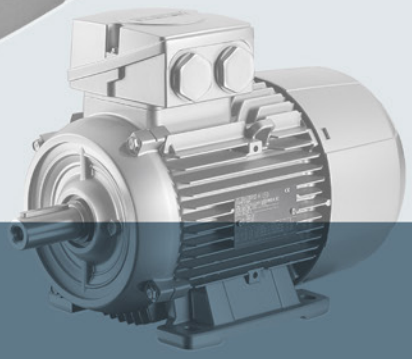
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SINAMICS

SINAMICS G120 low voltage inverters

Chassis devices with CU250S-2 Control Units and encoder evaluation

Operating instructions

Edition 04/2014

Answers for industry.

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SINAMICS G120 Converter with CU250S-2 Control Unit

Operating Instructions

Changes in this manual

Fundamental safety instructions 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 04/2014, Firmware V4.7

Original instructions
04/2014, FW V4.7
A5E31759476B AC

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

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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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℗ 07/2014 Subject to change

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Changes in this manual

Important changes with respect to the Manual, Edition 06/2013

New hardware	In Chapter
New PM240-2, FSA … FSC Power Modules	Power Modules (Page 28) Technical data, PM240-2 (Page 333)
Output reactors for PM240-2 Power Modules	Output reactor (Page 34)

New Firmware Functions for V4.7	In Chapter
Reducing the pulse frequency and increasing the current limit in the case of high-inertia starting.	Inverter temperature monitoring (Page 180)
Supporting the identification & maintenance data (I&M1 … 4)	Identification & maintenance data (I&M) (Page 318)
Pulse input as source of setpoint value	Pulse input as source of setpoint value (Page 158)

An overview of all the new and changed functions in the V4.7 firmware can be found in Section New and extended functions (Page 349).

Corrections	In Chapter
Macro 5 sets PROFIdrive telegram 352 (not telegram 1). Macro 14 sets PROFIdrive telegram 20 (not telegram 1).	Terminal blocks (Page 64)
Acknowledge input in macros 19 and 20 is at digital input 4 (not at digital input 3).	
When using an analog input as extended digital input, for a low signal, the analog input must be connected to ground (GND). The analog input must be connected to +10 V and GND via a changeover contact. An NO contact is not sufficient.	Digital inputs (Page 100)

Revised descriptions	In Chapter
STO safety function	Safe Torque Off (STO) safety function (Page 238)

Table of contents

Changes in this manual 5

1 Fundamental safety instructions 15

1.1 General safety instructions 15

1.2 Safety instructions for electromagnetic fields (EMF) 19

1.3 Handling electrostatic sensitive devices (ESD) 19

1.4 Industrial security 20

1.5 Residual risks of power drive systems 21

2 Introduction 23

2.1 About this manual 23

2.2 Guide through this manual 24

3 Description 25

3.1 Identifying the converter 25

3.2 Overview of Control Units 27

3.3 Power Modules 28

3.4 Components for the Power Modules 31
3.4.1 Line filter 31
3.4.2 Line reactor 32
3.4.3 Output reactor 34
3.4.4 Sine-wave filter 36
3.4.5 Braking resistor 38
3.4.6 Brake Relay 39
3.4.7 Safe Brake Relay 39

3.5 Motor series that are supported 40

3.6 Permissible encoders 40

3.7 Sensor Module 41

3.8 Tools to commission the converter 42

4 Installing 43

4.1 Overview of the inverter installation 43

4.2 Installing reactors, filters and braking resistors 44

4.3 Installing the Power Module 45
4.3.1 Installing Power Modules 45
4.3.2 Dimensions, hole drilling templates, minimum clearances, tightening torques 47
4.3.3 Connecting the line supply, motor, and inverter components 52
4.3.3.1 Permissible line supplies 52
4.3.3.2 Connecting the inverter 56

