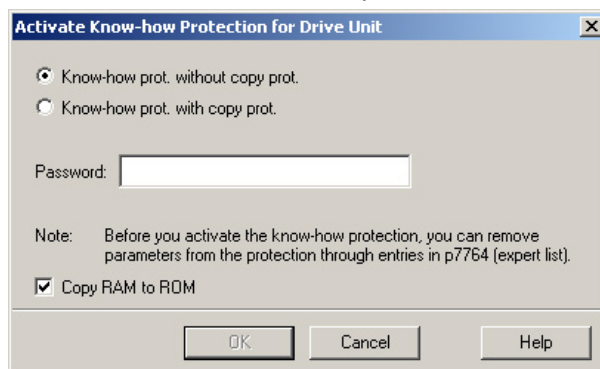


### Procedure

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 288)).
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.

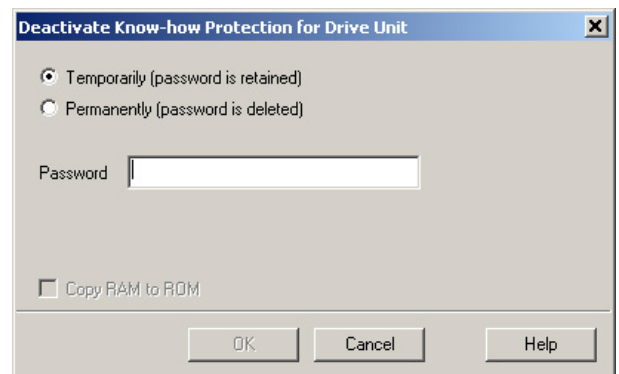
### Deactivate know-how protection, delete password



#### 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 with active know-how protection

#### Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the converter settings can be transferred to another converter using a memory card.

See also:

- Saving setting on memory card (Page 275)
- Transferring the setting from the memory card (Page 277)

#### 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 "Replacing a Control Unit with enabled safety function (Page 296)".

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 290)
  - 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 290)
  - 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 290)
  - 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 290)
  - 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.




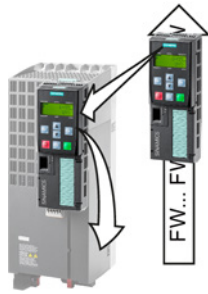
If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

## Corrective maintenance

### 10.1 Overview of replacing converter components

#### Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The inverter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement:	Replacement:	Replacement:	Replacement:
<ul style="list-style-type: none"> <li>Same type</li> <li>Same power rating</li> </ul>	<ul style="list-style-type: none"> <li>Same type</li> <li><i>Higher</i> power rating</li> </ul>	<ul style="list-style-type: none"> <li>Same type</li> <li>Same firmware version</li> </ul>	<ul style="list-style-type: none"> <li>Same type</li> <li><i>higher</i> firmware version (e.g. replace FW V4.2 by FW V4.3)</li> </ul>
			
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the inverter's settings.	

#### WARNING

##### 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, you can use environment detection to replace a defective inverter with a new device of the same type and with the same software release. Recommissioning is not required in this case.

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>).

## 10.2 Replacing a Control Unit with enabled safety function

### Replacing a Control Unit with data backup on a memory card



#### Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module. The new Control Unit must have the same order number and the same or higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
  - Alarm A01028:  
The 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 266).




You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.

## Replacing a Control Unit with data backup in the PC



### Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC to the inverter by pressing the  button.  
The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. In STARTER, select the screen form for the safety functions.
10. Select the "Change settings" button.
11. Select the "Activate settings" button.
12. Save your settings (copy RAM to ROM ).
13. Switch off the inverter power supply.
14. Wait until all 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 (Page 266).



You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.

## Replacing the Control Unit with data backup in the operator panel (BOP-2 or IOP)



### Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Attach the operator panel to the Control Unit.
8. Transfer the settings from the operator panel to the inverter, e.g. via menu "EXTRAS" - "FROM BOP" in the BOP-2.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs alarm A01028.
  - Alarm A01028:  
The loaded settings are not compatible with the inverter.  
Clear the alarm with p0971 = 1, and recommission the drive.
  - No alarm A01028: Proceed with the next step.
11. Switch off the inverter power supply.
12. Wait until all LED on the inverter go dark.
13. Switch on the inverter power supply again (power on reset).  
The inverter signals the faults F1650, F1680, and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0015 = 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 to 0.
18. Ensure that the settings are protected against power failure, e.g. via menu "EXTRAS" - "RAM-ROM" in the BOP-2.
19. Switch off the inverter power supply.
20. Wait until all LED on the inverter go dark.
21. Switch on the inverter power supply again (power on reset).
22. Perform a **reduced** acceptance test, see the section Reduced acceptance test (Page 266).



You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.

## 10.3 Replacing the Control Unit without the safety functions enabled

### Replacing a Control Unit with data backup on a memory card



#### Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module. The new Control Unit must have the same order number and the same or a higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
  - Alarm A01028:  
The settings that have been loaded are not compatible with the inverter.  
Clear the alarm with p0971 = 1, and recommission the drive.
  - No alarm A01028:  
The inverter accepts the settings that have been loaded.



You have successfully replaced the Control Unit.


## Replacing a Control Unit with data backup in the PC



### Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.

8. Go online and transfer the settings from the PC into the inverter by pressing the  button.

The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.

9. Save your settings (copy RAM to ROM ).



You have successfully replaced the Control Unit.

## 10.4 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.



### Procedure

To replace the Control Unit without backed-up settings, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Recommission the drive.



The Control Unit replacement has been completed after the drive has been successfully commissioned.

## 10.5 Replacing a Power Module with enabled safety function



### Procedure

To replace the Power Module, proceed as follows:

1. Disconnect the line voltage to the Power Module.  
You must not disconnect the external 24 V supply (if installed) to the Control Unit.



#### **DANGER**

##### **Risk of electric shock from touching inverter connections**

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 Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

#### **NOTICE**

##### **Material damage 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. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
8. Perform a reduced acceptance test, see the Section Reduced acceptance test (Page 266).



You have successfully replaced the Power Module.

## 10.6 Replacing a Power Module without the safety function being enabled



### Procedure

Proceed as follows to exchange a Power Module:

1. Switch off the supply voltage to the Power Module.  
You do not have to switch off an external 24 V power supply for the Control Unit if one is being used.



#### **DANGER**

##### **Risk of electric shock from touching inverter connections**

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is non-hazardous.

Check the voltage at the inverter connections, before removing the connection cables.

2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

#### **NOTICE**

##### **Material damage when interchanging the motor connecting cables**

The direction in which the motor rotates switches if you exchange the two phases of the motor line.

Connect the three phases of the motor lines in the right order.

After exchanging the power module check the direction in which the motor rotates.

7. Switch on the line supply and, if being used, the 24 V supply of the Control Unit.

You have successfully replaced the Power Module.



## 10.7 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.

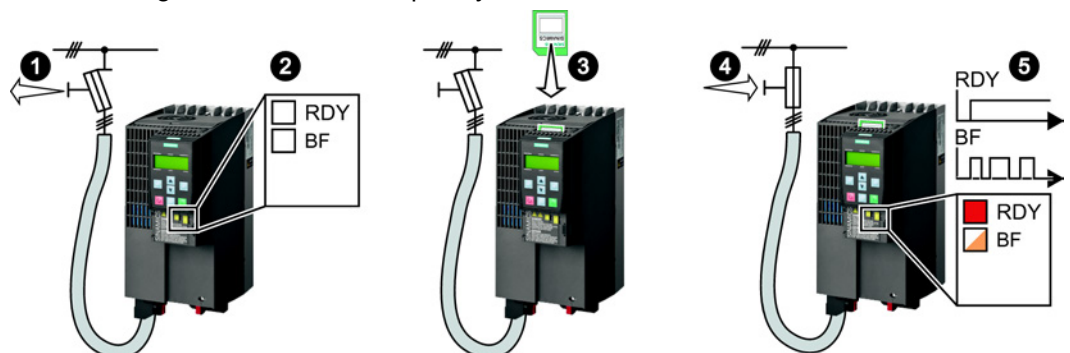
### Procedure

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).

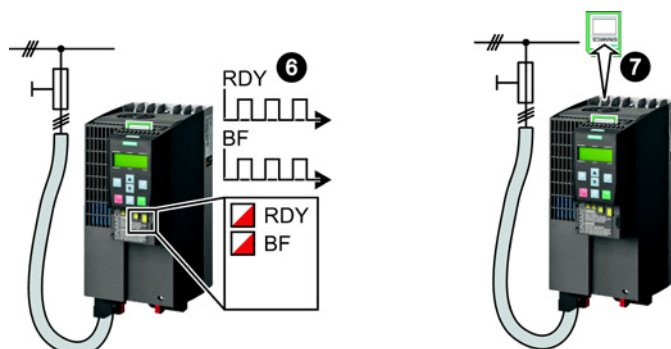
### Note

#### Corrupted firmware if the power supply fails during the transfer

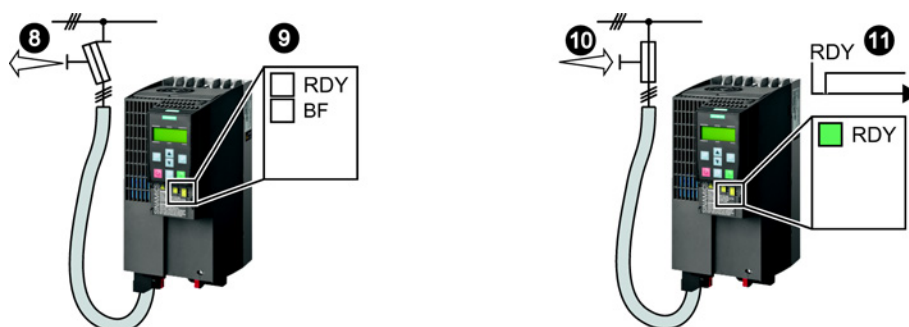
The inverter firmware can be corrupted if the power supply fails during the transfer.

- 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.

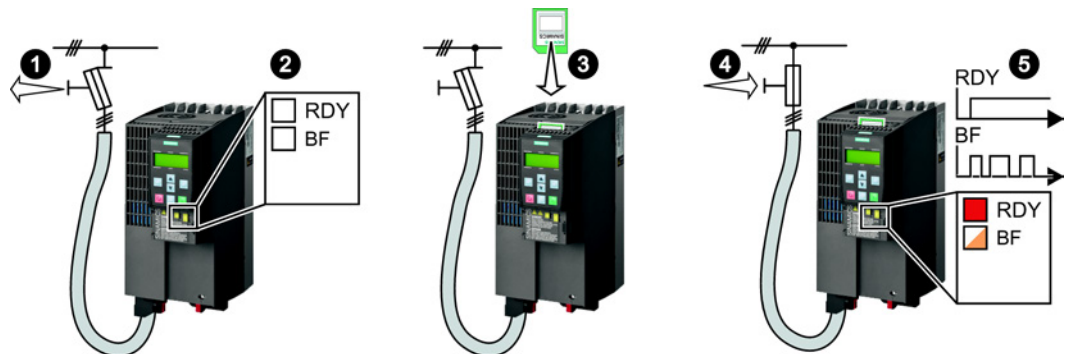
### Procedure

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).

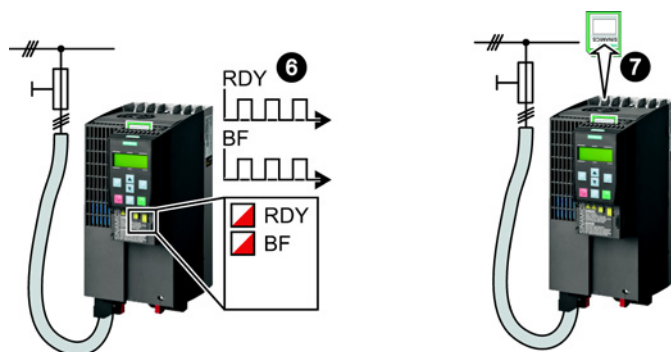
### Note

#### Corrupted firmware if the power supply fails during the transfer

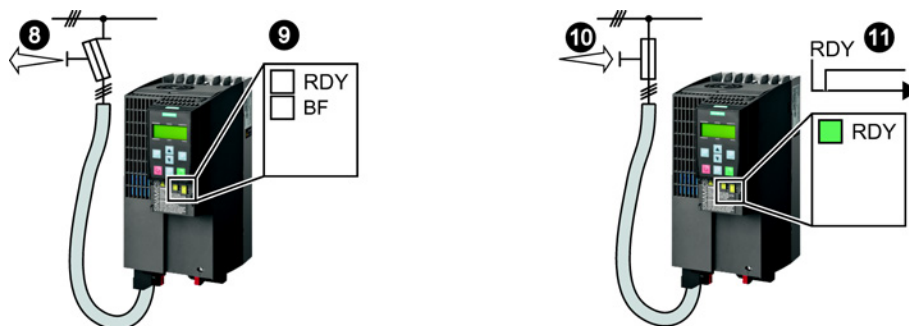
The inverter firmware can be corrupted if the power supply fails during the transfer.

- 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.

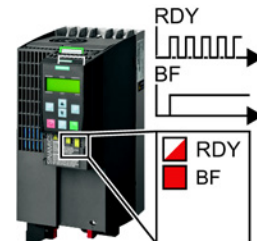
See also Section: Backing up data and series commissioning (Page 273).

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

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:

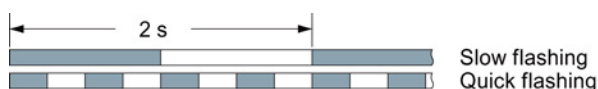


Table 11- 1 Inverter diagnostics

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

11.1 Operating states indicated on LEDs

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.

## 11.2 System runtime

By evaluating the system runtime of the inverter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

### Principle of operation

The system runtime is started as soon as the Control Unit power supply is switched-on. The system runtime stops when the Control Unit is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

If r2114[0] has reached a value of 86,400,000 ms (24 hours), r2114[0] is set to the value 0 and the value of r2114[1] is increased by 1.


Using system runtime, you can track the sequence of faults and alarms over time. When a corresponding message is triggered, parameter values r2114 are transferred unchanged to the corresponding parameters of the alarm or fault buffer, see chapter entitled Alarms, faults and system messages (Page 311).

Parameters	Description
r2114[0]	System runtime (ms)
r2114[1]	System runtime (days)

You cannot reset the system runtime.

## 11.3 Alarms

Alarms have the following properties:

- They do not have a direct effect in the converter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - At the Operator Panel with a Axxxxx
  - Via STARTER, if you click on TAB  at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

### Alarm buffer

For each incoming alarm, the converter saves the alarm, alarm value and the time that the alarm was received.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		I32	Float	Days	ms	Days	ms

Figure 11-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).

The converter uses an internal time calculation to save the alarm times. More information on the internal time calculation can be found in Chapter System runtime (Page 313).

As soon as the alarm has been removed, the converter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value			Alarm time received	Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3. Alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4. Alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5. Alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6. Alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7. Alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-3 Complete alarm buffer

### Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the converter shifts all alarms that have been removed from the alarm buffer into the alarm history. In the alarm history, alarms are also sorted according to the "alarm time received", however, when compared to the alarm buffer, in the inverse sequence:

- The youngest alarm is in index 8
- The second youngest alarm is in index 9
- etc.

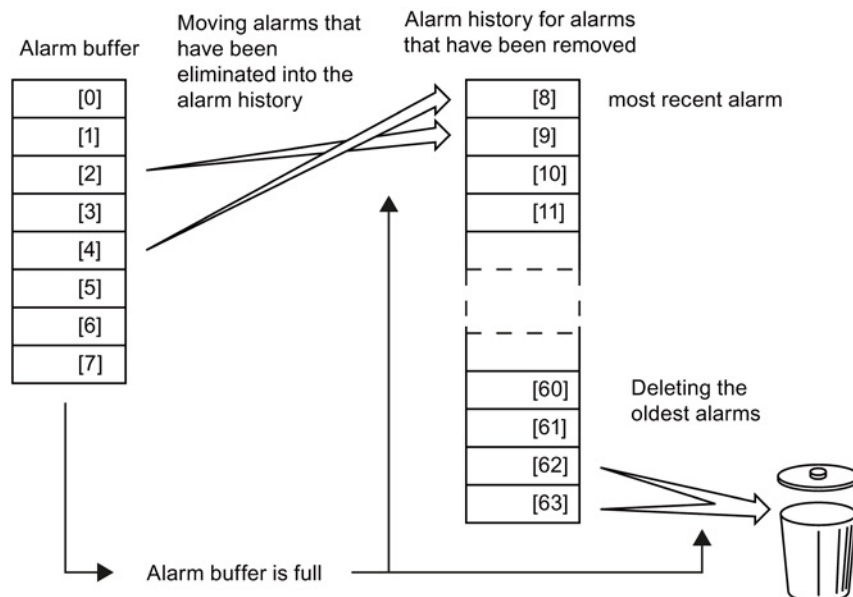


Figure 11-4 Shifting alarms that have been removed into the alarm history

Any alarms that have not been removed remain in the alarm buffer. The converter sorts the alarms and closes gaps between the alarms.

If the alarm history is filled up to index 63, each time a new alarm is accepted in the alarm history, the oldest alarm is deleted.

## Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	<b>Alarm code</b> Displays the numbers of alarms that have occurred
r2123	<b>Alarm time received in milliseconds</b> Displays the time in milliseconds when the alarm occurred
r2124	<b>Alarm value</b> Displays additional information about the alarm
r2125	<b>Alarm time removed in milliseconds</b> Displays the time in milliseconds when the alarm was removed
p2111	<b>Alarm counter</b> Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2145	<b>Alarm time received in days</b> Displays the time in days when the alarm occurred
r2132	<b>Actual alarm code</b> Displays the code of the alarm that last occurred
r2134	<b>Alarm value for float values</b> Displays additional information about the alarm that occurred for float values
r2146	<b>Alarm time removed in days</b> Displays the time in days when the alarm was removed

## Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118	<b>Setting the message number for the message type</b> Selection of the alarms for which the message type should be changed
p2119	<b>Setting the message type</b> Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

## 11.4 Faults

A fault displays a severe fault during operation of the inverter.

The inverter signals a fault as follows:

- At the operator panel with Fxxxxx
- On the inverter using the red LED RDY
- In bit 3 of status word 1 (r0052)
- Via STARTER

To delete a message, you must remedy the cause of the fault and acknowledge the fault.

