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# SINAMICS

## SINAMICS G120 inverter

### CU250-2 Control Units, control mode "vector"

Operating instructions

Output 06/2013

Answers for industry.

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**SINAMICS G120**
**Inverter with the CU250S-2 Control Unit (Vector)**

**Product information** **08/2013**

# Order numbers for memory cards and licenses

**Supplement to Operating Instructions 06/2013, FW V4.6, Section 3.2 Control Units**

The Control Unit provides software functions that have to be enabled through licenses.

You can purchase the software as a license without memory card if you are already using one of the memory cards listed below for operating your inverter. If you do not already use a memory card, purchase the license on a memory card. The inverter also uses an inserted license card as a memory card for saving settings.

Please find below a list of the memory cards and licenses available.

**Memory cards**

Empty memory card 6SL3054-4AG00-2AA0

Memory card with firmware 6SL3054-7XX00-2BA0
XX designates the firmware version: 4.6 ≙ EG, 4.7 ≙ EH, 4.8 ≙ EI …

**Licenses**

| License for | Order number for the license | |
|---|---|---|
| | Without memory card | With memory card |
| Basic Positioner with Vector control | 6SL3074-7AA04-0AA0 | 6SL3054-4AG00-2AA0-Z E01 |
| Extended safety functions with<br>• Safely Limited Speed (SLS)<br>• Safe Direction (SDI)<br>• Safe Speed Monitoring (SSM) | 6SL3074-0AA10-0AA0 | 6SL3054-4AG00-2AA0-Z F01 |
| • Basic Positioner with Vector control<br>• Extended safety functions | | 6SL3054-4AG00-2AA0-Z E01 F01 |

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# SINAMICS

# SINAMICS G120 Converter with the CU250S-2 Control Unit (vector)

Operating Instructions


Changes in this manual

Safety notes 1

Introduction 2

Description 3

Installing 4

Commissioning 5

Adapt terminal strip 6

Configuring the fieldbus 7

Setting functions 8

Backing up data and series commissioning 9

Corrective maintenance 10

Alarms, faults and system messages 11

Technical data 12

Appendix A



Edition 06/2013, Firmware V4.6

Original instructions
06/2013, FW V4.6
A5E31759476B AB

## Legal information

### Warning notice system

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

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

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

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

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

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

### Qualified Personnel

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

### Proper use of Siemens products

Note the following:

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

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### Disclaimer of Liability

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

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# Changes in this manual

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

An overview of all new and modified functions in Firmware V4.6 can be found in section New and extended functions (Page 411).

| Revised descriptions | In Chapter |
|---|---|
| Updated Order No. of the memory card. | Overview of Control Units (Page 24) |
| Overview of the permissible motors has been supplemented. | Motor series that are supported (Page 37) |
| SMC and SME Sensor Modules supplemented. | Installing encoders (Page 66) |
| Licensing procedure supplemented. | Activating licensed functions (Page 413) |

# Table of contents


Changes in this manual ..... 5

1 Safety notes ..... 15

1.1 General safety instructions ..... 15

1.2 Safety instructions for electromagnetic fields (EMF) ..... 18

1.3 Handling electrostatic sensitive devices (ESD) ..... 19

1.4 Residual risks of power drive systems ..... 19

2 Introduction ..... 21

2.1 About this manual ..... 21

2.2 Guide through this manual ..... 22

3 Description ..... 23

3.1 Identifying the converter ..... 23

3.2 Overview of Control Units ..... 24

3.3 Power Module ..... 26

3.4 Components for the Power Modules ..... 29
3.4.1 Line filter ..... 29
3.4.2 Line reactor ..... 30
3.4.3 Output reactor ..... 32
3.4.4 Sine-wave filter ..... 34
3.4.5 Braking resistor ..... 36
3.4.6 Brake Relay ..... 37
3.4.7 Safe Brake Relay ..... 37

3.5 Motor series that are supported ..... 37

3.6 Permissible encoders ..... 38

3.7 Sensor Module ..... 38

3.8 Tools to commission the converter ..... 39

4 Installing ..... 40

4.1 Overview of the inverter installation ..... 40

4.2 Installing reactors, filters and braking resistors ..... 41

4.3 Installing the Power Module ..... 43
4.3.1 Installing Power Modules ..... 43
4.3.2 Dimensions, hole drilling templates, minimum clearances, tightening torques ..... 45
4.3.3 Connecting the line supply, motor, and inverter components ..... 50
4.3.3.1 Connection overview for Power Module ..... 50
4.3.3.2 Power distribution systems ..... 52

4.4 Installing Control Unit ..... 55

4.4.1 Snapping the Control Unit onto the Power Module ... 55
4.4.2 Overview of the interfaces ... 56
4.4.3 Terminal blocks ... 58
4.4.4 Selecting the pre-assignment for the terminal strip ... 60
4.4.5 Wiring the terminal strip ... 64

4.5 Installing encoders ... 66

4.6 Connecting inverters in compliance with EMC ... 67
4.6.1 EMC-compliant connection of the converter ... 67
4.6.2 Avoid electromagnetic interference (EMI) ... 67

**5 Commissioning ... 73**

5.1 Commissioning guidelines ... 73

5.2 Preparing for commissioning ... 74
5.2.1 Wiring examples for the factory settings ... 75
5.2.2 Does the motor match the converter? ... 77
5.2.3 Factory setting of the inverter control ... 78
5.2.4 Inverter function modules ... 79
5.2.5 V/f control or vector control (speed/torque)? ... 81
5.2.6 Encoders for speed and position control ... 82
5.2.7 Defining additional requirements for the application ... 82

5.3 Restoring the factory setting ... 83

5.4 Basic commissioning with STARTER ... 85
5.4.1 Generating a STARTER project ... 85
5.4.2 Transfer inverters connected via USB into the project ... 86
5.4.3 Configuring a drive ... 87
5.4.4 Adapting the encoder data ... 90
5.4.5 Loading the configured data into the drive ... 91
5.4.6 Identifying motor data ... 92

**6 Adapt terminal strip ... 95**

6.1 Digital inputs ... 96

6.2 Fail-safe input ... 99

6.3 Digital outputs ... 101

6.4 Analog inputs ... 103

6.5 Analog outputs ... 107

**7 Configuring the fieldbus ... 111**

7.1 Fieldbus versions of the Control Unit ... 111

7.2 Communication via PROFINET ... 112
7.2.1 What do you need for communication via PROFINET? ... 112
7.2.2 Connect the converter to PROFINET ... 113
7.2.3 Configuring communication to the control ... 114
7.2.4 Select telegram – procedure ... 115
7.2.5 Activating diagnostics via the control ... 115

7.3 Communication via PROFIBUS ... 116
7.3.1 What do you need for communication via PROFIBUS? ... 116
7.3.2 Connect the frequency inverter to PROFIBUS ... 116

7.3.3 Configuring communication to the control ....117
7.3.4 Setting the address ....118
7.3.5 Select telegram – procedure ....118

7.4 PROFIdrive profile for PROFIBUS and PROFINET ....120
7.4.1 Cyclic communication ....120
7.4.1.1 Control and status word 1 ....124
7.4.1.2 Control and status word 3 ....127
7.4.1.3 Extend telegrams and change signal interconnection ....128
7.4.1.4 Data structure of the parameter channel ....130
7.4.1.5 Slave-to-slave communication ....135
7.4.2 Acyclic communication ....136

7.5 PROFIenergy profile for PROFINET ....141

7.6 Communication via EtherNet/IP ....144
7.6.1 Connect converter to Ethernet/IP ....144
7.6.2 What do you need for communication via Ethernet/IP? ....145
7.6.3 Communication settings for Ethernet/IP ....145
7.6.4 Additional settings if you are working with the AC/DC profile ....146
7.6.5 Supported objects ....147
7.6.6 Create generic I/O module ....156

7.7 Communication via RS485 ....157
7.7.1 Integrating inverters into a bus system via the RS485 interface ....157
7.7.2 Communication via USS ....158
7.7.2.1 Basic settings for communication ....158
7.7.2.2 Telegram structure ....159
7.7.2.3 User data range of the USS telegram ....160
7.7.2.4 USS parameter channel ....161
7.7.2.5 USS process data channel (PZD) ....166
7.7.2.6 Time-out and other errors ....167
7.7.3 Communication over Modbus RTU ....169
7.7.3.1 Basic settings for communication ....170
7.7.3.2 Modbus RTU telegram ....171
7.7.3.3 Baud rates and mapping tables ....172
7.7.3.4 Write and read access via FC 03 and FC 06 ....175
7.7.3.5 Communication procedure ....177

7.8 Communication over CANopen ....179
7.8.1 CANopen functions of the converter ....179
7.8.1.1 Network management (NMT service) ....180
7.8.1.2 SDO services ....183
7.8.1.3 Access to SINAMICS parameters via SDO ....184
7.8.1.4 Access PZD objects via SDO ....185
7.8.1.5 PDO and PDO services ....188
7.8.1.6 Predefined connection set ....191
7.8.1.7 Free PDO mapping ....192
7.8.1.8 Interconnect objects from the receive and transmit buffers ....195
7.8.1.9 CANopen operating modes ....197
7.8.1.10 RAM to ROM via the CANopen object 1010 ....197
7.8.2 Object directories ....198
7.8.2.1 General objects from the CiA 301 communication profile ....198
7.8.2.2 Free objects ....207
7.8.2.3 Objects from the CiA 402 drive profile ....208

7.8.3 Integrating the converter into CANopen ... 210
7.8.3.1 Connecting inverter to CAN bus ... 211
7.8.3.2 Setting the node ID and baud rate ... 211
7.8.3.3 Setting the baud rate ... 212
7.8.3.4 Setting the monitoring of the communication ... 212
7.8.4 Free PDO mapping for example of the actual current value and torque limit ... 213

**8 Setting functions ... 215**

8.1 Overview of the converter functions ... 215

8.2 Inverter control ... 217
8.2.1 Switching the motor on and off ... 217
8.2.2 Inverter control using digital inputs ... 219
8.2.3 Two-wire control: method 1 ... 220
8.2.4 Two-wire control, method 2 ... 221
8.2.5 Two-wire control, method 3 ... 222
8.2.6 Three-wire control, method 1 ... 223
8.2.7 Three-wire control, method 2 ... 224
8.2.8 Running the motor in jog mode (JOG function) ... 225
8.2.9 Switching over the inverter control (command data set) ... 226

8.3 Setpoints ... 229
8.3.1 Overview ... 229
8.3.2 Analog input as setpoint source ... 230
8.3.3 Specifying the motor speed via the fieldbus ... 230
8.3.4 Motorized potentiometer as setpoint source ... 231
8.3.5 Fixed speed as setpoint source ... 233

8.4 Setpoint calculation ... 235
8.4.1 Overview of setpoint processing ... 235
8.4.2 Invert setpoint ... 235
8.4.3 Inhibit direction of rotation ... 236
8.4.4 Minimum speed ... 236
8.4.5 Maximum speed ... 237
8.4.6 Ramp-function generator ... 237

8.5 Motor control ... 242
8.5.1 V/f control ... 242
8.5.1.1 Characteristics of U/f control ... 243
8.5.1.2 Selecting the U/f characteristic ... 244
8.5.1.3 Optimizing with a high break loose torque and brief overload ... 246
8.5.2 Closed-loop speed control ... 248
8.5.2.1 Checking the encoder signal ... 249
8.5.2.2 Select motor control ... 249
8.5.2.3 Optimizing the speed controller ... 251
8.5.2.4 Advanced settings ... 253
8.5.3 Torque control ... 254

8.6 Protection functions ... 255
8.6.1 Inverter temperature monitoring ... 255
8.6.2 Motor temperature monitoring using a temperature sensor ... 256
8.6.3 Overcurrent protection ... 258
8.6.4 Limiting the maximum DC link voltage ... 258

8.7 Application-specific functions ... 260

8.7.1 Unit changeover ....260
8.7.1.1 Changing over the motor standard ....262
8.7.1.2 Changing over the unit system ....262
8.7.1.3 Changing over process variables for the technology controller ....263
8.7.1.4 Switching units with STARTER ....264
8.7.2 Energy-saving display ....265
8.7.3 Braking functions of the inverter ....267
8.7.3.1 Electrical braking methods ....267
8.7.3.2 DC braking ....269
8.7.3.3 Compound braking ....272
8.7.3.4 Dynamic braking ....274
8.7.3.5 Braking with regenerative feedback to the line ....277
8.7.3.6 Motor holding brake ....278
8.7.4 Automatic restart and flying restart ....284
8.7.4.1 Flying restart – switching on while the motor is running ....284
8.7.4.2 Automatic switch-on ....285
8.7.5 PID technology controller ....290
8.7.5.1 Overview ....290
8.7.5.2 Setting the controller ....290
8.7.5.3 Optimizing the controller ....292
8.7.6 Monitor the load torque (system protection) ....294
8.7.7 Load failure monitoring ....296
8.7.8 Speed deviation monitoring ....297
8.7.9 Free function blocks ....299

8.8 Safe Torque Off (STO) safety function ....302
8.8.1 Function description ....302
8.8.2 Prerequisite for STO use ....303
8.8.3 Commissioning STO ....303
8.8.3.1 Commissioning tool ....303
8.8.3.2 Protection of the settings from unauthorized changes ....303
8.8.3.3 Resetting the safety function parameters to the factory setting ....304
8.8.3.4 Changing settings ....305
8.8.3.5 Interconnecting the "STO active" signal ....306
8.8.3.6 Setting the filter for fail-safe inputs ....307
8.8.3.7 Setting forced dormant error detection ....310
8.8.3.8 Activate settings ....312
8.8.3.9 Checking the assignment of the digital inputs ....312
8.8.3.10 Acceptance - completion of commissioning ....314

8.9 Switchover between different settings ....320

**9 Backing up data and series commissioning .... 323**

9.1 Saving settings on a memory card ....325
9.1.1 Saving setting on memory card ....326
9.1.2 Transferring the setting from the memory card ....328
9.1.3 Safely remove the memory card ....330

9.2 Saving settings on a PC ....332

9.3 Saving settings on an operator panel ....334

9.4 Other ways to back up settings ....334

9.5 Write and know-how protection ....335

9.5.1 Write protection ... 335
9.5.2 Know-how protection ... 337
9.5.2.1 Settings for the know-how protection ... 338
9.5.2.2 Creating an exception list for the know-how protection ... 340

**10 Corrective maintenance ... 343**

10.1 Overview of replacing converter components ... 343
10.2 Replacing a Control Unit with enabled safety function ... 345
10.3 Replacing the Control Unit without the safety functions enabled ... 348
10.4 Replacing the Control Unit without data backup ... 350
10.5 Replacing a Control Unit with active know-how protection ... 351
10.6 Replacing a Power Module with enabled safety function ... 353
10.7 Replacing a Power Module without the safety function being enabled ... 354
10.8 Replacing an encoder ... 355
10.8.1 Replacing the encoder - same encoder type ... 355
10.8.2 Replacing the encoder - different encoder type ... 356
10.9 Upgrading the firmware ... 358
10.10 Firmware downgrade ... 360
10.11 Correcting an unsuccessful firmware upgrade or downgrade ... 362
10.12 If the converter no longer responds ... 363

**11 Alarms, faults and system messages ... 365**

11.1 Operating states indicated on LEDs ... 366
11.2 System runtime ... 368
11.3 Alarms ... 369
11.4 Faults ... 372
11.5 List of alarms and faults ... 376

**12 Technical data ... 385**

12.1 Technical data, CU250S-2 Control Unit ... 385
12.2 Technical data, Power Modules ... 390
12.2.1 Technical data, PM240 ... 392
12.2.1.1 General data, PM240 ... 392
12.2.1.2 Power-dependent data, PM240 ... 393
12.2.2 Technical data, PM240-2 ... 398
12.2.2.1 General data, PM240-2 ... 398
12.2.2.2 Power-dependent data PM240-2 ... 399
12.2.3 Technical data, PM250 ... 403
12.2.3.1 Power-dependent data, PM250 ... 404
12.2.4 Technical data, PM260 ... 406
12.2.4.1 Power-dependent data, PM260 ... 407
12.2.5 Technical data, PM340 ... 408
12.2.5.1 General data, PM340, 1 AC 200 … 240 V ... 408
12.2.5.2 Power-dependent data, PM340 ... 409

A Appendix ..... 411
A.1 New and extended functions ..... 411
A.1.1 Firmware version 4.6 ..... 411
A.1.2 Firmware version 4.6.6 ..... 412
A.2 Activating licensed functions ..... 413
A.2.1 Licensing ..... 413
A.2.2 Creating or displaying the license key ..... 414
A.2.3 Writing the license key to the card ..... 417
A.3 Star-delta motor connection and application examples ..... 419
A.4 Parameter ..... 420
A.5 Handling the BOP 2 operator panel ..... 422
A.5.1 Changing settings using BOP-2 ..... 423
A.5.2 Changing indexed parameters ..... 424
A.5.3 Directly entering the parameter number and value ..... 424
A.5.4 A parameter cannot be changed ..... 425
A.6 Handling STARTER ..... 426
A.6.1 Change settings ..... 426
A.6.2 Optimize the drive using the trace function ..... 427
A.7 Interconnecting signals in the inverter ..... 430
A.7.1 Fundamentals ..... 430
A.7.2 Example ..... 432
A.8 Application Examples ..... 434
A.8.1 Setting an absolute encoder ..... 434
A.8.2 Configuring PROFIBUS communication in STEP 7 ..... 438
A.8.2.1 Creating a STEP 7 project and network ..... 438
A.8.2.2 Inserting the inverter into the project ..... 439
A.8.3 Configuring PROFINET communication in STEP 7 ..... 441
A.8.3.1 Configuring the controller and converter in HW Config ..... 441
A.8.3.2 Activate diagnostic messages via STEP 7 ..... 443
A.8.4 Go online with STARTER via PROFINET ..... 445
A.8.4.1 Adapting the PROFINET interface ..... 445
A.8.4.2 Create a reference for STARTERS ..... 446
A.8.4.3 Call the STARTER and go online ..... 447
A.8.5 STEP 7 program examples ..... 447
A.8.5.1 STEP 7 program example for cyclic communication ..... 448
A.8.5.2 STEP 7 program example for acyclic communication ..... 450
A.8.6 Configuring slave-to-slave communication in STEP 7 ..... 454
A.8.7 Connecting fail-safe digital inputs ..... 456
A.8.8 Connecting fail-safe digital inputs ..... 456
A.9 Documentation for accepting the safety functions ..... 458
A.9.1 Machine documentation ..... 458
A.9.2 Log the settings for the basic functions, firmware V4.4 ... V4.6 ..... 460
A.10 Additional information on the inverter ..... 461
A.10.1 Manuals for your converter ..... 461
A.10.2 Configuring support ..... 462
A.10.3 Product Support ..... 463
A.11 Mistakes and improvements ..... 464
Index ..... 465

# Safety notes 1

### Use for the intended purpose

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

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

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

## 1.1 General safety instructions

**⚠ DANGER**

**Danger to life due to live parts and other energy sources**

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

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

Generally, six steps apply when establishing safety:

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

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

**⚠ WARNING**

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

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

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

**⚠ WARNING**

**Danger to life when live parts are touched on damaged devices**

Improper handling of devices can cause damage.

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

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Do not use any damaged devices.
- Protect the components against conductive pollution, e.g., by installing them in a control cabinet with IP54 degree of protection according to IEC 60529 or NEMA 12. Provided conductive pollution can be prevented at the installation site, the degree of protection for the cabinet can be decreased accordingly.

**⚠ WARNING**

**Danger to life through electric shock due to unconnected cable shields**

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

- Connect cable shields and unused conductors of power cables (e.g., brake conductors) at least on one side to the grounded housing potential.

**⚠ WARNING**

**Danger to life due to electric shock when not grounded**

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

- Ground the device in compliance with the applicable regulations.

**⚠ WARNING**

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

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

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

⚠ WARNING

**Danger to life due to fire spreading if housing is inadequate**

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

- Install devices without a protective housing in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire inside and outside the device is prevented.
- Additionally, select the installation site so that an uncontrolled spreading of smoke can be avoided in the case of a fire.
- Ensure that smoke can escape via designated paths.

⚠ WARNING

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

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

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

⚠ WARNING

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

There is a greater load on the motor insulation through 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.

⚠ WARNING

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

Inadequate ventilation clearances can cause overheating with a risk for personnel through smoke development and fire. This can also result in increased downtime and reduced service lives for devices / systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component. They can be found in the dimension drawings or in the "Product-specific safety instructions" at the start of the respective section.

**WARNING**

**Danger of an accident occuring due to missing or illegible warning labels**

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

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

**WARNING**

**Danger to life when safety functions are inactive**

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

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

**Note**

**Important safety notices for safety functions**

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

## 1.2 Safety instructions for electromagnetic fields (EMF)

**WARNING**

**Danger to life from electromagnetic fields**

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

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

- Keep a distance of at least 2 m.

## 1.3 Handling electrostatic sensitive devices (ESD)

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

**NOTICE**

**Damage through electric fields or electrostatic discharge**

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

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

## 1.4 Residual risks of power drive systems

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

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

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

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

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination

- Parameterization, programming, cabling, and installation errors
- Use of radio devices / cellular phones in the immediate vicinity of the controller
- External influences / damage

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

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

**Note**

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

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

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

# Introduction 2

## 2.1 About this manual

### Who requires the operating instructions and what for?

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

#### What is described in the operating instructions?

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

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

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

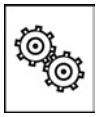
### What is the meaning of the symbols in the manual?

An operating instruction starts here.

This concludes the operating instruction.

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

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



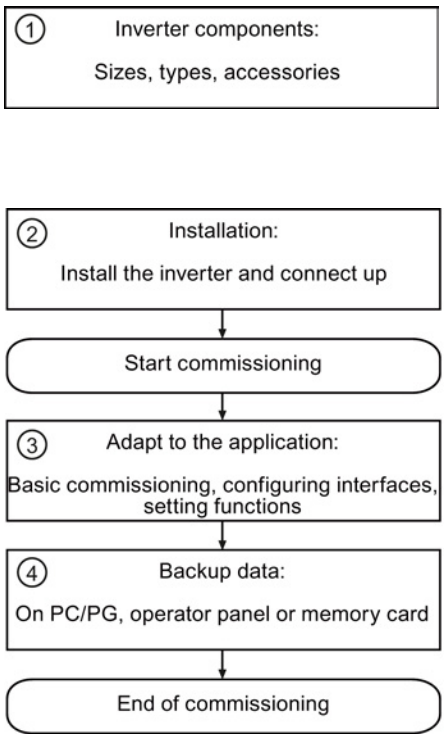
Examples for the symbols of the inverter functions.

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

See also: Overview of the converter functions (Page 215).

## 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:

- Description (Page 23)

② • Overview of the inverter installation (Page 40)

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

③ • Commissioning (Page 73)
- Adapt terminal strip (Page 95)
- Configuring the fieldbus (Page 111)
- Setting functions (Page 215)

④ • Backing up data and series commissioning (Page 323)

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

- Corrective maintenance (Page 343)
- Alarms, faults and system messages (Page 365)

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

- Technical data (Page 385)

⑦ The appendix contains some background information and explanatory examples:

- Appendix (Page 411)

# Description

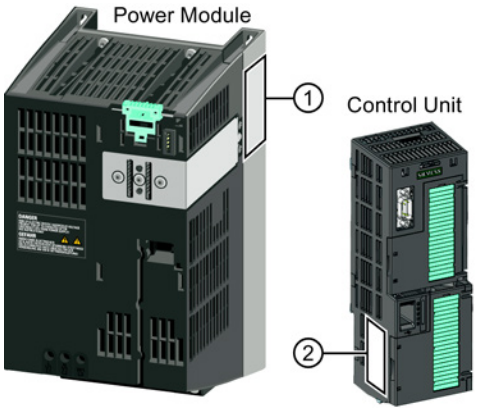
# 3

## 3.1 Identifying the converter

### Main components of the converter

Each SINAMICS G120 converter comprises a Control Unit and 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. CU250S-2 DP Control Unit
- Order number: e.g. 6SL3246-0BA22-1PA0
- Version: e.g. 02 (hardware) 4.6 (firmware)

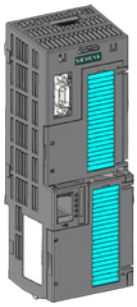
### Additional converter components

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

- Line filter (Page 29)
- Line reactor (Page 30)
- Output reactor (Page 32)
- Sine-wave filter (Page 34)
- Braking resistor (Page 36)
- Brake Relay to control a motor holding brake (Page 37).

## 3.2 Overview of Control Units

The Control Units CU250S-2 differ with regard to the type of fieldbus.

| | Designation | Order number | Fieldbus |
|---|---|---|---|
|  | CU250S-2 | 6SL3246-0BA22-1BA0 | USS, Modbus RTU |
| | CU250S-2 DP | 6SL3246-0BA22-1PA0 | PROFIBUS DP |
| | CU250S-2 PN | 6SL3246-0BA22-1FA0 | PROFINET IO<br>EtherNet/IP |
| | CU250S-2 CAN | 6SL3246-0BA22-1CA0 | CANopen |

### Memory cards

The following memory cards are available for the Control Unit as medium to backup inverter settings:

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

  The digit at position x designates the firmware version:

  4.6 ≙ EG, 4.7 ≙ EH, 4.8 ≙ EI …

### Licenses

You require a license to enable several inverter functions:

- License for the following extended safety functions with speed monitoring:
  - Safe Stop 1 (SS1)
  - Safely Limited Speed (SLS)
  - Safe Direction (SDI)
  - Safe Speed Monitor (SSM)

  Order number: 6SL3074-0AA10-0AA0.
- License for the "Basic positioner" function

  Order number: 6SL3074-7AA04-0AA0.

The license is supplied on a memory card. To operate the inverter, the card with the license must be inserted. The license key is saved in a non-volatile fashion on the card; it cannot be transferred to other cards

The inverter uses an inserted license card also as memory card to back its settings.

### 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

Order number for the SINAMICS CU Screening Termination Kit 4: 6SL3264-1EA00-0LA0.

## 3.3 Power Module

Important data on the Power Modules is provided in this section. For additional information, please refer to the relevant Hardware Installation Manual Manuals for your converter (Page 461).

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

### Which Power Module can I use with the Control Unit?

You can operate the CU250S-2 Control Unit in the "Vector" control mode with the following Power Modules:

- PM340 1AC
- PM240
- PM240-2 IP20 and push-through system
- PM250
- PM260

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

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

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

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

Order number range: 6SL3210-1SB1…

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

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

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

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

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

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

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

Range of order numbers:

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

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

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

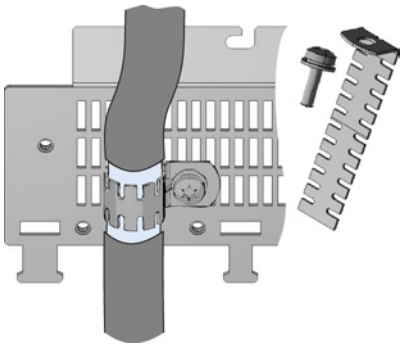
The PM260 Power Module is available without a filter or with an integrated class A line filter with degree of protection IP20. A sine-wave filter is fitted to the motor. The PM260 permits dynamic braking with energy feedback into the line supply.

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

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

## 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.



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

For the PM240, PM250, PM260 and PM340 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, PM340 | PM260 | |
| FSA | 6SL3262-1AA00-0BA0 | - | 6SL3262-1BA00-0BA0 |
| FSB | 6SL3262-1AB00-0DA0 | - | 6SL3262-1BB00-0BA0 |
| FSC | 6SL3262-1AC00-0DA0 | - | - |
| FSD | 6SL3262-1AD00-0DA0 | 6SL3262-1FD00-0CA0 | - |
| FSE | 6SL3262-1AD00-0DA0 | - | - |
| FSF | 6SL3262-1AF00-0DA0 | 6SL3262-1FF00-0CA0 | - |

# 3.4 Components for the Power Modules

## 3.4.1 Line filter

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

Adjacent examples of line filters.

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

for PM240 FSA

for PM240 FSGX

### External line filters for PM240

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

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

### External line filters for PM250

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

## 3.4.2 Line reactor

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

Adjacent examples of line reactors.

for PM240

for PM240-2

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

### Line reactors for PM240

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

## Line reactors for PM240-2

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

## Line reactors for PM340 1AC

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

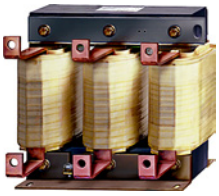
### 3.4.3 Output reactor

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

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

Adjacent examples of output reactors.

for PM240
FSA, FSB



for FSGX

#### Output reactors for PM240 Power Module

| Power Module 6SL3224-… | | Power | Output reactor |
|---|---|---|---|
| FSA | …0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0 | 0.37 kW … 1.5 kW | 6SE6400-3TC00-4AD2 |
| FSB | …0BE22-2□A0, …0BE23-0□A0, …0BE24-0□A0 | 2.2 kW … 4.0 kW | 6SL3202-0AE21-0CA0 |
| FSC | …0BE25-5□A0, …0BE27-5□A0, …0BE31-1□A0 | 7.5 kW … 15.0 kW | 6SL3202-0AJ23-2CA0 |
| FSD | …0BE31-5□A0 | 18.5 kW | 6SE6400-3TC05-4DD0 |
| | …0BE31-8□A0 | 22 kW | 6SE6400-3TC03-8DD0 |
| | …0BE32-2□A0 | 30 kW | 6SE6400-3TC05-4DD0 |
| FSE | …0BE33-0□A0 | 37 kW | 6SE6400-3TC08-0ED0 |
| | …0BE33-7□A0 | 45 kW | 6SE6400-3TC07-5ED0 |
| FSF | …0BE34-5□A0 | 55 kW | 6SE6400-3TC14-5FD0 |
| | …0BE35-5□A0 | 75 kW | 6SE6400-3TC15-4FD0 |
| | …0BE37-5□A0 | 90 kW | 6SE6400-3TC14-5FD0 |
| | …0BE38-8UA0 | 110 kW | 6SL3000-2BE32-1AA0 |
| | …0BE41-1UA0 | 132 kW | 6SL3000-2BE32-6AA0 |
| FSGX | …0XE41-3UA0 | 160 kW | 6SL3000-2BE33-2AA0 |
| | …0XE41-6UA0 | 200 kW | 6SL3000-2BE33-8AA0 |
| | …0XE42-0UA0 | 250 kW | 6SL3000-2BE35-0AA0 |

## Output reactors for PM250 Power Module

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

## 3.4.4 Sine-wave filter

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

for FSF

The following applies when using a sine-wave filter:

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

### Sine-wave filter for PM240 Power Module

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

## Sine-wave filter for PM250 Power Module

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

## 3.4.5 Braking resistor

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

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

### Braking resistors for PM240

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

*) Braking chopper for PM240 FSGX: 6SL3300-1AE32-5AA0

### Braking resistors for PM340, 1AC

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

### Braking resistors for PM240-2

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

### 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

### 3.4.7 Safe Brake Relay

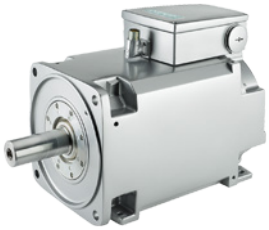
The Safe Brake Relay controls a 24 V motor brake. The inverter monitors the brake control using the Safe Brake Relay.

Order number: 6SL3252-0BB01-0AA0

You can find additional information on the Safe Brake Relay in the Safety Integrated Function Manual, also see Section: Function Manual for Safety Integrated (http://support.automation.siemens.com/WW/view/en/10804921/133300).

## 3.5 Motor series that are supported

The inverter is designed for the following motor series:

| SIMOTICS GP, SIMOTICS SD IEC motors | SIMOTICS M main motors |
|---|---|
| 1LG6, 1LA7, 1LA9 and 1LE1 standard induction motors |  1PH8 induction motors |
| Motors from other manufacturers | |
| Standard induction motors | |

## 3.6 Permissible encoders

You can connect the following encoders to the Control Unit:

| | |
|---|---|
| Resolver | for position and speed control |
| HTL encoder | for position and speed control |
| TTL encoder | for position and speed control |
| Sine/cosine encoder | for position and speed control |
| SSI encoder | for position control |
| Endat 2.1 | for position and speed control |

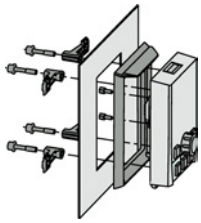
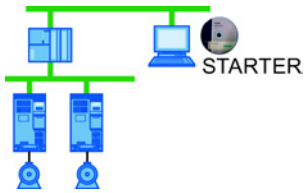
## 3.7 Sensor Module

You require a Sensor Module to connect a non-DRIVE-CLiQ-capable encoder to the DRIVE-CLiQ interface of the inverter.

| Sensor Module | | Order number | Permissible encoders |
|---|---|---|---|
| | SMC10 | 6SL3055-0AA00-5AA3 | Resolver |
| | SMC20 | 6SL3055-0AA00-5BA3 | sin/cos encoders, absolute encoders Endat 2.1, SSI encoders |
| | SMC30 | 6SL3055-0AA00-5CA2 | HTL or TTL encoders, SSI encoders |
| | SME20 | 6SL3055-0AA00-5EA3 | sin/cos encoder |
| | SME25 | 6SL3055-0AA00-5HA3 | Absolute encoders Endat 2.1, SSI encoders |

# 3.8 Tools to commission the converter

## Accessories for commissioning

| **Operator panels** for commissioning, diagnostics and controlling inverters | | Order number |
|---|---|---|
| | BOP-2 (Basic Operator Panel) - for snapping onto the inverter<br>• Two-line display<br>• Guided basic commissioning<br>• Backing up and transferring the inverter settings | 6SL3255-0AA00-4CA1 |
| | IOP (Intelligent Operator Panel) - for snapping onto the inverter<br>• Plain text display<br>• Menu-based operation and application wizards<br>• Backing up and transferring the inverter settings | 6SL3255-0AA00-4JA0 |
|  | Door mounting kit for IOP/BOP-2<br>• For installation of the BOP-2 or IOP in a control cabinet door.<br>• Degree of protection with IOP: IP54 or UL Type 12<br>• Degree of protection with BOP-2: IP55 | 6SL3256-0AP00-0JA0 |
| | For mobile use of the IOP:<br>IOP handheld with IOP housing, power supply unit and rechargeable batteries as well as RS232 connecting cable<br>If you are using your own connecting cable, carefully note the maximum permissible length of 5 m. | 6SL3255-0AA00-4HA0 |
| **PC tools** for commissioning, diagnostics and controlling the converter | | |
| | PC Connection Kit<br>Includes a STARTER DVD and USB port. | 6SL3255-0AA00-2CA0 |
| | STARTER Commissioning tool (PC software)<br>Connection to the inverter via USB port, PROFIBUS or PROFINET<br>Downloading: STARTER<br>(http://support.automation.siemens.com/WW/view/en/10804985/133200) | STARTER on DVD:<br>6SL3072-0AA00-0AG0 |
|  | Drive ES Basic<br>As an option to STEP 7 with routing function via network limits for PROFIBUS and PROFINET | 6SW1700-5JA00-5AA0 |

# Installing 4

## 4.1 Overview of the inverter installation

### Installing the inverter

#### Precondition

Before installation, please check:

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

#### Procedure

To install the inverter, proceed as follows:

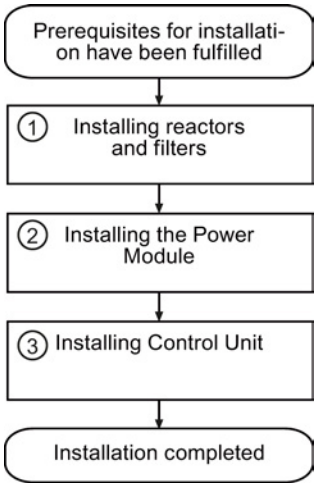
1. Install the accessories (reactors, filter or braking resistor) for the Power Module:
   - Observe the installation instructions that are supplied with the accessories.
   - If you are using more than one base-mounted component, then you must observe the sequence when installing.

     See also Installing reactors, filters and braking resistors (Page 41).
2. Install the Power Module.

   See also Installing the Power Module (Page 43).

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

   See also Installing Control Unit (Page 55).




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 461).

## 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.

| Inverter | | | Base component 1 | | | Base component 2 | | | |
|---|---|---|---|---|---|---|---|---|---|
| FSA | FSB | FSC | Line filter | Line reactor | Sine-wave filter | Line reactor | Output reactor | Sine-wave filter | Braking resistor |
| X | | | X | | | X | | | |
| X | | | X | | | | X | | |
| X | | | X | | | | | X | |
| X | | | X | | | | | | X |
| X | | | | X | | | X | | |
| X | | | | X | | | | X | |
| X | | | | X | | | | | X |
| | X | | X | | | X | | | |
| | X | | X | | | | X | | |
| | X | | X | | | | | | X |
| | X | | | | X | | | | |
| | X | | | X | | | X | | |
| | X | | | X | | | | | X |
| | | X | X | | | X | | | |
| | | X | X | | | | X | | |
| | | X | | X | | | X | | |
| | | X | | | X | | | | |

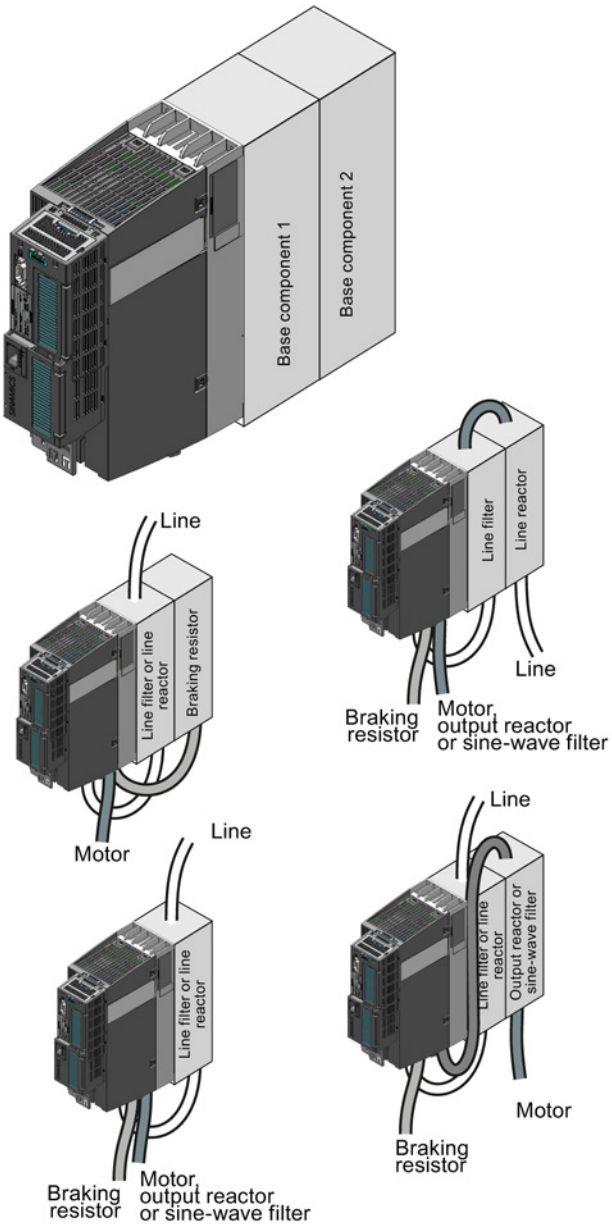



Figure 4-1 Permissible combination of base components

**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

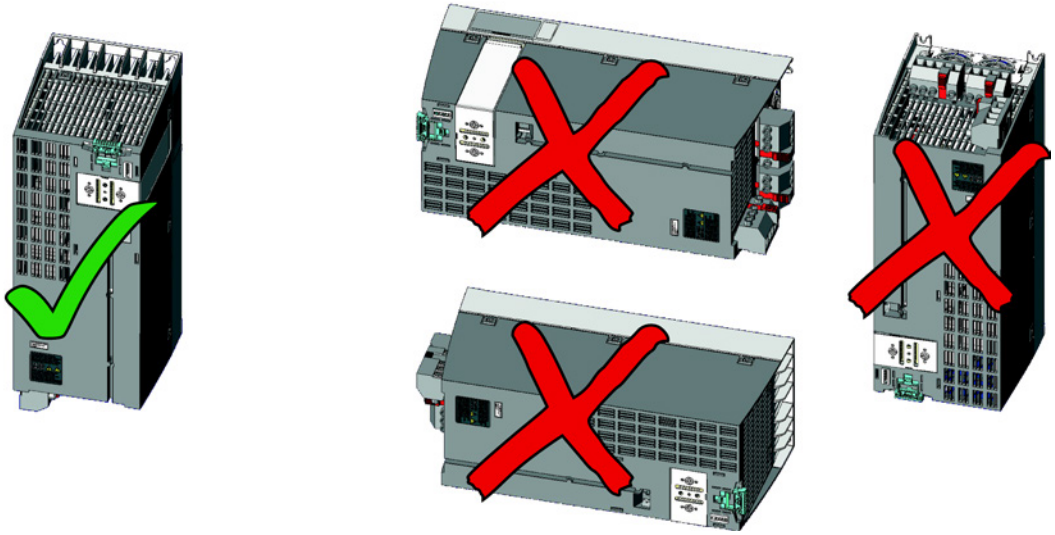
## 4.3.1 Installing Power Modules

### Mounting Power Modules with degree of protection IP20

**Procedure**

Proceed as follows to correctly mount the Power Module:

1. Mount the Power Module in a control cabinet.
2. Maintain the minimum clearances to other components in the control cabinet specified below.
3. Position the Power Module in the control cabinet so that the cables for the motor and line supply are connected at the lower side of the inverter.



4. Use the mounting devices specified below.
5. Comply with the torques of the mounting devices specified below.

You have correctly mounted the Power Module.

### Mounting Power Modules using through-hole technology

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

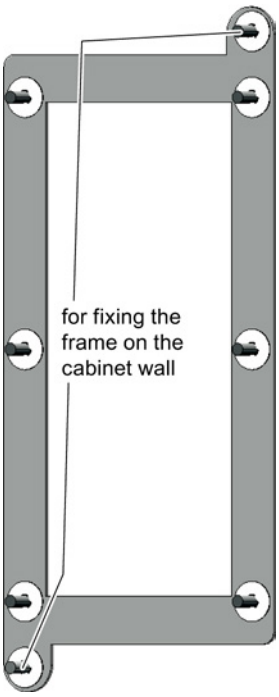
If you do not use the optional mounting frames, then you must ensure that the required degree of protection is complied with using other appropriate measures.

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

### Procedure

Proceed as follows to correctly mount the Power Module:

1. Prepare the cutout and the mounting holes for the Power Module and the mounting frame corresponding to the dimension drawings of the mounting frame.
2. Position the mounting frame at the rear of the control cabinet and attach it to the control cabinet by tightening the corresponding screws by hand.
3. Attach the seal to the inner side of the control cabinet.
4. Mount the inverter and initially tighten all of the mounting screws by hand.
5. Tighten the screws with a torque of 3 Nm.



Mounting frame

You have correctly mounted the Power Module.

## Mounting additional components

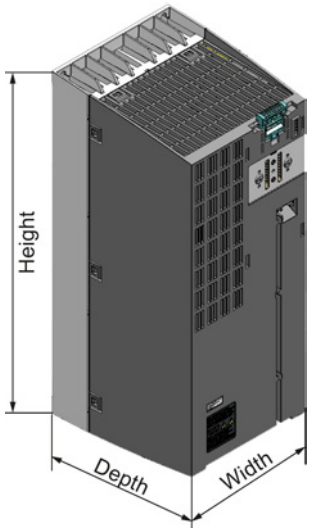
Depending on the application, the following additional components, for example, may be required (also refer to Section Identifying the converter (Page 23)):

- Line reactors
- Filter
- Braking resistors
- Brake Relay

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

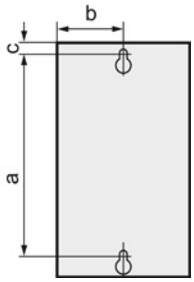
## 4.3.2 Dimensions, hole drilling templates, minimum clearances, tightening torques

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

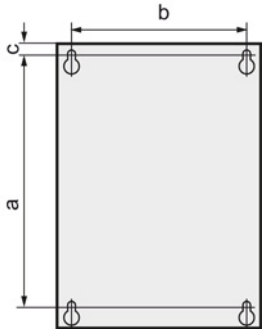



Drilling patterns for Power Modules PM240, PM250, PM260 and PM340 1AC

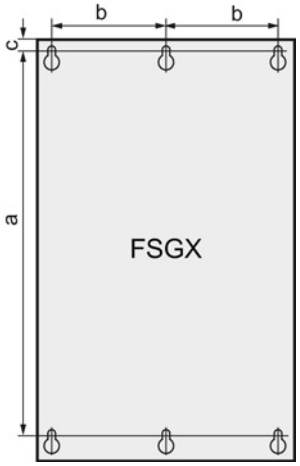
FSA




FSB…FSF

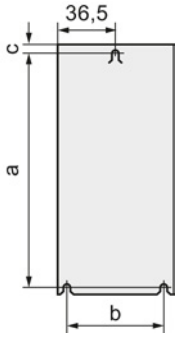



FSGX




Drilling patterns for the PM240-2 Power Modules

FSA




FSB, FSC

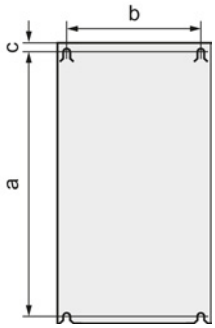


Table 4- 1 Dimensions and clearances for the PM240

| Frame size | Dimensions (mm) | | | | | | Clearances (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Height[1)] | Width | Depth[4)] | a | b | c | Top | Bottom | Lateral |
| FSA | 173 | 73 | 145 | 160 | 36,5 | -- | 100 | 100 | 30[2)] |
| FSB | 270 | 153 | 165 | 258 | 133 | -- | 100 | 100 | 40[2)] |
| FSC | 355 | 140 | 165 | 343 | 120 | 6 | 80 | 100 | 50[2)] |
| FSD without filter | 419 | 275 | 204 | 325 | 235 | 11 | 300 | 300 | 0[3)] |
| FSD with filter | 512 | 275 | 204 | 419 | 235 | 11 | 300 | 300 | 0[3)] |
| FSE without filter | 499 | 275 | 204 | 405 | 235 | 11 | 300 | 300 | 0[3)] |
| FSE with filter | 635 | 275 | 204 | 541 | 235 | 11 | 300 | 300 | 0[3)] |
| FSF without filter | 634 | 350 | 316 | 598 | 300 | 11 | 350 | 350 | 0[3)] |
| FSF with filter | 934 | 350 | 316 | 899 | 300 | 11 | 350 | 350 | 0[3)] |
| FSGX | 1533 | 326 | 547 | 1506 | 125 | 14,5 | 250 | 150 | 50 |

1) Additional height with shield connection kit: FSA: +84 mm; FSB: +85 mm; FSC: +89 mm; FSD…FSF: +123 mm

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

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

4) Total depth of the inverter: See below.

Table 4- 2 Mounting hardware for PM240

| Frame size | Material | Tightening torque |
|---|---|---|
| FSA, FSB | M4 screws | 2.5 Nm |
| FSC | M5 screws | 2.5 Nm |
| FSD, FSE | M6 screws | 6 Nm |
| FSF, FSGX | M8 screws | 13 Nm |

Table 4- 3 Dimensions and clearances for the PM240-2

| Frame size | Dimensions (mm) | | | | | | Clearances (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Height[1)] | Width | Depth[3)] | a | b | c | Top | Bottom | Lateral |
| FSA | 196 | 73 | 165 | 186 | 62,3 | 6 | 80 | 100 | 0[2)] |
| FSB | 292 | 100 | 165 | 281 | 80 | 6 | 80 | 100 | 0[2)] |
| FSC | 355 | 140 | 165 | 343 | 120 | 6 | 80 | 100 | 0[2)] |

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

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

3) Total depth of the inverter: See below.

Table 4- 4 Mounting materials for PM240-2

| Frame size | Material | Tightening torques |
|---|---|---|
| FSA, FSB | M4 screws | 2.5 Nm |
| FSC | M5 screws | 2.5 Nm |

Table 4- 5 Dimensions and clearances for the PM340 1AC

| Frame size | Dimensions (mm) | | | | | | Clearances (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Height[1)] | Width | Depth[3)] | a | b | c | Top | Bottom | Lateral |
| FSA | 173 | 73 | 145 | 160 | 36,5 | -- | 100 | 100 | 30[2)] |

1) With shield connection kit: +84 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.

3) Total depth of the inverter: See below.

Table 4- 6 Mounting materials for PM340 1AC

| Frame size | Material | Tightening torques |
|---|---|---|
| FSA | M4 screws | 2.5 Nm |

Table 4- 7 Dimensions and clearances for PM250

| Frame size | Dimensions (mm) | | | | | | Clearances (mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Height[1)] | Width | Depth[4)] | a | b | c | Top | Bottom | Lateral |
| FSC | 355 | 140 | 165 | 343 | 120 | 6 | 80 | 100 | 50[2)] |
| FSD without filter | 419 | 275 | 204 | 325 | 235 | 11 | 300 | 300 | 0[3)] |
| FSD with filter | 512 | 275 | 204 | 419 | 235 | 11 | 300 | 300 | 0[3)] |
| FSE without filter | 499 | 275 | 204 | 405 | 235 | 11 | 300 | 300 | 0[3)] |
| FSE with filter | 635 | 275 | 204 | 541 | 235 | 11 | 300 | 300 | 0[3)] |
| FSF without filter | 634 | 350 | 316 | 598 | 300 | 11 | 350 | 350 | 0[3)] |
| FSF with filter | 934 | 350 | 316 | 899 | 300 | 11 | 350 | 350 | 0[3)] |

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

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

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

4) Total depth of the inverter: See below.

Table 4- 8 Mounting hardware for PM250

| Frame size | Material | Tightening torque |
|---|---|---|
| FSC | M5 screws | 2.5 Nm |
| FSD, FSE | M6 screws | 6 Nm |
| FSF | M8 screws | 13 Nm |

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

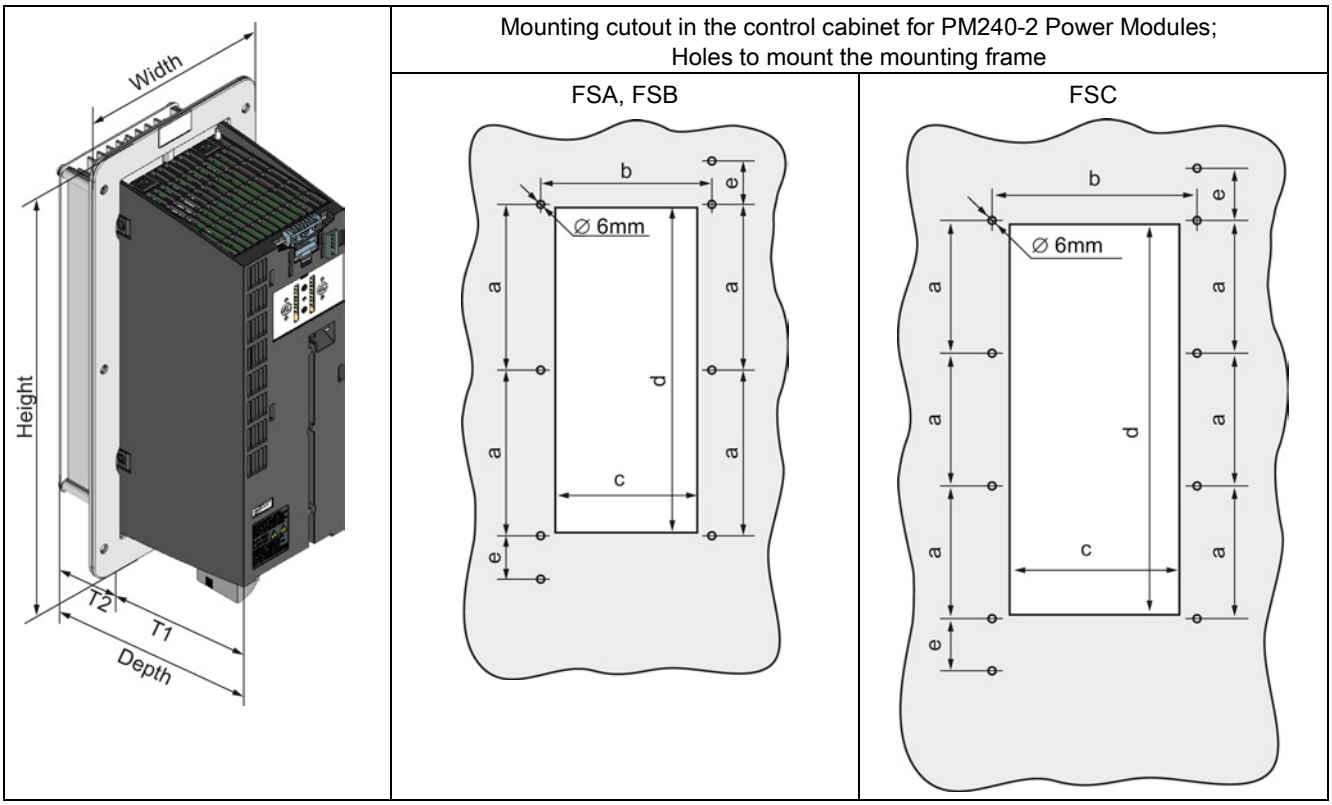



Table 4- 9 Dimensions and clearances for PM240-2 in through-hole technology, FSA … FSC

| Frame size | Dimensions (mm) | | | | | | | | | | Clearances (mm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height[1)] | Width | Depth | T1 | T2 | a | b | c | d | e | Top | Bottom | Lateral |
| FSA | 238 | 126 | 171 | 118 | 54 | 103 | 106 | 88 | 198 | 27 | 80 | 100 | 0[2)] |
| FSB | 345 | 154 | 171 | 118 | 54 | 147,5 | 134 | 116 | 304 | 34,5 | 80 | 100 | 0[2)] |
| FSC | 411 | 200 | 171 | 118 | 54 | 123 | 174 | 156 | 365 | 30,5 | 80 | 100 | 0[2)] |

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

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

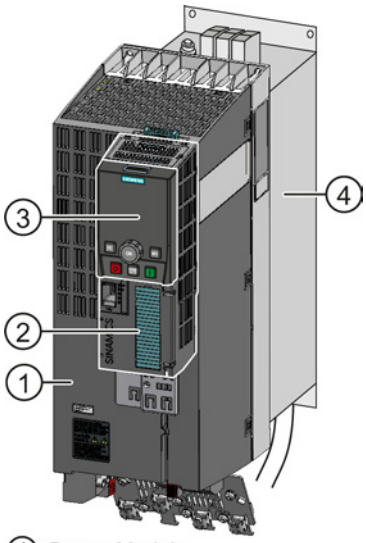
3) Total depth of the inverter: See below.

Table 4- 10 Mounting materials for PM240-2 in through-hole technology

| Frame size | Material | Tightening torque |
|---|---|---|
| FSA … FSC | M5 screws | 3 Nm |

## Total depth of the inverter

### Power Modules frame sizes FSA … FSF




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

① + ②

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

Total depth of the inverter = depth of the Power Module + 63 mm (Control Unit)

① + ② + ③

Inverter with inserted operator panel:

- Total depth of the inverter = depth of the Power Module + 76 mm (Control Unit + Basic Operator Panel BOP-2)
- Total depth of the inverter = depth of the Power Module + 85 mm (Control Unit + Intelligent Operator Panel IOP)

① + ② + ③ + ④

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

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

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

Total depth of the inverter = depth of the Power Module

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

### 4.3.3.1 Connection overview for Power Module

#### Connecting the Power Module to the motor and power supply

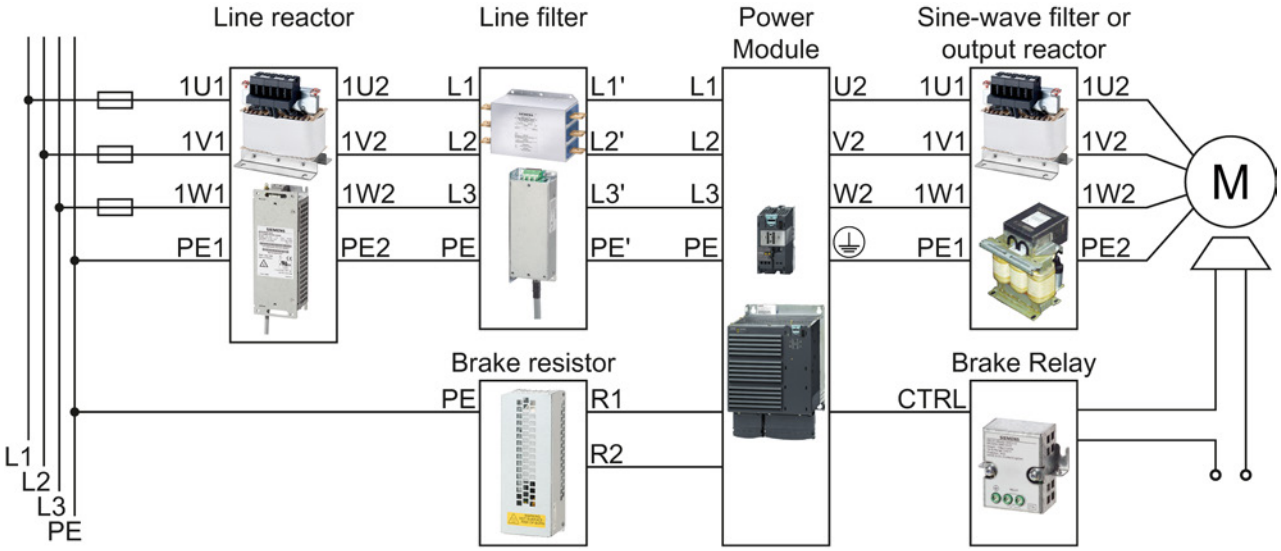



Figure 4-2 Connecting the PM240, PM240-2 and PM340 3AC Power Modules

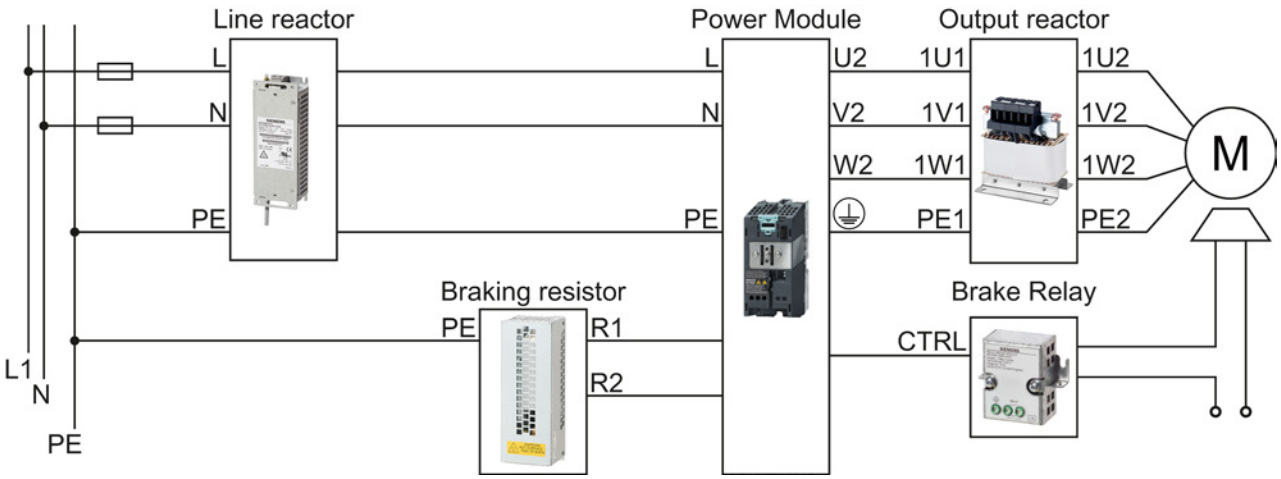



Figure 4-3 Connecting the PM340 1AC Power Module

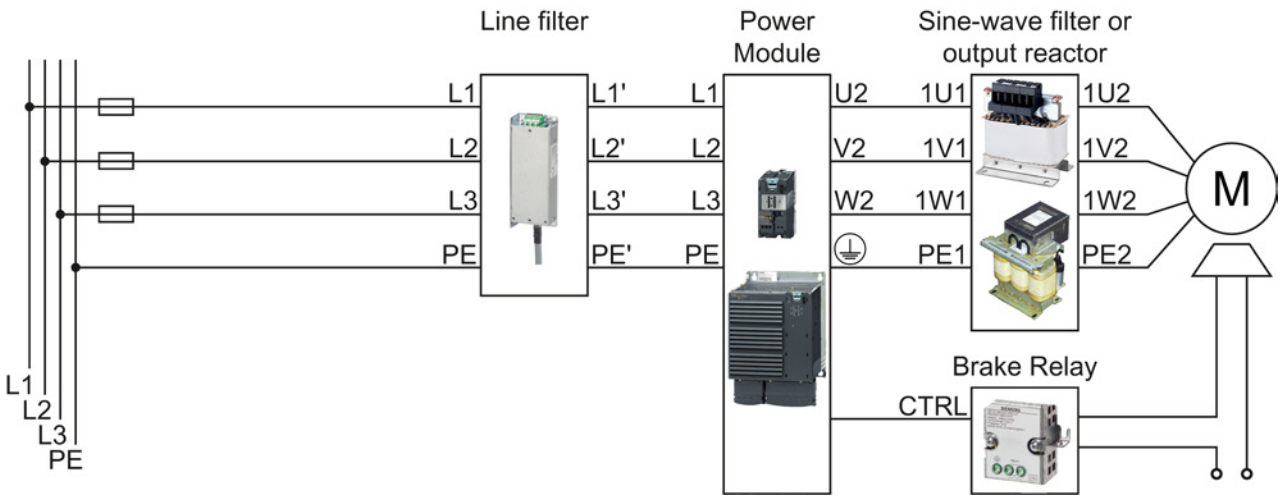



Figure 4-4 Connecting the PM250 Power Module

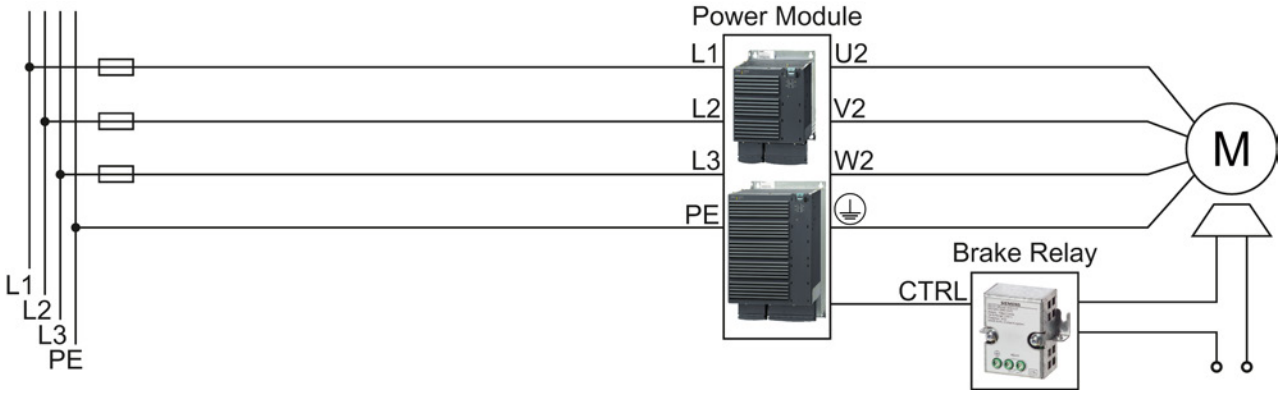
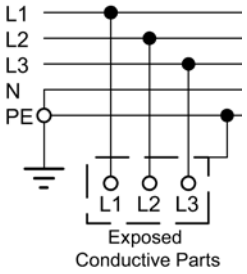
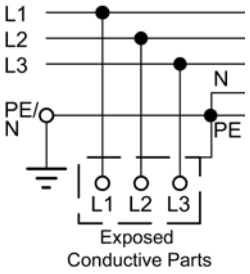
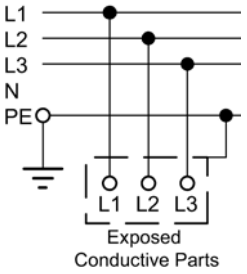
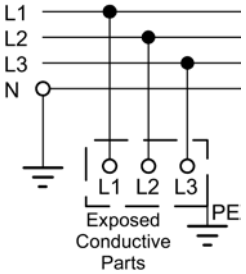
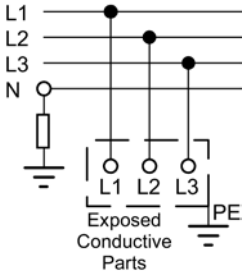



Figure 4-5 Connecting the PM260 Power Module

### 4.3.3.2 Power distribution systems

The inverter is designed for the following power distribution systems according to EN 60950.

| TN-S system | TN-C-S system | TN-C system | TT system | IT system |
|---|---|---|---|---|
|  |  |  |  |  |
| In a TN-S system, there is always a separate conductor as neutral or protective conductor. | In a TN-C-S system, the functions of the neutral conductor and the protective conductor are combined. | In a TN-C system, the functions of the neutral conductor and the protective conductor are combined in one single cable throughout the complete system. | In a TT system, one point is directly grounded. The accessible, conductive parts of the plant or system are grounded, so that they are electrically independent of the line supply ground. | An IT line supply does not have any direct connection to ground. Instead of this, the accessible parts of the electrical plant or system 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 mA via the protective conductor. When the protective conductor is interrupted, touching live components can result in electric shock, which can lead to death or serious injuries.

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

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

**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.

**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

## Connecting a motor cable to an induction motor

**Procedure**

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

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

   Additional information on this is provided in the Section Star-delta motor connection and application examples (Page 419).
3. If you are using a shielded motor cable, you must do the following:
   - Expose the shield of the motor cable in the area of the cable entry in the terminal box.
   - Attach the cable shield to the motor terminal box using a suitable screw connection.
4. Close the motor terminal box.

You have connected the motor cable to the induction motor.

## 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 67)
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.

# 4.4 Installing Control Unit

**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 modules, only use power supplies with protective extra low voltage (PELV), Class 2.

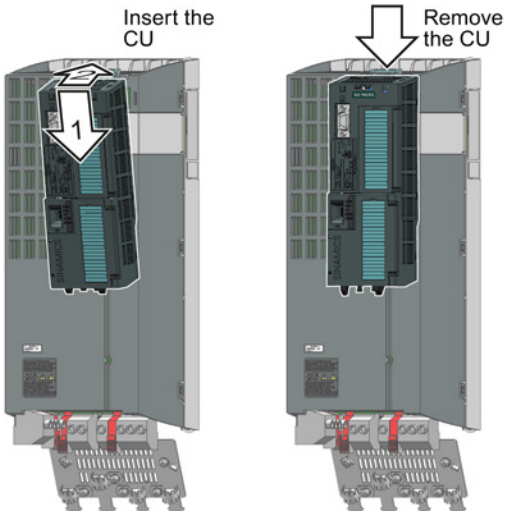
## 4.4.1 Snapping the Control Unit onto the Power Module

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

**Procedure**

Proceed as follows to connect Power Modules and Control Units:

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



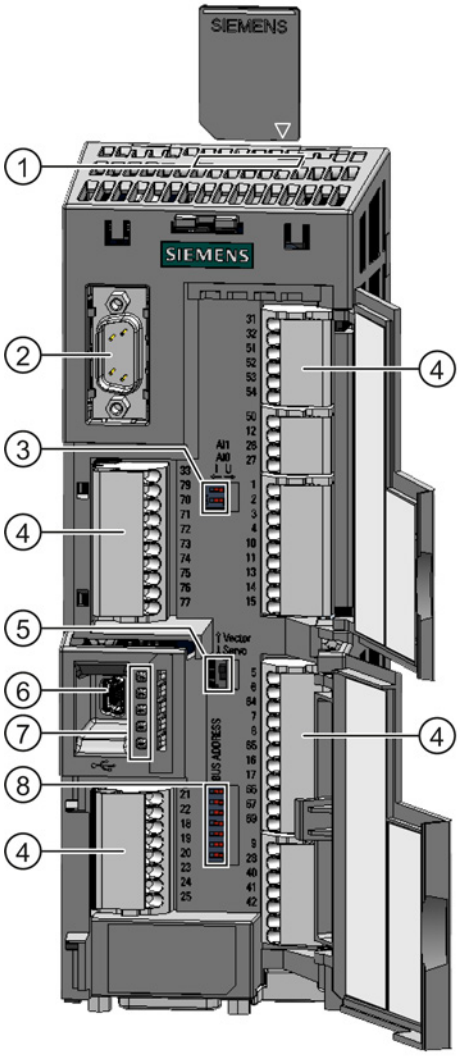
The Power Module and the Control Unit are now connected with one another.

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

## 4.4.2 Overview of the interfaces

### Interfaces at the front of the Control Unit

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



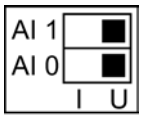

① Memory card slot

② Connection to the Operator Panel

③ Switch for analog inputs

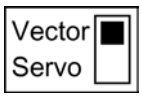
I 0/4 mA … 20 mA

U -10/0 V … 10 V




④ Terminal blocks

⑤ Selecting the control mode



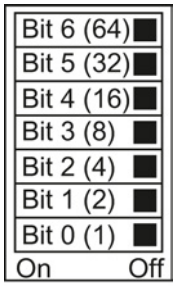

⑥ USB interface for connection to a PC

⑦ Status LED

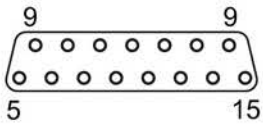
RDY
BF
SAFE
LNK1, only for PROFINET
LNK2, only for PROFINET

⑧ Selecting the fieldbus address:

- PROFIBUS
- USS
- Modbus RTU
- CanOpen



## Interfaces at the lower side of the Control Unit

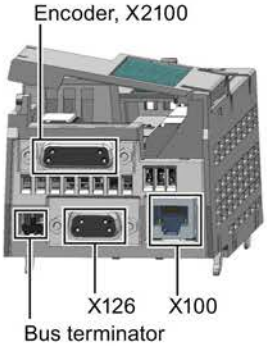


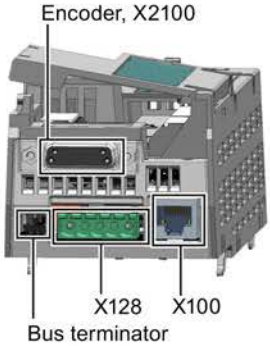

X2100 Encoder

| | | Motor temperature, KTY84 or PTC | HTL | TTL | SSI (RS422 standard) |
|---|---|---|---|---|---|
| 1 | Positive | X | --- | --- | --- |
| 2 | Clock + | --- | --- | --- | X |
| 3 | Clock - | --- | --- | --- | X |
| 4 | Power supply, referred to pin 7 | --- | X | X | X |
| 5 | Power supply, referred to pin 7 | --- | X | X | X |
| 6 | P_Sense, sense input for the power supply | --- | --- | X | --- |
| 7 | GND, reference potential for pins 4 and 5 | --- | X | X | X |
| 8 | Negative | X | --- | --- | --- |
| 9 | M_Sense, sense input, GND | --- | --- | X | --- |
| 10 | Z + | --- | X | X | --- |
| 11 | Z - | --- | X | X | --- |
| 12 | B - | --- | X | X | --- |
| 13 | B + | --- | X | X | --- |
| 14 | A - / data - | --- | A - | A - | Data - |
| 15 | A + / data + | --- | A + | A + | Data + |

X100 DRIVE-CLiQ

1 Transmit data +
2 Transmit data -
3 Receive data +
4 ---
5 ---
6 Receive data -
7 ---
8 ---
A + 24 V power supply, max. 450 mA
B M, reference potential for power supply

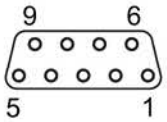



Bus terminator

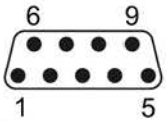
X150 P1
X150 P2
PROFINET

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



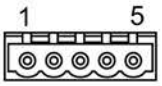

X126
CAN

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




X126
PROFIBUS

1 ---
2 M Reference potential for P24_Serv
3 RxD/TxD-P
receive and transmit (B/B')
4 CNTR-P control signal
5 GND
reference potential for data (C/C')
6 + 5 V power supply
7 P24_Serv
8 RxD/TxD-N
receive and transmit (A/A')
9 ---

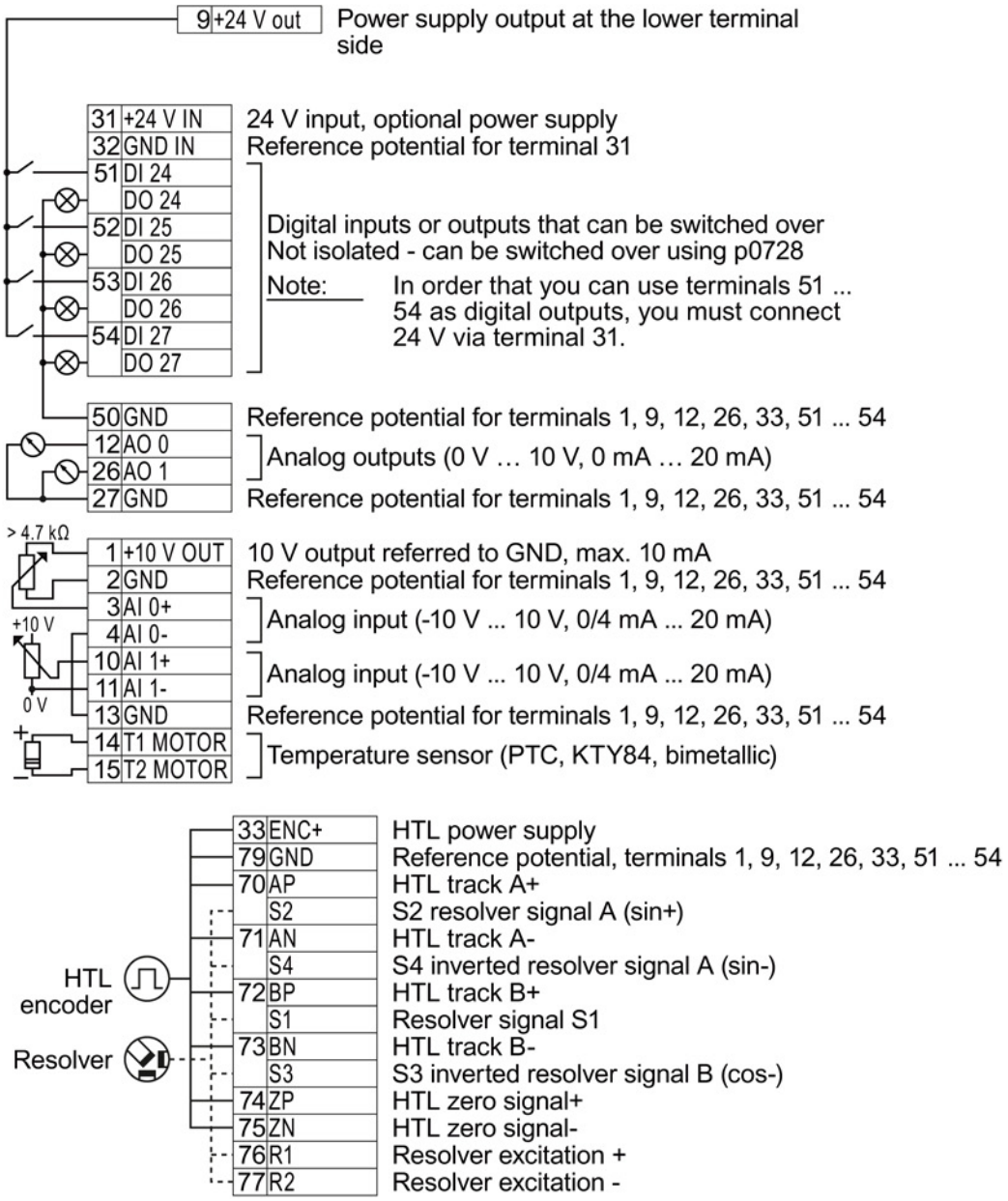



X128
RS485

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

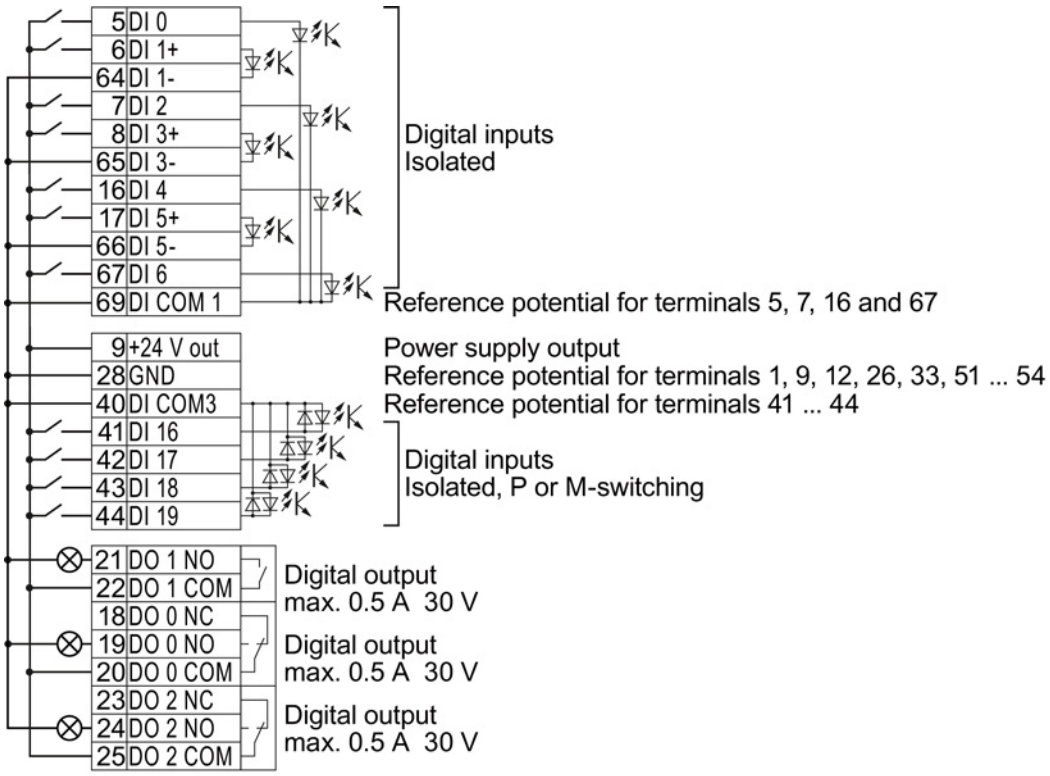
## 4.4.3 Terminal blocks

### Terminal strips behind the upper front door




For the analog inputs, you may use the internal 10 V power supply (example: terminals 1 … 4, 13) or an external power source (example: terminals 10, 11).