4.3.3.3 Connecting a motor holding brake ... 59
4.3.3.4 Connecting a braking resistor ... 61
4.4 Installing Control Unit ... 62
4.4.1 Snapping the Control Unit onto the Power Module ... 62
4.4.2 Overview of the interfaces ... 63
4.4.3 Terminal blocks ... 64
4.4.4 Factory setting of the terminals ... 66
4.4.5 Default settings of the terminals ... 68
4.4.6 Wiring the terminal strip ... 72
4.4.7 Assignment of the fieldbus and encoder interfaces ... 73
4.5 Installing encoders ... 74
4.6 Connecting inverters in compliance with EMC ... 75
4.6.1 EMC-compliant connection of the converter ... 75
4.6.2 Avoiding electromagnetic influence (EMI) ... 75
5 Commissioning ... 81
5.1 Commissioning guidelines ... 81
5.2 Preparing for commissioning ... 82
5.2.1 Inverter factory setting ... 83
5.2.2 Inverter function modules ... 84
5.2.3 Selecting the control mode ... 85
5.2.4 Defining additional requirements for the application ... 87
5.3 Restoring the factory setting ... 88
5.4 Basic commissioning with STARTER ... 90
5.4.1 Generating a STARTER project ... 90
5.4.2 Transfer inverters connected via USB into the project ... 91
5.4.3 Configuring a drive ... 92
5.4.4 Adapting the encoder data ... 96
5.4.5 Loading the configured data into the drive ... 97
5.4.6 Identifying motor data ... 97
6 Adapt terminal strip ... 99
6.1 Digital inputs ... 100
6.2 Safety-related input ... 102
6.3 Digital outputs ... 103
6.4 Analog inputs ... 105
6.5 Analog outputs ... 109
7 Configuring the fieldbus ... 113
7.1 Fieldbus versions of the Control Unit ... 113
7.2 Communication via PROFINET ... 114
7.2.1 What do you need for communication via PROFINET? ... 115
7.2.2 Integrating inverters into PROFINET ... 116
7.2.3 Configuring communication to the control ... 117
7.2.4 Select telegram ... 118
7.2.5 Activating diagnostics via the control ... 118

7.3 Communication via PROFIBUS 119
7.3.1 What do you need for communication via PROFIBUS? 119
7.3.2 Integrating inverters into PROFIBUS 119
7.3.3 Configuring the communication using SIMATIC S7 control 120
7.3.4 Setting the address 120
7.3.5 Select telegram 121

7.4 PROFIdrive profile for PROFIBUS and PROFINET 122
7.4.1 Cyclic communication 122
7.4.1.1 Control and status word 1 126
7.4.1.2 Control and status word 3 129
7.4.1.3 Extend telegrams and change signal interconnection 131
7.4.1.4 Data structure of the parameter channel 132
7.4.1.5 Slave-to-slave communication 137
7.4.2 Acyclic communication 137

8 Setting functions 139

8.1 Overview of the converter functions 139

8.2 Inverter control 141
8.2.1 Switching the motor on and off 141
8.2.2 Inverter control using digital inputs 143
8.2.3 Two-wire control: method 1 144
8.2.4 Two-wire control, method 2 145
8.2.5 Two-wire control, method 3 146
8.2.6 Three-wire control, method 1 147
8.2.7 Three-wire control, method 2 148
8.2.8 Running the motor in jog mode (JOG function) 149
8.2.9 Switching over the inverter control (command data set) 150

8.3 Setpoints 152
8.3.1 Overview 152
8.3.2 Analog input as setpoint source 153
8.3.3 Specifying the setpoint via the fieldbus 153
8.3.4 Motorized potentiometer as setpoint source 154
8.3.5 Fixed speed as setpoint source 156
8.3.6 Pulse input as source of setpoint value 158

8.4 Setpoint calculation 160
8.4.1 Overview of setpoint processing 160
8.4.2 Invert setpoint 160
8.4.3 Inhibit direction of rotation 161
8.4.4 Skip frequency bands and minimum speed 162
8.4.5 Speed limitation 163
8.4.6 Ramp-function generator 164

8.5 Motor control 169
8.5.1 V/f control 169
8.5.1.1 Characteristics of U/f control 170
8.5.1.2 Selecting the U/f characteristic 171
8.5.1.3 Optimizing with a high break loose torque and brief overload 172
8.5.2 Vector control 174
8.5.2.1 Checking the encoder signal 175
8.5.2.2 Select motor control 175
8.5.2.3 Optimizing the speed controller 176