Every fault has a 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 inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
		I32	Float	Days	ms	Days	ms

Figure 11-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written into parameters r2109 and r2136 when the fault has been acknowledged.

The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter System runtime (Page 313).

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 11-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]




Figure 11-7 Complete fault buffer

## Acknowledgement

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 detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only with switch-on and switch-off. The list of faults of the List Manual contains the note on this limited acknowledgement possibility.

## Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The 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 (indexes 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).

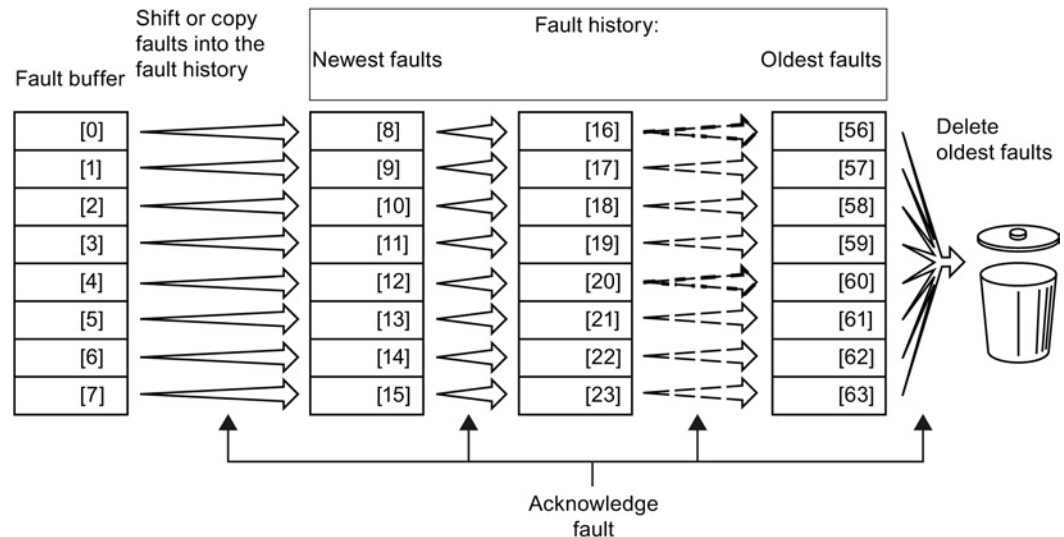


Figure 11-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history. For these faults, the "fault time coming" remains unchanged and the "fault time removed" remains empty.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indexes remain empty.

The inverter shifts the values previously saved in the fault history each by eight indexes. Faults, which were saved in indexes 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

Parameter	Description
r0945	<b>Fault code</b> Displays the numbers of faults that have occurred
r0948	<b>Fault time received in milliseconds</b> Displays the time in milliseconds when the fault occurred
r0949	<b>Fault value</b> Displays additional information about the fault
p0952	<b>Fault cases, counter</b> Number of fault cases that have occurred since the last acknowledgement The fault buffer is deleted with p0952 = 0.
r2109	<b>Fault time removed in milliseconds</b> Displays the time in milliseconds when the fault occurred
r2130	<b>Fault time received in days</b> Displays the time in days when the fault occurred
r2131	<b>Actual fault code</b> Displays the code of the oldest fault that is still active
r2133	<b>Fault value for float values</b> Displays additional information about the fault that occurred for float values
r2136	<b>Fault time removed in days</b> Displays the time in days when the fault was removed

## The motor cannot be switched-on

If the motor cannot be switched-on, then check the following:

- Is a fault present?  
If there is, then remove the fault cause and acknowledge the fault.
- Is p0010 = 0?  
If not, the inverter 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)?
- How does the inverter receive its setpoint and commands (p0015)?

## Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	<b>Setting the fault number for fault response</b> Selection of the faults for which the fault response applies
p2101	<b>Setting, fault response</b> Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	<b>Setting the fault number for the acknowledgement mode</b> Selection of the faults for which the acknowledgement type should be changed
p2127	<b>Setting, acknowledgement mode</b> Setting the acknowledgement type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgement after removing the fault cause
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	<b>Setting the message number for the message type</b> Selection of the message for which the message type should be changed
p2119	<b>Setting the message type</b> Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

## 11.5 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 6 The most important alarms and faults of the safety functions

Number	Cause	Remedy
F01600	STOP A Triggered	STO Select and then deselect again.
F01650	Acceptance test required	Carry out acceptance test and create test certificate. Switch the Control Unit off and then on again.
F01659	Write task for parameter rejected	Cause: The converter should be reset to the factory setting. The resetting of the safety functions is, however, not allowed, because the safety functions are currently enabled. Remedy with operator panel:
		p0010 = 30      Parameter reset
		p9761 = ...      Enter password for the safety functions.
		p0970 = 5      Reset Start Safety Parameter. The converter sets p0970 = 5 if it has reset the parameters.
		Then reset the converter to the factory setting again.
A01666	Static 1 signal at F-DI for safe acknowledgment	F-DI to a logical 0 signal.
A01698	Commissioning mode active for safety functions	This message is withdrawn after the Safety commissioning has ended.
A01699	Shutdown path test required	After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.
F30600	STOP A Triggered	STO Select and then deselect again.

Table 11- 7 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU.
F01001	Floating Point Exception	Switch CU off and on again.
F01015	Software fault in CU	Upgrade firmware or contact technical support.
F01018	Power-up aborted more than once	After this fault is output, the converter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the converter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
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.

## 11.5 List of alarms and faults

Table 11- 8 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	<ol style="list-style-type: none"> <li>1. Switch the module off and on again.</li> <li>2. After this fault has been output, the module is booted with the factory settings.</li> <li>3. Recommission the inverter.</li> </ol>
A01028	Configuration error	<p>Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB)</p> <p>Check the module parameters and recommission if necessary.</p>
F01033	Switching over units: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Switching over units: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
A01053	System overload measured	<p>The maximum computing power of the control unit was exceeded. The following measures reduce the load on the control unit:</p> <ul style="list-style-type: none"> <li>• Use only one data record (CDS and DDS)</li> <li>• Only use the safety features of the basic functions</li> <li>• De-activate the technology controller</li> <li>• Use the simple ramp-function generator rather than the extended ramp-function generator</li> <li>• Do not use any free function components</li> <li>• Reduce the sampling time of the free function blocks</li> </ul>
F01054	System limit exceeded	
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
A01900	PROFIBUS: Configuration telegram faulty	<p>Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram.</p> <p>Check the bus configuration on the master and slave side.</p>
A01910 F01910	Setpoint timeout	<p>The alarm is generated when p2040 <math>\neq</math> 0 ms and one of the following causes is present:</p> <ul style="list-style-type: none"> <li>• The bus connection is interrupted</li> <li>• The Modbus master is switched off</li> <li>• Communications error (CRC, parity bit, logical error)</li> <li>• An excessively low value for the fieldbus monitoring time (p2040)</li> </ul>
A01920	PROFIBUS: Cyclic connection interrupt	<p>Explanation: The cyclic connection to PROFIBUS master is interrupted.</p> <p>Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.</p>
F03505	Analog input, wire break	<p>Check the wiring for interruptions.</p> <p>Check the level of the injected signal.</p> <p>The input current measured by the analog input can be read out in r0752.</p>

Number	Cause	Remedy
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly set	Check the set supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check 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). Deactivate the motor temperature sensor fault evaluation (p0607 = 0).
F07086 F07088	Switching over units: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	DC link voltage maximum controller active	<p><b>Vector control or U/f control:</b> If it is not desirable that the controller intervenes:</p> <ul style="list-style-type: none"> <li>• Increase the ramp-down times.</li> <li>• Deactivate the Vdc_max control (p1240 = 0 for vector control, p1280 = 0 for U/f control).</li> </ul> <p><b>Servo control:</b> No measures required; the alarm disappears automatically if the upper threshold is significantly fallen below. Possible measures:</p> <ul style="list-style-type: none"> <li>• Use a Braking Module or regenerative feedback unit, increase the ramp-down times (p1121, p1135), deactivate the Vdc_max controller (p1240 = 0).</li> </ul>

## 11.5 List of alarms and faults

Number	Cause	Remedy
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: <ul style="list-style-type: none"> <li>• Increase the current limit (p0640).</li> <li>• Reduce the load.</li> <li>• Slow down the up ramp for the setpoint speed.</li> </ul>
F07426	Technology controller actual value limited	<ul style="list-style-type: none"> <li>• Adapt the limits to the signal level (p2267, p2268).</li> <li>• Check the actual value scaling (p2264).</li> </ul>
F07801	Motor overcurrent	<p>Check current limits (p0640).</p> <p>Vector control: Check current controller (p1715, p1717).</p> <p>U/f control: Check the current limiting controller (p1340 ... p1346).</p> <p>Increase acceleration ramp (p1120) or reduce load.</p> <p>Check motor and motor cables for short circuit and ground fault.</p> <p>Check the motor regarding the star/delta connection and rating plate parameterization.</p> <p>Check power unit / motor combination.</p> <p>Select flying restart function (p1200) if switched to rotating motor.</p>
A07805	Drive: Power unit overload I2t	<ul style="list-style-type: none"> <li>• Reduce the continuous load.</li> <li>• Adapt the load cycle.</li> <li>• Check the assignment of rated currents of the motor and power unit.</li> </ul>
F07806	Regenerative power limit exceeded	<p>Increase deceleration ramp.</p> <p>Reduce driving load.</p> <p>Use power unit with higher energy recovery capability.</p> <p>For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.</p>
F07807	Short circuit detected	<ul style="list-style-type: none"> <li>• Check the inverter connection on the motor side for any phase-phase short-circuit.</li> <li>• Rule out that line and motor cables have been interchanged.</li> </ul>
A07850 A07851 A07852	External alarm 1 ... 3	<p>The signal for "external alarm 1" has been triggered.</p> <p>Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1... 3.</p> <p>Remedy: Remove the causes of these alarms.</p>
F07860 F07861 F07862	External fault 1 ... 3	Remove the external causes for this fault.
F07900	Motor blocked	<p>Check that the motor can run freely.</p> <p>Check the torque limits (r1538 and r1539).</p> <p>Check the parameters of the "Motor blocked" message (p2175, p2177).</p>
F07901	Motor overspeed	<p>Activate the precontrol for the speed limiting controller (p1401 bit 7 = 1).</p> <p>Increase hysteresis for overspeed signal p2162.</p>
F07902	Motor stalled	<p>Check whether the motor data has been set correctly and perform a motor identification.</p> <p>Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized.</p> <p>Check whether motor cables are disconnected during operation.</p>

Number	Cause	Remedy
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. <ul style="list-style-type: none"> <li>Check the connection between the motor and the load.</li> <li>Adapt the parameterization corresponding to the load.</li> </ul>
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	<ul style="list-style-type: none"> <li>Check the connection between the motor and the load.</li> <li>Adapt the parameterization corresponding to the load.</li> </ul>
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	<ul style="list-style-type: none"> <li>Check the PROFINET connection.</li> <li>Set the controller into the RUN mode.</li> <li>If the fault occurs repeatedly, check the monitoring time set p2044.</li> </ul>
F08502	Monitoring time, sign-of-life expired	<ul style="list-style-type: none"> <li>Check the PROFINET connection.</li> </ul>
F08510	Send configuration data not valid	<ul style="list-style-type: none"> <li>Check the PROFINET configuration</li> </ul>
A08511	Receive configuration data not valid	
A08526	No cyclic connection	<ul style="list-style-type: none"> <li>Activate the controller with cyclic operation.</li> <li>Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).</li> </ul>
A08565	Consistency error affecting adjustable parameters	Check the following: <ul style="list-style-type: none"> <li>IP address, subnet mask or default gateway is not correct.</li> <li>IP address or station name used twice in the network.</li> <li>Station name contains invalid characters.</li> </ul>
F08700	Communications error	A CAN communications error has occurred. Check the following: <ul style="list-style-type: none"> <li>Bus cable</li> <li>Baud rate (p8622)</li> <li>Bit timing (p8623)</li> <li>Master</li> </ul> Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!

11.5 List of alarms and faults

Number	Cause	Remedy
F13100	Know-how protection: Copy protection error	<p>The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card.</p> <ul style="list-style-type: none"> <li>• Insert a suitable memory card and switch the inverter supply voltage temporarily off and then on again (POWER ON).</li> <li>• Deactivate the copy protection (p7765).</li> </ul>
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	<p>Check the following:</p> <ul style="list-style-type: none"> <li>• Motor data, if required, carry out commissioning</li> <li>• Motor connection method (Y / <math>\Delta</math>)</li> <li>• U/f operation: Assignment of rated currents of motor and Power Module</li> <li>• Line quality</li> <li>• Make sure that the line commutating reactor is connected properly</li> <li>• Power cable connections</li> <li>• Power cables for short-circuit or ground fault</li> <li>• Power cable length</li> <li>• Line phases</li> </ul> <p>If this doesn't help:</p> <ul style="list-style-type: none"> <li>• U/f operation: Increase the acceleration ramp</li> <li>• Reduce the load</li> <li>• Replace the power unit</li> </ul>
F30002	DC-link voltage overvoltage	<p>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.</p>
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Inverter overtemperature	<p>Check whether the inverter fan is running.  Check whether the ambient temperature is in the permissible range.  Check whether the motor is overloaded.  Reduce the pulse frequency.</p>
F30005	I2t inverter overload	<p>Check the rated currents of the motor and Power Module.  Reduce current limit p0640.  When operating with U/f characteristic: Reduce p1341.</p>
F30011	Line phase failure	<p>Check the inverter's input fuses.  Check the motor feeder cables.</p>
F30015	Motor cable phase failure	<p>Check the motor cables.  Increase the ramp-up or ramp-down time (p1120).</p>

Number	Cause	Remedy
F30021	Ground fault	<ul style="list-style-type: none"> <li>• Check the power cable connections.</li> <li>• Check the motor.</li> <li>• Check the current transformer.</li> <li>• Check the cables and contacts of the brake connection (a wire might be broken).</li> </ul>
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	<ul style="list-style-type: none"> <li>• Check whether the fan is running.</li> <li>• Check the fan filter elements.</li> <li>• Check whether the ambient temperature is in the permissible range.</li> </ul>
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: <ul style="list-style-type: none"> <li>• Check the motor load.</li> <li>• Check the line phases</li> </ul>
A30049	Internal fan defective	Check the internal fan and if required replace.
F30059	Internal fan defective	Check the internal fan and if required replace.
A30502	DC link overvoltage	<ul style="list-style-type: none"> <li>• Check the unit supply voltage (p0210).</li> <li>• Check the dimensioning of the line reactor.</li> </ul>
A30920	Temperature sensor fault	Check that the sensor is connected correctly.
A50001	PROFINET configuration error	A PROFINET controller is attempting to establish a connection with an incorrect configuration telegram. Check 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 available.
For further information, please refer to the List Manual.		

For further information, please refer to the List Manual.



## Technical data

### 12.1 Technical data, CU240B-2 Control Unit

Table 12- 1

Feature	Data	
Order numbers	6SL3244-0BB00-1BA1	With RS485 interface for the following protocols: <ul style="list-style-type: none"> <li>• USS</li> <li>• Modbus RTU</li> </ul>
	6SL3244-0BB00-1PA1	With PROFIBUS interface.
Operating voltage	<ul style="list-style-type: none"> <li>• Supply from the Power Module</li> <li>• or externally via terminals 31 and 32 with 24 V DC, a maximum of 200 VA</li> </ul> <p>Use a power supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1): The 0 V of the power supply must be connected with low resistance to the PE of the system. Example: SITOP Power power supply unit 5 A.</p> <p>The power supply is electrically isolated from the control terminals.</p>	
Current consumption	max 0.5 A	
Power loss	5.0 W	Plus power loss of the output voltages.
Output voltages	+24 V out (terminal 9), 18 V ... 28.8 V, max. 100 mA	
	+10 V out (terminals 1 and 35), 9.5 V ... 10.5 V, max. 10 mA	
Setpoint resolution	0.01 Hz	
Digital inputs	4 (DI 0 ... DI 3)	<ul style="list-style-type: none"> <li>• Low &lt; 5 V, high &gt; 11 V</li> <li>• Electrically isolated</li> <li>• 30 V maximum input voltage</li> <li>• 5.5 mA current consumption</li> <li>• SIMATIC-compatible</li> <li>• PNP/NPN switchable</li> <li>• 10 ms response time for debounce time p0724 = 0.</li> </ul>
Analog input	1 (AI 0)	<ul style="list-style-type: none"> <li>• Differential input</li> <li>• Switchable: 0 V ... 10 V, 0 mA ... 20 mA or -10 V ... +10 V</li> <li>• 12-bit resolution</li> <li>• 13 ms ± 1 ms response time</li> <li>• If AI 0 has been configured as additional digital input: Low &lt; 1.6 V, high &gt; 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.</li> </ul>
Digital output / relay output	1 (DO 0)	<ul style="list-style-type: none"> <li>• 30 V DC / max. 0.5 A with resistive load</li> <li>• Update time 2 ms</li> </ul>

## Technical data

### 12.1 Technical data, CU240B-2 Control Unit

Feature	Data	
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.	
Analog output	1 (AO 0)	<ul style="list-style-type: none"> <li>• 0 V ... 10 V or 0 mA ... 20 mA</li> <li>• Reference potential: "GND"</li> <li>• 16-bit resolution</li> <li>• 4 ms update time</li> </ul>
Temperature sensor	PTC	<ul style="list-style-type: none"> <li>• Short-circuit monitoring 22 <math>\Omega</math></li> <li>• Switching threshold 1650 <math>\Omega</math></li> </ul>
	KTY84	<ul style="list-style-type: none"> <li>• Short-circuit monitoring &lt; 50 <math>\Omega</math></li> <li>• Wire break &gt; 2120 <math>\Omega</math></li> </ul>
	Temperature switch with isolated contact.	
USB interface	Mini-B	
Dimensions (WxHxD)	73 mm × 199 mm × 39 mm	The depth specification is valid when mounting on the Power Module.
Weight	0.49 kg	
Memory cards	MMC	Recommendation: 6SL3254-0AM00-0AA0
	SD	Recommendation: 6ES7954-8LB00-0AA0 SDHC cards are not possible (SD High Capacity).
Operating temperature	0° C ... 55° C	For operation without inserted operator panel.
	0° C ... 50° C	For operation with inserted operator panel.
	Observe any possible restrictions regarding the operating temperature as a result of the Power Module.	
Storage temperature	- 40° C ... 70° C	
Relative humidity	< 95 %	Condensation is not permissible.