## Terminal strips behind the lower front door




**Note**

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU250S-2 Control Unit (Page 385).

Generally, you determine the pre-assignment of the functions of the inputs and outputs during the basic commissioning.

Control Units, where you cannot change the pre-assignment, to not offer this step in the basic commissioning. In this case, you must adapt the functions of the inputs and outputs depending on the specific plant or system, as described in Section Adapt terminal strip (Page 95).

Even if you have selected a pre-assignment in the basic commissioning, you can adapt the individual inputs and outputs depending on the specific plant or system, as described in Section Adapt terminal strip (Page 95).

You can find an overview of the standard assignment or the possible pre-assignments in Section: Selecting the pre-assignment for the terminal strip (Page 60).

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 461).

Further information on fail-safe inputs can be found in Section Fail-safe input (Page 99).

### 4.4.4 Selecting the pre-assignment for the terminal strip

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

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

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

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

**Procedure**

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

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

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

You have found the appropriate inverter pre-assignment.

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

| Macro 4: PROFIBUS or PROFINET | Macro 5: PROFIBUS or PROFINET with safety function | |
|---|---|---|
| PROFIdrive telegram 352<br>5 DI 0 ---<br>6 DI 1 ---<br>7 DI 2 Acknowledge<br>8 DI 3 ---<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 ---<br>4<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | PROFIdrive telegram 1<br>5 DI 0 ---<br>6 DI 1 ---<br>7 DI 2 Acknowledge<br>8 DI 3 ---<br>16 DI 4 ] Reserved for<br>17 DI 5 ] safety function<br>3 AI 0 ---<br>4<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | |

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

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

| Macro 14: Switch over between fieldbus and motorized potentiometer (MOP) via DI 3 | | |
|---|---|---|
| PROFIdrive telegram 1 | | |
| 5 DI 0 ---<br>6 DI 1 External fault<br>7 DI 2 Acknowledge<br>8 DI 3 LOW<br>16 DI 4 ---<br>17 DI 5 --- | 5 DI 0 ON/OFF1<br>6 DI 1 External fault<br>7 DI 2 Acknowledge<br>8 DI 3 HIGH<br>16 DI 4 MOP raise<br>17 DI 5 MOP lower | |
| 3 AI 0 ---<br>4 | 3 AI 0 ---<br>4 | |
| 18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22 | 18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22 | |
| 12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | 12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>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<br>Macro 18: Two-wire control with method 3 |
|---|---|---|
| 5 DI 0 ON/OFF1<br>6 DI 1 External fault<br>7 DI 2 Acknowledge<br>8 DI 3 LOW<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 Setpoint<br>4 I U -10 V ... 10 V<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | 5 DI 0 ON/OFF1<br>6 DI 1 External fault<br>7 DI 2 Acknowledge<br>8 DI 3 HIGH<br>16 DI 4 MOP raise<br>17 DI 5 MOP lower<br>3 AI 0 ---<br>4<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | 5 DI 0 ON/OFF1 right<br>6 DI 1 ON/OFF1 left<br>7 DI 2 Acknowledge<br>8 DI 3 ---<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 Setpoint<br>4 I U -10 V ... 10 V<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>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<br>Macro 22: Fieldbus CANopen |
|---|---|---|
| 5 DI 0 Enable/OFF1<br>6 DI 1 ON right<br>7 DI 2 ON left<br>8 DI 3 Acknowledge<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 Setpoint<br>4 I U -10 V ... 10 V<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | 5 DI 0 Enable/OFF1<br>6 DI 1 ON<br>7 DI 2 Reversing<br>8 DI 3 Acknowledge<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 Setpoint<br>4 I U -10 V ... 10 V<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V | USS setting: 38400 baud, 2 PZD, PKW variable<br>CANopen setting: 20 kBaud<br>5 DI 0 ---<br>6 DI 1 ---<br>7 DI 2 Acknowledge<br>8 DI 3 ---<br>16 DI 4 ---<br>17 DI 5 ---<br>3 AI 0 ---<br>4<br>18 DO 0 Fault<br>19<br>20<br>21 DO 1 Alarm<br>22<br>12 AO 0 Speed<br>13 0 V ... 10 V<br>26 AO 1 Current<br>27 0 V ... 10 V |

### 4.4.5 Wiring the terminal strip

| NOTICE |
| --- |
| **Damage to the inverter when using long signal cables**<br>Using long cables at the inverter's digital inputs and 24 V power supply can lead to overvoltage during switching operations. Overvoltages can damage the inverter.<br>• 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.<br>We recommend using the Weidmüller overvoltage protection terminal with designation MCZ OVP TAZ DIODE 24VDC. |

**Requirements**

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

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

  See also Section Selecting the pre-assignment for the terminal strip (Page 60).
- You have the appropriate tools:
  - Small screwdriver to open the spring-loaded terminals
  - Tool for stripping the cables

**Procedure**

To connect up 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. Connect up all of the required terminals on the terminal 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 strain relief.

You have now connected up the inverter's terminal strips.

# 4.5 Installing encoders

## Encoders for speed control

The encoder must be mounted on the motor shaft.

Table 4- 11 Permissible encoders for speed controllers

| Terminal block | | SUB-D connector | DRIVE-CLiQ interface | | | | |
|---|---|---|---|---|---|---|---|
| Resolver | HTL encoder | HTL or TTL encoder | Connected via Sensor Module SMC or SME | | | | DRIVE-CLiQ encoder |
| | | | HTL or TTL encoder | Resolver | Absolute encoder Endat 2.1 | sin/cos encoder | |
| For the connection, refer to Terminal blocks (Page 58) | | For the connection, refer to Overview of the interfaces (Page 56) | | | | | |

## Encoders for position control

Permissible encoders for position control and the permissible combination of encoders for speed and position control are listed in the "Basic positioner" Function Manual, also see Section: Manuals for your converter (Page 461).

## Permissible SMC/SME Sensor Modules and encoders that can be connected

| SMC10 | SMC20 | SMC30 | SME20 | SME25 |
|---|---|---|---|---|
| 2-pole resolvers | sin/cos encoder 1 $V_{pp}$ | HTL or TTL encoder | sin/cos encoders 1 $V_{pp}$ without rotor position track (C and D tracks) | Absolute encoders Endat 2.1 |
| Multipole resolvers | Absolute encoders Endat 2.1 | SSI encoders with TTL/HTL incremental signals | | SSI encoders with incremental signals sin/cos 1 $V_{pp}$ |
| | SSI encoders with incremental signals sin/cos 1 $V_{pp}$ | SSI encoder without incremental signals | | |

Information about installing and connecting the Sensor Modules is provided in the "SINAMICS S120 Control Units and additional system components" manual, also see Section: Manuals for your converter (Page 461).

# 4.6 Connecting inverters in compliance with EMC

## 4.6.1 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.

## 4.6.2 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.

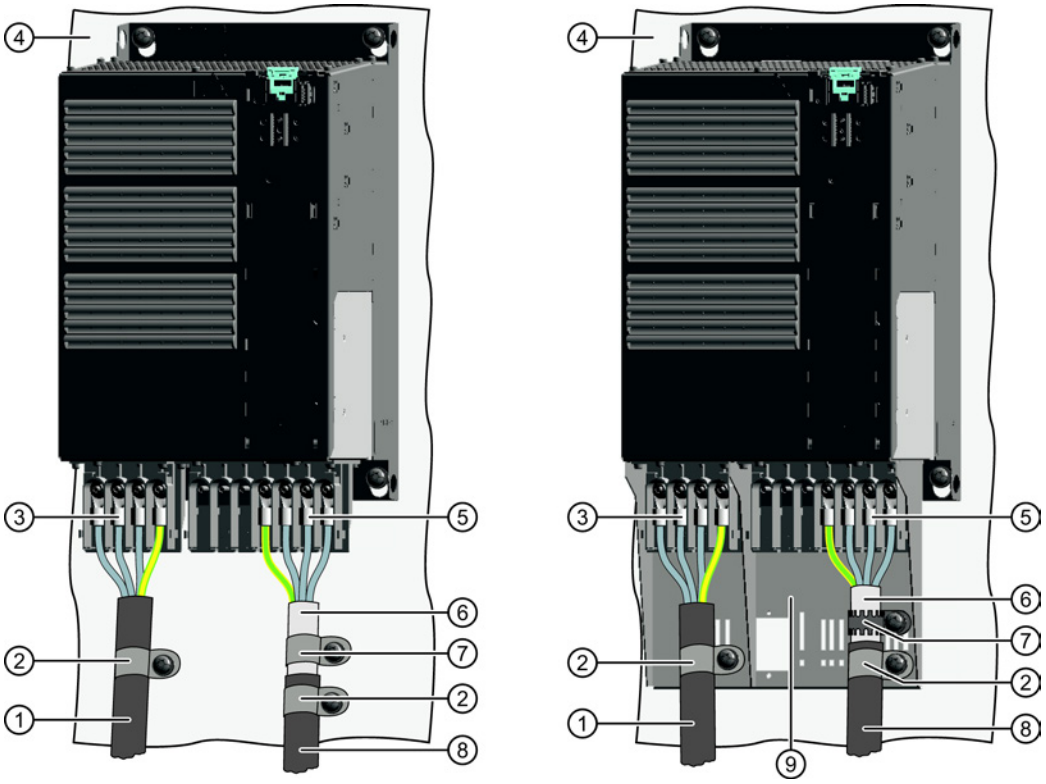
## Cable routing and shielding

- 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)

Figure 4-6 EMC-compliant wiring of a Power Module frame size E as example

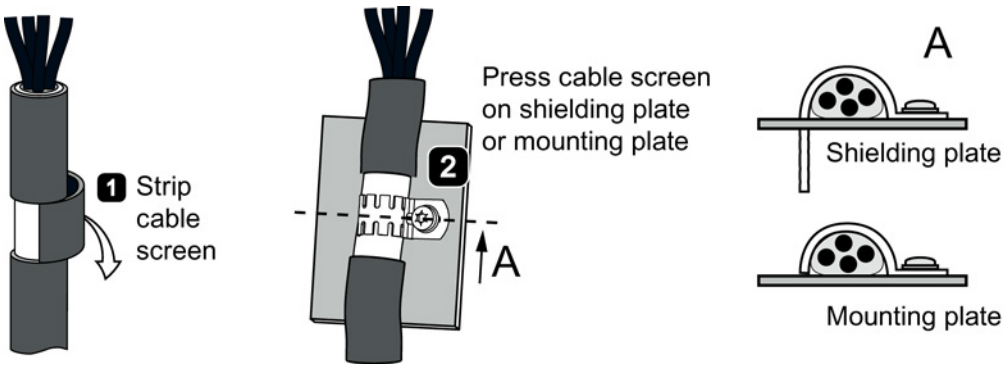



Figure 4-7 Shield connection - detail

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.

## Connecting encoder and signal cables to the terminal strip in compliance with EMC

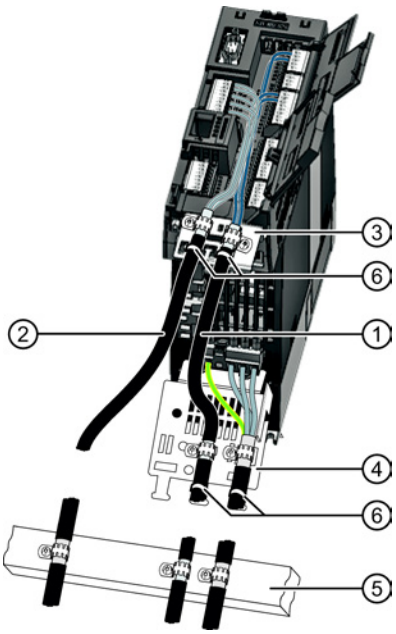
- Use shielded cables.
- Mount the shield plate of the Control Unit.

**Signal cables ①**

- Connect the shield of the signal cables to the shield plate of the Control Unit (③) and to the shield plate of the Power Module (④).
- Attach the strain relief elements to the shield plate ⑥.
- Also connect the shield to the shield rail of the control cabinet (⑤).

**Encoder cables ②**

- Connect the shield of the encoder cable to the shield plate of the Control Unit (③).
- Attach a strain relief element to the shield plate ⑥.
- Also connect the shield to the shield rail of the control cabinet (⑤).



### Connecting encoders to SUB-D connectors or via DRIVE-CLiQ in compliance with EMC

- Use shielded cables.
- Connect the cable shield in the connector housing.
- Mount a strain relief, e.g. at the shield plate of the Control Unit.
- Where the cable leaves the control cabinet, also connect the shield to the shield rail of the control cabinet.

### Additional information on EMC-compliant installation

You can find additional information on EMC-compliant installation, design of the control cabinet and equipotential bonding:

EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658).

# Commissioning 5

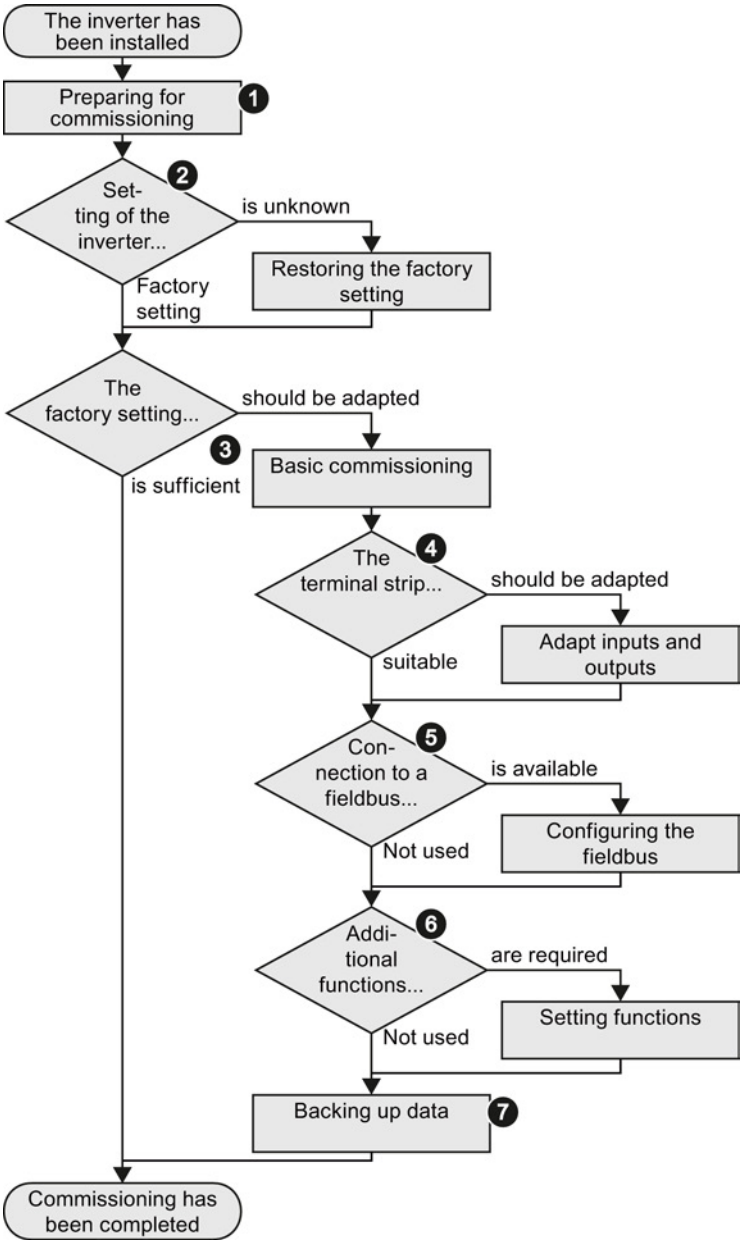
## 5.1 Commissioning guidelines

**Procedure**

Proceed as follows to commission the inverter:

1. Define the requirements of your application placed on the drive.
   → (Page 74).
2. Reset the inverter when required to the factory setting.
   → (Page 83).
3. Check whether the factory setting of the inverter is appropriate for your application.

   If not, start with the basic commissioning.
   → (Page 85).
4. Check whether you need to adapt the functions of the terminal strip that you specify in the basic commissioning.
   → (Page 95).
5. If necessary, adapt the communications interface in the inverter.
   → (Page 111).
6. If necessary, set further functions in the inverter.
   → (Page 215).
7. Save your settings.
   → (Page 323).




You have commissioned the inverter.

# 5.2 Preparing for commissioning

## Overview

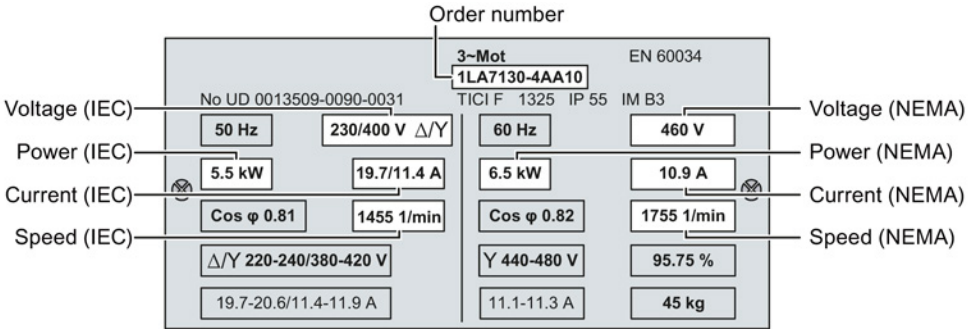
Before starting commissioning, you must know the answer to the following questions:

### Inverter

- **What is the data of my inverter?**
  → Identifying the converter (Page 23).
- **What inverter interfaces are active?**
  → Wiring examples for the factory settings (Page 75).
- **Via which inverter interfaces does the higher-level controller operate the drive?**
- **How is my inverter set?**
  → Factory setting of the inverter control (Page 78).
- **What technological requirements must the drive fulfill?**
  → V/f control or vector control (speed/torque)? (Page 81).
  → Defining additional requirements for the application (Page 82).

### Motor

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

## 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 CU250S-2 Control Unit without PROFIBUS or PROFINET interface

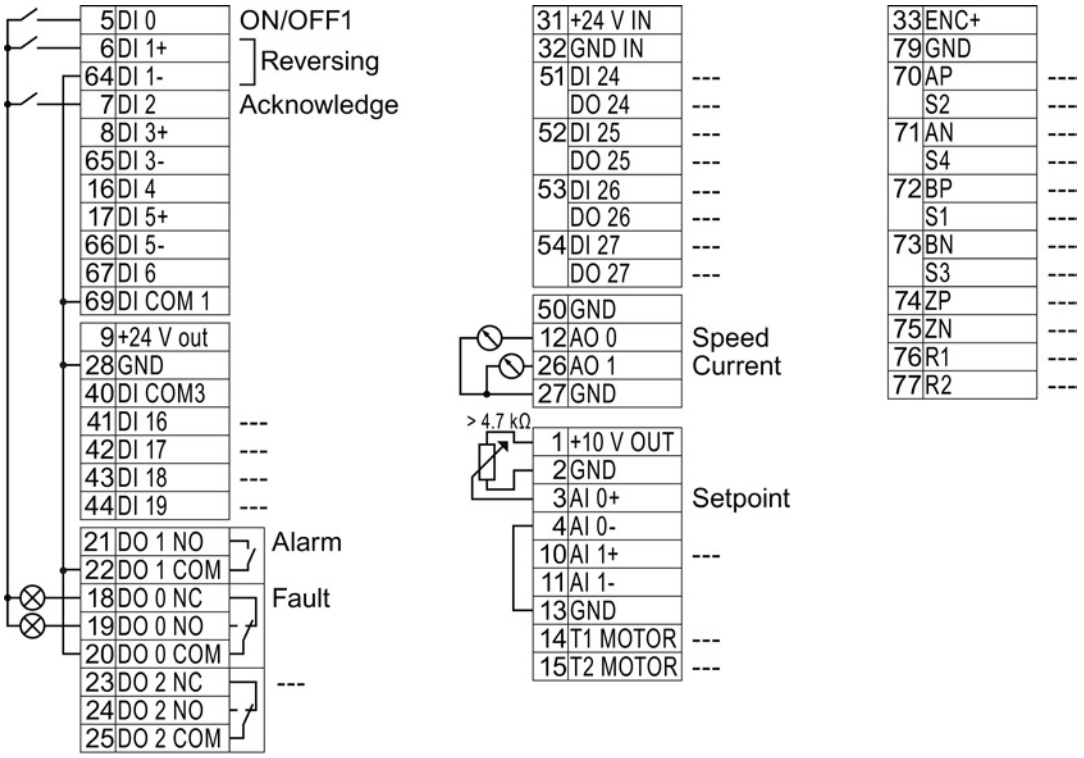



Figure 5-1 Wiring for the factory setting of the CU250S-2

## Wiring the CU250S-2 Control Unit with PROFIBUS or PROFINET interface

DI 3 = LOW: Communication via PROFIdrive telegram 1

DI 3 = HIGH: Control via terminal strip

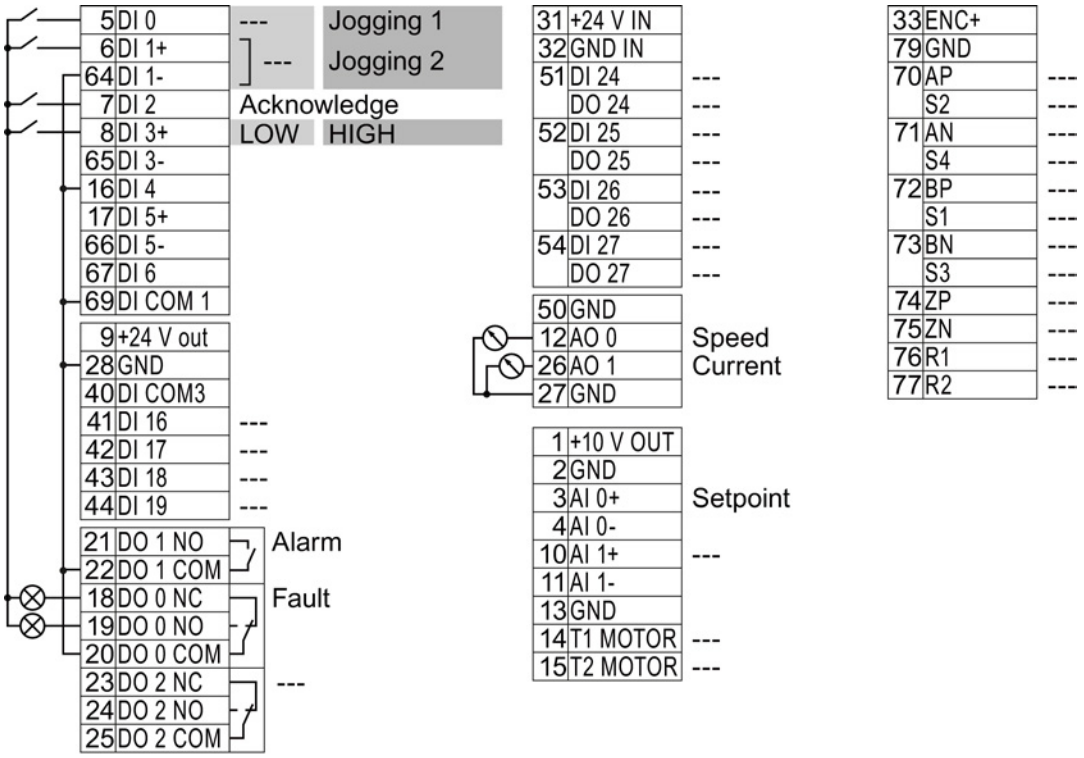



Figure 5-2 Wiring for the factory setting of the CU250S-2

### 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.

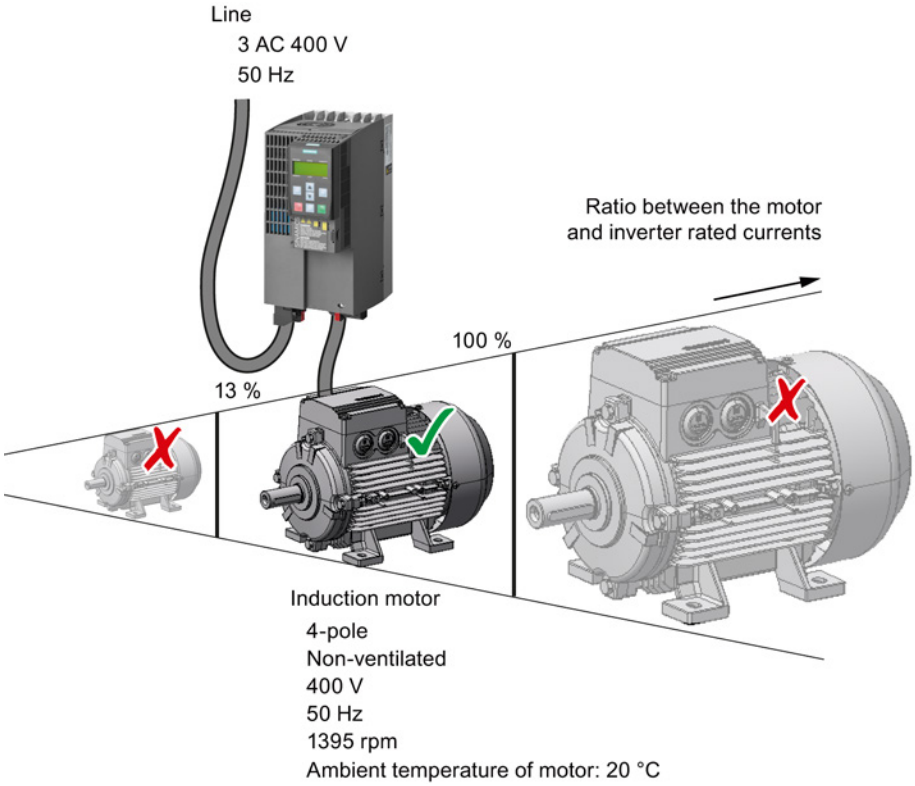



Figure 5-3 Motor data factory settings

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.

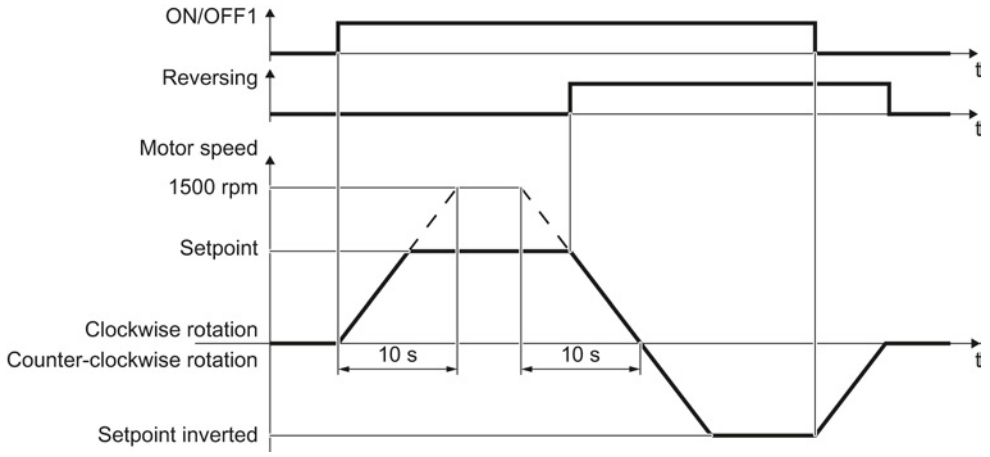



Figure 5-4 Switching on and switching off the motor and reversing in the factory setting

### Switching the motor on and off in the jog mode

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

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

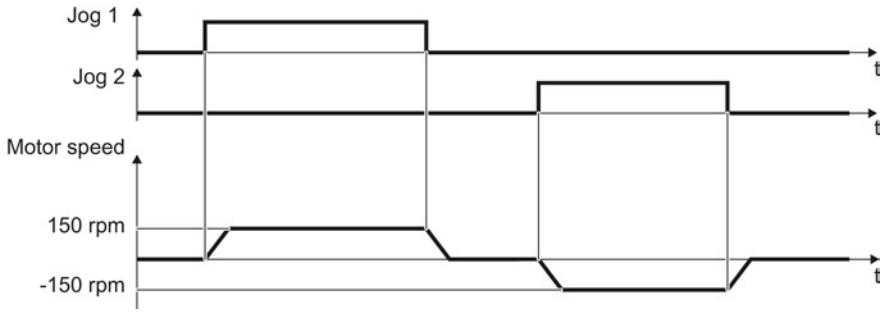



Figure 5-5 Jogging the motor in the factory setting

## 5.2.4 Inverter function modules

### Function modules

Not all of the inverter functions are enabled in the factory setting. For instance, you must enable the "Encoder" function, so that the inverter can evaluate an encoder signal.

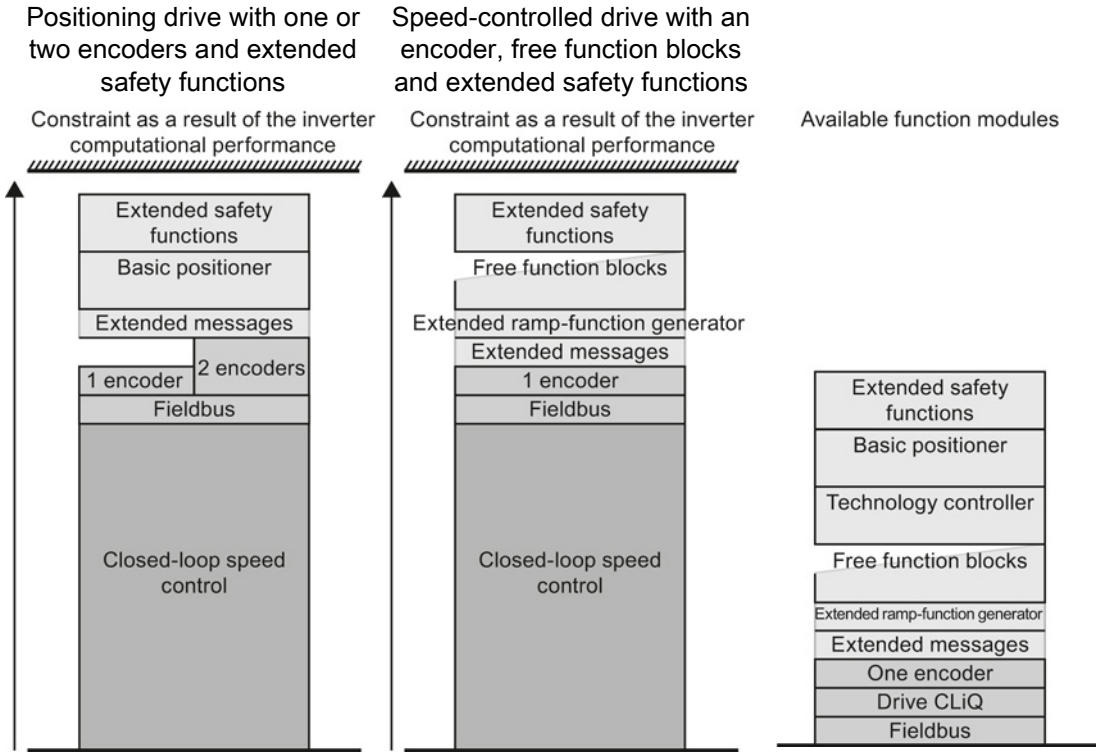
A function module is a set of inverter functions that can be released or inhibited all together.

You configure the following functions in the basic commissioning:

- Fieldbus interface
- DRIVE-CLiQ interface
- Technology controller for higher-level control tasks, e.g. temperature control.
- Basic positioner for the position control of an axis.
- Evaluating encoders
- Extended messages and monitoring functions
- Extended setpoint channel, e.g. motorized potentiometer or fixed setpoints
- Free function blocks for open-loop control functions in the inverter

You configure the following function modules when commissioning your drive:

- You monitor the motor speed using the extended safety functions.
- The extended ramp-function generator allows the motor to be accelerated and braked smoothly without any jerk.




Qualitative utilization level of the inverter using function modules that have been released

The computational performance of the inverter is designed for typical inverter applications.

Every configured function module uses part of the computational performance of the inverter. If you enable all of the inverter function modules, then the inverter responds with a fault, because its available computational performance is exceeded.

Only configure function modules that you actually require for your particular application.

### 5.2.5 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 |

## 5.2.6 Encoders for speed and position control

### Vector control without encoder or speed control with encoder?

The inverter can control the motor speed both with as well as without encoder.

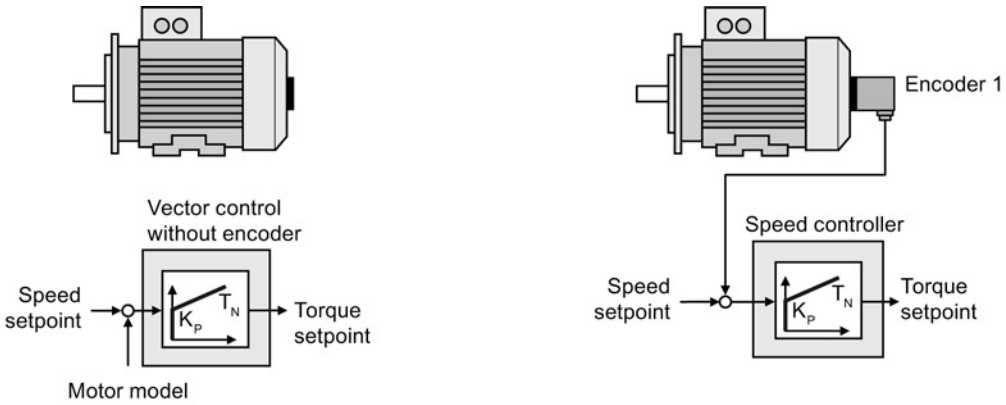



Figure 5-6 Speed control with and without encoder

Speed control with encoder has the advantage of higher speed accuracy when compared to vector control without encoder, especially for speeds < 5 % of the rated speed.

### Encoders for position control

The inverter can evaluate a second encoder for the position control. You can find information on the position control in the "Basic positioner" Function Manual, also see Section Manuals for your converter (Page 461).

## 5.2.7 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 setting.

### Restoring the factory settings when the safety functions are enabled

If your inverter is using safety functions, e.g. "Safe Torque Off" or "Safely Limited Speed", then you must first always reset the safety functions.

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

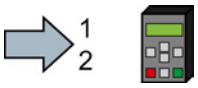
### Settings that are not changed when restoring the factory setting

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

### 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.

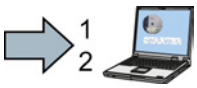
**Procedure**



Proceed as follows to restore the safety function settings in the inverter to the factory settings using an operator panel:

1. Set p0010 = 30
   Activate reset settings.
2. p9761 = …
   Enter the password for the safety functions
3. Start the reset with p970 = 5
   When the inverter has reset the settings, p0970 = 0.
4. Switch off the inverter power supply.
5. Wait until all LEDs on the inverter go dark.
6. Switch on the inverter power supply again.

You have restored the safety function settings of your inverter to the factory settings using an operator panel.



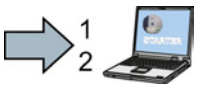
**Procedure**

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

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

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

## Restoring the inverter to the factory setting

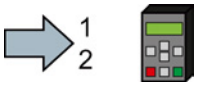


**Procedure**

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

1. Go online
2. Click the key.

You have restored the inverter factory settings.



Proceed as follows to restore the inverter settings to the factory settings using the BOP-2:

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

You have restored the inverter factory settings.

## 5.4 Basic commissioning with STARTER

### STARTER and STARTER screen forms

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

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

### Preconditions for commissioning

You require the following to commission the inverter using STARTER:

- An installed drive (motor and inverter)
- A computer with Windows XP or Windows 7
- The installed STARTER V4.3 or higher.

  You can find updates for STARTER in section: Tools to commission the converter (Page 39)
- An appropriate USB cable. If you are not using the USB interface, but the PROFINET interface of the inverter, you can find information in section: Go online with STARTER via PROFINET (Page 445).

### Overview of commissioning

Commissioning using STARTER essentially comprises the following steps:

1. Create a STARTER project.
2. Configure your drive.
3. Load your configuration into the inverter.

The individual commissioning steps are described below.

## 5.4.1 Generating a STARTER project

**Procedure**

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

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

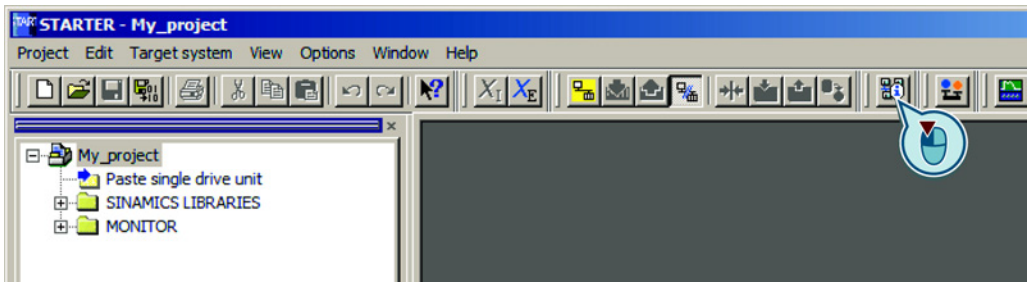
You have created a new STARTER project.

## 5.4.2 Transfer inverters connected via USB into the project

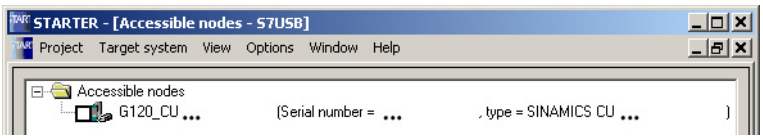
### Procedure

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

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




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




   If you have not correctly set the USB interface, then the following "No additional nodes found" message is displayed. In this case, follow the description below.

7. Select the inverter ☑.
8. Press the "Accept" button.

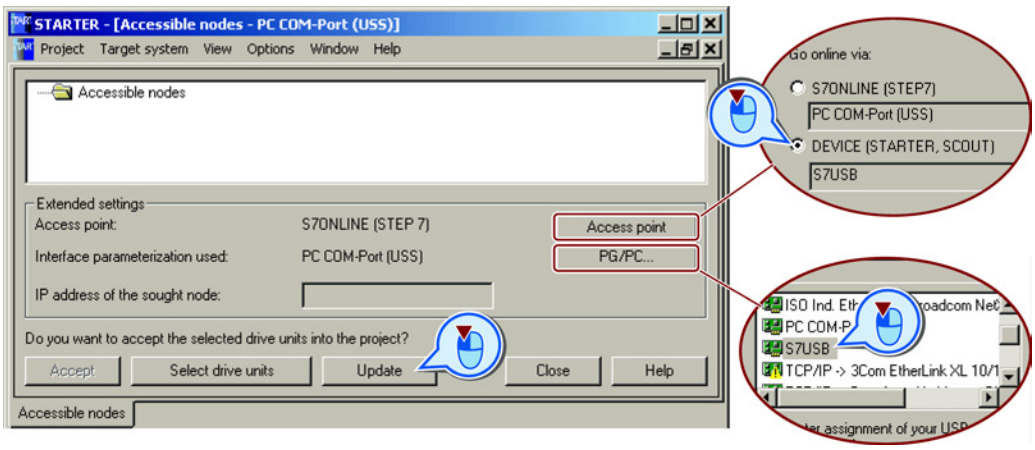
You have transferred an inverter accessible via the USB interface into your project.

### Setting the USB interface

#### Procedure

Proceed as follows to set the USB interface in STARTER:

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




You have set the USB interface.

STARTER now shows the inverters connected via USB.

## 5.4.3 Configuring a drive

The basic commissioning of the inverter comprises the following steps:

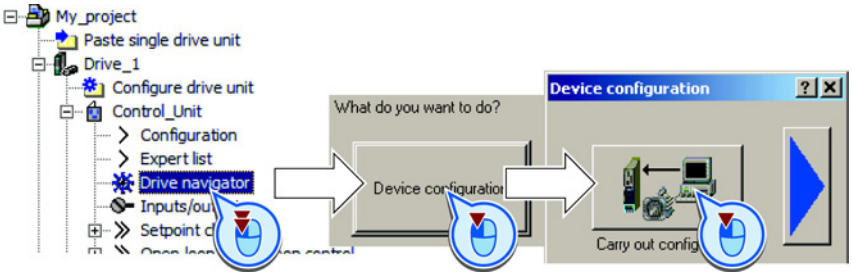
1. Starting basic commissioning
2. Configuring a drive
3. Loading the configured data into the drive

### Starting basic commissioning

**Procedure**

To start the basic commissioning, proceed as follows:

1. In STARTER select the drive you wish to commission.
2. Start the wizard for the device configuration:



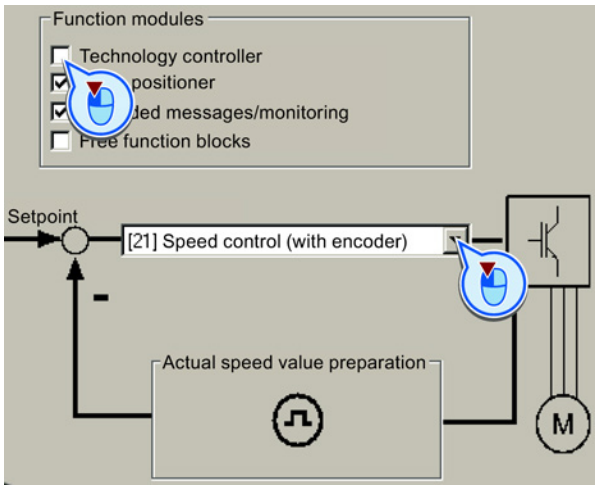

You have started the basic commissioning.

## Configuring a drive

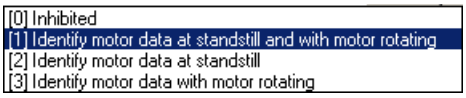
### Procedure

To configure the drive, proceed as follows:

1. ☑ Control structure — Select the required function modules for your application.
   Select the control mode.



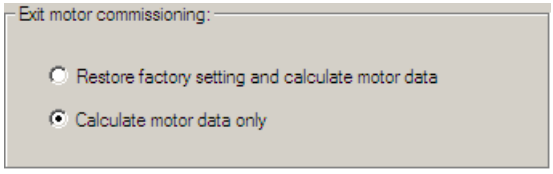

2. ☑ Defaults of the setpoin — Select the default setting of the inverter interfaces.
   See also Section: Selecting the pre-assignment for the terminal strip (Page 60).
3. ☑ Drive setting — Select the application for the inverter:
   Low overload for applications that only require a low dynamic performance, e.g. pumps or fans.
   High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4. ☑ Motor — Select your motor.
5. ☑ Motor data — Enter the motor data according to the rating plate of your motor.
   If you have selected a motor based on its order number, the data has already been entered.
6. ☑ Drive functions — If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".
   With this setting, the inverter optimizes its speed controller.




   If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":
   - You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
   - You have set "V/f control" as control mode.

7. ☑ Important parameters — Set the most important parameters to suit your application.

8. ☑ Calculation of the motc — We recommend the setting "Calculate motor data only".

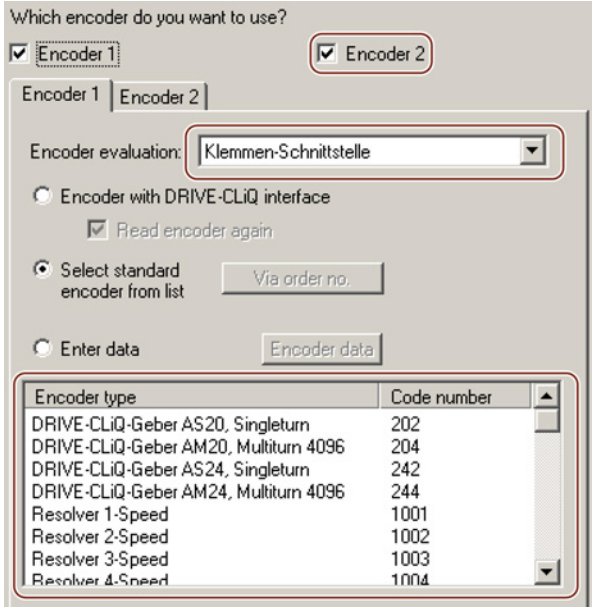



9. ☑ Encoder — Select whether the inverter evaluates one or two encoders.

Select the interface to which the encoder is connected.

Select a standard encoder from the list of encoder types.

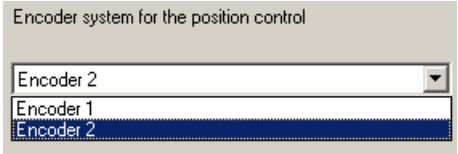
- Code number < 1000: Encoders with integrated DRIVE-CLiQ
- 100x: Resolvers with different pole pair numbers
- 2xxx: sin/cos encoder
- 3xxx: HTL/TTL encoders and SSI encoders




If you cannot find your encoder in the list, then initially select the closest possible encoder type. Continue the configuration, and then adapt the encoder data. See also Section: Adapting the encoder data (Page 90).

10. ☑ Measurement system — This step is only visible if you have configured the basic positioner.

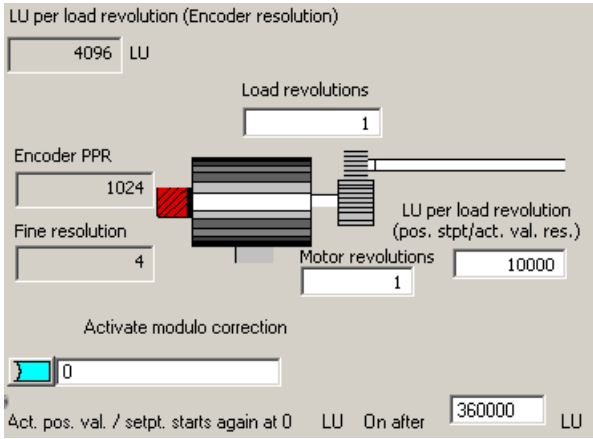
Select the encoder that you use for position sensing.



11. ☑ Mechanics

This step is only visible if you have configured the basic positioner.

You may skip this screen form initially. The settings are explained in the context of commissioning the basic positioner in the function manual "Basic positioner".




12. ☐ Summary

Exit basic commissioning by means of Finish.

Back up your project .

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

## 5.4.4 Adapting the encoder data

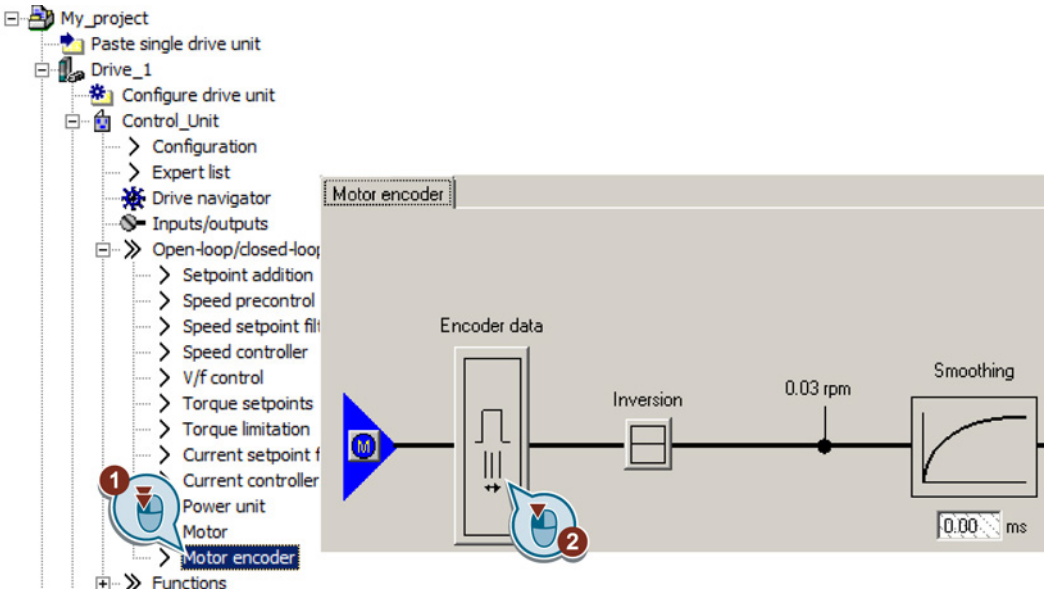
### Preconditions

- You have selected an encoder type that does not precisely match your encoder, because it is not included in the list of default encoder types.
- You have completely configured the drive.

### Procedure

Proceed as follows to adapt the encoder data:

1. Select the "Motor encoder" screen form.
2. Select the "Encoder data" button.




3. You have access to the following settings in the "Encoder data" screen form:
   - You can change all of the encoder data.
   - You can select another encoder. In this screen form, STARTER only lists the encoder types, which are permitted for the configured interface.

     If you wish to set another encoder interface, then you must reconfigure the inverter.

You have adapted the encoder data.

An example to set an absolute encoder is provided in the appendix, also see Section: Setting an absolute encoder (Page 434).

## 5.4.5 Loading the configured data into the drive

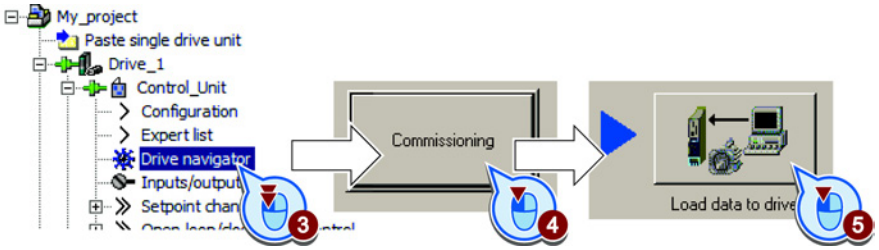
### Procedure

Proceed as follows to load the configured data into the drive:

1. Select your project and go online: .
2. STARTER compares your configuration with the real inverter. STARTER signals any differences in the "Online/offline comparison".

   Acknowledge the message by pressing the "Load HW configuration to PG" button.
3. Open "Drive Navigator".
4. Select the "Commissioning" button.

5. Click on "Load data to the drive".




6. ☑ In the screen form, select "After loading copy RAM to ROM".
7. Load your configuration into the inverter.
8. Close the "Commissioning" screen form.

You have loaded your configuration into the drive and therefore performed the basic commissioning.

## 5.4.6 Identifying motor data

### Preconditions

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

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

**⚠ DANGER**

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

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

Secure dangerous machine parts before starting motor data identification:

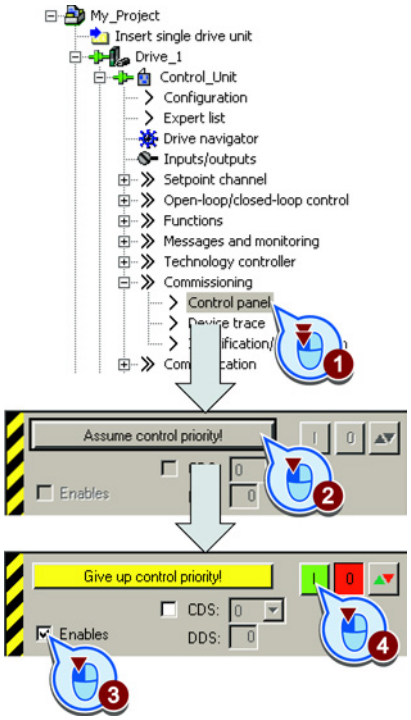
- Before switching on, check that no parts are loose on the machine or can be spun out.
- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower hanging/suspended loads to the floor.

### Procedure

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

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

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




You have now completed motor data identification.

## Self-optimization of the closed-loop control

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

# Adapt terminal strip

# 6

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 with STARTER (Page 85)
- Selecting the pre-assignment for the terminal strip (Page 60)
- Interconnecting signals in the inverter (Page 430)

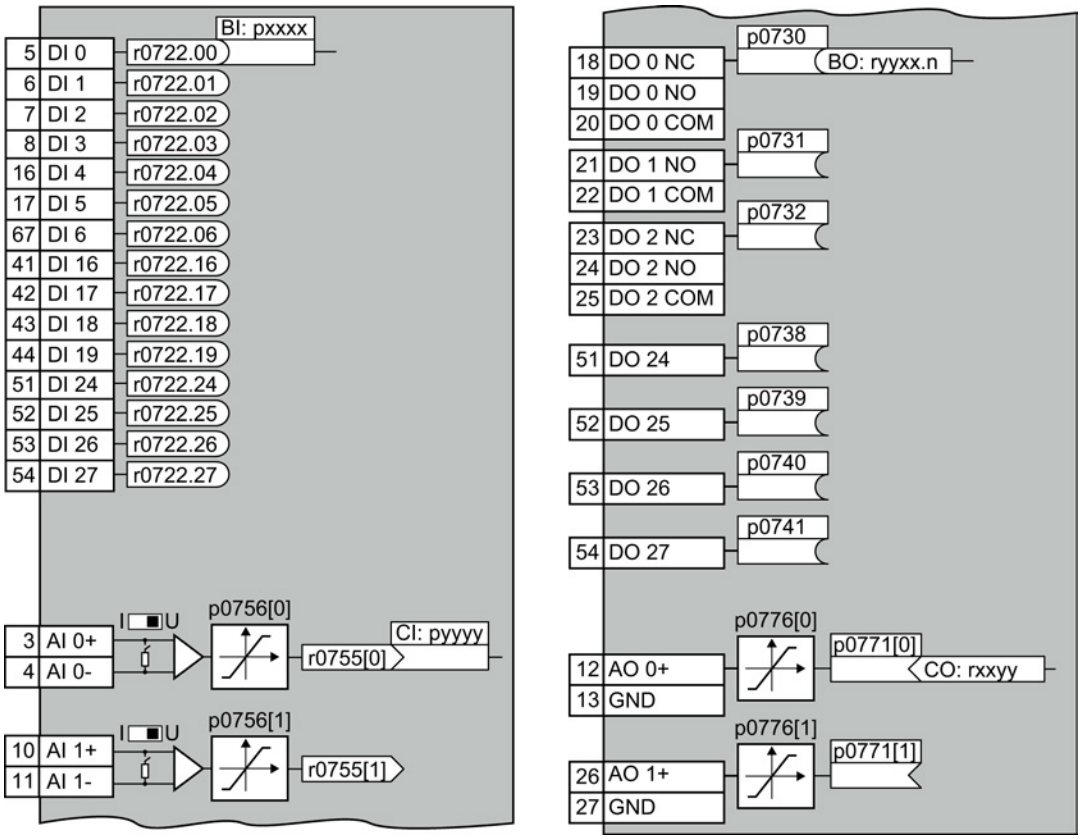



Figure 6-1 Internal interconnection of the inputs and outputs

# 6.1 Digital inputs

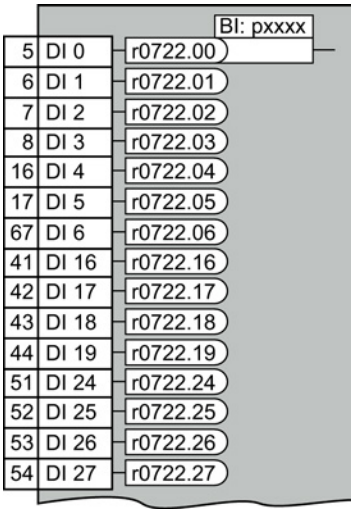
| Digital input terminals | Changing the function of the digital input |
|---|---|
|  | Interconnect the status parameter of the digital input with a binector input of your choice.<br>Binector inputs are marked with "BI" in the parameter list of the List Manual. |

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

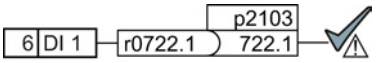
| BI | Significance | BI | Significance |
|---|---|---|---|
| p0810 | Command data set selection CDS bit 0 | p1036 | Motorized potentiometer, setpoint, lower |
| p0840 | ON/OFF1 | p1055 | Jog bit 0 |
| p0844 | OFF2 | p1056 | Jog bit 1 |
| p0848 | OFF3 | p1113 | Setpoint inversion |
| p0852 | Enable operation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

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

## Changing the function of a digital input

### Example

You want to acknowledge inverter fault messages using digital input DI 1. To do this, you must interconnect DI1 with the command to acknowledge faults (p2103). See the adjacent diagram.

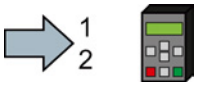



### Procedure

To acknowledge faults with digital input DI 1, using STARTER to establish the interconnection, proceed as follows:

1. Go online.
2. Select "Inputs/outputs".
3. Change the input function via the corresponding screen form.

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



To acknowledge faults with digital input DI 1, using BOP-2 to establish the interconnection, proceed as follows:

1. Go into the menu "PARAMS".
2. As parameter filter, select "EXPERT".
3. Set p2103 = 722.1

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.

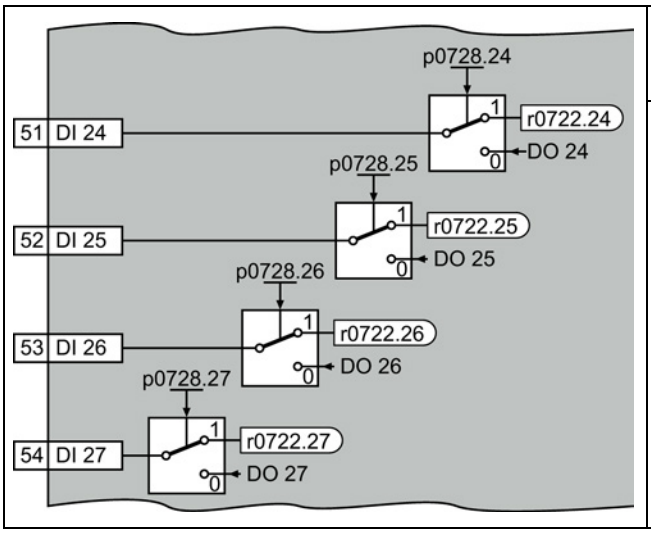
## Using switchable terminals as digital inputs

In the inverter factory setting, the switchable terminals are active as digital inputs.

### Procedure

1
2

To use a switchable terminal as digital input proceed as follows:

| | | |
|---|---|---|
|  | | |
| | 1. Go into the menu "PARAMS".<br>2. As a parameter filter select "EXPERT".<br>3. Set the corresponding bit of parameter p0728.x to 1. | 1. Go online.<br>2. In your project, select the corresponding inverter.<br>3. Select "Inputs/outputs".<br>4. Change the function of the input via the screen form "Bidirectional digital inputs and outputs". |

The switchable terminal is now a digital input.

## Analog inputs as digital inputs

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

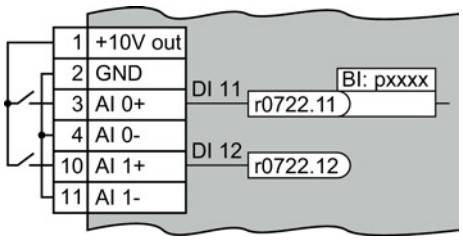



Figure 6-2 Additional digital inputs

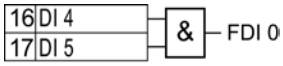
## 6.2 Fail-safe input

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 Selecting the pre-assignment for the terminal strip (Page 60)).

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 302).

### 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 456).

# 6.3 Digital outputs

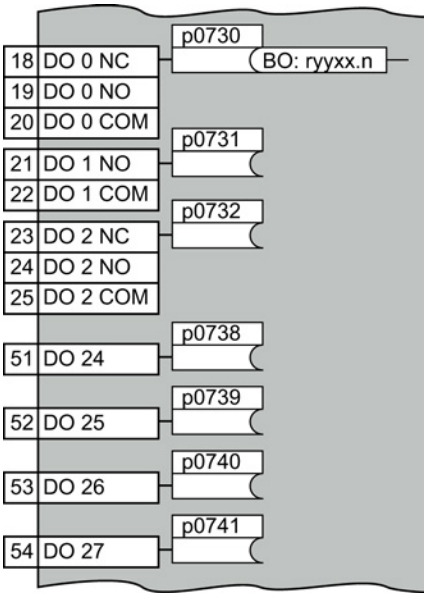
| Digital output terminals | Changing the function of the digital output |
|---|---|
|  | Interconnect the digital output with a binector output of your choice.<br>Binector outputs are marked with "BO" in the parameter list of the List Manual. |

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

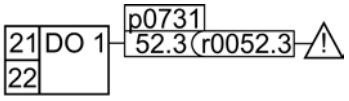
| | | | |
|---|---|---|---|
| 0 | Deactivating digital output | r0052.9 | Process data control |
| r0052.0 | Drive ready | r0052.10 | f_actual >= p1082 (f_max) |
| r0052.1 | Drive ready for operation | r0052.11 | Alarm: Motor current/torque limit |
| r0052.2 | Drive running | r0052.12 | Brake active |
| 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. To do this, you must interconnect DO1 with the alarm messages.

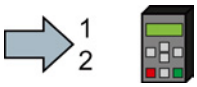


**Procedure**

Proceed as follows to interconnect digital output DO 1 with the alarm message using STARTER:

1. Go online.
2. Select "Inputs/outputs".
3. Change the output function via the corresponding screen form.

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



Proceed as follows to interconnect digital output DO 1 with the alarm message using BOP-2:

1. Go into the menu "PARAMS".
2. As parameter filter, select "EXPERT".
3. Set p0731 = 52.3

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

## Advanced settings

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

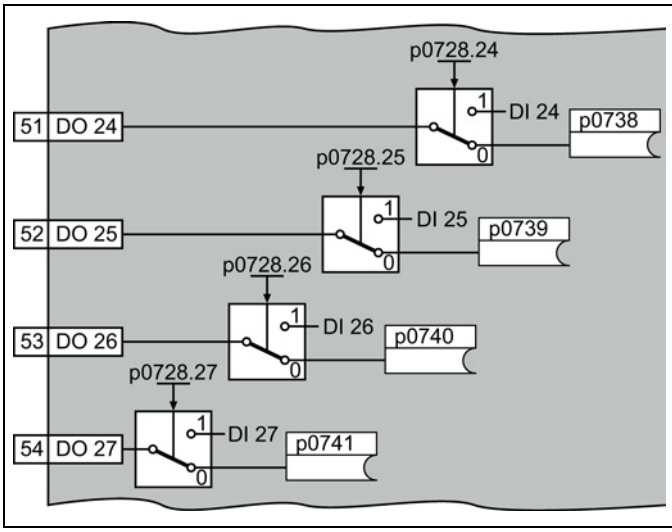
For more information, please see the parameter list and the function block diagrams 2230 f of the List Manual.

## Using switchable terminals as digital outputs

In the inverter factory setting, the switchable terminals are active as digital inputs.

**Procedure**

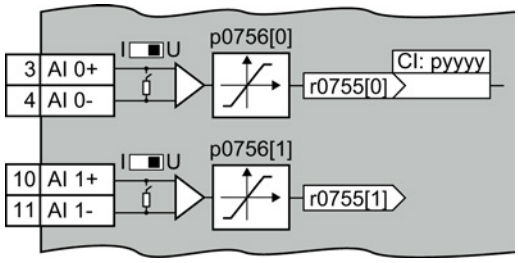
To use a switchable terminal as digital output proceed as follows:

|  | | |
|---|---|---|
| | 1. Go into the menu "PARAMS".<br>2. As a parameter filter select "EXPERT".<br>3. Set the corresponding bit of parameter p0728.x to 0. | 1. Go online.<br>2. In your project, select the corresponding inverter.<br>3. Select "Inputs/outputs".<br>4. Change the function of the input via the screen form "Bidirectional digital inputs and outputs". |



The switchable terminal is now a digital output.

# 6.4 Analog inputs

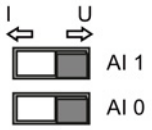
| Analog input terminals | Changing the function of the analog input |
|---|---|
|  | 1. Define the analog input type using parameter p0756 and the switch on the converter (e.g. voltage input -10 V … 10 V or current input 4 mA … 20 mA).<br>2. Specify the significance of the analog input by interconnecting parameter p0755 with a connector input CI of your choice, e.g. as speed setpoint. |

## Define the analog input type

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

| | | | | |
|---|---|---|---|---|
| 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 |

In addition, you must set the switch belonging to the analog input. You can find the switch on the Control Unit behind the lower front doors.




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

## Characteristics of the analog input

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

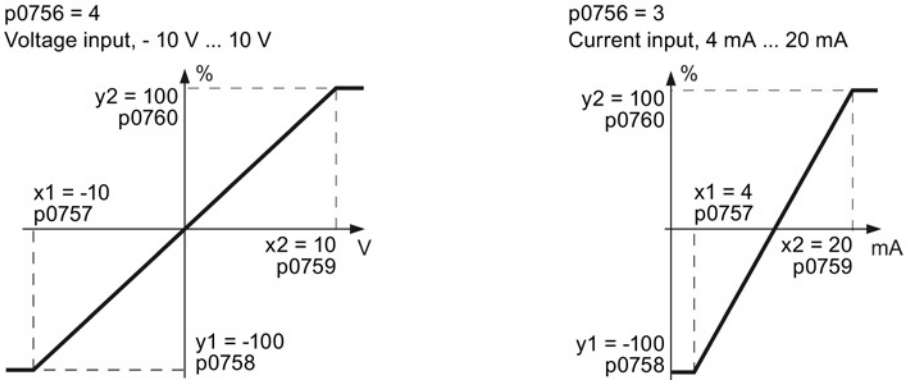



Figure 6-3 Examples for scaling characteristics

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

## Adapting the characteristic of the analog input

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

### Example

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

**Procedure**

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

1. Set p0756[0] = 3

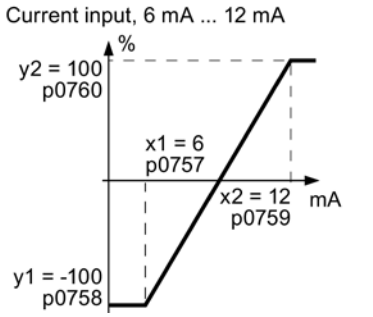
   You have defined analog input 0 as current input with wire break monitoring.

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

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

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

3. Adapt the characteristic:

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



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

## Internal interconnection of the analog input

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

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

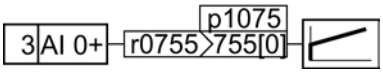
| CI | Significance | CI | Significance |
|---|---|---|---|
| p1070 | Main setpoint | p1522 | Torque limit, upper |
| p1075 | Supplementary setpoint | p2253 | Technology controller setpoint 1 |
| p1503 | Torque setpoint | p2264 | Technology controller actual value |
| p1511 | Supplementary torque 1 |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

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

## Adapting the internal interconnection of the analog input

### Example

The inverter should receive the additional setpoint via analog input AI 0. To do this, you must connect AI 0 with the signal source for the supplementary setpoint.

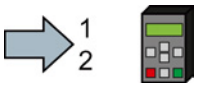



### Procedure

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

1. Go online.
2. Select "Inputs/outputs".
3. Change the input function via the corresponding screen form.

You have interconnected the analog input with the additional setpoint.



Proceed as follows to interconnect the analog input with the additional setpoint using BOP-2:

1. Go into the menu "PARAMS".
2. As parameter filter, select "EXPERT".
3. Set p1075 = 755[0]

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.

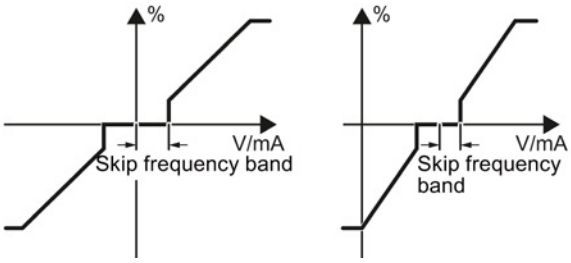
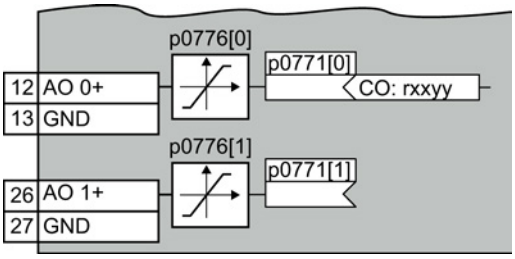



Figure 6-4 Skip frequency band of the analog input

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

# 6.5 Analog outputs

| Analog output terminals | Changing the function of the analog output |
|---|---|
|  | 1. Define the analog output type using parameter p0776 (e.g. voltage output -10 V … 10 V or current output 4 mA … 20 mA).<br>2. Interconnect parameter p0771 with a connector output of your choice (e.g. the actual speed).<br>In the parameter list of the List Manual, connector outputs are marked with "CO". |

## Define the analog output type

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

| | | | | |
|---|---|---|---|---|
| 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 |

## Characteristics of the analog output

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

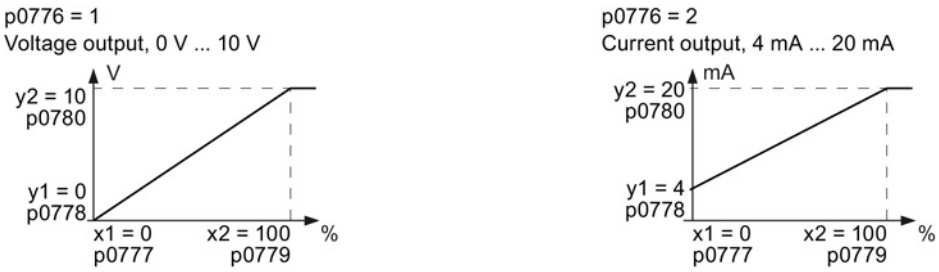



Figure 6-5 Examples for scaling characteristics

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

Table 6- 4 Parameters for the scaling characteristic

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

## Setting the characteristic of the analog output

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

### Example:

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

### Procedure

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

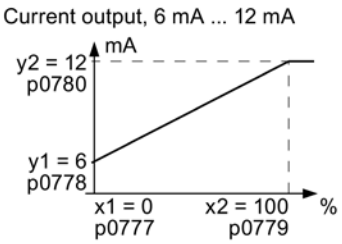
1. Set p0776[0] = 2.

   You have defined analog output 0 as current output.

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

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

2. Adapt the characteristic:

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

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

## Internal interconnection of the analog output

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

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

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

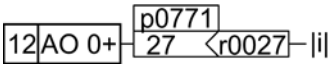
A complete list of the connector outputs is provided in the List Manual.

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

## Adapting the internal interconnection of the analog output

### Example

You wish to output the inverter output current via analog output 0. To do this, you must connect AO 0 with the signal for the output current.

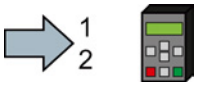



### Procedure

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

1. Go online.
2. Select "Inputs/outputs".
3. Change the output function via the corresponding screen form.

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



Proceed as follows to interconnect analog output 0 with the signal for the output current using BOP-2:

1. Go into the menu "PARAMS".
2. As parameter filter, select "EXPERT".
3. Set p0771 = 27

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 7

## 7.1 Fieldbus versions of the Control Unit

### Fieldbus interfaces of the Control Units

There are different versions of the Control Units for communication with a higher-level control system:

| Fieldbus | Profiles | Control Unit | Interface |
|---|---|---|---|
| PROFIBUS (Page 116) | • PROFIdrive<br>• PROFIenergy<br>• PROFIsafe [1] | CU250S-2 DP | Sub-D socket |
| PROFINET (Page 112) | | CU250S-2 PN | Two RJ45 connectors |
| EtherNet/IP (Page 144) | • OVDA AC/DC Drive<br>• SINAMICS | | |
| USS (Page 158) | --- | CU250S-2 | RS485 connector |
| Modbus RTU (Page 169) | --- | | |
| CANopen (Page 179) | --- | CU250S-2 CAN | Sub-D connector |
| | [1] Information on PROFIsafe can be found in the Safety Integrated Function Manual, also see section: Manuals for your converter (Page 461). | | |

## 7.2 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 115).
- 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.

### 7.2.1 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 113) | |
| Do the IP address and device name in the converter and controller match? | See Configuring communication to the control (Page 114) | See Configuring the controller and converter in HW Config (Page 441) |
| 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 115) | See: Configuring the controller and converter in HW Config (Page 441) |
| 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 120) | See: STEP 7 program examples (Page 447) |

## 7.2.2 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: Overview of the interfaces (Page 56).

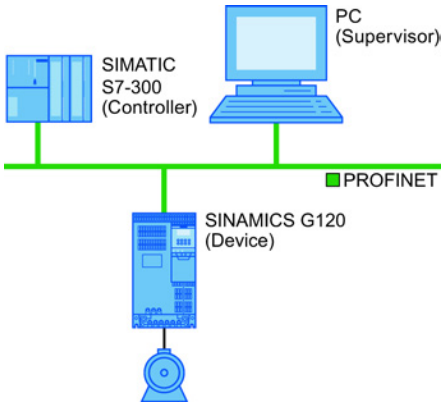



Figure 7-1 Example: PROFINET in a line topology

#### 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/).

## 7.2.3 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**

1
2

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.

## 7.2.4 Select telegram – procedure

**Precondition**

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

See also Section: Selecting the pre-assignment for the terminal strip (Page 60).