8.5.2.4 Advanced settings ... 177
8.5.3 Torque control ... 179

8.6 Protection and monitoring functions ... 180
8.6.1 Inverter temperature monitoring ... 180
8.6.2 Motor temperature monitoring using a temperature sensor ... 183
8.6.3 Protecting the motor by calculating the motor temperature ... 184
8.6.4 Overcurrent protection ... 186
8.6.5 Limiting the maximum DC link voltage ... 187

8.7 Application-specific functions ... 189
8.7.1 Unit changeover ... 189
8.7.1.1 Changing over the motor standard ... 191
8.7.1.2 Changing over the unit system ... 191
8.7.1.3 Changing over process variables for the technology controller ... 192
8.7.1.4 Switching units with STARTER ... 192
8.7.2 Calculating the energy saving ... 194
8.7.3 Electrically braking the motor ... 196
8.7.3.1 DC braking ... 198
8.7.3.2 Compound braking ... 201
8.7.3.3 Dynamic braking ... 203
8.7.3.4 Braking with regenerative feedback to the line ... 204
8.7.4 Motor holding brake ... 205
8.7.5 Flying restart – switching on while the motor is running ... 209
8.7.6 Automatic switch-on ... 210
8.7.7 Kinetic buffering (Vdc min control) ... 214
8.7.8 PID technology controller ... 215
8.7.8.1 Overview ... 215
8.7.8.2 Setting the controller ... 216
8.7.8.3 Optimizing the controller ... 218
8.7.9 Monitoring the load torque (system protection) ... 219
8.7.10 Load failure monitoring ... 221
8.7.11 Speed deviation monitoring ... 222
8.7.12 Free function blocks ... 224
8.7.12.1 Overview ... 224
8.7.12.2 Runtime groups and run sequence ... 224
8.7.12.3 List of the free function blocks ... 225
8.7.12.4 Scaling ... 236
8.7.12.5 Activating free function block ... 237
8.7.12.6 Further information ... 237

8.8 Safe Torque Off (STO) safety function ... 238
8.8.1 Function description ... 238
8.8.2 Prerequisite for STO use ... 240
8.8.3 Commissioning STO ... 240
8.8.3.1 Commissioning tools ... 240
8.8.3.2 Protection of the settings from unauthorized changes ... 241
8.8.3.3 Resetting the safety function parameters to the factory setting ... 241
8.8.3.4 Changing settings ... 242
8.8.3.5 Interconnecting the "STO active" signal ... 243
8.8.3.6 Setting the filter for safety-related inputs ... 244
8.8.3.7 Setting the forced checking procedure (test stop) ... 247
8.8.3.8 Activate settings ... 248
8.8.3.9 Checking the assignment of the digital inputs ... 248

8.8.3.10 Acceptance - completion of commissioning 250
8.9 Switchover between different settings 253
9 Backing up data and series commissioning 255
9.1 Saving settings on a memory card 256
9.1.1 Saving setting on memory card 257
9.1.2 Transferring the setting from the memory card 260
9.1.3 Safely remove the memory card 262
9.2 Saving settings on a PC 264
9.3 Saving settings on an operator panel 266
9.4 Other ways to back up settings 266
9.5 Write and know-how protection 267
9.5.1 Write protection 267
9.5.2 Know-how protection 269
9.5.2.1 Settings for the know-how protection 270
9.5.2.2 Creating an exception list for the know-how protection 272
10 Corrective maintenance 273
10.1 Overview of replacing converter components 273
10.2 Replacing a Control Unit with enabled safety function 275
10.3 Replacing the Control Unit without the safety functions enabled 278
10.4 Replacing the Control Unit without data backup 280
10.5 Replacing a Control Unit with active know-how protection 281
10.6 Replacing a Power Module with enabled safety function 283
10.7 Replacing a Power Module without the safety function being enabled 284
10.8 Upgrading firmware 285
10.9 Firmware downgrade 288
10.10 Correcting an unsuccessful firmware upgrade or downgrade 290
10.11 Reduced acceptance test after component replacement 291
10.12 Replacing an encoder 292
10.12.1 Replacing the encoder - same encoder type 292
10.12.2 Replacing the encoder - different encoder type 293
10.13 If the converter no longer responds 295
11 Alarms, faults and system messages 297
11.1 Operating states indicated on LEDs 298
11.2 System runtime 301
11.3 Alarms 302
11.4 Faults 305
11.5 List of alarms and faults 309
11.6 Identification & maintenance data (I&M) 318