## 12.2 Technical data, CU240E-2 Control Unit

Table 12- 2

Feature	Data	
Order numbers	6SL3244-0BB12-1BA1 6SL3244-0BB13-1BA1	With RS485 interface for the following protocols: <ul style="list-style-type: none"> <li>• USS</li> <li>• Modbus RTU</li> </ul>
	6SL3244-0BB12-1PA1 6SL3244-0BB13-1PA1	With PROFIBUS interface.
	6SL3244-0BB12-1FA0 6SL3244-0BB13-1FA0	With PROFINET interface.
Operating voltage	<ul style="list-style-type: none"> <li>• Supply from the Power Module</li> <li>• or externally via terminals 31 and 32 with 24 V DC, a maximum of 200 VA</li> </ul> <p>Use a power supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1): The 0 V of the power supply must be connected with low resistance to the PE of the system. Example: SITOP Power power supply unit 5 A.</p> <p>The power supply is electrically isolated from the control terminals.</p>	
Current consumption	max 0.5 A	
Power loss	5.0 W	Plus power loss of the output voltages.
Output voltages	+24 V out (terminal 9), 18 V ... 28.8 V, max. 100 mA	
	+10 V out (terminals 1 and 35), 9.5 V ... 10.5 V, max. 10 mA	
Setpoint resolution	0.01 Hz	
Digital inputs	6 (DI 0 ... DI 5)	<ul style="list-style-type: none"> <li>• Low &lt; 5 V, high &gt; 11 V</li> <li>• Electrically isolated</li> <li>• 30 V maximum input voltage</li> <li>• 5.5 mA current consumption</li> <li>• SIMATIC-compatible</li> <li>• PNP/NPN switchable</li> <li>• 10 ms response time for debounce time p0724 = 0.</li> </ul>
Pulse input	1 (DI 3)	Maximum frequency 32 kHz
Analog inputs	2 (AI 0, AI 1)	<ul style="list-style-type: none"> <li>• Differential input</li> <li>• Switchable: 0 V ... 10 V, 0 mA ... 20 mA or -10 V ... +10 V</li> <li>• 12-bit resolution</li> <li>• 13 ms ± 1 ms response time</li> <li>• If AI 0 has been configured as additional digital input: Low &lt; 1.6 V, high &gt; 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.</li> </ul>

Feature	Data	
Digital outputs	3 (DO 0 ... DO 2)	<ul style="list-style-type: none"> <li>DO 0: Relay output, 30 V DC / max. 0.5 A with resistive load</li> <li>DO 1: Transistor output, 30 V DC / max. 0.5 A with resistive load, protection against incorrect voltage polarity.</li> <li>DO 2: Relay output, 30 V DC / max. 0.5 A with resistive load.</li> <li>2 ms update time</li> </ul>
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.	
Analog outputs	2 (AO 0, AO 1)	<ul style="list-style-type: none"> <li>0 V ... 10 V or 0 mA ... 20 mA</li> <li>Reference potential: "GND"</li> <li>16-bit resolution</li> <li>4 ms update time</li> </ul>
Temperature sensor	PTC	<ul style="list-style-type: none"> <li>Short-circuit monitoring 22 <math>\Omega</math></li> <li>Switching threshold 1650 <math>\Omega</math></li> </ul>
	KTY84	<ul style="list-style-type: none"> <li>Short-circuit monitoring &lt; 50 <math>\Omega</math></li> <li>Wire break &gt; 2120 <math>\Omega</math></li> </ul>
	Temperature switch with isolated contact.	
Fail-safe digital input	1 (DI 4 and DI 5)	<ul style="list-style-type: none"> <li>If you have enabled the basic functions of the safety functions, DI 4 and DI 5 form the fail-safe digital input.</li> <li>Maximum input voltage 30 V, 5.5 mA</li> <li>Response time: <ul style="list-style-type: none"> <li>Typical: 5 ms + debounce time p9651</li> <li>Typical, if debounce time = 0: 6 ms</li> <li>Worst-case scenario: 15 ms + debounce time</li> <li>Worst case, if debounce time = 0: 16 ms</li> </ul> </li> </ul>
	The data of the extended functions of the safety functions can be found in the Safety Integrated Function Manual, see also Section: Additional information on the inverter (Page 397).	
PFH	$5 \times 10E-8$	Probability of failure of the safety functions (Probability of Failure per Hour)
USB interface	Mini-B	
Dimensions (WxHxD)	73 mm $\times$ 199 mm $\times$ 39 mm	The depth specification is valid when mounting on the Power Module.
Weight	0.49 kg	
Memory cards	MMC	Recommendation: 6SL3254-0AM00-0AA0
	SD	Recommendation: 6ES7954-8LB00-0AA0 SDHC cards are not possible (SD High Capacity).
Operating temperature	0° C ... 55° C	For operation without inserted operator panel.

Feature	Data
	<p>0° C ... 53° C</p> <p>Only applies to Control Units with PROFINET interface without inserted operator panel when both of the following conditions are satisfied:</p> <ul style="list-style-type: none"> <li>• There is no lateral spacing between one Control Unit and the other. For instance, this is the case if several Power Modules with Frame Size A are mounted directly side by side.</li> <li>• The input voltage of the associated Power Module is greater than 480 V.</li> </ul>
	<p>0° C ... 50° C</p> <p>For operation with inserted operator panel.</p>
	<p>Observe any possible restrictions regarding the operating temperature as a result of the Power Module.</p>
Storage temperature	- 40° C ... 70° C
Relative humidity	<p>&lt; 95 %</p> <p>Condensation is not permissible.</p>

#### Note

##### Losses of voltage from external 24 V power supply if the 400 V supply is switched off

The converter responds to losses of voltage from the external 24 V supply ( $\leq 95\%$  and  $\leq 3\text{ ms}$ ) with error F30074 without however interrupting the fieldbus communication.

You can confirm the error via DI2 (default setting).

## 12.3 Technical data, Power Modules

### Permissible converter overload

There are two different power data specifications for the Power Modules: "**Low Overload**" (LO) and "**High Overload**" (HO), depending on the expected load.

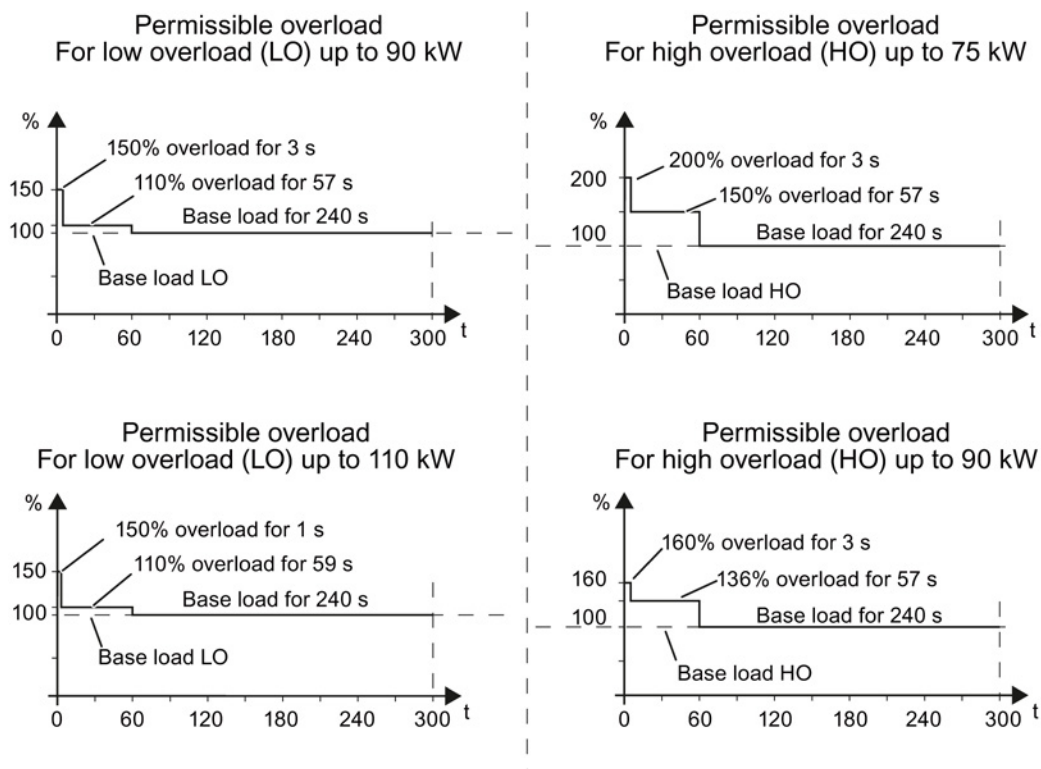


Figure 12-1 Duty cycles, "High Overload" and "Low Overload"

#### 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 Additional information on the inverter (Page 397).

## 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.

## 12.3.1 Technical data, PM230 IP20

### 12.3.1.1 General data, PM230 - IP20

Feature	Version		
Line voltage	380 V ... 480 V 3-ph. AC ± 10%		
Output voltage	0 V 3-ph. AC ... input voltage x 0.95 (max.)		
Input frequency	50 Hz ... 60 Hz, ± 3 Hz		
Output frequency	0 ... 650 Hz, depending on the control mode		
Power factor λ	0.9		
Line impedance	U <sub>k</sub> ≤ 1%, no line reactor permitted		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps up to 16 kHz (up to 8 kHz for 55 kW and 75 kW). An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. For details, see the Hardware Installation Manual, Appendix A2.		
Braking methods	DC braking		
Degree of protection	IP20 built-in units PT devices	IP20 when mounted in a control cabinet IP54 on the control cabinet wall	
Operating temperature	LO without power reduction: HO without power reduction: LO/HO with power reduction:	0° C ... +40° C 0° C ... +50° C to 60° C	For details, see the Hardware Installation Manual.
Storage temperature	-40 °C ... +70 °C		
Relative humidity	< 95% - condensation not permissible		
Contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	<ul style="list-style-type: none"><li>Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997</li><li>Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997</li><li>Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995</li></ul>		
Installation altitude	without power reduction: with power reduction:	up to 1000 m above sea level up to 4000 m above sea level	For details, see the Hardware Installation Manual
Permissible short-circuit current	Frame size D ... F: 65 kA <sup>1)</sup>		
Overvoltage category	Supply circuits: Non-supply circuits:	Overvoltage category III Overvoltage category II	
Standards	UL <sup>1),2)</sup> , CE, C-tick The drive only satisfies the UL requirements when UL-certified fuses are used.		

<sup>1)</sup> If fuse-protected with a listed Class J or 3NE1 fuse, rated voltage 600 VAC with the rated current of the specific converter.

<sup>2)</sup> UL available soon for frame sizes D ... F

### 12.3.1.2 Power-dependent data, PM230, IP20

#### Note

For the PM230 Power Modules, IP20, the low overload values (LO) are identical to the rated values.

Table 12- 3 PM230, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE11-3UL0	...1NE11-7UL0	...1NE12-2UL0
Order No. - with filter	6SL3210...	...1NE11-3AL0	...1NE11-7AL0	...1NE12-2AL0
LO power		0.37 kW	0.55 kW	0.75 kW
LO input current		1.3 A	1.8 A	2.3 A
LO output current		1.3 A	1.7 A	2.2 A
HO power		0.25 kW	0.37 kW	0.55 kW
HO input current		0.9 A	1.3 A	1.8 A
HO output current		0.9 A	1.3 A	1.7 A
Fuse according to IEC		3NE1 813-0	3NE1 813-0	3NE1 813-0
Fuse according to UL		AJT2 / 3NE1 813-0	AJT4 / 3NE1 813-0	AJT4 / 3NE1 813-0
Power loss		0.04 kW	0.04 kW	0.05 kW
Required cooling air flow		1.5 l/s	1.5 l/s	4.5 l/s
Cross section of line and motor cables		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.6 kg	1.6 kg	1.6 kg

Table 12- 4 PM230, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE13-1UL0	...1NE14-1UL0	...1NE15-8UL0
Order No. - with filter	6SL3210...	...1NE13-1AL0	...1NE14-1AL0	...1NE15-8AL0
LO power		1.1 kW	1.5 kW	2.2 kW
LO input current		3.2 A	4.2 A	6.1 A
LO output current		3.1 A	4.1 A	5.9 A
HO power		0.75 kW	1.1 kW	1.5 kW
HO input current		2.3 A	3.2 A	4.2 A
HO output current		2.2 A	3.1 A	4.1 A
Fuse according to IEC		3NE1 813-0	3NE1 813-0	3NE1 813-0
Fuse according to UL		AJT6 / 3NE1 813-0	AJT6 / 3NE1 813-0	AJT10 / 3NE1 813-0
Power loss		0.06 kW	0.07 kW	0.08 kW
Required cooling air flow		4.5 l/s	4.5 l/s	4.5 l/s
Cross section of line and motor cables		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.6 kg	1.6 kg	1.6 kg

Table 12- 5 PM230, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

<b>Order No. - without filter</b>	<b>6SL3210...</b>	<b>...1NE17-7UL0</b>
<b>Order No. - with filter</b>	<b>6SL3210...</b>	<b>...1NE17-7AL0</b>
LO power		3 kW
LO input current		8.0 A
LO output current		7.7 A
HO power		2.2 kW
HO input current		6.1 A
HO output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power loss		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cables		1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg
Weight, filtered		1.6 kg

Table 12- 6 PM230, PT, Frame Sizes A, 3 AC 380 V ... 480 V

<b>Order No. - without filter</b>	<b>6SL3211...</b>	<b>...1NE17-7UL0</b>
<b>Order No. - with filter</b>	<b>6SL3211...</b>	<b>...1NE17-7AL0</b>
LO power		3 kW
LO input current		8.0 A
LO output current		7.7 A
HO power		2.2 kW
HO input current		6.1 A
HO output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power loss		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cables		1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in
Weight, unfiltered		1.7 kg
Weight, filtered		1.9 kg

Table 12- 7 PM230, IP20, Frame Sizes B, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE21-0UL0	...1NE21-3UL0	...1NE21-8UL0
Order No. - with filter	6SL3210...	...1NE21-0AL0	...1NE21-3AL0	...1NE21-8AL0
LO power		4 kW	5.5 kW	7.5 kW
LO input current		10.5 A	13.6 A	18.6 A
LO output current		10.2 A	13.2 A	18 A
HO power		3 kW	4 kW	5.5 kW
HO input current		8.0 A	10.5 A	13.6 A
HO output current		7.7 A	10.2 A	13.2 A
Fuse according to IEC		3NE1 813-0	3NE1 814-0	3NE1 815-0
Fuse according to UL		AJT15 / 3NE1 813-0	AJT20 / 3NE1 814-0	AJT25 / 3NE1 815-0
Power loss		0.12 kW	0.15 kW	0.22 kW
Required cooling air flow		9.2 l/s	9.2 l/s	9.2 l/s
Cross section of line and motor cables		1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG	1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG	1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG
Tightening torque for line and motor cables		0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in
Weight, unfiltered		2.8 kg	2.8 kg	2.8 kg
Weight, filtered		3 kg	3 kg	3 kg

Table 12- 8 PM230, PT, Frame Sizes B, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3211...	...1NE21-8UL0
Order No. - with filter	6SL3211...	...1NE21-8AL0
LO power		7.5 kW
LO input current		18.6 A
LO output current		18 A
HO power		5.5 kW
HO input current		13.6 A
HO output current		13.2 A
Fuse according to IEC		3NE1 815-0
Fuse according to UL		AJT25 / 3NE1 815-0
Power loss		0.22 kW
Required cooling air flow		9.2 l/s
Cross section of line and motor cables		1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG
Tightening torque for line and motor cables		0.6 Nm / 5 lbf in
Weight, unfiltered		3.4 kg
Weight, filtered		3.6 kg

## Technical data

### 12.3 Technical data, Power Modules

Table 12- 9 PM230, IP20, Frame Sizes C, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE22-6UL0	...1NE23-2UL0	...1NE23-8UL0
Order No. - with filter	6SL3210...	...1NE22-6AL0	...1NE23-2AL0	...1NE23-8AL0
LO power		11 kW	15 kW	18.5 kW
LO input current		26.9 A	33.1 A	39.2 A
LO output current		26 A	32 A	38 A
HO power		7.5 kW	11 kW	15 kW
HO input current		18.6 A	26.9 A	33.1 A
HO output current		18 A	26 A	32 A
Fuse according to IEC		3NE1 803-0	3NE1 817-0	3NE1 817-0
Fuse according to UL		AJT35 / 3NE1 803-0	AJT45 / 3NE1 817-0	AJT50 / 3NE1 817-0
Power loss		0.3 kW	0.35 kW	0.45 kW
Required cooling air flow		18.5 l/s	18.5 l/s	18.5 l/s
Cross section of line and motor cables		6 ...16 mm <sup>2</sup> 10 ... 6 AWG	6 ...16 mm <sup>2</sup> 10 ... 6 AWG	6 ...16 mm <sup>2</sup> 10 ... 6 AWG
Tightening torque for line and motor cables		1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in
Weight, unfiltered		4.5 kg	4.5 kg	4.5 kg
Weight, filtered		5.1 kg	5.1 kg	5.1 kg

Table 12- 10 PM230, PT, Frame Sizes C, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3211...	...1NE23-8UL0
Order No. - with filter	6SL3211...	...1NE23-8AL0
LO power		18.5 kW
LO input current		39.2 A
LO output current		38 A
HO power		15 kW
HO input current		33.1 A
HO output current		32 A
Fuse according to IEC		3NE1 817-0
Fuse according to UL		AJT50 / 3NE1 817-0
Power loss		0.45 kW
Required cooling air flow		18.5 l/s
Cross section of line and motor cables		6 ...16 mm <sup>2</sup> 10 ... 6 AWG
Tightening torque for line and motor cables		1.3 Nm / 12 lbf in
Weight, unfiltered		5.4 kg
Weight, filtered		6 kg

Table 12- 11 PM230, IP20, Frame Sizes D, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE24-5UL0	...1NE26-0UL0
Order No. - with filter	6SL3210...	...1NE24-5AL0	...1NE26-0AL0
LO power		22 kW	30 kW
LO input current		42 A	56 A
LO output current		45 A	60 A
HO power		18.5 kW	22 kW
HO input current		36 A	42 A
HO output current		38 A	45 A
Fuse according to IEC		3NE1818-0	3NE1820-0
Fuse according to UL		3NE1818-0	3NE1820-0
Power loss		0.52 kW	0.68 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cables		16 ... 35 mm <sup>2</sup> 5 ... 2 AWG	16 ... 35 mm <sup>2</sup> 5 ... 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		11 kg	11 kg
Weight, filtered		14 kg	14 kg