**Procedure**

1
2

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

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

You have set a specific telegram in the inverter.

| Parameter | Description | |
|---|---|---|
| p0015 | **Macro drive unit**<br>Configure the interface in basic commissioning, and select a telegram. | |
| p0922 | **PROFIdrive Telegram selection**<br>Setting send and receive telegrams. | |
| | The following values apply if you have still not enabled the "Basic positioner" function in the inverter:<br>See also Cyclic communication (Page 120). | |
| | 1:<br>2:<br>3:<br>4:<br>20:<br>350:<br>352<br>353:<br>354:<br>999: | Standard telegram 1, PZD-2/2 (factory setting)<br>Standard telegram 2, PZD-4/4<br>Standard telegram 3, PZD-5/9<br>Standard telegram 4, PZD-6/14<br>Standard telegram 20, PZD-2/6<br>SIEMENS telegram 350, PZD-4/4<br>SIEMENS telegram 352, PZD-6/6<br>SIEMENS telegram 353, PZD-2/2, PKW-4/4<br>SIEMENS telegram 354, PZD-6/6, PKW-4/4<br>Extend telegrams and change signal interconnection (Page 128) |
| | The following values apply if you have enabled the "Basic positioner" function in the inverter: | |
| | 7:<br>9:<br>110:<br>111:<br>999: | Standard telegram 7, PZD-2/2<br>Standard telegram 9, PZD-10/5<br>SIEMENS telegram 110, PZD-12/7<br>SIEMENS telegram 111, PZD-12/12<br>Factory setting. See also Extend telegrams and change signal interconnection (Page 128) |

## 7.2.5 Activating diagnostics via the control

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

The functionality must be selected in the higher-level control (see example ofSTEP 7 (Page 443)) and activated by powering up.

# 7.3 Communication via PROFIBUS

## 7.3.1 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 116). | --- |
| Have you configured the communication between the inverter and the higher-level controller? | See Section: Configuring communication to the control (Page 117) | See also Section: Configuring PROFIBUS communication in STEP 7 (Page 438). |
| Do the addresses in the inverter and the higher-level controller match? | See Section: Setting the address (Page 118). | |
| 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 118). | |
| 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 120). | See also Section: STEP 7 program examples (Page 447). |

## 7.3.2 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 Overview of the interfaces (Page 56).

#### 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.

### 7.3.3 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 438).

You have configured the communication to the control system.

## 7.3.4 Setting the address

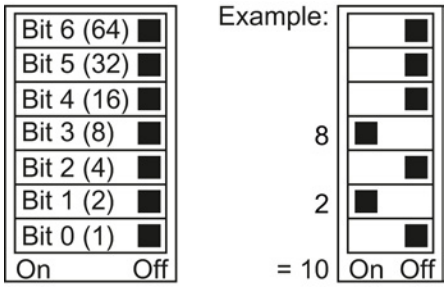
You set the PROFIBUS address of the inverter using the address switch on the Control Unit, using parameter p0918 or in STARTER.

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: Overview of the interfaces (Page 56).




### 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/PROFIBUS", 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.

## 7.3.5 Select telegram – procedure

### Precondition

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

See also Section: Selecting the pre-assignment for the terminal strip (Page 60).

### Procedure

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

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

You have set a specific telegram in the inverter.

| Parameter | Description | |
|---|---|---|
| p0015 | **Macro drive unit**<br>Configure the interface in basic commissioning, and select a telegram. | |
| p0922 | **PROFIdrive Telegram selection**<br>Setting send and receive telegrams. | |
| | The following values apply if you have still not enabled the "Basic positioner" function in the inverter:<br>See also Cyclic communication (Page 120). | |
| | 1:<br>2:<br>3:<br>4:<br>20:<br>350:<br>352<br>353:<br>354:<br>999: | Standard telegram 1, PZD-2/2 (factory setting)<br>Standard telegram 2, PZD-4/4<br>Standard telegram 3, PZD-5/9<br>Standard telegram 4, PZD-6/14<br>Standard telegram 20, PZD-2/6<br>SIEMENS telegram 350, PZD-4/4<br>SIEMENS telegram 352, PZD-6/6<br>SIEMENS telegram 353, PZD-2/2, PKW-4/4<br>SIEMENS telegram 354, PZD-6/6, PKW-4/4<br>Extend telegrams and change signal interconnection (Page 128) |
| | The following values apply if you have enabled the "Basic positioner" function in the inverter: | |
| | 7:<br>9:<br>110:<br>111:<br>999: | Standard telegram 7, PZD-2/2<br>Standard telegram 9, PZD-10/5<br>SIEMENS telegram 110, PZD-12/7<br>SIEMENS telegram 111, PZD-12/12<br>Factory setting. See also Extend telegrams and change signal interconnection (Page 128) |

# 7.4 PROFIdrive profile for PROFIBUS and PROFINET

## 7.4.1 Cyclic communication

### Telegrams if "basic positioner" has been configured

The inverter has the following telegrams if you have configured the "Basic positioner" function:

- Standard telegram 7, PZD-2/2
- Standard telegram 9, PZD-10/5
- SIEMENS telegram 110, PZD-12/7
- SIEMENS telegram 111, PZD-12/12
- Telegram 999, free interconnection

These telegrams are described in the "Basic positioner and technology" Function Manual. See also section Manuals for your converter (Page 461).

## Telegrams without "basic positioner"

The inverter has the following telegrams if you have not configured the "Basic positioner" function:

| PKW | PZD01 | PZD02 | PZD03 | PZD04 | PZD05 | PZD06 | PZD07 | PZD08 | PZD09 | PZD10 | PZD11 | PZD12 | PZD13 | PZD14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Telegram 1, speed control**

| | |
|---|---|
| STW1 | NSOLL_A |
| ZSW1 | NIST_A |

**Telegram 2, speed control**

| | | |
|---|---|---|
| STW1 | NSOLL_B | STW3 |
| ZSW1 | NIST_B | ZSW3 |

**Telegram 3, speed control, 1 position encoder**

| | | | | | |
|---|---|---|---|---|---|
| STW1 | NSOLL_B | STW3 | G1_STW | | |
| ZSW1 | NIST_B | ZSW3 | G1_ZSW | G1_XIST1 | G1_XIST2 |

**Telegram 4, speed control, 2 position encoder**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| STW1 | NSOLL_B | STW3 | G1_STW | G2_STW | | | | |
| ZSW1 | NIST_B | ZSW3 | G1_ZSW | G1_XIST1 | G1_XIST2 | G2_ZSW | G2_XIST1 | G2_XIST2 |

**Telegram 20, speed control VIK/NAMUR**

| | | | | | |
|---|---|---|---|---|---|
| STW1 | NSOLL_A | | | | |
| ZSW1 | NIST_A GLATT | IAIST_ GLATT | MIST_ GLATT | PIST_ GLATT | MELD_ NAMUR |

**Telegram 350, speed control**

| | | | |
|---|---|---|---|
| STW1 | NSOLL_A | M_LIM | STW3 |
| ZSW1 | NIST_A GLATT | IAIST_ GLATT | ZSW3 |

**Telegram 352, speed control for PCS7**

| | | | | | |
|---|---|---|---|---|---|
| STW1 | NSOLL_A | Process data for PCS7 | | | |
| ZSW1 | NIST_A GLATT | IAIST_ GLATT | MIST_ GLATT | WARN_ CODE | FAULT_ CODE |

Figure 7-2 Telegrams 1 … 352 for cyclic communication

| PKW | PZD01 | PZD02 | PZD03 | PZD04 | PZD05 | PZD06 | PZD07 | PZD08 | PZD09 | PZD10 | PZD11 | PZD12 | PZD13 | PZD14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Telegram 353, speed control with PKW area to read and write parameters**

| | | |
|---|---|---|
| PKW | STW1 | NSOLL_A |
| | ZSW1 | NIST_A GLATT |

**Telegram 354, speed control for PCS7 with PKW area to read and write parameters**

| | | | | | | |
|---|---|---|---|---|---|---|
| PKW | STW1 | NSOLL_A | Process data for PCS7 | | | |
| | ZSW1 | NIST_A GLATT | IAIST_ GLATT | MIST_ GLATT | WARN_ CODE | FAULT_ CODE |

**Telegram 999, free interconnection**

| | |
|---|---|
| STW1 | Telegram length for the receive data |
| ZSW1 | Telegram length for the transmit data |

Figure 7-3 Telegrams 353 … 999 for cyclic communication

| Abbreviation | Explanation | Abbreviation | Explanation |
|---|---|---|---|
| STW1 | Control word 1 | MIST_GLATT | Smoothed torque actual value |
| ZSW1 | Status word 1 | PIST | Actual active power |
| STW3 | Control word 3 | M_LIM | Torque limit |
| ZSW3 | Status word 3 | FAULT_CODE | Fault number |
| NSOLL_A | Speed setpoint 16 bit | WARN_CODE | Alarm number |
| NSOLL_B | Speed setpoint 32 bit | MELD_NAMUR | Control word according to the VIK-NAMUR definition |
| NIST_A | Speed actual value 16 bit | G1_STW / G2_STW | Control word for encoder 1 or encoder 2 |
| NIST_B | Speed actual value 32 bit | G1_ZSW / G2_ZSW | Status word for encoder 1 or encoder 2 |
| IAIST | Current actual value | G1_XIST1 / G2_XIST1 | Position actual value 1 from encoder 1 or encoder 2 |
| IAIST_GLATT | Smoothed current actual value | G1_XIST2 / G2_XIST2 | Position actual value 2 from encoder 1 or encoder 2 |

## Interconnection of the process data

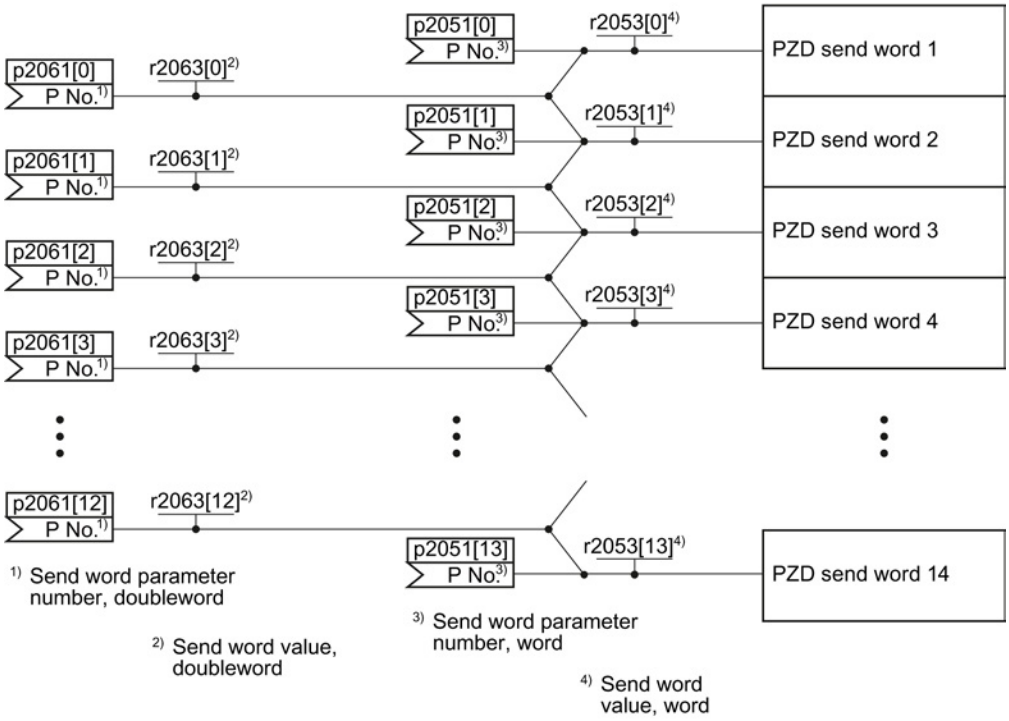



Figure 7-4 Interconnection of the send words

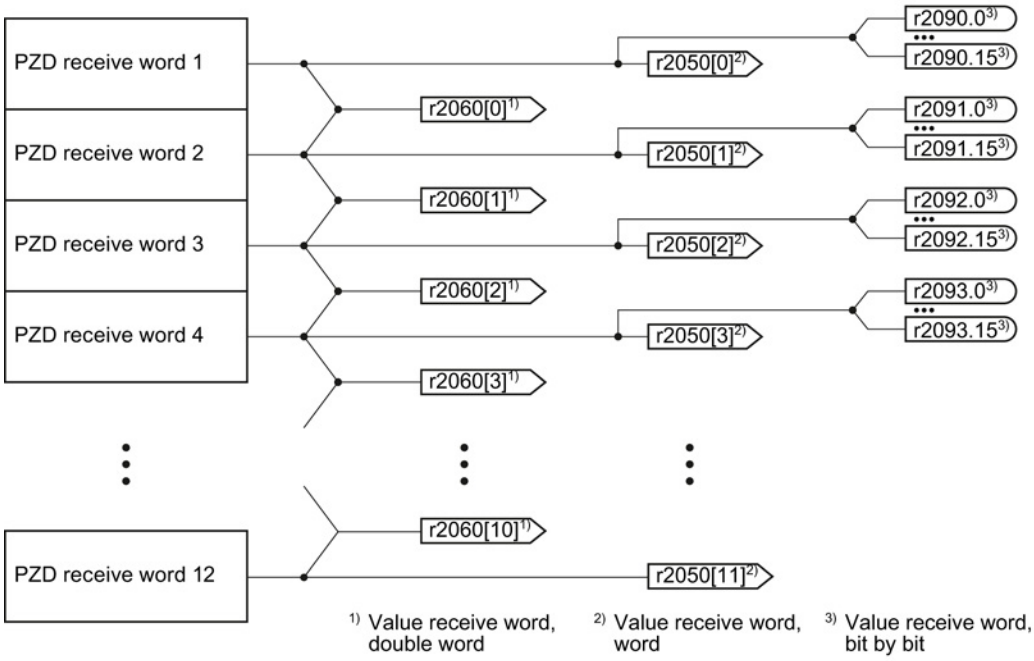



Figure 7-5 Interconnection of the receive words

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.

### 7.4.1.1 Control and status word 1

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

## Control word 1 (STW1)

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

| Bit | Significance | | Explanation | Signal interconnection in the inverter |
|---|---|---|---|---|
| | Telegram 20 | All other telegrams | | |
| 0 | 0 = OFF1 | | The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill. | p0840[0] = r2090.0 |
| | 0 → 1 = ON | | The inverter goes into the "ready" state. If, in addition bit 3 = 1, then the inverter switches on the motor. | |
| 1 | 0 = OFF2 | | Switch off the motor immediately, the motor then coasts down to a standstill. | p0844[0] = r2090.1 |
| | 1 = No OFF2 | | The motor can be switched on (ON command). | |
| 2 | 0 = Quick stop (OFF3) | | Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill. | p0848[0] = r2090.2 |
| | 1 = No quick stop (OFF3) | | The motor can be switched on (ON command). | |
| 3 | 0 = Inhibit operation | | Immediately switch-off motor (cancel pulses). | p0852[0] = r2090.3 |
| | 1 = Enable operation | | Switch-on motor (pulses can be enabled). | |
| 4 | 0 = Disable RFG | | The inverter immediately sets its ramp-function generator output to 0. | p1140[0] = r2090.4 |
| | 1 = Do not disable RFG | | The ramp-function generator can be enabled. | |
| 5 | 0 = Stop RFG | | The output of the ramp-function generator stops at the actual value. | p1141[0] = r2090.5 |
| | 1 = Enable RFG | | The output of the ramp-function generator follows the setpoint. | |
| 6 | 0 = Inhibit setpoint | | The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator. | p1142[0] = r2090.6 |
| | 1 = Enable setpoint | | Motor accelerates with the ramp-up time p1120 to the setpoint. | |
| 7 | 0 → 1 = Acknowledge faults | | Acknowledge fault. If the ON command is still active, the inverter switches to"closing lockout" state. | p2103[0] = r2090.7 |
| 8, 9 | Reserved | | | |
| 10 | 0 = No control via PLC | | Inverter ignores the process data from the fieldbus. | p0854[0] = r2090.10 |
| | 1 = Control via PLC | | Control via fieldbus, inverter accepts the process data from the fieldbus. | |
| 11 | ---[1] | 0 = Direction reversal | Invert setpoint in the inverter. | p1113[0] = r2090.11 |
| 12 | Not used | | | |
| 13 | ---[1] | 1 = MOP up | Increase the setpoint saved in the motorized potentiometer. | p1035[0] = r2090.13 |
| 14 | ---[1] | 1 = MOP down | Reduce the setpoint saved in the motorized potentiometer. | p1036[0] = r2090.14 |
| 15 | CDS bit 0 | Reserved | Changes over between settings for different operation interfaces (command data sets). | p0810 = r2090.15 |

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

## Status word 1 (ZSW1)

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

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

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

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

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

### Status word 3 (ZSW3)

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 ≧ p2170 | Actual current ≥ current threshold value | |
| 4 | 1 | \|n_act\| > p2155 | Absolute actual speed > speed threshold value 2 | |
| 5 | 1 | \|n_act\| ≦ p2155 | Absolute actual speed < speed threshold value 2 | |
| 6 | 1 | \|n_act\| ≧ r1119 | Speed setpoint reached | |
| 7 | 1 | DC link voltage ≦ p2172 | Actual DC link voltage ≦ threshold value | |
| 8 | 1 | DC link voltage > p2172 | Actual DC link voltage > threshold value | |
| 9 | 1 | Ramping completed | Ramp-function generator is not active. | |
| 10 | 1 | Technology controller output at lower limit | Technology controller output ≦ p2292 | |
| 11 | 1 | Technology controller output at upper limit | Technology controller output > p2291 | |
| 12 | | Not used | | |
| 13 | | Not used | | |
| 14 | | Not used | | |
| 15 | | Not used | | |

## 7.4.1.3 Extend telegrams and change signal interconnection

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

### Extend telegram

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

**Procedure**

Proceed as follows to extend a telegram:

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

You have extended the telegram.

| Parameter | Description | |
|---|---|---|
| p0922 | **PROFIdrive telegram selection** | |
| | 999: | Free telegram (message frame) configuration |
| p2079 | **PROFIdrive PZD telegram selection extended** | |
| | The following values apply if you have still not enabled the "Basic positioner" function in the inverter: | |
| | 1:<br>2:<br>3:<br>4:<br>20:<br>350:<br>352:<br>353:<br>354: | Standard telegram 1, PZD-2/2<br>Standard telegram 2, PZD-4/4<br>Standard telegram 3, PZD-5/9<br>Standard telegram 4, PZD-6/14<br>Standard telegram 20, PZD-2/6<br>SIEMENS telegram 350, PZD-4/4<br>SIEMENS telegram 352, PZD-6/6<br>SIEMENS telegram 353, PZD-2/2, PKW-4/4<br>SIEMENS telegram 354, PZD-6/6, PKW-4/4 |
| | The following values apply if you have enabled the "Basic positioner" function in the inverter: | |
| | 7:<br>9:<br>110:<br>111: | Standard telegram 7, PZD-2/2<br>Standard telegram 9, PZD-10/5<br>SIEMENS telegram 110, PZD-12/7<br>SIEMENS telegram 111, PZD-12/12 |
| r2050[0…11] | **PROFIdrive PZD receive word**<br>Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller. | |
| p2051[0…13] | **PROFIdrive PZD send word**<br>Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller. | |

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

## Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

### Procedure

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

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

You have freely interconnected the signals transferred in the telegram.

| Parameter | Description | |
|---|---|---|
| p0922 | **PROFIdrive telegram selection** | |
| | 999: | Free telegram (message frame) configuration |
| p2079 | **PROFIdrive PZD telegram selection extended** | |
| | 999: | Free telegram (message frame) configuration |
| r2050[0…11] | **PROFIdrive PZD receive word**<br>Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller. | |
| p2051[0…13] | **PROFIdrive PZD send word**<br>Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller. | |

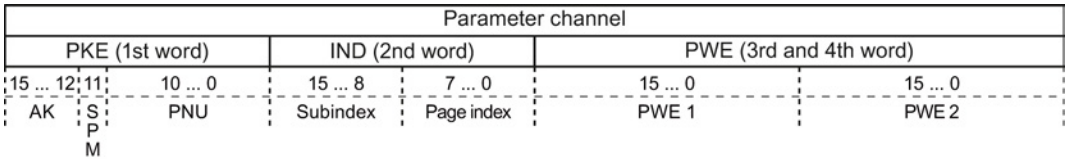
For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

### 7.4.1.4 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.




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

## Request and response IDs

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

Table 7- 1 Request identifiers, control → inverter

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

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

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

Table 7- 2 Response identifiers, inverter → control

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

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

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

Table 7- 3 Error numbers for response identifier 7

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

## Offset and page index of the parameter numbers

| | |
|---|---|
| Parameter numbers < 2000 | PNU = parameter number.<br>Write the parameter number into the PNU (PKE bit 10 ... 0). |
| Parameter numbers ≥ 2000 | PNU = parameter number - offset.<br>Write the parameter number minus the offset into the PNU (PKE bit 10 … 0).<br>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 430).

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

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

Enter a connector parameter as follows:

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

## Telegram examples

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

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

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

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

Figure 7-6 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 0 0 0 0 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 |

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

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

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

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

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

Figure 7-8 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).

## 7.4.1.5 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 454).

## 7.4.2 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

You can find a STEP 7 program example for acyclic data transfer in Section STEP 7 program example for acyclic communication (Page 450).

### Reading parameter values

Table 7- 4 Request to read parameters

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

Table 7- 5 Inverter response to a read request

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

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

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

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

Table 7- 8 Response if the inverter was not able to completely execute the change request

| Data block | Byte n | Bytes n + 1 | n |
|---|---|---|---|
| Header | Reference (identical to a change request) | 82 hex | 0 |
| | 01 hex | Number of parameters (identical to a change request) | 2 |
| Values, parameter 1 | Format<br>40 hex: Zero (change request for this data block executed)<br>44 hex: Error (change request for this data block not executed) | Number of error values<br>00 hex or 02 hex | 4 |
| | Only for "Error" - error value 1<br>You can find the error values in the table at the end of this section. | | 6 |
| | Only for "Error" - error value 2<br>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- 9 Error value in the parameter response

| Error value 1 | Significance |
|---|---|
| 00 hex | Illegal parameter number (access to a parameter that does not exist) |
| 01 hex | Parameter value cannot be changed (change request for a parameter value that cannot be changed) |
| 02 hex | Lower or upper value limit exceeded (change request with a value outside the value limits) |
| 03 hex | Incorrect subindex (access to a parameter index that does not exist) |
| 04 hex | No array (access with a subindex to non-indexed parameters) |
| 05 hex | Incorrect data type (change request with a value that does not match the data type of the parameter) |
| 06 hex | Setting not permitted, only resetting (change request with a value not equal to 0 without permission) |
| 07 hex | Descriptive element cannot be changed (change request to a descriptive element that cannot be changed) |
| 09 hex | Description data not available (access to a description that does not exist, parameter value is available) |
| 0B hex | No master control (change request but with no master control) |
| 0F hex | Text array does not exist (although the parameter value is available, the request is made to a text array that does not exist) |
| 11 hex | Request cannot be executed due to the operating state (access is not possible for temporary reasons that are not specified) |
| 14 hex | Inadmissible value (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values) |
| 15 hex | Response too long (the length of the actual response exceeds the maximum transfer length) |
| 16 hex | Illegal parameter address *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)* |
| 17 hex | Illegal format (change request for an illegal or unsupported format) |
| 18 hex | Number of values not consistent *(number of values of the parameter data to not match the number of elements in the parameter address)* |
| 19 hex | Drive object does not exist (access to a drive object that does not exist) |

| Error value 1 | Significance |
|---|---|
| 6B hex | **No change access for a controller that is enabled**. |
| 6C hex | **Unknown unit**. |
| 6E hex | **Change request is only possible when the motor is being commissioned (p0010 = 3).** |
| 6F hex | **Change request is only possible when the power unit is being commissioned (p0010 = 2).** |
| 70 hex | **Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).** |
| 71 hex | **Change request is only possible if the inverter is ready (p0010 = 0).** |
| 72 hex | **Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).** |
| 73 hex | **Change request possible only during commissioning of the safety functions (p0010 = 95).** |
| 74 hex | **Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).** |
| 75 hex | **Change request is only possible in a commissioning state (p0010 ≠ 0).** |
| 76 hex | **Change request is not possible for internal reasons (p0010 = 29).** |
| 77 hex | **Change request is not possible at download.** |
| 81 hex | **Change request is not possible at download.** |
| 82 hex | **Transfer of the control authority (master) is inhibited by BI: p0806.** |
| 83 hex | **Desired interconnection is not possible** (the connector output does not supply a float value although the connector input requires a float value) |
| 84 hex | **Inverter does not accept a change request** (inverter is busy with internal calculations. See parameter r3996 in the inverter List Manual. See also Section: Manuals for your converter (Page 461)) |
| 85 hex | **No access methods defined**. |
| 86 hex | **Write access only during commissioning of the data records (p0010 = 15)** (operating status of the inverter prevents a parameter change.) |
| 87 hex | **Know-how protection active, access locked** |
| C8 hex | **Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit) |
| C9 hex | **Change request above the currently valid limit** (example: a parameter value is too large for the inverter power) |
| CC hex | **Change request not permitted** (change is not permitted as the access code is not available) |

## Other application examples

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

# 7.5 PROFIenergy profile for PROFINET

The non-proprietary PROFIenergy profile provides the following functions:

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

## PROFIenergy functions of the inverter

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

### Control commands

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

### Status queries

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

## Basic settings in the inverter

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

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

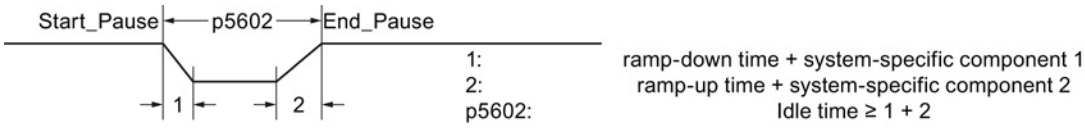
Table 7- 10 Dependency on the settings of p5611.0 … p5611.2

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

## Additional settings and displays

### Settings

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




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

### Displaying

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

# 7.6 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 147)

## 7.6.1 Connect converter to Ethernet/IP

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

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

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

### Procedure

1
2

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 156) 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://support.automation.siemens.com/WW/view/en/48351511) .

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 56).

### Routing and shielding the Ethernet cable

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

### Commissioning the inverter in an EtherNet/IP network

To commission the inverter, using STARTER you must access the inverter via the USB interface. To do this, connect the computer to the inverter via the USB interface. See also Basic commissioning with STARTER (Page 85).

## 7.6.2 What do you need for communication via Ethernet/IP?

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

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

## 7.6.3 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 147). In this case, you must integrate the inverter into your control system.

#### Setting the bus monitoring time

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

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

### 7.6.4 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 217)

#### 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

## 7.6.5 Supported objects

### EtherNet/IP objects supported by the G120

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

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

### ODVA AC/DC assembly

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

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

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

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

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

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

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

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

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | Running Forward | | Faulted |
| 1 | | | | | | | | |
| 2 | Speed Actual (Low Byte) | | | | | | | |
| 3 | Speed Actual (High Byte) | | | | | | | |
| 4 | Data In 1 Value (Low Byte) | | | | | | | |
| 5 | Data In 1 Value (High Byte) | | | | | | | |
| 6 | Data In 2 Value (Low Byte) | | | | | | | |
| 7 | Data In 2 Value (High Byte) | | | | | | | |
| 8 | Data In 3 Value (Low Byte) | | | | | | | |
| 9 | Data In 3 Value (High Byte) | | | | | | | |
| 10 | Data In 4 Value (Low Byte) | | | | | | | |
| 11 | Data In 4 Value (High Byte) | | | | | | | |
| 12 | Data In 5 Value (Low Byte) | | | | | | | |
| 13 | Data In 5 Value (High Byte) | | | | | | | |
| 14 | Data In 6 Value (Low Byte) | | | | | | | |
| 15 | Data In 6 Value (High Byte) | | | | | | | |
| 16 | Data In 7 Value (Low Byte) | | | | | | | |
| 17 | Data In 7 Value (High Byte) | | | | | | | |
| 18 | Data In 8 Value (Low Byte) | | | | | | | |
| 19 | Data In 8 Value (High Byte) | | | | | | | |
| 20 | Data In 9 Value (Low Byte) | | | | | | | |
| 21 | Data In 9 Value (High Byte) | | | | | | | |
| 22 | Data In10 Value (Low Byte) | | | | | | | |
| 23 | Data In 10 Value (High Byte) | | | | | | | |

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

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

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

| Byte | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | At Reference | Ref From Net | 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) | | | | | | | |

### 7.6.6 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 145))

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

# 7.7 Communication via RS485

## 7.7.1 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 Overview of the interfaces (Page 56). This connector has short-circuit proof, isolated pins.

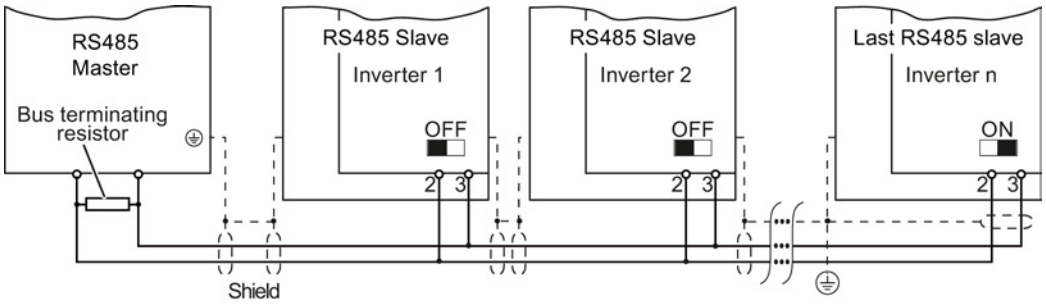



Figure 7-9 Communication network via RS485

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 Overview of the interfaces (Page 56).

---

**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.

## 7.7.2 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 157).

### 7.7.2.1 Basic settings for communication

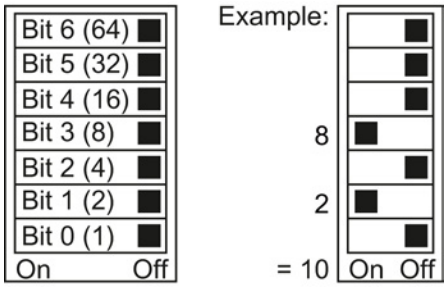
#### Setting the address

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: Overview of the interfaces (Page 56).




**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 | | | |
|---|---|---|---|---|
| p2020 | **Setting the baud rate** | | | |
| | 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 | **Fieldbus interface USS PZD number**<br>Sets the number of 16-bit words in the PZD part of the USS telegram<br>Setting range: 0… 8 (0 … 8 words) | | | |
| p2023 | **Fieldbus interface USS PIV number**<br>Sets the number of 16-bit words in the PIV part of the USS telegram<br>Setting range:<br>• 0, 3, 4: 0, 3 or 4 words<br>• 127: variable length | | | |
| p2040 | **Fieldbus interface monitoring time [ms]**<br>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 | | | |

### 7.7.2.2 Telegram structure

## Overview

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

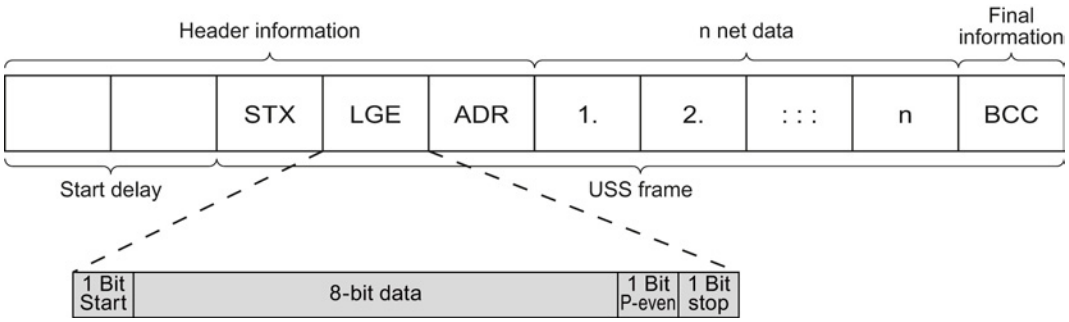



Figure 7-10 Structure of a USS telegram

| 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 167)) |
| STX | An ASCII character (02 hex) indicates the beginning of the message. |
| LGE | The telegram length "LGE" is calculated as follows:<br>LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte) |
| ADR | 7 Special telegram; 6 Mirror telegram; 5 Broadcast bit; 4 3 2 1 0 Address<br>• Bit 7 = 0: Normal data exchange.<br>Bit 7 =1, to transfer telegrams that require a net data structure different from the device profile.<br>• Bit 6 = 0: Normal data exchange.<br>Bit 6 = 1: Testing the bus connection: The converter returns the telegram unchanged to the master.<br>• Bit 5 = 0: Normal data exchange.<br>(Bit 5 = 1: Not supported in the converter.)<br>• Bits 0 ... 4: Address of the converter. |
| Net data | See section User data range of the USS telegram (Page 160). |
| BCC | Checksum (exclusive or) across all telegram bytes – with the exception of BCC. |

### 7.7.2.3 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.

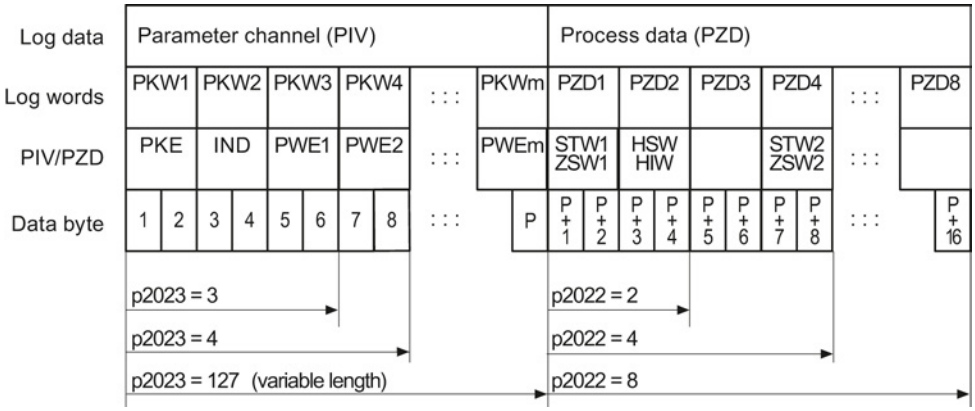



Figure 7-11 USS telegram - user data structure

### Parameter channel

In parameter p2023 you specify the parameter channel length.

#### Parameter channel with fixed and variable length

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

### Process data

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

## 7.7.2.4 USS parameter channel

### Structure of the parameter channel

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

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

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

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

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

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

## Request and response IDs

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

Table 7- 11 Request identifiers, control → inverter

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

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

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

Table 7- 12 Response identifiers, inverter → control

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

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

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

Table 7- 13 Error numbers for response identifier 7

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

## Parameter number

| | |
|---|---|
| Parameter numbers < 2000 | PNU = parameter number.<br>Write the parameter number into the PNU (PKE bit 10 ... 0). |
| Parameter numbers ≥ 2000 | PNU = parameter number - offset.<br>Write the parameter number minus the offset into the PNU (PKE bit 10 … 0).<br>Write the offset in the page index (IND bit 15 … 8). |

Table 7- 14 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 430).

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 ≙ 90 hex)
- **IND, bit 0 … 7 (subindex): = 2** (Index of the parameter)
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

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

Figure 7-12 Telegram for a read request from p7841[2]

### Write request: Changing the automatic restart mode (p1210)

Parameter p1210 defines the automatic restart mode:

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

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

Figure 7-13 Telegram, to activate the automatic restart with p1210 = 26

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

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

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

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

Figure 7-14 Telegram, to assign DI 2 with ON/OFF1

### 7.7.2.5 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.

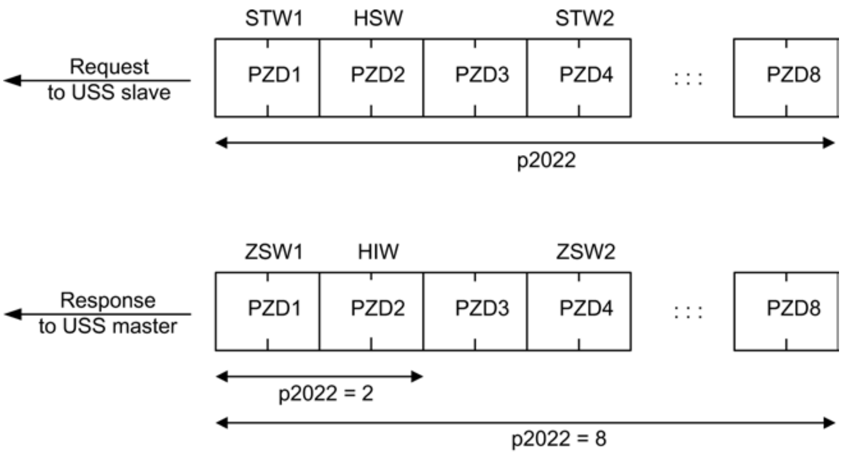



Figure 7-15 Process data channel

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.

### 7.7.2.6 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- 15 Character runtime

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

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

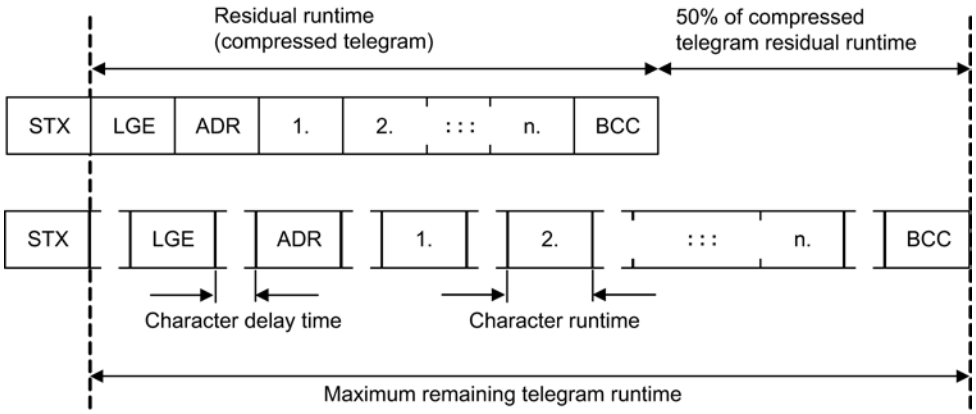



Figure 7-16 Telegram runtime as the sum of the residual runtime and character delay times

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

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

The slave only responds after the response delay has expired.

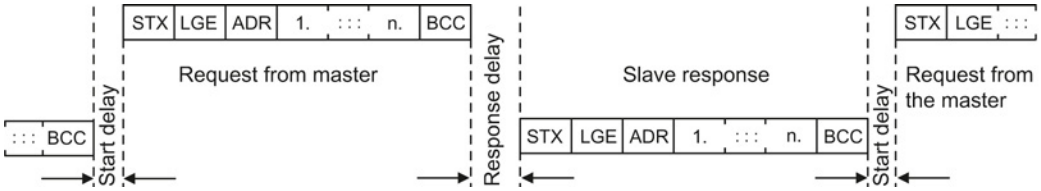



Figure 7-17 Start delay and response delay

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- 16 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.

## 7.7.3 Communication over Modbus RTU

### Overview of communication using Modbus

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

Modbus offers three transmission modes:

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

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

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

### Communication settings

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

---

**Note**

**It is not permitted to change over the units**

The "Unit changeover (Page 260)" function is not permissible with this bus system!

---

### 7.7.3.1 Basic settings for communication

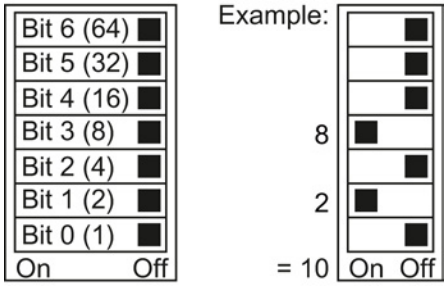
You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

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: Overview of the interfaces (Page 56).




**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 |
|---|---|
| p2030 = 2 | **Fieldbus protocol selection**<br>2: Modbus |
| p2020 | **Fieldbus baud rate**<br>Factory setting = 19200 bit/s |
| p2024 | **Modbus timing** (see Section "Baud rates and mapping tables (Page 172)")<br>• **Index 0: Maximum slave telegram processing time:**<br>The time after which the slave must have sent a response to the master.<br>• **Index 1: Character delay time:**<br>Character delay time: Maximum permissible delay time between the individual characters in the Modbus frame (Modbus standard processing time for 1.5 bytes).<br>• **Index 2: Inter-telegram delay:**<br>Maximum permissible delay time between Modbus telegrams (Modbus standard processing time for 3.5 bytes). |

| Parameter | Description |
|---|---|
| p2029 | **Fieldbus fault statistics**<br>Displays receive faults on the fieldbus interface |
| p2040 | **Process data monitoring time**<br>Determines the time after which an alarm is generated if no process data is transferred<br>**Note:** You must adapt the time depending on the number of slaves and the baud rate is set on the bus (factory setting = 100 ms). |

### 7.7.3.2 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.

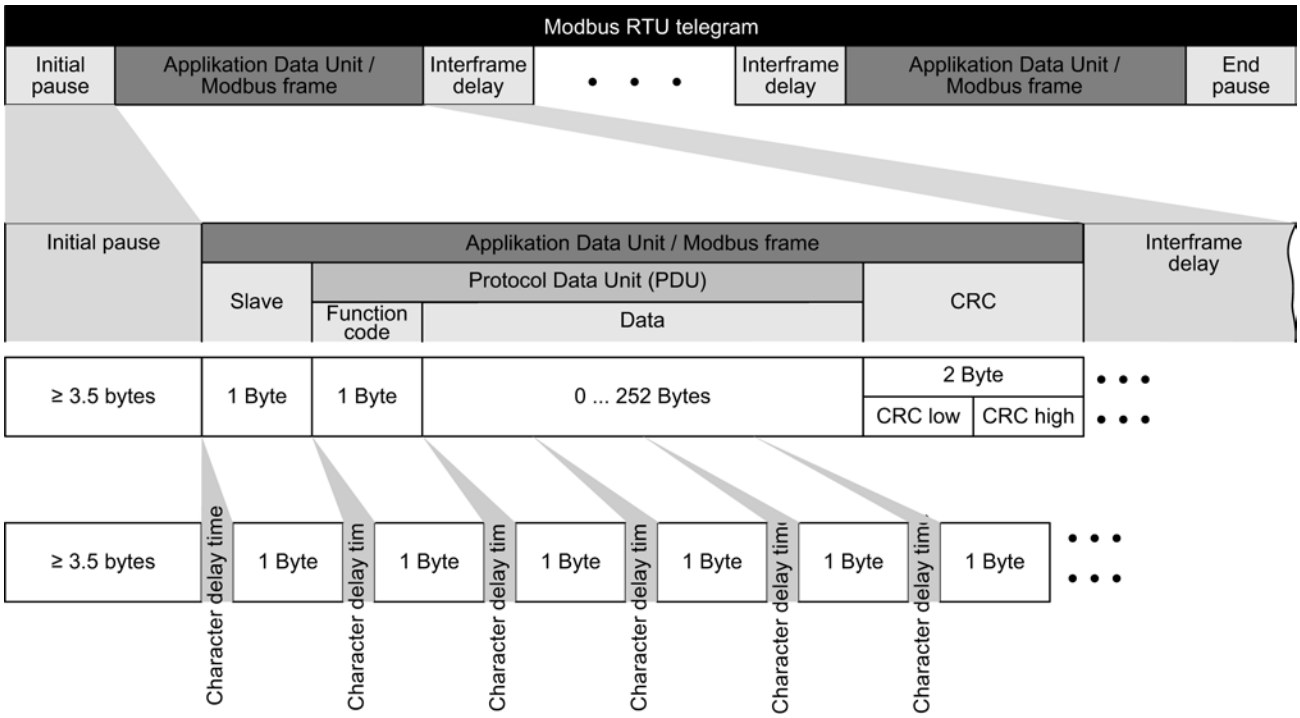



Figure 7-18 Modbus with delay times

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

### 7.7.3.3 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- 17 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- 18 Assigning the Modbus register to the parameters of the Control Unit

| Modbus Reg. No. | Description | Modbus access | Unit | Scaling factor | On/Off text or value range | | Data / parameter |
|---|---|---|---|---|---|---|---|
| **Process data** | | | | | | | |
| **Control data** | | | | | | | |
| 40100 | Control word | R/W | -- | 1 | | | Process data 1 |
| 40101 | Main setpoint | R/W | -- | 1 | | | Process data 2 |
| **Status data** | | | | | | | |
| 40110 | Status word | R | -- | 1 | | | Process data 1 |
| 40111 | Main actual value | R | -- | 1 | | | Process data 2 |
| **Parameter data** | | | | | | | |
| **Digital outputs** | | | | | | | |
| 40200 | DO 0 | R/W | -- | 1 | HIGH | LOW | p0730, r747.0, p748.0 |
| 40201 | DO 1 | R/W | -- | 1 | HIGH | LOW | p0731, r747.1, p748.1 |
| 40202 | DO 2 | R/W | -- | 1 | HIGH | LOW | p0732, r747.2, p748.2 |
| **Analog outputs** | | | | | | | |
| 40220 | AO 0 | R | % | 100 | -100.0 … 100.0 | | r0774.0 |
| 40221 | AO 1 | R | % | 100 | -100.0 … 100.0 | | r0774.1 |
| **Digital inputs** | | | | | | | |
| 40240 | DI 0 | R | -- | 1 | HIGH | LOW | r0722.0 |
| 40241 | DI 1 | R | -- | 1 | HIGH | LOW | r0722.1 |
| 40242 | DI 2 | R | -- | 1 | HIGH | LOW | r0722.2 |
| 40243 | DI 3 | R | -- | 1 | HIGH | LOW | r0722.3 |
| 40244 | DI 4 | R | -- | 1 | HIGH | LOW | r0722.4 |
| 40245 | DI 5 | R | -- | 1 | HIGH | LOW | r0722.5 |
| **Analog inputs** | | | | | | | |
| 40260 | AI 0 | R | % | 100 | -300.0 … 300.0 | | r0755 [0] |
| 40261 | AI 1 | R | % | 100 | -300.0 … 300.0 | | r0755 [1] |
| 40262 | AI 2 | R | % | 100 | -300.0 … 300.0 | | r0755 [2] |
| 40263 | AI 3 | R | % | 100 | -300.0 … 300.0 | | r0755 [3] |

| Modbus Reg. No. | Description | Modbus access | Unit | Scaling factor | On/Off text or value range | Data / parameter |
|---|---|---|---|---|---|---|
| **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 |

| Modbus Reg. No. | Description | Modbus access | Unit | Scaling factor | On/Off text or value range | Data / parameter |
|---|---|---|---|---|---|---|
| 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 |

### 7.7.3.4 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- 19 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- 20 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- 21 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- 22 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- 23 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- 24 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" |

### 7.7.3.5 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- 25 Overview of exception codes

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

## Maximum processing time, p2024[0]

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

## Process data monitoring time (setpoint timeout), p2040

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

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

**Note**

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

# 7.8 Communication over CANopen

## General information on CAN

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

### Integrating a converter in a CANopen network

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

## 7.8.1 CANopen functions of the converter

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

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

- Via the Predefined connection set (Page 191)
- Via Free PDO mapping (Page 192)

## Communication objects (COB)

The inverter operates with communication objects from the following profiles:

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

Specifically, these are:

- **NMT** Network management (NMT service) (Page 180)
  Network management objects for controlling CANopen communication and for monitoring the individual nodes on the basis of a master-slave relationship
- **SDO** SDO services (Page 183)
  Service data objects for reading and changing parameters
- **PDO** PDO and PDO services (Page 188)
  Process data objects to transfer process data; TPDO to send, RPDO to receive
- **SYNC**
  Synchronization objects
- **EMCY**
  Time stamp and fault messages

## COB ID

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

### COB ID for individual communication objects

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

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

* ) In the "Predefined Connection Set", see SectionPredefined connection set (Page 191) .

### 7.8.1.1 Network management (NMT service)

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

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

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

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

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

The NMT recognizes the following transitional states:

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

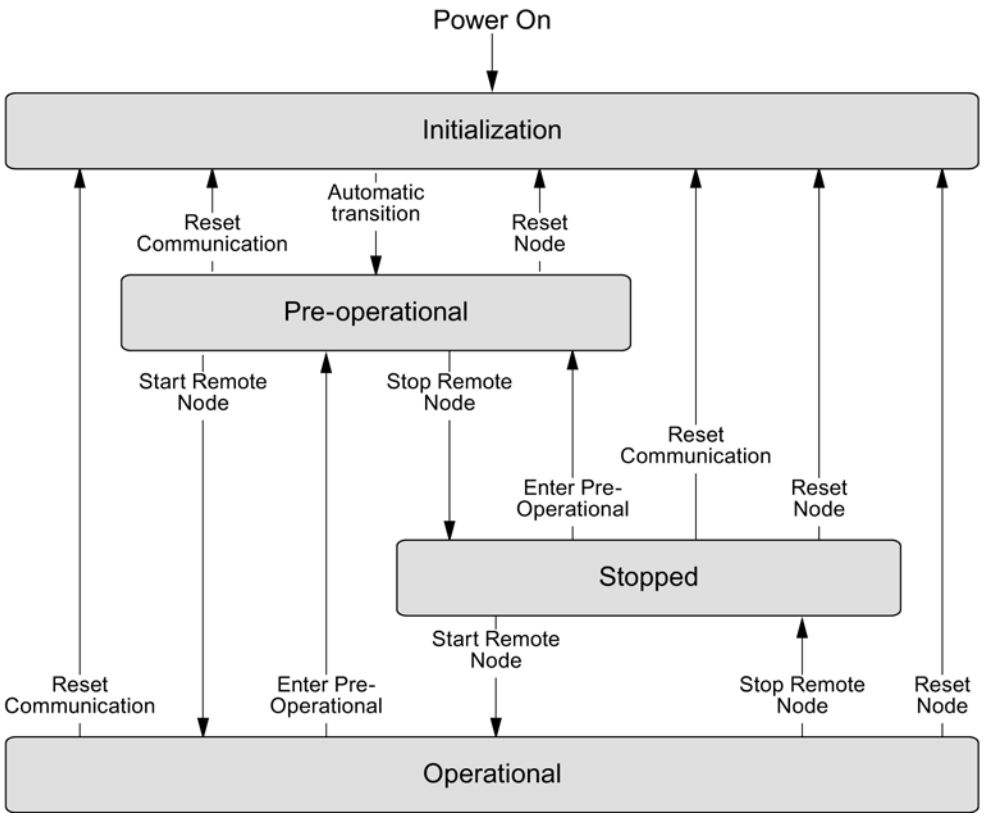



Figure 7-19 CANopen state diagram

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

**Overview of NMT commands**

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

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

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

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

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

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

### 7.8.1.2 SDO services

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

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

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

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

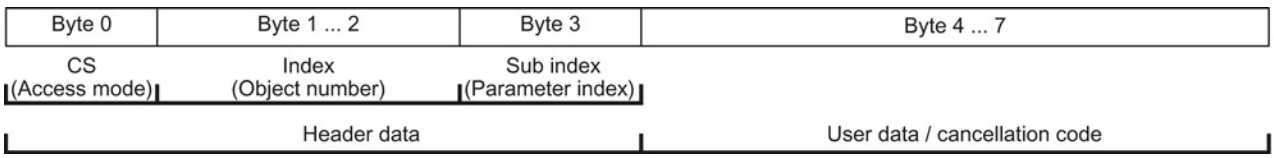
#### Properties

The SDOs have the following properties:

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

#### Structure of the SDO protocols

The basic structure of the SDO protocols is shown below:



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

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

### 7.8.1.3 Access to SINAMICS parameters via SDO

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

You also configure RPDO and TPDO telegrams via SDO. You can find the objects that are available to do this in Section Object directories (Page 198).

#### Object numbers for SDO jobs

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

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

#### Selection of parameter range and the associated offset

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

Calculate object number for an SDO job

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

Examples of object numbers

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

### Selection, index range

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

- p8630[1] = 0: 0 … 255
- p8630[1] = 1: 256 … 511
- p8630[1] = 2: 512 … 767
- p8630[1] = 3: 768 … 1023

### Switch-on access to objects of the inverter parameters

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

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

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

## 7.8.1.4 Access PZD objects via SDO

### Access to mapped PZD objects

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

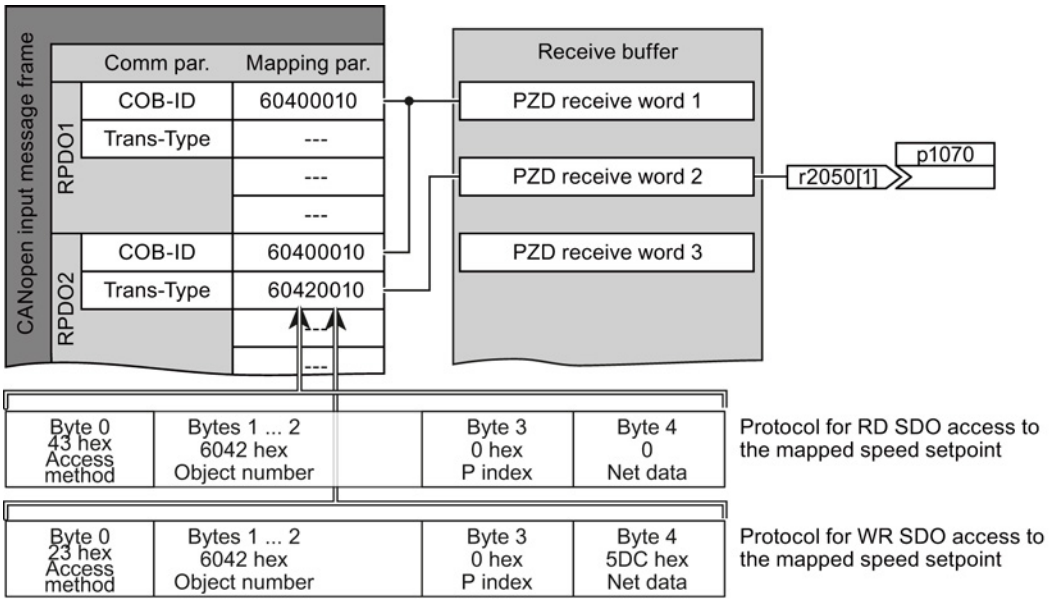



Figure 7-20 Access to the process data

## Access to non-mapped PZD objects

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

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

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

## SDO abort codes

| Abort code | Description |
|---|---|
| 0503 0000 hex | Toggle bit not alternated<br>Toggle bit has not changed |
| 0504 0000 hex | SDO protocol timed out<br>Timeout for the SDO protocol |
| 0504 0001 hex | Client/server command specifier not valid or unknown<br>Client/server command not valid or unknown |
| 0504 0002 hex | Invalid block size (block mode only)<br>Invalid block size |
| 0504 0003 hex | Invalid sequence number (block mode only)<br>Invalid sequence number |
| 0504 0004 hex | CRC error (block mode only)<br>CRC error |
| 0504 0005 hex | Out of memory.<br>Memory overflow |
| 0601 0000 hex | Unsupported access to an object.<br>Access to an object that is not supported |
| 0601 0001 hex | Attempt to read a write only object.<br>Attempt to read a "write-only object" |
| 0601 0002 hex | Attempt to write a read only object.<br>Attempt to write a "read-only object" |
| 0602 0000 hex | Object does not exist in the object dictionary.<br>Object does not exist in the object dictionary |
| 0604 0041 hex | Object cannot be mapped to the PDO.<br>Object cannot be linked with the PDO |
| 0604 0042 hex | The number and length of the objects to be mapped would exceed PDO length.<br>The number and length of the linked objects exceeds the PDO length |

| Abort code | Description |
|---|---|
| 0604 0043 hex | General parameter incompatibility reason.<br>Basic parameter incompatibility |
| 0604 0047 hex | General internal incompatibility in the device.<br>Basic incompatibility in the device |
| 0606 0000 hex | Access failed due to an hardware error.<br>Access failed due to a hardware fault |
| 0607 0010 hex | Data type does not match, length of service parameter does not match.<br>Data type and length of the service parameter do not match |
| 0607 0012 hex | Data type does not match, length of service parameter too high.<br>Data type is not correct, service parameter is too long |
| 0607 0013 hex | Data type does not match, length of service parameter too low.<br>Data type is not correct, service parameter is too short |
| 0609 0011 hex | Subindex does not exist.<br>Subindex does not exist |
| 0609 0030 hex | Value range of parameter exceeded (only for write access).<br>Value range of the parameter exceeded (only for write access) |
| 0609 0031 hex | Value of parameter written too high.<br>Subindex does not exist |
| 0609 0032 hex | Value of parameter written too low.<br>Value of written parameter too small |
| 0609 0036 hex | Maximum value is less than minimum value.<br>Maximum value is less than the minimum value |
| 060A 0023 hex | Resource not available: SDO connection.<br>Source does not exist: SDO connection |
| 0800 0000 hex | General error.<br>General error |
| 0800 0020 hex | Data cannot be transferred or stored to the application.<br>Data cannot be transferred or saved in the application |
| 0800 0021 hex | Data cannot be transferred or stored to the application because of local control.<br>Data cannot be transferred or saved because of the local controller |
| 0800 0022 hex | Data cannot be transferred or stored to the application because of the current device state.<br>Data cannot be transferred or saved because of the device condition |
| 0800 0023 hex | Object dictionary dynamic generation failed or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error).<br>Dynamic creation of the object dictionary failed or no object dictionary exists (e.g. object directory was generated from a defective file) |

### 7.8.1.5 PDO and PDO services

#### Process data objects (PDO)

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

PDO communication parameters and PDO mapping parameters define a PDO.

Link the PDO with the elements of the object directory that contain the process data. You can use Free PDO mapping (Page 192) or the Predefined connection set (Page 191) to do this.

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

#### Structure of the PDO

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

The values for communication parameters can be found in the tables in Section Object directories (Page 198)

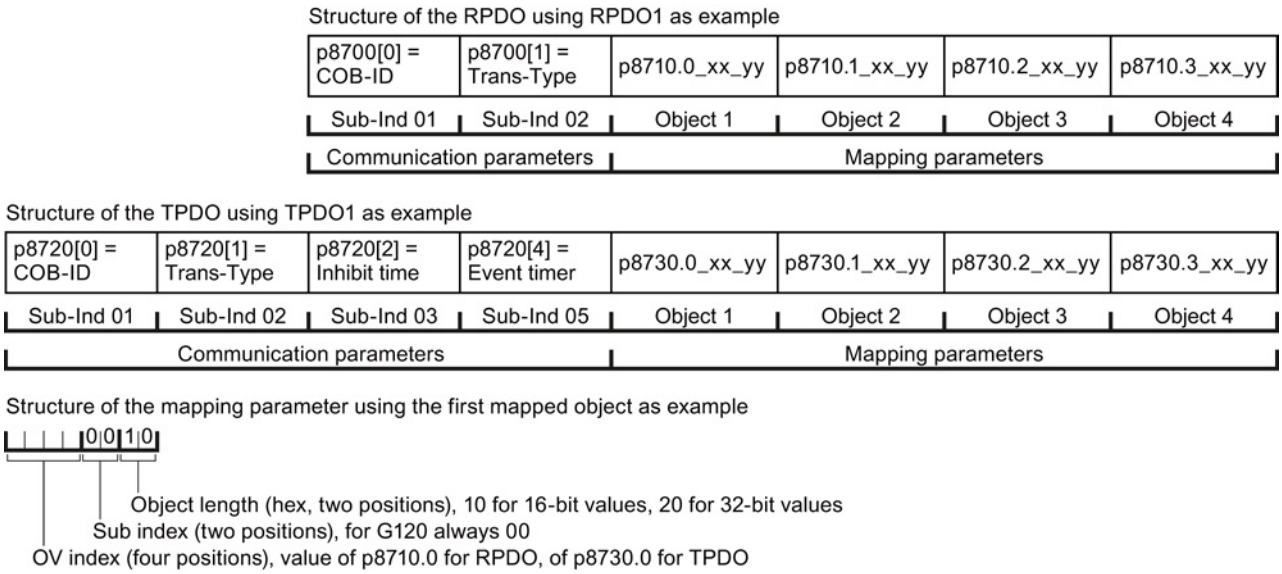



Figure 7-21 Structure of the RPDO and TPDO communication objects

#### COB ID

An overview of the COB IDs can be found in Section CANopen functions of the converter (Page 179). Section Predefined connection set (Page 191) explains how the COB IDs are calculated.

#### Transmission type

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

- Cyclic synchronous (value range: 1 … 240)
  - TPDO after each n-th SYNC
  - RPDO after each n-th SYNC
- Acyclic synchronous (value: 0)
  - TPDO when a SYNC is received and a process data has changed in the telegram.
- Cyclic asynchronous (values: 254, 255 + event time)
  - TPDO when a process data has changed in the telegram.
- Acyclic asynchronous (values: 254, 255)
  - TPDO when a process data has changed in the telegram.
  - The controller accepts the RPDO immediately.

#### Inhibit time

The inhibit time defines the minimum interval between two transmissions.

### Synchronous data transmission

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

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

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

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

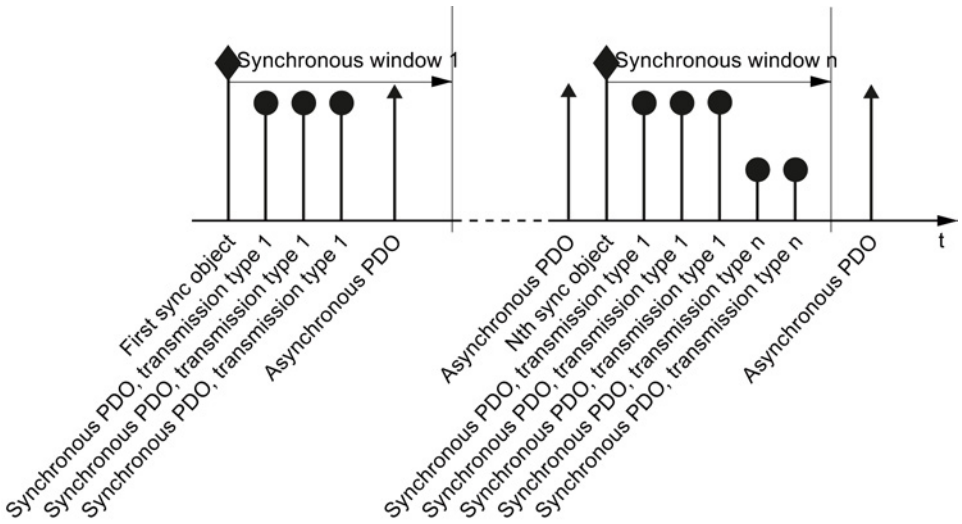



Figure 7-22 Principle of synchronous and asynchronous transmission

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

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

---

**Note**

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

---

## PDO services

The PDO services can be subdivided as follows:

- Write PDO
- Read PDO
- SYNC service

### Write PDO

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

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

### Read PDO

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

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

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

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

---

**Note**

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

---

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

### 7.8.1.6 Predefined connection set

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

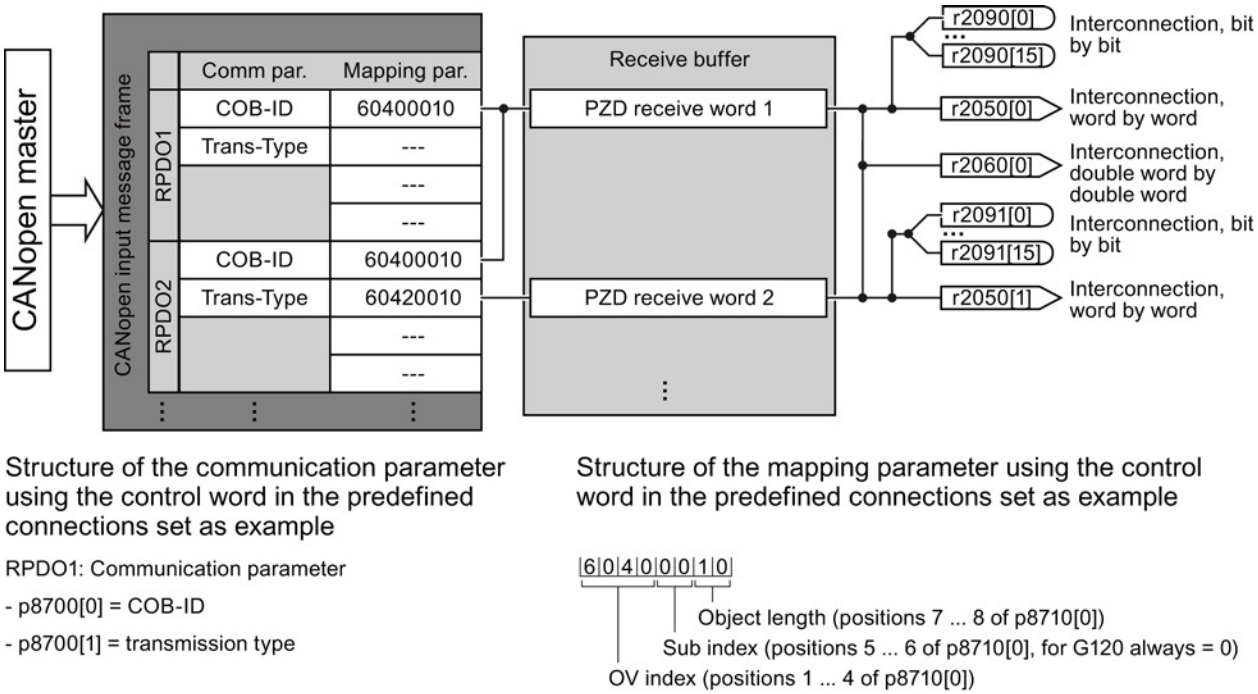



Figure 7-23 RPDO mapping with the Predefined Connection Set

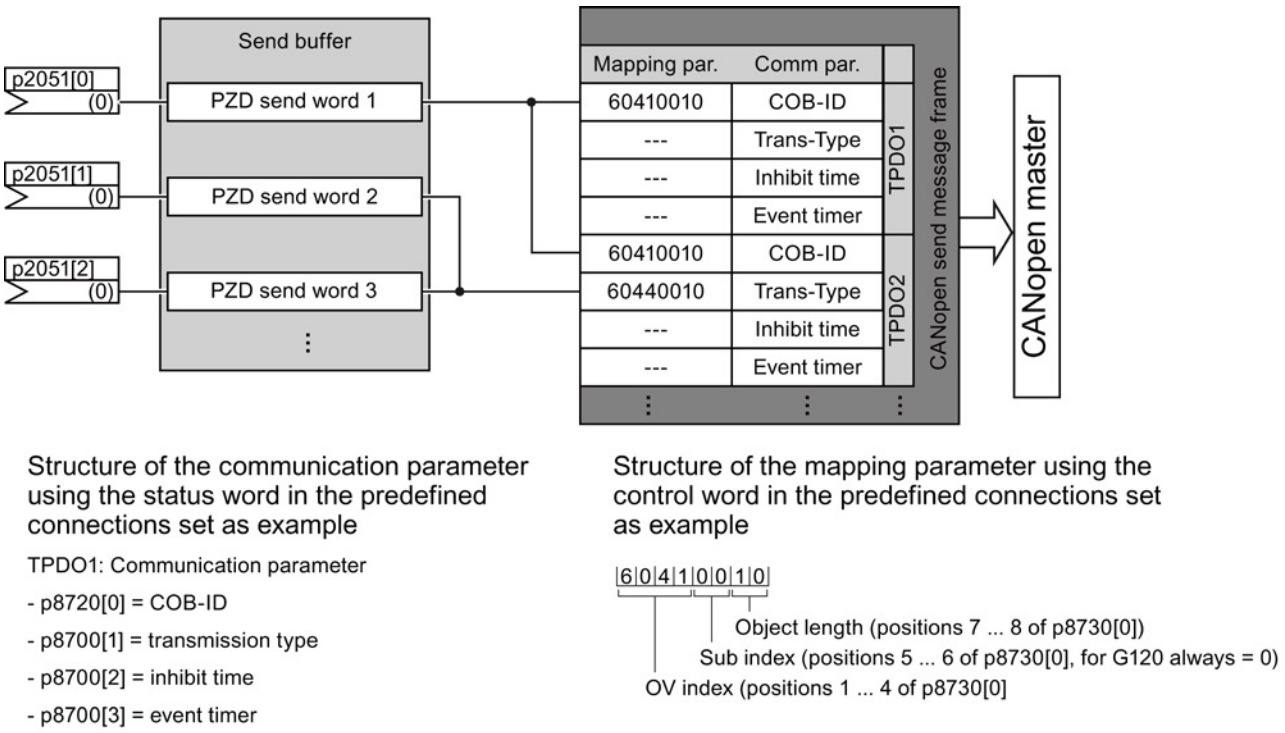



Figure 7-24 TPDO mapping with the Predefined Connection Set

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

**COB ID for TPDO and RPDO in the Predefined Connection Set**

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

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

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

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

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

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

### 7.8.1.7 Free PDO mapping

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

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

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

## Interconnecting process data via a free PDO mapping

### Procedure

To interconnect process data, proceed as follows:

1. Define process data,
   examples:
   - Send actual current value (r0068) from the inverter to the controller (TPDO - Transmit Process Data Object)
   - Send additional speed setpoint from the controller to the inverter (RPDO - Receive Process Data Object) and write in p1075
2. Specify objects for transmission of the process data
   - TPDO1 for the actual current value
   - RPDO1 for additional speed setpoint
3. Set communication parameters for RPDO and TPDO
   - Define the communication parameters for RPDO, see RPDO communication parameters (Page 200)
   - Define the communication parameters for TPDO, see TPDO communication parameters (Page 203)
4. Select the OD index for the mapping parameters:
   - Mapping parameters for RPDO, see RPDO mapping parameters (Page 201)
   - Mapping parameters for TPDO, see TPDO mapping parameters (Page 205)
5. Write OV index into the SINAMICS mapping parameters
   - p8710 … p8717 for RPDO
   - p8730 … p8737 for TPDO
   - You will find the OD index in the free objects (Page 207) or in the objects of the CiA 402 drive profile (Page 208)

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**Note**

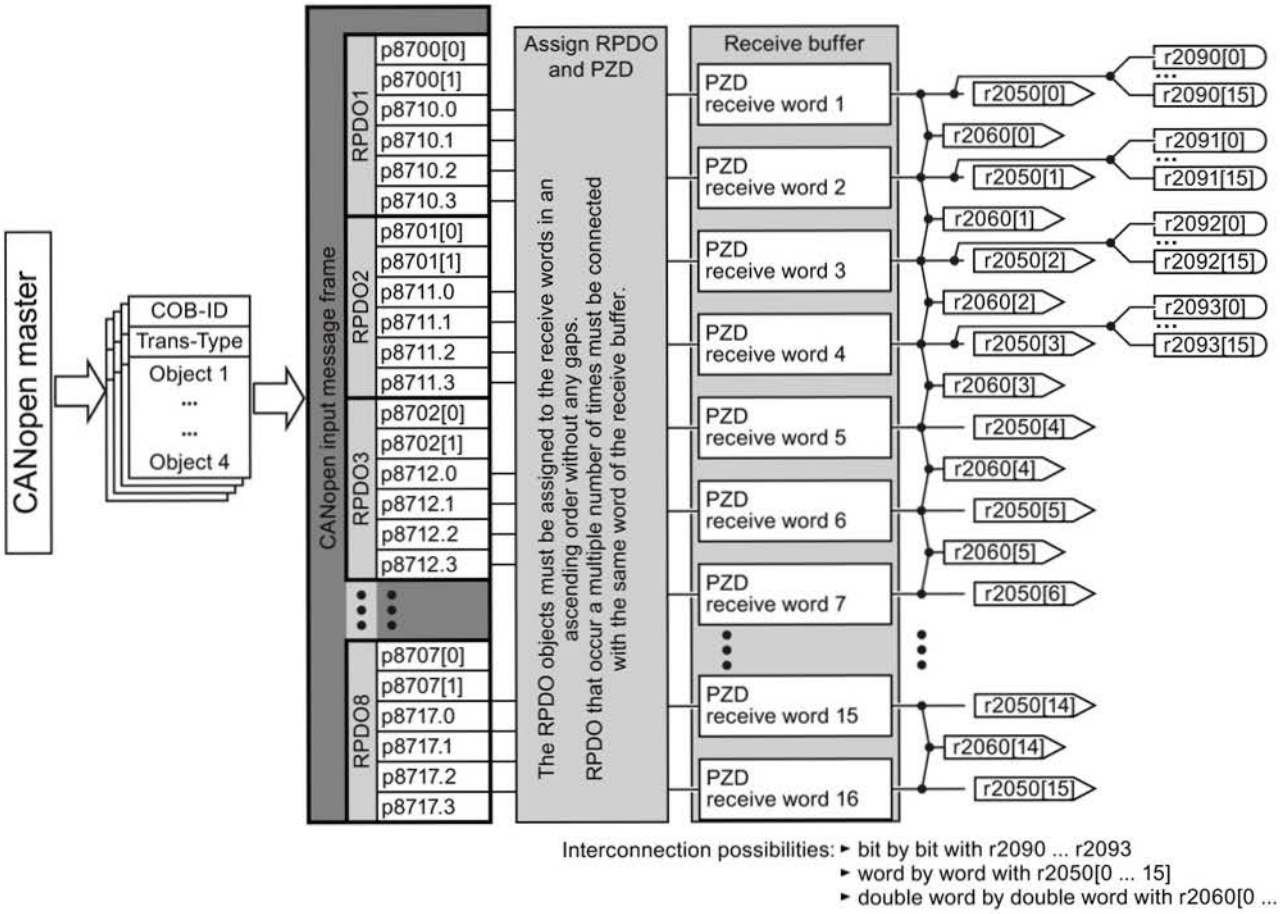
**Requirement for changing the OD indexes of the SINAMICS mapping parameters**

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

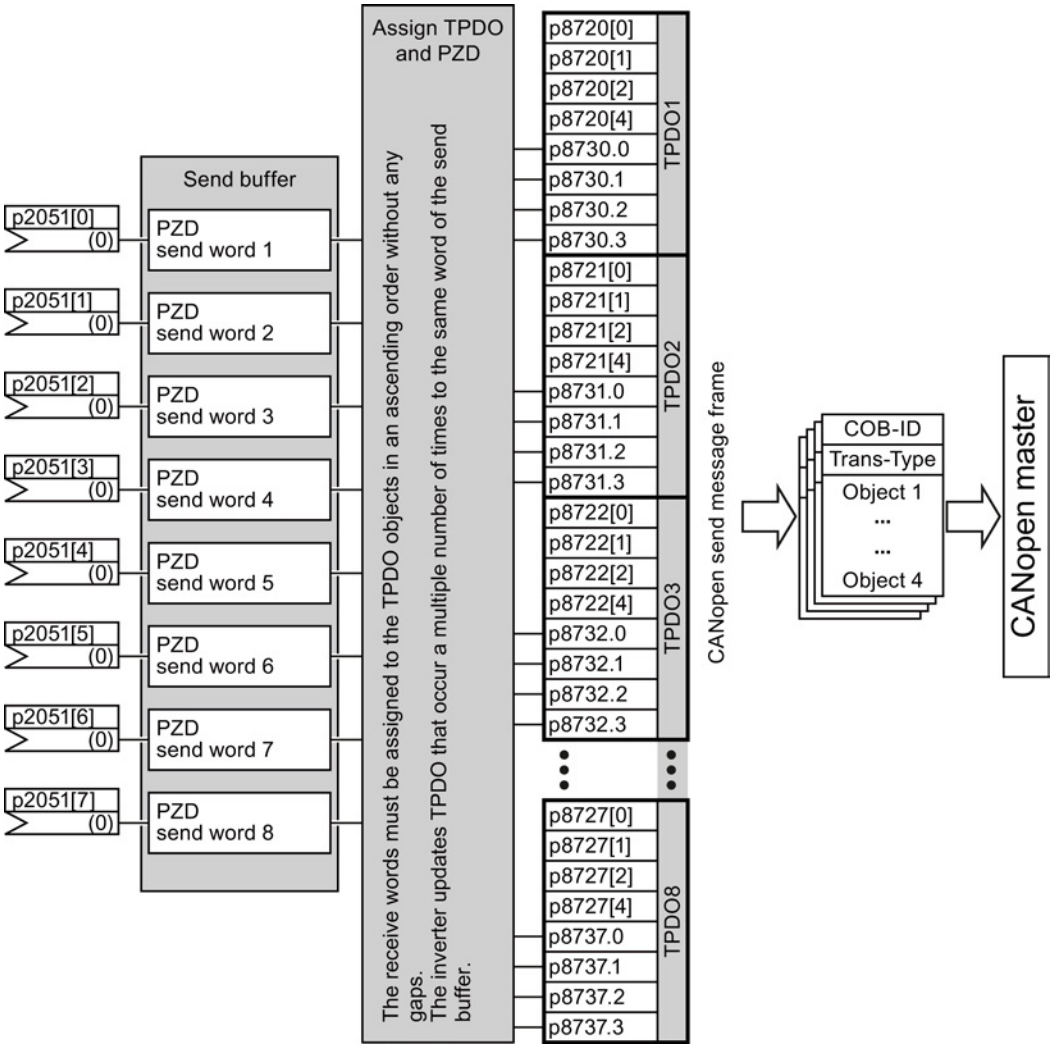
---

You have interconnected the process data.