12 Technical data 319
12.1 Technical data, CU250S-2 Control Unit 319
12.2 Technical data, Power Modules 324
12.2.1 Technical data, PM240 325
12.2.1.1 General data, PM240 325
12.2.1.2 Power-dependent data, PM240 327
12.2.2 Technical data, PM240-2 333
12.2.2.1 General data, PM240-2 - 400V 333
12.2.2.2 Power-dependent data PM240-2 334
12.2.3 Technical data, PM250 339
12.2.3.1 General data, PM250 339
12.2.3.2 Power-dependent data, PM250 340
12.2.4 Technical data, PM260 343
12.2.4.1 General data, PM260 343
12.2.4.2 Power-dependent data, PM260 344
12.2.5 Technical data, PM340 346
12.2.5.1 General data, PM340, 1 AC 200 … 240 V 346
12.2.5.2 Power-dependent data, PM340 347
12.3 Restrictions for special ambient conditions 348
A Appendix 349
A.1 New and extended functions 349
A.2 Activating licensed functions 352
A.2.1 Licensing 352
A.2.2 Creating or displaying the license key 353
A.2.3 Writing the license key to the card 356
A.3 Star-delta motor connection and application examples 358
A.4 Parameter 359
A.5 Handling the BOP 2 operator panel 362
A.5.1 Changing settings using BOP-2 363
A.5.2 Changing indexed parameters 364
A.5.3 Directly entering the parameter number and value 364
A.5.4 A parameter cannot be changed 365
A.6 Handling STARTER 366
A.6.1 Change settings 366
A.6.2 Optimize the drive using the trace function 367
A.7 Interconnecting signals in the inverter 370
A.7.1 Fundamentals 370
A.7.2 Example 372
A.8 Application Examples 374
A.8.1 Setting an absolute encoder 374
A.8.2 Connecting a safety-related input 378
A.9 Acceptance tests for the safety functions 380
A.9.1 Recommended acceptance test 380
A.9.2 Machine documentation 383
A.9.3 Log the settings for the basic functions, firmware V4.4 ... V4.7 385

A.10 Manuals and technical support 386
A.10.1 Manuals for your converter 386
A.10.2 Configuring support 387
A.10.3 Product Support 388
A.11 Mistakes and improvements 389
Index 391

1 Fundamental safety instructions

1.1 General safety instructions



⚠ DANGER

Danger to life due to live parts and other energy sources

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

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

Generally, six steps apply when establishing safety:

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

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



⚠ WARNING

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

Touching live components can result in death or severe injury.

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



⚠WARNING

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

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

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



⚠WARNING

Danger to life through electric shock due to unconnected cable shields

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

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



⚠WARNING

Danger to life due to electric shock when not grounded

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

- Ground the device in compliance with the applicable regulations.



⚠WARNING

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

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

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

⚠WARNING

Danger to life due to fire spreading if housing is inadequate

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

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

⚠WARNING

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

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

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

⚠WARNING

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

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

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

⚠WARNING

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

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

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

⚠WARNING

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

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

⚠WARNING

Danger to life when safety functions are inactive

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

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

Note

Important safety notices for Safety Integrated functions

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

⚠WARNING

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

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

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

1.2 Safety instructions for electromagnetic fields (EMF)



⚠WARNING

Danger to life from electromagnetic fields

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

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

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

1.3 Handling electrostatic sensitive devices (ESD)

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



NOTICE

Damage through electric fields or electrostatic discharge

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

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

1.4 Industrial security

Note

Industrial security

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

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

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

⚠WARNING

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

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

- Keep the software up to date.

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

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

1.5 Residual risks of power drive systems

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

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

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

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

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

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

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

Note

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

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

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

Introduction 2

2.1 About this manual

Who requires the operating instructions and what for?