Table 12- 12 PM230, IP20, Frame Sizes E, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE27-5UL0	...1NE28-8UL0
Order No. - with filter	6SL3210...	...1NE27-5AL0	...1NE28-8AL0
LO power		37 kW	45 kW
LO input current		70 A	84 A
LO output current		75 A	90 A
HO power		30 kW	37 kW
HO input current		56 A	70 A
HO output current		60 A	75 A
Fuse according to IEC		3NE1021-0	3NE1022-0
Fuse according to UL		3NE1021-0	3NE1022-0
Power loss		0.99 kW	1.2 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cables		25 ... 50 mm <sup>2</sup> 3 ... 1-1/0 AWG	25 ... 50 mm <sup>2</sup> 3 ... 1-1/0 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		15 kg	15 kg
Weight, filtered		22 kg	22 kg

## Technical data

### 12.3 Technical data, Power Modules

Table 12- 13 PM230, IP20, Frame Sizes F, 3 AC 380 V ... 480 V

Order No. - without filter	6SL3210...	...1NE31-1UL0	...1NE31-5UL0
Order No. - with filter	6SL3210...	...1NE31-1AL0	...1NE31-5AL0
LO power		55 kW	75 kW
LO input current		102 A	135 A
LO output current		110 A	145 A
HO power		45 kW	55 kW
HO input current		84 A	102 A
HO output current		90 A	110 A
Fuse according to IEC		3NE1224-0	3NE1225-0
Fuse according to UL		3NE1224-0	3NE1225-0
Power loss		1.4 kW	1.9 kW
Required cooling air flow		150 l/s	150 l/s
Cross section of line and motor cables		35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG	35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG
Tightening torque for line and motor cables		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight, unfiltered		33 kg	33 kg
Weight, filtered		48 kg	48 kg

## 12.3.2 Technical data, PM240

### 12.3.2.1 General data, PM240

Feature	Version		
Line voltage	380 V ... 480 V 3-ph. AC $\pm$ 10%		
Output voltage	0 V 3-ph. AC ... input voltage x 0.95 (max.)		
Input frequency	50 Hz ... 60 Hz, $\pm$ 3 Hz		
Output frequency	0 ... 650 Hz, depending on the control mode		
Power factor $\lambda$	0,7 ... 0,85		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz for 0.37 kW ... 90 kW 2 kHz for 110 kW ... 250 kW The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20 chassis units		
Operating temperature	LO without derating: all power ratings HO without derating: 0.37 ... 110 kW HO without derating: 132 ... 200 kW LO/HO with derating: all power ratings	0° C ... +40° C 0° C ... +50° C 0° C ... +40° C up to 60° C	For details, see the Hardware Installation Manual.
Storage temperature	-40° C ... +70° C		
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Relative humidity	< 95% - condensation not permissible		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	<ul style="list-style-type: none"> <li>Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997</li> <li>Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997</li> <li>Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995</li> </ul>		
Installation altitude	without derating: 0.37 kW ... 132 kW 160 kW ... 250 kW with derating: all power ratings	up to 1000 m above sea level up to 2000 m above sea level up to 4000 m above sea level	For details, see the Hardware Installation Manual
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

### 12.3.2.2 Power-dependent data, PM240

#### Note

The given input currents are valid for operation without a line reactor for a line voltage of 400 V with  $V_k = 1\%$  referred to the rated power of the inverter. If a line reactor is used, the specified values are reduced by a few percent.

Table 12- 14 PM240, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE13-7UA0	...0BE15-5UA0	...0BE17-5UA0
Rated / LO power		0.37 kW	0.55 kW	0.75 kW
Rated / LO input current		1.6 A	2.0 A	2.5 A
Rated / LO Output current		1.3 A	1.7 A	2.2 A
HO power		0.37 kW	0.55 kW	0.75 kW
HO input current		1.6 A	2.0 A	2.5 A
HO output current		1.3 A	1.7 A	2.2 A
Fuse		10 A, class J	10 A, class J	10 A, class J
Power losses		0.097 kW	0.099 kW	0.102 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.2 kg	1.2 kg	1.2 kg

Table 12- 15 PM240, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE21-1UA0	...0BE21-5UA0
Rated / LO power		1.1 kW	1.5 kW
Rated / LO input current		3.9 A	4.9 A
Rated / LO Output current		3.1 A	4.1 A
HO power		1,1 kW	1,5kW
HO input current		3.8 A	4.8 A
HO output current		3.1 A	4.1 A
Fuse		10 A, class J	10 A, class J
Power losses		0.108 kW	0.114 kW
Required cooling air flow		4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.1 kg	1.1 kg

Table 12- 16 PM240, IP20, Frame Sizes B, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE22-2UA0	...0BE23-0UA0	...0BE24-0UA0
Order No. - Filtered	6SL3224-...	...0BE22-2AA0	...0BE23-0AA0	...0BE24-0AA0
Rated / LO power		2.2 kW	3 kW	4 kW
Rated / LO input current		7.6 A	10.2 A	13.4 A
Rated / LO Output current		5.9 A	7.7 A	10.2 A
HO power		2.2 kW	3 kW	4 kW
HO input current		7.6 A	10.2 A	13.4 A
HO output current		5.9 A	7.7 A	10.2 A
Fuse		16 A, Class J	16 A, Class J	20 A, Class J
Power losses		0.139 kW	0.158 kW	0.183 kW
Required cooling air flow		24 l/s	24 l/s	24 l/s
Cross section of line and motor cable		1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG	1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG	1.5 ... 6 mm <sup>2</sup> 16 ... 10 AWG
Tightening torque for line and motor cable		1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in
Weight		4.3 kg	4.3 kg	4.3 kg

Table 12- 17 PM240, IP20, Frame Sizes C, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE25-5UA0	...0BE27-5UA0	...0BE31-1UA0
Order No. - Filtered	6SL3224-...	...0BE25-5AA0	...0BE27-5AA0	...0BE31-1AA0
Rated / LO power		7.5 kW	11 kW	15 kW
Rated / LO input current		21.9 A	31.5 A	39.4 A
Rated / LO Output current		18 A	25 A	32 A
HO power		5.5 kW	7.5 kW	11 kW
HO input current		16.7 A	23.7 A	32.7 A
HO output current		13.2 A	19 A	26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power losses		0.240 kW	0.297 kW	0.396 kW
Required cooling air flow		55 l/s	55 l/s	55 l/s
Cross section of line and motor cable		4 ... 10 mm <sup>2</sup> 12 ... 8 AWG	4 ... 10 mm <sup>2</sup> 12 ... 8 AWG	4 ... 10 mm <sup>2</sup> 12 ... 8 AWG
Tightening torque for line and motor cable		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight, unfiltered		6.5 kg	6.5 kg	6.5 kg
Weight, filtered		7 kg	7 kg	7 kg

Table 12- 18 PM240, IP20, Frame Sizes D, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE31-5UA0	...0BE31-8UA0	...0BE32-2UA0
Order No. - Filtered	6SL3224-...	...0BE31-5AA0	...0BE31-8AA0	...0BE32-2AA0
Rated / LO power		18.5 kW	22 kW	30 kW
Rated / LO input current		46 A	53 A	72 A
Rated / LO Output current		38 A	45 A	60 A
HO power		15 kW	18.5 kW	22 kW
HO input current		40 A	46 A	56 A
HO output current		32 A	38 A	45 A
Fuse according to IEC		3NA3820	3NA3822	3NA3824
Fuse according to UL		50 A, Class J	63 A, Class J	80 A, Class J
Power losses		0.44 kW	0.55 kW	0.72 kW
		0.42 kW	0.52 kW	0.69 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		10 ... 35 mm <sup>2</sup> 7 ... 2 AWG	10 ... 35 mm <sup>2</sup> 7 ... 2 AWG	16 ... 35 mm <sup>2</sup> 5 ... 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		13 kg	13 kg	13 kg
Weight, filtered		16 kg	16 kg	16 kg

Table 12- 19 PM240, IP20, Frame Sizes E, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE33-0UA0	...0BE33-7UA0
Order No. - Filtered	6SL3224-...	...0BE33-0AA0	...0BE33-7AA0
Rated / LO power		37 kW	45 kW
Rated / LO input current		88 A	105 A
Rated / LO Output current		75 A	90 A
HO power		30 kW	37 kW
HO input current		73 A	90 A
HO output current		60 A	75 A
Fuse according to IEC		3NA3830	3NA3832
Fuse according to UL		100 A, Class J	125 A, Class J
Power losses, unfiltered		0.99 kW	1.2 kW
Power losses, filtered		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cable		25 ... 35 mm <sup>2</sup> 3 ... 2 AWG	25 ... 35 mm <sup>2</sup> 3 ... 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		16 kg	16 kg
Weight, filtered		23 kg	23 kg

Table 12- 20 PM240, IP20, Frame Sizes F, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE34-5UA0	...0BE35-5UA0	...0BE37-5UA0
Order No. - Filtered	6SL3224-...	...0BE34-5AA0	...0BE35-5AA0	...0BE37-5AA0
Rated / LO power		55 kW	75 kW	90 kW
Rated / LO input current		129 A	168 A	204 A
Rated / LO Output current		110 A A	145 A	178 A
HO power		45 kW	55 kW	75 kW
HO input current		108 A	132 A	169 A
HO output current		90 A	110 A	145 A
Fuse according to IEC		3NA3832	3NA3140	3NA3144
Fuse according to UL		160 A, Class J	200 A, Class J	250 A, Class J
Power losses, unfiltered		1.4 kW	1.9 kW	2.3 kW
Power losses, filtered		1.5 kW	2.0 kW	2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG	70 ... 120 mm <sup>2</sup> 2/0 ... 4/0 AWG	95 ... 120 mm <sup>2</sup> 3/0 ... 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight, unfiltered		36 kg	36 kg	36 kg
Weight, filtered		52 kg	52 kg	52 kg

Table 12- 21 PM240, IP20, Frame Sizes F, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0BE38-8UA0	...0BE41-1UA0
Rated / LO power		110 kW	132 kW
Rated / LO input current		234 A	284 A
Rated / LO Output current		205 A	250 A
HO power		90 kW	110 kW
HO input current		205 A	235 A
HO output current		178 A	205 A
Fuse according to IEC		---	---
Fuse according to UL		250 A, Class J	315 A, Class J
Power losses		2.4 kW	2.5 kW
Required cooling air flow		117 l/s	117 l/s
Cross section of line and motor cable		95 ... 120 mm <sup>2</sup> 3/0 ... 4/0 AWG	95 ... 120 mm <sup>2</sup> 3/0 ... 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight,		39 kg	39 kg

Table 12- 22 PM240 Frame Sizes GX, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3224-...	...0XE41-3UA0	...0XE41-6UA0	...0XE42-0UA0
<b>Rated / Low Overload values</b>				
Rated / LO power		160 kW	200 kW	240 kW
Rated / LO input current		297 A	354 A	442 A
Rated / LO Output current		302 A	370 A	477 A
<b>High Overload values</b>				
HO power		132 kW	160 kW	200 kW
HO input current		245 A	297 A	354 A
HO output current		250 A	302 A	370 A
Fuse according to IEC		3NA3254	3NA3260	3NA3372
Fuse according to UL		355 A, Class J	400 A, Class J	630 A, Class J
Power losses,		3.9 kW	4.4 kW	5.5 kW
Required cooling air flow		360 l/s	360 l/s	360 l/s
Cross section of line and motor cable		95 ... 2 x 240 mm <sup>2</sup> 3/0 ... 2 x 600 AWG	120 ... 2 x 240 mm <sup>2</sup> 4/0 ... 2 x 600 AWG	185 ... 2 x 240 mm <sup>2</sup> 6/0 ... 2 x 600 AWG
Tightening torque for line and motor cable		14 Nm / 120 lbf in	14 Nm / 120 lbf in	14 Nm / 120 lbf in
Weight,		176 kg	176 kg	176 kg

## 12.3.3 Technical data, PM240-2

### 12.3.3.1 General data, PM240-2

Feature	Version		
Line voltage	380 V ... 480 V 3-ph. AC $\pm$ 10%		
Output voltage	0 V 3-ph. AC ... input voltage x 0.95 (max.)		
Input frequency	50 ... 60 Hz, $\pm$ 3 Hz		
Output frequency	0 ... 650 Hz, depending on the control mode		
Power factor $\lambda$	0.7 without line reactor; 0.85 with line reactor		
Line impedance	UK $\geq$ 1%, a line reactor is required for lower values		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. For details, see the Hardware Installation Manual, Appendix A2.		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20 built-in units PT devices	IP20 when mounted in a control cabinet IP54 on the control cabinet wall	
Operating temperature	LO without derating: HO without derating: LO/HO with derating:	0° C ... +40° C 0° C ... +50° C to 60° C	For details, see the Hardware Installation Manual.
Storage temperature	-40° C ... +70° C (-40° F ... 158° F)		
Relative humidity	< 95% - condensation not permissible		
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	<ul style="list-style-type: none"> <li>Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997</li> <li>Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997</li> <li>Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995</li> </ul>		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see the Hardware Installation Manual
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

### 12.3.3.2 Power-dependent data PM240-2

Table 12- 23 PM240-2, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3210...	...1PE11-8UL0	...1PE12-3UL0	...1PE13-2UL0
Order No. - Filtered	6SL3210...	...1PE11-8AL0	...1PE12-3AL0	...1PE13-2AL0
LO power		0.55 kW	0.75 kW	1.1 kW
LO input current		2.3 A	2.9 A	4.1 A
LO output current		1.7 A	2.2 A	3.1 A
HO power		0.37 kW	0.55 kW	0.75 kW
HO input current		2 A	2.6 A	3.3 A
HO output current		1.3 A	1.7 A	2.2 A
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
Power losses, unfiltered		0.04 kW	0.04 kW	0.04 kW
Power losses, filtered		0.04 kW	0.04 kW	0.04 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.5 kg	1.5 kg	1.5 kg

Table 12- 24 PM240-2, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3210...	...1PE14-3UL0	...1PE16-1UL0	...1PE18-0UL0
Order No. - Filtered	6SL3210...	...1PE14-3AL0	...1PE16-1AL0	---
LO power		1.5 kW	2.2 kW	3 kW
LO input current		5.5 A	7.7 A	10.1 A
LO output current		4.1 A	5.9 A	7.7 A
HO power		1.1 kW	1.5 kW	2.2 kW
HO input current		4.7 A	6.1 A	8.8 A
HO output current		3.1 A	4.1 A	5.9 A
Fuse according to IEC		3NA3 803 (10 A)	3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A class J	10 A class J	15 A class J
Power losses, unfiltered		0.07 kW	0.1 kW	0.12 kW
Power losses, filtered		0.07 kW	0.1 kW	0.12 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable		1 ... 2.5 mm <sup>2</sup> 18 ... 14 AWG	1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG	1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.5 kg	1.5 kg	---

Table 12- 25 PM240-2, PT, Frame Sizes A, 3 AC 380 V ... 480 V

Order No. - Unfiltered	6SL3211...	---	...1PE18-0UL0
Order No. - Filtered	6SL3211...	...1PE16-1AL0	---
LO power		2.2 kW	3 kW
LO input current		7.7 A	10.1 A
LO Output current		5.9 A	7.7 A
HO power		1.5 kW	2.2 kW
HO input current		6.1 A	8.8 A
HO output current		4.1 A	5.9 A
Fuse according to IEC		3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A class J	15 A class J
Power losses, unfiltered		0.1 kW <sup>1)</sup>	0.12 kW <sup>2)</sup>
Power losses, filtered		0.1 kW <sup>1)</sup>	0.12 kW <sup>2)</sup>
Required cooling air flow		7 l/s	7 l/s
Cross section of line and motor cable		1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG	1.5 ... 2.5 mm <sup>2</sup> 16 ... 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		---	1.7 kg
Weight, filtered		1.8 kg	---

1) 0.08 kW via heat sink;

2) 0.1 kW via heat sink

### 12.3.4 Technical data, PM250

Feature	Version		
Line voltage	380 V ... 480 V 3-ph. AC ± 10%		
Output voltage	0 V 3-ph. AC ... input voltage x 0.87 (max.)		
Input frequency	47 Hz ... 63 Hz		
Power factor λ	0.9		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased up to 16 kHz in 2 kHz steps. An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2		
Braking methods	DC braking, energy recovery (up to 100% of the output power)		
Degree of protection	IP20 chassis units		
Operating temperature	LO without derating:	0° C ... +40° C	For details, see the Hardware Installation Manual.
	HO without derating:	0° C ... +50° C	
	LO/HO with derating:	to 60° C	
Storage temperature	-40° C ... +70° C		
Relative humidity	< 95% - condensation not permissible		
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	<ul style="list-style-type: none"><li>• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997</li><li>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997</li><li>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995</li></ul>		
Installation altitude	without derating:	up to 1000 m above sea level	For details, see the Hardware Installation Manual
	with derating:	up to 4000 m above sea level	
Standards	UL, CE, CE, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

### 12.3.4.1 Power-dependent data, PM250

Table 12- 26 PM250, IP20, Frame Sizes C, 3 AC 380 V ... 480 V

Order No. - Filtered	6SL3225-...	0BE25-5AA0	0BE27-5AA0	0BE31-1AA0
Rated / LO power		7.5 kW	11 kW	15 kW
Rated / LO input current		18 A	25 A	32 A
Rated / LO Output current		18 A	25 A	32 A
HO power		5.5 kW	7.5 kW	11 kW
HO input current		13.2 A	19 A	26 A
HO output current		13.2 A	19 A	26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power losses		0.24 kW	0.30 kW	0.31 kW
Required cooling air flow		38 l/s	38 l/s	38 l/s
Cross section of line and motor cable		2.5 ... 10 mm <sup>2</sup> 14 ... 8 AWG	4.0 ... 10 mm <sup>2</sup> 12 ... 8 AWG	4.0 ... 10 mm <sup>2</sup> 12 ... 8 AWG
Tightening torque for line and motor cable		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight		7.5 kg	7.5 kg	7.5 kg