## Free RPDO mapping - Overview



### Free TPDO mapping - Overview




## 7.8.1.8 Interconnect objects from the receive and transmit buffers

**Procedure**

Proceed as follows to configure the CANopen PDO:

1. Create a telegram:
   create PDO (parameterize the PDO Com. Parameter and PDO mapping parameters), see Predefined connection set (Page 191) and Free PDO mapping (Page 192)
2. Interconnect the parameters:
   Interconnect the parameters of the PZD buffer ( p2050/p2060, p2051) corresponding to the mapping of point "Create telegram" using the mapping table r8750/r8760 or r8751/r8761. The mapping table indicates the position of a mapped CANopen object in the PZD buffer.

You have configured the CANopen PDO.

## Interconnecting the receive buffer

The inverter writes the received data in the receive buffer:

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

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

- r8760 for double word switching
- r8750 for word switching

### Examples

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

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

## Interconnecting the send buffer

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

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

### Examples

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

### 7.8.1.9 CANopen operating modes

The converter has the following CANopen operating modes

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

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

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

Parameter access via SDO  Parameter change via PDO

Figure 7-25 Switching the CANopen operating modes

### 7.8.1.10 RAM to ROM via the CANopen object 1010

You save the parameter changes in the EEPROM of the inverter using the CANopen object 1010. This function is identical with the data save function using the button (RAM -> ROM) in STARTER or via p0971 = 1.

Saving data using the CANopen object 1010 is not possible when an MMC is inserted, the inverter is connected with a computer via the USB connector, but STARTER is not accessing the inverter online.

Withdraw the USB cable in order to be able to save data using CANopen object 1010.

## 7.8.2 Object directories

### 7.8.2.1 General objects from the CiA 301 communication profile

#### Overview

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

Table 7- 26 Drive-independent communication objects

| OD index (hex) | Subindex (hex) | Object name | SINAMICS parameters | Transmission | Data type | Default values | Can be read/ written |
|---|---|---|---|---|---|---|---|
| 1000 | | Device type | r8600 | SDO | U32 | – | r |
| 1001 | | Error register | r8601 | SDO | U8 | – | r |
| 1003 | 0...52 hex | Predefined error field | p8611[0...82] | SDO | U32 | 0 | r/w |
| | 0 | Number of errors | p8611.0 | SDO | U32 | 0 | rw |
| | 1 | Number of module | p8611.1 | SDO | U32 | 0 | r |
| | 2 | Number of errors: module 1 | p8611.2 | SDO | U32 | 0 | r |
| | 3-A | Standard error field: module 1 | p8611.3- p8611.10 | SDO | U32 | 0 | r |
| | B | Number of errors: module 2 | p8611.11 | SDO | U32 | 0 | r |
| | C-13 | Standard error field: module 2 | p8611.12-p8611.19 | SDO | U32 | 0 | r |
| | 14 | Number of errors: module 3 | p8611.20 | SDO | U32 | 0 | r |
| | 15-1C | Standard error field: module 3 | p8611.21-p8611.28 | SDO | U32 | 0 | r |
| | 1D | Number of errors: module 4 | p8611.29 | SDO | U32 | 0 | r |
| | 1E-25 | Standard error field: module 4 | p8611.30-p8611.37 | SDO | U32 | 0 | r |
| | 26 | Number of errors: module 5 | p8611.38 | SDO | U32 | 0 | r |
| | 27-2E | Standard error field: module 5 | p8611.39-p8611.46 | SDO | U32 | 0 | r |
| | 2F | Number of errors: module 6 | p8611.47 | SDO | U32 | 0 | r |
| | 30-37 | Standard error field: module 6 | p8611.48-p8611.55 | SDO | U32 | 0 | r |
| | 38 | Number of errors: module 7 | p8611.56 | SDO | U32 | 0 | r |
| | 39-40 | Standard error field: module 7 | p8611.57-p8611.64 | SDO | U32 | 0 | r |

| OD index (hex) | Subindex (hex) | Object name | SINAMICS parameters | Transmission | Data type | Default values | Can be read/ written |
|---|---|---|---|---|---|---|---|
| | 41 | Number of errors: module 8 | p8611.65 | SDO | U32 | 0 | r |
| | 42-49 | Standard error field: module 8 | p8611.66-p8611.73 | SDO | U32 | 0 | r |
| | 4A | Number of Control Unit faults | p8611.74 | SDO | U32 | 0 | r |
| | 4B-52 | Field Control Unit standard error | p8611.75-p8611.82 | SDO | U32 | 0 | r |
| 1005 | | SYNCH COB ID | p8602 | SDO | U32 | 128 | rw |
| 1008 | | Manufacturer device name | | SDO | | | |
| 100A | | Manufacturer software version | r0018 | SDO | U32 | – | r |
| 100C | | Guard time | p8604.0 | SDO | U16 | 0 | rw |
| 100D | | Lifetime factor | p8604.1 | SDO | U16 | 0 | rw |
| 1010 | | Store parameters | p0977 | SDO | U16 | 0 | rw |
| | 0 | Largest subindex supported | | SDO | | | |
| | 1 | Save all parameters | p0977 | SDO | U16 | 0 | rw |
| | 2 | Save communication parameters (0x1000-0x1fff) | p0977 | SDO | U16 | 0 | rw |
| | 3 | Save application-related parameters (0x6000-0x9fff) | p0977 | SDO | U16 | 0 | rw |
| 1011 | | Restore default parameters | p0976 | SDO | U16 | 0 | rw |
| | 0 | Largest subindex supported | | SDO | | | |
| | 1 | Restore all default parameters | p0976 | SDO | U16 | 0 | rw |
| | 2 | Restore communication default parameters (0x1000-0x1fff) | p0976 | SDO | U16 | 0 | rw |
| | 3 | Restore application default parameters (0x6000-0x9fff) | p0976 | SDO | U16 | 0 | rw |
| 1014 | | COB ID emergency | p8603 | SDO | U32 | 0 | rw |
| 1017 | | Producer heartbeat time | p8606 | SDO | U16 | 0 | rw |
| 1018 | | Identy Object | r8607[0...3] | | U32 | – | r |
| | 0 | Number of entries | | SDO | | | |
| | 1 | Vendor ID | r8607.0 | SDO | U32 | – | r |
| | 2 | Product code | r8607.1 | SDO | U32 | – | r |
| | 3 | Revision number | r8607.2 | SDO | U32 | – | r |
| | 4 | Serial number | r8607.3 | SDO | U32 | 0 | r |

| OD index (hex) | Subindex (hex) | Object name | SINAMICS parameters | Transmission | Data type | Default values | Can be read/ written |
|---|---|---|---|---|---|---|---|
| 1027 | | Module list | | | | | |
| | 0 | Number of entries | r0102 | SDO | U16 | – | r |
| | 1-8 | Module ID | p0107[0...15] | SDO | I16 | 0 | rw |
| 1029 | | Error behavior | | | | | |
| | 0 | Number of error classes | | SDO | | | |
| | 1 | Communication Error | p8609.0 | SDO | U32 | 1 | rw |
| | 2 | Device profile or manufacturer-specific error | p8609.1 | SDO | U32 | 1 | rw |
| 1200 | | 1st server SDO parameter | | | | | |
| | 0 | Number of entries | | SDO | | | |
| | 1 | COB ID client -> server (rx) | r8610.0 | SDO | U32 | – | r |
| | 2 | COB ID server -> client (tx) | r8610.1 | SDO | U32 | – | r |

## RPDO configuration objects

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

Table 7- 27 RPDO configuration objects - communication parameters

| OD Index (hex) | Subindex (hex) | Name of the object | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written to |
|---|---|---|---|---|---|---|
| 1400 | | Receive PDO 1 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8700.0 | U32 | 200 hex + node ID | r/w |
| | 2 | Transmission type | p8700.1 | U8 | FE hex | r/w |
| 1401 | | Receive PDO 2 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8701.0 | U32 | 300 hex + node ID | r/w |
| | 2 | Transmission type | p8701.1 | U8 | FE hex | r/w |
| 1402 | | Receive PDO 3 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8702.0 | U32 | 8000 06DF hex | r/w |
| | 2 | Transmission type | p8702.1 | U8 | FE hex | r/w |
| 1403 | | Receive PDO 4 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8703.0 | U32 | 8000 06DF hex | r/w |

| OD Index (hex) | Subi ndex (hex) | Name of the object | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written to |
|---|---|---|---|---|---|---|
| | 2 | Transmission type | p8703.1 | U8 | FE hex | r/w |
| 1404 | | Receive PDO 5 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8704.0 | U32 | 8000 06DF hex | r/w |
| | 2 | Transmission type | p8704.1 | U8 | FE hex | r/w |
| 1405 | | Receive PDO 6 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8705.0 | U32 | 8000 06DF hex | r/w |
| | 2 | Transmission type | p8705.1 | U8 | FE hex | r/w |
| 1406 | | Receive PDO 7 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8706.0 | U32 | 8000 06DF hex | r/w |
| | 2 | Transmission type | p8706.1 | U8 | FE hex | r/w |
| 1407 | | Receive PDO 8 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 2 | r |
| | 1 | COB ID used by PDO | p8707.0 | U32 | 8000 06DF hex | r/w |
| | 2 | Transmission type | p8707.1 | U8 | FE hex | r/w |

Table 7- 28 RPDO configuration objects - mapping parameters

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

| OD index (hex) | Subi ndex (hex) | Name of the object | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written to |
|---|---|---|---|---|---|---|
| | 4 | PDO mapping for the fourth application object to be mapped | p8711.3 | U32 | 0 | r/w |
| 1602 | | Receive PDO 3 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8712.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8712.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8712.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8712.3 | U32 | 0 | r/w |
| 1603 | | Receive PDO 4 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8713.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8713.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8713.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8713.3 | U32 | 0 | r/w |
| 1604 | | Receive PDO 5 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8714.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8714.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8714.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8714.3 | U32 | 0 | r/w |
| 1605 | | Receive PDO 6 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8715.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8715.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8715.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8715.3 | U32 | 0 | r/w |
| 1606 | | Receive PDO 7 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |

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

## TPDO configuration objects

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

Table 7- 29 TPDO configuration objects - communication parameters

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

| OD index (hex) | Subi ndex (hex) | Object name | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written |
|---|---|---|---|---|---|---|
| | 3 | Inhibit time | p8721.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8721.3 | U8 | --- | r/w |
| | 5 | Event timer | p8721.4 | U16 | 0 | r/w |
| 1802 | | Transmit PDO 3 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |
| | 1 | COB ID used by PDO | p8722.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8722.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8722.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8722.3 | U8 | --- | r/w |
| | 5 | Event timer | p8722.4 | U16 | 0 | r/w |
| 1803 | | Transmit PDO 4 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |
| | 1 | COB ID used by PDO | p8723.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8723.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8723.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8723.3 | U8 | --- | r/w |
| | 5 | Event timer | p8723.4 | U16 | 0 | r/w |
| 1804 | | Transmit PDO 5 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |
| | 1 | COB ID used by PDO | p8724.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8724.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8724.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8724.3 | U8 | --- | r/w |
| | 5 | Event timer | p8724.4 | U16 | 0 | r/w |
| 1805 | | Transmit PDO 6 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |
| | 1 | COB ID used by PDO | p8725.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8725.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8725.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8725.3 | U8 | --- | r/w |
| | 5 | Event timer | p8725.4 | U16 | 0 | r/w |
| 1806 | | Transmit PDO 7 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |
| | 1 | COB ID used by PDO | p8726.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8726.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8726.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8726.3 | U8 | --- | r/w |
| | 5 | Event timer | p8726.4 | U16 | 0 | r/w |
| 1807 | | Transmit PDO 8 communication parameter | | | | |
| | 0 | Largest subindex supported | | U8 | 5 | r |

| OD index (hex) | Subi ndex (hex) | Object name | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written |
|---|---|---|---|---|---|---|
| | 1 | COB ID used by PDO | p8727.0 | U32 | C000 06DF hex | r/w |
| | 2 | Transmission type | p8727.1 | U8 | FE hex | r/w |
| | 3 | Inhibit time | p8727.2 | U16 | 0 | r/w |
| | 4 | Reserved | p8727.3 | U8 | --- | r/w |
| | 5 | Event timer | p8727.4 | U16 | 0 | r/w |

Table 7- 30 TPDO configuration objects - mapping parameters

| OD index (hex) | Subind ex (hex) | Object name | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written |
|---|---|---|---|---|---|---|
| 1A00 | | Transmit PDO 1 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 1 | r/w |
| | 1 | PDO mapping for the first application object to be mapped | p8730.0 | U32 | 6041 hex | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8730.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8730.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8730.3 | U32 | 0 | r/w |
| 1A01 | | Transmit PDO 2 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 2 | r/w |
| | 1 | PDO mapping for the first application object to be mapped | p8731.0 | U32 | 6041 hex | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8731.1 | U32 | 6044 hex | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8731.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8731.3 | U32 | 0 | r/w |
| 1A02 | | Transmit PDO 3 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r/w |
| | 1 | PDO mapping for the first application object to be mapped | p8732.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8732.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8732.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8732.3 | U32 | 0 | r/w |
| 1A03 | | Transmit PDO 4 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r/w |

| OD index (hex) | Subindex (hex) | Object name | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written |
|---|---|---|---|---|---|---|
| | 1 | PDO mapping for the first application object to be mapped | p8733.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8733.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8733.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8733.3 | U32 | 0 | r/w |
| 1A04 | | Transmit PDO 5 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8734.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8734.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8734.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8734.3 | U32 | 0 | r/w |
| 1A05 | | Transmit PDO 6 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r/w |
| | 1 | PDO mapping for the first application object to be mapped | p8735.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8735.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8735.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8735.3 | U32 | 0 | r/w |
| 1A06 | | Transmit PDO 7 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8736.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8736.1 | U32 | 0 | r/w |
| | 3 | PDO mapping for the third application object to be mapped | p8736.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8736.3 | U32 | 0 | r/w |
| 1A07 | | Transmit PDO 8 mapping parameter | | | | |
| | 0 | Number of mapped application objects in PDO | | U8 | 0 | r |
| | 1 | PDO mapping for the first application object to be mapped | p8737.0 | U32 | 0 | r/w |
| | 2 | PDO mapping for the second application object to be mapped | p8737.1 | U32 | 0 | r/w |

| OD index (hex) | Subindex (hex) | Object name | SINAMICS parameters | Data type | Predefined connection set | Can be read/ written |
|---|---|---|---|---|---|---|
| | 3 | PDO mapping for the third application object to be mapped | p8737.2 | U32 | 0 | r/w |
| | 4 | PDO mapping for the fourth application object to be mapped | p8737.3 | U32 | 0 | r/w |

### 7.8.2.2 Free objects

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

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

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

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

### 7.8.2.3 Objects from the CiA 402 drive profile

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

| OD index (hex) | Subindex (hex) | Name of the object | SINAMICS parameters | Transmission | Data type | Default setting | Can be read/ written |
|---|---|---|---|---|---|---|---|
| **Predefinitions** | | | | | | | |
| 67FF | | Single device type | | SDO | U32 | | r |
| **Common entries in the object dictionary** | | | | | | | |
| 6007 | | Abort connection option code | p8641 | SDO | I16 | 3 | r/w |
| 6502 | | Supported drive modes | | SDO | I32 | | r |
| 6504 | | Drive manufacturer | | SDO | String | SIEMENS | r |
| **Device control** | | | | | | | |
| 6040 | | Control word | r8795 | PDO/SDO | U16 | – | r/w |
| 6041 | | Status word | r8784 | PDO/SDO | U16 | – | r |
| 605D | | Halt option code | p8791 | PDO/SDO | I16 | – | r/w |
| 6060 | | Modes of operation | p1300 | SDO | I8 | – | r/w |
| 6061 | | Modes of operation display | p1300 | SDO | I8 | – | r |
| **Factor group** | | | | | | | |
| 6094 | | Velocity encoder factor | | SDO | U8 | - | r |
| | 01 | velocity encoder factor numerator | p8798[1] | SDO | U32 | 1 | r/w |
| | 02 | velocity encoder factor denumerator | p8798[2] | SDO | U32 | 1 | r/w |
| **Profile velocity mode** | | | | | | | |
| 6063 | | Actual position value | r0482 | SDO/PDO | I32 | – | r |
| 6069 | | Velocity sensor actual value | r0061 | SDO/PDO | I32 | – | r |
| 606B | | Velocity demand value | r1170 | SDO/PDO | I32 | – | r |
| 606C | | Velocity actual value<br>Actual velocity | r0063 | SDO/PDO | I32 | – | r |
| 6083 | | Profile acceleration | p1082/p1120 | SDO | I32 | – | r/w |
| 6084 | | Profile deceleration | p1082/p1121 | SDO | I32 | 0 | r/w |
| 6085 | | Quick stop deceleration | p1082/p1135 | SDO | I32 | 0 | r/w |
| 6086 | | Motion profile type | p1115/p1134 | SDO | I32 | 0 | r/w |
| 60FF | | Target velocity<br>Set velocity | p1155[0] 1)<br>p1072 2) | SDO/PDO | I32 | 0 | r/w |

| OD index (hex) | Subindex (hex) | Name of the object | SINAMICS parameters | Transmission | Data type | Default setting | Can be read/ written |
|---|---|---|---|---|---|---|---|
| Profile Torque Mode [3] | | | | | | | |
| 6071 | | Target torque<br>torque setpoint | r8797 | SDO/PDO | I16 | – | r/w |
| 6072 | | Max. torque | p1520 | SDO | 0 | 0 | |
| 6074 | | Torque demand value<br>overall torque setpoint | r0079 | SDO/PDO | I16 | – | r |
| 6077 | | Torque actual value | r0080 | SDO/PDO | I16 | – | r |
| Velocity mode | | | | | | | |
| 6042 | | vl target velocity | r8792 | SDO/PDO | I16 | – | r/w |
| 6043 | | vl velocity demand | r1170 | SDO/PDO | I16 | – | r |
| 6044 | | vl velocity actual value | r0063 | SDO/PDO | I16 | – | r |
| 6046 | 0 | vl velocity min./max. amount | | SDO | U8 | – | r |
| | 1 | vl velocity min. amount | p1080 | SDO | U32 | – | r/w |
| | 2 | vl velocity max. amount | p1082 | SDO | U32 | – | r/w |
| 6048 | 0 | vl velocity acceleration | | SDO | U8 | – | r |
| | 1 | Delta speed | p1082 | SDO | U32 | – | r/w |
| | 2 | Delta time | p1120 | SDO | U16 | – | r/w |

1) Without ramp-function generator

2) With ramp-function generator

3) The converter can process the objects from the Profile Torque Mode. But they cannot be set nor selected in converters.

## 7.8.3 Integrating the converter into CANopen

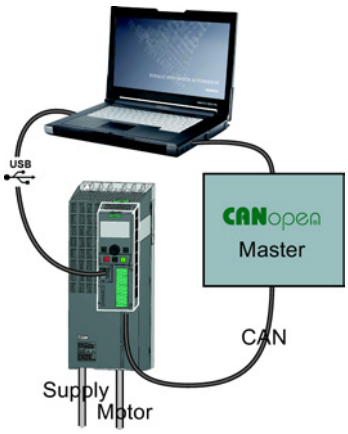
### Commissioning

#### Precondition

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

  See also Basic commissioning with STARTER (Page 85).

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




#### Procedure

Proceed as follows to commission the CANopen interface:

1. Connecting inverter to CAN bus (Page 211)
2. Set the node ID, baud rate and the monitoring of the communication.
   Also see "Setting the baud rate (Page 212)" as well as "Setting the monitoring of the communication (Page 212)"
3. Interconnecting additional process data
   Set p8744 = 2. You can now interconnect additional process data.

   See also "Free PDO mapping (Page 192)"
4. Signal interconnection of the links created in free PDO mapping.

   See also Interconnect objects from the receive and transmit buffers (Page 195).
5. Exiting commissioning
   Select the "Operational" status in the "Network management" tab in the "Control Unit/Communication/CAN" STARTER screen form and exit the commissioning.

You have commissioned the CANopen interface.

More information about configuring the communication is provided in Sections CANopen functions of the converter (Page 179) and Object directories (Page 198).

### 7.8.3.1 Connecting inverter to CAN bus

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

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

For additional information on the SUB-D pin connector and on the bus-terminating resistor, please refer to Section Overview of the interfaces (Page 56).

### 7.8.3.2 Setting the node ID and baud rate

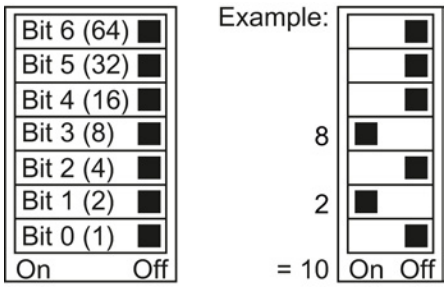
#### Setting the node ID

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

Valid address range: 1 … 127

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

The positions of the address switches are described in Section: Overview of the interfaces (Page 56).




**Procedure**

To change the bus address, proceed as follows:

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

This means that you have changed the bus address.

### 7.8.3.3 Setting the baud rate

#### Setting the data transfer rate

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

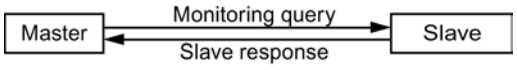
Setting range: 10 kbit/s … 1 Mbit/s. The maximum permissible cable length for1 Mbit/s is 40 m.

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

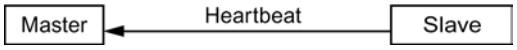
### 7.8.3.4 Setting the monitoring of the communication

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

- Node guarding / life guarding




- Heartbeat




#### Node guarding / life guarding

##### Principle of operation

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

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

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

  ##### Calculate value for lifetime

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

## Heartbeat

### Principle of operation

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

### Setting value for heartbeat

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

## Converter behavior with a bus fault

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

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

**⚠ WARNING**

**Stopping the motor after a bus error**

If the converter does not enter into a fault for a bus fault (p8641 = 0), the motor cannot be stopped via the controller.

For this case, wire an additional OFF command via terminals.

To stop the motor from the controller, you must resolve the bus fault and restart the communication via p8608 = 1.

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

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

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

## Mapping the actual current value (r0068) with TPDO1

**Procedure**

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

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

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

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

## Mapping the torque limit (p1520) with RPDO1

**Procedure**

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

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

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

This means you have transferred the value for the torque limit into the communication.

# Setting functions

# 8

## 8.1 Overview of the converter functions

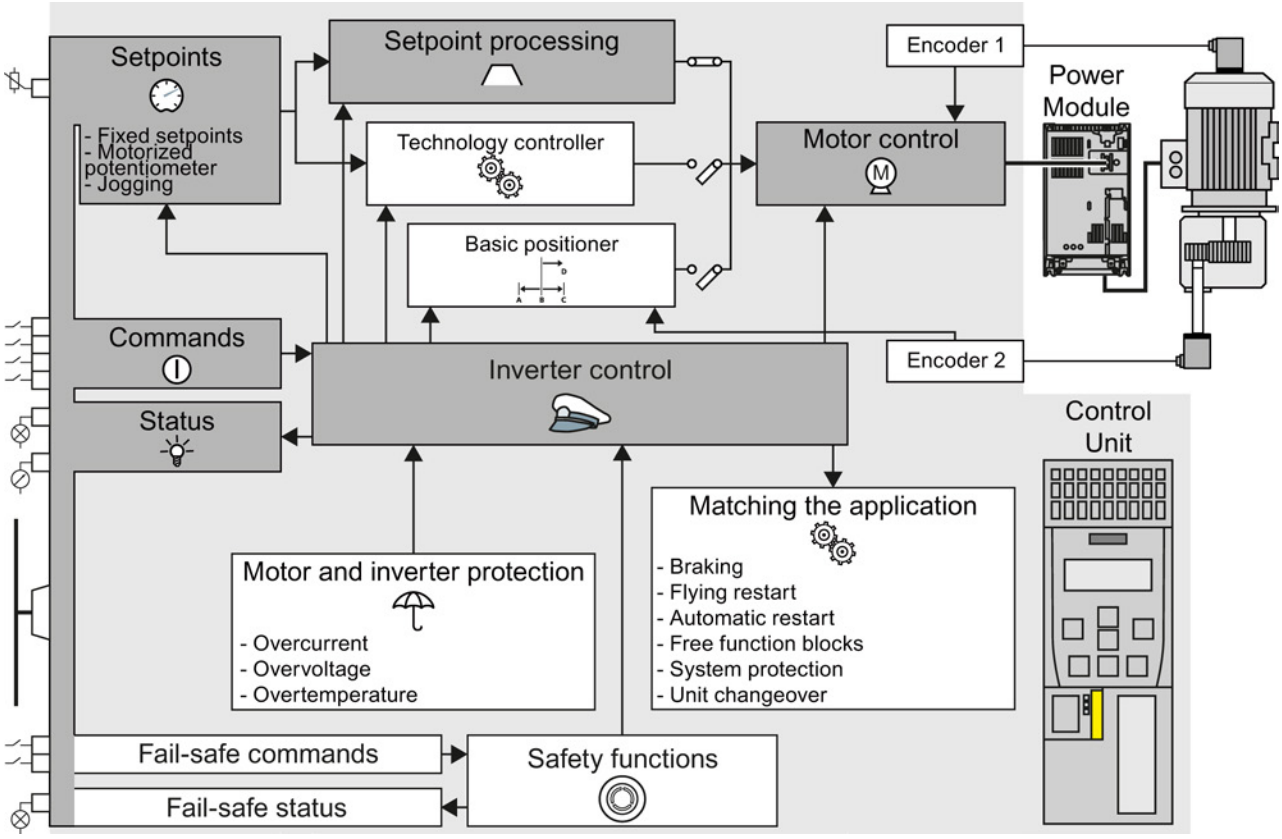
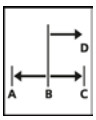



Figure 8-1 Overview of inverter functions

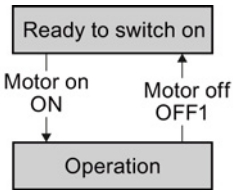
| Functions relevant to all applications | | Functions required in special applications only | |
|---|---|---|---|
| The functions that you require in each application are shown in a dark color in the function overview above.<br>You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings. | | The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above. | |
| | **Inverter control** is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to commands from the higher-level control system.<br>Inverter control (Page 217) | | The **protection functions** prevent damage to the motor, inverter and driven load, e.g. using temperature monitoring or torque monitoring.<br>Protection functions (Page 255) |
| <br> | The **commands** from the higher-level control are sent to the inverter via digital inputs or the fieldbus. The inverter returns its **status signals** to the outputs of the Control Unit or to the fieldbus.<br>Adapt terminal strip (Page 95)<br>Configuring the fieldbus (Page 111) | | Functions **suitable for the application** 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.<br>Application-specific functions (Page 260) |
| | You must define a **setpoint** , which defines the motor speed, for example.<br>Setpoints (Page 229) | | The **safety functions** fulfill increased requirements regarding the functional safety of the drive.<br>The basic functions safely switch off the drive torque.<br>Safe Torque Off (STO) safety function (Page 302) |
| | The **setpoint calculation** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value.<br>Setpoint calculation (Page 235) | | The extended safety functions monitor the drive speed. You require a license to use the extended functions, also refer to Section: Activating licensed functions (Page 413).<br>The extended safety functions are described in the "Safety Integrated Function Manual", also refer to Section: Manuals for your converter (Page 461). |
| | The **motor closed-loop control** ensures that the motor follows the speed setpoint. You can select either closed-loop speed control or U/f control.<br>Motor control (Page 242) |  | The **basic positioner** traverses an axis with position control to a target position.<br>You require a license to use the basic positioner, also refer to Section: Activating licensed functions (Page 413).<br>The basic positioner is described in the "Function Manual, Basic Positioner", also see Section: Manuals for your converter (Page 461). |

# 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.
- The inverter brakes the motor after the OFF1 command. 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.

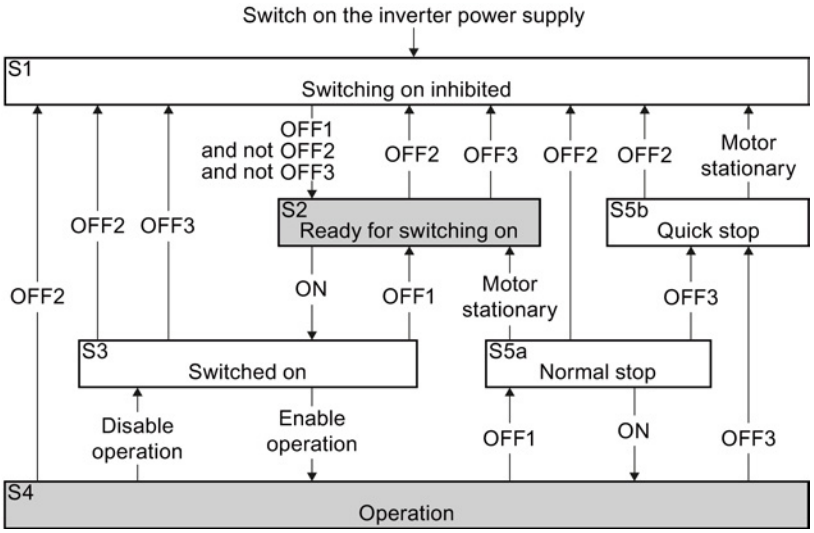



Figure 8-2 Internal sequence control of the inverter when the motor is switched on and off

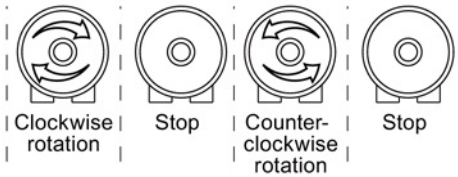
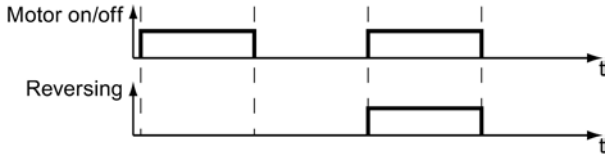
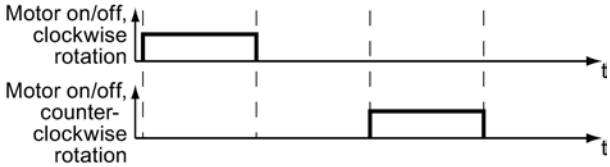
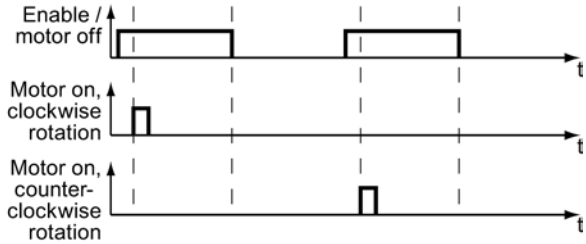
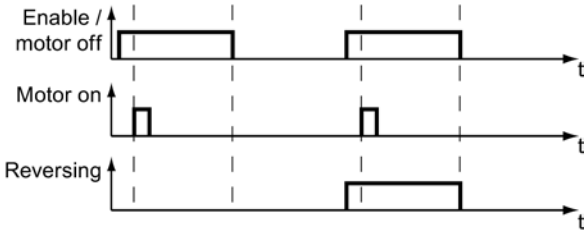
The abbreviations S1 … S5b to identify the inverter states are defined in the PROFIdrive profile.

| Inverter status | Explanation |
|---|---|
| S1 | In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions:<br>• ON was active when switching on the inverter.<br>Exception: When the automatic start function is active, ON must be active after switching on the power supply.<br>• OFF2 or OFF3 is selected. |
| S2 | This state is required to switch on the motor. |
| S3 | The inverter waits for the operating enable.<br>If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit.<br>If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting. |
| S4 | The motor is switched on. |
| S5a | The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator. |
| S5b | The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time. |

## 8.2.2 Inverter control using digital inputs

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

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

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

### 8.2.3 Two-wire control: method 1

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

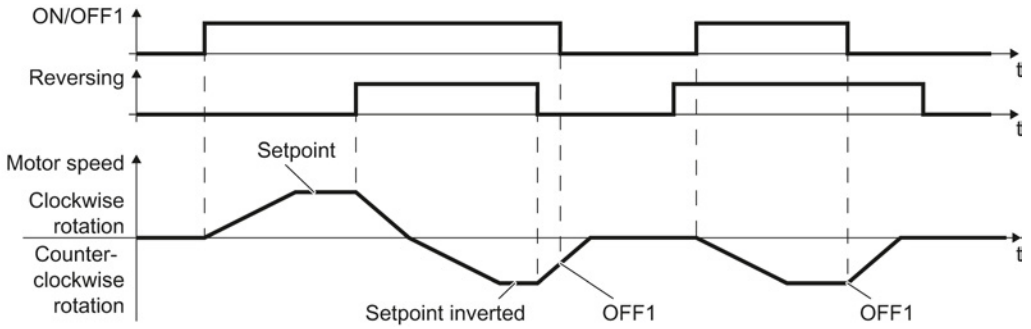



Figure 8-3 Two-wire control, method 1

Table 8- 2 Function table

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

| Parameter | Description | | |
|---|---|---|---|
| p0015 = 12 | **Macro drive unit** (factory setting for inverters without PROFIBUS interface) | | |
| | Controlling the motor using the digital inputs of the inverter: | DI 0 | DI 1 |
| | | ON/OFF1 | Reversing |
| **Advanced setting**<br>Interconnecting control commands with digital inputs of your choice (DI x). | | | |
| p0840[0 … n] = 722.x | **BI: ON/OFF1** (ON/OFF1) | | |
| p1113[0 … n] = 722.x | **BI: Setpoint inversion** (reversing) | | |
| **Example** | | | |
| p0840 = 722.3 | DI 3: ON/OFF1<br>Also see section Digital inputs (Page 96). | | |

## 8.2.4 Two-wire control, method 2

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

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

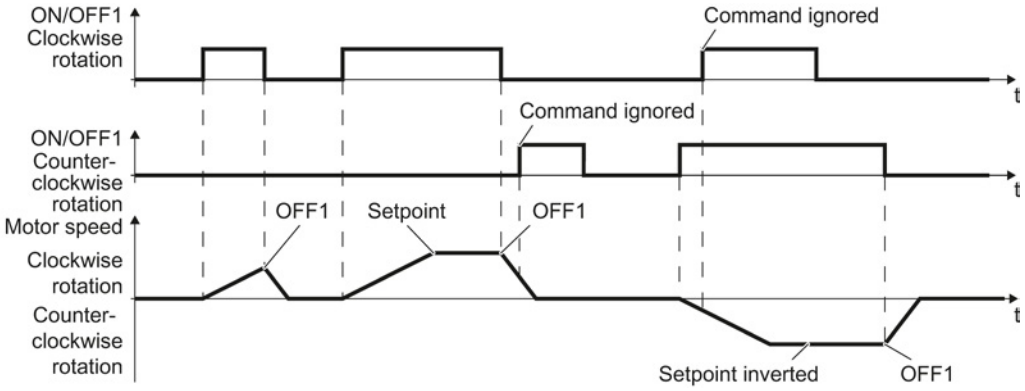



Figure 8-4 Two-wire control, method 2

Table 8- 3 Function table

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

| Parameter | Description | | |
|---|---|---|---|
| p0015 = 17 | **Macro drive unit** | | |
| | Controlling the motor using the digital inputs of the inverter: | DI 0 | DI 1 |
| | | ON/OFF1 clockwise rotation | ON/OFF1 counter-clockwise rotation |
| **Advanced setting**<br>Interconnecting control commands with digital inputs of your choice (DI x). | | | |
| p3330[0 … n] = 722.x | **BI: 2-3-WIRE control command 1** (ON/OFF1 clockwise rotation) | | |
| p3331[0 … n] = 722.x | **BI: 2-3-WIRE control command 2** (ON/OFF1 counter-clockwise rotation) | | |
| **Example** | | | |
| p3331 = 722.0 | DI 0: ON/OFF1 counter-clockwise rotation<br>Also see section Digital inputs (Page 96). | | |

## 8.2.5 Two-wire control, method 3

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

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

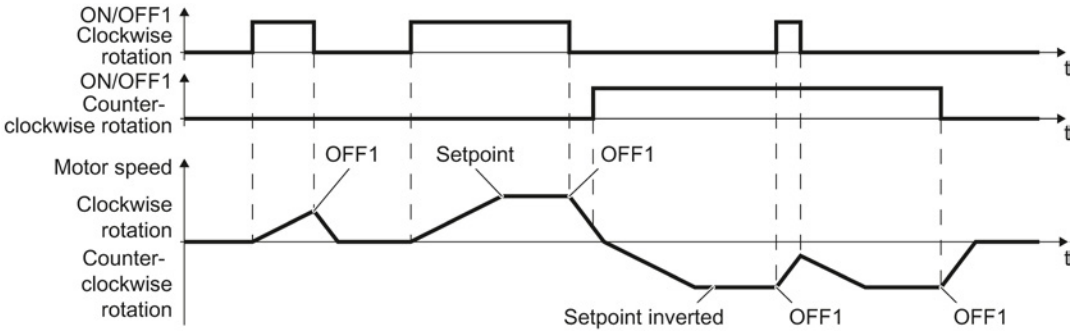



Figure 8-5 Two-wire control, method 3

Table 8- 4 Function table

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

| Parameter | Description | | |
|---|---|---|---|
| p0015 = 18 | **Macro drive unit** | | |
| | Controlling the motor using the digital inputs of the inverter: | DI 0 | DI 1 |
| | | ON/OFF1 clockwise rotation | ON/OFF1 counter-clockwise rotation |
| **Advanced setting**<br>Interconnecting control commands with digital inputs of your choice (DI x). | | | |
| p3330[0 … n] = 722.x | **BI: 2-3-WIRE control command 1** (ON/OFF1 clockwise rotation) | | |
| p3331[0 … n] = 722.x | **BI: 2-3-WIRE control command 2** (ON/OFF1 counter-clockwise rotation) | | |
| **Example** | | | |
| p3331[0 … n] = 722.2 | DI 2: ON/OFF1 counter-clockwise rotation<br>Also see section Digital inputs (Page 96). | | |

## 8.2.6 Three-wire control, method 1

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

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

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

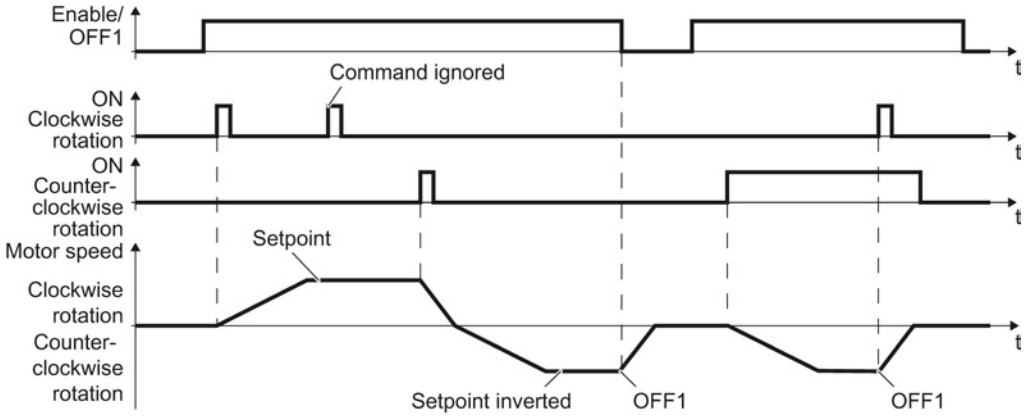



Figure 8-6 Three-wire control, method 1

Table 8- 5 Function table

| Enable / OFF1 | ON clockwise rotation | ON 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**<br>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.<br>Also see section Digital inputs (Page 96). | | | |

## 8.2.7 Three-wire control, method 2

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

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

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

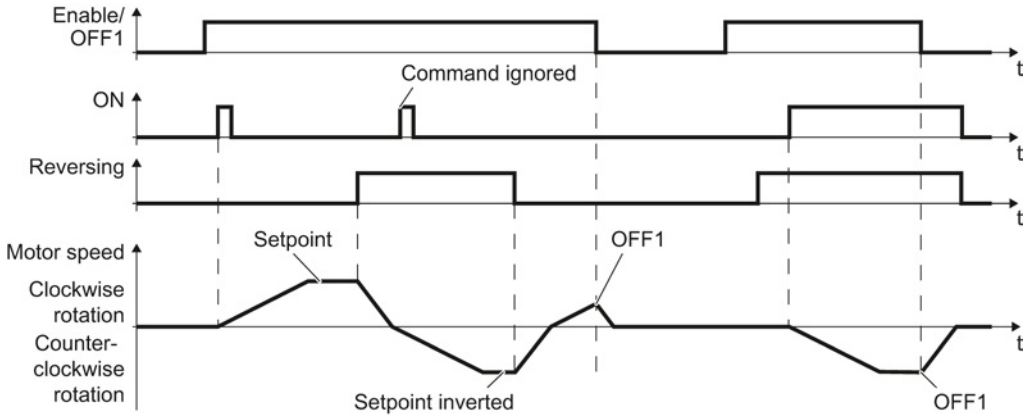



Figure 8-7 Three-wire control, method 2

Table 8- 6 Function table

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

| Parameter | Description | | | |
|---|---|---|---|---|
| p0015 = 20 | **Macro drive unit** | | | |
| | Controlling the motor using the digital inputs of the inverter: | DI 0 | DI 1 | DI 2 |
| | | Enable / OFF1 | ON | Reversing |
| **Advanced setting**<br>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) | | | |
| **Example** | | | | |
| p3331 = 722.0 | DI 0: ON<br>Also see section Digital inputs (Page 96). | | | |

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

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

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

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

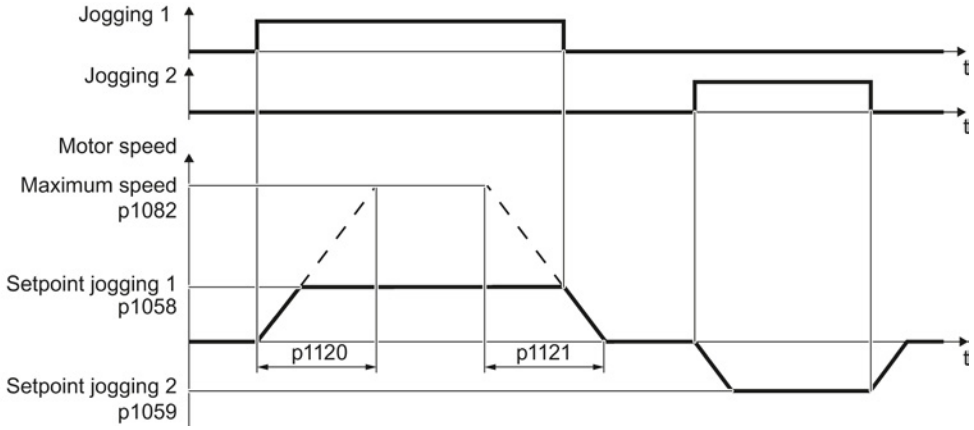
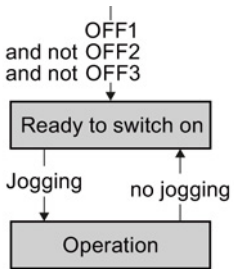



Figure 8-8 Behavior of the motor when "jogging"

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



### Jog settings

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

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

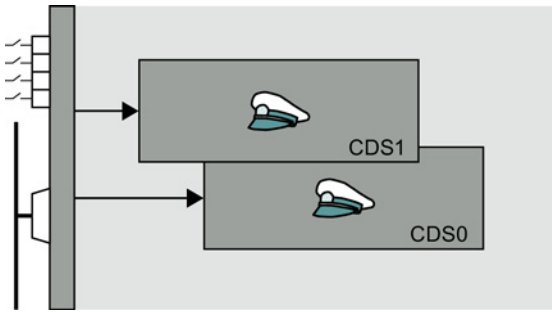
In several applications, the inverter must be able to be operated from different, higher-level control systems.

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

### Command data set (CDS)

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

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



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

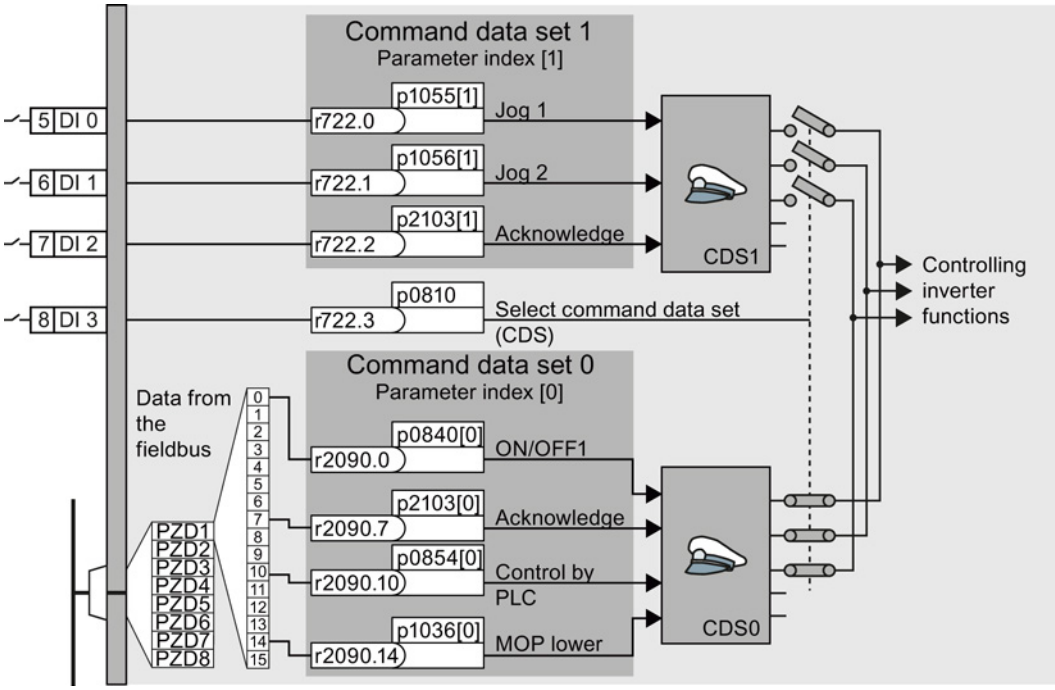



Figure 8-9 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

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

**Note**

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

## Advanced settings

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

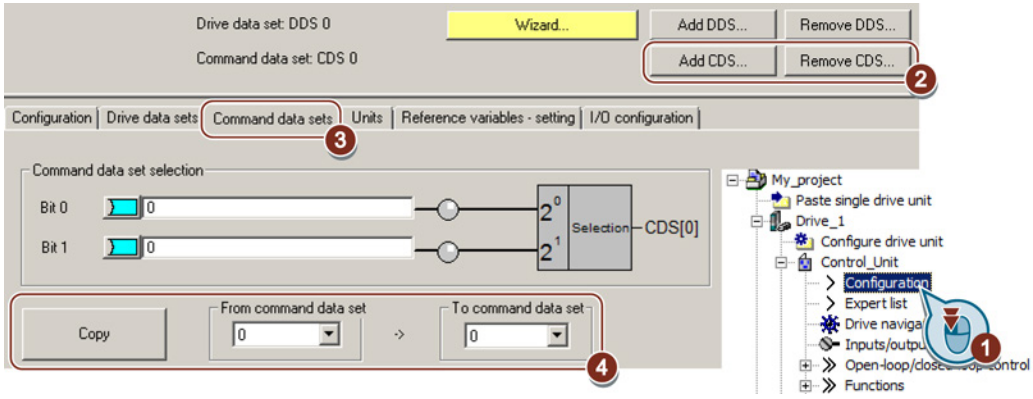



Figure 8-10 Editing command data sets in STARTER

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

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

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

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

# 8.3 Setpoints

## 8.3.1 Overview

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

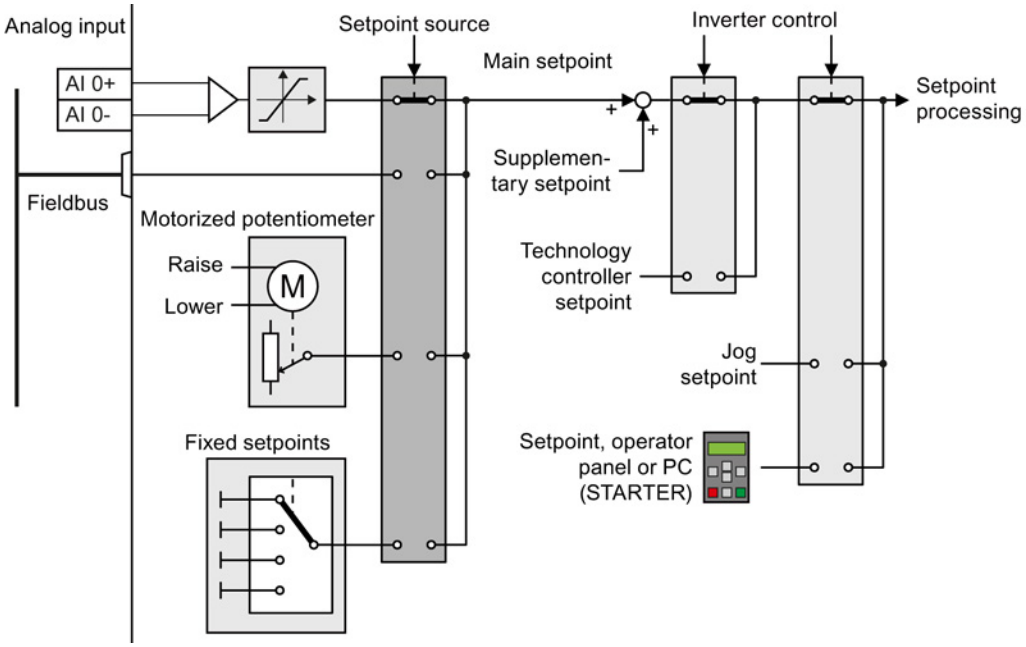



Figure 8-11 Setpoint sources for the inverter

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

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

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

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

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

## 8.3.2 Analog input as setpoint source

### Interconnecting an analog input

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

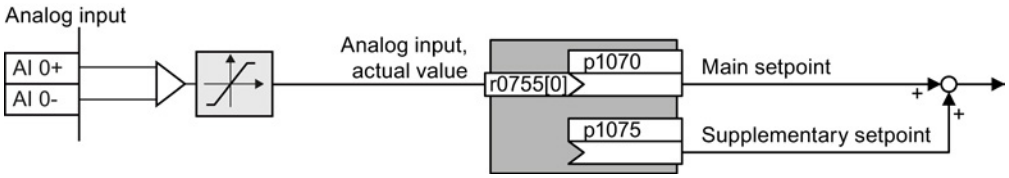



Figure 8-12 Example: Analog input 0 as setpoint source

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

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

You must adapt the analog input to the connected signal, e.g. ± 10 V or 4 … 20 mA. You will find additional information in the section: Analog inputs (Page 103).

## 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 111).

### Interconnecting the fieldbus with the main setpoint

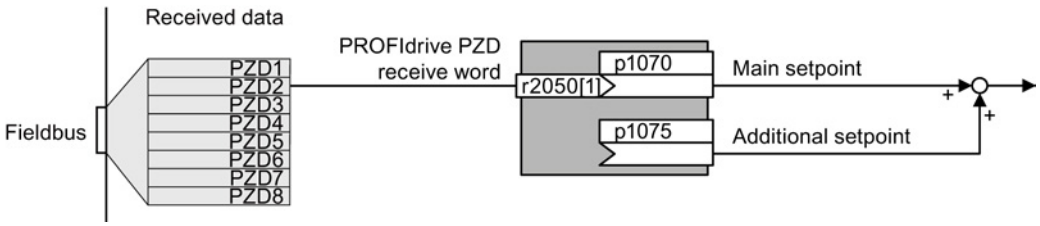



Figure 8-13 Fieldbus as setpoint source

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

Table 8- 8 Setting the fieldbus as setpoint source

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

## 8.3.4 Motorized potentiometer as setpoint source

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

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

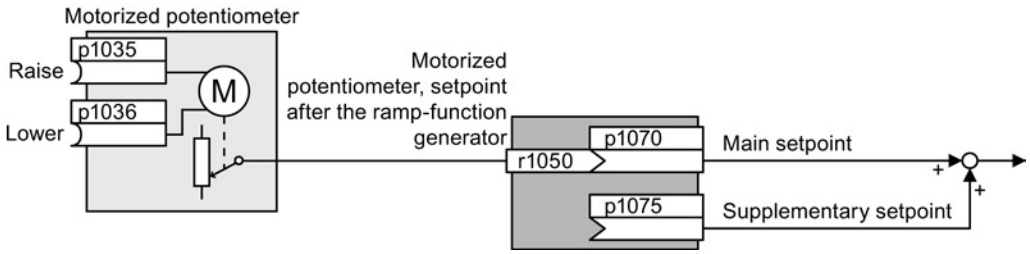



Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 9 Basic setup of motorized potentiometer

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

Table 8- 10 Setting the MOP as setpoint source

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

## Adapting the behavior of the motorized potentiometer

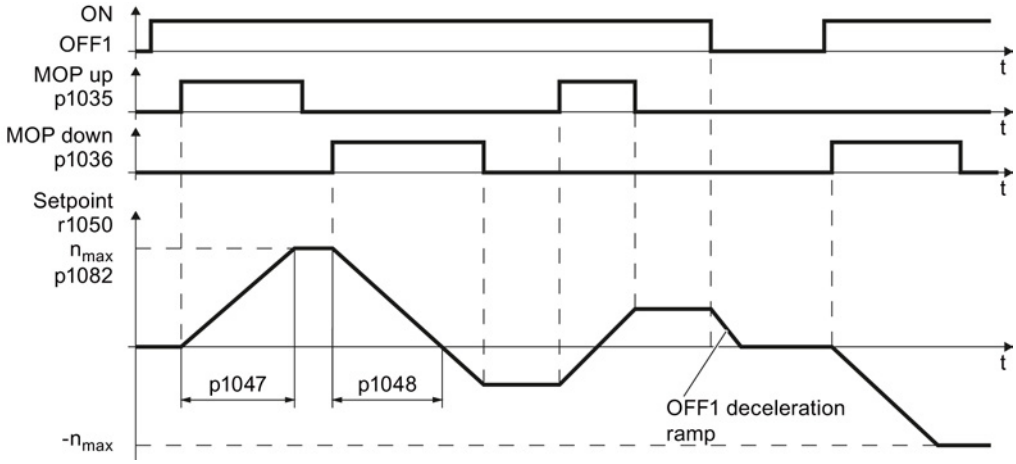



Figure 8-15 Function chart of motorized potentiometer

Table 8- 11 Extended setup of motorized potentiometer

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

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

## 8.3.5 Fixed speed as setpoint source

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

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

### Interconnecting the fixed speeds with a main setpoint

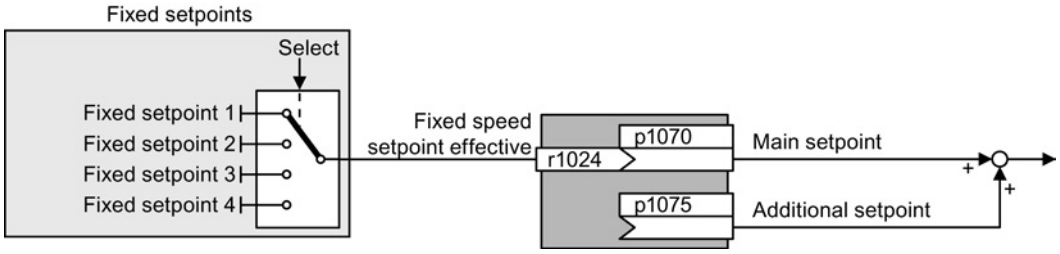



Figure 8-16 Fixed speeds as setpoint source

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

| Parameter | Remark |
|---|---|
| p1070 = 1024 | **Main setpoint**<br>Interconnecting the main setpoint with fixed speeds. |
| p1075 = 1024 | **Additional setpoint**<br>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.

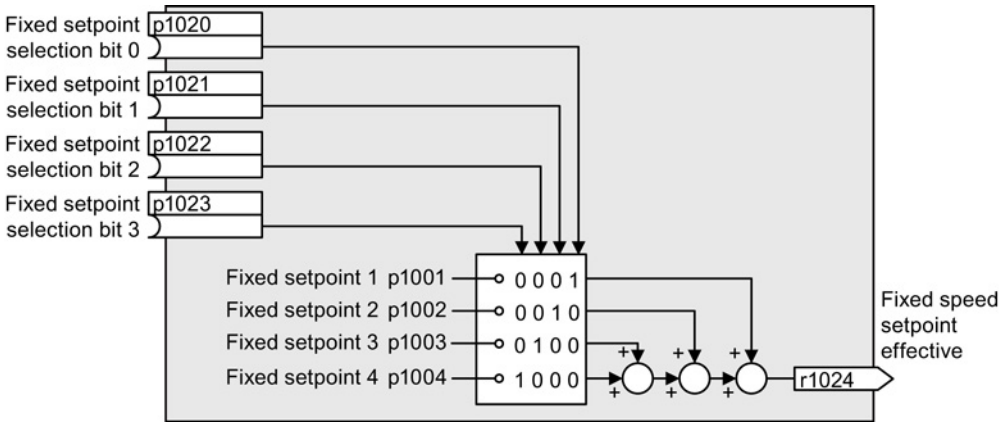



Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

## 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- 13 Settings for the example

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

Table 8- 14 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.

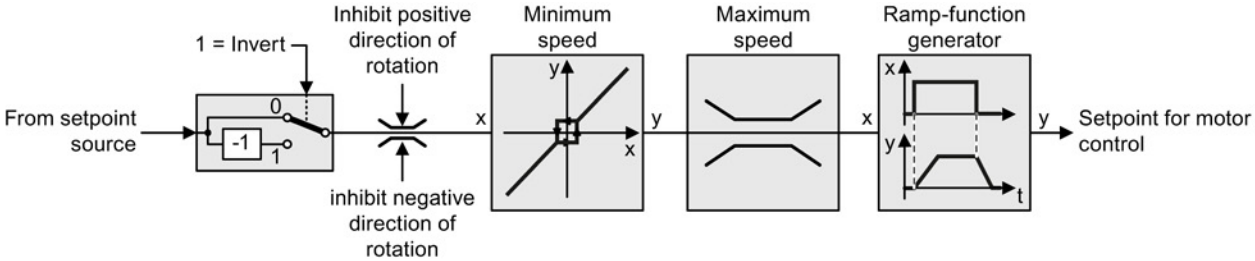


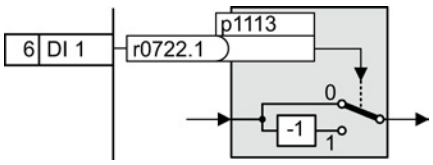

Figure 8-18 Setpoint processing in the inverter

## 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- 15 Examples of settings to invert the setpoint

| Parameter | Remark |
|---|---|
| p1113 = 722.1 | **Setpoint inversion**<br>Digital input 1 = 0: Setpoint remains unchanged.<br>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

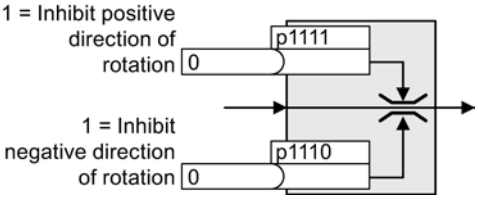
In the factory setting of the inverter, both motor directions of rotation are enabled.

### Procedure

1
2

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- 16 Examples of settings to inhibit the direction of rotation

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

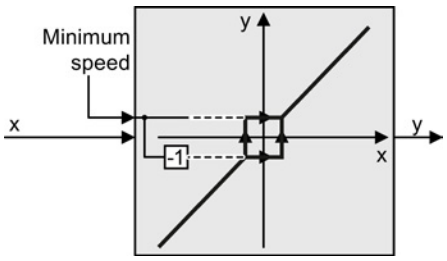



Table 8- 17 Setting the minimum speed

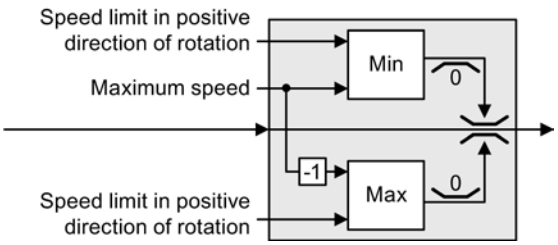
| Parameter | Description |
|---|---|
| p1080 | Minimum speed |

## 8.4.5 Maximum speed

### Function

The maximum speed limits the speed setpoint range for both directions of rotation.

The inverter generates a message (fault or alarm) when the maximum speed is exceeded.




If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 8- 18 Parameters for minimum and maximum speed

| Parameter | Description |
|---|---|
| p1082 | **Maximum speed** (factory setting: 1500 rpm) |
| p1083 | **Speed limit, positive direction of rotation** (factory setting: 210,000 rpm) |
| p1086 | **Speed limit, negative direction of rotation** (factory setting: -210,000 rpm) |

## 8.4.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

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

- Extended ramp-function generator

  The extended ramp-function generator limits acceleration and jerk.

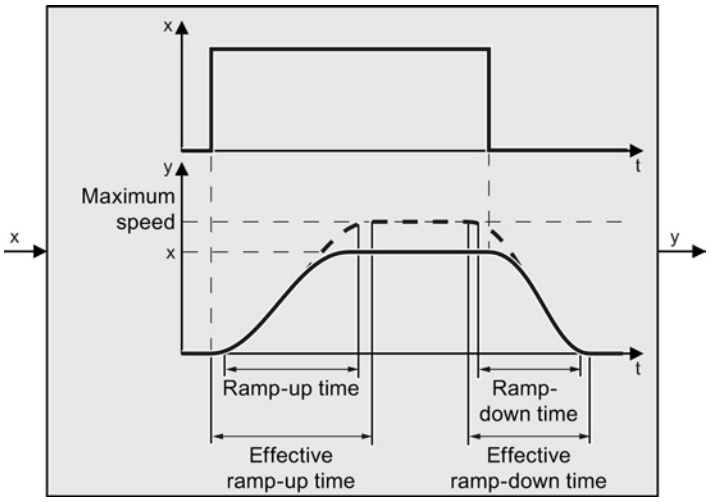
- Basic ramp-function generator

  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).

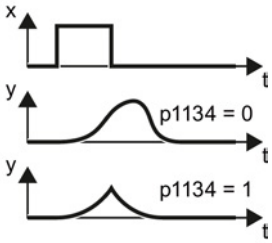
Initial and final rounding permit smooth, jerk-free acceleration and braking.




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

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

Table 8- 19 Additional parameters to set the extended ramp-function generator

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

You can find more information in function diagram 3070 and in the parameter list of the List Manual.

## Setting the extended ramp-function generator

### Procedure

Proceed as follows to set the extended ramp-function generator:

1. Enter the highest possible speed setpoint.
2. Switch on the motor.
3. Evaluate your drive response.
   - If the motor accelerates too slowly, then reduce the ramp-up time.

     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
   - If the motor accelerates too fast, then extend the ramp-up time.
   - Increase the initial rounding if the acceleration is jerky.
   - We recommend that you set the final rounding to the same value as the initial rounding.
4. Switch off the motor.
5. Evaluate your drive response.
   - If the motor decelerates too slowly, then reduce the ramp-down time.

     The minimum ramp-down time that makes sense depends on your particular application. Depending on the Power Module used, for an excessively short ramp-down time, the inverter either reaches the motor current, or the DC link voltage in the inverter becomes too high. Depending on the inverter setting, the real braking time exceeds the set ramp-down time, or the inverter goes into a fault condition when braking.
   - Extend the ramp-down time if the motor is braked too quickly or the inverter goes into a fault condition when braking.
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.

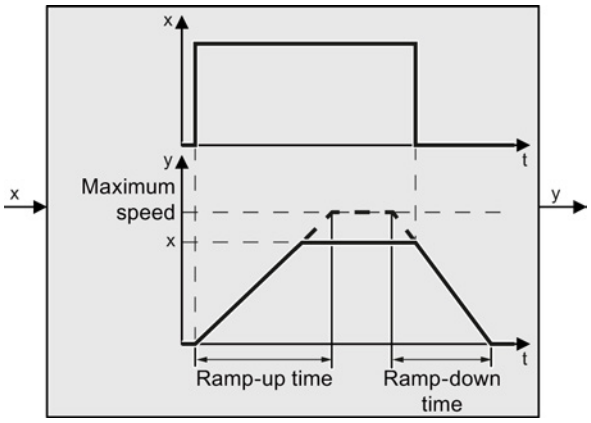



Table 8- 20 Parameters for setting the ramp-function generator

| Parameter | Description |
|---|---|
| p1115 = 0 | **Ramp-function generator selection** (factory setting: 1)<br>Select ramp-function generator:<br>0: Basic ramp-function generator<br>1: Extended ramp-function generator |
| p1120 | **Ramp-function generator, ramp-up time** (factory setting: 10 s)<br>Accelerating time in seconds from zero speed up to the maximum speed p1082 |
| p1121 | **Ramp-function generator, ramp-down time** (factory setting: 10 s)<br>Braking time in seconds from the maximum speed down to standstill |
| p1135 | **OFF3 ramp-down time** (factory setting: 0 s)<br>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

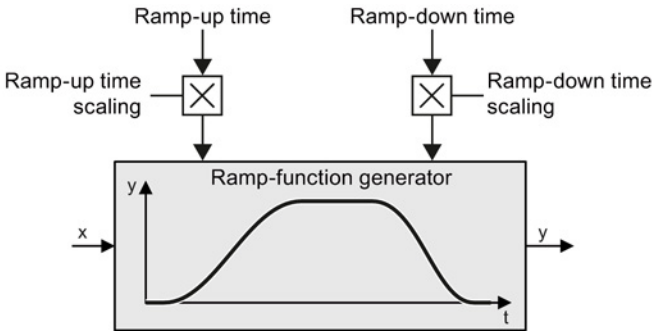


Table 8- 21 Parameters for setting the scaling

| Parameter | Description |
|---|---|
| p1138 | **Up ramp scaling** (factory setting: 1)<br>Signal source for scaling the up ramp. |
| p1139 | **Down ramp scaling** (factory setting: 1)<br>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.

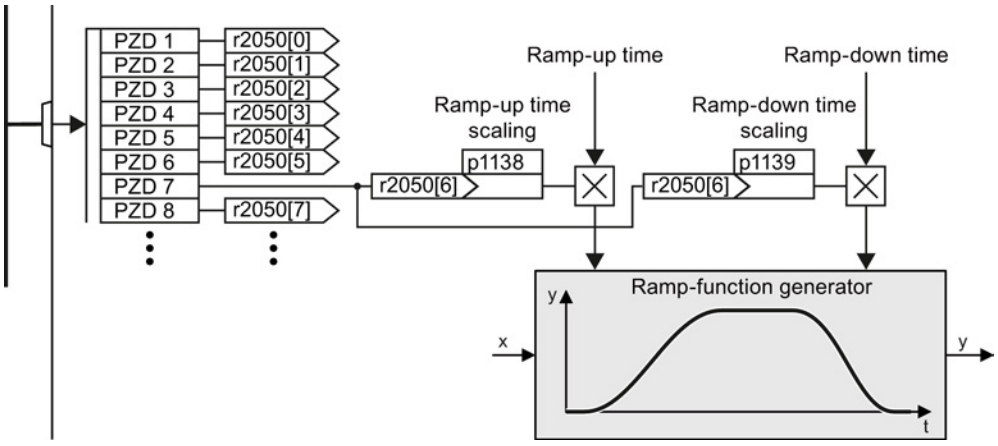



Figure 8-19 Example for changing the ramp-function generator times in operation

### 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: Select telegram – procedure (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 81)

## 8.5.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: $f_{max}$ = p1082 * number of pole pairs / 60).

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

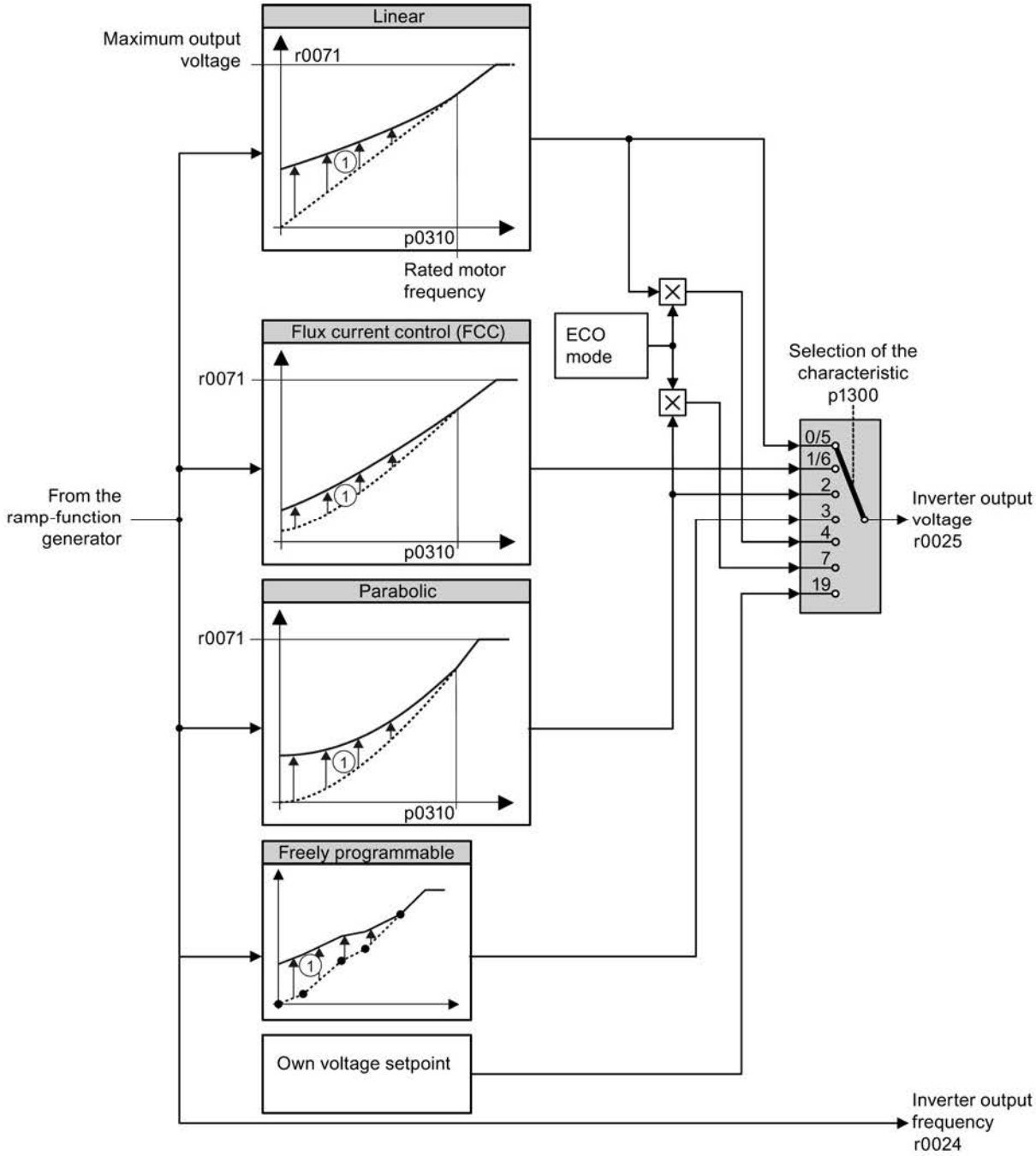
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

### 8.5.1.1 Characteristics of U/f control

The inverter has several U/f characteristics. Based on the characteristic, as the frequency increases, the inverter increases the voltage at the motor.




① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective for frequencies < rated frequency

Figure 8-20 U/f characteristics of the inverter

The inverter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum inverter output voltage.

If the inverter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the motor voltage at the rated motor frequency also depends on the following variables:

- Ratio between the inverter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible motor voltage as a function of the input voltage is provided in the technical data, also see Section Technical data (Page 385).

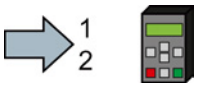
### 8.5.1.2 Selecting the U/f characteristic

**Procedure**

Proceed as follows to select a U/f characteristic using STARTER:

1. Go online.
2. Select the U/f characteristic curve in one of the screen forms "speed controller" or "U/f control".

You have selected a U/f characteristic.



Proceed as follows to select a U/f characteristic using BOP-2:

1. Go into the menu "PARAMS".
2. As parameter filter, select "EXPERT".
3. Set p1300 to the appropriate value.

You have selected a U/f characteristic.

Table 8- 22 Linear and parabolic characteristics

| Requirement | Application examples | Remark | Characteristic | Parameter |
|---|---|---|---|---|
| The required torque is independent of the speed | Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers | - | Linear | p1300 = 0 |
| | | The inverter equalizes the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW.<br>Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning. | Linear with Flux Current Control (FCC) | p1300 = 1 |
| The required torque increases with the speed | Centrifugal pumps, radial fans, axial fans | Lower losses in the motor and inverter than for a linear characteristic. | Parabolic | p1300 = 2 |

Table 8- 23 Characteristics for special applications

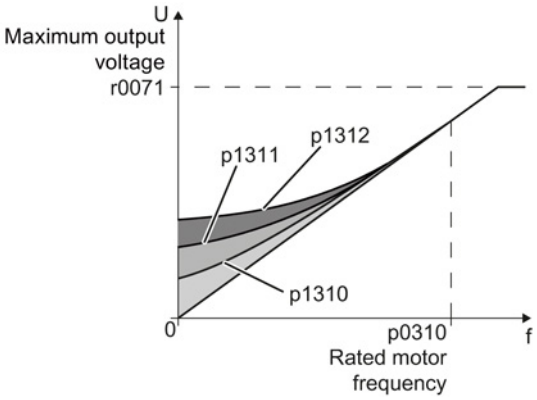
| Requirement | Application examples | Remark | Characteristic | Parameter |
|---|---|---|---|---|
| Applications with a low dynamic response and constant speed | Centrifugal pumps, radial fans, axial fans | The ECO mode results in additional energy saving when compared to the parabolic characteristic.<br>If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage. | ECO mode | p1300 = 4<br>or<br>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<br>or<br>p1300 = 6 |
| Freely adjustable U/f characteristic | - | - | Adjustable characteristic | p1300 = 3 |
| U/f characteristic with independent voltage setpoint | - | The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user. | Independent voltage setpoint | p1300 = 19 |

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

### 8.5.1.3 Optimizing with a high break loose torque and brief overload

#### Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.