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

What is described in the operating instructions?

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

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

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

What is the meaning of the symbols in the manual?



An operating instruction starts here.



This concludes the operating instruction.



The subsequent text is applicable for an operator panel.



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







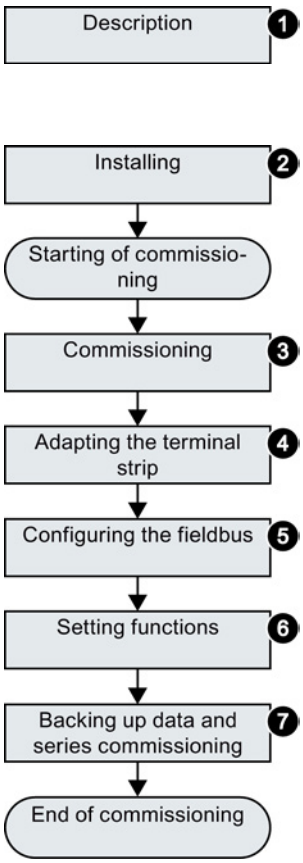


Examples of the inverter-function symbols

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

See also: Overview of the converter functions (Page 139).

2.2 Guide through this manual



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

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

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

④ Adjust the function of the inputs and outputs.

⑤ Configure communication via PROFIBUS or PROFINET.
Communication using other fieldbuses can be found in the "Fieldbus" function manual; see also: Manuals and technical support (Page 386).

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

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

⑧ Replace the inverter and its components.
Firmware update.

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

⑩ The most important technical data of the inverter.

⑪ Setting up the new inverter functions.
Application examples.

Description

3

Use for the intended purpose

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

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

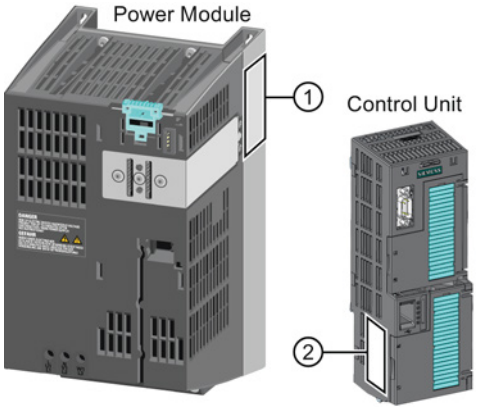
The technical specifications and information about connection conditions are indicated on the rating plate and in the operating instructions.

3.1 Identifying the converter

Main components of the 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):

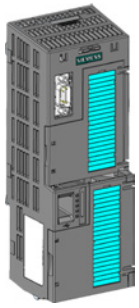
- Designation: e.g. CU250S-2 DP Control Unit
- Order number: e.g. 6SL3246-0BA22-1PA0
- Version: e.g. 02 (hardware) 4.6 (firmware)

Additional converter components

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

- Line filter (Page 31)
- Line reactor (Page 32)
- Output reactor (Page 34)
- Sine-wave filter (Page 36)
- Braking resistor (Page 38)
- Brake Relay to control a motor holding brake (Page 39).

3.2 Overview of Control Units



The CU250S-2 Control Units 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
CU250S-2 PN	6SL3246-0BA22-1FA0	PROFINET, EtherNet/IP
CU250S-2 CAN	6SL3246-0BA22-1CA0	CANopen

Memory cards and licenses

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

Several inverter functions require a license.

When you use a licensed function, the licensed card must be inserted when the inverter is operational.

License for	Order number	
	without memory card	with memory card
Basic positioner	6SL3074-7AA04-0AA0	6SL3054-4AG00-2AA0-Z E01
Extended safety functions	6SL3074-0AA10-0AA0	6SL3054-4AG00-2AA0-Z F01

There are two ways of ordering a license:

- Without a memory card: You order a license and you then transfer it to precisely one memory card.
- With memory card: You order the license on a memory card. This license cannot be transferred to other cards.

The inverter uses an inserted license card also as memory card to backup 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 Modules

Important data on the Power Modules is provided in this section. Further information is contained in the hardware installation manuals listed in Section Manuals for your converter (Page 386).