Table 12- 27 PM250, IP20, Frame Sizes D, 3 AC 380 V ... 480 V

Order No. - Filtered	6SL3225-...	0BE31-5AA0	0BE31-8AA0	0BE32-2AA0
Rated / LO power		18.5 kW	22 kW	30 kW
Rated / LO input current		36 A	42 A	56 A
Rated / LO Output current		38 A	45 A	60 A
HO power		15 kW	18.5 kW	22 kW
HO input current		30 A	36 A	42 A
HO output current		32 A	38 A	45 A
Fuse according to IEC		3NA3820	3NA3822	3NA3824
Fuse according to UL		50 A, Class J	63 A, Class J	80 A, Class J
Power losses		0.44 kW	0.55 kW	0.72 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		10 ... 35 mm <sup>2</sup> 7 ... 2 AWG	10 ... 35 mm <sup>2</sup> 7 ... 2 AWG	16 ... 35 mm <sup>2</sup> 6 ... 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		15 kg	15 kg	16 kg

## Technical data

### 12.3 Technical data, Power Modules

Table 12- 28 PM250, IP20, Frame Sizes E, 3 AC 380 V ... 480 V

Order No. - Filtered	6SL3225-...	0BE33-0AA0	0BE33-7AA0
Rated / LO power		37 kW	45 kW
Rated / LO input current		70 A	84 A
Rated / LO Output current		75 A	90 A
HO power		30 kW	37 kW
HO input current		56 A	70 A
HO output current		60 A	75 A
Fuse according to IEC		3NA3830	3NA3832
Fuse according to UL		100 A, Class J	125 A, Class J
Power losses		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cable		25 ... 35 mm <sup>2</sup> 3 ... 2 AWG	25 ... 35 mm <sup>2</sup> 3 ... 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		21 kg	21 kg

Table 12- 29 PM250, IP20, Frame Sizes F, 3 AC 380 V ... 480 V

Order No. - Filtered	6SL3225-...	0BE34-5AA0	0BE35-5AA0	0BE37-5AA0
Rated / LO power		55 kW	75 kW	90 kW
Rated / LO input current		102 A	135 A	166 A
Rated / LO Output current		110 A	145 A	178 A
HO power		45 kW	55 kW	75 kW
HO input current		84 A	102 A	135 A
HO output current		90 A	110 A	145 A
Fuse according to IEC		3NA3836	3NA3140	3NA3144
Fuse according to UL		160 A, Class J	200 A, Class J	250 A, Class J
Power losses		1.5 kW	2.0 kW	2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG	35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG	35 ... 120 mm <sup>2</sup> 2 ... 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight		51 kg	51 kg	51 kg

### 12.3.5 Technical data, PM260

Feature	Version		
Line voltage	660 V ... 690 V 3-ph. AC ± 10%  The power units can also be operated with a minimum voltage of 500 V –10 %. In this case, the power is linearly reduced.		
Input frequency	50 Hz ... 60 Hz, ± 3 Hz		
Power factor λ	0.9		
Starting current	Less than the input current		
Pulse frequency	16 kHz		
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2		
Braking methods	DC braking, energy recovery (up to 100% of the output power)		
Degree of protection	IP20 chassis units		
Operating temperature	LO without derating: HO without derating: LO/HO with derating:	0° C ... +40° C 0° C ... +50° C to 60° C	For details, see the Hardware Installation Manual.
Storage temperature	-40° C ... +70° C (-40° F ... 158° F)		
Relative humidity	< 95% - condensation not permissible		
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	<ul style="list-style-type: none"><li>• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997</li><li>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997</li><li>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995</li></ul>		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see the Hardware Installation Manual
Standards	CE, C-TICK		

### 12.3.5.1 Power-dependent data, PM260

Table 12- 30 PM260, IP20, Frame Sizes D - 3 AC 660 V ... 690 V

Order No. - Unfiltered	6SL3225-...	0BH27-5UA1	0BH31-1UA1	0BH31-5UA1
Order No. - Filtered	6SL3225-...	0BH27-5AA1	0BH31-1AA1	0BH31-5AA1
Rated / LO power		11 kW	15 kW	18.5 kW
Rated / LO input current		13 A	18 A	22 A
Rated / LO Output current		14 A	19 A	23 A
HO power		7.5 kW	11 kW	15 kW
HO input current		10 A	13 A	18 A
HO output current		10 A	14 A	19 A
Fuse		20 A	20 A	32 A
Power losses, unfiltered				
Power losses, filtered				
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		2,5 ... 16 mm <sup>2</sup> 14 ... 6 AWG	4 ... 16 mm <sup>2</sup> 12 ... 6 AWG	6 ... 16 mm <sup>2</sup> 10 ... 6 AWG
Tightening torque for line and motor cable		1,5 Nm / 53 lbf in	1,5 Nm / 53 lbf in	1,5 Nm / 53 lbf in
Weight, unfiltered		22 kg	22 kg	22 kg
Weight, filtered		23 kg	23 kg	23 kg
Noise pressure		< 64 dB(A)	< 64 dB(A)	< 64 dB(A)

Table 12- 31 PM260, IP20, Frame Sizes F - 3 AC 660 V ... 690 V

Order No. - Unfiltered	6SL3225-...	0BH32-2UA1	0BH33-0UA1	0BH33-7UA1
Order No. - Filtered	6SL3225-...	0BH32-2AA1	0BH33-0AA1	0BH33-7AA1
Rated / LO power		30 kW	37 kW	55 kW
Rated / LO input current		34 A	41 A	60 A
Rated / LO Output current		35 A	42 A	62 A
HO power		22 kW	30 kW	37 kW
HO input current		26 A	34 A	41 A
HO output current		26 A	35 A	42 A
Fuse		50 A	50 A	80 A
Power losses, unfiltered				
Power losses, filtered				
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		10 ... 35 mm <sup>2</sup> 8 ... 2 AWG	16 ... 35 mm <sup>2</sup> 6 ... 2 AWG	25 ... 35 mm <sup>2</sup> 4 ... 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		56 kg	56 kg	56 kg
Weight, filtered		58 kg	58 kg	58 kg
Noise pressure		< 70 dB(A)	< 70 dB(A)	< 70 dB(A)

# Appendix

## 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 PROFlenergy 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 <ul style="list-style-type: none"> <li>PM240-2 IP20 FSB ... FSC</li> <li>PM240-2 in through-hole technology FSB ... FSC</li> </ul>	-	✓	✓	✓	✓	✓	-	-
2	Support for the new Power Modules <ul style="list-style-type: none"> <li>PM230 in through-hole technology FSD ... FSF</li> </ul>	-	✓	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number <ul style="list-style-type: none"> <li>During basic commissioning with the operator panel, set the motor data using a code number</li> </ul>	✓	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen <ul style="list-style-type: none"> <li>CAN velocity, ProfiTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm</li> </ul>	✓	✓	-	-	✓	✓	-	-
5	Extension to communication via BACnet <ul style="list-style-type: none"> <li>Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller</li> </ul>	-	✓	-	-	-	-	-	-
6	Communication via Ethernet/IP	✓	✓	-	✓	✓	✓	✓	✓
7	Skip frequency band for analog input <ul style="list-style-type: none"> <li>A symmetrical skip frequency band can be set for each analog input around the 0 V range.</li> </ul>	✓	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) <ul style="list-style-type: none"> <li>Secure control of a motor holding brake when using the "Safe Brake Module" option</li> </ul>	-	-	-	-	✓	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	✓	-	-
11	Straightforward selection of standard motors <ul style="list-style-type: none"> <li>Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers</li> </ul>	✓	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓	✓
13	Safety info channel <ul style="list-style-type: none"> <li>BICO source r9734.0...14 for the status bits of the extended safety functions</li> </ul>	-	-	-	✓	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓	✓

## A.2 Star-delta motor connection and application examples

Depending on your application, you can operate the motor in the star or delta connection (Y/ $\Delta$ ).

### Examples for operating the converter and motor on a 400 V line supply

Assumption: The motor rating plate states 230/400 V  $\Delta$ /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  $\Delta$ .

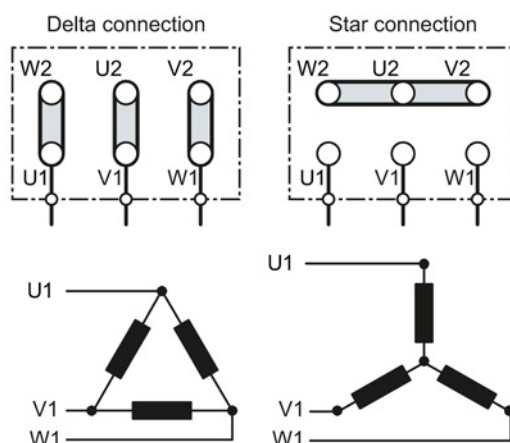
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

Before you connect the motor, ensure that the motor has the appropriate connection for your application:

### Motor is connected in the star or delta configuration

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

- Star connection (Y)
- Delta connection ( $\Delta$ )



## A.3 Parameter

Parameters are the interface between the firmware of the converter and the commissioning tool, e.g. an Operator Panel.

### Adjustable parameters

Adjustable parameters are the "adjusting screws" with which you adapt the converter to its particular application. If you change the value of an adjustable parameter, then the converter behavior also changes.

Adjustable parameters are shown with a "p" as prefix, e.g. p1082 is the parameter for the maximum motor speed.

### Display parameters

Display parameters allow internal measured quantities of the converter and the motor to be read.

The Operator Panel and STARTER represent display parameters with an "r" prefix, for example, r0027 is the parameter for the converter output current.

### Parameters that in many cases help

Table A- 3 How to switch to commissioning mode or restore the factory setting

Parameter	Description
p0010	<b>Commissioning parameters</b> 0: Ready (factory setting) 1: Carry out basic commissioning 3: Carry out motor commissioning 5: Technological applications and units 15: Define number of data sets 30: Factory setting - initiate restore factory settings

Table A- 4 How to determine the firmware version of the Control Unit

Parameter	Description
R0018	Firmware version is displayed

Table A- 5 How to select the command and setpoint sources for the inverter

Parameter	Description
p0015	Additional information is available in Section Finding a suitable setting for the interfaces (Page 55).

Table A- 6 How to set the ramp-up and ramp-down

Parameter	Description
p1080	<b>Minimum speed</b> 0.00 [rpm] factory setting
p1082	<b>Maximum speed</b> 1500.000 [rpm] factory setting
p1120	<b>Ramp-up time</b> 10.00 [s]
p1121	<b>Ramp-down time</b> 10.00 [s]

Table A- 7 This is how you set the closed-loop type

Parameter	Description
P1300	0: U/f control with linear characteristic 1: U/f control with linear characteristic and FCC 2: U/f control with parabolic characteristic 3: U/f control with adjustable characteristic 4: U/f control with linear characteristic and ECO 5: U/f control for drives requiring a precise frequency (textile area) 6: U/f control for drives requiring a precise frequency and FCC 7: U/f control with parabolic characteristic and ECO 19: U/f control with independent voltage setpoint 20: Speed control (without encoder) 22: Torque control (without encoder)

Table A- 8 This is how you optimize the starting behavior of the U/f control for a high break loose torque and overload

Parameter	Description
p1310	<b>Voltage boost to compensate ohmic losses</b> The voltage boost is active from standstill up to the rated speed. It is at its highest at speed 0 and continually decreases as the speed increases. Value of the voltage boost at speed 0 in V: $1.732 \times \text{rated motor current (p0305)} \times \text{stator resistance (r0395)} \times \text{p1310} / 100\%$
p1311	<b>Voltage boost when accelerating</b> 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: $1.732 \times \text{rated motor current (p0305)} \times \text{stator resistance (p0350)} \times \text{p1311} / 100\%$
p1312	<b>Voltage boost when starting</b> Setting to additionally boost the voltage when starting, however only when accelerating for the first time.

## A.4 Handling the BOP 2 operator panel

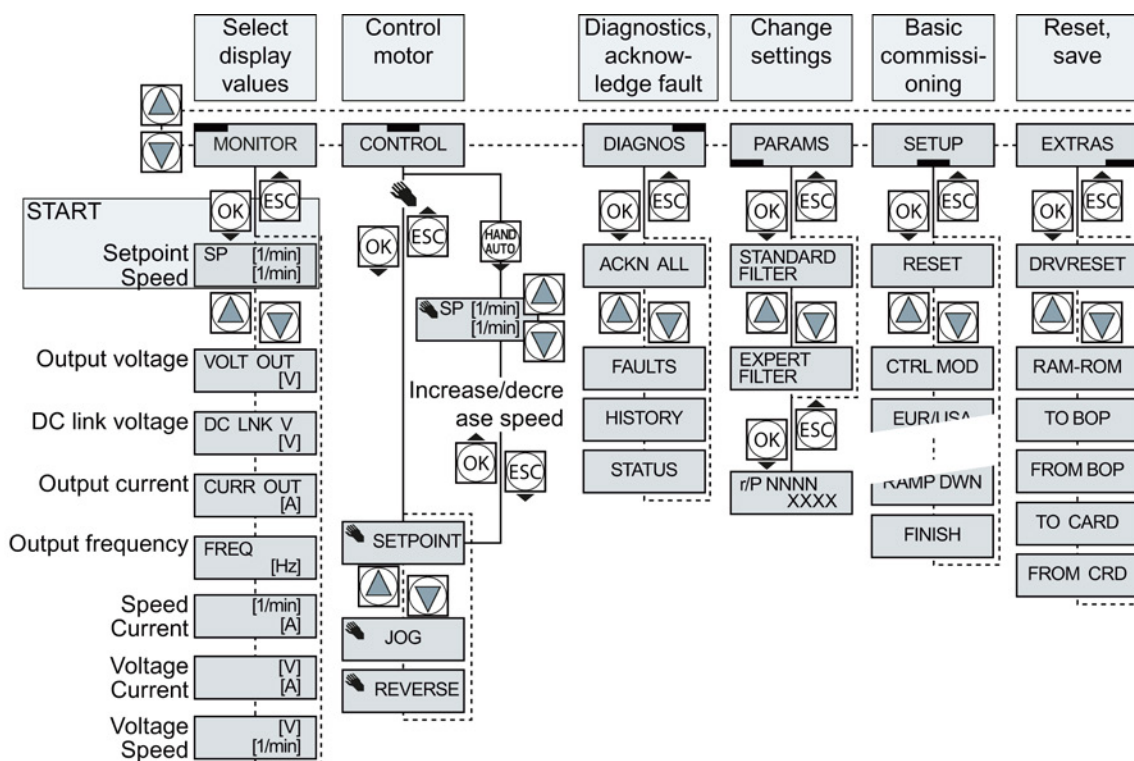


Figure A-1 Menu of the BOP-2

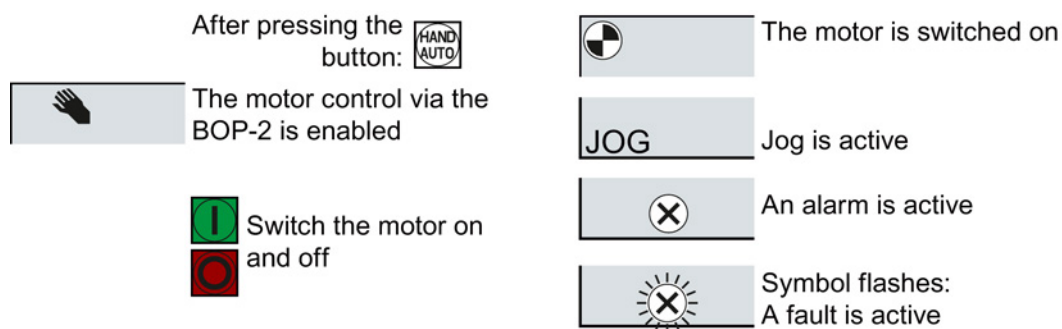


Figure A-2 Other keys and symbols of the BOP-2

## A.4.1 Changing settings using BOP-2

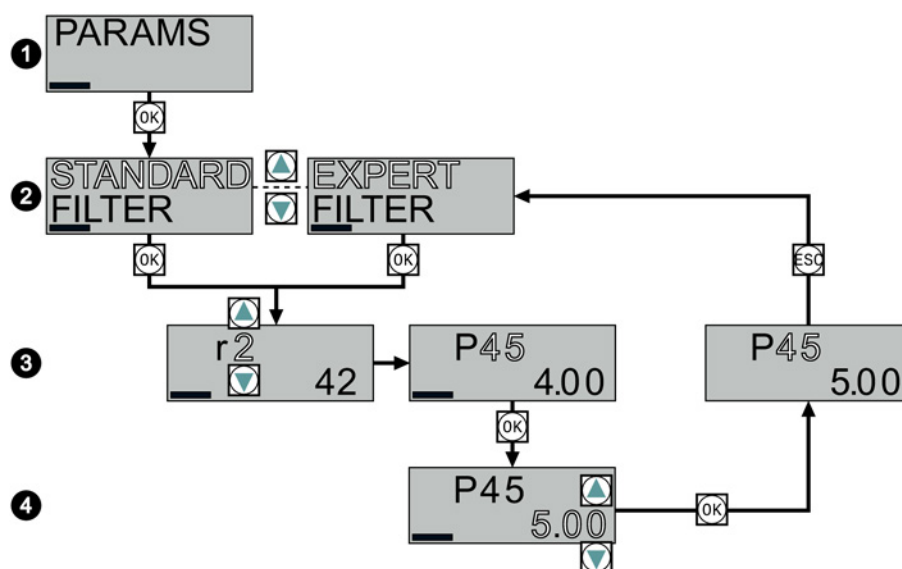
### Changing settings using BOP-2

You can modify the settings of your 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.4.2 Changing indexed parameters

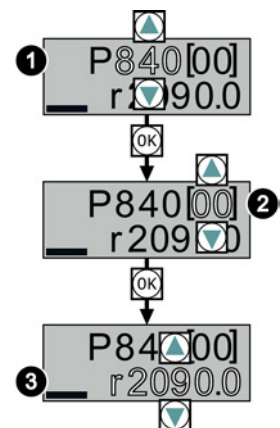
### Changing indexed parameters

For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

#### Procedure

To change an indexed parameter, proceed as follows:

1. Select the parameter number.
2. Press the OK 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.4.3 Directly entering the parameter number and value

### Directly select the parameter number

The BOP-2 offers the possibility of setting the parameter number digit by digit.