**Procedure**

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

| Parameter | Description |
|---|---|
| p1310 | **Permanent voltage boost** (factory setting 50%)<br>Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor. |
| p1311 | **Voltage boost when accelerating** (factory setting 0%)<br>Provides additional torque when the motor accelerates. |
| p1312 | **Voltage boost when starting** (factory setting 0%)<br>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

### 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".

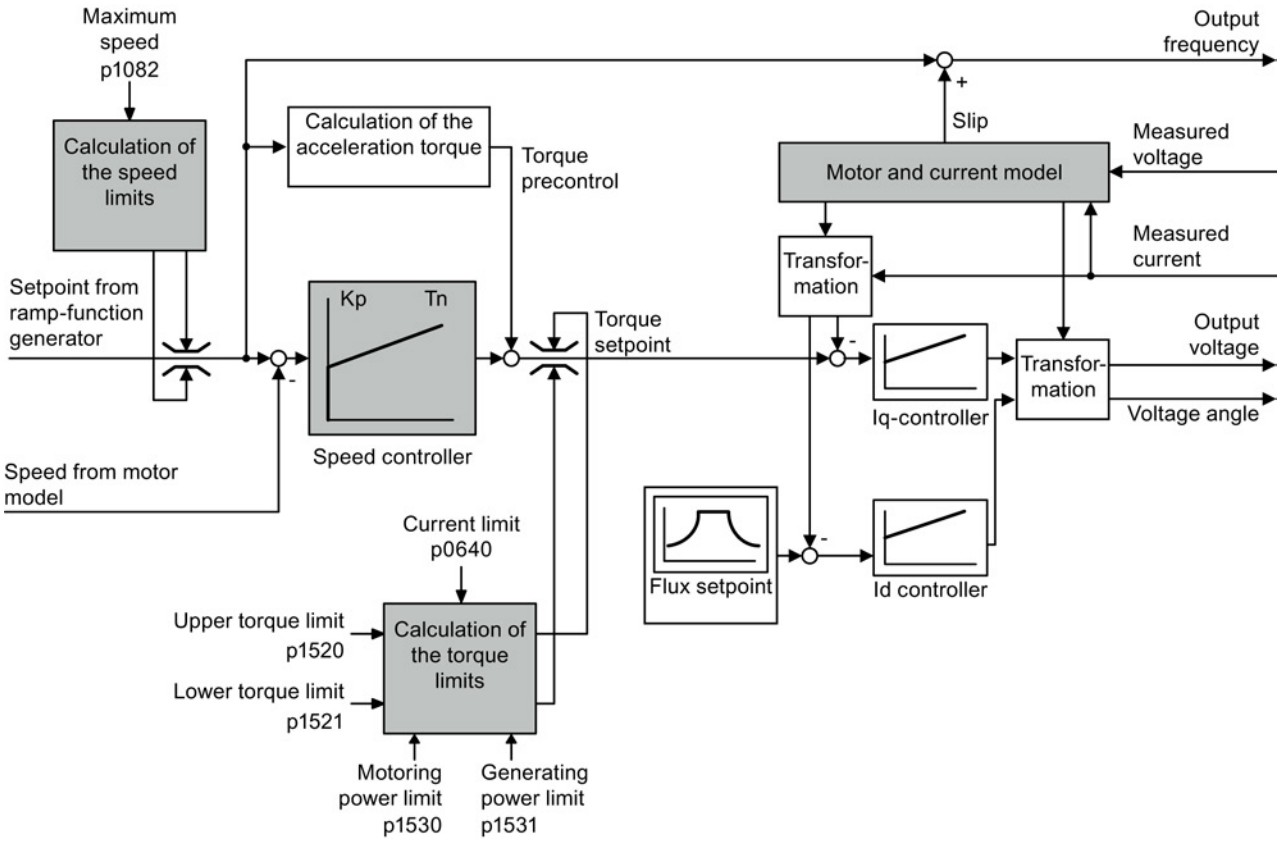



Figure 8-21 Simplified function diagram of sensorless vector control

You can find additional information on speed control in the function diagrams 6020 ff. of the List Manual.

### Vector control with encoder

Instead of the calculated speed from the motor model, the vector control with encoder evaluates an encoder.

### 8.5.2.1 Checking the encoder signal

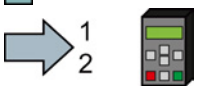
If you use an encoder to measure the speed, you should check the encoder signal before the encoder feedback is active.

**Procedure**

Proceed as follows to check the encoder signal using STARTER:

1. Go online.
2. Select closed-loop speed control without encoder in the "Speed controller" screen form.
3. Switch-on the motor with an average speed.
4. Compare parameters r0061 (speed encoder signal in rpm) and r0021 (calculated speed in rpm) regarding the sign and absolute value.
5. If the signs do not match, invert the speed encoder signal: Set p0410 = 1.
6. If the absolute values of the two values do not match, check the setting of p0408 and the encoder wiring.

You have ensured that the scaling and polarity of the encoder signal are correct.



Proceed as follows to check the encoder signal using the operator panel:

1. Set the control mode "encoderess vector control": p1300 = 20.
2. Switch-on the motor with an average speed.
3. Compare parameters r0061 (speed encoder signal in rpm) and r0021 (calculated speed in rpm) regarding the sign and absolute value.
4. If the signs do not match, invert the speed encoder signal: Set p0410 = 1.
5. If the absolute values of the two values do not match, check the setting of p0408 and the encoder wiring.

You have ensured that the scaling and polarity of the encoder signal are correct.

### 8.5.2.2 Select motor control

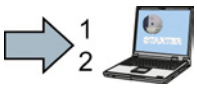
#### Speed control is already preset

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

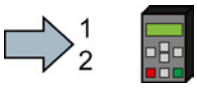


**Procedure**

Proceed as follows to select encoderless vector control using STARTER:

1. Go online
2. Select closed-loop speed control without encoder in the "Speed controller" screen form.

You have selected encoderless vector control.



Proceed as follows to select encoderless vector control using BOP-2:

1. In the "Parameters" menu, go to p1300
2. Set p1300 = 20.

You have selected encoderless vector control.

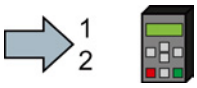
## Select vector control with encoder

**Procedure**

Proceed as follows to set speed control with encoder as control mode using STARTER:

1. Go online.
2. Select speed control with encoder in the "Speed controller" or "V/f control" mask.

You have selected speed control with encoder using STARTER.



**Procedure**

Proceed as follows to set speed control with encoder as control mode using an operator panel:

1. In the "Parameters" menu, select p1300.
2. Set p1300 = 21.

You have selected speed control with encoder using an operator panel.

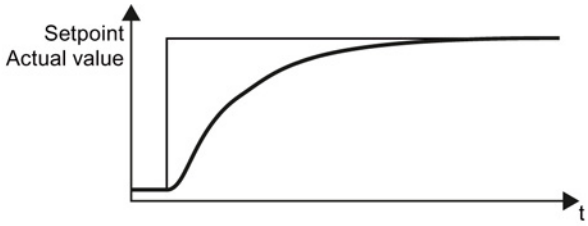
### 8.5.2.3 Optimizing the speed controller

#### Optimum control response - post optimization not required

You do not have to manually adapt the speed controller, if, after the speed controller self optimization, the motor manifests the following acceleration response:

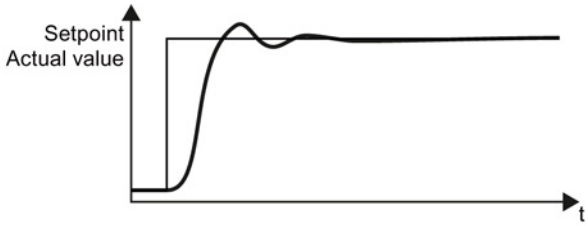
**Optimum control response for applications that do not permit any overshoot.**

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




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

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).




#### Control optimization required

In some cases, the self optimization result is not satisfactory, or the inverter cancels the self-optimization routine with a fault. Further, self optimization is not permissible in plants and systems in which the motor cannot freely rotate.

In these cases you must manually optimize the speed controller:

The examples listed below show you which variables you can use to adapt the control response.

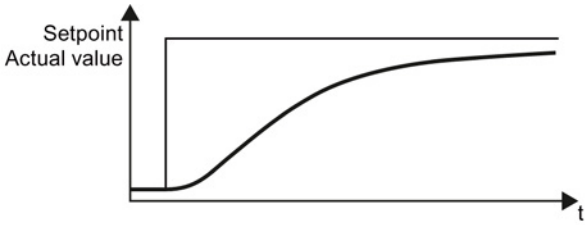
The basic procedure is described in the following paragraph for STARTER and BOP-2.

Depending on whether the control operates with or without encoder, different parameters define the controller response.

| | $K_p$ | $T_n$ |
|---|---|---|
| Encoderless speed control | p1470 | p1472 |
| Speed control with encoder | p1460 | p1462 |

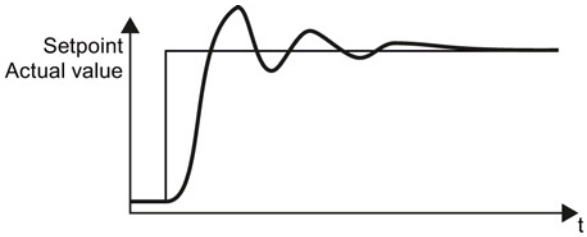
**The actual value only slowly approaches the setpoint.**

- 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 $T_N$.



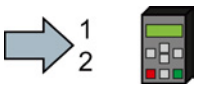

## Optimizing the speed control with BOP-2 or STARTER

**Procedure**

To manually optimize the speed controller with STARTER, proceed as follows:

1. Go online, and in the "Ramp-function generator" screen form, set the times = 0.
2. Set pre-control = 0 in the "Speed controller" screen form.
3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.
4. Optimize the controller in the "Speed controller" screen form by adjusting controller parameters $K_P$ and $T_N$.
5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.
6. Set the pre-control of the speed controller back to 100%.

You have optimized the speed controller using STARTER.



To manually optimize the speed controller with BOP-2, proceed as follows:

1. Set the ramp-up and ramp-down times of the ramp-function generator p1120 = 0 and p1121 = 0.
2. Set the pre-control of the speed controller p1496 = 0.
3. Enter a setpoint step and observe the associated actual value.
4. Optimize the speed controller by changing controller parameters $K_P$ and $T_N$ until the drive runs optimally.
5. Set the ramp-up and ramp-down times of the ramp-function generator p1120 and p1121 back to their original value.
6. Set the pre-control of the speed controller p1496 = 100%.

You have optimized the speed controller using BOP-2.

### 8.5.2.4 Advanced settings

#### $K_p$- and $T_n$ adaptation

The $K_p$- and $T_n$ adaptation suppresses possible speed control oscillations. During basic commissioning, the inverter optimizes its control using the "rotating measurement" function. If you have performed the rotating measurement, then the $K_p$- and $T_n$adaptation has been set.

You can find additional information in the List Manual, function block diagram 6050.

#### Droop

The droop function reduces the speed setpoint as a function of the torque setpoint.

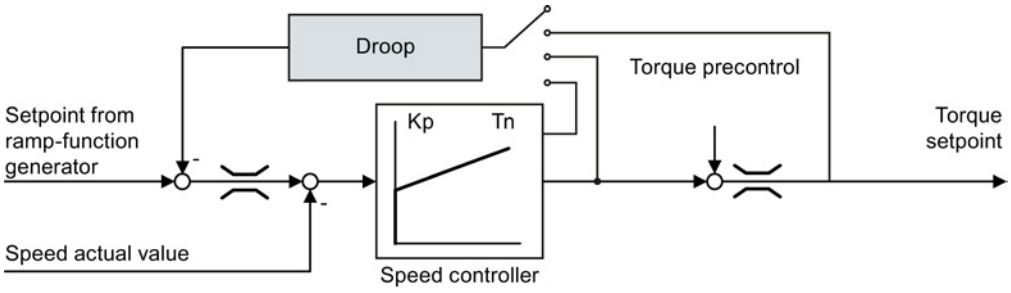



Figure 8-22 Effect of droop in the speed control

The droop function ensures even torque distribution between two or more mechanically coupled drives. Load distribution using the droop function also masters soft mechanical couplings or a permanent speed difference as a result of slip.

#### Preconditions for using the droop function

- All coupled drives must be operated in vector control and closed-loop speed control, with or without an encoder.
- Only a one common ramp-function generator may be used for mechanically coupled drives.

| Par. | Explanation |
|---|---|
| r1482 | **Speed controller I torque output** |
| p1488 | **Droop input source** (factory setting: 0)<br>0: Droop feedback not connected<br>1: Droop from the torque setpoint<br>2: Droop from the speed control output<br>3: Droop from the integral output, speed controller |
| p1489 | **Droop feedback scaling** (factory setting: 0.05)<br>A value of 0.05 means: At the rated motor torque, the inverter reduces the speed by 5% of the rated motor speed. |
| r1490 | **Droop feedback speed reduction** |
| p1492 | **Droop feedback enable** (factory setting: 0) |

You can find additional information in the List Manual, function block diagram 6030.

## 8.5.3 Torque control

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

### Typical applications for torque control

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

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

### Commissioning the torque control

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

See also Section: Basic commissioning with STARTER (Page 85).

Table 8- 24 The most important torque control parameters

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

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

# 8.6 Protection functions

The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter as well as the motor. Further, the frequency inverter protects itself against an excessively high DC link voltage when the motor is regenerating.

## 8.6.1 Inverter temperature monitoring

The inverter protects itself against overtemperature with different monitoring functions:

- $I^2t$ monitoring (alarm A07805, fault F30005)
  The $I^2t$ monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a %. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
- Monitoring the chip temperature of the power unit (alarm A05006 - fault F30024)
  The inverter monitors the difference in temperature between the power chip (IGBT) and the heat sink. The measured values are in r0037[1] [°C].
- Heat sink monitoring (alarm A05000, fault F30004)
  The inverter monitors the heat sink temperature of the Power Module. The values are in r0037[0] [°C].

### Inverter response

The inverter temperature is essentially defined by the following effects:

- the ohmic losses of the output current
- the switching losses that occur when the motor is pulsed

Parameter p0290 defines how the inverter responds to an excessively high temperature.

| Parameter | Description |
|---|---|
| p0290 | **Power unit overload response**<br>(factory setting for SINAMICS G120 inverters with Power Module PM260: 0; factory setting for all other inverters: 2)<br>Setting the reaction to a thermal overload of the power unit:<br>0: Reduce output current (in vector control mode) or speed (in U/f mode)<br>1: No reduction, shutdown when overload threshold is reached (F30024)<br>2: Reduce pulse frequency and output current (in vector control mode) or pulse frequency and speed (in U/f mode)<br>3: Reduce pulse frequency |
| p0292 | **Power unit temperature warning threshold** (factory setting Heat sink [0] 5° C, power semiconductor [1] 15° C)<br>The value is set as a difference to the shutdown temperature. |

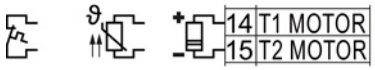
## 8.6.2 Motor temperature monitoring using a temperature sensor

### 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.




### Temperature switch

The inverter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

### PTC sensor

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

The inverter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the inverter shuts down with fault F07016.

### KTY84 sensor

Use a KTY sensor to monitor the motor temperature and the sensor itself for wire-break or short-circuit.

| NOTICE |
| --- |
| **Motor destruction through overheating**<br>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.<br>Connect the KTY sensor with the correct polarity. |

- Temperature monitoring:
  The inverter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The inverter switches off with fault in the following cases:
    - motor temperature > p0605
    - motor temperature > p0604 and p0610 ≠ 0
- Sensor monitoring (A07015 or F07016):
  - Wire-break:
    The inverter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.

## Setting parameters for the temperature monitoring

| Parameter | Description |
|---|---|
| p0335 | **Specify the motor cooling**<br>0: Natural cooling - with fan on the motor shaft (factory setting)<br>1: Forced ventilation - with a separately driven fan<br>2: Liquid cooling<br>128: No fan |
| p0601 | **Motor-temperature sensor type**<br>0: No sensor (factory setting)<br>1: PTC (→ p0604)<br>2: KTY84 (→ p0604, p0605)<br>4: Temperature switch |
| p0604 | **Motor temperature alarm threshold** (factory setting 130° C) |
| p0605 | **Motor temperature fault threshold** (factory setting 145° C)<br>Setting for KTY84 sensor. The parameter has no significance for a PTC sensor. |
| p0610 | **Motor-overtemperature response**<br>Determines the response when the motor temperature reaches the alarm threshold p0604.<br>0: Alarm (A07910), no fault.<br>1: Alarm (A07910); current limit is reduced and timer is started. Shutdown with fault (F07011).<br>2: Alarm (A07910); timer is started. Shutdown with fault (F07011).<br>12: As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting). |
| p0640 | **Current limit** (input in A) |

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

## 8.6.3 Overcurrent protection

During vector control, the motor current remains within the torque limits set there.

During V/f control, the maximum current controller (I-max controller) protects the motor and converter against overload by limiting the output current.

### I-max controller operation

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, (i.e. it is being driven by the connected machine), the I-max controller increases the speed and stator voltage of the motor to reduce the current.

**Note**

The converter load is only reduced if the motor torque decreases at lower speeds (e.g. for fans).

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

### Settings

You only have to change the factory settings of the I-max controller if the drive tends to oscillate when it reaches the current limit or it is shut down due to overcurrent.

Table 8- 25 I-max controller parameters

| Parameter | Description |
|---|---|
| p0305 | Rated motor current |
| p0640 | Motor current limit |
| p1340 | Proportional gain of the I-max controller for speed reduction |
| p1341 | Integral time of the I-max controller for speed reduction |
| r0056.13 | Status: I-max controller active |
| r1343 | Speed output of the I-max controller<br>Shows the amount to which the I-max controller reduces the speed. |

For more information about this function, see function diagram 1690 in the List Manual.

## 8.6.4 Limiting the maximum DC link voltage

### How does the motor generate overvoltage?

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

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

"DC-link overvoltage".

## Protecting the motor and inverter against overvoltage

To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

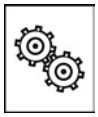
The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Braking functions of the inverter (Page 267).

There are two different groups of parameters for the Vdc_max control, depending on whether the motor is being operated with U/f control or vector control.

| Parameter for V/f control | Parameter for vector control | Description |
|---|---|---|
| p1280 = 1 | p1240 = 1 | **Vdc_max control Vdc monitoring configuration** (factory setting: 1)<br>1: Enable Vdc_max control |
| r1282 | r1242 | **Vdc_max control activation level**<br>Shows the value of the DC link voltage above which the Vdc_max control is active |
| p1283 | p1243 | **Vdc_max control dynamic factor** (factory setting: 100 %)<br>Scaling control parameters p1290, p1291 and p1292 |
| p1290 | p1250 | **Vdc_max control proportional gain** (factory setting: 1) |
| p1291 | p1251 | **Vdc_max control integral time** (factory setting p1291: 40 ms, factory setting p1251: 0 ms) |
| p1292 | p1252 | **Vdc_max control rate time** (factory setting p1292: 10 ms, factory setting p1252: 0 ms) |
| p1294 | p1254 | **Vdc_max control automatic sensing ON level** (factory setting p1294: 0, factory setting p1254: PM330/PM240 = 1, PM230 = 0)<br>Activates or deactivates automatic detection of the switch-on levels of the Vdc_max control.<br>0: Automatic detection disabled<br>1: Automatic detection enabled |
| p0210 | p0210 | **Unit supply voltage**<br>If p1254 or p1294 = 0, the inverter uses this parameter to calculate the switch-in thresholds of the Vdc_max control.<br>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 262) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 262)
- Changing over process variables for the technology controller (Page 263)

**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 264).

**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- 26 Variables affected by changing over the motor standard

| P no. | Designation | Unit for p0100 = | | |
|---|---|---|---|---|
| | | 0*) | 1 | 2 |
| r0206 | Power Module rated power | kW | HP | kW |
| p0307 | Rated motor power | kW | HP | kW |
| p0316 | Motor torque constant | Nm/A | lbf ft/A | Nm/A |
| r0333 | Rated motor torque | Nm | lbf ft | Nm |
| r0334 | Motor torque constant, actual | Nm/A | lbf ft/A | Nm/A |
| p0341 | Motor moment of inertia | $kgm^2$ | lb $ft^2$ | $kgm^2$ |
| p0344 | Motor weight (for thermal motor type) | kg | Lb | kg |
| r1969 | Speed_cont_opt moment of inertia determined | $kgm^2$ | lb $ft^2$ | $kgm^2$ |

*) Factory setting

### 8.7.1.2 Changing over the unit system

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

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

Note

Special features

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

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

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

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

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

Note

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

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

#### Changing over process variables of the technology controller

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

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

### 8.7.1.4 Switching units with STARTER

#### Precondition

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

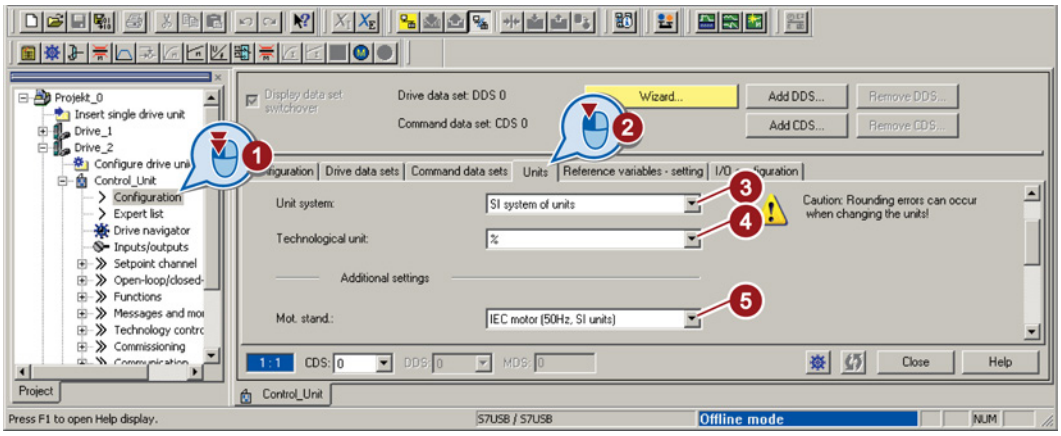
STARTER shows whether you change settings online in the inverter or change offline in the PC (Online mode / Offline mode).

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

#### Procedure

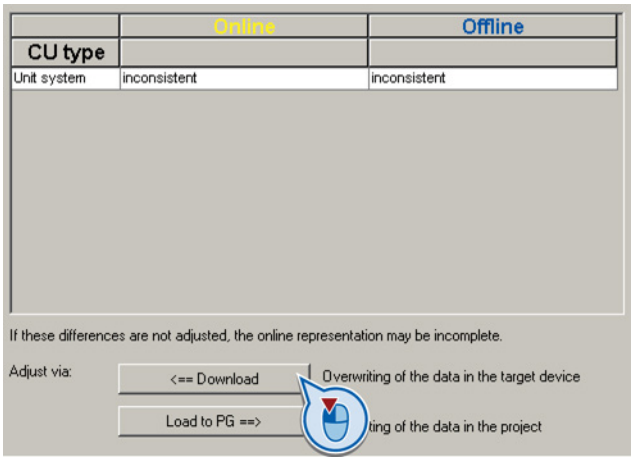
To change over the units with STARTER, proceed as follows:

1. Select the configuration
2. Go to the "Units" tab in the configuration screen form to change over the units.
3. Changing over the system of units
4. Select process variables of the technology controller
5. Adapting to the line supply




6. Save your settings.
7. Go online.

   The inverter signals that offline, other units and process variables are set than in the inverter itself.
8. Accept these settings in the inverter.




You have changed over the units.

## 8.7.2 Energy-saving display

### Background

Conventionally-controlled fluid flow machines control the flow rate using valves or throttles. In so doing, the drive operates constantly at the rated speed. The efficiency of the system decreases if the flow rate is reduced using valves or throttles. The efficiency is the lowest when valves or throttles are ompletely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

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

### Function

The energy-saving display calculates the energy saved when operating fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors. The energy saving display compares inverter operation with direct on line operation and throttle control.

The inverter indicates the energy saved in parameter r0041 in kWh, referred to the last 100 operating hours.

For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.

The inverter calculates the energy-saving based on the operating characteristic that has been saved.

Table 8- 27 Operating characteristic set in the factory

| | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 |
|---|---|---|---|---|---|
| Power | p3320 = 25 % | p3322 = 50 % | p3324 = 77 % | p3326 = 92 % | p3328 = 100 % |
| Speed | p3321 = 0 % | p3323 = 25 % | p3325 = 50 % | p3327 = 75 % | p3329 = 100 % |

If you require a precise value for the energy saving, then you must adapt the operating characteristic set in the factory.

**Additional parameters for the energy usage display:**

r0039.0: Energy usage since the last reset

r0039.1: Energy drawn since the last reset

r0039.2: Energy fed back since the last reset

p0040: Parameter to reset parameters r0039 and r0041.

r0041: Displays the saved energy since the last reset, referred to the operating characteristic, defined by parameters p3320 …p3329.

## Adapting the operating characteristic

### Precondition

You require the following data to calculate the system-specific operating characteristic:

- Operating characteristics of the manufacturer
  - for pumps: Delivery height and power as a function of the flow rate
  - for fans: Total pressure increase and power as a function of the flow rate
- System characteristics for 5 different flow rates.

### Procedure

Proceed as follows to adapt the operating characteristic:

1. For the 5 different flow rates, calculate the delivery height requirement, referred to a pump, which is directly connected to the line supply (n = 100 %).

   To do this, set the formula for the system characteristic the same as the formula for the operating characteristic of the delivery height.

   For a correspondingly lower delivery height, you only require a correspondingly low speed.
2. Enter the speeds into parameters p3321, p3323, p3325, p3327 and p3329.
3. Based on the flow rates and the associated operating characteristic of the manufacturer, calculate the power that the pump requires for the various flow rates when connected directly to the line supply.
4. Enter the values into parameters p3320, p3322, p3324, p3326 and p3328.

You have adapted the operating characteristic, and you now obtain a precise result for the energy saving.

## 8.7.3 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 278).
- 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)

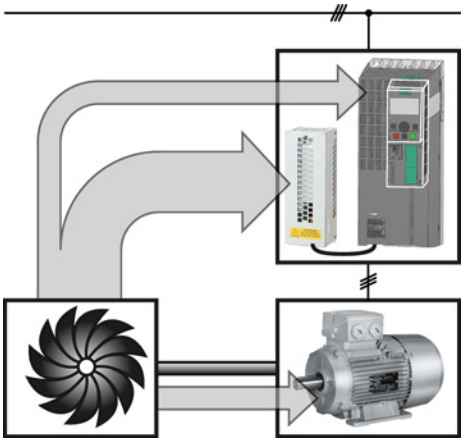
Depending on the Power Module used, the inverter offers the following options to convert the regenerative power of the motor into heat or to feed it back into the line:

- DC braking (Page 269)
  For Power Modules **PM240, PM340, PM250** and **PM260**
- Compound braking (Page 272)
  for Power Modules **PM240** and **PM340**
- Dynamic braking (Page 274)
  for Power Modules **PM240** and **PM340**
- Braking with regenerative feedback to the line (Page 277)
  for Power Modules **PM250** and **PM260**

**Dynamic braking**

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

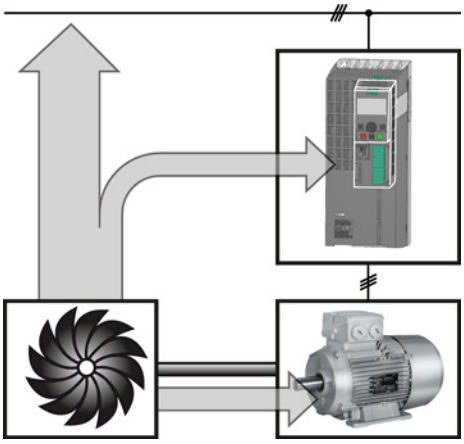
- *Advantages:* defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* braking resistor required; regenerative power is dissipated as heat



**Braking with regenerative feedback into the line supply**

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

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



## What braking method is suitable for what application?

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

### 8.7.3.2 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:

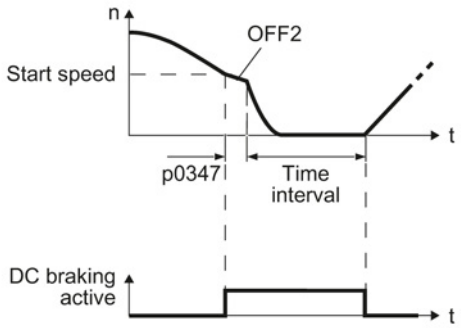
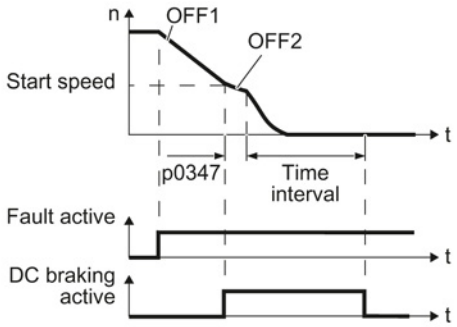
- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

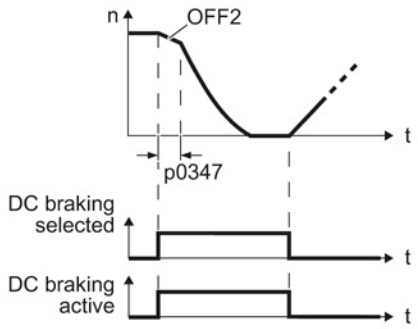
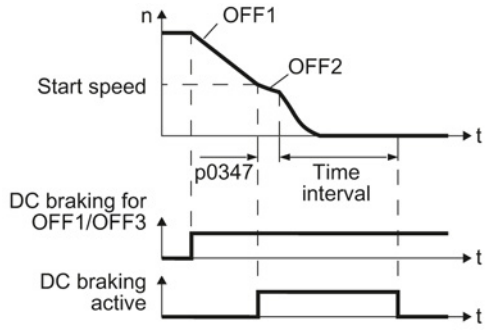
## Function

| NOTICE |
|---|
| **Motor damage caused by overheating**<br>The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor.<br>• Monitor the motor temperature.<br>• If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down. |

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

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

| DC braking when falling below a start speed<br>Precondition: p1230 = 1 and p1231 = 14 | DC braking when a fault occurs<br>Precondition: Fault number and fault response are assigned using p2100 and p2101 |
|---|---|
|  |  |

| DC braking initiated using a control command<br>Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3) | DC braking when switching off the motor<br>Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14 |
|---|---|
|  |  |

### DC braking when falling below a starting speed

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

### DC braking when a fault occurs

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

### DC braking initiated by a control command

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

### DC braking when the motor is switched off

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

## Settings for DC braking

| Parameter | Description | |
|---|---|---|
| p0347 | **Motor de-excitation time** (calculated after the basic commissioning)<br>The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short. | |
| p1230 | **DC braking activation** (factory setting: 0)<br>Signal source to activate DC braking<br>• 0 signal: Deactivated<br>• 1 signal: Active | |
| p1231 | **Configuring DC braking** (factory setting: 0) | |
| | 0<br>4<br>5<br>14 | No DC braking<br>General release for DC braking<br>DC braking for OFF1/OFF3<br>DC braking below the starting speed |
| p1232 | **DC braking braking current** (factory setting 0 A) | |
| p1233 | **DC braking duration** (factory setting 1 s) | |
| p1234 | **DC braking start speed** (factory setting 210000 rpm) | |
| r1239 | **DC braking status word** | |
| | .08<br>.10<br>.11<br>.12<br>.13 | DC braking active<br>DC braking ready<br>DC braking selected<br>DC braking selection internally locked<br>DC braking for OFF1/OFF3 |

Table 8- 28 Configuring DC braking when faults occur

| Parameter | Description |
|---|---|
| p2100 | **Set fault number for fault response** (factory setting 0)<br>Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1). |
| p2101 = 6 | **Fault response setting** (factory setting 0)<br>Assigning the fault response: p2101[3] = 6. |
| The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response.<br>The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault. | |

### 8.7.3.3 Compound braking

Typical applications for compound braking include:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

For these applications, the motor is normally operated with a constant speed, and is only braked down to standstill after longer periods of time.

#### Principle of operation

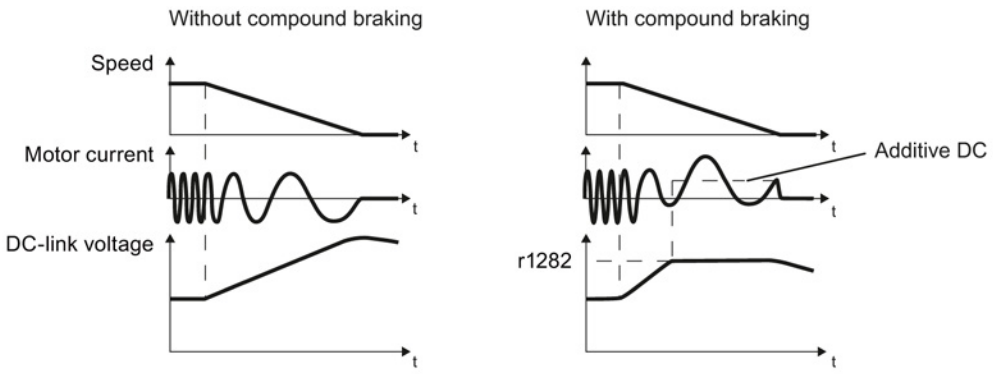



Figure 8-23 Motor brakes with and without active compound braking

Compound braking prevents the DC-link voltage increasing above a critical value. The inverter activates compound braking depending on the DC-link voltage. Above a DC-link voltage threshold (r1282), the inverter adds a DC current to the motor current. The DC current brakes the motor and prevents an excessive increase in the DC-link voltage.

**Note**

Compound braking is possible only with the U/f control.

Compound braking does not operate in the following cases:

- The "flying restart" function is active
- DC braking is active
- Vector control is selected

## Setting and enabling compound braking

| Parameter | Description |
|---|---|
| p3856 | **Compound braking current (%)**<br>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.<br>p3856 = 0<br>Compound braking locked<br>p3856 = 1 … 250<br>Current level of the DC braking current as a % of the rated motor current (p0305)<br>Recommendation: p3856 < 100% × (r0209 - r0331) / p0305 / 2 |
| r3859.0 | **Compound-braking status word**<br>r3859.0 = 1: Compound braking is active |

| NOTICE |
|---|
| **Motor damage from overheating with compound braking**<br>The motor will overheat if braking lasts too long or the motor is braked too often. This may damage the motor.<br>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 $U_{DC\ link,\ max}$ .

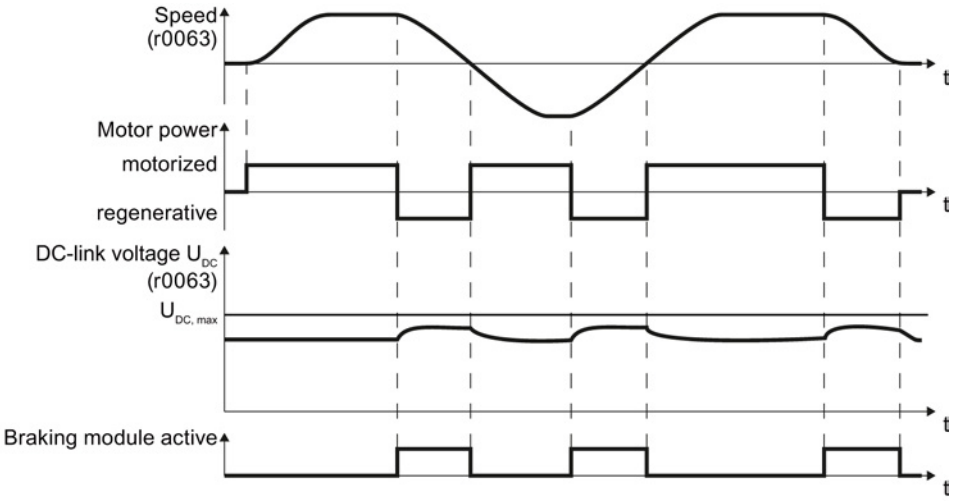



Figure 8-24 Simplified representation of dynamic braking with respect to time

## 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.

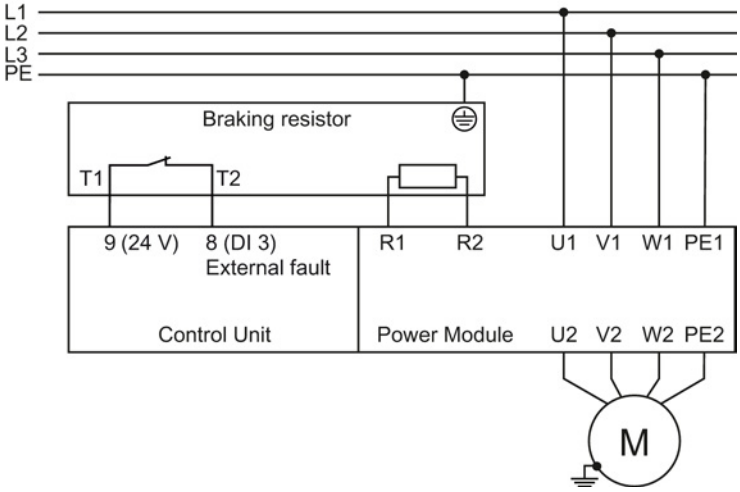



Figure 8-25 Braking resistor connection (as example: Temperature monitoring via digital input DI 3)

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- 29 Parameter

| Parameter | Description | |
|---|---|---|
| p0219 | **Braking power of the braking resistor** (factory setting: 0 kW)<br>Set the maximum braking power that the braking resistor must handle in your particular application.<br>Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor.<br>**Example**: In your particular application, the motor brakes every 10 seconds. In so doing, the braking resistor must handle a braking power of 1 kW for 2 s. Use a braking resistor with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the maximum braking power to: p0219 = 1 (kW). | |
| p0844 | **No coast down/coast down (OFF2) signal source 1** | |
| | p0844 = 722.x | Monitor the overtemperature of the braking resistor with digital input x of the inverter. |

### 8.7.3.5 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 390)).

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

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

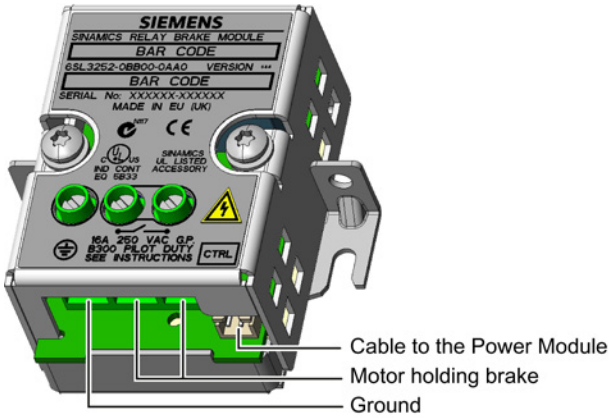
The inverter-internal control of the motor holding brake is suitable typically for horizontal, inclined and vertical conveyors.

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.

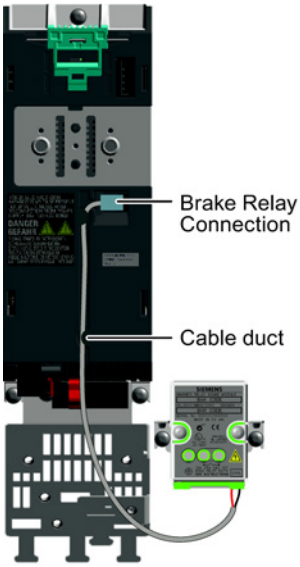
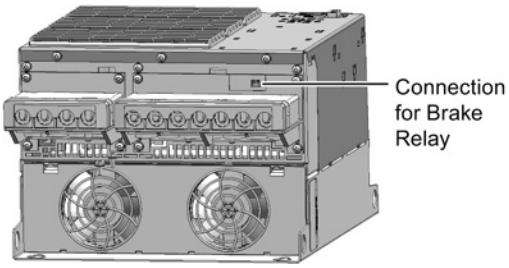
The Brake Relay can be mounted on a mounting plate, the cabinet wall or the inverter's shield connection kit. For additional information, please refer to the associated installation instructions: Installation instructions for the Brake Relay (http://support.automation.siemens.com/WW/view/en/23623179).



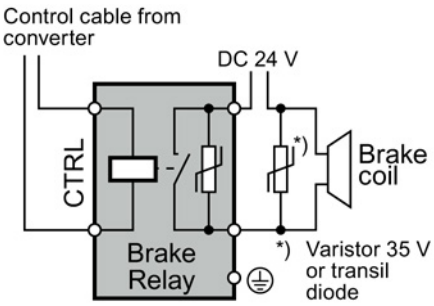
### Procedure

Proceed as follows to connect the Brake Relay with the inverter:

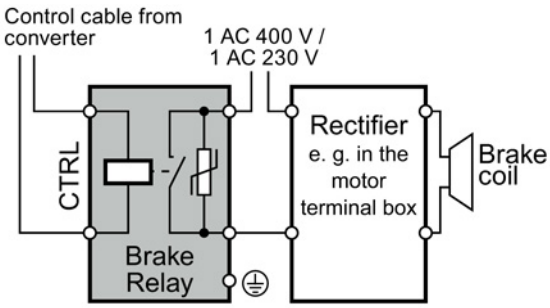
1. Connect the Brake Relay to the Power Module using the cable form provided.

| Power Modules FSA … FSC | Power Modules FSD … FSF |
|---|---|
|  <br>• Connect the Brake Relay at the connector on the front of the Power Module.<br>• Route the control cable in the guide on the Power Module. |  <br>Connect the Brake Relay at the connector on the lower side of the Power Module. |

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




24 V brake connection




440V brake connection

You have connected the Brake Relay with the inverter.

## 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.

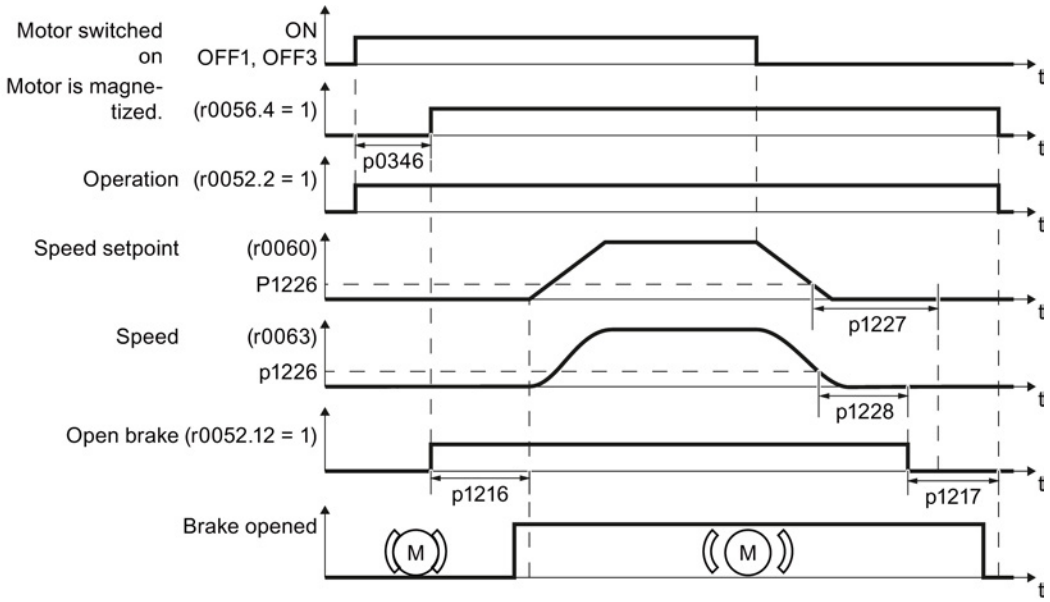



Figure 8-26 Controlling the motor holding brake when the motor is switched on and off

## 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.

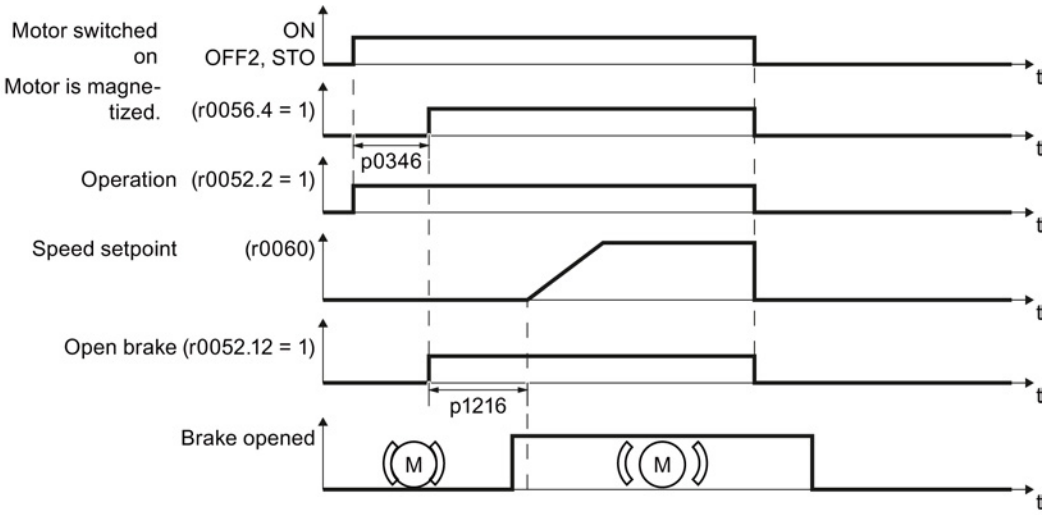



Figure 8-27 Controlling the motor holding brake after an OFF2 command or selecting STO

## 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 ≤ p1216.
   - Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   - If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.

     In this case, increase the opening time p1216.
   - After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   - U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   - Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   - If the brake closes too late, the load briefly sags before the brake closes.

     In this case, increase the closing time p1217.
   - After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.

You have commissioned the "Motor holding brake" function.

Table 8- 30 Setting the control logic of the motor holding brake

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

Table 8- 31 Advanced settings

| Parameter | Description |
|---|---|
| p0346 | **Magnetizing time** (factory setting 0 s)<br>During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3. |
| p0855 | **Open motor holding brake (imperative)** (factory setting 0) |
| p0858 | **Close motor holding brake (imperative)** (factory setting 0) |
| p1226 | **Stationary state detection speed threshold** (factory setting 20 rpm)<br>When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started |
| p1227 | **Stationary state detection monitoring time** (factory setting 300 s) |
| p1228 | **Pulse deletion delay time** (factory setting 0.01 s) |
| p1351 | **Starting frequency, motor holding brake** (factory setting 0%)<br>Setting the frequency set value at the slip compensation output when starting with motor holding brake.<br>When the parameter p1351 is set to > 0, slip compensation is automatically switched on. |
| p1352 | **Starting frequency for motor holding brake** (factory setting 1351)<br>Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake. |
| p1475 | **Speed controller torque set value for motor holding brake** (factory setting 0)<br>Setting the signal source for the torque set value when starting with motor holding brake. |

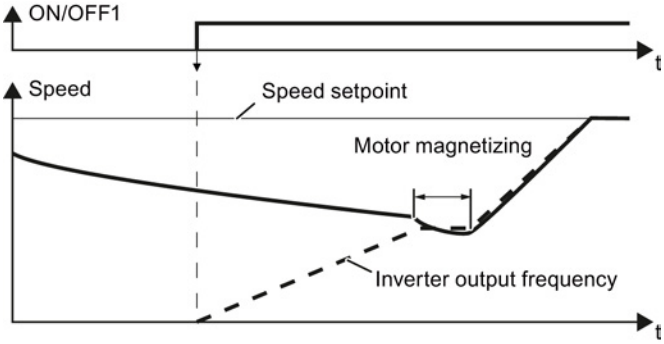
## 8.7.4 Automatic restart and flying restart

### 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- 32 Basic setting

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

Table 8- 33 Advanced settings

| Parameter | Description |
|---|---|
| p1201 | **Flying restart enable signal source** (factory setting 1)<br>Defines a control command, e.g. a digital input, through which the flying restart function is enabled. |
| p1202 | **Flying restart search current** (factory setting 100%)<br>Defines the search current with respect to the motor magnetizing current (r0331), which flows in the motor while the flying restart function is being used. |
| p1203 | **Flying restart search speed factor** (factory setting 100%)<br>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.<br>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.

**⚠ WARNING**

**Injuries from the automated machine restart**

When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. The movements that the machine executes may result in serious injuries.

- Block the machine to prevent unintentional access.
- Before working on the machine switch the automatic restart mechanism off.

## Commissioning the automatic restart

### Procedure

Proceed as follows to commission the automatic restart:

1. If it is possible that the motor is still rotating for a longer period of time after a power failure or after a fault, then in addition, you must activate the "flying restart" function, see Flying restart – switching on while the motor is running (Page 284).
2. Using p1210, select the automatic restart mode that best suits your application.

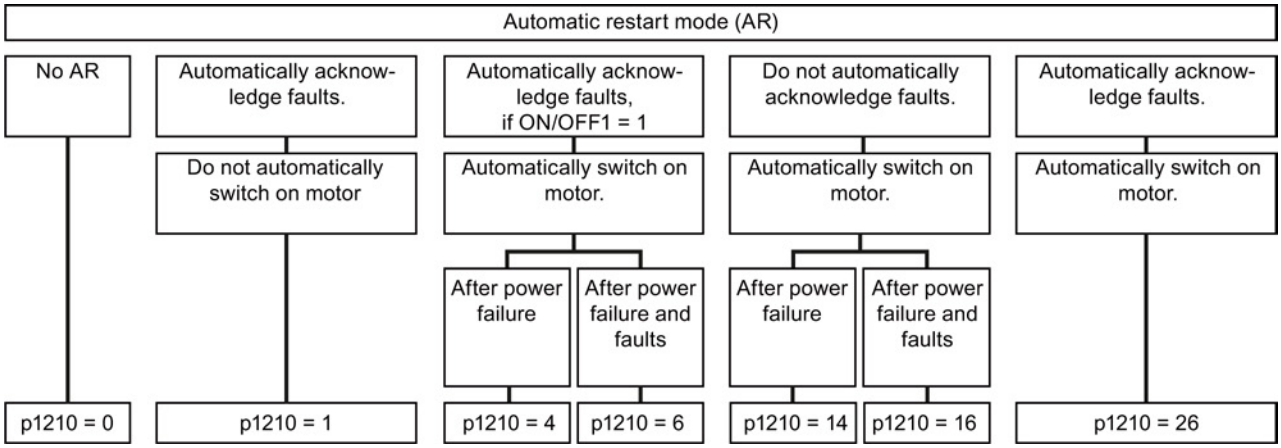
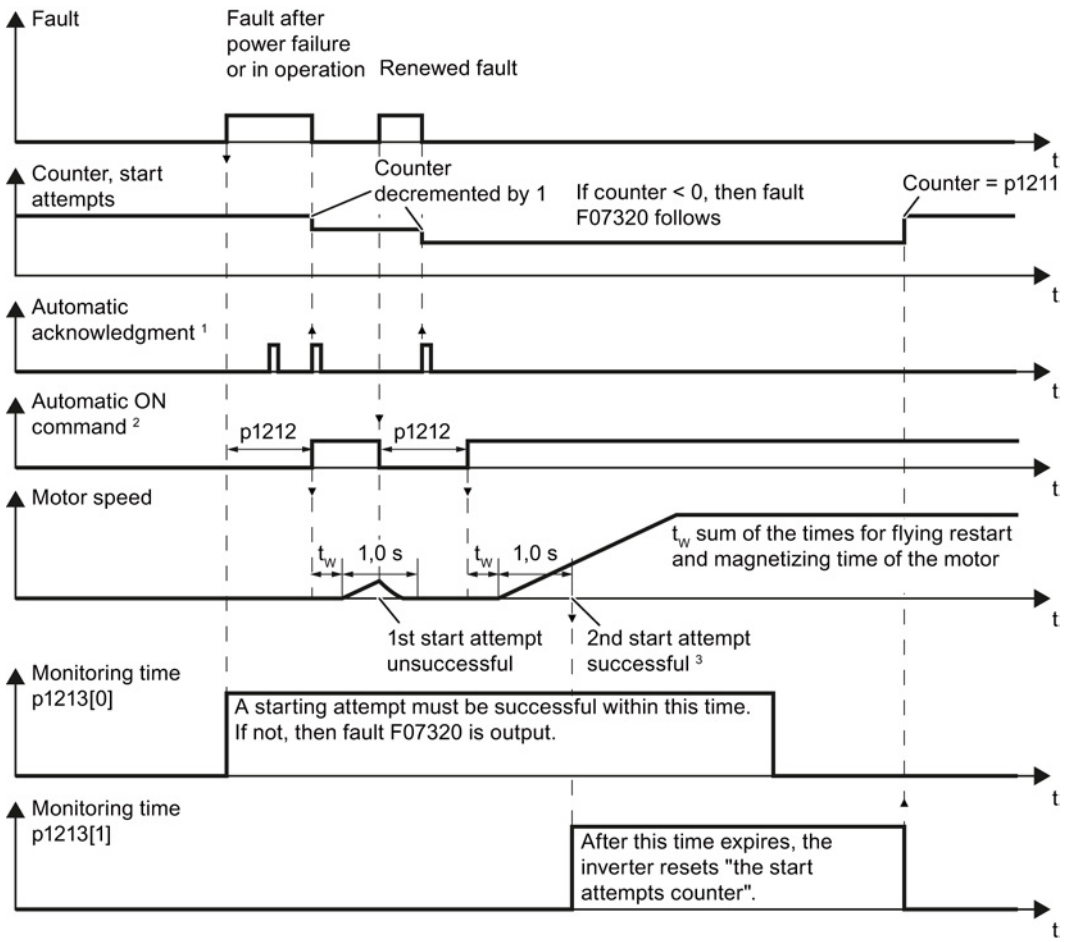



Figure 8-28 Selecting the automatic restart mode

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.




[1] The inverter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: Always.
- p1210 = 4 or 6: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).
- p1210 = 14 or 16: Never.

[2] The inverter attempts to automatically switch-on the motor under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).

[3] If no fault has occurred one second after flying restart and magnetizing (r0056.4 = 1), the start attempt was successful.

Figure 8-29 Time response of the automatic restart

You have commissioned the automatic restart function.

### Parameter for setting the automatic restart

| Parameter | Explanation |
|---|---|
| p1210 | **Automatic restart mode** (factory setting 0)<br>0: Disable automatic restart.<br>1: Acknowledge all faults without restarting.<br>4: Restart after power failure without further restart attempts.<br>6: Restart after fault with further restart attempts.<br>14: Restart after power failure after manual acknowledgement.<br>16: Restart after fault after manual acknowledgement.<br>26: Acknowledgement of all faults and restart with ON/OFF1 = 1 command. |
| p1211 | **Automatic restart start attempts** (factory setting 3)<br>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.<br>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.<br>For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts.<br>The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled:<br>• After a successful start attempt, the time in p1213[1] has expired.<br>• After fault F07320, switch off the motor (OFF1) and acknowledge the fault.<br>• You change the start value p1211 or the mode p1210. |
| p1212 | **Automatic restart wait time start attempt** (factory setting 1.0 s)<br>This parameter is only effective for the settings p1210 = 4, 6, 26.<br>Examples for setting this parameter:<br>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.<br>2. In operation, the inverter develops a fault condition. The lower you select p1212, then the sooner the inverter attempts to switch-on the motor again. |

| Parameter | Explanation |
|---|---|
| p1213[0] | **Automatic restart monitoring time for restart** (factory setting 60 s)<br>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.<br>With this monitoring function, you limit the time in which the inverter may attempt to automatically switch-on the motor again.<br>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.<br>Set the monitoring time longer than the sum of the following times:<br>+ p1212<br>+ Time that the inverter requires to start the motor on the fly.<br>+ Motor magnetizing time (p0346)<br>+ 1 second<br>You deactivate the monitoring function with p1213 = 0. |
| p1213[1] | **Automatic restart monitoring time to reset the fault counter** (factory setting 0 s)<br>This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.<br>Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time.<br>The monitoring function starts with a successful start attempt and ends after the monitoring time has expired.<br>If the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch on the motor again, you must acknowledge the fault and set ON/OFF1 = 1. |

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

## Advanced settings

If you with to suppress the automatic restart function for certain faults, then you must enter the appropriate fault numbers in p1206[0 … 9].

Example: p1206[0] = 07331 ⇒ No restart for fault F07331.

Suppressing the automatic restart only functions for the setting p1210 = 6, 16 or 26.

**⚠ WARNING**

**Personal injury and property damage**

In the case of communication via the fieldbus interface, the motor restarts with the setting p1210 = 6 even if the communication link is interrupted. This means that the controller cannot stop the motor. To avoid this dangerous situation, you must enter the fault code of the communications fault in parameter p1206.

Example: A communication failure via PROFIBUS is signaled using fault code F01910. You should therefore set p1206[n] = 1910 (n = 0 … 9).

## 8.7.5 PID technology controller

### 8.7.5.1 Overview

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

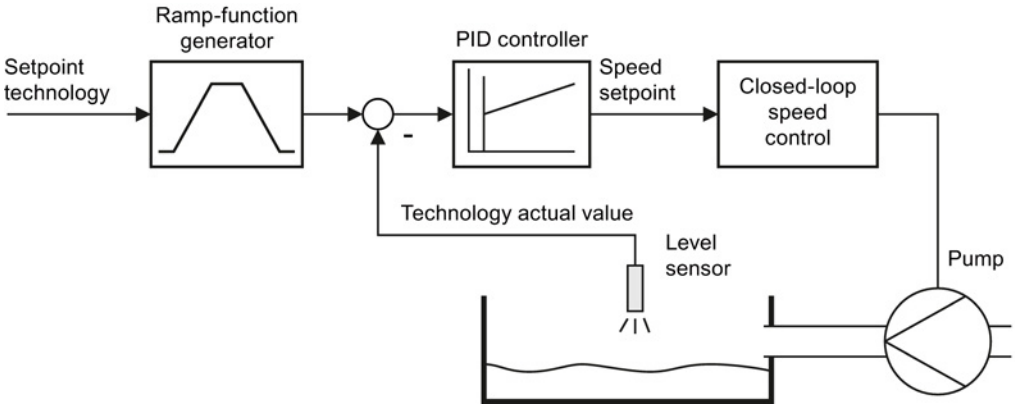



Figure 8-30 Example: technology controller as a level controller

### 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.

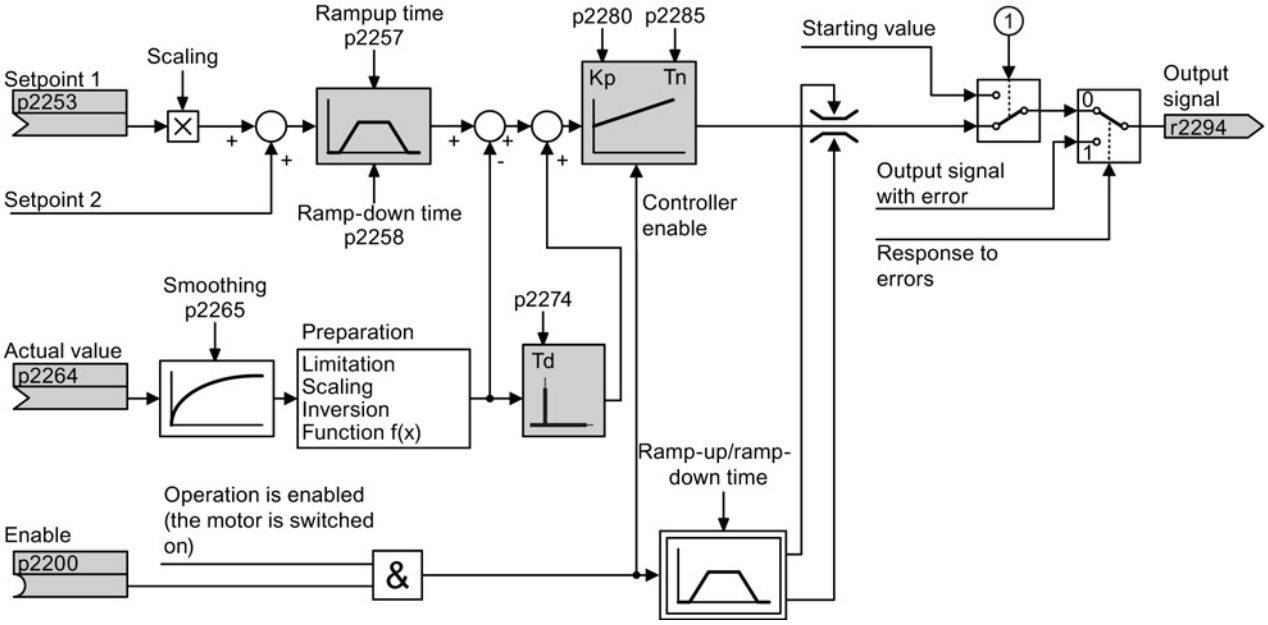



Figure 8-31 Simplified representation of the technology controller

① The inverter uses the start value if the following conditions are met simultaneously:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

## Setting the technology controller

| Parameter | Remark |
|---|---|
| p2200 = 1 | Enable technology controller. |
| p1070 = 2294 | Interconnect the main speed setpoint with the output of the technology controller. |
| p2253 | Define the setpoint for the technology controller.<br>Example:<br>p2253 = 2224: The inverter interconnects the fixed setpoint p2201 with the setpoint of the technology controller.<br>p2220 = 1: The fixed setpoint p2201 is selected. |
| p2264 | Define the actual value for the technology controller.<br>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]<br>The differentiation improves the rise time characteristics for very slow controlled variables, e.g. a temperature control.<br>p2274 = 0: The differentiation is switched off. |
| p2280 | Proportional gain $K_P$ |
| p2285 | Integral time $T_N$ [s]<br>Without an integral time, the controller cannot completely equalize deviations between the setpoint and actual value.<br>p2285 = 0: The integral time is switched off. |

## Advanced settings

| Parameter | Remark |
|---|---|
| **Limiting the output of the technology controller**<br>In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application.<br>Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction. | |
| p2297 = 2291 | Interconnect the upper limit with p2291. |
| p2298 = 2292 | Interconnect the lower limit with p2292. |
| p2291 | Upper limit for the technology controller output e.g.: p2291 =100 |
| p2292 | Lower limit for the technology controller output e.g.: p2292 = 0 |
| **Manipulating the actual value of the technology controller** | |
| p2267, p2268 | Limit the actual value |
| p2269 | Scale the actual value |
| p2271 | Invert the actual value |
| p2270 | Actual value |

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

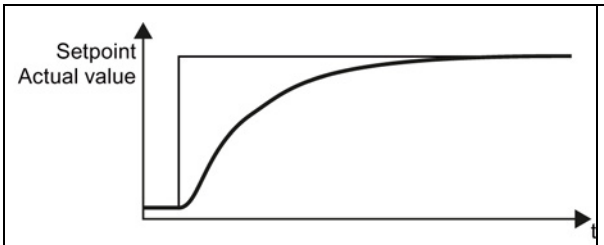
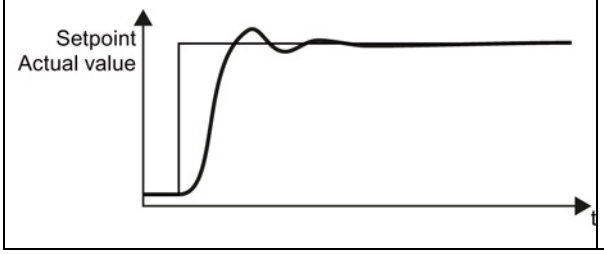
### 8.7.5.3 Optimizing the controller

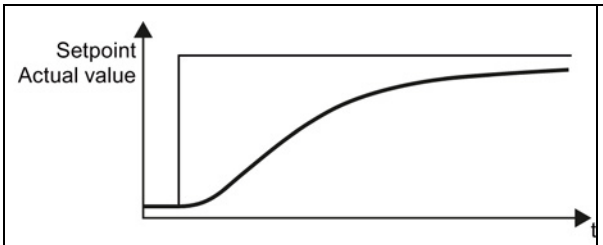
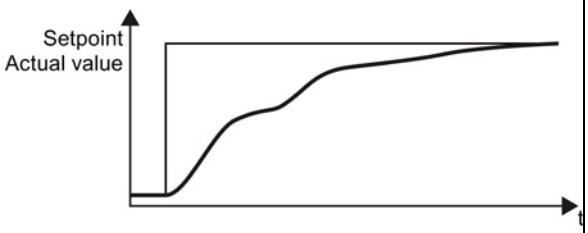
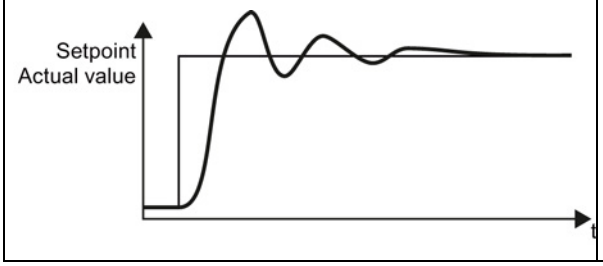
#### Setting the technology controller from a practical perspective

**Procedure**

Proceed as follows to set the technology controller:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

| | |
|---|---|
|  | **Optimum controller response for applications that do not permit any overshoot.**<br>The actual value approaches the setpoint without any significant overshoot. |
|  | **Optimum controller behavior for fast correction and quick compensation of noise components.**<br>The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step). |

| | |
|---|---|
|  | **The actual value only slowly approaches the setpoint.**<br>• Increase the proportional component $K_P$ and reduce the integration time $T_N$. |
|  | **Actual value only slowly approaches the setpoint with slight oscillation.**<br>• Increase the proportional component $K_P$ and reduce the rate time $T_D$ (differentiating time). |
|  | **The actual value quickly approaches the setpoint, but overshoots too much**<br>• Decrease the proportional component $K_P$ and increase the integration time $T_N$. |

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

You have now set the technology controller.

## 8.7.6 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.

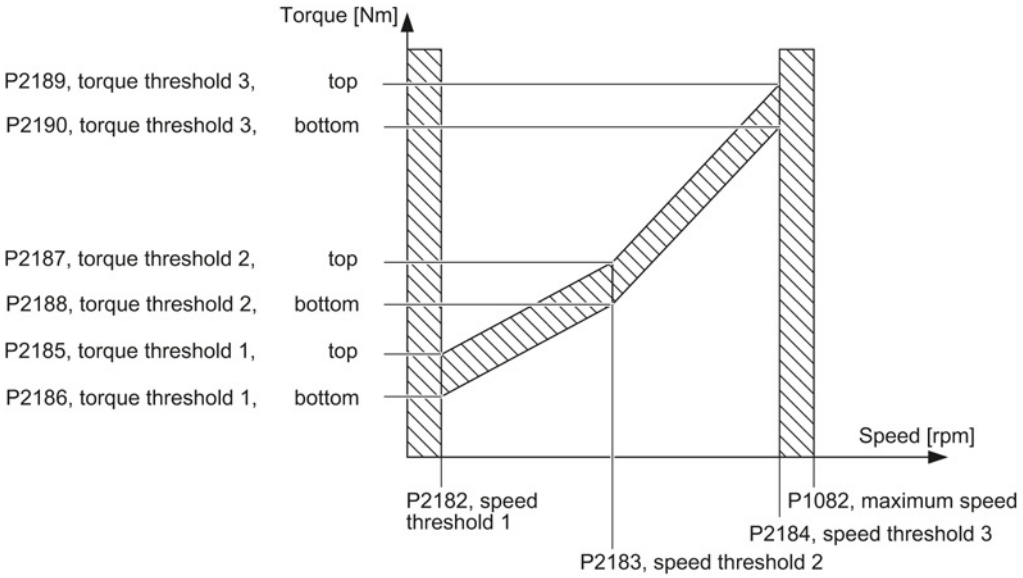



Figure 8-32 Parameters for the load torque monitoring

Table 8- 34 Parameterizing the monitoring functions

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

### Load failure

Using this function, the inverter monitors the speed or velocity of a machine component. The inverter evaluates whether an encoder signal is present. If the encoder signal fails for a time that can be adjusted, then the inverter signals a fault.

Examples of how the function can be used:

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

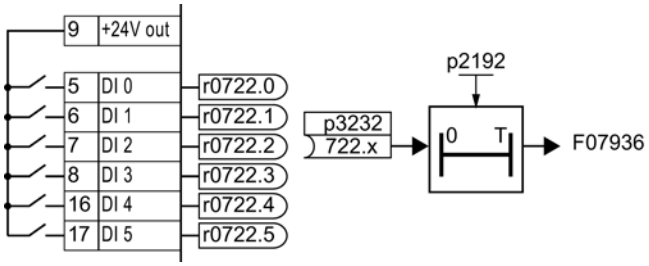



Figure 8-33 Load failure monitoring using a digital input

| Parameter | Description |
|---|---|
| p2192 | **Load monitoring delay time** (factory setting 10 s)<br>After the motor is switched on, if the "LOW" signal is present at the associated digital input for longer than this time, the inverter signals a load failure (F07936). |
| p2193 = 1…3 | **Load monitoring configuration** (factory setting: 1)<br>0: Monitoring is deactivated<br>1: Torque monitoring (see Monitor the load torque (system protection) (Page 294)) and load failure<br>2: Speed deviation monitoring (see below) and load failure<br>3: Load failure monitoring |
| p3232 = 722.x | **Load monitoring failure detection** (factory setting: 1)<br>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)

## 8.7.8 Speed deviation monitoring

### Speed deviation

Using this function, the inverter calculates and monitors the speed or velocity of a machine component. The inverter evaluates an encoder signal, calculates a speed from the signal and compares it with the motor speed. The inverter signals if there is an excessive deviation between the encoder signal and the motor speed.

Examples of how the function can be used:

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

You require a transmitter for this function, e.g. a proximity switch. The inverter evaluates the transmitter signal via digital input 3.

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

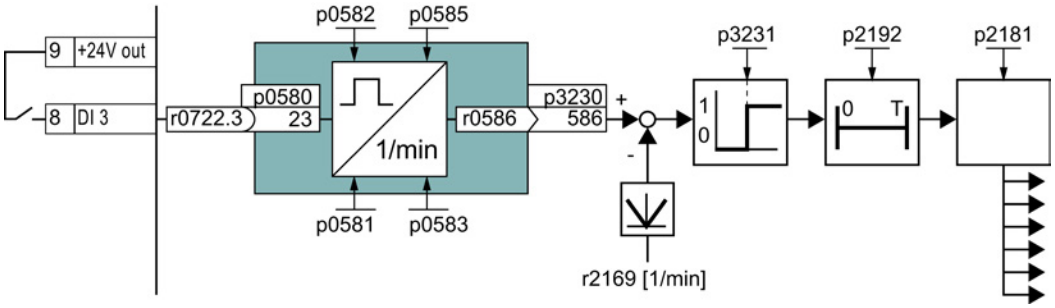



Figure 8-34 Speed deviation monitoring

The "probe" function calculates a speed from the pulse signal at the digital input.

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 | **Invert probe** (factory setting 0000bin)<br>The 3rd bit of the parameter value inverts the input signals of digital input 3 for the probe. |
| p0580 = 23 | **Probe input terminal** (factory setting 0)<br>Interconnect the probe input with DI 3. |
| p0581 | **Probe edge** (factory setting 0)<br>Edge for evaluation of the probe signal to measure the actual speed value<br>0: 0/1 edge<br>1: 1/0 edge |
| p0582 | **Probe pulses per revolution** (factory setting 1)<br>Number of pulses per revolution. |

| Parameter | Description | |
|---|---|---|
| p0583 | **Maximum probe measuring time** (factory setting 10 s)<br>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.<br>The time is restarted with the next pulse. | |
| p0585 | **Probe gear factor** (factory setting 1)<br>The inverter multiplies the measured speed by the gear factor and then displays it in r0586. | |
| p2181 | **Load monitoring response** (factory setting 0)<br>Response for evaluating load monitoring. | |
| | 0 | Load monitoring disabled |
| | 1 | A07920 for speed too low |
| | 2 | A07921 for speed too high |
| | 3 | A07922 for speed outside tolerance |
| | 4 | F07923 for speed too low |
| | 5 | F07924 for speed too high |
| | 6 | F07925 for speed outside tolerance |
| p2192 | **Load monitoring delay time** (factory setting 10 s)<br>Delay time for evaluating load monitoring. | |
| p2193 = 2 | **Load monitoring configuration** (factory setting: 1)<br>2: Speed deviation and load failure monitoring. | |
| p3230 = 586 | **Load monitoring actual speed value** (factory setting 0)<br>Result of the speed calculation with the evaluation of the speed monitoring. | |
| p3231 | **Load monitoring speed deviation** (factory setting 150 rpm)<br>Permissible speed deviation of load monitoring. | |

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

## 8.7.9 Free function blocks

The free function blocks permit additional signal processing inside 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.

The following free function blocks are available:

- Logic AND, OR, XOR, NOT
- Arithmetic ADD, SUB, MUL, DIV, AVA (absolute value), NCM (comparison), PLI (polyline)
- Timers MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), PST (pulse stretching)
- RSR (RS flip-flop), DSR (D flip-flop)
- Switches NSW (analog) BSW (binary)
- Controllers LIM (limiters), PT1 (smoothing), INT (integrators), DIF (differentiators)
- Monitoring LVM

### Activating and interconnecting free function blocks

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

#### Precondition

You have configured the inverter with the "Free function blocks" function module. See also: Basic commissioning with STARTER (Page 85).

#### Procedure

Proceed as follows to activate a free function block and interconnect with signals:

1. Select the required function block in the List Manual. You can find the parameters to set the free function blocks in function diagrams 7200 ff. See also: Manuals for your converter (Page 461).
2. From an operator panel or via the expert list in STARTER, set the parameters that define the runtime group of the function block to the required value.

   The function block is now active.
3. If you have assigned several function blocks to the same runtime group, set the parameter that defines the execution sequence within the runtime group.
4. Interconnect the inputs and outputs of the function block with the required signals in the inverter.

You have activated a free function block and interconnected its inputs and outputs.

## Runtime groups and time slices

The inverter computes runtime groups 1 … 6 in different time slices.

Table 8- 35 Runtime groups, time slices and assignment of the free function blocks

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

✓: The inverter can compute the free function block in this runtime group
-: A free function block is not possible in this runtime group

## Scaling the analog signals

If you interconnect a physical quantity, e.g. speed or voltage to the input of a free function block, then the inverter automatically scales the signal to a value of 1. The analog output signals of the free function blocks are also scaled (0 ≙ 0 %, 1≙ 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).

**Scaling parameters of physical quantities:**

| | | | |
|---|---|---|---|
| Speed | p2000 | Reference speed | (≙100 %) |
| Voltage | p2001 | Reference voltage | (≙100 %) |
| Current | p2002 | Reference current | (≙100 %) |
| Torque | p2003 | Reference torque | (≙100 %) |
| Power | p2004 | Reference power | (≙100 %) |
| Angle | p2005 | Reference angle | (≙100 %) |
| Acceleration | p2007 | Reference acceleration | (≙100 %) |
| Temperature | 100° C ≙ 100% | | |

The assignments to the reference parameters are in the parameter description in the List Manual.

### 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° C / 100° C = 1.2.

### Limits

Enter limits within the function blocks as scaled values.

Scaled limit = physical limit value / value of the reference parameter.

## Example: Or logic combination of two digital inputs

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

### Procedure

1
2

Proceed as follows to logically interconnect digital inputs 0 and 1:

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

## Example: AND operation

An additional example of an AND logic operation, including the use of a timer block, is provided in Chapter Example (Page 432).

## Additional information about free function blocks

See also: SINAMICS S110 Function Manual (http://support.automation.siemens.com/WW/view/en/66206528).

# 8.8 Safe Torque Off (STO) safety function

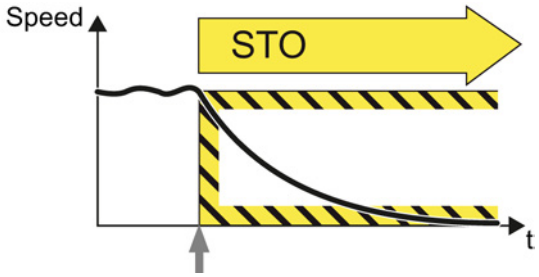
These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Manuals for your converter (Page 461).