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

You can operate the CU250S-2 Control Unit 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

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

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

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

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

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

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

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

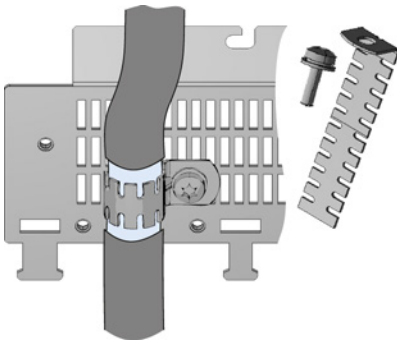
PM260, 3 AC 690 V - Application areas with line regeneration

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

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

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

Shield connection kit



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

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

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

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

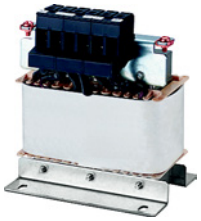
3.4.2 Line reactor

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. • Install a line reactor if the relative short-circuit voltage of the line supply is below 1%

Line reactors for PM240

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

Line reactors for PM240-2

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

Line reactors for PM340 1AC

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

3.4.3 Output reactor

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

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

Adjacent examples of output reactors.



for PM240
FSA, FSB



for FSGX

Output reactors for PM240 Power Module

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

Output reactors for PM250 Power Module

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

Output reactors for PM240-2 Power Modules (IP20)

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

Output reactors for PM240-2 push-through Power Modules

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

3.4.4 Sine-wave filter

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



for FSF

The following applies when using a sine-wave filter:

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

Sine-wave filter for PM240 Power Module

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

Sine-wave filter for PM250 Power Module

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

3.4.5 Braking resistor

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

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

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



Braking resistors for PM240

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

Braking resistors for 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.

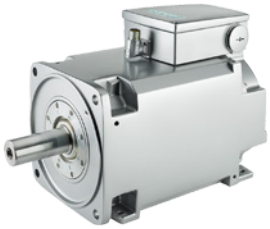
Order number: 6SL3252-0BB01-0AA0

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/108049211333300).



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 Multi-motor drive is permissible, i.e. multiple motors operated on one inverter. See also: Multi-motor drive (http://support.automation.siemens.com/WW/view/en/84049346).	 1PH8 induction motors
On request: Encoderless permanently excited synchronous motors SIMOTICS S	**Motors from other manufacturers**
 1FK7 synchronous motors	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

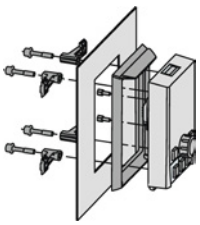
3.7 Sensor Module

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

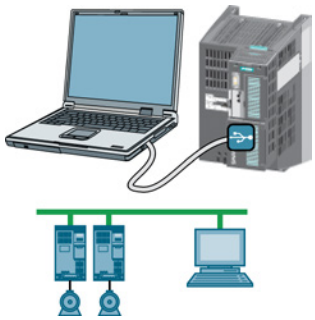
Sensor Module		Order number	Permissible encoders
	SMC10	6SL3055-0AA00-5AA3	Resolver
	SMC20	6SL3055-0AA00-5BA3	sin/cos encoders, absolute encoders Endat 2.1, SSI encoders
	SMC30	6SL3055-0AA00-5CA2	HTL or TTL encoders, SSI encoders
	SME20	6SL3055-0AA00-5EA3	sin/cos encoder
	SME25	6SL3055-0AA00-5HA3	Absolute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