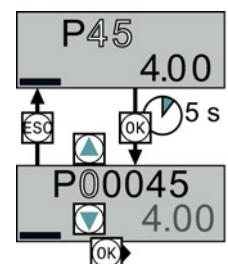
#### Prerequisite

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

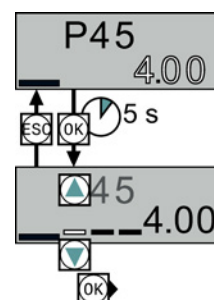
The parameter value flashes in the BOP-2 display.

### 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.

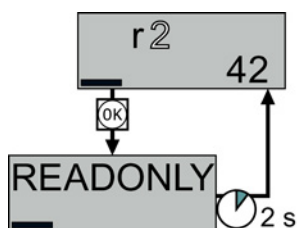


You have now entered the parameter value directly.

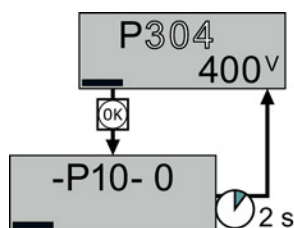
## A.4.4 A parameter cannot be changed

### When must you not change a parameter?

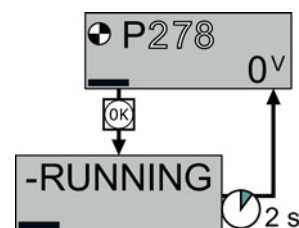
The converter indicates why it currently does not permit a parameter to be changed:



You have attempted to change a read-only parameter.



You must change to basic commissioning to set this parameter.



You must turn the motor off to set this parameter.

The operating state in which you can change a parameter is provided in the List Manual for each parameter.

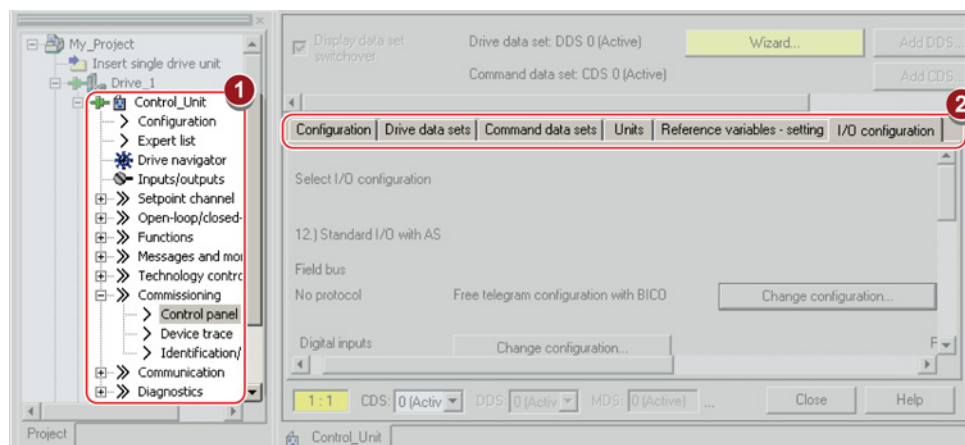
## A.5 Handling STARTER

### A.5.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidelines (Page 67).

STARTER offers two options:

- Change the settings using the appropriate screen forms - **our recommendation**.
  - ① Navigation bar: For each inverter function, select the corresponding screen form.
  - ② tabs: Switch between screen forms.
 If you change the settings using screen forms you do not need to know the parameter numbers.



- You change the settings using the parameters in the expert list.  
If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.


### Saving settings so that they are not lost when the power fails

The inverter initially only saves changes temporarily. You must do the following so that the inverter saves your settings securely in the event of a power failure.

#### Procedure




Proceed as follows to save your settings in the inverter so that they are not lost when the power fails:

1. Mark the appropriate drive in the project navigator.
2. Click the  Save (RAM to ROM) button.



You have saved your settings securely in the inverter in case of a power failure.


## Go offline

You can now exit the online connection after the data backup (RAM to ROM) with  "Disconnect from target system".

## A.5.2 Optimize the drive using the trace function

### Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control\_Unit/Commissioning/Device trace".



In two settings that are independent of one another, using  you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the \*.trc format.


If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the \*.clg format – and if necessary, load or import.

### Recording


Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with . Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

#### Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" (.

#### Mathematical function

Using the mathematical function () you can define a curve, for example the difference between the speed setpoint and the actual speed value.



---

#### Note

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

---


## Trigger


You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the  button (Start Trace). Using the button , you can define another trigger to start the measurement.


Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

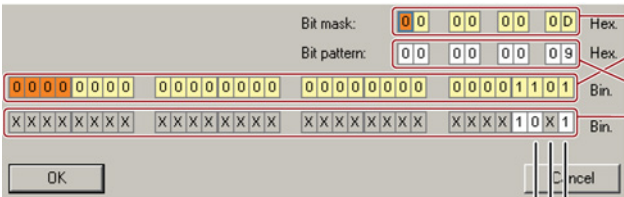
### Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using , select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using , 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

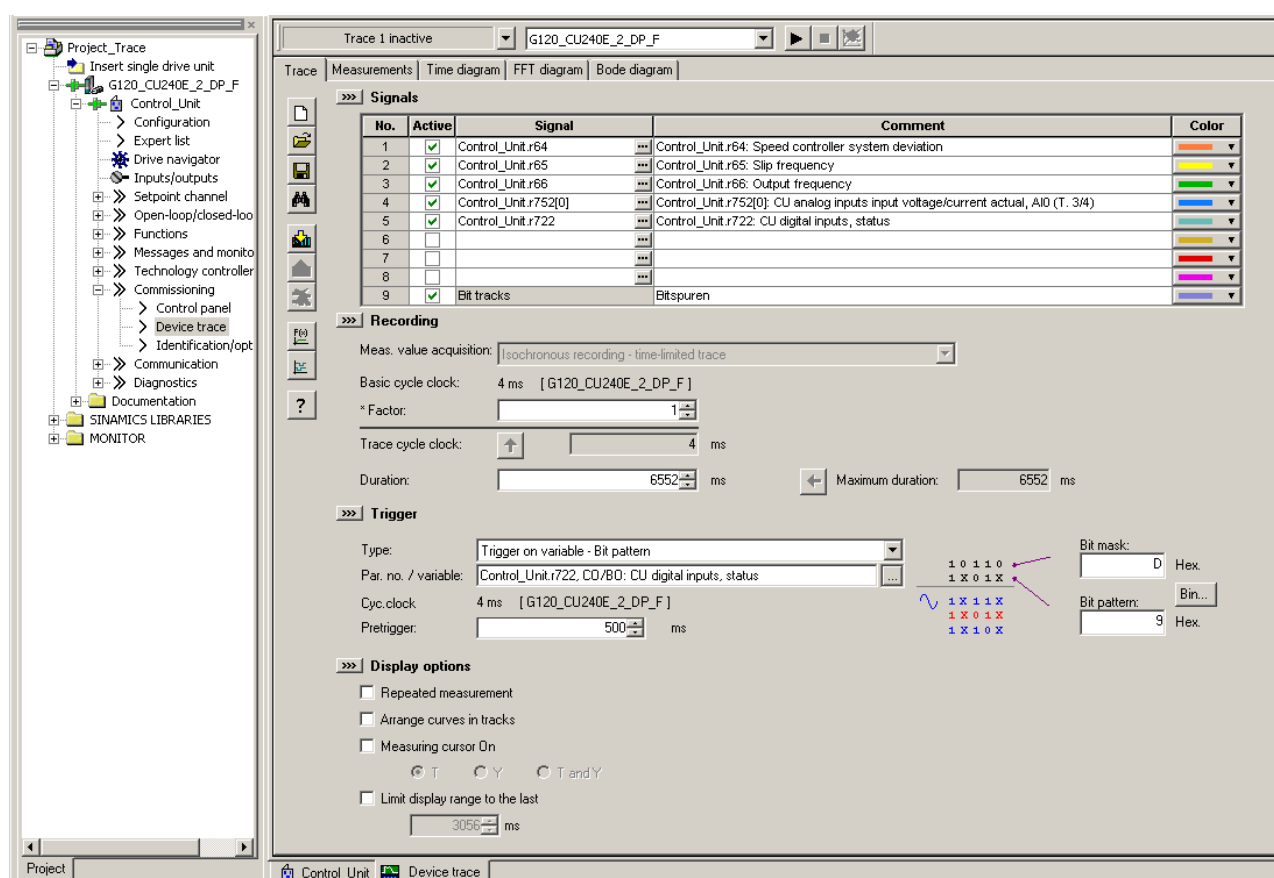


Figure A-4 Trace dialog box

## A.6 Interconnecting signals in the inverter

### A.6.1 Fundamentals

The following functions are implemented in the converter:

- Open-loop and closed-loop control functions
- Communication functions
- Diagnosis and operating functions

Every function comprises one or several blocks that are interconnected with one another.

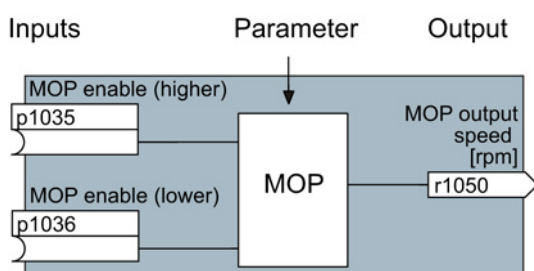


Figure A-5 Example of a block: Motorized potentiometer (MOP)

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.



Figure A-6 Example: Signal interconnection of two blocks for digital input 0

## Binectors and connectors

Connectors and binectors are used to exchange signals between the individual blocks:

- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

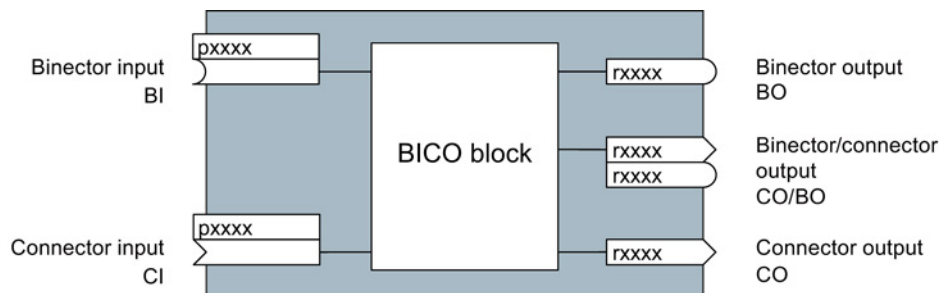


Figure A-7 Symbols for binector and connector inputs and outputs

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

Binector or connector outputs (CO, BO or CO/BO) can be used more than once.

### When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

### How much care is required when you change the signal interconnection?

Always take care when establishing internal signal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers signals in plain text and simplifies their interconnection.

### Where can you find additional information?

- This manual is sufficient for simple signal interconnections (e.g. assigning a different function to digital inputs).
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

## A.6.2 Example

### Example: Moving a basic control logic into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).

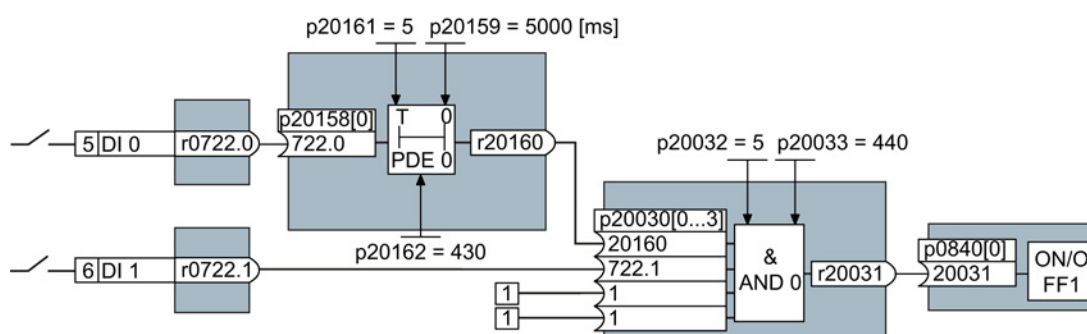


Figure A-8 Example: Signal interconnection for control logic

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

### Setting the control logic

Parameter	Description
p20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
p20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
p20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
p20158 = 722.0	Connect the status of DI 0 to the input of the time block r0722.0 = Parameter that displays the status of digital input 0.
p20030[0] = 20160	Interconnecting the time block to the 1st input of the AND
p20030[1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input r0722.1 = Parameter that displays the status of digital input 1.
p0840 = 20031	Interconnect the AND output to ON/OFF1

**Explanation of the example using the ON/OFF1 command**

Parameter p0840[0] is the input of the "ON/OFF1" block of the inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

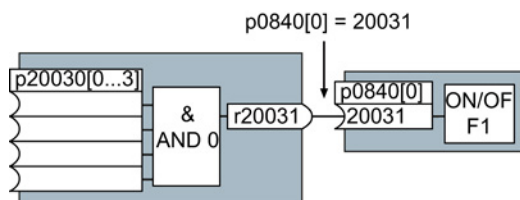


Figure A-9 Interconnecting blocks by setting p0840[0] = 20031

**Principle for interconnecting blocks**

Always interconnect the input (connector or binector input) with the signal source.

**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.7 Application Examples

### A.7.1 Configuring PROFIBUS communication in STEP 7

#### A.7.1.1 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.

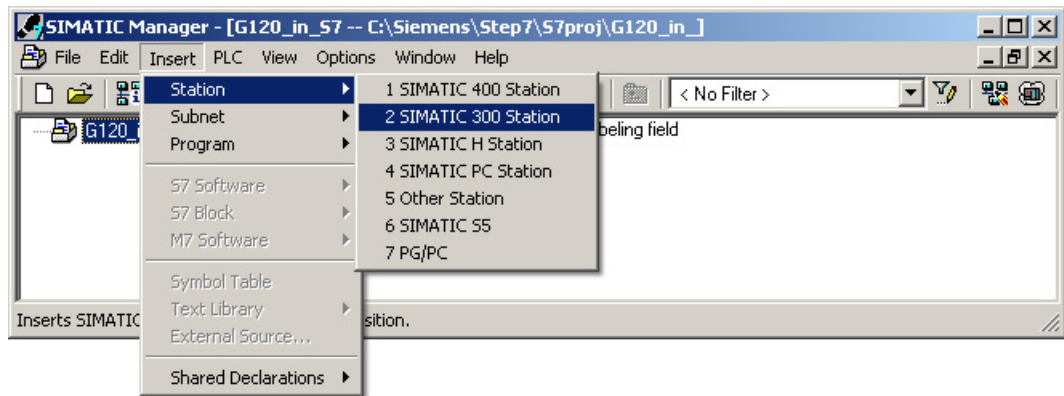
#### A.7.1.2 Creating a STEP 7 project and network



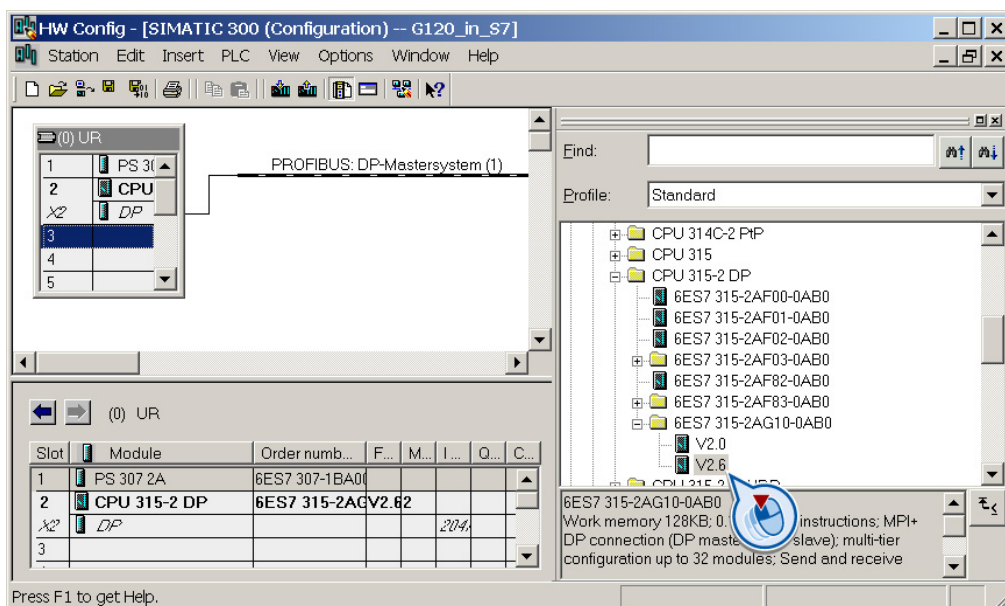
##### Procedure

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.7.1.3 Inserting the inverter into the project

There are two ways to insert an inverter into the project:

- Using the inverter GSD
- Using the STEP 7 object manager

The more user-friendly option is only available when STARTER is installed (see Section Tools to commission the converter (Page 35)).

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 using the GSD.

#### 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.

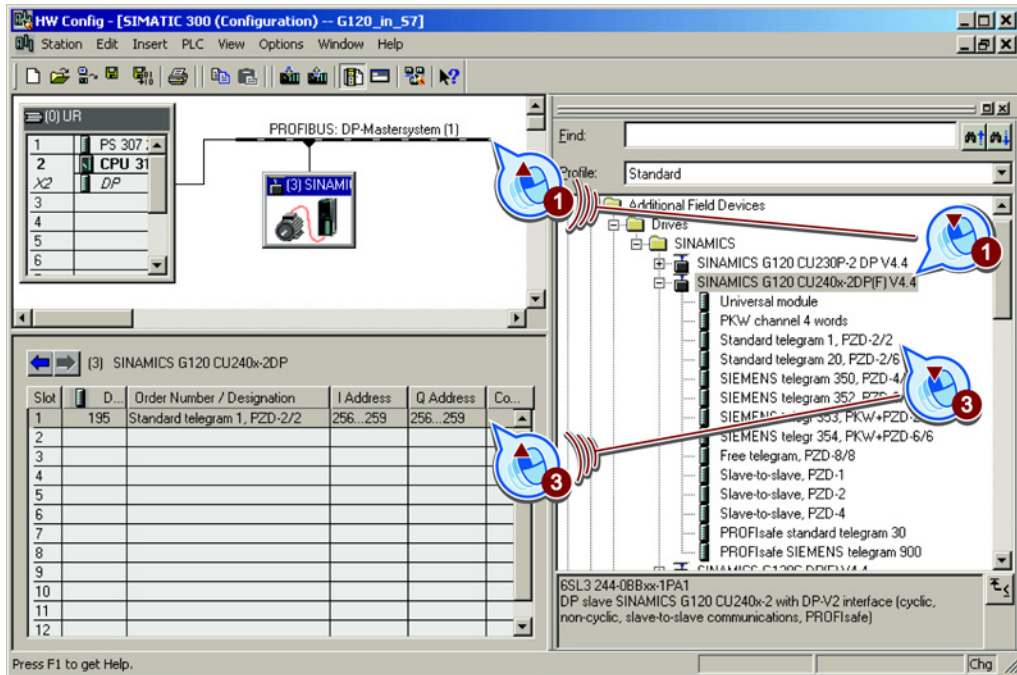
You can find the inverter under "PROFIBUS DP - Other field devices" in the HW Config hardware catalog.