## 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. | • Wire the Emergency Stop button with a fail-safe input.<br>• Select STO via the fail-safe input. |
| A central Emergency Stop button ensures that several drives cannot unintentionally start. | • Evaluate the Emergency Stop button in a central control.<br>• Select STO via PROFIsafe. |

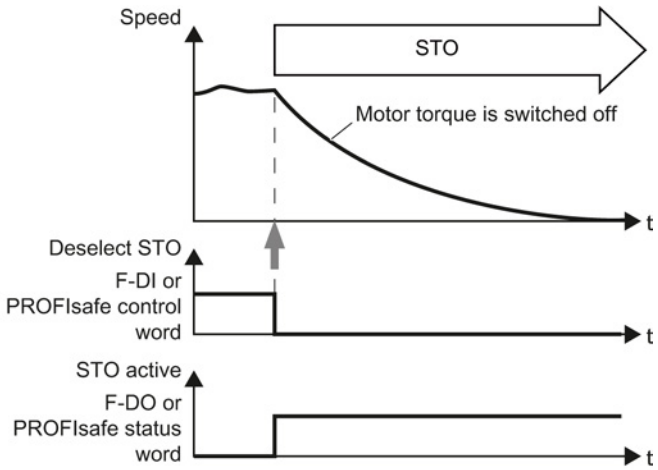
### How does STO function in detail?

The inverter recognizes the selection ofSTO via a fail-safe input or via the safe communicationPROFIsafe.

The inverter then safely switches off the torque of the connected motor.

If no motor holding brake is present, the motor coasts to a standstill.

If you use a motor holding brake, the inverter closes the brake immediately after selecting STO.



## 8.8.2 Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

## 8.8.3 Commissioning STO

### 8.8.3.1 Commissioning tool

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

If you use STARTER for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 36 STARTER commissioning tool (PC software)

| Download | Order number |
|---|---|
| STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000) | 6SL3255-0AA00-2CA0<br>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- 37 Parameter

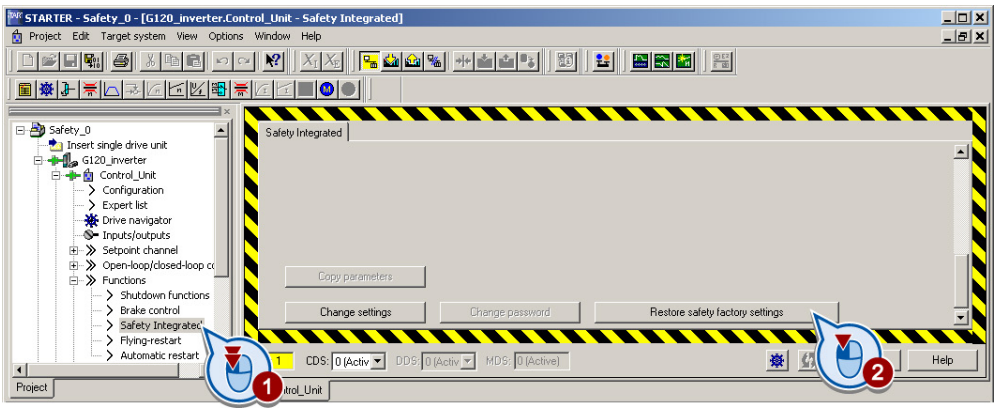
| No. | Description |
|---|---|
| p9761 | **Entering a password** (factory setting 0000 hex)<br>Permissible passwords lie in the range 1 … FFFF FFFF. |
| p9762 | **New password** |
| p9763 | **Confirm password** |

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

**Procedure**

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

1. Go online with STARTER
2. Open the screen form for the safety functions ①.




3. Press the button to restore the factory settings ②.
4. Enter the password,for the safety functions.
5. Confirm saving parameters (RAM to ROM).
6. Go offline with STARTER .
7. Switch off the inverter supply voltage.
8. Wait until all of the LED on the inverter go dark. Now switch on the inverter power supply again (power on reset).

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

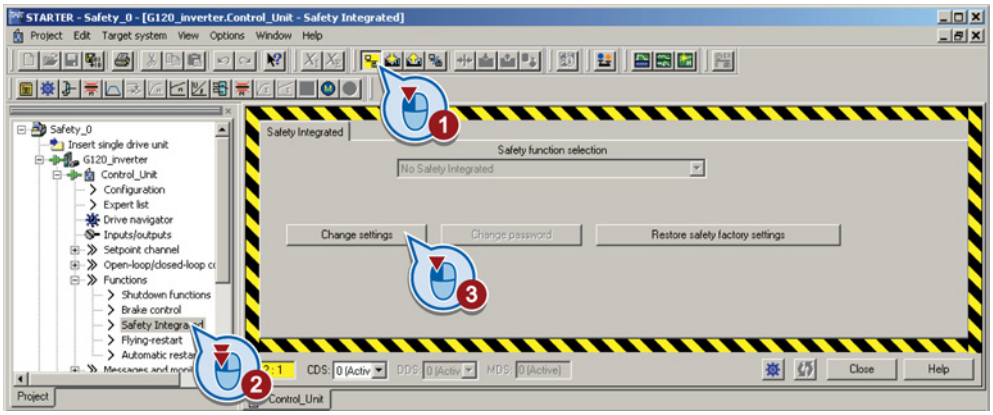
| Parameters | Description | |
|---|---|---|
| p0010 | **Drive, commissioning parameter filter** | |
| | 0 | Ready |
| | 95 | Safety Integrated commissioning |
| p0970 | **Reset drive parameters** | |
| | 0 | Inactive |
| | 5 | Starts a safety parameter reset.<br>After the reset, the inverter sets p0970 = 0. |
| p9761 | **Enter a password** (factory setting 0000 hex)<br>Permissible passwords lie in the range 1 … FFFF FFFF. | |
| p9762 | **New password** | |
| p9763 | **Confirm password** | |

### 8.8.3.4 Changing settings

**Procedure**

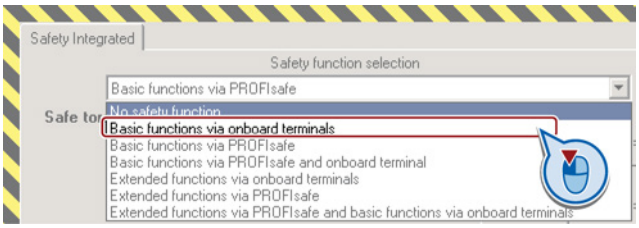
To start commissioning the safety functions, proceed as follows:

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




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

4. Selecting "STO via terminal":




You have completed the following commissioning steps:

- You have started to commission the safety functions.
- You have selected the basic functions via onboard terminals of the inverter.

Table 8- 38 Parameter

| Parameter | Description | |
|---|---|---|
| p9601 | **Enable functions integrated in the drive** (factory setting: 0000 bin) | |
| | p9601 = 0 | Safety functions integrated in the drive inhibited |
| | p9601 = 1 | Enable basic functions via onboard terminals |

The other selection options are described in the "Safety Integrated Function Manual". See also Section: Manuals for your converter (Page 461).

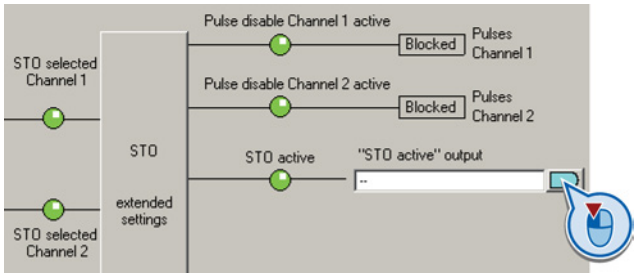
### 8.8.3.5 Interconnecting the "STO active" signal

If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

**Procedure**

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.




2. In the following selection menu, select the appropriate setting for your particular application.

You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

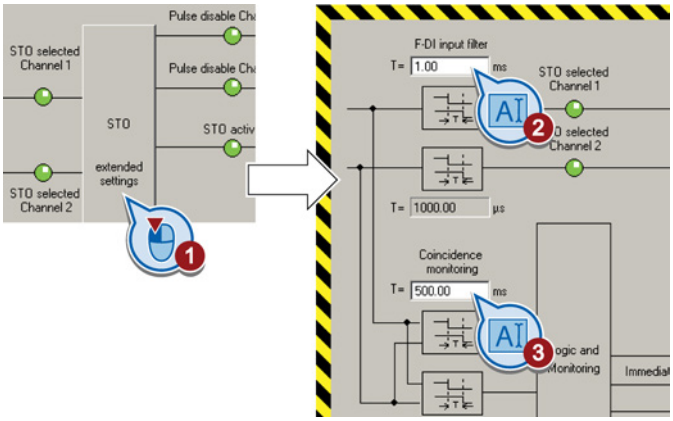
| Parameter | Description |
|---|---|
| r9773.01 | **1 signal**: STO is active in the drive |

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

**Procedure**

To set the input filter and monitoring for simultaneous operation for a fail-safe input, proceed as follows:

1. Select the advanced settings for STO.




2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the fail-safe input.

## Description of the signal filter

The following are available for the signal processing of the fail-safe inputs:

- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

## A tolerance for the simultaneous monitoring

The inverter checks whether the signals at both inputs always have the same signal status (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A long-term discrepancy indicates a fault in the wiring of a fail-safe input, e.g. a wire break.

When appropriately set, the inverter tolerates brief discrepancies.

The tolerance time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

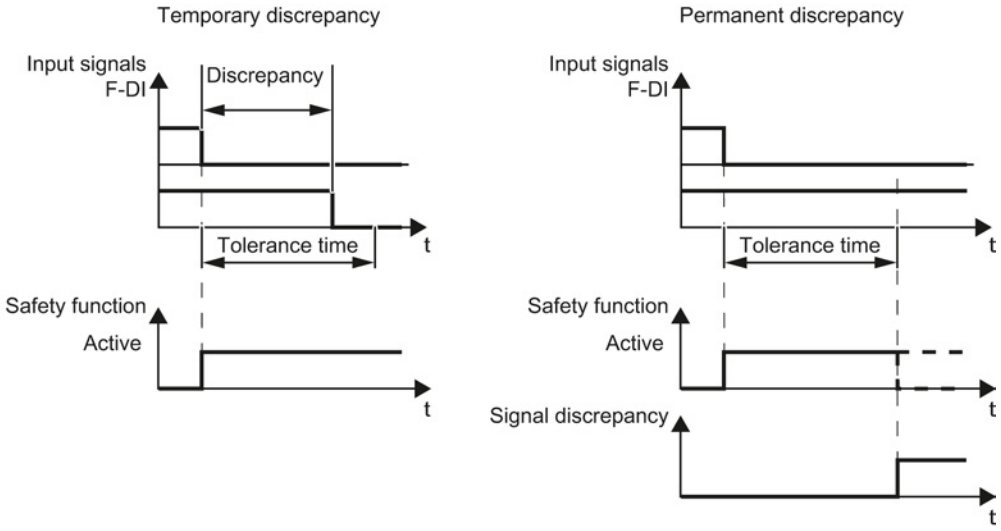



Figure 8-35 Tolerance regarding discrepancy

## 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.

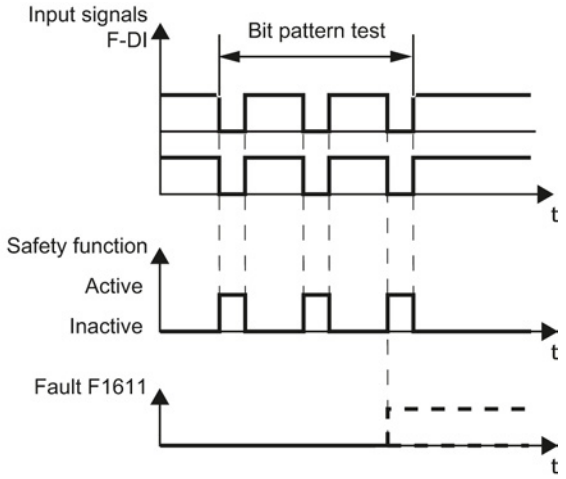



Figure 8-36 Inverter response to a bit pattern test

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.

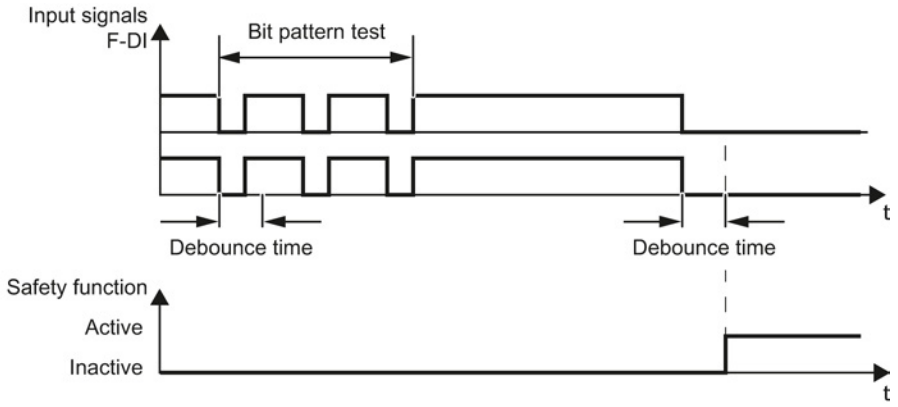



Figure 8-37 Filter for suppressing temporary signal changes

| Parameter | Description |
|---|---|
| p9650 | **F-DI changeover tolerance time** (factory setting: 500 ms)<br>Tolerance time to change over the fail-safe digital input for the basic functions. |
| p9651 | **STO debounce time** (factory setting: 1 ms)<br>Debounce time of the fail-safe digital input for the basic functions. |

#### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

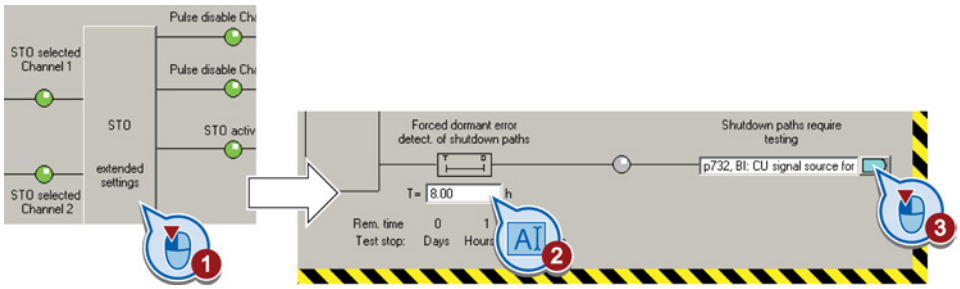
If you use an input as a fail-safe input, set the debounce time as described above.

### 8.8.3.7 Setting forced dormant error detection

#### Procedure

To set forced dormant error detection of the basic functions, proceed as follows:

1. Select the advanced settings for STO.




2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced dormant error detection is required.

   Interconnect this signal - for example - with a digital output of your choice.

You have set the forced dormant error detection for the basic functions.

## Description of the forced dormant error detection

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the inverter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

#### Forced dormant error detection of the basic functions

The forced dormant error detection of the basic functions is the regular self-test of the inverter that causes the inverter to check its circuits to switch-off the torque. If you use the Safe Brake Relay, for a forced dormant error detection, the inverter also checks the circuits of this option module.

The inverter executes a forced dormant error detection under the following circumstances:

- every time the supply voltage is connected.
- every time after the STOfunction has been selected.

The inverter monitors the regular forced dormant error detection.

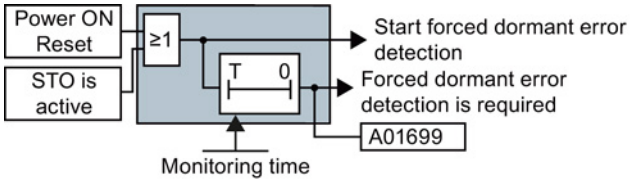



Figure 8-38 Triggering and monitoring the forced dormant error detection

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

### Time of the forced dormant error detection

In the case of warning A01699 , you must initiate a forced dormant error detection at the next opportunity. These alarms do not affect the operation of your machine.

- Switch off the motor.
- Select function STO or switch off the inverter supply voltage temporarily and on again.

### Examples for the times when forced dormant error detection is performed:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent).

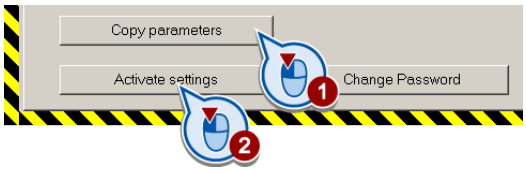
### 8.8.3.8 Activate settings

#### Activate settings

**Procedure**

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.




2. Press the "Activate settings" button.
3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
4. Confirm the prompt for saving your settings (copy RAM to ROM).
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark (no voltage condition).
7. Switch on the inverter supply voltage again.

Your settings are now active.

| Parameter | Description |
|---|---|
| p9700 = 57 hex | **SI copy function** (factory setting: 0)<br>Start copy function SI parameter. |
| p9701 = AC hex | **Confirm data change** (factory setting: 0)Confirm data change overall. |
| p0010 = 0 | **Drive commissioning parameter filter**<br>0: Ready |
| p9761 | **Enter a password** (factory setting 0000 hex)<br>Permissible passwords lie in the range 1 … FFFF FFFF. |
| p9762 | **New password** |
| p9763 | **Confirm password** |

### 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.

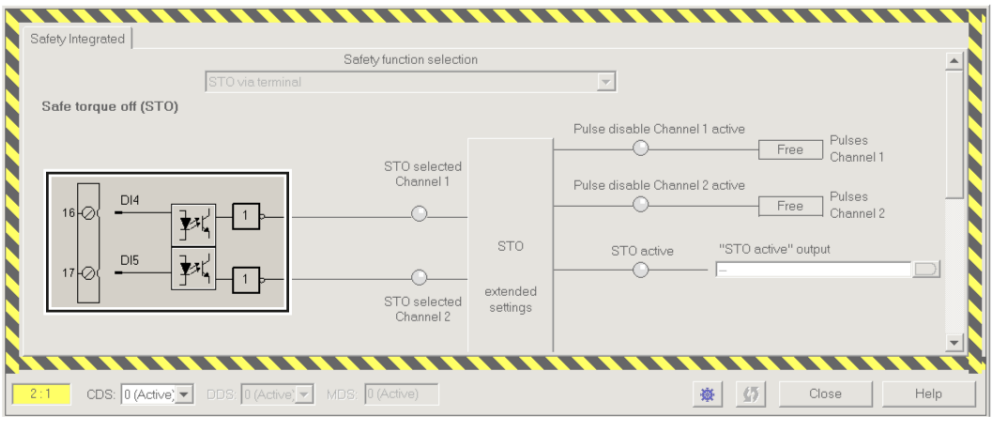



Figure 8-39 Example: Assignment of digital inputs DI 4 and DI 5 with STO

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

1
2

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:

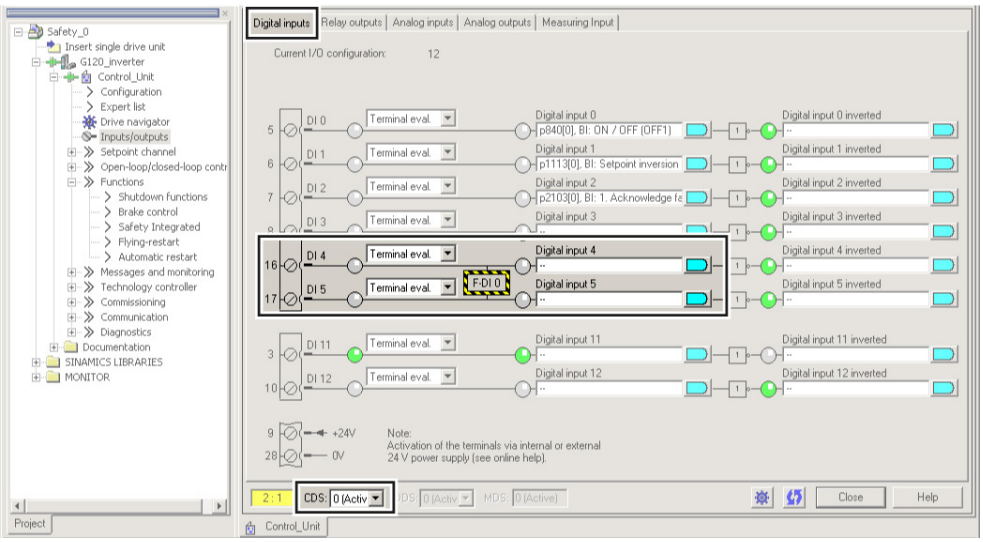



Figure 8-40 Remove pre-assignment of digital inputs DI 4 and DI 5

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 Acceptance - completion of 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

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- 39 Reduced scope of acceptance test for function expansions

| Measure | Acceptance test | |
|---|---|---|
| | Acceptance test | Documentation |
| Replacing the Control Unit. | No.<br>Only check the direction of rotation of the motor. | • Supplement inverter data<br>• Log the new checksums<br>• Countersignature |
| Replacing the Power Module. | | Supplement the hardware version in the inverter data |
| Replacing the motor. | | No change. |
| Replacing the gearbox. | | |
| Replacing safety-related peripherals (e.g. Emergency Stop switch). | No.<br>Only check the control of the safety functions that are influenced by the components that have been replaced. | No change. |
| Inverter firmware update. | No. | • Supplement firmware version in the inverter data<br>• Log the new checksums<br>• Countersignature. |
| Functional expansion of the machine (additional drive). | Yes.<br>Only check the safety functions of the new drive. | • Supplement machine overview<br>• Supplement inverter data<br>• Add function table<br>• Supplement limit values<br>• Log the new checksums<br>• Countersignature |
| Transfer of inverter settings to other identical machines by means of series commissioning. | No.<br>Only check the control of all of the safety functions. | • Add machine description<br>• Check checksums<br>• Check firmware versions |

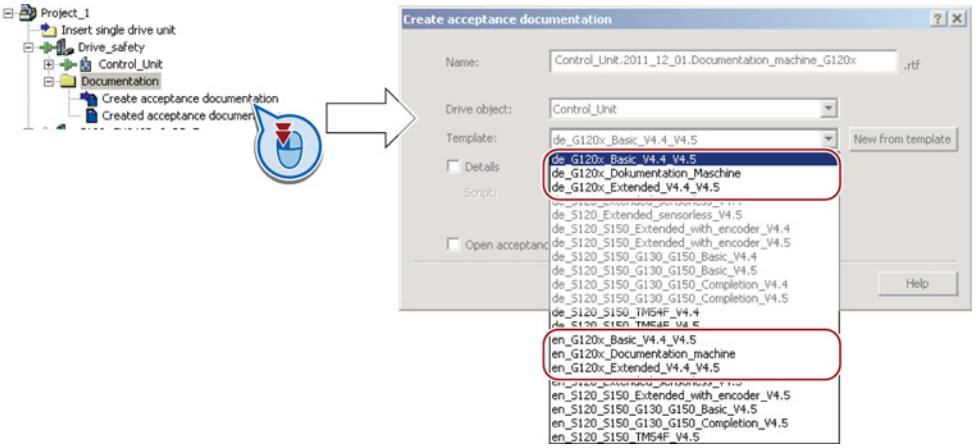
## Documents for acceptance

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

### Procedure

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

1. In STARTER, select "Create acceptance documentation":




   STARTER has templates in German and English.

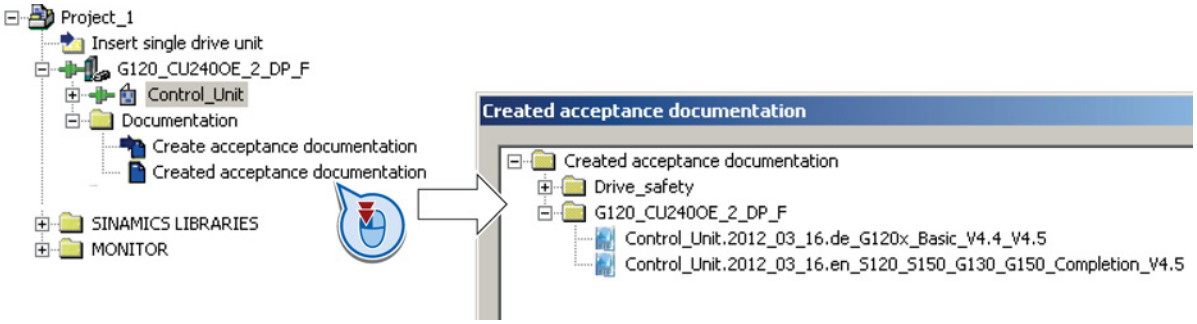
2. Select the suitable template and create a report for each drive of your machine or system:
   - Template for the machine documentation:

     de_G120x_Dokumentation_Maschine: German template.

     en_G120x_Documentation_machine: English template.
   - Report of the settings for the basic functions, from firmware version V4.4 onwards:

     de_G120x_Basicc_V4.4…: German report.

     en_G120x_Basic_V4.4…: English report.
3. You load the created reports for archiving and the machine documentation for further processing:




4. Archive the reports and the machine documentation.

You have generated the documents to accept the safety functions.

The reports and the machine documentation can also be found in the section: Documentation for accepting the safety functions (Page 458).

## 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

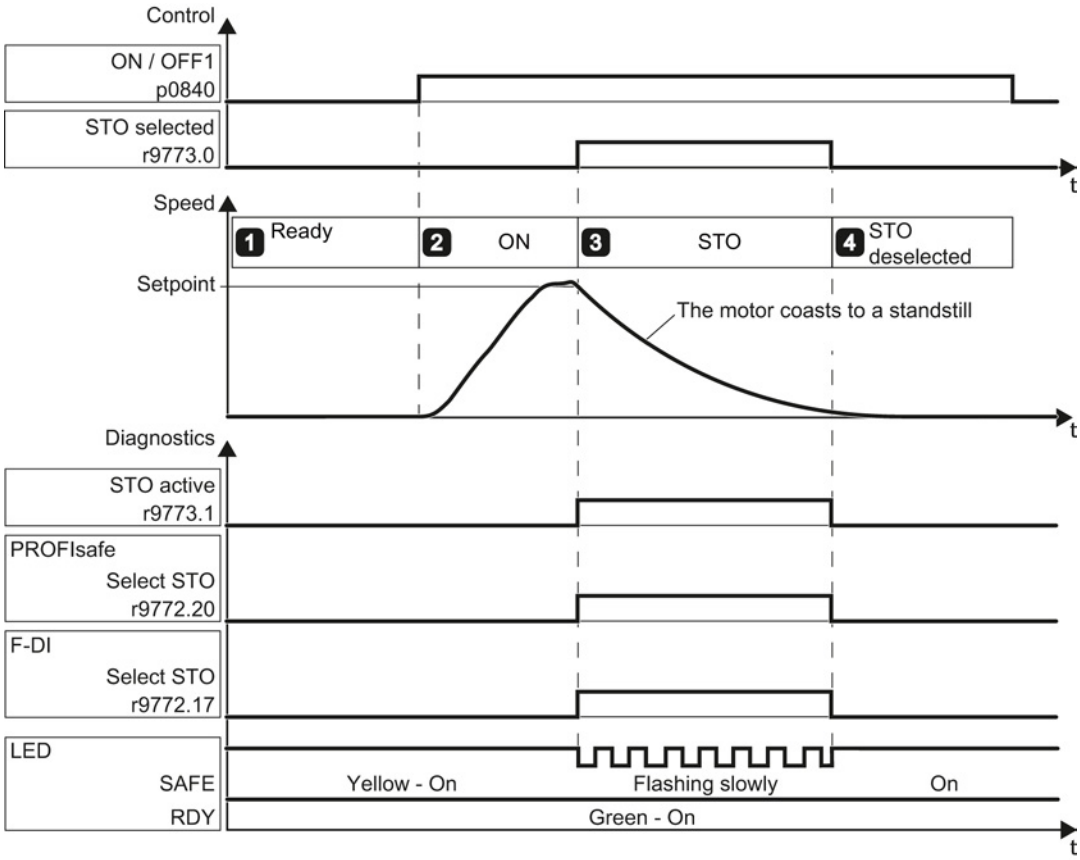



Figure 8-41 Acceptance test for STO (basic functions)

### Procedure

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

| | | | | Status |
|---|---|---|---|---|
| 1. | **The inverter is ready** | | | |
| | • The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]). | | | |
| | • STO is not active (r9773.1 = 0). | | | |
| 2. | **Switch on motor** | | | |
| | 2.1. | Enter a speed setpoint ≠ 0. | | |
| | 2.2. | Switch on the motor (ON command). | | |
| | 2.3. | Check that the correct motor is running. | | |
| 3. | **Select STO** | | | |
| | 3.1. | Select STO while the motor is running<br>*Test each configured activation, e.g. via digital inputs and PROFIsafe.* | | |
| | 3.2. | Check the following: | | |
| | | When controlled by PROFIsafe | For control via terminal | |
| | | • The inverter signals the following:<br>"STO selection via PROFIsafe" (r9772.20 = 1) | • The inverter signals the following:<br>"STO Selection via terminal" (r9772.17 = 1) | |
| | | • If a mechanical brake is not available, the motor coasts down.<br>A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill. | | |
| | | • The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]). | | |
| | | • The inverter signals the following:<br>"STO is selected" (r9773.0 = 1).<br>"STO is active" (r9773.1 = 1). | | |
| 4. | **Deselect STO** | | | |
| | 4.1. | Deselect STO. | | |
| | 4.2. | Check the following: | | |
| | | • STO is not active (r9773.1 = 0). | | |
| | | • The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]). | | |

You have performed the acceptance test of the STO function.

# 8.9 Switchover between different settings

There are applications that require different inverter settings.

**Example:**

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

## Drive data sets (DDS)

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

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

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

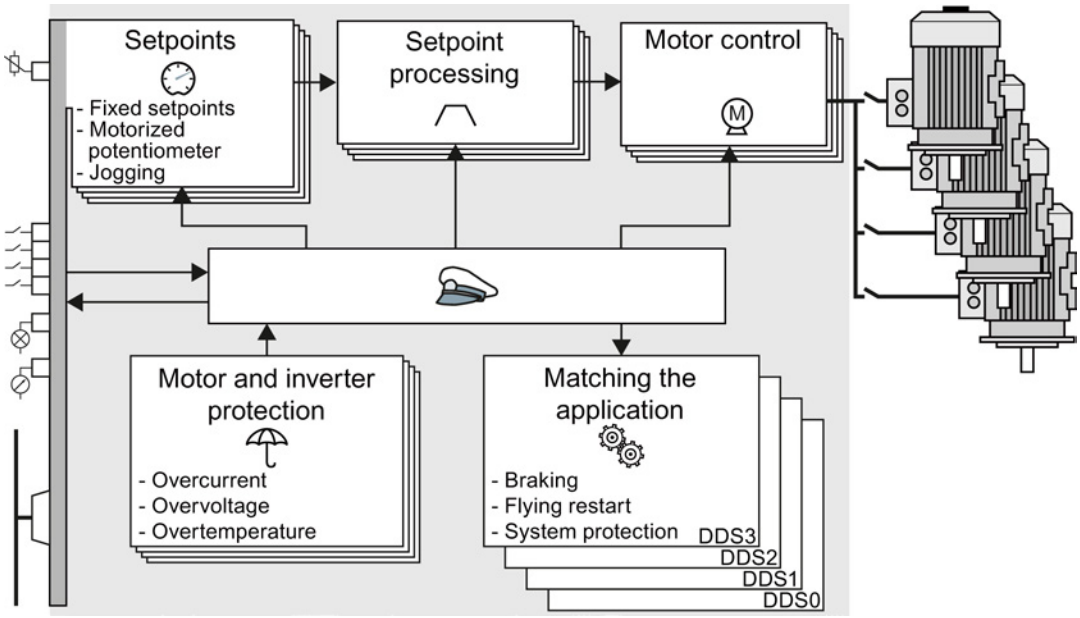



Figure 8-42 Switching over between different settings using drive data sets (DDS)

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

Table 8- 40 Selecting the number of **drive data sets**

| Parameter | Description |
|---|---|
| p0010 = 15 | **Drive commissioning:** Data sets |
| p0180 | **Drive data sets (DDS) number**(factory setting: 1) |
| p0010 = 0 | **Drive commissioning:** Ready |

Table 8- 41 Parameters for switching the drive data sets:

| Parameter | Description | |
|---|---|---|
| p0820[0…n] | **Drive data set selection DDS bit 0** | If you use several command data sets CDS, then you must set this parameter for each CDS. The parameters are assigned to a CDS through their index:<br>CDS0: p0820[0], p0821[0]<br>CDS1: p0820[1], p0821[1]<br>… |
| p0821[0…n] | **Drive data set selection DDS bit 1** | |
| p0826 | **Motor changeover, motor number**<br>Each drive data set is assigned a motor number:<br>p0826[0] = motor number for drive data set 0.<br>…<br>p0826[3] = motor number for drive data set 3.<br>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.<br>If you operate different motors on one inverter, then you must number the motors in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms. | |
| r0051 | **Displaying the number of the DDS that is currently effective** | |

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

Table 8- 42 Parameters for copying the drive data sets

| Parameter | Description |
|---|---|
| p0819[0] | **Source drive data set** |
| p0819[1] | **Target drive data set** |
| p0819[2] = 1 | **Start copy operation** |

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

# Backing up data and series commissioning 9

## External data backup

After commissioning, your settings are saved in the inverter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the inverter. Without backup, your settings could be lost if the inverter developed a defect (see also Replacing a Control Unit with enabled safety function (Page 345)).

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

---

Note

**Data backup using operator panels with USB connection with the PG/PC is not possible**

If the inverter is connected to a PG/PC via a USB cable, you can save any data on the memory card using an operator panel.

- Before you save data to the memory card using an operator panel, disconnect the USB connection between the PG/PC and inverter.

---

## Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

### Precondition

The Control Unit to which the settings are transferred has the same order number and the same or a higher firmware version as the source Control Unit.

### Overview

You must proceed as follows to carry out series commissioning:

1. Commission the first 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.

See also the following sections:

- Saving settings on a memory card (Page 325)
- Saving settings on a PC (Page 332)
- Saving settings on an operator panel (Page 334)

# 9.1 Saving settings on a memory card

## What memory cards do we recommend?

You will find the recommended memory cards in Section: Overview of Control Units (Page 24).

## Using memory cards from other manufacturers

The inverter only supports memory cards up to 2 GB. SDHC cards (SD High Capacity) and SDXC cards (SD Extended Capacity) are not permitted.

If you use other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 16 or FAT 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat or format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

## Functional restrictions with memory cards from other manufacturers

The following functions are either not possible – or only with some restrictions – when using memory cards from other manufacturers:

- Licensing functions is only possible using a recommended memory card.
- Know-how protection is only possible using a recommended memory card.
- Under certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the inverter.

## 9.1.1 Saving setting on memory card

We recommend that you insert the memory card before switching on the inverter. The inverter always also backs up its settings on an inserted card.

If you wish to backup the inverter settings on a memory card, you have two options:

### Automatically backing up

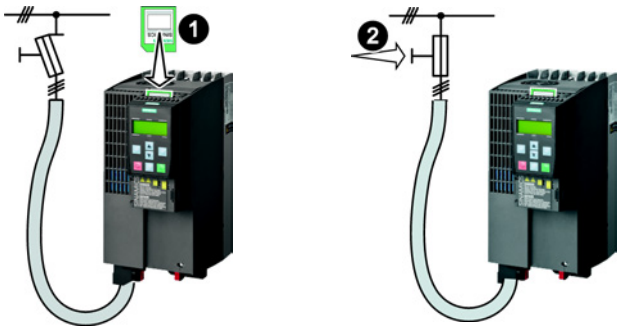
#### Preconditions

- The inverter power supply has been switched off.
- No USB cable is inserted in the inverter.

#### Procedure

Proceed as follows to automatically backup your settings:

1. Insert an empty memory card into the inverter.
2. Then switch-on the inverter power supply.



After it has been switched on, the 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 data then overwrites the data in the inverter.

- Only use empty memory cards to automatically backup your settings.

### Manually backing up

#### Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

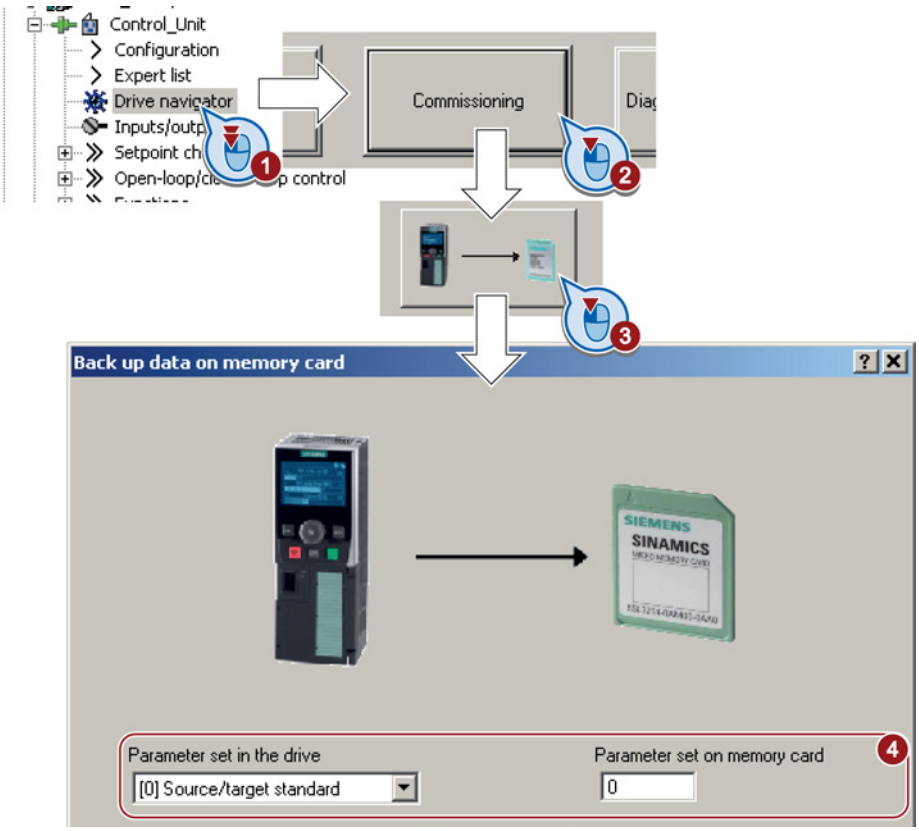
**Procedure**

Proceed as follows to backup your settings on a memory card using STARTER:

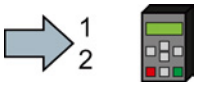
1. Go online with STARTER, e.g. via a USB cable.

   In STARTER, press the "Copy RAM to ROM" button .

   In your drive, select "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.



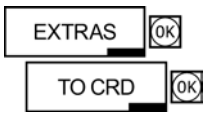

You have backed up the settings on the memory card using STARTER.



**Procedure**

Proceed as follows to backup your settings on a memory card using BOP-2:

1. Remove the USB cable if one is inserted in the inverter.
2. Plug a BOP-2 onto the inverter.
3. Go to the menu level "EXTRAS".
4. In the menu, select "EXTRAS" - "TO CRD".




You have backed up the settings on the memory card using BOP-2.

## 9.1.2 Transferring the setting from the memory card

### Automatically transferring

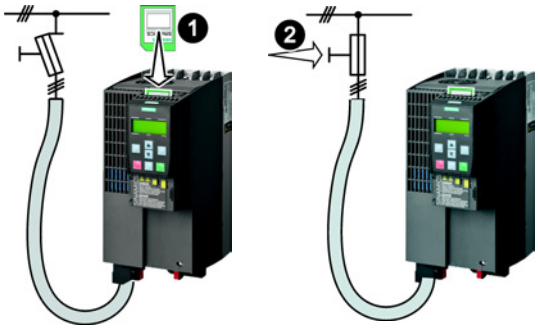
**Precondition**

The inverter power supply has been switched off.

**Procedure**

Proceed as follows to automatically transfer your settings:

1. Insert the memory card into the inverter.
2. Then switch on the inverter power supply.



If there is valid parameter data on the memory card, then the inverter accepts the data from the memory card.

### Manually transferring

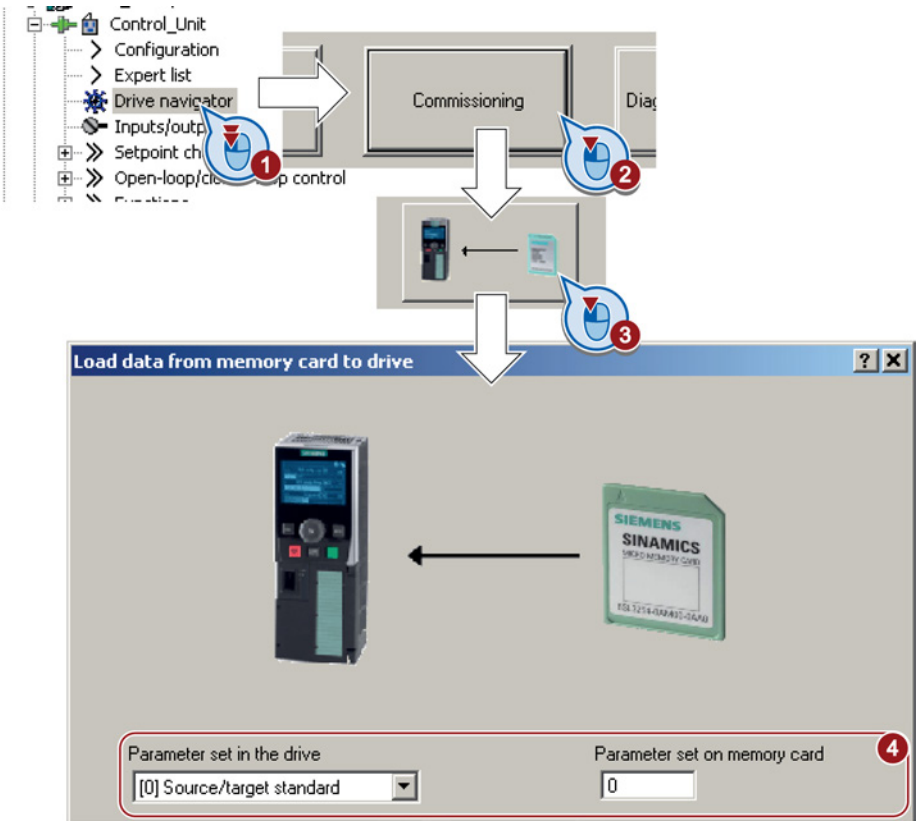
**Preconditions**

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

**Procedure**

Proceed as follows to transfer settings from a memory card using STARTER:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.




5. Close the screen forms.
6. Go offline with STARTER.
7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark.
9. Switch on the inverter power supply again.

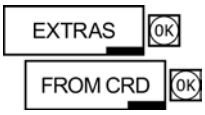
   Your settings become effective after this power-on reset.

You have transferred the settings from the memory card using STARTER.

### Procedure

Proceed as follows to transfer settings from a memory card using BOP-2:

1. Remove the USB cable if one is inserted in the inverter.
2. Attach the BOP-2 operator panel to the inverter.
3. Go to the menu level "EXTRAS".
4. Start data transfer in the menu "EXTRAS" - "FROM CRD".




5. Switch off the inverter power supply.
6. Wait until all LED on the inverter go dark.
7. Switch on the inverter power supply again.

   Your settings take effect after this power-on reset.

You have transferred the settings from the memory card using BOP-2.

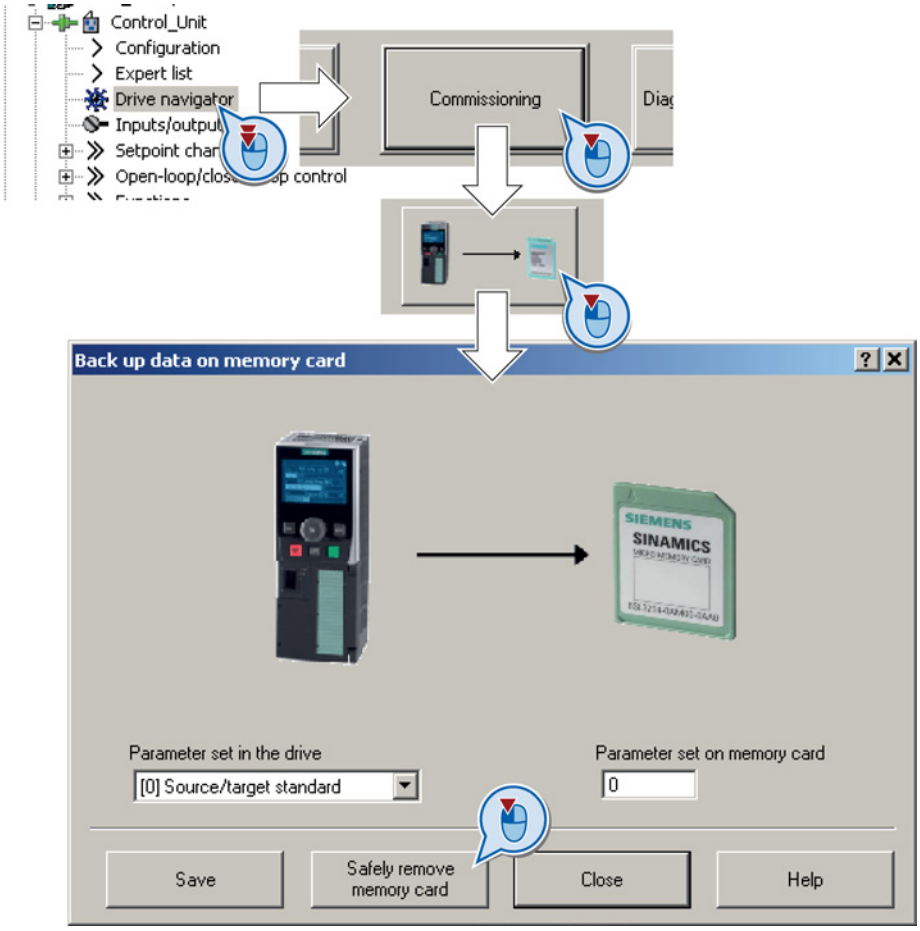
### 9.1.3 Safely remove the memory card

| NOTICE |
| --- |
| **Destruction of files on the memory card when the memory card is removed**<br>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.<br>Only remove the memory card using the "safe removal" function. |

**Procedure**

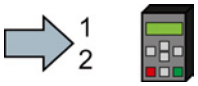
To safely remove the memory card using STARTER, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



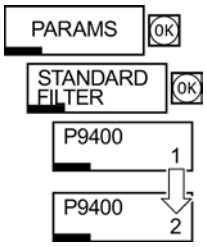

2. Click on the button to safely remove the memory card.
3. You may remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card using STARTER.




**Procedure**

To safely remove the memory card using BOP-2, proceed as follows:




1. Go to parameter p9400. If a memory card is correctly inserted, then p9400 = 1.
2. Set 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.

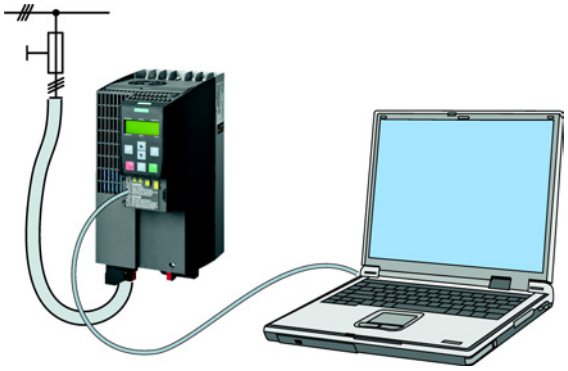
You have now safely removed the memory card using BOP-2.

## 9.2 Saving settings on a PC

### Precondition

With the supply voltage switched on, you can transfer the inverter settings from the inverter to a PG/PC, or the data from a PG/PC to the inverter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.



You will find additional information about STARTER in Section Tools to commission the converter (Page 39).

### Inverter → PC/PG

#### Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

### PC/PG → inverter

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

#### Procedure without safety functions

To load the settings from the PG to the inverter, proceed as follows:

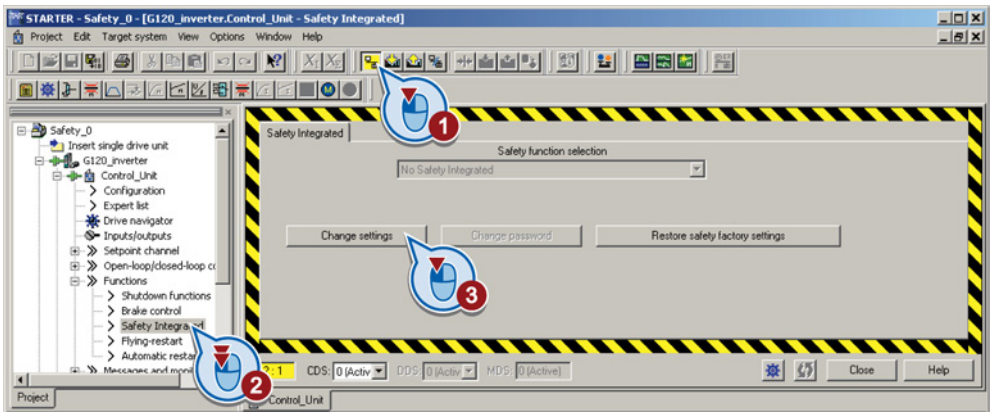
1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. To save the data in the inverter so that it is not lost when the power fails, select the "Copy RAM to ROM" button: .
4. Go offline with STARTER : .

You have transferred the settings from the PG to the inverter.

**Procedure with safety functions:**

To load the settings from the PG to the inverter and to activate the safety functions, proceed as follows:

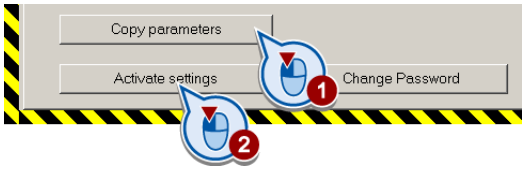
1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. Call the STARTER screen form for the safety functions.




You have transferred the settings from the PG to the inverter.

To activate the safety functions, proceed as follows:

1. Select the "Copy parameter" button.
2. Press the "Activate settings" button.




3. To save the data in the inverter, select the "Copy RAM to ROM" button: .
4. Go offline with STARTER : .
5. Switch off the inverter power supply.
6. Wait until all LED on the inverter go dark.
7. Switch on the inverter power supply again. Your settings only become effective after this power-on reset.

You have transferred the settings from the PG to the inverter and have activated the safety functions.

## 9.3 Saving settings on an operator panel

**Precondition**

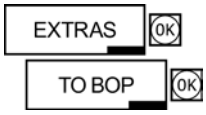
When the power supply is switched on, you can transfer the settings of the inverter to the BOP-2 or, vice versa, transfer the data from the BOP-2 to the inverter.

### Inverter → BOP-2

**Procedure**

To back up the settings, proceed as follows:

1. Start data transfer in the menu "EXTRAS" - "TO BOP".



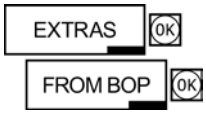

2. You have backed up the settings.

### 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.




2. You have transferred the settings.

## 9.4 Other ways to back up settings

In addition to the default setting, the inverter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

## 9.5 Write and know-how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

### 9.5.1 Write protection

Write protection prevents 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".

## Activate and deactivate write protection

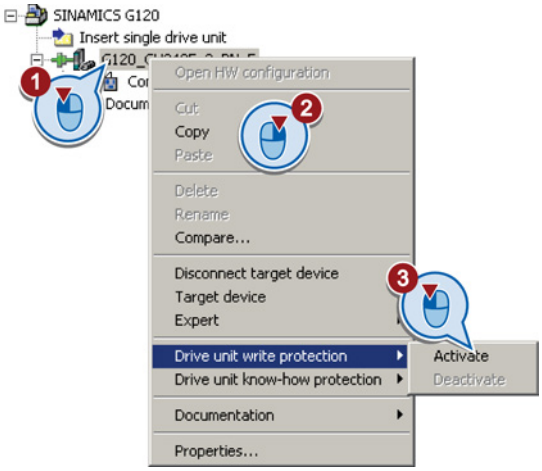
### Precondition

You are online with STARTER.

### Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the inverter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate or deactivate write protection.
4. Press the "Copy RAM to ROM" button . Otherwise, your settings will be lost when the 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

The know-how protection is used to encrypt configuring/engineering know-how, and protect it against being changed or copied.

In the case of active know-how protection, support by technical support personnel is only possible with the consent of the machine manufacturer.

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 recommended Siemens memory card, also see Section: Overview of Control Units (Page 24))

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".

### Commissioning the inverter with know-how protection

**Procedure - overview**

Proceed as follows to commission an inverter with know-how protection:

1. Commission the inverter.
2. Create the exception list (Page 340).
3. Activate the know-how protection (Page 338).
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

**Preconditions**

- You are online with STARTER.

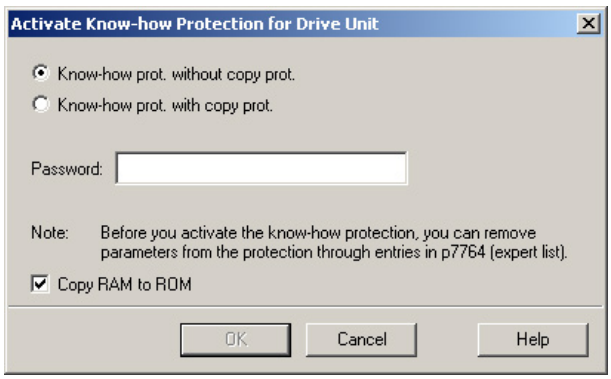
  If you have created a project offline on your computer, you must download it to the inverter and go online.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 24).

**Procedure**

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 335)).
2. Enter your password. Length of the password: 1 … 30 characters.

   For the password, we recommend that you only use characters from the ASCII character set. If you use any character for the password, then if changes are made to the Windows language settings after activating know-how protection, errors can occur when subsequently checking the password.




3. In this screen form, press the "Copy RAM to ROM" button. This means that you save your settings so that they are protected against power failure.

You have activated know-how protection.

### Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

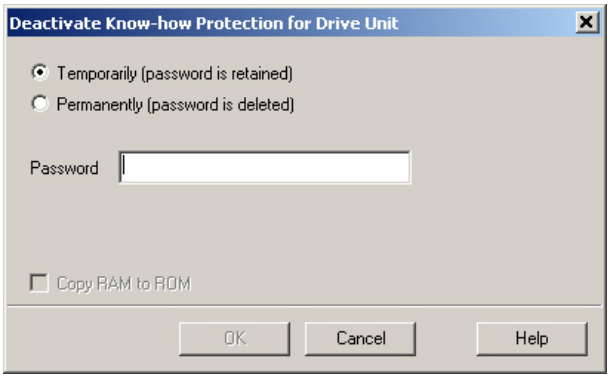
## Deactivate know-how protection, delete password

### Preconditions

- You are online with STARTER.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 24).

### Procedure

Proceed as follows to deactivate know-how protection:




1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.

   Temporary status:

   Know-how protection is active again after switching the power supply off and on.

   Final status:
   - If you select "Copy RAM to ROM", the inverter immediately deletes the password.
   - If you do not select "Copy RAM to ROM", the inverter deletes the password the next time that the supply voltage is switched off.
3. Enter the password and exit the screen form with OK.

You have deactivated know-how protection.

## Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

## 9.5.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

**Procedure**

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ( ).
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

---

**Note**

**Block access to the inverter as a result of incomplete exception lists**

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

---

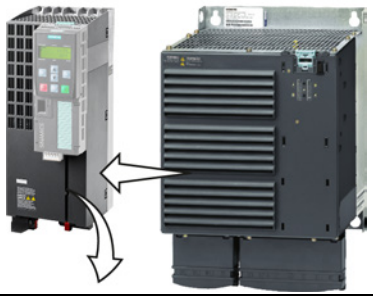
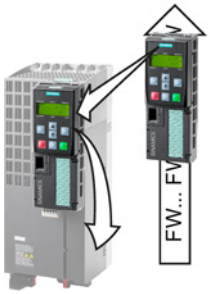
# Corrective maintenance

# 10

## 10.1 Overview of replacing converter components

### Permissible replacement of components

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

| Replacing the Power Module | | Replacing the Control Unit | |
|---|---|---|---|
| Replacement:<br>• Same type<br>• Same power rating | Replacement:<br>• Same type<br>• *Higher* power rating | Replacement:<br>• Same type<br>• Same firmware version | Replacement:<br>• Same type<br>• *higher* firmware version (e.g. replace FW V4.2 by FW V4.3) |
| |  | |  |
| | 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

**Precondition**

You have a memory card with the actual settings of the Control unit to be replaced.

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

**Procedure**

1
2

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 (Page 315).

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

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

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

### Procedure

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the 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 (Page 315).

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)

### Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

**Procedure**

To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. 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 p0010 to 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 (Page 315).

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

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

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

**Procedure**

Proceed as follows to exchange the Control Unit:

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

     The settings that have been loaded are not compatible with the inverter.

     Clear the alarm with p0971 = 1, and recommission the drive.
   - No alarm A01028:

     The inverter accepts the settings that have been loaded.

You have successfully replaced the Control Unit.

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

### Procedure

Proceed as follows to exchange the Control Unit:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit onto the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the project that matches the drive in STARTER.
8. Go online and transfer the settings from the PC into the inverter by pressing the button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. Save your settings (copy RAM to ROM ).

You have successfully replaced the Control Unit.

## 10.4 Replacing the Control Unit without data backup

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

**Procedure**

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

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

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

## 10.5 Replacing a Control Unit with active know-how protection

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

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

See also:

- Saving setting on memory card (Page 326)
- Transferring the setting from the memory card (Page 328)

### 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 345)".

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 338)
  - 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 338)
  - writes the configuration with p0971 = 1 to the memory card
  - sends the memory card to the end customer
- The end customer inserts the memory card and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

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

**Option 2: The machine manufacturer knows the serial number of the new inverter and the serial number of the memory card**

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 338)
  - 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 338)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

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

## 10.6 Replacing a Power Module with enabled safety function

**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 (Page 315).

You have successfully replaced the Power Module.

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

**Procedure**

Proceed as follows to exchange a Power Module:

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

| DANGER |
|---|
| **Risk of electric shock from touching inverter connections**<br>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.<br>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**<br>The direction in which the motor rotates switches if you exchange the two phases of the motor line.<br>Connect the three phases of the motor lines in the right order.<br>After exchanging the power module check the direction in which the motor rotates. |

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

You have successfully replaced the Power Module.

## 10.8 Replacing an encoder

### Same interface, same encoder type

If you have to replace a defective encoder, then it is best if you use the same encoder type. In this case, carry out the steps described in section "Replacing the encoder - same encoder type (Page 355)".

### Same interface, different encoder type

If you use an encoder of different type, carry out the steps described in section "Replacing the encoder - different encoder type (Page 356)".

### Different interface

If you connect the encoder through a different interface, you must carry out the commissioning procedure again, see section Configuring a drive (Page 87).

## 10.8.1 Replacing the encoder - same encoder type

**Procedure**

1
2

Proceed as follows to replace a defective encoder by a new encoder of the same type:

1. Switch off the inverter power supply, including the external 24 V supply for the Control Unit and digital outputs.
2. Replace the encoder. Connect the encoder cable shield as specified, also see Section: Connecting inverters in compliance with EMC (Page 67).
3. Switch on the supply voltages.
4. If you have replaced an absolute encoder, and you use this encoder to sense positions, then you must adjust the encoder. Additional information on this topic is available in Section "Function Manual, Basic Positioner", also see Section: Manuals for your converter (Page 461).

You have replaced the encoder.

## 10.8.2 Replacing the encoder - different encoder type

### Precondition

You have backed up the actual inverter settings to your PC using STARTER.

### Procedure

Proceed as follows to replace an encoder by another encoder type:

1. Switch off the inverter power supply, including the external 24 V supply for the Control Unit and the digital outputs.
2. Remove the encoder to be replaced.
3. Switch on the supply voltages.
4. Change the encoder data in STARTER (see below).
5. Acknowledge the changes by pressing OK and save the data to your computer ( ).
6. Go online ( ).
7. Select the inverter in the navigation bar ( G120_CU250S_2 ) and load the settings from the PG to the inverter ( ).
8. In the following screen form, set the check mark to "Copy RAM -> ROM after loading".
9. Go offline ( ).
10. Connect the new encoder.

    Connect the encoder cable shield as specified, also see Section: Connecting inverters in compliance with EMC (Page 67).
11. Switch on the supply voltages.
12. Check that the drive functions correctly.

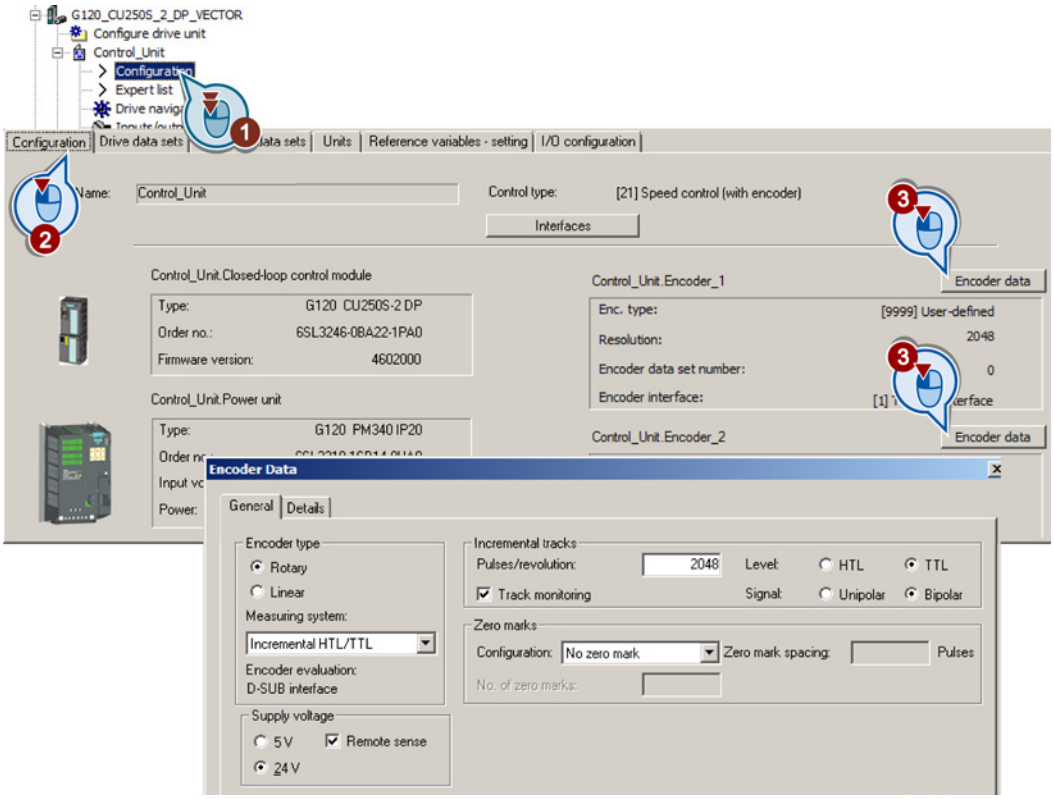
You have replaced the encoder with another encoder type.

## Changing the encoder data

### Procedure

To change the encoder data, proceed as follows:

1. From the navigation bar, open the screen form "Control_Unit/Configuration".
2. Select the "Configuration" tab.
3. Select the "Encoder data" button.
4. Change the encoder data.




You have changed the encoder data.

## 10.9 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.

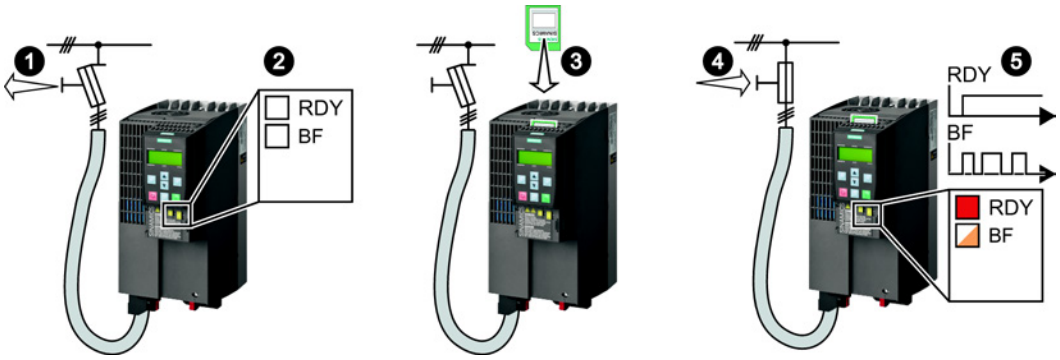
### Procedure

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**

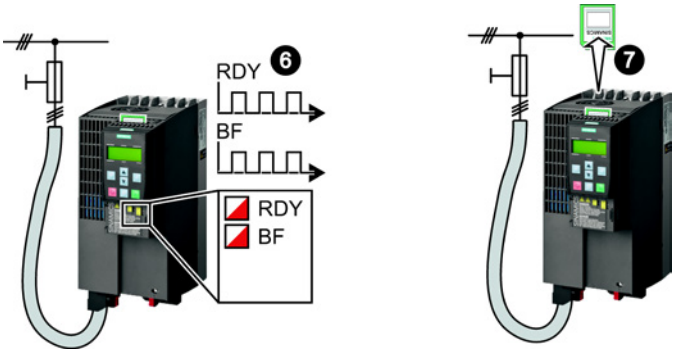
**Corrupted firmware if the power supply fails during the transfer**

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

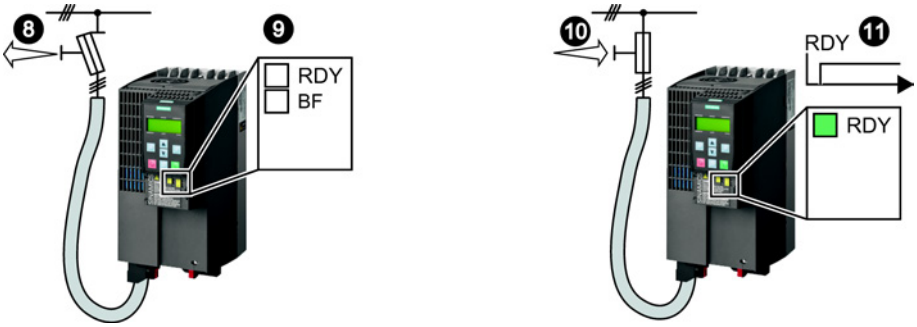
- Do not switch off the inverter power supply as long as data is being transferred.

---

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.

## 10.10 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.

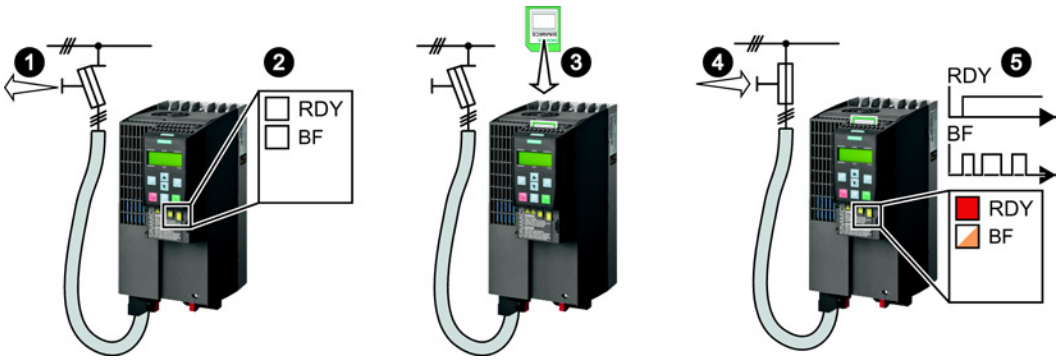
### Procedure

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**

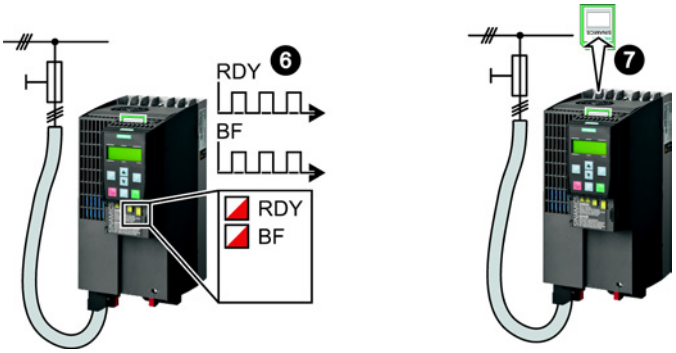
**Corrupted firmware if the power supply fails during the transfer**

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

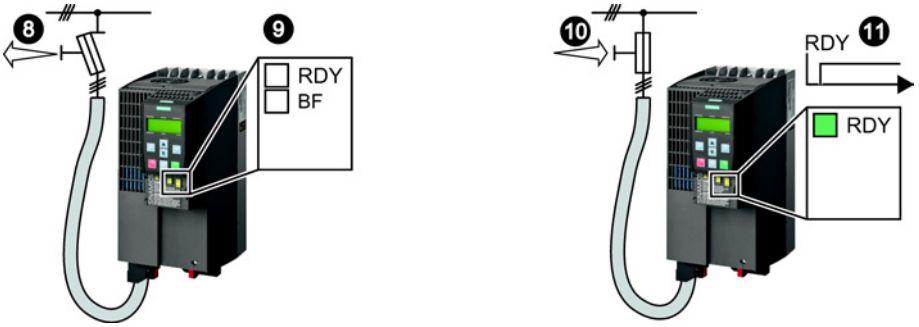
- Do not switch off the inverter power supply as long as data is being transferred.

---

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.

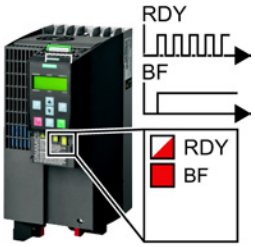
    See also Section: Backing up data and series commissioning (Page 323).

You have downgraded the firmware of the inverter to an older version and have transferred the backed up settings into the inverter.

# 10.11 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.

## 10.12 If the converter no longer responds

### If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

**Case 1**

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

**Procedure**

1
2

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018:
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.

You have restored the inverter factory settings.

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

Procedure

Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter factory settings.

## 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.
- Has the inverter been completely commissioned 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 some enable signals (r0046)?
- How does the inverter receive its setpoint and commands?

  Digital inputs, analog inputs or fieldbus?

# Alarms, faults and system messages 11

The inverter has the following diagnostic types:

- LED

  The LED at the front of the inverter immediately informs you about the most important inverter states.

- 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:

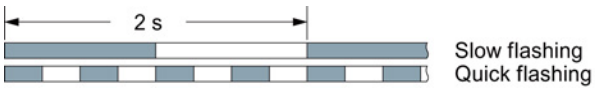



Table 11- 1 Inverter diagnostics

| 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 |
| Green / Red - slow | --- | Licensing is not sufficient, for details, see Activating licensed functions (Page 413) |

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<br>- no data exchange<br>- baud rate search<br>- 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 365).

| 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 368).

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.

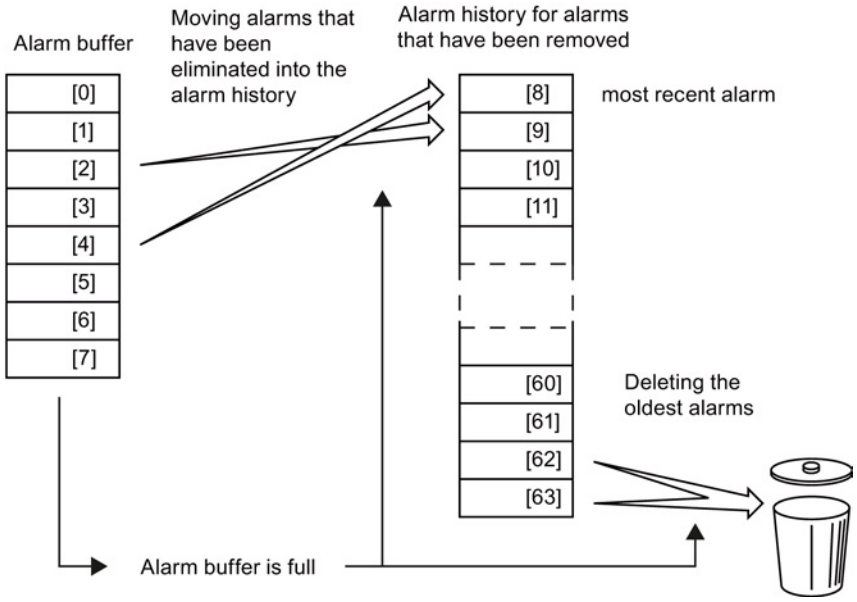



Figure 11-4 Shifting alarms that have been removed into the alarm history

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

## Extended settings for alarms

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

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

# 11.4 Faults

A fault indicates a severe fault during inverter operation.

The inverter signals a fault as follows:

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

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

Every fault has a unique fault code and also a fault value. You need this information to determine the cause of the fault.

## Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

| | Fault code | Fault value | | Fault time received | | Fault time removed | |
|---|---|---|---|---|---|---|---|
| 1st fault | r0945[0] | r0949[0] | 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 to parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter System runtime (Page 368).

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 by switching the supply voltage off and on again. The list of faults in the List Manual contains a 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 causes for the faults in the buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

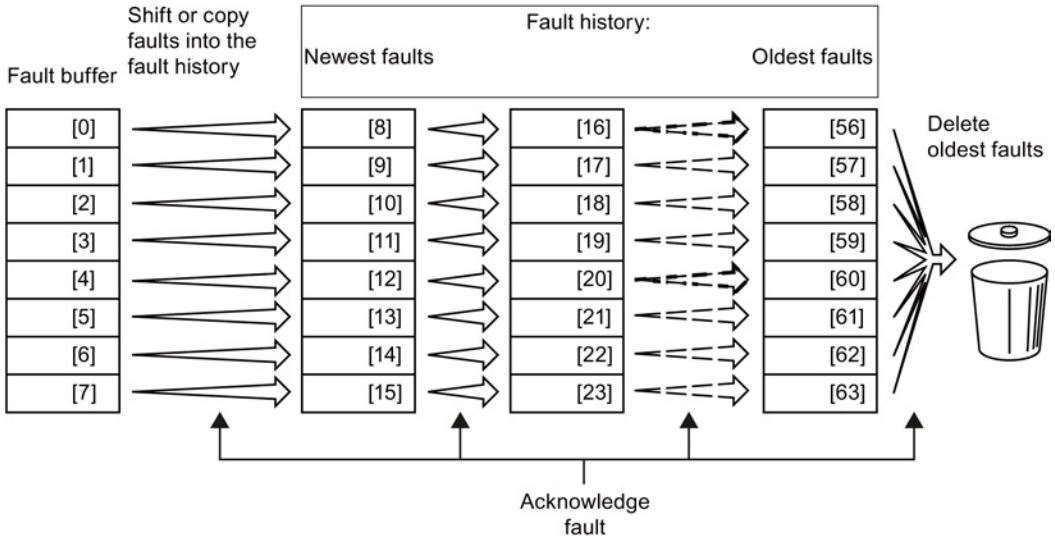



Figure 11-8 Fault history after acknowledging the faults

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

## Extended settings for faults

| Parameter | Description |
|---|---|
| You can change the fault response of the motor for up to 20 different fault codes: | |
| p2100 | **Setting the fault number for fault response**<br>Selection of the faults for which the fault response applies |
| p2101 | **Setting, fault response**<br>Setting the fault response for the selected fault |
| You can change the acknowledgement type for up to 20 different fault codes: | |
| p2126 | **Setting the fault number for the acknowledgement mode**<br>Selection of the faults for which the acknowledgement type should be changed |
| p2127 | **Setting, acknowledgement mode**<br>Setting the acknowledgement type for the selected fault<br>1: Can only be acknowledged using POWER ON<br>2: IMMEDIATE acknowledgement after removing the fault cause |
| You can change up to 20 different faults into an alarm or suppress faults: | |
| p2118 | **Setting the message number for the message type**<br>Selection of the message for which the message type should be changed |
| p2119 | **Setting the message type**<br>Setting the message type for the selected fault<br>1: Fault<br>2: Alarm<br>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.<br>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.<br>Remedy with operator panel: | |
| | | p0010 = 30 | Parameter reset |
| | | p9761 = … | Enter password for the safety functions. |
| | | p0970 = 5 | Reset Start Safety Parameter.<br>The converter sets p0970 = 5 if it has reset the parameters. |
| | | Then reset the converter to the factory setting again. | |
| A01666 | Static 1 signal atF-DI for safe acknowledgment | F-DI to a logical 0 signal. | |
| A01698 | Commissioning mode active for safety functions | This message is withdrawn after the Safety commissioning has ended. | |
| A01699 | Shutdown path test required | After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset. | |
| F30600 | STOP A Triggered | STO Select and then deselect again. | |

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

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

| Number | Cause | Remedy |
|---|---|---|
| F01662 | CU hardware fault | Switch CU off and on again, upgrade firmware, or contact technical support. |
| F30022 | Power Module: Monitoring $U_{CE}$ | Check or replace the Power Module. |
| F30052 | Incorrect Power Module data | Replace Power Module or upgrade CU firmware. |
| F30053 | Error in FPGA data | Replace the Power Module. |
| F30662 | CU hardware fault | Switch CU off and on again, upgrade firmware, or contact technical support. |
| F30664 | CU power up aborted | Switch CU off and on again, upgrade firmware, or contact technical support. |
| F30850 | Software fault in Power Module | Replace Power Module or contact technical support. |

Table 11- 8 The most important alarms and faults

| Number | Cause | Remedy |
|---|---|---|
| F01018 | Power-up aborted more than once | 1. Switch the module off and on again.<br>2. After this fault has been output, the module is booted with the factory settings.<br>3. Recommission the inverter. |
| A01028 | Configuration error | Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB).<br>Check the module parameters and recommission if necessary. |
| F01033 | Switching over units: Reference parameter value invalid | Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004). |
| F01034 | Switching over units: Calculation of the parameter values after reference value change unsuccessful | Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004). |
| A01053 | System overload measured | The maximum computing power of the control unit was exceeded. The following measures reduce the load on the control unit:<br>• Use only one data record (CDS and DDS)<br>• Only use the safety features of the basic functions<br>• De-activate the technology controller<br>• Use the simple ramp-function generator rather than the extended ramp-function generator<br>• Do not use any free function components<br>• Reduce the sampling time of the free function blocks |
| F01054 | System limit exceeded | |
| F01122 | Frequency at the probe input too high | Reduce the frequency of the pulses at the probe input. |
| F01303 | The DRIVE-CLiQ does not support the requested function | A function requested by the Control Unit is not supported by a DRIVE-CLiQ component. |
| A01590 | Motor maintenance interval lapsed | Carry out maintenance and reset the maintenance interval (p0651). |
| F01800 | DRIVE-CLiQ: Incorrect hardware/configuration | A DRIVE-CLiQ connection error has occurred.<br>Check the DRIVE-CLiQ cables at the Control Unit. |
| A01900 | PROFIBUS: Configuration telegram faulty | Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram.<br>Check the bus configuration on the master and slave side. |

| Number | Cause | Remedy |
|---|---|---|
| A01910<br>F01910 | Setpoint timeout | The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present:<br>• The bus connection is interrupted<br>• The Modbus master is switched off<br>• Communications error (CRC, parity bit, logical error)<br>• An excessively low value for the fieldbus monitoring time (p2040) |
| A01920 | PROFIBUS: Cyclic connection interrupt | Explanation: The cyclic connection to PROFIBUS master is interrupted.<br>Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation. |
| F03505 | Analog input, wire break | Check the wiring for interruptions.<br>Check the level of the injected signal.<br>The input current measured by the analog input can be read out in r0752. |
| A03520 | Temperature sensor fault | Check that the sensor is connected correctly. |
| A05000<br>A05001<br>A05002<br>A05004<br>A05006 | Power Module overtemperature | Check the following:<br>- Is the ambient temperature within the defined limit values?<br>- Are the load conditions and duty cycle configured accordingly?<br>- Has the cooling failed? |
| F06310 | Supply voltage (p0210) incorrectly set | Check the set supply voltage and if required change (p0210).<br>Check the line voltage. |
| F07011 | Motor overtemperature | Reduce the motor load.<br>Check ambient temperature.<br>Check the wiring and connection of the sensor. |
| A07012 | I2t Motor Module overtemperature | Check and if necessary reduce the motor load.<br>Check the motor's ambient temperature.<br>Check thermal time constant p0611.<br>Check overtemperature fault threshold p0605. |
| A07015 | Motor temperature sensor alarm | Check that the sensor is connected correctly.<br>Check the parameter assignment (p0601). |
| F07016 | Motor temperature sensor fault | Make sure that the sensor is connected correctly.<br>Check the parameterization (p0601).<br>Deactivate the motor temperature sensor fault evaluation (p0607 = 0). |
| F07086<br>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.<br>Increase the wait time in p1212 and/or monitoring time in p1213.<br>Connect an ON command (p0840).<br>Increase the monitoring time of the power unit or switch off (p0857).<br>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. |

| Number | Cause | Remedy |
|---|---|---|
| A07400 | DC link voltage maximum controller active | If it is not desirable that the controller intervenes:<br>• Increase the ramp-down time of the ramp-function generator (p1121, p1135).<br>• Deactivate the Vdc_max controller.<br>See also Section: Limiting the maximum DC link voltage (Page 258). |
| F07403 | Lower DC link voltage threshold reached | The DC link voltage monitoring is active (p1240 = 5, 6) and the lower DC link voltage threshold (p1248) was reached in the "Operation" state.<br>Check the following:<br>• Line voltage<br>• Infeed<br>Reduce the lower DC link voltage threshold (p1248). |
| F07404 | DC link voltage monitoring $V_{DCmax}$ | The DC link voltage monitoring p1284 has responded.<br>Check the following:<br>• Line voltage<br>• Braking resistor<br>• Device supply voltage (p210)<br>Increase the DC link voltage threshold (p1284). |
| A07409 | U/f control, current limiting controller active | The alarm automatically disappears after one of the following measures:<br>• Increase the current limit (p0640).<br>• Reduce the load.<br>• Slow down the up ramp for the setpoint speed. |
| F07412 | Commutation angle incorrect (motor model) | An incorrect commutation angle can result in positive feedback in the speed controller.<br>Check the motor phase sequence (wiring, p1820).<br>Adjust the encoder.<br>Replace the encoder.<br>Carry out motor data identification.<br>Carry out pole position identification. |
| F07413 | Commutation angle incorrect (pole position identification) | An incorrect commutation angle can result in positive feedback in the speed controller.<br>Check the motor phase sequence (wiring, p1820).<br>Adjust the encoder.<br>Replace the encoder.<br>Carry out pole position identification. |
| F07426 | Technology controller actual value limited | • Adapt the limits to the signal level (p2267, p2268).<br>• Check the actual value scaling (p2264). |

| Number | Cause | Remedy |
|---|---|---|
| F07801 | Motor overcurrent | Check current limits (p0640).<br>Vector control: Check current controller (p1715, p1717).<br>U/f control: Check the current limiting controller (p1340 … p1346).<br>Increase acceleration ramp (p1120) or reduce load.<br>Check motor and motor cables for short-circuit and ground fault.<br>Check the motor regarding the star/delta connection and rating plate parameterization.<br>Check power unit / motor combination.<br>Select flying restart function (p1200) if switched to rotating motor. |
| A07805 | Drive: Power unit overload I2t | • Reduce the continuous load.<br>• Adapt the load cycle.<br>• Check the assignment of rated currents of the motor and power unit. |
| F07806 | Regenerative power limit exceeded | Increase deceleration ramp.<br>Reduce driving load.<br>Use power unit with higher energy recovery capability.<br>For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated. |
| F07807 | Short-circuit detected | • Check the inverter connection on the motor side for any phase-phase short-circuit.<br>• Rule out that line and motor cables have been interchanged. |
| A07850<br>A07851<br>A07852 | External alarm 1 … 3 | The signal for "external alarm 1" has been triggered.<br>Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3.<br>Remedy: Remove the causes of these alarms. |
| F07860<br>F07861<br>F07862 | External fault 1 … 3 | Remove the external causes for this fault. |
| F07900 | Motor blocked | Check that the motor can run freely.<br>Check the torque limits (r1538 and r1539).<br>Check the parameters of the "Motor blocked" message (p2175, p2177). |
| F07901 | Motor overspeed | Activate the precontrol for the speed limiting controller (p1401 bit 7 = 1).<br>Increase hysteresis for overspeed signal p2162. |
| F07902 | Motor stalled | Check whether the motor data has been set correctly and perform a motor identification.<br>Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized.<br>Check whether motor cables are disconnected during operation. |
| A07903 | Motor speed deviation | Increase p2163 and/or p2166.<br>Increase the torque, current and power limits. |

| Number | Cause | Remedy |
|---|---|---|
| A07904 | External armature short-circuit: "Closed" contactor feedback signal missing | When closing, the contactor feedback signal (p1235) did not signal "closed" (r1239.1 = 1) within the monitoring time (p1236).<br>Check the following:<br>• Has the contactor feedback signal been incorrectly connected (p1235)?<br>• Contactor feedback signal logic (r1239.1 = 1: "Closed", r1239.1 = 0: "Open").<br>Increase the monitoring time (p1236). |
| F07905 | External armature short-circuit: "Open" contactor feedback signal missing | When opening, the contactor feedback signal (p1235) did not signal "open" (r1239.1 = 0) within the monitoring time (p1236).<br>Check the following:<br>• Has the contactor feedback signal been incorrectly connected (p1235)?<br>• Contactor feedback signal logic (r1239.1 = 1: "Closed", r1239.1 = 0: "Open").<br>Increase the monitoring time (p1236). |
| A07908 | Internal armature short-circuit active | The motor is short-circuited via the power semiconductor (r1239.5 = 1). |
| F07909 | Internal voltage protection: Deactivation only active after POWER ON | The inverter has activated the "Internal voltage protection" function" (p1231 = 3). Deactivation of the internal voltage protection (p1231 not equal to 3) only becomes active after POWER ON. |
| A07910 | Motor overtemperature | Check the motor load.<br>Check the motor's ambient temperature.<br>Check the KTY84 sensor.<br>Check the overtemperatures of the thermal model (p0626 ... p0628). |
| A07920 | Torque/speed too low | The torque deviates from the torque/speed envelope curve.<br>• Check the connection between the motor and the load.<br>• Adapt the parameterization corresponding to the load. |
| A07921 | Torque/speed too high | |
| A07922 | Torque/speed out of tolerance | |
| F07923 | Torque/speed too low | • Check the connection between the motor and the load.<br>• Adapt the parameterization corresponding to the load. |
| F07924 | Torque/speed too high | |
| A07927 | DC braking active | Not required |
| F7966 | Check commutation angle | Carry out pole position identification. |
| F7969 | Pole position identification incorrect | An error has occurred during the pole position identification.<br>Check the following:<br>• Motor connection<br>• Motor data |
| A07980 | Rotary measurement activated | Not required |
| A07981 | No enabling for rotary measurement | Acknowledge pending faults.<br>Establish missing enables (see r00002, r0046). |
| A07991 | Motor identification activated | Switch on the motor and identify the motor data. |

| Number | Cause | Remedy |
|---|---|---|
| F07995 | Pole position identification unsuccessful | An error has occurred during the pole position identification.<br>Check the following:<br>• Motor connection<br>• Motor data |
| F08501 | Setpoint timeout | • Check the PROFINET connection.<br>• Set the controller into the RUN mode.<br>• If the fault occurs repeatedly, check the monitoring time set p2044. |
| F08502 | Monitoring time, sign-of-life expired | • Check the PROFINET connection. |
| F08510 | Send configuration data not valid | • Check the PROFINET configuration |
| A08511 | Receive configuration data not valid | |
| A08526 | No cyclic connection | • Activate the controller with cyclic operation.<br>• Check the parameters "Name of Station" and "IP of Station" (r61000, r61001). |
| A08565 | Consistency error affecting adjustable parameters | Check the following:<br>• IP address, subnet mask or default gateway is not correct.<br>• IP address or station name used twice in the network.<br>• Station name contains invalid characters. |
| A08800 | PROFIenergy energy-saving mode active | The PROFIenergy energy-saving mode is active.<br>The alarm automatically disappears when the energy-saving mode is exited. |
| A13000 | Licensing is not sufficient | You are using functions that require a license, but you don't have the appropriate licenses. See also Section: Activating licensed functions (Page 413). |
| F13010 | Licensing is not sufficient | Options requiring a license are used in the inverter, and the licensing is not<br>sufficient. |
| F13010 | Licensing, function module not licensed. | At least one function module requiring a license is not licensed.<br>Deactivate the function module that is not licensed. |
| F13101 | Know-how protection: Copy protection cannot be activated | Insert a valid memory card. |
| F30001 | Overcurrent | Check the following:<br>• Motor data, if required, carry out commissioning<br>• Motor connection method (Y / Δ)<br>• U/f operation: Assignment of rated currents of motor and Power Module<br>• Line quality<br>• Make sure that the line commutating reactor is connected properly<br>• Power cable connections<br>• Power cables for short-circuit or ground fault<br>• Power cable length<br>• Line phases |

| Number | Cause | Remedy |
|---|---|---|
| | | If this doesn't help:<br>• U/f operation: Increase the acceleration ramp<br>• Reduce the load<br>• Replace the power unit |
| F30002 | DC-link voltage overvoltage | Increase the ramp-down time (p1121).<br>Set the rounding times (p1130, p1136).<br>Activate the DC link voltage controller (p1240, p1280).<br>Check the line voltage (p0210).<br>Check the line phases. |
| F30003 | DC-link voltage undervoltage | Check the line voltage (p0210). |
| F30004 | Inverter overtemperature | Check whether the inverter fan is running.<br>Check whether the ambient temperature is in the permissible range.<br>Check whether the motor is overloaded.<br>Reduce the pulse frequency. |
| F30005 | I2t inverter overload | Check the rated currents of the motor and Power Module.<br>Reduce current limit p0640.<br>When operating with U/f characteristic: Reduce p1341. |
| F30011 | Line phase failure | Check the inverter's input fuses.<br>Check the motor feeder cables. |
| F30015 | Motor cable phase failure | Check the motor cables.<br>Increase the ramp-up or ramp-down time (p1120). |
| F30021 | Ground fault | • Check the power cable connections.<br>• Check the motor.<br>• Check the current transformer.<br>• Check the cables and contacts of the brake connection (a wire might be broken). |
| F30027 | Time monitoring for DC link pre-charging | Check the supply voltage at the input terminals.<br>Check the line voltage setting (p0210). |
| F30035 | Overtemperature, intake air | • Check whether the fan is running.<br>• Check the fan filter elements.<br>• Check whether the ambient temperature is in the permissible range. |
| F30036 | Overtemperature, inside area | |
| F30037 | Rectifier overtemperature | See F30035 and, in addition:<br>• Check the motor load.<br>• Check the line phases |
| A30049 | Internal fan defective | Check the internal fan and if required replace. |
| F30059 | Internal fan defective | Check the internal fan and if required replace. |
| A30502 | DC link overvoltage | • Check the unit supply voltage (p0210).<br>• Check the dimensioning of the line reactor. |
| A30920 | Temperature sensor fault | Check that the sensor is connected correctly. |
| A50001 | PROFINET configuration error | A PROFINET controller is attempting to establish a connection with an incorrect configuration telegram. Check to see whether "Shared Device" is activated (p8929 = 2). |

| Number | Cause | Remedy |
|---|---|---|
| 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

## 12.1 Technical data, CU250S-2 Control Unit

| Feature | Data | |
|---|---|---|
| Order numbers | 6SL3246-0BA22-1BA0 | With RS485 interface for the following protocols:<br>• USS<br>• Modbus RTU |
| | 6SL3246-0BA22-1PA0 | With PROFIBUSinterface. |
| | 6SL3246-0BA22-1FA0 | With RJ45 connector for the following fieldbuses:<br>• PROFINET<br>• EtherNet/IP |
| | 6SL3246-0BA22-1CA0 | With CANopen interface. |
| Operating voltage | You have two options for the Control Unit power supply:<br>• Supply from the Power Module.<br>The sum of all of the currents of the following interfaces is limited to 0.8 A:<br>– Encoder power supply<br>– Drive-Cliq<br>– Power supply for the operator panel<br>– Analog outputs<br>– 24 V output voltage (terminal 9)<br>– 24 V PROFIBUS teleservice<br>– Resolver excitation<br>If a short circuit occurs at the output terminals when the CU is fully loaded, then the Power Module overcurrent protection response, and the inverter is tripped with overcurrent (Power Module and Control Unit).<br>• External supply via terminals 31 and 32 with 20.4 ... 28.8 V DC, a maximum of 200 VA.<br>Use a DVC A power supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1, Class 2.<br>Example: SITOP Power 5 A power supply unit<br>The 0 V of the power supply must be connected with low resistance to the PE of the system. | |
| | The power supply is electrically isolated from the other terminal strip. | |
| Current consumption | max 0.5 A | |
| Power loss | 12.0 W | Plus power loss of the output voltages. |
| Output voltages | +24 V out (terminal 9) | 18 V … 26.8 V (max. 200 mA).<br>Depending on the operating voltage |
| | +10 V out (terminal 1) | 9.5 V … 10.5 V (max. 10 mA) |
| | HTL encoder (terminal 33) | Operating voltage - 2 V, max. 200 mA |

| Feature | Data | |
|---|---|---|
| | HTL encoder (pins 4 and 5 of the Sub-D connector on the lower side of the Control Unit) | Operating voltage - 2 V, max. 350 mA |
| | TTL encoder (pins 4 and 5 of the Sub-D connector on the lower side of the Control Unit) | 4.75 V … 5.25 V (max. 350 mA) |
| Setpoint resolution | 0.01 Hz | |
| Maximum frequency of the HTL encoder | 500 kHz | |
| Digital inputs | 11 fixed | • DI 0 … DI 6 and DI 16 … DI 19<br>• Electrically isolated |
| | 4 can be switched over | • DI 24 … DI 27<br>• Not isolated |
| | Common data | • Low < 5 V, high > 11 V<br>• 30 V maximum input voltage<br>• 5.5 mA current consumption<br>• SIMATIC-compatible<br>• 10 ms response time for debounce time p0724 = 0 |
| Pulse input | 1 (DI 3) | Maximum frequency 32 kHz |
| Analog inputs | 2 (AI 0, AI 1) | • Differential inputs<br>• Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V<br>• 120 Ω input resistance at 0 mA … 20 mA<br>• 12-bit resolution<br>• 13 ms ± 1 ms response time<br>• Analog input as additional digital input: Low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0 |
| Digital outputs | 3 fixed | • DO 0 … DO 2: Relay outputs, 30 V DC / max. 0.5 A with resistive load |
| | 4 can be switched over | • DO 24 … DO27: Transistor outputs<br>• Max. 0.1 A per output<br>• An external power supply is required via terminals 31 and 32<br>• 2 ms update time |
| | For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply. | |
| Analog outputs | 2 (AO 0, AO 1) | • 0 V … 10 V or 0 mA … 20 mA<br>• Reference potential: "GND"<br>• 16-bit resolution<br>• 4 ms update time |

| Feature | Data | |
|---|---|---|
| Encoder input | HTL, TTL | 500 kHz maximum input frequency |
| | SSI | 1 MHz maximum baud rate. The dependency on baud rate and cable length is shown in the diagram below. |
| | Resolver | • Ratio ü = 0.3 … 0.7<br>It is always possible to use resolvers with lower or higher ratios. Ratios ü < 0.3 or ü > 0.7 reduce the accuracy of the speed sensing and the resolution of the position actual value.<br>• 1.8 $V_{rms}$ excitation voltage for ü = 0.5<br>• 8 kHz excitation frequency, synchronized to the current controller clock cycle<br>The impedances that can be connected and the maximum speed that can be evaluated are listed below. |
| Temperature sensor | PTC | • Short-circuit monitoring 22 Ω<br>• Switching threshold 1650 Ω |
| | KTY84 | • Short-circuit monitoring < 50 Ω<br>• Wire break > 2120 Ω |
| | Temperature switch isolated contact. | |
| Fail-safe digital input | 1 (DI 4 and DI 5) | • If you have enabled the basic safety functions, DI 4 and DI 5 form the fail-safe digital input.<br>• Maximum input voltage 30 V, 5.5 mA<br>• Response time:<br>– Typical: 5 ms + debounce time p9651<br>– Typical, if debounce time = 0: 6 ms<br>– Worst-case scenario: 15 ms + debounce time<br>– Worst case, if debounce time = 0: 16 ms |
| | The data of the extended functions of the safety functions can be found in the Safety Integrated Function Manual, see also Section: Manuals for your converter (Page 461). | |
| PFH | 5 × 10E-8 | Probability of failure of the safety functions (Probability of Failure per Hour) |
| USB interface | Mini-B | |
| Dimensions (WxHxD) | 73 mm × 199 mm × 63 mm | The depth specification is valid when mounting on the Power Module. |
| Weight | 0.49 kg | |
| Memory cards | Slot for SD or MMC memory cards, also see Section: Overview of Control Units (Page 24). | |
| Operating temperature | 0° C … 50° C | |
| | 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. |

## Permissible encoder cable lengths

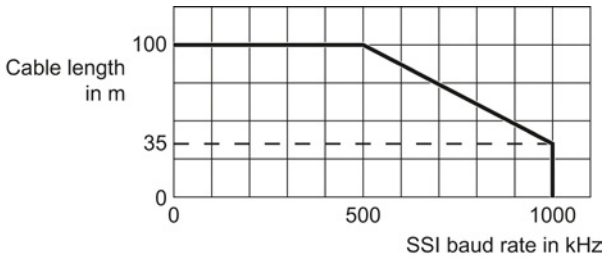
Permissible cable lengths depend on the encoder type and the encoder cable.

Table 12- 1 Maximum cable length:

| | |
|---|---|
| TTL encoder | 100 m |
| HTL encoder with bipolar signals (differential signals) | 300 m |
| HTL encoder with unipolar signals | 100 m |
| SSI encoder | 100 m |
| DRIVE-CLiQ with MC800 | 50 m |
| DRIVE-CLiQ with MC500 | 100 m |

We recommend that SIEMENS cables are connected using DRIVE-CLiQ components.

For SSI encoders, the permissible cable length also depends on the baud rate.




## Maximum speeds that can be evaluated by a resolver

| Resolver | | Maximum speed that can be evaluated by the resolver | |
|---|---|---|---|
| No. of poles | Number of pole pairs | Pulse frequency = 4 kHz | Pulse frequency = 2 kHz |
| 2-pole | 1 | 60000 rpm | 30000 rpm |
| 4-pole | 2 | 30000 rpm | 15000 rpm |
| 6-pole | 3 | 20000 rpm | 10000 rpm |
| 8-pole | 4 | 15000 rpm | 7500 rpm |

## Impedances that can be connected at the resolver input

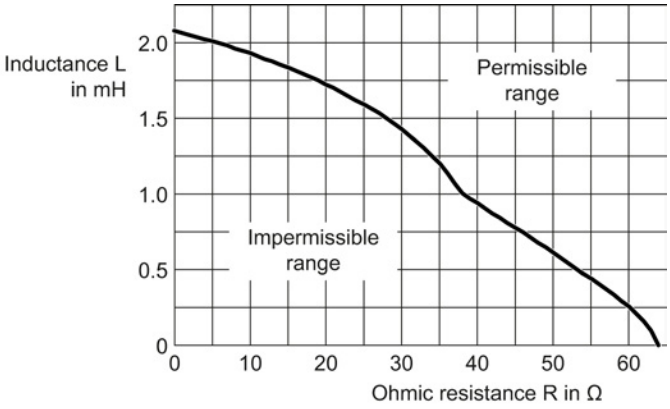



Figure 12-1 Connectable impedances with an excitation frequency of f = 8kHz

# 12.2 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.

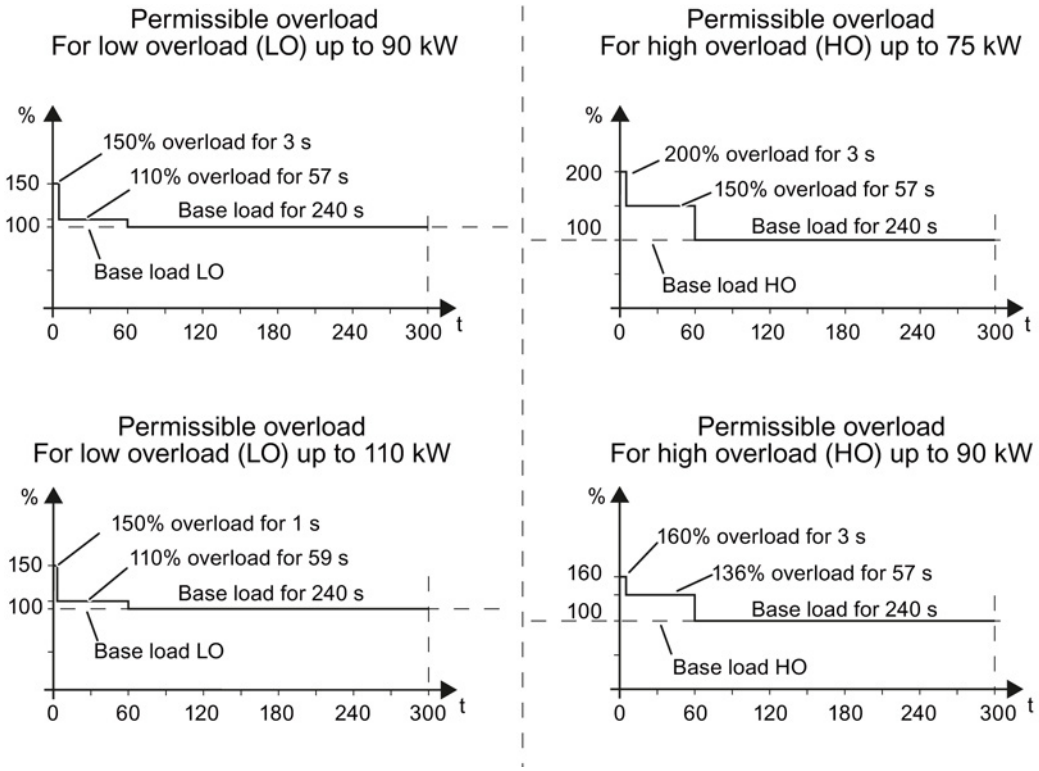



Figure 12-2 Duty cycles, "High Overload" and "Low Overload"

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**Note**

The base load (100% power or current) of "Low Overload" is greater than the base load of "High Overload".

We recommend the "SIZER" engineering software to select the inverter based on duty cycles. See Configuring support (Page 462).

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## 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.

## 12.2.1 Technical data, PM240

### 12.2.1.1 General data, PM240

| 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 | 0,7 ... 0,85 |
| Starting current | Less than the input current |
| Pulse frequency (factory setting) | 4 kHz for 0.37 kW ... 90 kW<br>2 kHz for 110 kW ... 250 kW<br>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 0° C … +40° C<br>HO without derating: 0.37 ... 110 kW 0° C … +50° C<br>HO without derating: 132 … 200 kW 0° C … +40° C<br>LO/HO with derating: all power ratings up to 60° C<br>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 | • Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997<br>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997<br>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995 |
| Installation altitude | without derating: 0.37 kW ... 132 kW up to 1000 m above sea level<br>160 kW ... 250 kW up to 2000 m above sea level<br>with derating: all power ratings up to 4000 m above sea level<br>For details, see the Hardware Installation Manual |
| Standards | UL, cUL, CE, C-tick, SEMI F47<br>The drive only satisfies the UL requirements when UL-certified fuses are used. |

### 12.2.1.2 Power-dependent data, PM240

**Note**

The given input currents are valid for operation without a line reactor for a line voltage of 400 V with Vk = 1 % referred to the rated power of the inverter. If a line reactor is used, the specified values are reduced by a few percent.

Table 12- 2 PM240, IP20, frame sizes A, 3-ph. 380 V AC… 480 V

| Order No. - without filter | 6SL3224-… | …0BE13-7UA0 | …0BE15-5UA0 | …0BE17-5UA0 |
|---|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 0.37 kW<br>1.6 A<br>1.3 A | 0.55 kW<br>2.0 A<br>1.7 A | 0.75 kW<br>2.5 A<br>2.2 A |
| HO power<br>HO input current<br>HO output current | | 0.37 kW<br>1.6 A<br>1.3 A | 0.55 kW<br>2.0 A<br>1.7 A | 0.75 kW<br>2.5 A<br>2.2 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J, K-1 or K-5) | | 3NE1813-0, 16 A<br>10 A | 3NE1813-0, 16 A<br>10 A | 3NE1813-0, 16 A<br>10 A |
| Power loss | | 0.097 kW | 0.099 kW | 0.102 kW |
| Required cooling air flow | | 4.8 l/s | 4.8 l/s | 4.8 l/s |
| Cross section of line and motor cables | | 1 … 2.5 mm² 18 … 14 AWG | 1 … 2.5 mm²<br>18 … 14 AWG | 1 … 2.5 mm²<br>18 … 14 AWG |
| Tightening torque for line and motor cables | | 0.5 Nm / 4 lbf in | 0.5 Nm / 4 lbf in | 0.5 Nm / 4 lbf in |
| Weight | | 1.2 kg | 1.2 kg | 1.2 kg |

Table 12- 3 PM240, IP20, frame sizes A, 3-ph. 380 V AC… 480 V

| Order No. - without filter | 6SL3224-… | …0BE21-1UA0 | …0BE21-5UA0 |
|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 1.1 kW<br>3.9 A<br>3.1 A | 1.5 kW<br>4.9 A<br>4.1 A |
| HO power<br>HO input current<br>HO output current | | 1.1 kW<br>3.8 A<br>3.1 A | 1.5 kW<br>4.8 A<br>4.1 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J, K-1 or K-5) | | 3NE1813-0, 16 A<br>10 A | 3NE1813-0, 16 A<br>10 A |
| Power loss | | 0.108 kW | 0.114 kW |
| Required cooling air flow | | 4.8 l/s | 4.8 l/s |
| Cross section of line and motor cables | | 1 … 2.5 mm²<br>18 … 14 AWG | 1 … 2.5 mm²<br>18 … 14 AWG |
| Tightening torque for line and motor cables | | 0.5 Nm / 4 lbf in | 0.5 Nm / 4 lbf in |
| Weight | | 1.1 kg | 1.1 kg |

Table 12- 4 PM240, IP20, frame sizes B, 3-ph. 380 V AC… 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3224-…<br>6SL3224-… | …0BE22-2UA0<br>…0BE22-2AA0 | …0BE23-0UA0<br>…0BE23-0AA0 | …0BE24-0UA0<br>…0BE24-0AA0 |
|---|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 2.2 kW<br>7.6 A<br>5.9 A | 3 kW<br>10.2 A<br>7.7 A | 4 kW<br>13.4 A<br>10.2 A |
| HO power<br>HO input current<br>HO output current | | 2.2 kW<br>7.6 A<br>5.9 A | 3 kW<br>10.2 A<br>7.7 A | 4 kW<br>13.4 A<br>10.2 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J, K-1 or K-5) | | 3NE1813-0, 16 A<br>16 A | 3NE1813-0, 16 A<br>16 A | 3NE1814-0, 20 A<br>20 A |
| Power loss | | 0.139 kW | 0.158 kW | 0.183 kW |
| Required cooling air flow | | 24 l/s | 24 l/s | 24 l/s |
| Cross section of line and motor cables | | 1.5 … 6 mm$^2$<br>16 … 10 AWG | 1.5 … 6 mm$^2$<br>16 … 10 AWG | 1.5 … 6 mm$^2$<br>16 … 10 AWG |
| Tightening torque for line and motor cables | | 1.5 Nm / 13 lbf in | 1.5 Nm / 13 lbf in | 1.5 Nm / 13 lbf in |
| Weight | | 4.3 kg | 4.3 kg | 4.3 kg |

Table 12- 5 PM240, IP20, frame sizes C, 3-ph. 380 V AC… 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3224-…<br>6SL3224-… | …0BE25-5UA0<br>…0BE25-5AA0 | …0BE27-5UA0<br>…0BE27-5AA0 | …0BE31-1UA0<br>…0BE31-1AA0 |
|---|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 7.5 kW<br>21.9 A<br>18 A | 11 kW<br>31.5 A<br>25 A | 15 kW<br>39.4 A<br>32 A |
| HO power<br>HO input current<br>HO output current | | 5.5 kW<br>16.7 A<br>13.2 A | 7.5 kW<br>23.7 A<br>19 A | 11 kW<br>32.7 A<br>26 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J, K-1 or K-5) | | 3NE1814-0, 20 A<br>20 A | 3NE1814-0, 20 A<br>20 A | 3NE1803-0, 35 A<br>35 A |
| Power loss | | 0.240 kW | 0.297 kW | 0.396 kW |
| Required cooling air flow | | 55 l/s | 55 l/s | 55 l/s |
| Cross section of line and motor cables | | 4 … 10 mm$^2$<br>12 … 8 AWG | 4 … 10 mm$^2$<br>12 … 8 AWG | 4 … 10 mm$^2$<br>12 … 8 AWG |
| Tightening torque for line and motor cables | | 2.3 Nm / 20 lbf in | 2.3 Nm / 20 lbf in | 2.3 Nm / 20 lbf in |
| Weight without filter<br>Weight with filter | | 6.5 kg<br>7 kg | 6.5 kg<br>7 kg | 6.5 kg<br>7 kg |

Table 12- 6 PM240, IP20, frame sizes D, 3-ph. 380 V AC… 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3224-…<br>6SL3224-… | …0BE31-5UA0<br>…0BE31-5AA0 | …0BE31-8UA0<br>…0BE31-8AA0 | …0BE32-2UA0<br>…0BE32-2AA0 |
|---|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 18.5 kW<br>46 A<br>38 A | 22 kW<br>53 A<br>45 A | 30 kW<br>72 A<br>60 A |
| HO power<br>HO input current<br>HO output current | | 15 kW<br>40 A<br>32 A | 18.5 kW<br>46 A<br>38 A | 22 kW<br>56 A<br>45 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J) | | 3NE1817-0<br>50 A, 600 V | 3NE1818-0<br>--- | 3NE1820-0<br>--- |
| Power loss | | 0.44 kW<br>0.42 kW | 0.55 kW<br>0.52 kW | 0.72 kW<br>0.69 kW |
| Required cooling air flow | | 22 l/s | 22 l/s | 39 l/s |
| Cross section of line and motor cables | | 10 … 35 $mm^2$<br>7 … 2 AWG | 10 … 35 $mm^2$<br>7 … 2 AWG | 16 … 35 $mm^2$<br>5 … 2 AWG |
| Tightening torque for line and motor cables | | 6 Nm / 53 lbf in | 6 Nm / 53 lbf in | 6 Nm / 53 lbf in |
| Weight without filter<br>Weight with filter | | 13 kg<br>16 kg | 13 kg<br>16 kg | 13 kg<br>16 kg |

Table 12- 7 PM240, IP20, frame sizes E, 3-ph. 380 V AC… 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3224-…<br>6SL3224-… | …0BE33-0UA0<br>…0BE33-0AA0 | …0BE33-7UA0<br>…0BE33-7AA0 |
|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 37 kW<br>88 A<br>75 A | 45 kW<br>105 A<br>90 A |
| HO power<br>HO input current<br>HO output current | | 30 kW<br>73 A<br>60 A | 37 kW<br>90 A<br>75 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL | | 3NE1021-0<br>--- | 3NE1022-0<br>--- |
| Power losses without filter<br>Power losses with filter | | 0.99 kW<br>1.04 kW | 1.2 kW<br>1.2 kW |
| Required cooling air flow | | 22 l/s | 39 l/s |
| Cross section of line and motor cables | | 25 … 35 $mm^2$<br>3 … 2 AWG | 25 … 35 $mm^2$<br>3 … 2 AWG |
| Tightening torque for line and motor cables | | 6 Nm / 53 lbf in | 6 Nm / 53 lbf in |
| Weight without filter<br>Weight with filter | | 16 kg<br>23 kg | 16 kg<br>23 kg |

Table 12- 8 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3224-…<br>6SL3224-… | …0BE34-5UA0<br>…0BE34-5AA0 | …0BE35-5UA0<br>…0BE35-5AA0 | …0BE37-5UA0<br>…0BE37-5AA0 |
|---|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 55 kW<br>129 A<br>110 A A | 75 kW<br>168 A<br>145 A | 90 kW<br>204 A<br>178 A |
| HO power<br>HO input current<br>HO output current | | 45 kW<br>108 A<br>90 A | 55 kW<br>132 A<br>110 A | 75 kW<br>169 A<br>145 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL (Class J) | | 3NE1224-0<br>150 A, 600 V | 3NE1225-0<br>200 A, 600 V | 3NE1227-0<br>250 A, 600 V |
| Power losses without filter<br>Power losses with filter | | 1.4 kW<br>1.5 kW | 1.9 kW<br>2.0 kW | 2.3 kW<br>2.4 kW |
| Required cooling air flow | | 94 l/s | 94 l/s | 117 l/s |
| Cross section of line and motor cables | | 35 … 120 mm²<br>2 … 4/0 AWG | 70 … 120 mm²<br>2/0 … 4/0 AWG | 95 … 120 mm²<br>3/0 … 4/0 AWG |
| Tightening torque for line and motor cables | | 13 Nm / 115 lbf in | 13 Nm / 115 lbf in | 13 Nm / 115 lbf in |
| Weight without filter<br>Weight with filter | | 36 kg<br>52 kg | 36 kg<br>52 kg | 36 kg<br>52 kg |

Table 12- 9 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

| Order No. - without filter | 6SL3224-… | …0BE38-8UA0 | …0BE41-1UA0 |
|---|---|---|---|
| Rated/LO power<br>Rated/LO input current<br>Rated/LO output current | | 110 kW<br>234 A<br>205 A | 132 kW<br>284 A<br>250 A |
| HO power<br>HO input current<br>HO output current | | 90 kW<br>205 A<br>178 A | 110 kW<br>235 A<br>205 A |
| Fuse according to UL (from SIEMENS)<br>Fuse according to UL | | 3NE1227-0<br>300 A, 600 V, Class J | 3NE1230-0<br>400 A, 600 V, Class J |
| Power loss | | 2.4 kW | 2.5 kW |
| Required cooling air flow | | 117 l/s | 117 l/s |
| Cross section of line and motor cables | | 95 … 120 mm²<br>3/0 … 4/0 AWG | 95 … 120 mm²<br>3/0 … 4/0 AWG |
| Tightening torque for line and motor cables | | 13 Nm / 115 lbf in | 13 Nm / 115 lbf in |
| Weight | | 39 kg | 39 kg |

Table 12- 10 PM240 frame sizes GX, 3-ph. 380 V AC… 480 V

| Order No. - without filter 6SL3224-… | …0XE41-3UA0 | …0XE41-6UA0 | …0XE42-0UA0 |
|---|---|---|---|
| **Values for rated load/low overload** | | | |
| 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 |
| **Values for high overload** | | | |
| 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<br>Fuse according to UL (from SIEMENS) | 3NA3254<br>3NE1333-2 | 3NA3260<br>3NE1333-2 | 3NA3372<br>3NE1436-2 |
| Power loss, | 3.9 kW | 4.4 kW | 5.5 kW |
| Required cooling air flow | 360 l/s | 360 l/s | 360 l/s |
| Cross section of line and motor cables | 95 ... 2 x 240 $mm^2$<br>3/0 … 2 x 600 AWG | 120 ... 2 x 240 $mm^2$<br>4/0 … 2 x 600 AWG | 185 ... 2 x 240 $mm^2$<br>6/0 … 2 x 600 AWG |
| Tightening torque for line and motor cables | 14 Nm / 120 lbf in | 14 Nm / 120 lbf in | 14 Nm / 120 lbf in |
| Weight | 176 kg | 176 kg | 176 kg |

## Applications with UL certification

Table 12- 11 Frame size A … C

| | |
|---|---|
| Class J fuses | Suitable for plants/systems with a max. current of 65 kA (symmetrical, rms value), max. 480 VAC |
| Class K-1 or K-5 fuses | Suitable for plants/systems with a max. current of 10 kA (symmetrical, rms value), max. 480 VAC |
| Semiconductor fuses R/C (JFHR2, E167357) | Suitable for plants/systems with a max. current of 5 kA (symmetrical, rms value), max. 480 VAC |

Table 12- 12 Frame size D … GX

| | |
|---|---|
| Only with Class J or R/C semiconductor fuses (JFRH2) | Suitable for plants/systems with a max. current of 65 kA (symmetrical, rms value), max. 480 VAC |

## 12.2.2 Technical data, PM240-2

### 12.2.2.1 General data, PM240-2

| 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 … 60 Hz, ± 3 Hz | | |
| Output frequency | 0 … 650 Hz, depending on the control mode | | |
| Power factor λ | 0.7 without line reactor; 0.85 with line reactor | | |
| Line impedance | Uk ≥ 1%, a line reactor is required for lower values | | |
| Starting current | Less than the input current | | |
| Pulse frequency (factory setting) | 4 kHz<br>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<br>PT devices | IP20 when mounted in a control cabinet<br>IP54 on the control cabinet wall | |
| Operating temperature | LO without derating:<br>HO without derating:<br>LO/HO with derating: | 0° C … +40° C<br>0° C … +50° C<br>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 | • Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997<br>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997<br>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995 | | |
| Installation altitude | without derating:<br>with derating: | up to 1000 m above sea level<br>up to 4000 m above sea level | For details, see the Hardware Installation Manual |
| Standards | UL, cUL, CE, C-tick, SEMI F47<br>The drive only satisfies the UL requirements when UL-certified fuses are used. | | |

### 12.2.2.2 Power-dependent data PM240-2

#### 400V versions

Table 12- 13 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3210…<br>6SL3210… | …1PE11-8UL1<br>…1PE11-8AL1 | …1PE12-3UL1<br>…1PE12-3AL1 | …1PE13-2UL1<br>…1PE13-2AL1 |
|---|---|---|---|---|
| LO power<br>LO input current<br>LO output current | | 0,55 kW<br>2,3 A<br>1,7 A | 0,75 kW<br>2,9 A<br>2,2 A | 1,1 kW<br>4,1 A<br>3,1 A |
| HO power<br>HO input current<br>HO output current | | 0,37 kW<br>2,0 A<br>1,3 A | 0,55 kW<br>2,6 A<br>1,7 A | 0,75 kW<br>3,3 A<br>2,2 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3 804 (4 A)<br>4 A Class J | 3NA3 804 (4 A)<br>4 A Class J | 3NA3 801 (6 A)<br>6 A Class J |
| Power losses without filter<br>Power losses with filter | | 0,04 kW<br>0,04 kW | 0,04 kW<br>0,04 kW | 0,04 kW<br>0,04 kW |
| Required cooling air flow | | 5 l/s | 5 l/s | 5 l/s |
| Cross section of line and motor cables | | 1 … 2,5 mm²<br>18 … 14 AWG | 1 … 2,5 mm²<br>18 … 14 AWG | 1 … 2,5 mm²<br>18 … 14 AWG |
| Tightening torque for line and motor cables | | 0,5 Nm / 4 lbf in | 0,5 Nm / 4 lbf in | 0,5 Nm / 4 lbf in |
| Weight without filter<br>Weight with filter | | 1,4 kg<br>1,5 kg | 1,4 kg<br>1,5 kg | 1,4 kg<br>1,5 kg |

Table 12- 14 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

| Order No. - without filter<br>Order No. - with filter | 6SL3210…<br>6SL3210… | …1PE14-3UL1<br>…1PE14-3AL1 | …1PE16-1UL1<br>…1PE16-1AL1 | …1PE18-0UL1<br>…1PE18-0AL1 |
|---|---|---|---|---|
| LO power<br>LO input current<br>LO output current | | 1,5 kW<br>5,5 A<br>4,1 A | 2,2 kW<br>7,7 A<br>5,9 A | 3,0 kW<br>10,1 A<br>7,7 A |
| HO power<br>HO input current<br>HO output current | | 1,1 kW<br>4,7 A<br>3,1 A | 1,5 kW<br>6,1 A<br>4,1 A | 2,2 kW<br>8,8 A<br>5,9 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3 803 (10 A)<br>10 A Class J | 3NA3 803 (10 A)<br>10 A Class J | 3NA3 805 (16 A)<br>15 A Class J |
| Power losses without filter<br>Power losses with filter | | 0,07 kW<br>0,07 kW | 0,1 kW<br>0,1 kW | 0,12 kW<br>0,12 kW |
| Required cooling air flow | | 5 l/s | 5 l/s | 5 l/s |
| Cross section of line and motor cables | | 1 … 2,5 mm²<br>18 … 14 AWG | 1,5 … 2,5 mm²<br>16 … 14 AWG | 1,5 … 2,5 mm²<br>16 … 14 AWG |
| Tightening torque for line and motor cables | | 0,5 Nm / 4 lbf in | 0,5 Nm / 4 lbf in | 0,5 Nm / 4 lbf in |
| Weight without filter<br>Weight with filter | | 1,4 kg<br>1,5 kg | 1,4 kg<br>1,5 kg | 1,4 kg<br>1,5 kg |

Table 12- 15 PM240-2, PT, Frame Sizes A, 3 AC 380 V … 480 V

| Order No. - without filter | 6SL3211… | --- | …1PE18-0UL1 |
|---|---|---|---|
| Order No. - with filter | 6SL3211… | …1PE16-1AL1 | — |
| LO power<br>LO input current<br>LO output current | | 2,2 kW<br>7,7 A<br>5,9 A | 3,0 kW<br>10,1 A<br>7,7 A |
| HO power<br>HO input current<br>HO output current | | 1,5 kW<br>6,1 A<br>4,1 A | 2,2 kW<br>8,8 A<br>5,9 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3 803 (10 A)<br>10 A Class J | 3NA3 805 (16 A)<br>15 A Class J |
| Power losses without filter<br>Power losses with filter | | 0,1 kW 1)<br>0,1 kW 1) | 0.,12 kW 2)<br>0,12 kW 2) |
| Required cooling air flow | | 7 l/s | 7 l/s |
| Cross section of line and motor cables | | 1,5 … 2,5 mm²<br>16 … 14 AWG | 1,5 … 2,5 mm²<br>16 … 14 AWG |
| Tightening torque for line and motor cables | | 0,5 Nm / 4 lbf in | 0,5 Nm / 4 lbf in |
| Weight without filter<br>Weight with filter | | ---<br>1,8 kg | 1,7 kg<br>--- |

1) 0,08 kW via heat sink;

2) 0,1 kW via heat sink

Table 12- 16 PM240-2, IP20, Frame Sizes B, 3 AC 380 V … 480 V

| Order No. - without filter | 6SL3210… | …1PE21-1UL0 | …1PE21-4UL0 | …1PE21-8UL0 |
|---|---|---|---|---|
| Order No. - with filter | 6SL3210… | …1PE21-1AL0 | …1PE21-4AL0 | …1PE21-8AL0 |
| LO power<br>LO input current<br>LO output current | | 4,0, kW<br>13,3 A<br>10,2 A | 5,5 kW<br>17,2 A<br>13,2 A | 7,5 kW<br>22,2 A<br>18,0 A |
| HO power<br>HO input current<br>HO output current | | 3,0 kW<br>11,6 A<br>7,7 A | 4,0 kW<br>15,3 A<br>10,2 A | 5,5 kW<br>19,8 A<br>13,7 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NE 1814-0 (20 A)<br>20 A Class J | 3NE 1815-0 (25 A)<br>25 A Class J | 3NE 1803-0 (35 A)<br>35 A Class J |
| Power losses without filter<br>Power losses with filter | | kW<br>kW | kW<br>kW | kW<br>kW |
| Required cooling air flow | | l/s | l/s | l/s |
| Cross section of line and motor cables | | 1,5 … 6 mm²<br>16 … 10 AWG | 1,5 … 6 mm²<br>16 … 10 AWG | 1,5 … 6 mm²<br>16 … 10 AWG |
| Tightening torque for line and motor cables | | 0,6 Nm / 5 lbf in | 0,6 Nm / 5 lbf in | 0,6 Nm / 5 lbf in |
| Weight without filter<br>Weight with filter | | 2,9 kg<br>3,1 kg | 2,9 kg<br>3,1 kg | 3,0 kg<br>3,2 kg |

Table 12- 17 PM240-2, PT, Frame Sizes B, 3 AC 380 V … 480 V

| Order No. - without filter | 6SL3211… | ...1PE21-8UL0 |
|---|---|---|
| Order No. - with filter | 6SL3211… | ...1PE21-8AL0 |
| LO power<br>LO input current<br>LO output current | | 7,5 kW<br>22,2 A<br>18,0 A |
| HO power<br>HO input current<br>HO output current | | 5,5 kW<br>19,8 A<br>13,7 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NE 1803-0 (35 A)<br>35 A Class J |
| Power losses without filter<br>Power losses with filter | | kW 1)<br>kW 1) |
| Required cooling air flow | | l/s |
| Cross section of line and motor cables | | 1,5 … 6 mm²<br>16 … 10 AWG |
| Tightening torque for line and motor cables | | 0,6 Nm / 5 lbf in |
| Weight without filter<br>Weight with filter | | 3,6 kg<br>3,9 kg |

1) 0,08 kW via heat sink;

2) 0,1 kW via heat sink

Table 12- 18 PM240-2, IP20, Frame Sizes C, 3 AC 380 V … 480 V

| Order No. - without filter | 6SL3210… | …1PE22-7UL0 | …1PE23-3UL0 |
|---|---|---|---|
| Order No. - with filter | 6SL3210… | …1PE22-7AL0 | …1PE23-3AL0 |
| LO power<br>LO input current<br>LO output current | | 11,0 kW<br>32,6 A<br>26,0 A | 15,0 kW<br>39,9 A<br>32,0 A |
| HO power<br>HO input current<br>HO output current | | 7,5 kW<br>27,0 A<br>18,0 A | 11,0 kW<br>36,0 A<br>26,0 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NE 1817-0 (50 A)<br>50 A Class J | 3NE 1817-0 (50 A)<br>50 A Class J |
| Power losses without filter<br>Power losses with filter | | kW<br>kW | kW<br>kW |
| Required cooling air flow | | l/s | l/s |
| Cross section of line and motor cables | | 6 …16 mm²<br>10 … 6 AWG | 6 …16 mm²<br>10 … 6 AWG |
| Tightening torque for line and motor cables | | 1,3 Nm / 12 lbf in | 1,3 Nm / 12 lbf in |
| Weight without filter<br>Weight with filter | | 4,7 kg<br>5,3 kg | 4,8 kg<br>5,4 kg |

Table 12- 19 PM240-2, PT, Frame Sizes C, 3 AC 380 V … 480 V

| | | |
|---|---|---|
| **Order No. - without filter** | **6SL3211…** | **...1PE23-3UL0** |
| **Order No. - with filter** | **6SL3211…** | **...1PE23-3AL0** |
| LO power | | 15,0 kW |
| LO input current | | 39,9 A |
| LO output current | | 32,0 A |
| HO power | | 11,0 kW |
| HO input current | | 36,0 A |
| HO output current | | 26,0 A |
| Fuse according to IEC | | 3NE 1817-0 (50 A) |
| Fuse according to UL | | 50 A Class J |
| Power losses without filter | | kW 1) |
| Power losses with filter | | kW 1) |
| Required cooling air flow | | l/s |
| Cross section of line and motor cables | | 6 …16 $mm^2$<br>10 … 6 AWG |
| Tightening torque for line and motor cables | | 1,3 Nm / 12 lbf in |
| Weight without filter | | 5,8 kg |
| Weight with filter | | 6,3 kg |

1) 0,08 kW via heat sink;

2) 0,1 kW via heat sink

### 12.2.3 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<br>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<br>HO without derating: 0° C … +50° C<br>LO/HO with derating: to 60° C<br>For details, see the Hardware Installation Manual. |
| 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 | • Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997<br>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997<br>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995 |
| Installation altitude | without derating: up to 1000 m above sea level<br>with derating: up to 4000 m above sea level<br>For details, see the Hardware Installation Manual |
| Standards | UL, CE, CE, SEMI F47<br>The drive only satisfies the UL requirements when UL-certified fuses are used. |

### 12.2.3.1 Power-dependent data, PM250

Table 12- 20 PM250, IP20, Frame Sizes C, 3 AC 380 V … 480 V

| Order No. - Filtered | 6SL3225-… | 0BE25-5AA0 | 0BE27-5AA0 | 0BE31-1AA0 |
|---|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 7.5 kW<br>18 A<br>18 A | 11 kW<br>25 A<br>25 A | 15 kW<br>32 A<br>32 A |
| HO power<br>HO input current<br>HO output current | | 5. 5 kW<br>13.2 A<br>13.2 A | 7.5 kW<br>19 A<br>19 A | 11 kW<br>26 A<br>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 mm²<br>14 … 8 AWG | 4.0 … 10 mm²<br>12 … 8 AWG | 4.0 … 10 mm²<br>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- 21 PM250, IP20, Frame Sizes D, 3 AC 380 V … 480 V

| Order No. - Filtered | 6SL3225-… | 0BE31-5AA0 | 0BE31-8AA0 | 0BE32-2AA0 |
|---|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 18.5 kW<br>36 A<br>38 A | 22 kW<br>42 A<br>45 A | 30 kW<br>56 A<br>60 A |
| HO power<br>HO input current<br>HO output current | | 15 kW<br>30 A<br>32 A | 18.5 kW<br>36 A<br>38 A | 22 kW<br>42 A<br>45 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3820<br>50 A, Class J | 3NA3822<br>63 A, Class J | 3NA3824<br>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 mm²<br>7 … 2 AWG | 10 … 35 mm²<br>7 … 2 AWG | 16 … 35 mm²<br>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 |

Table 12- 22 PM250, IP20, Frame Sizes E, 3 AC 380 V … 480 V

| Order No. - Filtered | 6SL3225-… | 0BE33-0AA0 | 0BE33-7AA0 |
|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 37 kW<br>70 A<br>75 A | 45 kW<br>84 A<br>90 A |
| HO power<br>HO input current<br>HO output current | | 30 kW<br>56 A<br>60 A | 37 kW<br>70 A<br>75 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3830<br>100 A, Class J | 3NA3832<br>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 $mm^2$<br>3 … 2 AWG | 25 … 35 $mm^2$<br>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- 23 PM250, IP20, Frame Sizes F, 3 AC 380 V … 480 V

| Order No. - Filtered | 6SL3225-… | 0BE34-5AA0 | 0BE35-5AA0 | 0BE37-5AA0 |
|---|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 55 kW<br>102 A<br>110 A | 75 kW<br>135 A<br>145 A | 90 kW<br>166 A<br>178 A |
| HO power<br>HO input current<br>HO output current | | 45 kW<br>84 A<br>90 A | 55 kW<br>102 A<br>110 A | 75 kW<br>135 A<br>145 A |
| Fuse according to IEC<br>Fuse according to UL | | 3NA3836<br>160 A, Class J | 3NA3140<br>200 A, Class J | 3NA3144<br>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 $mm^2$<br>2 … 4/0 AWG | 35 … 120 $mm^2$<br>2 … 4/0 AWG | 35 … 120 $mm^2$<br>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 |

### 12.2.4 Technical data, PM260

| Feature | Version |
|---|---|
| Line voltage | 660 V ... 690 V 3-ph. AC ± 10%<br>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: 0° C … +40° C<br>HO without derating: 0° C … +50° C<br>LO/HO with derating: to 60° C<br>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 | • Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997<br>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997<br>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995 |
| Installation altitude | without derating: up to 1000 m above sea level<br>with derating: up to 4000 m above sea level<br>For details, see the Hardware Installation Manual |
| Standards | CE, C-TICK |

### 12.2.4.1 Power-dependent data, PM260

Table 12- 24 PM260, IP20, Frame Sizes D - 3 AC 660 V … 690 V

| Order No. - Unfiltered<br>Order No. - Filtered | 6SL3225-…<br>6SL3225-… | 0BH27-5UA1<br>0BH27-5AA1 | 0BH31-1UA1<br>0BH31-1AA1 | 0BH31-5UA1<br>0BH31-5AA1 |
|---|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 11 kW<br>13 A<br>14 A | 15 kW<br>18 A<br>19 A | 18.5 kW<br>22 A<br>23 A |
| HO power<br>HO input current<br>HO output current | | 7.5 kW<br>10 A<br>10 A | 11 kW<br>13 A<br>14 A | 15 kW<br>18 A<br>19 A |
| Fuse | | 20 A | 20 A | 32 A |
| Power losses, unfiltered<br>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 mm²<br>14 … 6 AWG | 4 … 16 mm²<br>12 … 6 AWG | 6 … 16 mm²<br>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<br>Weight, filtered | | 22 kg<br>23 kg | 22 kg<br>23 kg | 22 kg<br>23 kg |
| Noise pressure | | < 64 dB(A) | < 64 dB(A) | < 64 dB(A) |

Table 12- 25 PM260, IP20, Frame Sizes F - 3 AC 660 V … 690 V

| Order No. - Unfiltered<br>Order No. - Filtered | 6SL3225-…<br>6SL3225-… | 0BH32-2UA1<br>0BH32-2AA1 | 0BH33-0UA1<br>0BH33-0AA1 | 0BH33-7UA1<br>0BH33-7AA1 |
|---|---|---|---|---|
| Rated / LO power<br>Rated / LO input current<br>Rated / LO Output current | | 30 kW<br>34 A<br>35 A | 37 kW<br>41 A<br>42 A | 55 kW<br>60 A<br>62 A |
| HO power<br>HO input current<br>HO output current | | 22 kW<br>26 A<br>26 A | 30 kW<br>34 A<br>35 A | 37 kW<br>41 A<br>42 A |
| Fuse | | 50 A | 50 A | 80 A |
| Power losses, unfiltered<br>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 mm²<br>8 … 2 AWG | 16 … 35 mm²<br>6 … 2 AWG | 25 … 35 mm²<br>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<br>Weight, filtered | | 56 kg<br>58 kg | 56 kg<br>58 kg | 56 kg<br>58 kg |
| Noise pressure | | < 70 dB(A) | < 70 dB(A) | < 70 dB(A) |

## 12.2.5 Technical data, PM340

### 12.2.5.1 General data, PM340, 1 AC 200 … 240 V

| Feature | Version |
|---|---|
| Input voltage | 1 AC 200 … 240 V |
| Output voltage | 0 V 3-ph. AC … input voltage x 0.95 (max.) |
| Input frequency | 47 Hz … 63 Hz |
| Output frequency | 0 … 650 Hz, depending on the control mode |
| Power factor λ | 1 AC 200 … 240 V 0.45 ... 0.7 |
| Starting current | Less than the input current |
| Pulse frequency (factory setting) | 4 kHz<br>The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current. Details, see Catalog D 31 |
| Electromagnetic compatibility | The devices comply with EN 61800-3: 2004 are suitable for Category C2 environments. Details, see Catalog D 31. |
| Braking methods | DC braking, compound braking, dynamic braking with integrated braking chopper |
| Degree of protection | IP20 chassis units as supplied from the factory.<br>IP00 after removing the terminal cover. |
| Operating temperature | Without power reduction: 0 °C … +40 °C Details, see Catalog D 31.<br>HO without power reduction: >+40 °C … +55 °C |
| Storage temperature | -40 °C … +70 °C |
| 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 | • Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997<br>• Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997<br>• Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995 |
| Installation altitude | without power reduction: up to 1000 m above sea level Details, see Catalog D 31<br>with power reduction: up to 4000 m above sea level |
| Standards | UL, cUL, CE<br>The drive only satisfies the UL requirements when UL-certified fuses are used. |

### 12.2.5.2 Power-dependent data, PM340

#### Air-cooled Power Modules

Table 12- 26 PM340, IP20, Frame Size A, 1 AC 200 V … 240 V

| Order No. - without filter | 6SL3210… | …1SB11-0UA0 | …1SB12-3UA0 | …1SB14-0UA0 |
|---|---|---|---|---|
| Order No. - with filter | 6SL3210… | …1SB11-0AA0 | …1SB12-3AA0 | …1SB14-0AA0 |
| Rated power | | 0.12 kW | 0.37 kW | 0.75 kW |
| Rated input current | | 2.2 A | 6 A | 10 A |
| Rated output current | | 0.9 A | 2.3 A | 3.9 A |
| Base load current | | 0.8 A | 2.0 A | 3.4 A |
| Maximum current | | 2.0 A | 4.6 A | 7.8 A |
| Current for S6 duty | | 1.4 A | 3.3 A | 5.5 A |
| Fuse according to IEC | | 6 A | 10 A | 15 A |
| Fuse according to UL | | 6 A Class J | 10 A Class J | 15 A Class J |
| Power loss | | 0.06 kW | 0.075 kW | 0.11 kW |
| Required cooling air flow | | 5 l/s | 5 l/s | 5 l/s |
| Cross section of line and motor cables | | 1 … 2.5 $mm^2$<br>18 … 14 AWG | 1 … 2.5 $mm^2$<br>18 … 14 AWG | 1 … 2.5 $mm^2$<br>18 … 14 AWG |
| Tightening torque for line and motor cables | | 0.5 Nm / 4 lbf in | 0.5 Nm / 4 lbf in | 0.5 Nm / 4 lbf in |
| Weight without filter | | 1.2 kg | 1.3 kg | 1.3 kg |

# Appendix A

## A.1 New and extended functions

### A.1.1 Firmware version 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<br>• PM240-2 IP20 FSB … FSC<br>• PM240-2 in through-hole technology FSB ... FSC | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - |
| 2 | Support for the new Power Modules<br>• PM230 in through-hole technology FSD ... FSF | - | ✓ | ✓ | ✓ | - | - | - | - |
| 3 | Motor data preassignment for the 1LA/1LE motors via code number<br>• During basic commissioning with the operator panel, set the motor data using a code number | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | Extension to communication via CANopen<br>• CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm | ✓ | ✓ | - | - | ✓ | ✓ | - | - |
| 5 | Extension to communication via BACnet<br>• Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller | - | ✓ | - | - | - | - | - | - |
| 6 | Communication via Ethernet/IP | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 7 | Skip frequency band for analog input<br>• A symmetrical skip frequency band can be set for each analog input around the 0 V range. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - |
| 8 | Changing the control of the motor holding brake | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - |
| 9 | Safety function SBC (Safe Brake Control)<br>• Secure control of a motor holding brake when using the "Safe Brake Module" option | - | - | - | - | ✓ | ✓ | - | - |
| 10 | Safety function SS1 (Safe Stop 1) without speed monitoring | - | - | - | - | ✓ | ✓ | - | - |
| 11 | Straightforward selection of standard motors<br>• Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | Function | SINAMICS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | G120 | | | | | G120D | |
| 12 | Firmware update via memory card | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 13 | Safety info channel<br>• BICO source r9734.0...14 for the status bits of the extended safety functions | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ |
| 14 | Diagnostic alarms for PROFIBUS | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## A.1.2 Firmware version 4.6.6

| | 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<br>• PM330 IP20 FSGX | - | ✓ | - | - | - | - | - | - |

# A.2 Activating licensed functions

## A.2.1 Licensing

### How do I activate a licensed function?

**Procedure, case 1: Recommended**

1. Order a memory card - with or without firmware - with the license that you require as Z option.
2. Insert the card in the switched off inverter.
3. Switch the inverter on.

You have activated the function.

**Procedure, case 2**

Precondition: You have one of the following memory cards

- 6SL3054-4AG00-2AA0: card without firmware
- 6SL3054-7EG00-2BA0: card with firmware
  Positions "EG" in the second block correspond to the firmware version of your device 4.6 ≙ EG, 4.7 ≙ EH, 4.8 ≙ EI …

1. Order the license for the function that you require.
2. You receive the "Certificate of License", it contains:
   – the software order number
   – the license number
   – the delivery note number
3. Create the license key (Page 414) using the "WEB License Manager".
4. Insert the card into the inverter.
5. Write the license key to the card using STARTER or BOP-2. See Writing the license key to the card (Page 417).
6. Switch the inverter off and on again.

You have activated the function.

## A.2.2 Creating or displaying the license key

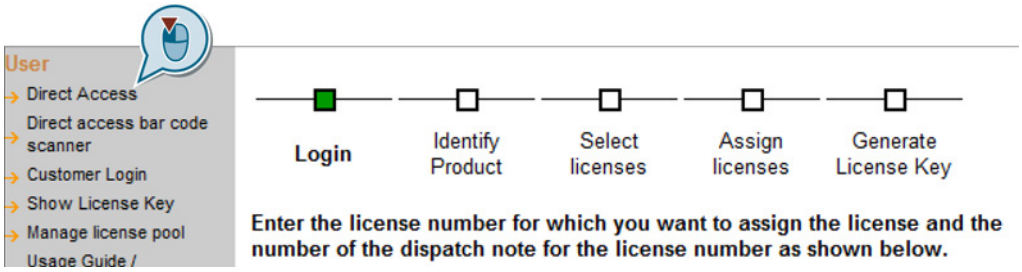
In order to create a license key for a new license – or to display which licenses are saved on a card, use the, "WEB License Manager" (http://www.siemens.com/automation/license (https://workplace.automation.siemens.com/pls/swl-pub/SWL_MAIN_MENU.NAVIGATION_HEAD?a_lang_id=E&a_action=)).

### Creating license keys using "WEB License Manager"

#### Precondition

- You have opened the License Manager (http://www.siemens.com/automation/license (https://workplace.automation.siemens.com/pls/swl-pub/SWL_MAIN_MENU.NAVIGATION_HEAD?a_lang_id=E&a_action=)).
- You have the license number and the delivery note number from the Certificate of License as well as the serial number of your memory card.
- You know the product family of your inverter. In your particular case, "SINAMICS G120".

Using the License Manager you create the license key in the steps shown in the following diagram.




You can identify in which step you presently are based on the green square (progress display).

#### Procedure

1
2

Proceed as follows to create a License Key:

1. In the License Manager click on "Direct access" in the navigation bar.
   The progress identifier is at "Login".
2. Enter the license number and delivery note number from your Certificate of License. Then click "Next".
   The progress indicator is then at "Identify product".
3. Enter the serial number of the memory card and select SINAMICS G120 for "Product". Then click on "Next".
   If licenses are already assigned to your software, then they are displayed here. The progress indicator still remains at "Identify product".
   Then click again on "Next".
4. You can now see the licenses that you can assign. The progress indicator is at "Select licenses".
   Set the check mark to Assign and click on "Next"

5. You can see a summary of the licenses selected for assignment.
   The progress indicator is at "Assign licenses".
6. To start the assignment, click "Assign".
7. Confirm the following confirmation prompt with OK.
8. The licenses are permanently assigned to the specified memory card. The progress indicator is at "Generate license key".
   The license key is displayed. You can save it as follows on your computer:

   - License Key in SIN++SINAMICS G120+N3093102760044+;incl_key.Alm abspeichern.
   - License Key in keys.txt abspeichern
   - License Report als PDF abspeichern

You have created a new license key.

## Displaying and requesting license keys via the "WEB License Manager"

You want an overview of which functions are assigned to which card and to which license key.

### Precondition

- You have opened the License Manager (http://www.siemens.com/automation/license (https://workplace.automation.siemens.com/pls/swl-pub/SWL_MAIN_MENU.NAVIGATION_HEAD?a_lang_id=E&a_action=)).
- You require either:
  - the serial number of the memory card
  - the license number of the function

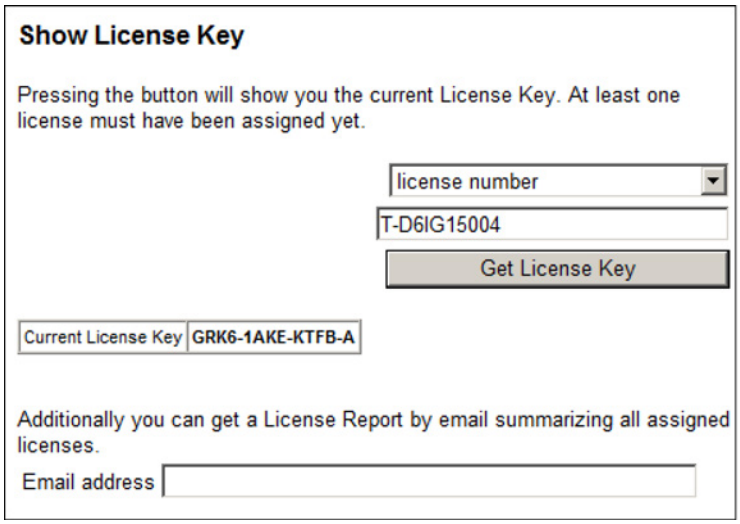
### Procedure

Proceed as follows to display a license key or to request one:

1. In the "WEB License Manager" in the navigation bar, click on "Display license key".
2. At the right in the drop-down list, make the entry based on the license key you wish to display or request.

3. Appropriately complete the fields below, and then click on the "Display license key" button.

   The current license key is then displayed.




4. Enter your e-mail address and click on "Request license report".
5. You receive the license report as a PDF. In addition to the actual license key, it includes the serial number of the memory card and all of the licenses assigned to this memory card.

You have requested the license key as e-mail.

**Note**

A new license is not required if you upgrade/downgrade to older or newer software versions. For this reason, do not delete the license key from the memory card (..\KEYS\SINAMICS\KEYS.txt), if you want to switch over to another software version.

## A.2.3 Writing the license key to the card

You write the license key to the memory card by writing the individual positions – in an ascending order – into the bits of parameter p9920, and then subsequently activate the key using p9921.

The procedure for STARTER and BOP-2, based on the fictitious "E1MQ-4BEA" license key, is described below.

---

**Note**

If you subsequently purchase an additional license, then you will require a new license key. You must overwrite the old license key. The new license key can have more than 9 positions.

You set p9920 to 0, by setting p9920[0] = 0.

---

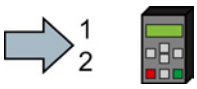
### Writing the license key to the memory card and activating

**Procedure**

In order to write and activate the license key using STARTER, proceed as follows:

1. Go online and open the expert list via "Project/Control_Unit/Expert list".
2. In the expert list, go to parameter p9920
3. Enter the license key (example: "E1MQ-4BEA") - always use uppercase letters:
   - p9920[0] = E
   - p9920[1] = 1
   - …
   - p9920[7] = E
   - p9920[8] = A
4. Set p9921 = 1.
   After activation, P9921 jumps back to 0.

You have activated the license key using STARTER.



In order to write and activate the license key using BOP-2, proceed as follows:

1. Convert the license key (example: "E1MQ-4BEA") into decimal numbers based on the table below.
   – E = 69, 1 = 49, M = 77, Q = 81, - = 45, 4 = 52, B = 66, E = 69, A = 65
2. Enter the value in ascending order into p9920
   – p9920[0] = 69
   – p9920[1] = 49
   – …
   – p9920[7] = 69
   – p9920[8] = 65
3. Set p9921 = 1.
   After activation, P9921 jumps back to 0.

You have activated the license key using BOP-2.

## Converting the license key for input using the BOP-2

You convert the license code into decimal numbers based on the following ASCII table.

### Excerpt of ASCII code

| Character | Decimal | | Character | Decimal | | Character | Decimal |
|---|---|---|---|---|---|---|---|
| - | 45 | | C | 67 | | P | 80 |
| 0 | 48 | | D | 68 | | Q | 81 |
| 1 | 49 | | E | 69 | | R | 82 |
| 2 | 50 | | F | 70 | | S | 83 |
| 3 | 51 | | G | 71 | | T | 84 |
| 4 | 52 | | H | 72 | | U | 85 |
| 5 | 53 | | I | 73 | | V | 86 |
| 6 | 54 | | J | 74 | | W | 87 |
| 7 | 55 | | K | 75 | | X | 88 |
| 8 | 56 | | L | 76 | | Y | 89 |
| 9 | 57 | | M | 77 | | Z | 90 |
| A | 65 | | N | 78 | | Blank | 32 |
| B | 66 | | O | 79 | | | |

### License key table

In the following table, you can enter the characters of the license key and the associated decimal numbers.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | | | | | | | | | | | | |
| Decimal number | | | | | | | | | | | | |

# A.3 Star-delta motor connection and application examples

Depending on your application, you can operate the motor in the star or delta connection (Y/Δ).

**Examples for operating the converter and motor on a 400 V line supply**

Assumption: The motor rating plate states 230/400 V Δ/Y.

Case 1: A motor is normally operated between standstill and its rated speed (i.e. a speed corresponding to the line frequency). In this case, you need to connect the motor in Y. Operating the motor above its rated speed is only possible in field weakening, i.e. the motor torque available is reduced above the rated speed.