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 111).

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.7.2 Configuring PROFINET communication in STEP 7

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.7.2.1 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



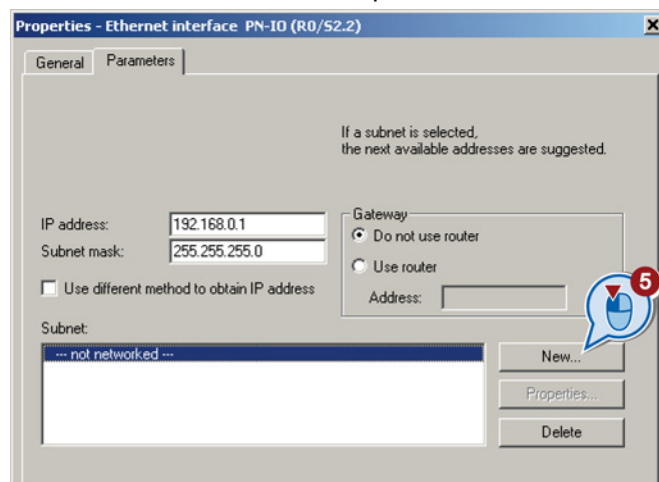
Proceed as follows to configure communications between the inverter and the control system via PROFINET:

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.

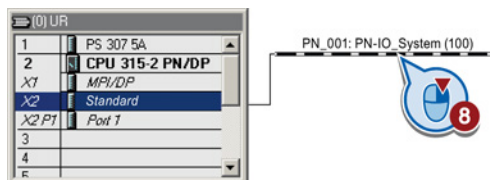
Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. CPU and supervisor must have the same subnet screen form.



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.

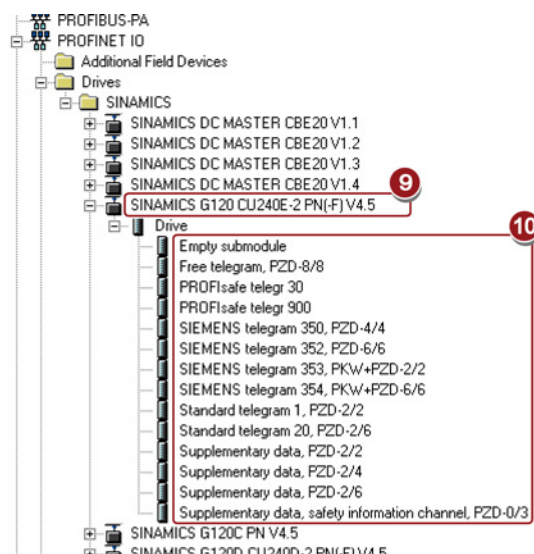
7. Exit this screen form and the next one with OK.

8. Select your subnet.



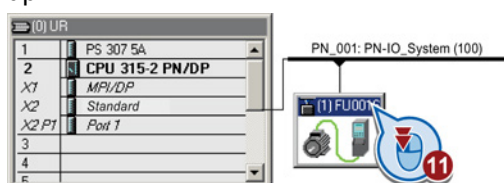
9. Using the hardware catalog, first insert the inverter using drag & drop.

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.

Select Node Address

Over which station address is the programming device connected to the module CPU 317-2 PN/DP?

Rack: 0

Slot: 2

Target Station: ☒ Local ☐ Can be reached by means of gateway

Enter connection to target station:

IP address	MAC address	Module type	Station name	Module name	P
192.168.0.11	00-1B-1B-14-70-E0	CPU 317-...	Standard	CPU 317-2...	

Accessible Nodes

IP address	MAC address	Module type	Station name	Module name
192.168.0.12	00-1B-1B-14-81-87	CPU 317F...	Safety	CPU 317F...
192.168.0.11	00-1B-1B-14-70-E0	CPU 317...	Standard	CPU 317-2...

Update

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 .

### A.7.2.2 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.

Characteristic	Order no.
CU240	6SL3 244-xxxx-xxxx
CU240B-2	6SL3 244-xxxx0-xBxx
CU240B-2 DP	6SL3 244-xxxx0-xPxx
CU240E-2	6SL3 244-xxxx2-xBxx
CU240E-2 DP	6SL3 244-xxxx2-xPxx
CU240E-2 DP-F	6SL3 244-xxxx3-xPxx
CU240E-2 F	6SL3 244-xxxx3-xBxx
CU240E-2 PN	6SL3 244-xxxx3-xPxx
CU240E-2 PN-F	6SL3 244-xxxx3-xPxx

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.7.2.3 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.7.2.4 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.

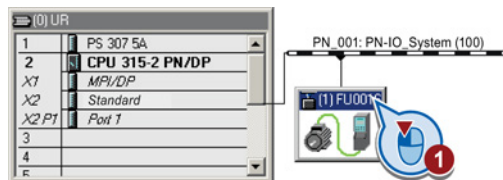
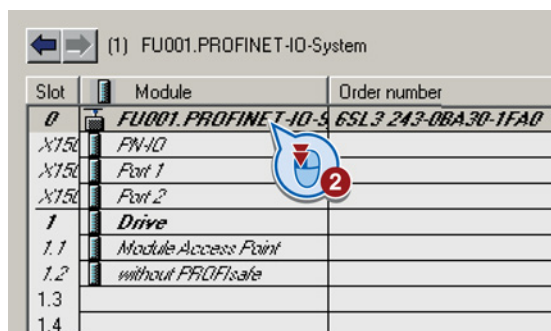
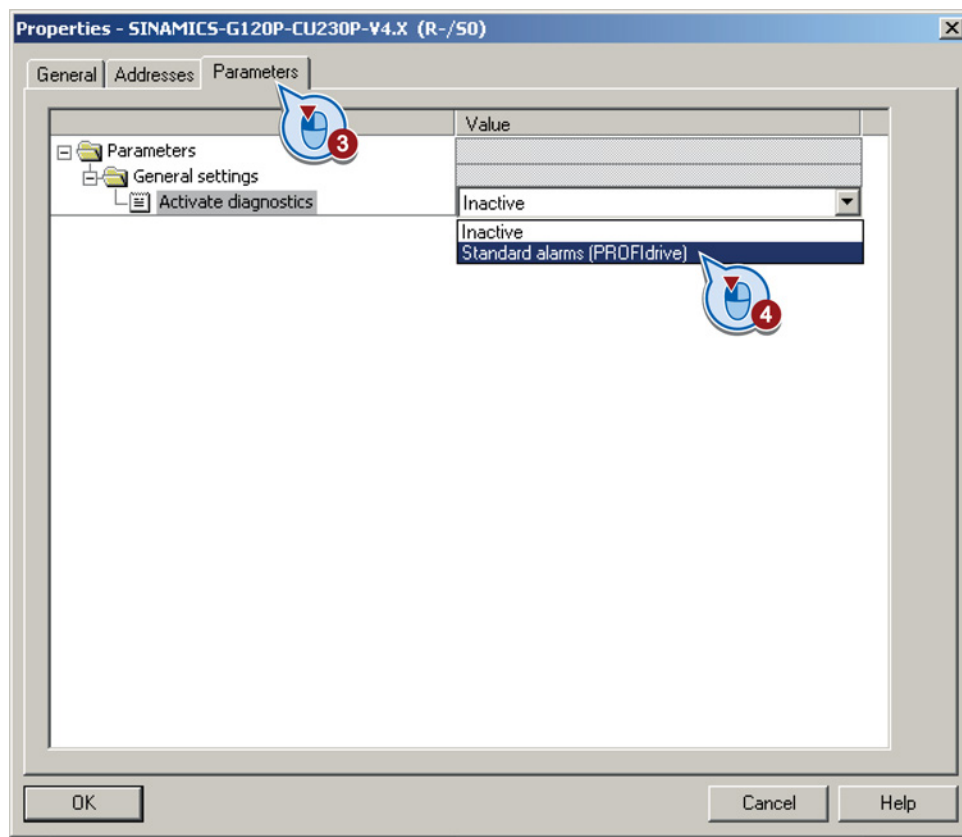


Figure A-10 Highlight inverter in HW Config

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.7.3 STEP 7 program examples

#### Data exchange via the fieldbus

##### Analog signals

The inverter always scales signals that are transferred via the fieldbus to a value of 4000 hex.

Table A- 9 Signal category and the associated scaling parameters

Signal category	4000 hex $\Delta$ ...	Signal category	4000 hex $\Delta$ ...
Speeds, frequencies	p2000	Power	p2004
Voltage	p2001	Angle	p2005
Current	p2002	Temperature	p2006
Torque	p2003	Acceleration	p2007

##### Control and status words

Control and status words consist of a high byte and a low byte. A SIMATIC control interprets words differently than the inverter: The higher and lower-order bytes are interchanged when they are transferred. See also the following program example.

### A.7.3.1 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 STEP 7 program examples (Page 384)).

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.7.3.2 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 Data set communication

(<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

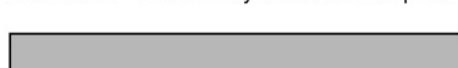
```

```

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-11 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

```

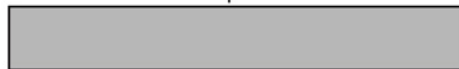
// -----

```

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-12 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 <i>MB 42</i>	02 hex: Change request	0
	01 hex	Number of parameters <i>MB 44</i>	2
Address, parameter 1	10 hex: Parameter value	Number of indexes <i>00 hex</i>	4
	Parameter number <i>MW 21</i>		6
	Number of the 1st index <i>MW 23</i>		8
Values, parameter 1	Format <i>MB 25</i>	Number of index values <i>MB 27</i>	10
	Value of the 1st index <i>MW 35</i>		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.7.4 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).

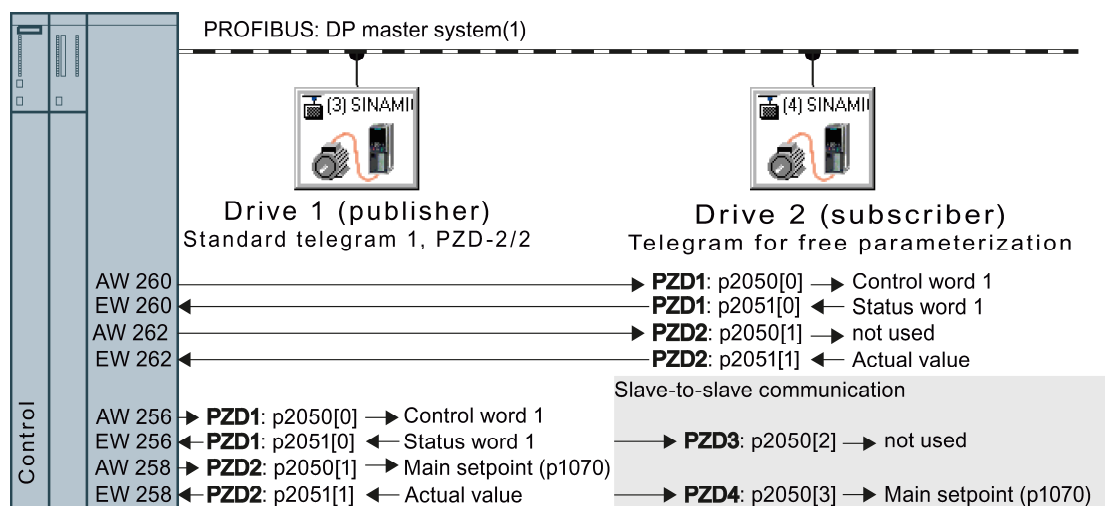


Figure A-13 Communication with the higher-level controller and between the drives with direct data exchange

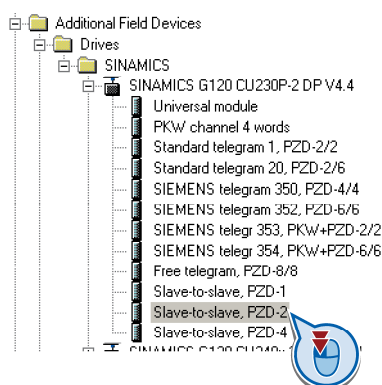
### Setting direct data exchange in the control

#### Procedure



Proceed as follows to set direct data exchange in the control:

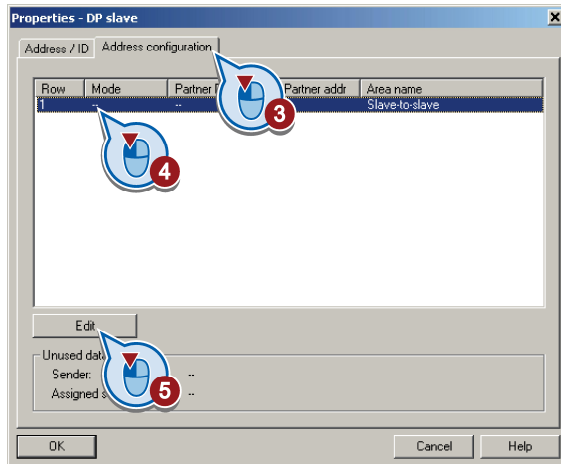
1. In HW Config in drive 2 (subscriber), insert a direct data exchange object, e.g. "Slave-to-slave, PZD2".



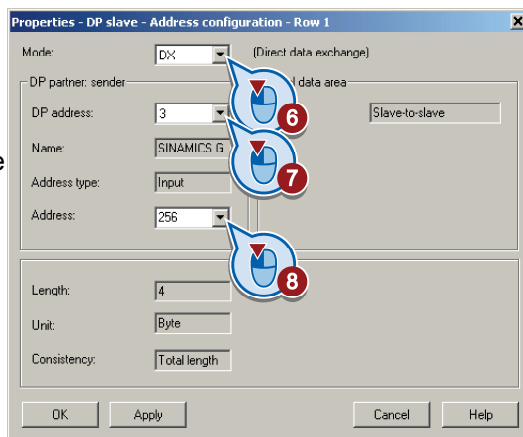
2. With a double-click, open the dialog box to make additional settings for the direct data exchange.

Slot	D.	Order Number / Designation	I Address	Q Address	Co...
1	195	Standard telegram 1, PZD-2/2	260..263	260..263	
2	129	Slave-to-slave, PZD-2			
3					
4					
5					
6					

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.7.5 Connecting fail-safe digital inputs

The following examples show the interconnection of a fail-safe digital input accordance with PL d to EN 13849-1 and SIL2 according to IEC61508. You can find further examples and information in the Safety Integrated Function Manual.

The examples comply with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all components are installed within one control cabinet.

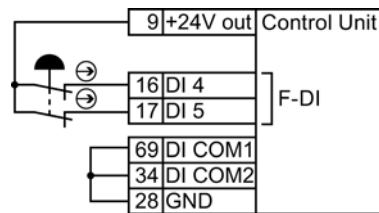


Figure A-14 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

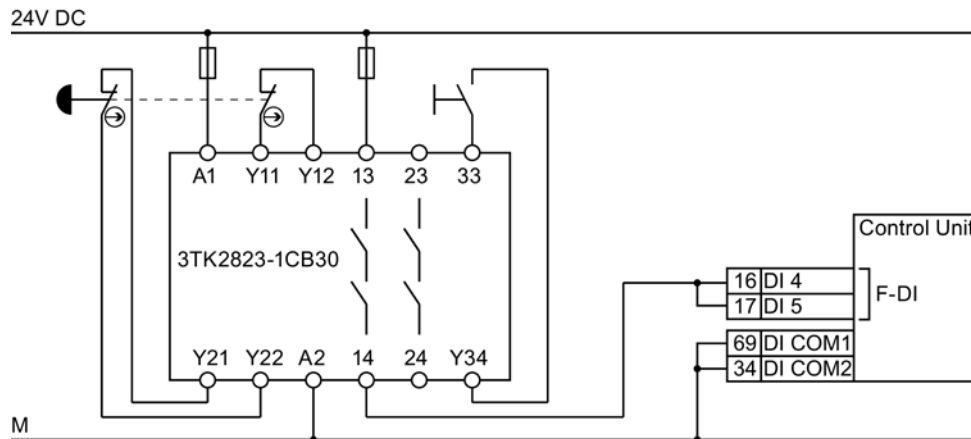


Figure A-15 Connecting a safety relay, e.g. SIRIUS 3TK28

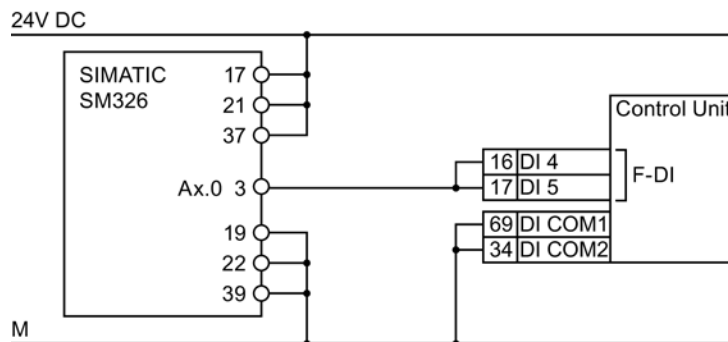


Figure A-16 Connecting an F digital output module, e.g. SIMATIC F digital output module

You can find additional connection options and connections in separate control cabinets in the Safety Integrated Function Manual, see Section: Additional information on the inverter (Page 397).

## A.8 Documentation for accepting the safety functions

### A.8.1 Machine documentation

#### Machine or plant description

Designation	...
Type	...
Serial number	...
Manufacturer	...
End customer	...
Block diagram of the machine and/or plant: <div style="text-align: center;"> ...  ...  ...  ...  ...  ...  ... </div>	

#### 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
...	...	...	...	
...	...	...	...	
<i>Example:</i>				
<i>Automatic</i>	<i>Protective door closed</i>	<i>Conveyor belt</i>	---	---
	<i>Protective door open</i>	<i>Conveyor belt</i>	<i>STO</i>	
	<i>Emergency Stop button pressed</i>	<i>Conveyor belt</i>	<i>STO</i>	

**Acceptance test reports**

File name of the acceptance reports	
...	...
...	...

**Data backup**

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Acceptance test reports	...	...	...	...
PLC program	...	...	...	...
Circuit diagrams	...	...	...	...

**Countersignatures****Commissioning engineer**

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

Date	Name	Company/dept.	Signature
...	...	...	...

**Machine manufacturer**

This confirms that the settings recorded above are correct.

Date	Name	Company/dept.	Signature
...	...	...	...

## A.8.2 Log the settings for the basic functions, firmware V4.4 ... V4.6

Drive = &lt;pDO-NAME\_v&gt;

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>
<i>Only for the CU250S-2 Control Unit</i> 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>
<i>Only for the CU250S-2 Control Unit</i> 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.9 Additional information on the inverter

Table A- 20 Manuals for your inverter

Depth of the information	Manual	Contents	Available languages	Download or order number
++	<b>Getting Started Guide</b> for the SINAMICS G120 inverter with the CU230P-2; CU240B-2 and CU240E-2 Control Units	Installing the inverter and commissioning.	English, German, Italian, French, Spanish, Chinese	Download: <a href="http://support.automation.siemens.com/WW/view/en/22339653/133300">http://support.automation.siemens.com/WW/view/en/22339653/133300</a> <b>SINAMICS Manual Collection</b> Documentation on DVD, order number 6SL3097-4CA00-0YG0
+++	<b>Operating instructions</b>	(this manual)		
+++	<b>Safety Integrated Function Manual</b> for the SINAMICS G120 and G120C and G120D inverters	Configuring PROFI-safe. Installing, commissioning and operating fail-safe functions of the inverter.	English, German	
+++	<b>List Manual</b> for the SINAMICS G120 inverter with the CU240B-2; CU240E-2 Control Units	Graphic function block diagrams. Complete list of all parameters, alarms and faults.	English, German, Chinese	
+	<b>Getting Started Guide</b> for the following SINAMICS G120 Power Modules: <ul style="list-style-type: none"> <li>PM240, PM250 and PM260</li> <li>PM240-2</li> <li>PM230</li> </ul>	Installing the Power Module	English	
+	<b>Installation Instructions</b> for reactors, filters and braking resistors	Installing components		
+++	<b>Hardware Installation Manual</b> for the following SINAMICS G120 Power Modules: <ul style="list-style-type: none"> <li>PM230 IP20</li> <li>PM230 IP55</li> <li>PM240</li> <li>PM240-2</li> <li>PM250</li> <li>PM260</li> </ul>	Installing power modules, reactors and filters. Maintaining power modules.	English, German	
+++	<b>Operating instructions</b> for the following operator panels: <ul style="list-style-type: none"> <li>BOP-2</li> <li>IOP</li> </ul>	Operation of operator panels, door mounting kit for mounting of IOP.		

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	Everything about SINAMICS G120 ( <a href="http://www.siemens.com/sinamics-g120">www.siemens.com/sinamics-g120</a> )
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 ( <a href="http://support.automation.siemens.com/W/view/en/10804987/130000">http://support.automation.siemens.com/W/view/en/10804987/130000</a> )
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Configuration Manual ( <a href="http://support.automation.siemens.com/W/view/en/37728795">http://support.automation.siemens.com/W/view/en/37728795</a> )

### 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/W/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".

## **A.10 Mistakes and improvements**

If you come across any mistakes when reading this manual or if you have any suggestions for how it can be improved, then please send your suggestions to the following address or by E-mail:

Siemens AG  
Drive Technologies  
Motion Control Systems  
Postfach 3180  
91050 Erlangen, Germany

E-mail (<mailto:documentation.standard.drives@siemens.com>)



# Index

## 8

87 Hz characteristic, 361

## A

AC/DC drive profile, 135

Acceptance test, 265

Authorized person, 265

Preconditions, 265

Reduced scope of, 266

Requirements, 265

STO, 269

Test scope, 266

Acceptance test record, 265

Acyclic communication, 125

Acyclic data transfer, 125

Additional components, 40

Adjustable parameters, 362

Alarm, 311, 314

Alarm buffer, 314

Alarm code, 314

Alarm history, 315

Alarm time, 314

Alarm value, 314

Ambient temperature, 68, 210

Analog input, 52, 53, 70

Function, 89, 97, 101

Analog output, 52, 53, 70

Function, 89, 101

Application

Reading and writing parameters acyclically via PROFIBUS and PROFINET, 129

Reading and writing parameters cyclically via PROFIBUS, 124

Authorized person, 265

Automatic mode, 180

Automatic restart, 237

## B

Base components, 38

Basic commissioning, 55

Basic functions, 92

BF (Bus Fault), 311, 312

BICO block, 372

Bimetallic switch, 207

Binector input, 90

Binectors, 373

Bit pattern test, 259

Block, 372

Blocking protection, 245, 246

BOP-2

Installing, 76

Menu, 364

Symbols, 364

Brake Relay, 231

Braking

Regenerative, 230

Braking functions, 220, 221

Braking method, 220, 222

Braking module, 33, 226

Braking resistor, 33, 226

Break loose torque, 363

Bus fault, 312

Bus termination, 51

## C

Catalog, 398

CDS (Command Data Set), 180, 264

Centrifuge, 220, 222, 225, 230

Changing parameters (STARTER), 368

Characteristic

Additional, 199

Linear, 198

parabolic, 198

square-law, 198

Checklist

PROFIBUS, 107

PROFINET, 104, 134

Circuit diagram, 395

Clockwise rotation, 173

Closed-loop speed control, 201

Closed-loop torque control, 205

Command Data Set, 180

Command source, 170

Selecting, 362

Commissioning

Accessories, 35

Guidelines, 67

Commissioning:

Overview, 20

- Communication
  - Acyclic, 125
  - Cyclically, 111
- Commutation dips, 28
- Compound braking, 225, 226
- Compressor, 73
- Configuring support, 398
- Connectors, 373
- Consistency, 258
- Consistent signals, 258
- Contact bounce, 259
- Control mode, 363
- Control terminals, 69
- Control Units, 21, 22, 296
- Control word, 113, 116
  - Control word 1, 113
  - Control word 3, 116
- Controlling the motor, 173
- Converter components, 21
- Conveyor belt, 222
- Conveyor systems, 85
- Copy
  - Series commissioning, 266
- Copy parameters (series commissioning), 266
- Correction manual, 399
- Counter-clockwise rotation, 173
- Countersignatures, 395
- Crane, 220, 230, 233
- Current input, 95
- Cyclic communication, 113

## D

- Data backup, 35, 273, 277, 282, 284, 395
- Data exchange fieldbus, 384
- Data set 47 (DS), 125, 389
- Data set changeover, 264
- Data transfer, 277, 282, 284
- DC braking, 116, 223, 224
- DC-link overvoltage, 211
- DC-link voltage, 211
- Default settings, 71
- Delta connection ( $\Delta$ ), 68, 361
- DI (Digital Input), 92, 264
- Digital input, 52, 70, 90, 173
  - Fail-safe, 54
  - Function, 89
- Digital inputs
  - Multiple assignment,
- Digital output, 52, 70
  - Function, 89, 93
- Dimensions, 41, 43

- DIP switch
  - Analog input, 95
- Direct data exchange, 124, 391
- Direction of rotation, 188
- Direction reversal, 173
- Discrepancy, 258
  - Filter, 258
  - Tolerance time, 258
- Display parameters, 362
- Door mounting kit, 35
- Down ramp, 363
- Download, 35, 277, 282, 284
- Download manuals, 397
- Drilling patterns, 41, 43
- Drive Data Set, DDS, 270
- Drive Data Sets, 270
- Drive ES Basic, 35, 377
- DS 47, 125
- Dynamic braking, 226

## E

- Electromechanical sensor, 393
- Elevator, 233
- EMC, 63
- Emergency Stop button, 253
- EN 61800-5-2, 253
- End customer, 394
- Energy recovery option, 230
- Energy-saving display, 218
- Ethernet/IP, 133
- Extended functions, 92
- Extruders, 73

## F

- Factory assignment, 69
- Factory settings
  - Restoring the, 75, 255
- Fail-safe input, 92
- Fan, 73, 85
- Fans, 24, 220, 230
- Fault, 311, 317
  - Acknowledge, 317, 318
  - motor, 320
- Fault buffer, 317
- Fault case, 317
- Fault code, 317
- Fault detection, 261
- Fault history, 318
- Fault time, 317

- received, 317
- removed, 317
- Fault value, 317
- F-DI (Fail-safe Digital Input), 92
- F-digital output module, 393
- FFC (Flux Current Control), 198
- Field weakening, 361
- Fieldbus interfaces, 51, 62, 103
- Filter
  - Contact bounce, 259
  - Discrepancy, 258
  - On/off test, 259
- Firmware
  - Update, 266
- Firmware downgrade, 305
- Firmware version, 362, 394
- Flow control, 241
- Flying restart, 236, 237
- Forced dormant error detection, 261
- Forced dormant error detection (basic functions), 261
- Formatting, 274
- Free function blocks, 249, 252
- Function Manual for Safety Integrated, 397
- Function table, 394
- Functional expansions, 266
- Functions
  - BOP-2, 364
  - Overview, 169
  - Technological, 170

**G**

- Getting Started, 397
- Grinding machine, 220, 222, 225
- GSD (Generic Station Description), 109, 377
- GSDML (Generic Station Description Markup Language), 106

**H**

- Hardware Installation Manual, 397
- Hoisting gear, 73, 220, 226, 230, 233
- Holding brake, 220
- Horizontal conveyor, 73
- Horizontal conveyors, 225, 226, 230
- Hotline, 398
- HW Config (hardware configuration), 376, 379

**I**

- I<sub>max</sub> controller, 210

- I<sub>2t</sub> monitoring, 206
- Inclined conveyors, 73, 220, 226, 230
- IND, 122, 153
- Industry Mall, 398
- Installation, 37, 40
- Interfaces, 51, 55
  - Configuring, 55
- Interlock, 374
- Inverter
  - does not respond, 308
  - Update, 266
- Inverter accessories, 397
- Inverter components, 295
- Inverter control, 170
- IT, 46

## J

- JOG function, 179

## K

- Know-how protection, 286, 289
- KTY84 sensor, 207

## L

- LED
  - BF, 311, 312
  - LNK, 312
  - RDY, 311
  - SAFE, 312
- LED (light emitting diode), 311
- Level control, 241
- Line filter, 27
- Line reactor, 28
- Line supply cable, 48
- Linear characteristic, 198
- LNK (PROFINET Link), 312
- Load failure, 247
- Load torque, 245

## M

- Machine description, 394
- Machine manufacturer, 265
- Manual Collection, 397
- Manual mode, 180
- Manuals, overview, 397
- Manufacturer, 394

- Maximum cable length
  - Modbus, 158
  - PROFIBUS, 108
  - PROFINET, 105
  - USS, 147
- Maximum current controller, 210
- Maximum speed, 74, 188, 190, 363
- Menu
  - BOP-2, 364
  - Operator panel, 364
- Minimum speed, 74, 188, 189, 363
- Mistakes manual, 399
- MLFB (order number), 394
- MMC (memory card), 274
- MMC card, 35
- MOP (motorized potentiometer), 184
- MotID (motor data identification), 78
- Motor cable, 48
- Motor control, 170
- Motor data, 68
  - Identify, 78, 86, 203, 205
  - measurement, 78
- Motor fault, 320
- Motor holding brake, 220, 230, 232, 233
- Motor standard, 215
- Motor temperature, 210
- Motor temperature sensor, 70
- Motorized potentiometer, 184
- Motor-temperature sensor, 52, 53, 209
- Multiple assignment
  - Digital inputs, 264

## N

- No-load monitoring, 245, 246

## O

- OFF1 command, 173
- OFF3 ramp-down time, 192
- ON command, 173
- On/off test, 259
- Operating instruction, 19
- Operating instructions, 397
- Operating mode, 394
- Operation, 172
- Operator panel
  - BOP-2, 364
  - Installing, 76
  - Menu, 364
- Operator Panel

- BOP-2, 35
- Door mounting kit, 35
- Handheld, 35
- IOP, 35
- Order number, 21
- Output reactor, 29
- Overload, 210, 363
- Overview of the functions, 169
- Overvoltage, 211
- Overvoltage protection, 28

## P

- p0015, configuring macro interfaces, 55
- Page index, 122, 153
- Parabolic characteristic, 198
- Parameter channel, 119, 150
  - IND, 122, 153
- Parameter index, 122, 153
- Parameter Manual, 397
- Parameter number, 122, 366
- Parameter types, 362
- Parameter value, 125, 367
- Password, 255
- PC Connection Kit, 35, 254
- PELV, 331, 333
- PFH (Probability of failure per hour), 334
- PID controller, 242
- Plant description, 394
- PLC functionality, 374
- PLC program, 395
- Power Distribution Systems, 46
- Power failure, 237
- Power Module, 21
- Power on reset, 75, 255, 263, 297, 298
- Pressure control, 241
- Probe, 248
- Procedure, 19
- Process variables of the technology controller, 216
- PROFIBUS, 107
- PROFInergy, 130
- PROFINET, 104
- PROFIsafe, 103, 378
- Protection functions, 170
- PTC sensor, 207
- Pulse cancelation, 114
- Pulse enable, 114
- Pump, 73, 85
- Pumps, 24, 230

**Q**

Questions, 398  
Quick stop, 171

**R**

Radio interference class, 27  
Ramp-down time, 74, 192, 194, 363  
    Scaling, 195  
Ramp-function generator, 188, 191  
Rampup time,  
Ramp-up time  
    Scaling, 195  
Ramp-up time, 363  
RDY (Ready), 311  
Ready, 172  
Ready to switch on, 172  
Regenerative feedback, 25, 230  
Regenerative power, 220  
Replacing  
    Control Unit, 266  
    Gearbox, 266  
    Hardware, 266  
    Motor, 266  
    Power Module, 266  
Reset  
    Parameter, 75, 255  
Residual risks of drive systems, 17  
Reversing, 188  
Rounding, 192  
Rounding OFF3, 192  
RS485 interface, 146  
Run sequence, 250  
Runtime group, 250

**S**

SAFE, 312  
Safe Brake Relay, 261  
Safety function, 170, 296, 301  
Safety Integrated Function Manual, 393  
Safety relay, 393  
Saw, 222, 225  
Scaling  
    Analog input, 95  
    Analog output, 99  
    Fieldbus, 384  
SD (memory card), 35, 274  
    Formatting, 274  
    MMC, 274  
Self-test (forced dormant error detection, 261

Sensor (electromechanical), 393  
Sequence control, 171  
Serial number, 394  
Series commissioning, 35, 266, 273  
Setpoint processing, 170, 188  
Setpoint source, 170  
    Selecting, 183, 184, 362  
Shield connection kit, 22, 25  
Short-circuit monitoring, 208  
Signal interconnection, 372  
Signal states, 311  
SIMATIC, 376, 377, 379  
Sine-wave filter, 31  
SIZER, 398  
Skip frequency band, 98  
Speed  
    change with BOP-2, 364  
    Limiting, 188  
Speed deviation, 247  
Speed monitoring, 247  
Square-law characteristic, 198  
Stall protection, 245, 246  
Standards  
    EN 60950, 46  
Star connection (Y), 361  
STARTER, 35, 81, 84, 254, 282, 368  
    Download, 36  
STARTER commissioning tool, 254  
STARTER PC tool, 254  
Starting characteristics  
    Optimization, 199  
State overview, 171  
Status messages, 170  
Status word, 113, 116  
    Status word 1, 115  
    Status word 3, 117  
STEP 7 object manager, 377  
STO (Safe Torque Off), 253, 254  
    Acceptance test, 269  
    select, 254  
Storage medium, 273  
STW1 (control word 1), 113  
STW3 (control word 3), 116  
Subindex, 122, 153  
Suggestions for improvement manual, 399  
Support, 398  
Switch off  
    Motor, 171  
    OFF1 command, 171  
    OFF2 command, 171  
    OFF3 command, 171  
Switch on

- Motor, 171
- ON command, 171
- Switching on inhibited, 114, 172
- Switching over units, 213
- Switching-on a motor with BOP-2, 364
- Switch-off signal paths (forced dormant error detection), 261
- Symbols, 19
- System runtime, 313

## T

- Technical data
  - Control Unit, 331, 333
- Technology controller, 116, 216, 241
- Telegram
  - Extending, 118
  - paste, 106, 110
- Telegram types, 377
- Temperature calculation, 210
- Temperature monitoring, 206, 210
- Temperature sensor, 52, 53, 54, 70
- Temperature switch, 207
- Terminal block, 52, 61, 89
- Terminal strip
  - Factory setting, 69
- Test signals, 259
- Test stop (forced dormant error protection), 261
- Three-wire control, 173
- Time slices, 250
- TN-C, 46
- TN-C-S, 46
- TN-S, 46
- Torque monitoring
  - Speed-dependent, 245, 246
- Trace function, 369
- TT, 46
- Two-wire control, 173
- Type plate
  - Control Unit, 21
  - Power Module, 21

## U

- U/f control, 196, 363
- Unit system, 216
- Unwinders, 230
- Up ramp, 363
- Update (firmware), 266
- Upgrading the firmware, 303
- Upload, 35, 275, 282, 284

- USB interface, 82
- USB port, 35
- Use for the intended purpose, 15
- User interfaces, 51
- USS (universal serial interface), 147, 150

## V

- Vector control, 363
  - Sensorless, 201
- Vector control, 363
- Vector control, 363
- Version
  - Control Unit, 21
  - Firmware, 394
  - Hardware, 394
  - Power Module, 21
  - Safety function, 394
- Vertical conveyors, 73, 226, 230
- Voltage boost, 199, 363
- Voltage input, 95

## W

- Winders, 73, 230
- Wire breakage, 258
- Wire-break monitoring, 96, 208
- Write protection, 286, 288

## Z

- ZSW1 (status word 1), 115
- ZSW3 (status word 3), 117



Siemens AG  
Industry Sector  
Drive Technologies  
Motion Control Systems  
P.O. Box 3180  
91050 ERLANGEN  
GERMANY

**[www.siemens.com/sinamics-g120](http://www.siemens.com/sinamics-g120)**

We reserve the right to make technical changes.  
© Siemens AG 2013