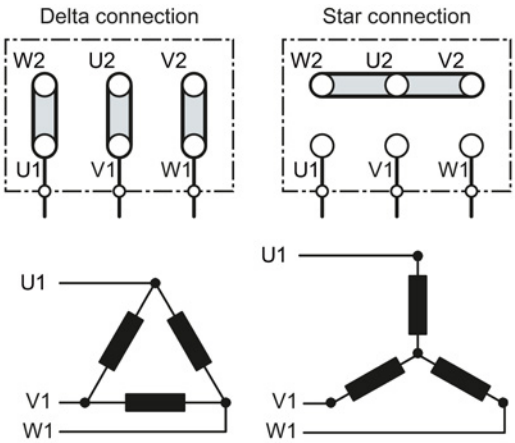
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

Before you connect the motor, ensure that the motor has the appropriate connection for your application:

## Motor is connected in the star or delta configuration

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

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



# A.4 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- 1 How to switch to commissioning mode or restore the factory setting

| Parameter | Description |
|---|---|
| p0010 | Commissioning parameters<br>0: Ready (factory setting)<br>1: Carry out basic commissioning<br>3: Carry out motor commissioning<br>5: Technological applications and units<br>15: Define number of data sets<br>30: Factory setting - initiate restore factory settings |

Table A- 2 How to determine the firmware version of the Control Unit

| Parameter | Description |
|---|---|
| r0018 | Firmware version is displayed |

Table A- 3 How to select the command and setpoint sources for the inverter

| Parameter | Description |
|---|---|
| p0015 | Additional information is available in Section Selecting the pre-assignment for the terminal strip (Page 60). |

Table A- 4 How to set the ramp-up and ramp-down

| Parameter | Description |
|---|---|
| p1080 | Minimum speed<br>0.00 [rpm] factory setting |
| p1082 | Maximum speed<br>1500.000 [rpm] factory setting |

| Parameter | Description |
|---|---|
| p1120 | **Ramp-up time**<br>10.00 [s] |
| p1121 | **Ramp-down time**<br>10.00 [s] |

Table A- 5 **This is how you set the closed-loop type**

| Parameter | Description |
|---|---|
| P1300 | 0: U/f control with linear characteristic<br>1: U/f control with linear characteristic and FCC<br>2: U/f control with parabolic characteristic<br>3: U/f control with adjustable characteristic<br>4: U/f control with linear characteristic and ECO<br>5: U/f control for drives requiring a precise frequency (textile area)<br>6: U/f control for drives requiring a precise frequency and FCC<br>7: U/f control with parabolic characteristic and ECO<br>19: U/f control with independent voltage setpoint<br>20: Speed control (without encoder)<br>22: Torque control (without encoder) |

Table A- 6 **This is how you optimize the starting behavior of the U/f control for a high break loose torque and overload**

| Parameter | Description |
|---|---|
| p1310 | **Voltage boost to compensate ohmic losses**<br>The voltage boost is active from standstill up to the rated speed.<br>It is at its highest at speed 0 and continually decreases as the speed increases.<br>Value of the voltage boost at speed 0 in V:<br>1.732 × rated motor current (p0305) × stator resistance (r0395) × p1310 / 100% |
| p1311 | **Voltage boost when accelerating**<br>The voltage boost is effective from standstill up to the rated speed.<br>It is independent of the speed and has a value in V of:<br>1.732 × rated motor current (p0305) × stator resistance (p0350) × p1311 / 100% |
| p1312 | **Voltage boost when starting**<br>Setting to additionally boost the voltage when starting, however only when accelerating for the first time. |

Table A- 7 How to change the inverter pulse frequency

| Parameter | Description |
|---|---|
| p1800 | **Setting the inverter pulse frequency**<br>The pulse frequency depends on the power unit. You can find the setting limits and the factory setting in Section Technical data, Power Modules (Page 390).<br>If you increase the pulse frequency, the inverter output current decreases (the maximum output current is displayed in r0076).<br>If you use a sine-wave filter, you can only set the pulse frequency to values that are permissible for the filter.<br>When operated with an output reactor, the pulse frequency is limited to a maximum of 4 kHz. |

# A.5 Handling the BOP 2 operator panel

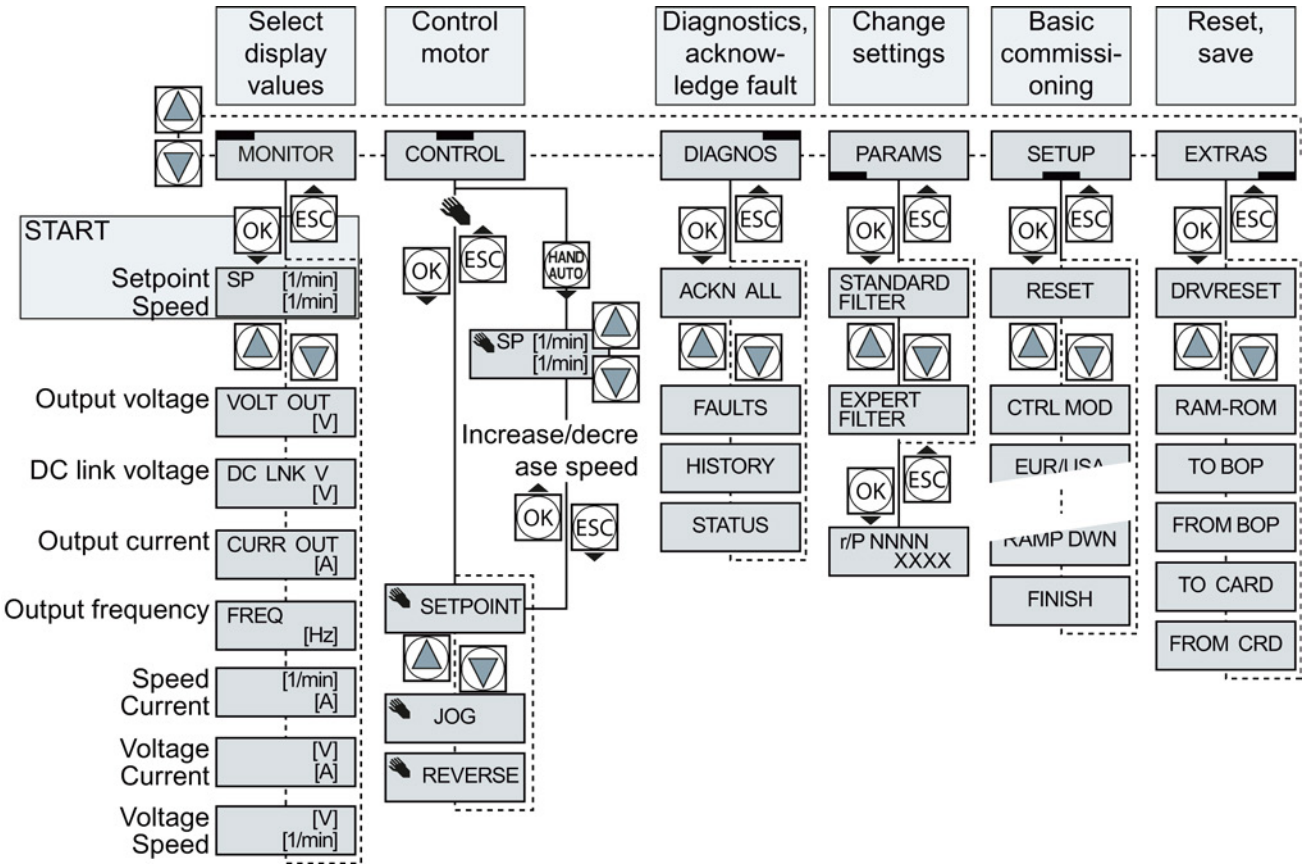



Figure A-1 Menu of the BOP-2

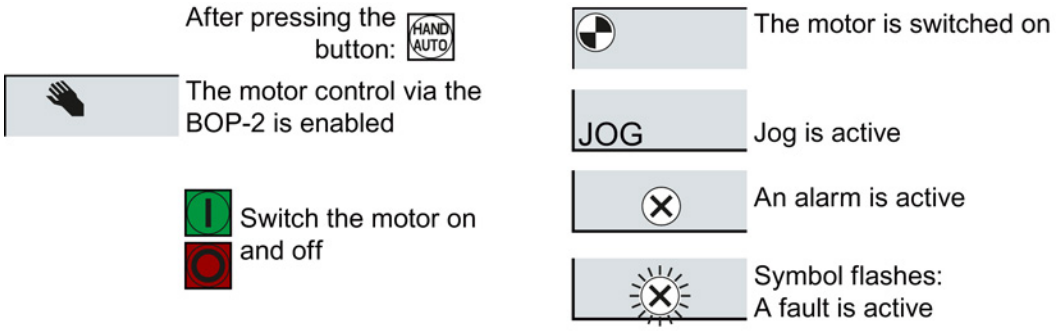



Figure A-2 Other keys and symbols of the BOP-2

## A.5.1 Changing settings using BOP-2

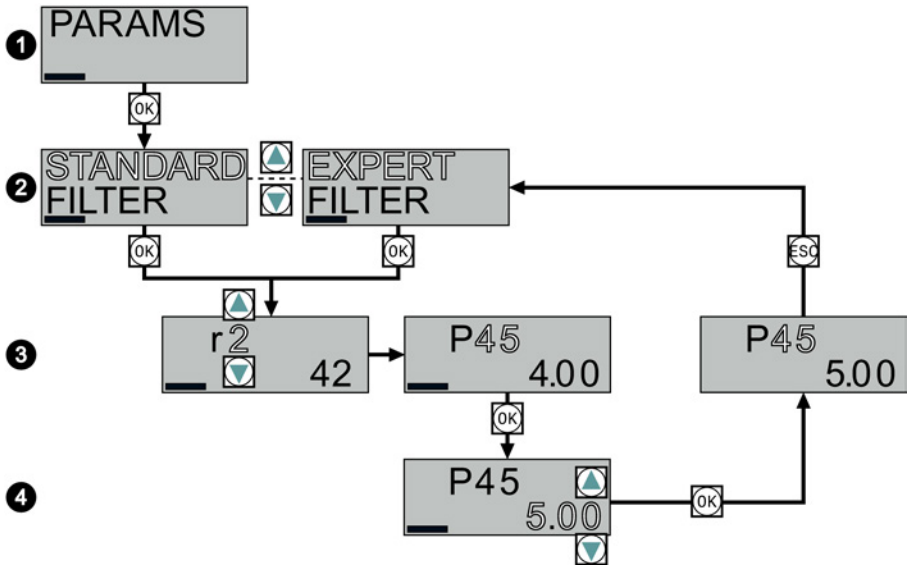
### Changing settings using BOP-2

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.5.2 Changing indexed parameters

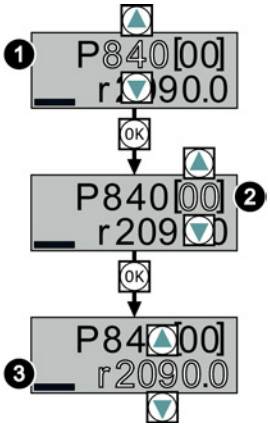
### Changing indexed parameters

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.5.3 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.

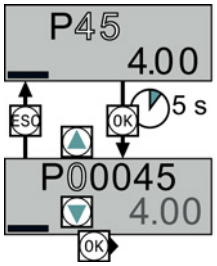
#### Prerequisite

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.

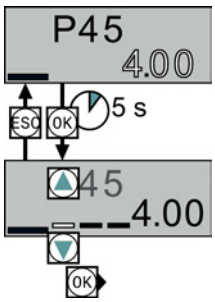
#### Prerequisite

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.

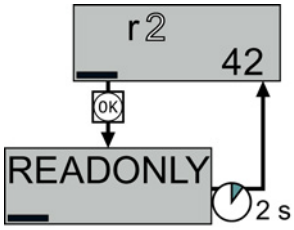



You have now entered the parameter value directly.

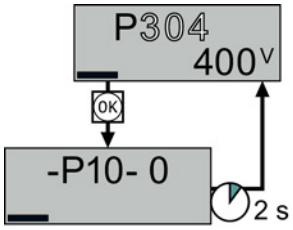
## A.5.4 A parameter cannot be changed

### When must you not change a parameter?

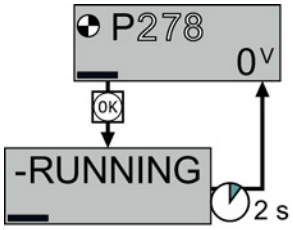
The converter indicates why it currently does not permit a parameter to be changed:




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.

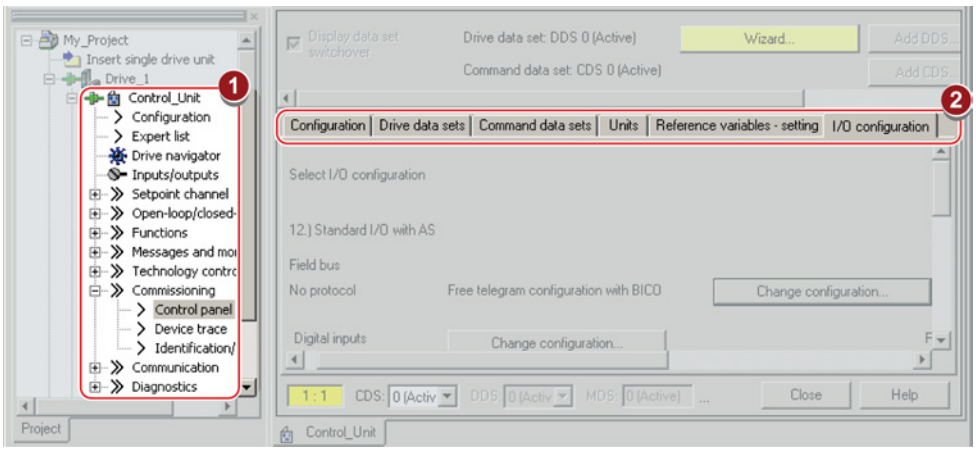
# A.6 Handling STARTER

## A.6.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidelines (Page 73).

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.6.2 Optimize the drive using the trace function

### Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control_Unit/Commissioning/Device trace".

In two settings that are independent of one another, using ... you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

### Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with ←. Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using ↑.

#### Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ( ).

#### Mathematical function

Using the mathematical function ( ) you can define a curve, for example the difference between the speed setpoint and the actual speed value.

---

**Note**

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

---

## Trigger

You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the button (Start Trace). Using the button , you can define another trigger to start the measurement.

Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

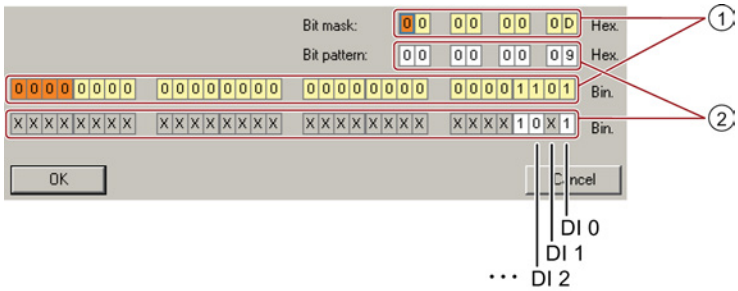
### Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using , select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using bin..., open the screen form in which you set the bits and their values for the start condition




① Select the bits for the trace trigger, upper row hex format, lower row binary format

② Define the bits for the trace trigger, upper row hex format, lower row binary format

Figure A-3 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

## Display options

In this area, you can set how the measurement results are displayed.

- Repeating measurements
  This places the measurements that you wish to perform at different times above one other.
- Arrange the curves in tracks
  This means you define whether the trace of all measured values is displayed with respect to a common zero line – or to separate zero lines.
- Measuring cursor on
  This allows you to analyze the measuring intervals in more detail.

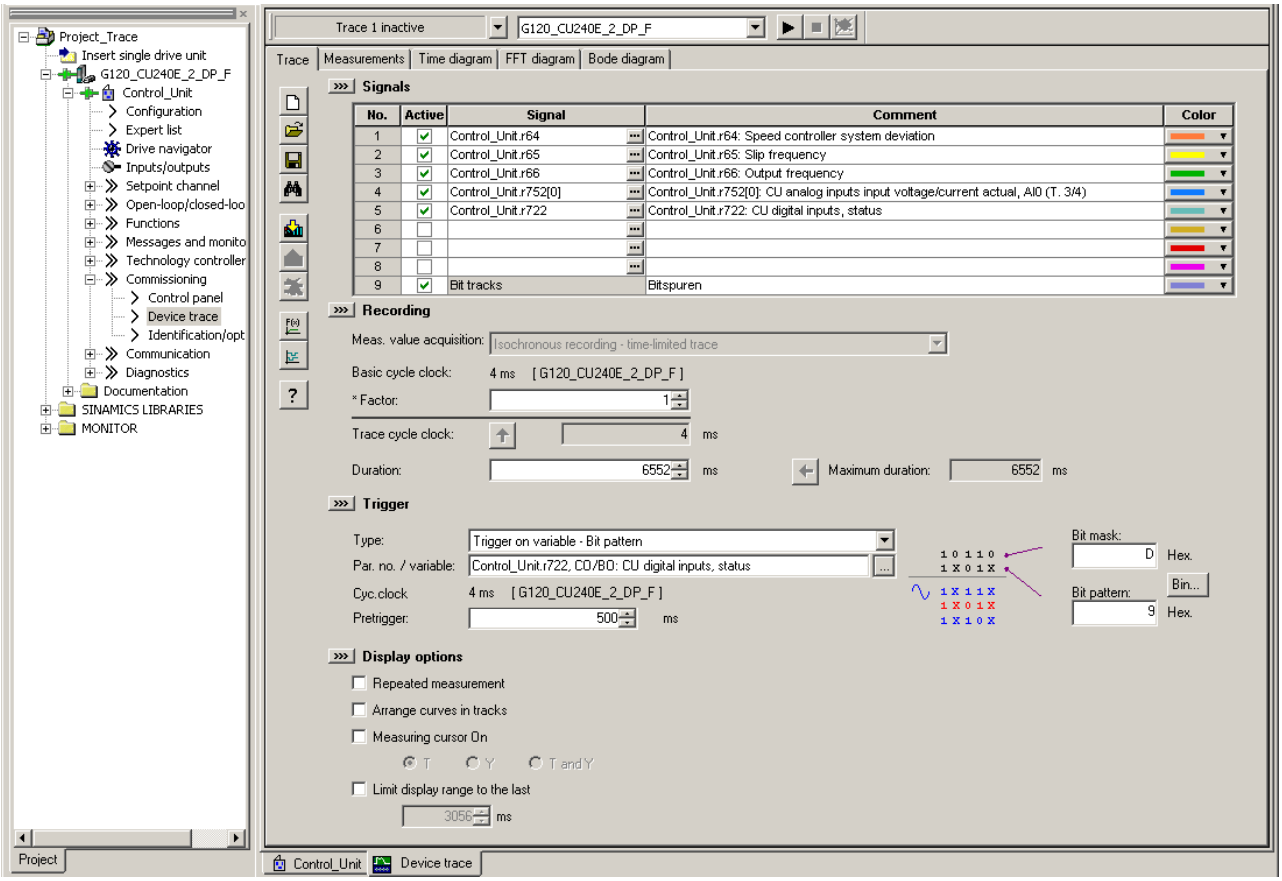



Figure A-4 Trace dialog box

# A.7 Interconnecting signals in the inverter

## A.7.1 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.

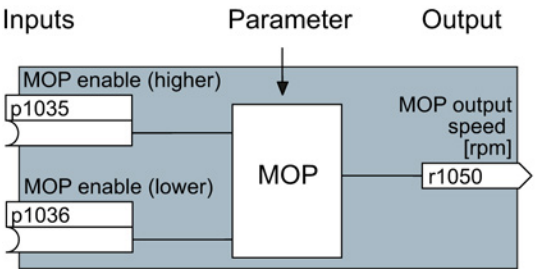



Figure A-5 Example of a block: Motorized potentiometer (MOP)

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.

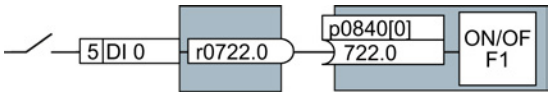



Figure A-6 Example: Signal interconnection of two blocks for digital input 0

## 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)

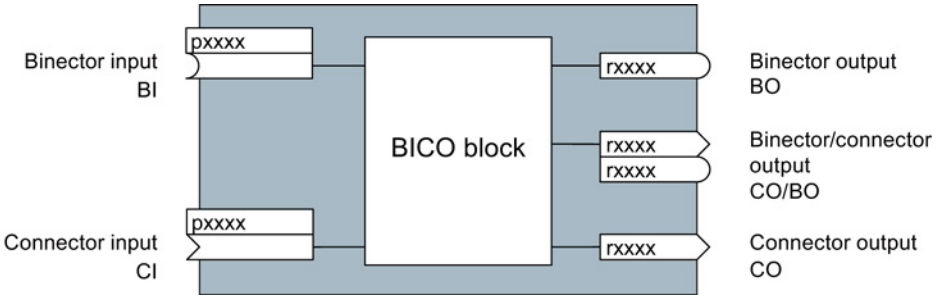



Figure A-7 Symbols for binector and connector inputs and outputs

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.7.2 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).

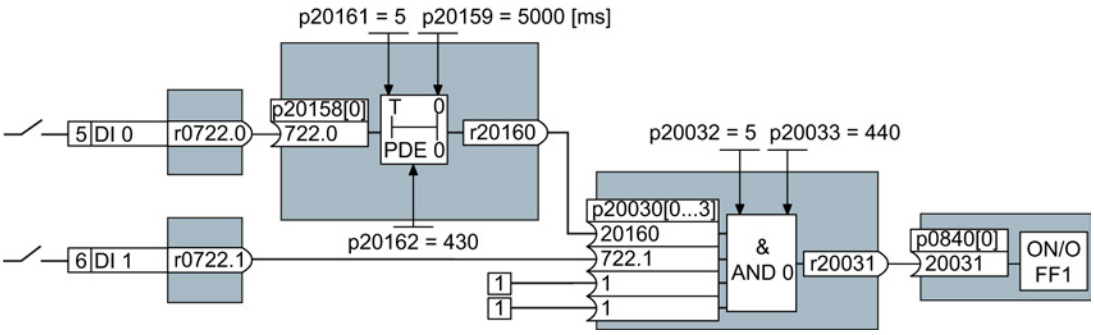



Figure A-8 Example: Signal interconnection for control logic

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<br>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<br>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.

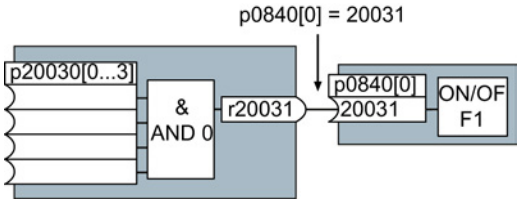



Figure A-9 Interconnecting blocks by setting p0840[0] = 20031

### 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.8 Application Examples

## A.8.1 Setting an absolute encoder

### Encoder data

In the following example, the inverter must evaluate an SSI encoder. The encoder data sheet also includes the following encoder data:

Table A- 8 Excerpt from the data sheet of the absolute encoder

| Feature | Value | Configuring an encoder | Adapting the encoder data | Parameter |
|---|---|---|---|---|
| Principle of operation | Multiturn | ① | ③ | p0404.2 = 1 |
| Operating voltage | 10 V … 30 V | | ④ | p0404.21 = 1 |
| Clock frequency of the SSI interface | 100 kHz … 1 MHz | | ⑤ | p0427 = 100 |
| Digital resolution | 25 bit (8192 steps x 4096 revolutions) | | ⑥ | p0423 = 8192<br>p0421 = 4096 |
| SSI telegram | 25 bit, without parity | | ⑦ | p0447 = 25 |
| Code type | Gray | | ⑧ | p429.0 = 0 |

## Configuring an encoder

When configuring the encoder, you must select an encoder type that has the best possible fit to the real encoder.

### Precondition

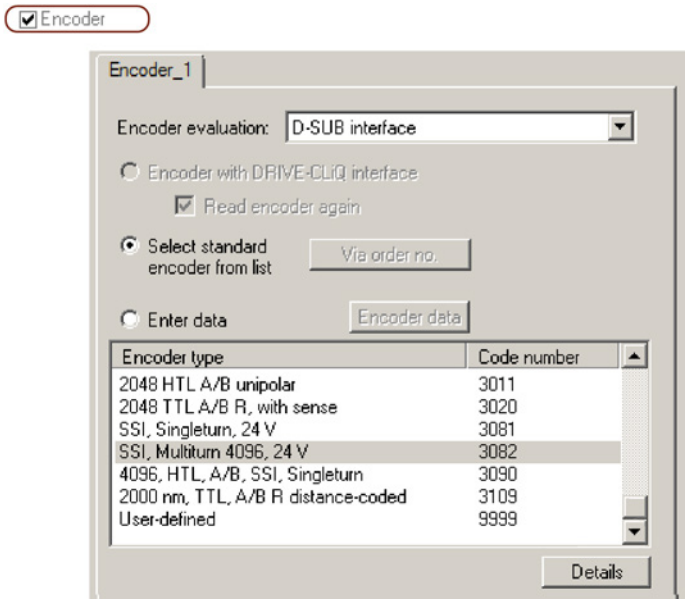
You have started to configure the drive.

### Procedure

1
2

Proceed as follows to set an absolute encoder in STARTER:

1. In the "Encoder" configuration step, select the multiturn encoder with SSI interface.




2. Complete the configuration.

You have now configured the absolute encoder.

## Adapting the encoder data

After the configuration you may now adapt the encoder data.

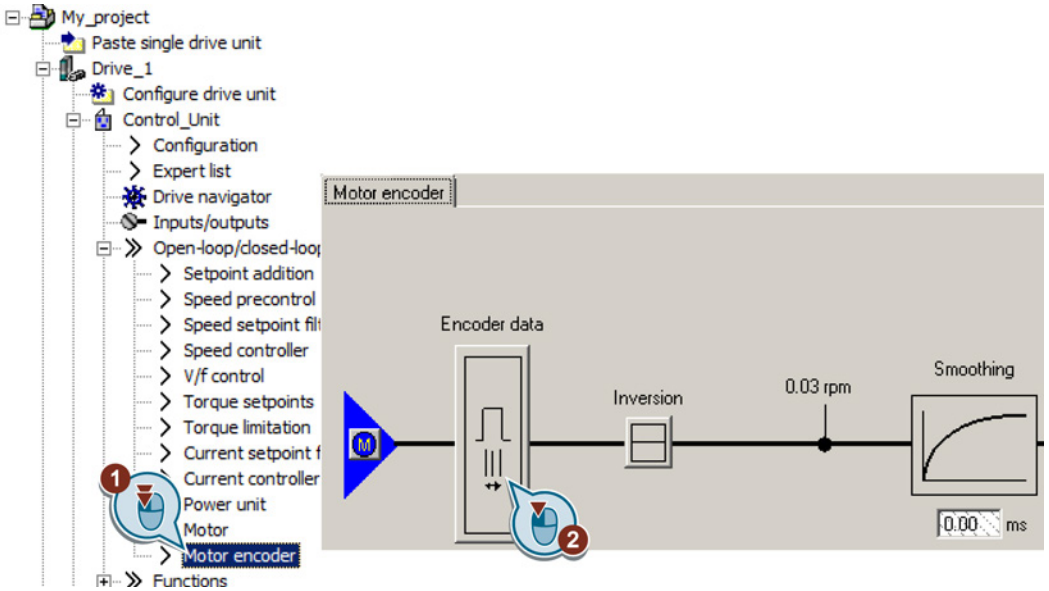
### Preconditions

- You have now configured an absolute encoder.
- You have completely configured the drive.

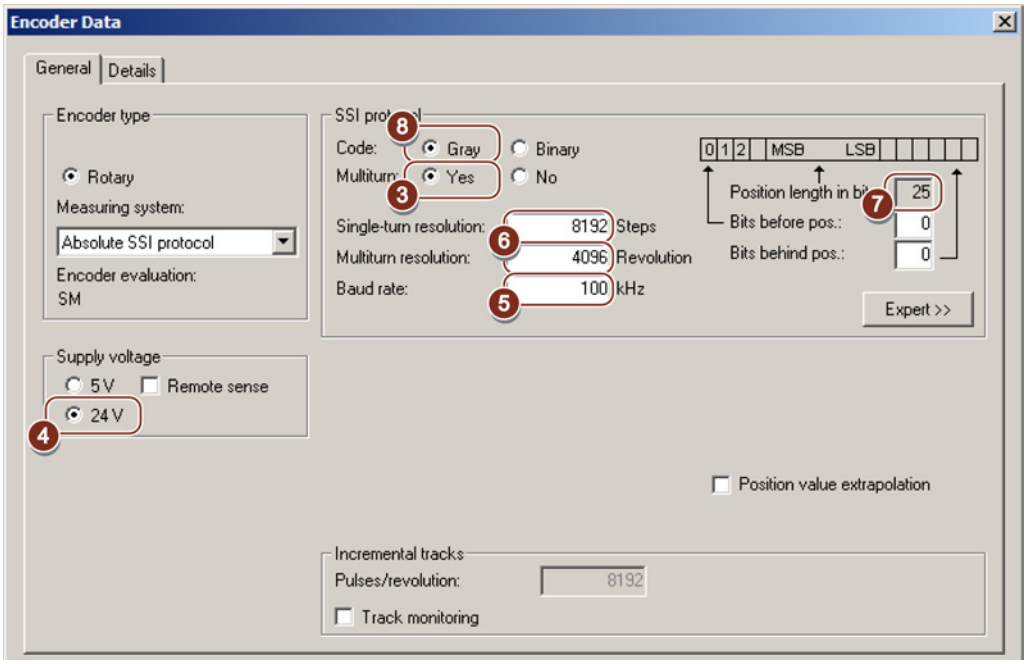
### Procedure

Proceed as follows to adapt the encoder data:

1. Select the "Motor encoder" screen form.
2. Select the "Encoder data" button.



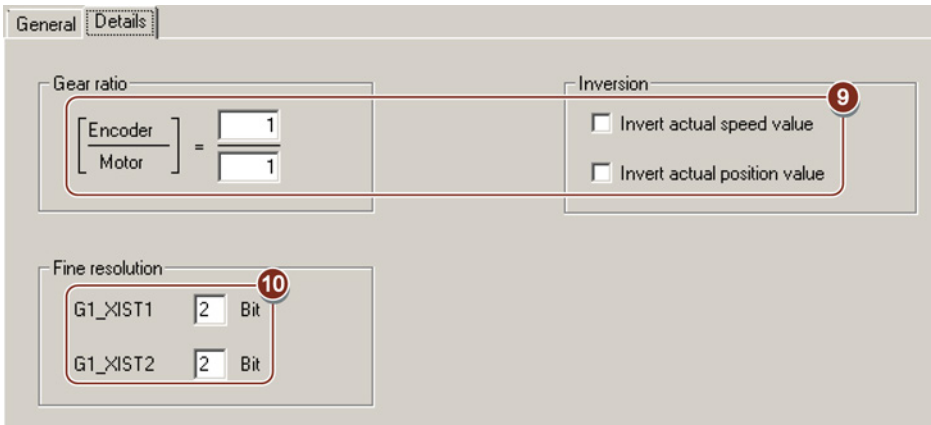
3. … 10. In the "Encoder data" screen form, adapt the settings corresponding to the data sheet of your encoder.




The "Details" tab is used for application-specific settings, e.g. to invert the encoder signal.

The fine resolution can be separately set for the process data Gx_XIST1 and Gx_XIST2.

2 bit fine resolution is practical for square wave encoders. Typically, sin/cos encoders have an 11 bit fine resolution.




You have adapted the encoder data.

## A.8.2 Configuring PROFIBUS 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.

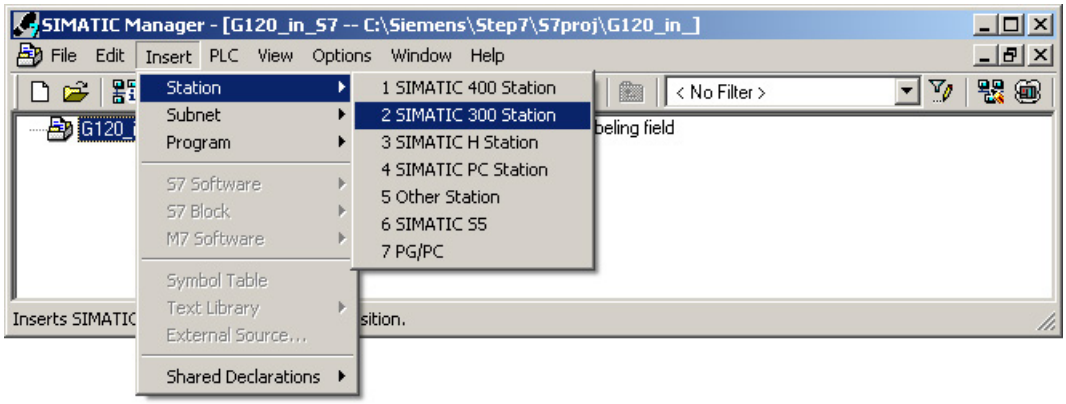
### A.8.2.1 Creating a STEP 7 project and network

**Procedure**

1
2

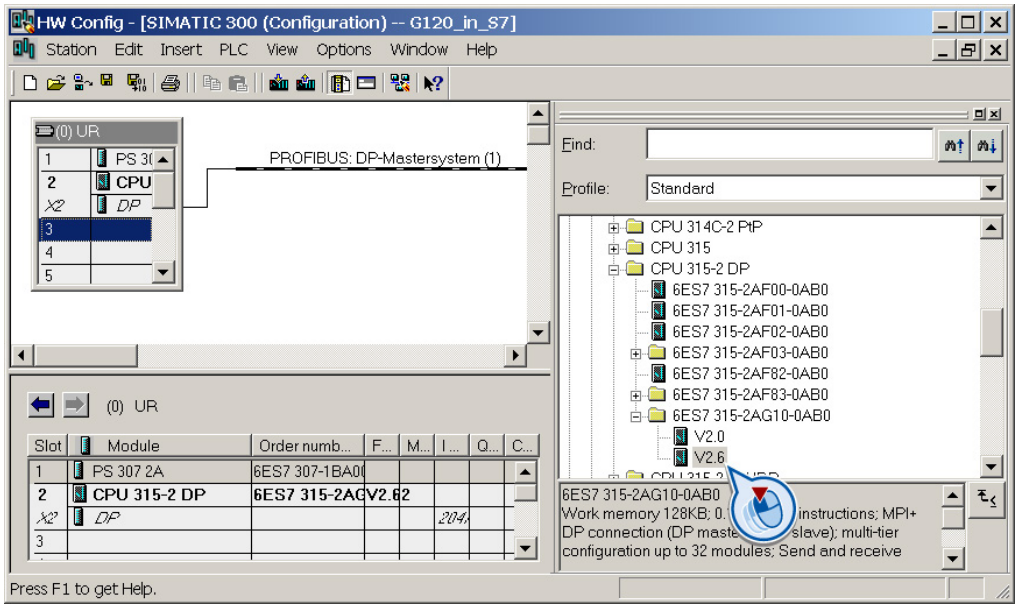
In order to create a STEP 7 project, proceed as follows:

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.8.2.2 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 39)).

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

1
2

In order to insert an inverter into your project, proceed as follows:

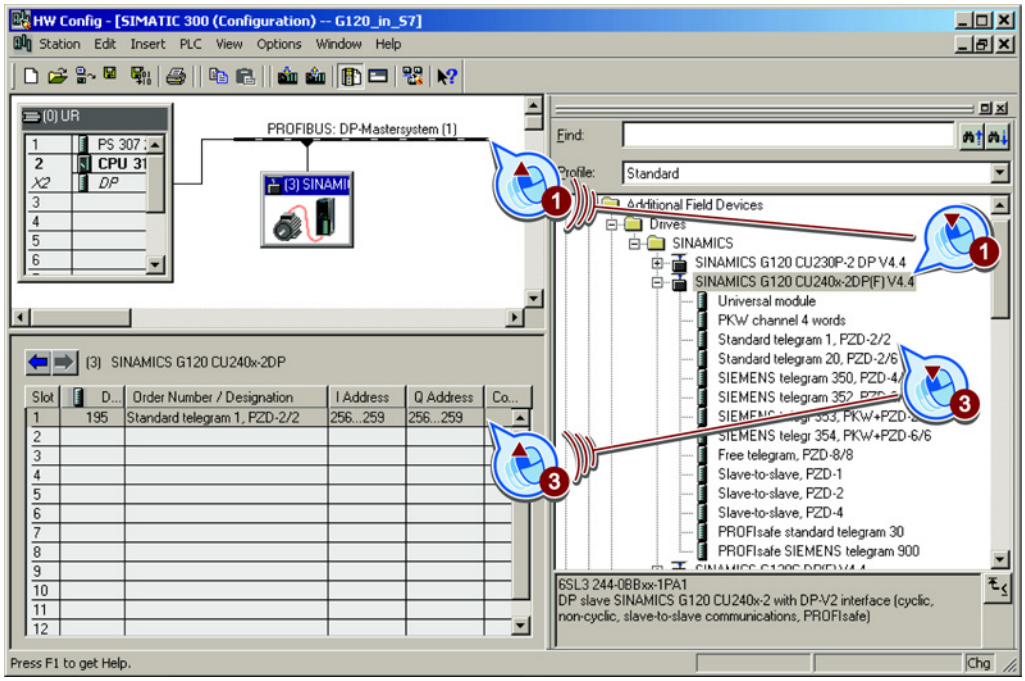
1. Insert the inverter by dragging and dropping it into the PROFIBUS network.

   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 120).

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.8.3 Configuring PROFINET communication in STEP 7

### A.8.3.1 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**

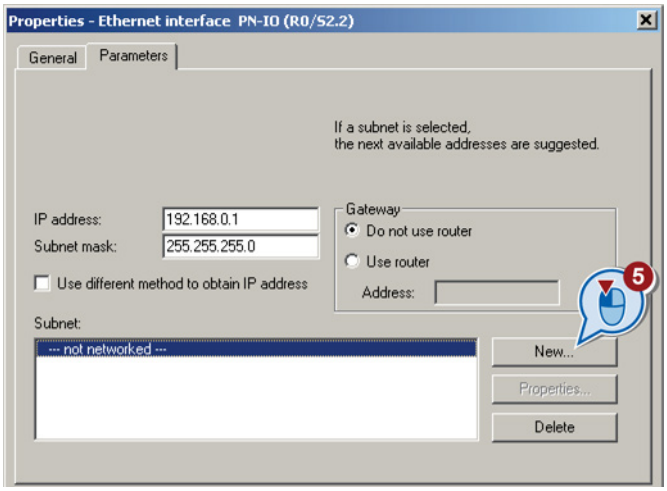
1
2

Proceed as follows to configure communications between the inverter and the control system via PROFINET:

1. Open HW Config in STEP 7 via "Insert/[Station]", and create the components in accordance with your hardware structure. The following example is limited to the components that are absolutely required.
2. Build your station with a rack and power supply unit.
3. Insert the CPU.

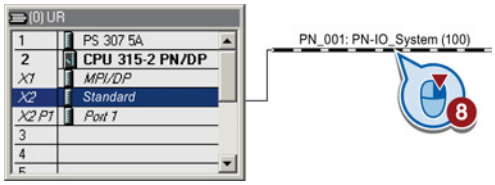
   HW Config opens a screen form with suggestions for the next free IP address and a subnet screen form.
4. If you have configured a local area network, and are not working within a larger Ethernet network, use the proposed entries.

   Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. CPU and supervisor must have the same subnet screen form.



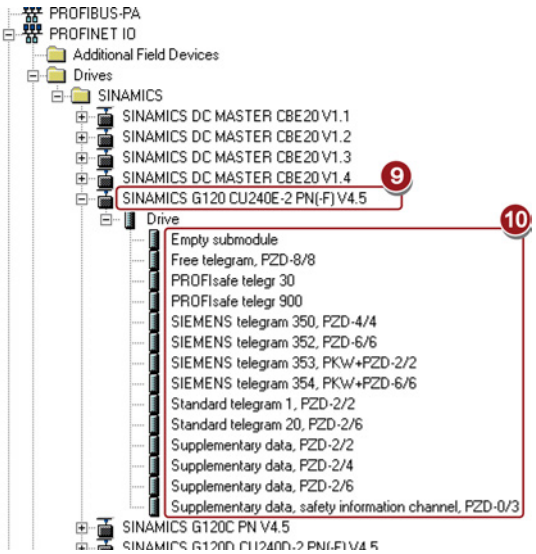

5. Use the "New" button to either create a new PROFINET subnet or select an existing one.
6. Assign a name for your PROFINET network.
7. Exit this screen form and the next one with OK.

8. Select your subnet.



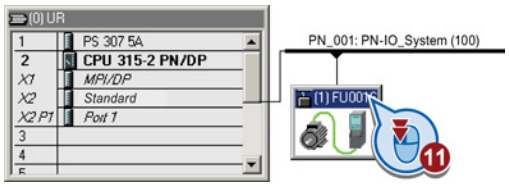

9. Using the hardware catalog, first insert the inverter using drag & drop.

10. Insert the communication telegram.




11. Open the properties window of the inverter and enter a unique and descriptive device name for the inverter.

    Using the device name, the PROFINET controller assigns the IP address when starting up.



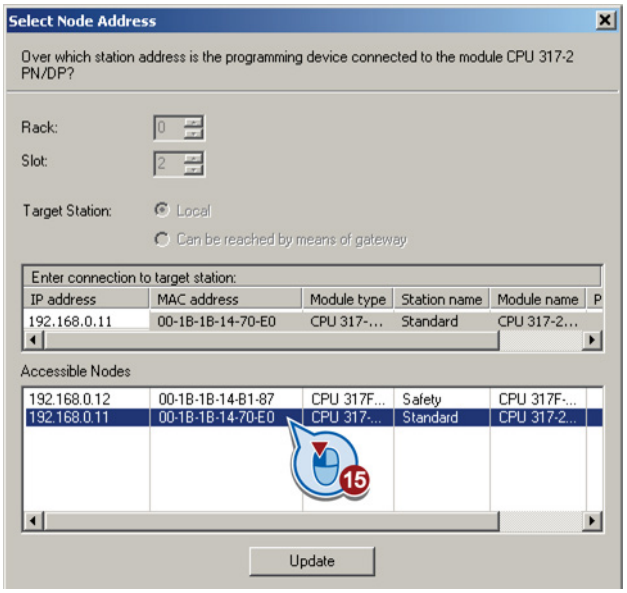

12. You will also find the proposed IP address in this screen form. If required, you can change the IP address via "Properties".

13. Save your hardware configuration with "Save and compile" ( ).

14. Load the configuration into the control unit via the button.

15. Enter the IP address of the controller.

    If you do not have the IP address readily available, you can display the participants that can be reached by clicking the "Display" button. Select the control from the list of accessible participants, and exit the screen form with OK.




16. If you have installed Drive ES Basic, open the STARTER by double-clicking the inverter symbol in the Hardware Manager and configure the inverter in the STARTER.

    In this case, STARTER automatically accepts the device name and IP address. The approach described in the following section is therefore superfluous.

17. If you are working with the GSDML, close HW Config now and create a reference for STARTER as described in the following section.

You have configured the communication between the inverter and the control unit using PROFINET .

### A.8.3.2 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.

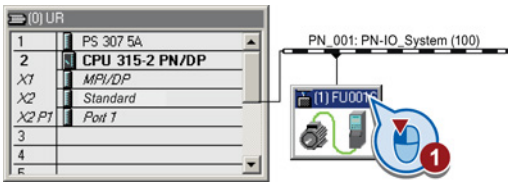
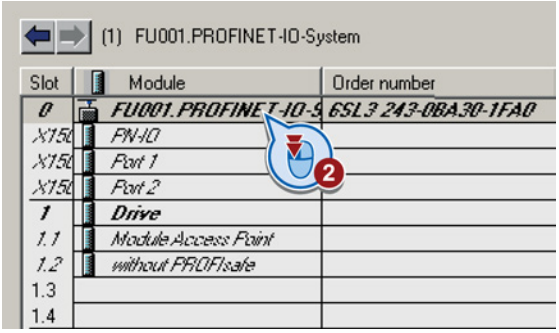
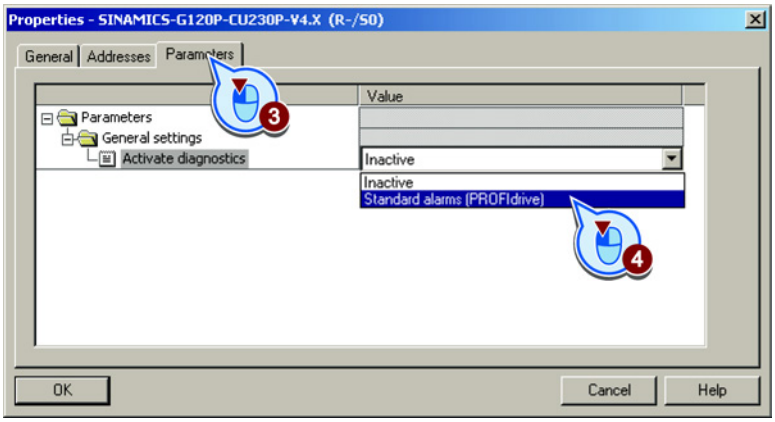



Figure A-10 Highlight inverter in HW Config

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.8.4 Go online with STARTER via PROFINET

### A.8.4.1 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.

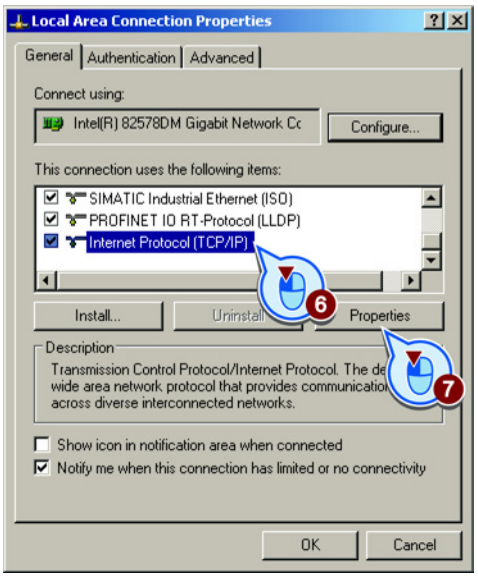
#### Procedure

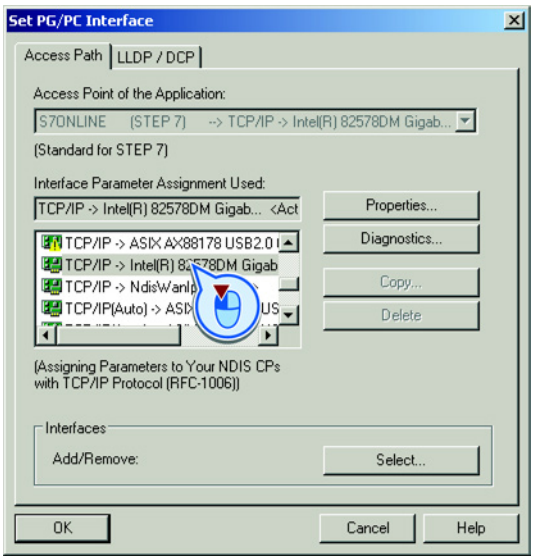
To address the inverter, proceed as follows:

1. Establish the bus connection.

   See Section Communication via PROFINET (Page 112))
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.

### A.8.4.2 Create a reference for STARTERS

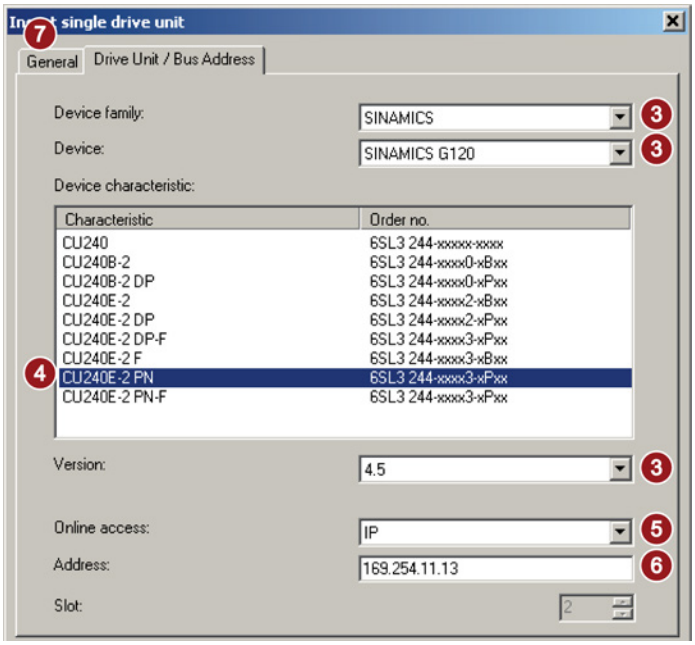
If you have configured the inverter via GSDML, in STEP 7, you must create a reference of the inverter for STARTER, so that you can call up STARTER from STEP 7.

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.




8. Exit the screen form with OK.
9. The inverter is visible in your project.

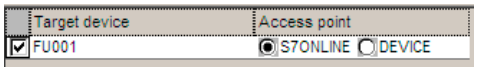
In your project, you have created an inverter reference for STARTER. You can now call STARTER from your STEP 7 project.

### A.8.4.3 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.8.5 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 ≙ … | Signal category | 4000 hex ≙ … |
|---|---|---|---|
| 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.8.5.1 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 447)).

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.8.5.2 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 *MB 42* | 02 hex: Change request | 0 |
| | 01 hex | Number of parameters *MB 44* | 2 |
| Address, parameter 1 | 10 hex: Parameter value | Number of indexes *00 hex* | 4 |
| | Parameter number *MW 21* | | 6 |
| | Number of the 1st index *MW 23* | | 8 |
| Values, parameter 1 | Format *MB 25* | Number of index values *MB 27* | 10 |
| | Value of the 1st index*MW35* | | 12 |

SFC 58 copies the specifications for the parameters to be written from DB 3 and sends them to the inverter. The inverter blocks other write jobs while this write job is running.

## A.8.6 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).

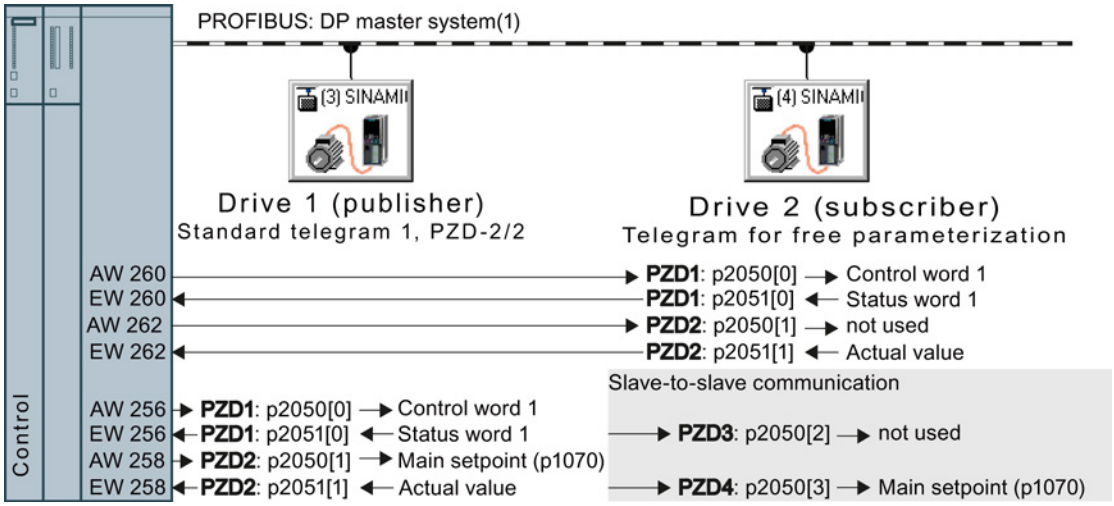


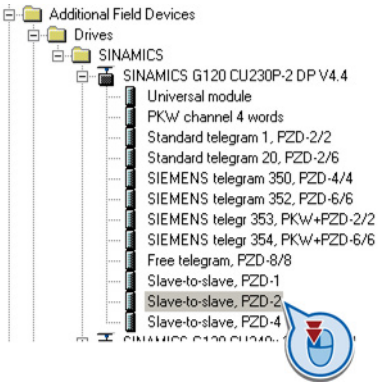

Figure A-13 Communication with the higher-level controller and between the drives with direct data exchange

### Setting direct data exchange in the control

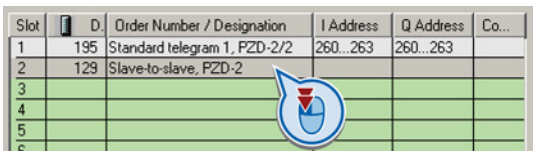
#### Procedure

Proceed as follows to set direct data exchange in the control:

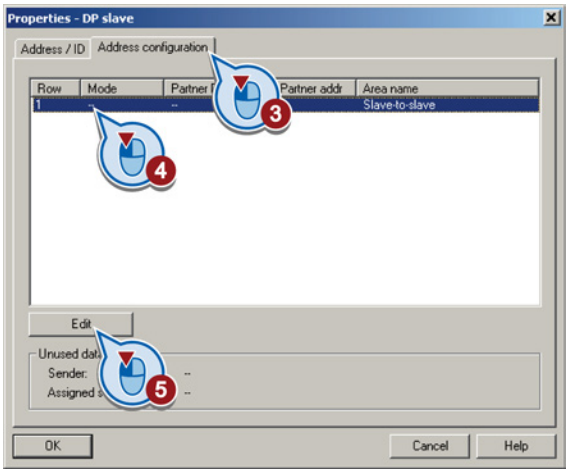
1. In HW Config in drive 2 (subscriber), insert a direct data exchange object, e.g. "Slave-to-slave, PZD2".



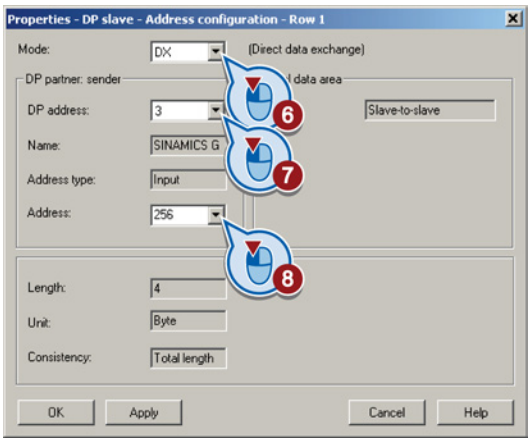

2. With a double-click, open the dialog box to make additional settings for the direct data exchange.



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.8.7 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.

## A.8.8 Connecting fail-safe digital inputs

The inverter allows a PM-switching output as well as a PP-switching output to be connected.

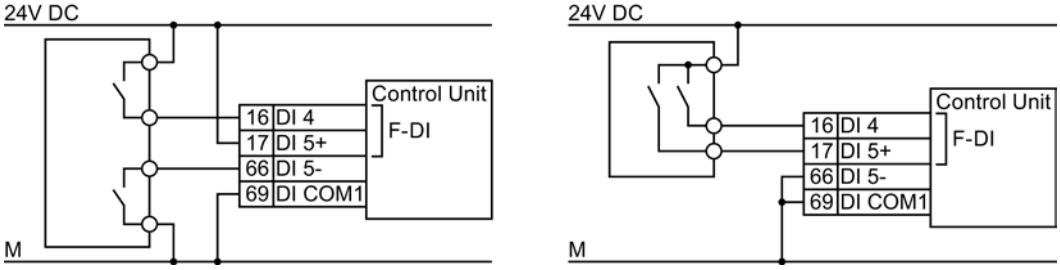



Figure A-14 Connecting a PM-switching and a PP-switching output

The following 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.

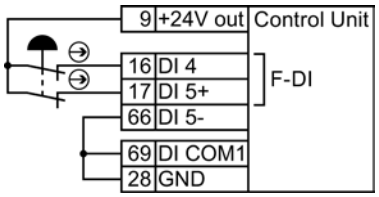



Figure A-15 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

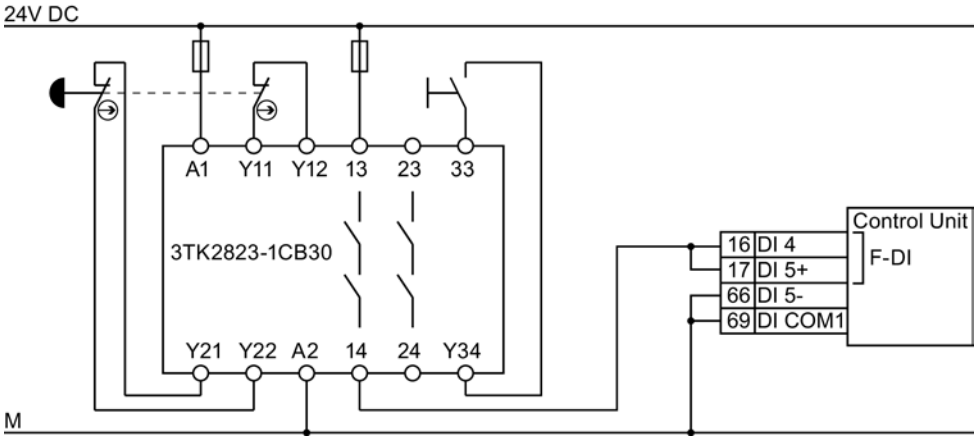



Figure A-16 Connecting a safety relay connection of a safety relay, e.g. SIRIUS 3TK28

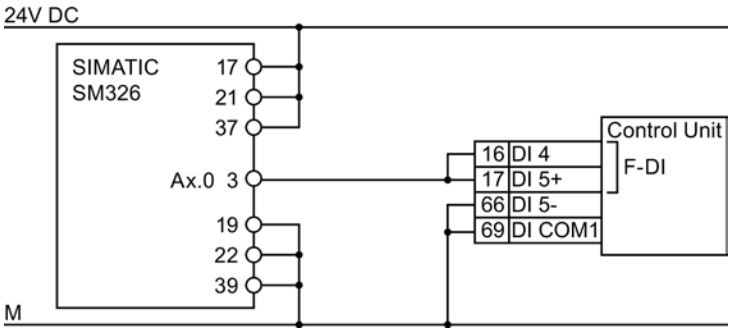



Figure A-17 Connecting an F-DO module connection of an F digital output module, e.g. SIMATIC F digital output module

You can find additional connection options and connections in separate control cabinets in the Safety Integrated Function Manual, see Section: Manuals for your converter (Page 461).

# A.9 Documentation for accepting the safety functions

## A.9.1 Machine documentation

### Machine or plant description

| | |
|---|---|
| Designation | … |
| Type | … |
| Serial number | … |
| Manufacturer | … |
| End customer | … |
| Block diagram of the machine and/or plant:<br>…<br>…<br>…<br>…<br>…<br>…<br>… | |

### Inverter data

Table A- 13 Hardware version of the safety-related inverter

| Labeling the drive | Order number and hardware version of the inverter |
|---|---|
| … | … |
| … | … |

### Function table

Table A- 14 Active safety functions depending on the operating mode and safety equipment

| Operating mode | Safety equipment | Drive | Selected safety function | Checked |
|---|---|---|---|---|
| … | … | … | … | |
| … | … | … | … | |
| *Example:* | | | | |
| *Automatic* | *Protective door closed* | *Conveyor belt* | --- | --- |
| | *Protective door open* | *Conveyor belt* | *STO* | |
| | *Emergency Stop button pressed* | *Conveyor belt* | *STO* | |

## Acceptance test reports

| File name of the acceptance reports | |
|---|---|
| … | … |
| … | … |

## Data backup

| Data | Storage medium | | | Holding area |
|---|---|---|---|---|
| | Archiving type | Designation | Date | |
| Acceptance test reports | … | … | … | … |
| PLC program | … | … | … | … |
| Circuit diagrams | … | … | … | … |

## Countersignatures

### Commissioning engineer

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

| Date | Name | Company/dept. | Signature |
|---|---|---|---|
| … | … | … | … |

### Machine manufacturer

This confirms that the settings recorded above are correct.

| Date | Name | Company/dept. | Signature |
|---|---|---|---|
| … | … | … | … |

## A.9.2 Log the settings for the basic functions, firmware V4.4 ... V4.6

### Drive = <pDO-NAME_v>

Table A- 15 Firmware version

| Name | Number | Value |
|---|---|---|
| Control Unit firmware version | r18 | <r18_v> |
| SI version, safety functions integrated in the drive (processor 1) | r9770 | <r9770_v> |

Table A- 16 Monitoring cycle

| Name | Number | Value |
|---|---|---|
| SI monitoring clock cycle (processor 1) | r9780 | <r9780_v> |

Table A- 17 Checksums

| Name | Number | Value |
|---|---|---|
| SI reference checksum SI parameters (processor 1) | p9799 | <p9799_v> |
| SI reference checksum SI parameters (processor 2) | p9899 | <p9899_v> |

Table A- 18 Settings of the safety functions

| Name | | Number | Value |
|---|---|---|---|
| SI enable, functions integrated in the drive | | p9601 | <p9601_v> |
| *Only for the CU250S-2 Control Unit* | SI enable safe brake control | p9602 | <p9602_v> |
| SI PROFIsafe address | | p9610 | <p9610_v> |
| SI F-DI changeover, tolerance time | | p9650 | <p9650_v> |
| SI STO debounce time | | p9651 | <p9651_v> |
| *Only for the CU250S-2 Control Unit* | SI Safe Stop 1 delay time | p9652 | <p9652_v> |
| SI forced dormant error detection timer | | p9659 | <p9659_v> |

Table A- 19 Safety logbook

| Name | Number | Value |
|---|---|---|
| SI checksum to check changes | r9781[0] | <r9781[0]_v> |
| SI checksum to check changes | r9781[1] | <r9781[1]_v> |
| SI change control time stamp | r9782[0] | <r9782[0]_v> |
| SI change control time stamp | r9782[1] | <r9782[1]_v> |

# A.10 Additional information on the inverter

## A.10.1 Manuals for your converter

Table A- 20 Manuals for your inverter

| Informa-tion depth | Manual | Contents | Available languages | Download or order number |
|---|---|---|---|---|
| ++ | **Getting Started Guide** | Installing and commissioning the inverter. | English, German, Italian, French, Spanish, Chinese | Download manuals (http://support.automation.siemens.com/WW/view/en/22339653/133300)<br>**SINAMICS Manual Collection**<br>Documentation on DVD, order number 6SL3097-4CA00-0YG0 |
| +++ | **Operating instructions**<br>for the SINAMICS G120 inverter with a CU250S-2 Control Unit, "Vector" control mode | (this manual) | | |
| +++ | **Operating instructions**<br>for the SINAMICS G120 inverter with a CU250S-2 Control Unit, "Servo" control mode | Installing, commissioning and operating the inverter.<br>Setting the inverter functions.<br>Technical data | | |
| +++ | **Function Manual, basic positioner** | Commissioning the basic positioner. | English, German, Chinese | |
| +++ | **Function Manual for Safety Integrated**<br>for the SINAMICS G120, G120C and G120D inverters | Configuring PROFIsafe.<br>Installing, commissioning and operating fail-safe functions of the inverter. | English, German, Chinese | |
| +++ | **List Manual** | Complete list of all parameters, alarms and faults.<br>Graphic function diagrams. | English, German, Chinese | |
| + | **Getting Started Guide**<br>for the following SINAMICS G120 Power Modules:<br>• PM240, PM250 and PM260<br>• PM240-2 | Installing the Power Module. | English | |
| + | **Installation Instructions**<br>for reactors, filters and braking resistors | Installing components. | | |
| +++ | **Hardware Installation Manual**<br>for the following SINAMICS G120 Power Modules:<br>• PM240<br>• PM240-2<br>• PM250<br>• PM260 | Installing power modules, reactors and filters.<br>Maintaining power modules. | English, German | |

| Informa-tion depth | Manual | Contents | Available languages | Download or order number |
|---|---|---|---|---|
| +++ | **Operating Instructions**<br>for the following Operator Panels:<br>• BOP-2<br>• IOP | Operating operator panels, installing door assembly kit for IOP. | English, German | |
| +++ | **Manual**<br>SINAMICS S110 Manual<br>PM340 Power Module | Installing the PM340 Power Module.<br>Technical data<br>Maintenance | English, German, Italian, French, Spanish | S110 Manual (http://support.automation.siemens.com/WW/view/en/49086218) |
| +++ | **SINAMICS S120 Control Units and Additional System Components** | Including: SMC and SME Sensor Modules | English, German, Italian, French, Spanish, Chinese, Russian | S120 system components (http://support.automation.siemens.com/WW/view/en/68040800) |

## A.10.2 Configuring support

Table A- 21 Support when configuring and selecting the inverter

| Manual or tool | Contents | Available languages | Download or order number |
|---|---|---|---|
| Catalog D 31 | Ordering data and technical information for the standard SINAMICS G inverters | English, German, Italian, French, Spanish | Everything about SINAMICS G120 (www.siemens.en/sinamics-g120) |
| Online catalog (Industry Mall) | Ordering data and technical information for all SIEMENS products | English, German | |
| SIZER | The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology | English, German, Italian, French | You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and in the Internet:<br>Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000) |

## A.10.3 Product Support

### If you have further questions

You can find additional information on the product and more in the Internet under: Product support (http://support.automation.siemens.com/WW/view/en/4000024).

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

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

## A.11 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, 419

## A

Absolute encoder, 435
AC/DC drive profile, 146
Acceptance test, 314
    Authorized person, 314
    Preconditions, 314
    Reduced scope of, 315
    Requirements, 314
    STO, 319
    Test scope, 315
Acceptance test record, 314
Acyclic communication, 136
Additional components, 44
Adjustable parameters, 420
Alarm, 365, 369
Alarm buffer, 369
Alarm code, 369
Alarm history, 370
Alarm time, 369
Alarm value, 369
Ambient temperature, 74
Analog input, 58
    Function, 95, 105, 106, 109
Analog inputs, 75
Analog output, 58
    Function, 95, 109
Analog outputs, 75
Application
    Reading and writing parameters acyclically via PROFIBUS and PROFINET, 140
    Reading and writing parameters cyclically via PROFIBUS, 135
ASCII code
    Licensing, 418
Authorized person, 314
Automatic mode, 226
Automatic restart, 285

## B

Base components, 41
Basic commissioning, 60
Basic functions, 99
Basic positioner, 216
BF (Bus Fault), 366, 367
BICO block, 430
Bimetallic switch, 256
Binectors, 431
Bit pattern test, 308
Block, 430
Blocking protection, 294, 295
BOP-2
    Menu, 422
    Symbols, 422
Brake Relay, 278
Braking
    Regenerative, 277
Braking functions, 267
Braking method, 267, 268
Braking module, 36, 274
Braking resistor, 36, 274
Break loose torque, 421
Bus fault, 367
Bus termination, 56

## C

CAN
    COB, 179
    COB ID, 180
    Device profile, 179
    EMCY, 179
    NMT, 179
    SDO, 179
    SYNC, 179
CANopen communication profile, 179
Catalog, 462
CDS (Command Data Set), 226, 313
Centrifuge, 267, 269, 272, 277
Changing parameters (STARTER), 426
Characteristic
    Additional, 245
    Linear, 245
    parabolic, 245

square-law, 245
Checklist
PROFIBUS, 116
PROFINET, 112, 145
Circuit diagram, 459
Clockwise rotation, 219
Closed-loop speed control, 248
Closed-loop torque control, 254
COB, 179
COB ID, 180
Command Data Set, 226
Command source, 216
Selecting, 420
Commissioning
Accessories, 39
Guidelines, 73
Overview, 22
Communication
Acyclic, 136
Compound braking, 272, 273
Compressor, 81
Computational performance, 80
Configuring support, 462
Connectors, 431
Consistency, 307
Consistent signals, 307
Contact bounce, 308
Control mode, 421
Control terminals, 75
Control Units, 23, 345
Control word, 124, 127
Control word 1, 125
Control word 3, 127
Controlling the motor, 219
Conveyor belt, 269
Conveyor systems, 88
Copy
Series commissioning, 315
Copy parameters (series commissioning), 315
Correction manual, 464
Counter-clockwise rotation, 219
Countersignatures, 459
Crane, 267, 277, 281
Current input, 103


## D


Data backup, 323, 328, 332, 334, 459
Data exchange fieldbus, 447
Data set 47 (DS), 136, 452
Data set changeover, 313
Data transfer, 328, 332, 334
DC braking, 127, 270, 271
DC-link overvoltage, 259
DC-link voltage, 259
Default settings, 77
Delta connection (Δ), 74, 419
Device profile, 179
DI (Digital Input), 99, 312, 313
Digital input, 58, 219
Fail-safe, 59
Function, 95
Digital inputs, 75
Multiple assignment,
Digital output, 58
Function, 95, 101
Digital outputs, 75
Dimensions, 45, 48
DIP switch
Analog input, 103
Direct data exchange, 135, 454
Direction of rotation, 235
Direction reversal, 219
Discrepancy, 307
Filter, 307
Tolerance time, 307
Display parameters, 420
Door mounting kit, 39
Down ramp, 420
Download, 328, 332, 334
Drilling patterns, 45, 48
Drive Data Set, DDS, 320
Drive Data Sets, 320
Drive ES Basic, 39, 439
Drive-independent communication objects, 198
Droop, 253
DS 47, 136
Dynamic braking, 274


## E


Electromagnetic fields, 18
Electrostatic sensitive devices, 19
Elevator, 281
EMC, 67
EMCY, 179
Emergency Stop button, 302
EN 61800-5-2, 302
Encoder, 249
Encoder cables, 70
Encoder data, 436
End customer, 458
Energy recovery option, 277
Energy-saving display, 265

Ethernet/IP, 144
Extended functions, 99
Extruders, 81

## F

Factory assignment, 75
Factory settings, 83
    Restoring the, 83, 84, 304
Fail-safe input, 99
Fan, 81, 88
Fans, 267, 278
Fault, 365, 372
    Acknowledge, 372, 373
    Motor, 364
Fault buffer, 372
Fault case, 372
Fault code, 372
Fault detection, 310
Fault history, 373
Fault time, 372
    received, 372
    removed, 372
Fault value, 372
F-DI (Fail-safe Digital Input), 99
F-digital output module, 457
FFC (Flux Current Control), 245
Field weakening, 419
Fieldbus interfaces, 56
Filter
    Contact bounce, 308
    Discrepancy, 307
    On/off test, 308
Fine resolution, 437
Firmware, 23
    Update, 315
Firmware downgrade, 360
Firmware version, 5, 343, 411, 412, 420, 458
Flow control, 290
Flying restart, 284, 285
Forced dormant error detection, 310
Formatting, 325
Free function blocks, 299, 301
Function module, 79
Function table, 458
Functional expansions, 315
Functions
    BOP-2, 422
    Technological, 216
Fundamental safety instructions
    SINAMICS hardware, 15

## G

Getting Started, 461
Grinding machine, 267, 269, 272
GSD (Generic Station Description), 117, 439
GSDML (Generic Station Description Markup Language), 114

## H

Hardware Installation Manual, 461
Hoisting gear, 81, 267, 274, 277, 281
Holding brake, 267
Horizontal conveyor, 81
Horizontal conveyors, 272, 274, 278
Hotline, 463
HW Config (hardware configuration), 438

## I

I_max controller, 258
I2t monitoring, 255
Inclined conveyors, 81, 267, 274, 278
IND (page index), 132, 163
Industry Mall, 462
Installation, 40
Interfaces, 56, 60
    Configuring, 60
Interlock, 432
Inverter
    does not respond, 363
    Update, 315
Inverter components, 343
Inverter control, 216
IT system, 52

## J

JOG function, 225

## K

Know-how protection, 325, 337
KTY84 sensor, 256

## L

LED
    BF, 366, 367
    LNK, 366

RDY, 366
SAFE, 367
LED (light emitting diode), 365
Level control, 290
License, 24, 216, 325
License key
Create, 414
Displaying, 414
Entering in STARTER, 417
Entry using the BOP-2, 418
Licensing
ASCII code, 418
Line filter, 29
Line supply cable, 53
Line supply type, 52
Linear characteristic, 245
List Manual, 461
LNK (PROFINET Link), 366
Load failure, 296, 297
Load torque, 294


## M


Machine description, 458
Machine manufacturer, 314
Macro p15, 74
Manual Collection, 461
Manual mode, 226
Manuals
Download, 461
Function Manual for Safety Integrated, 461
Inverter accessories, 461
Overview, 461
Manufacturer, 458
Maximum cable length
DRIVE-CLiQ, 388
Encoder, 388
Modbus, 169
PROFIBUS, 116
PROFINET, 113
USS, 158
Maximum current controller, 258
Maximum speed, 82, 235, 237, 420
Memory cards, 24
Menu
BOP-2, 422
Operator panel, 422
Minimum speed, 82, 235, 236, 420
Mistakes manual, 464
MLFB (order number), 458
MMC (memory card), 325
MOP (motorized potentiometer), 231
Motor cable, 54
Motor control, 216
Motor data, 74
Identify, 92, 251, 254
Motor fault, 364
Motor holding brake, 267, 278, 280, 281
Motor standard, 262
Motor temperature sensor, 58, 75, 257
Motorized potentiometer, 231
Mounting, 43
Multiple assignment
Digital inputs, 312, 313
Multiturn encoder, 435


## N


Network management (NMT service), 180
Neutral conductor, 52
NMT,
No-load monitoring, 294, 295


## O


OFF1 command, 219
ON command, 219
On/off test, 308
Operating instruction, 21
Operating instructions, 461
Operating mode, 458
Operation, 218
Operator panel
BOP-2, 39, 422
Door mounting kit, 39
Handheld, 39
IOP, 39
Menu, 422
Optimizing the speed control with BOP-2 or STARTER, 251
Order number, 23
Overload, 258, 421
Overview
Manuals, 461
Overvoltage, 259


## P


p0015, configuring macro interfaces, 60
p15 macro, 74
Page index, 132, 163
Parabolic characteristic, 245
Parameter channel, 130, 161

IND, 132, 163
Parameter index, 132, 163
Parameter number, 132, 424
Parameter types, 420
Parameter value, 136, 425
Password, 303
PC Connection Kit, 39, 303
PDO, 188
PELV, 385
PFH (Probability of failure per hour), 387
PID controller, 290
Plant description, 458
PLC functionality, 432
PLC program, 459
Power distribution systems, 52
Power failure, 285
Power Module, 23
Power on reset, 83, 84, 304, 312, 346, 347
Pressure control, 290
Probe, 297
Procedure, 21
Process variables of the technology controller, 263
PROFIBUS, 116
PROFIenergy, 111, 141
PROFINET, 112
PROFIsafe, 111, 440
Protection functions, 216
Protective conductor, 52
PTC sensor, 256
Pulse cancelation, 125
Pulse enable, 125
Pulse frequency, 421
Pump, 81, 88
Pumps, 278

## Q

Questions, 463
Quick stop, 217

## R

Radio interference class, 29
Ramp-down time, 82, 238, 240, 421
Scaling, 241
Ramp-down time OFF3, 238
Ramp-function generator, 235, 237
Rampup time,
Ramp-up time
Scaling, 241
RDY (Ready), 366
Ready, 218
Ready to switch on, 218
Regenerative feedback, 27, 277
Regenerative power, 267
Replacing
Control Unit, 315
Gearbox, 315
Hardware, 315
Motor, 315
Power Module, 315
Reset
Parameter, 83, 84, 304
Residual risks of drive systems,
Reversing, 235
Rounding, 238
Rounding OFF3, 238
RPDO, 184
RS485 interface, 157
Run sequence, 300
Runtime group, 300

## S

SAFE, 367
Safe Brake Relay, 37, 310
Safety function, 216, 345, 353
Safety instructions
Electromagnetic fields, 18
Electrostatic sensitive devices, 19
General safety instructions, 15
Safety Integrated Function Manual, 456
Safety relay, 456
Saw, 269, 272
Scaling
Analog input, 104
Analog output, 107
Fieldbus, 447
SD (memory card), 325
Formatting, 325
MMC, 325
SDO, 179, 184
SDO protocols, 183
SDO services, 183
Self-test, 310
Sensor
Electromechanical, 456
Sensor Module, 38, 66, 462
Sequence control, 217
Serial number, 458
Series commissioning, 315, 323
Setpoint processing, 216, 235
Setpoint source, 216

Selecting, 230, 231, 420
Shield connection kit, 28
Short-circuit monitoring, 257
Signal cables, 70
Signal interconnection, 430
Signal states, 366
SIMATIC, 438, 439
Sine-wave filter, 34
SIZER, 462
Skip frequency band, 106
SMC (Sensor Module Cabinet), 38, 66
SMC: Sensor Module Cabinet, 66
SME (Sensor Module External), 38, 66
SME: Sensor Module External, 66
Speed
change with BOP-2, 422
Limiting, 235
Speed deviation, 296, 297
Speed monitoring, 296, 297
Square-law characteristic, 245
Stall protection, 294, 295
Star connection (Y), 419
STARTER, 39, 85, 303, 332, 426
Download, 39
STARTER commissioning tool, 303
STARTER PC tool, 303
Starting characteristics
Optimization, 246
State overview, 217
Status word, 124, 127
Status word 1, 126
Status word 3, 128
STEP 7 object manager, 439
STO (Safe Torque Off), 302
Acceptance test, 319
select, 302
Storage medium, 323
STW1 (control word 1), 125
STW3 (control word 3), 127
Subindex, 132, 163
Suggestions for improvement manual, 464
Support, 463
Switch off
Motor, 217
OFF1 command, 217
OFF2 command, 217
OFF3 command, 217
Switch on
Motor, 217
ON command, 217
Switching on inhibited, 125, 218
Switching over units, 260
Switching-on a motor with BOP-2, 422
Switch-off signal paths, 310
Symbols, 21
SYNC, 179
System runtime, 368


## T


Technical data
Control Unit, 385
Technology controller, 127, 263, 290
Telegram
paste, 115, 118
Telegram types, 439
Temperature monitoring, 255
Temperature sensor, 58, 59, 75
Temperature switch, 256
Terminal block, 64, 95
Terminal strip, 75, 76
Assignment, 75
Overview, 58
Test signals, 308
Three-wire control, 219
Time slices, 300
TN-C system, 52
TN-C-S system, 52
TN-S system, 52
Torque monitoring
Speed-dependent, 294, 295
TPDO, 184
Trace function, 427
TT system, 52
Two-wire control, 219
Type plate
Control Unit, 23
Power Module, 23


## U


U/f control, 242, 421
UL, 397
Unit system, 262
Unwinders, 277
Up ramp, 420
Update (firmware), 315
Upgrading the firmware, 358
Upload, 326, 332, 334
USB cable, 39
USB interface, 86
Use for the intended purpose, 15
User interfaces, 56

USS (universal serial interface), 158, 161

## V

Vector control, 421
    Sensorless, 248
Vector control, 421
Vector control, 421
Version
    Control Unit, 23
    Firmware, 458
    Hardware, 458
    Power Module, 23
    Safety function, 458
Vertical conveyors, 81, 274, 278
Voltage boost, 246, 421
voltage input, 103

## W

Winders, 81, 277
Wire breakage, 307
Wire-break monitoring, 104, 257
Write protection, 335, 336

## Z

ZSW1 (status word 1), 126
ZSW3 (status word 3), 128

## Further information

SINAMICS inverters:
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