3.8 Tools to commission the converter

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

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

IOP:
6SL3255-0AA00-4JA0

Door mounting kit:
6SL3256-0AP00-0JA0</td></tr>
<tr><td></td><td>IOP (Intelligent Operator Panel) - for snapping onto the inverter
• Plain text display
• Menu-based operation and application wizards</td></tr>
<tr><td colspan="2"></td><td colspan="2">For mobile use of the IOP:
IOP handheld with power supply unit and rechargeable batteries as well as RS232 connection cable
If you are using your own connection cable, carefully note the maximum permissible length of 5 m.</td><td>6SL3255-0AA00-4HA0</td></tr>
<tr><td colspan="5">PC tools</td></tr>
<tr><td colspan="2" rowspan="3"></td><td colspan="2">STARTER
Connected to the inverter via USB port, PROFIBUS or PROFINET
Download: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)</td><td>STARTER on DVD:
6SL3072-0AA00-0AG0</td></tr>
<tr><td colspan="2">Startdrive
Connected to the inverter via USB port, PROFIBUS or PROFINET
Download: Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)</td><td>Startdrive on DVD:
6SL3072-4CA02-1XG0</td></tr>
<tr><td colspan="2">SINAMICS PC Inverter Connection Kit 2
Contains the correct USB cable (3 m) to connect a PC to the inverter.</td><td>6SL3255-0AA00-2CA0</td></tr>
</table>

4 Installing

4.1 Overview of the inverter installation

Installing the inverter

Precondition

Before installation, please check:

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

Procedure

1
2

To install the inverter, proceed as follows:

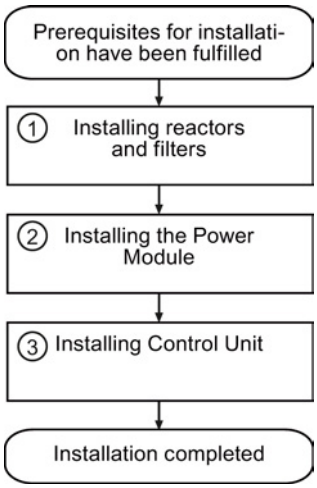
1. Install the accessories (reactors, filter or braking resistor) for the Power Module:
   - Observe the installation instructions that are supplied with the accessories.
   - If you are using more than one base-mounted component, then you must observe the sequence when installing.

     See also Installing reactors, filters and braking resistors (Page 44).
2. Install the Power Module.

   See also Installing the Power Module (Page 45).

   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 62).



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

4.2 Installing reactors, filters and braking resistors

Installing reactors, filters and braking resistors

The installation of reactors, filters and braking resistors is described in the documentation provided. See also Section: Manuals and technical support (Page 386).

Installing base components

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

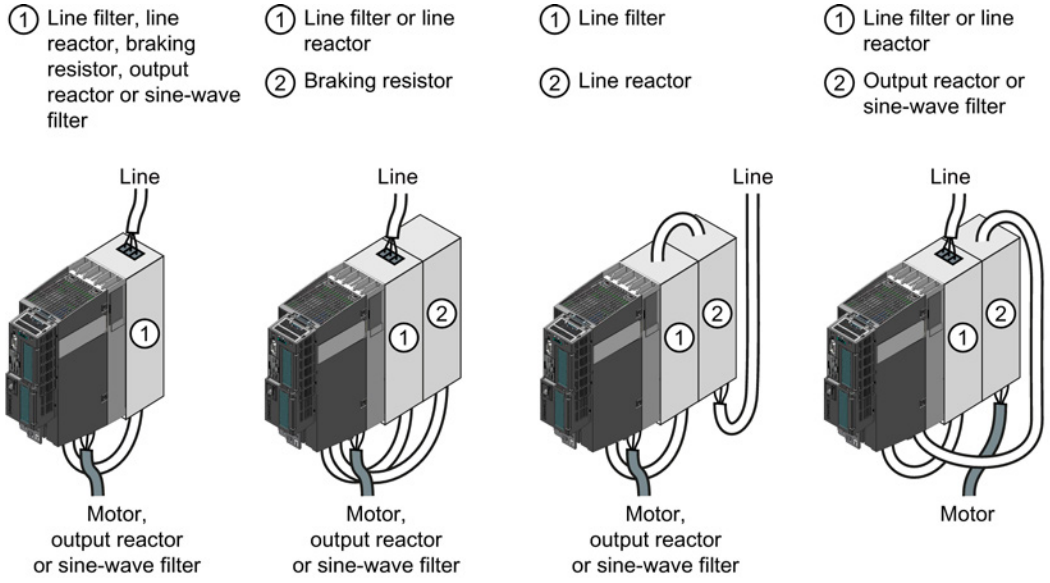


Figure 4-1 Permissible combination of base components

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

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

4.3 Installing the Power Module

4.3.1 Installing Power Modules

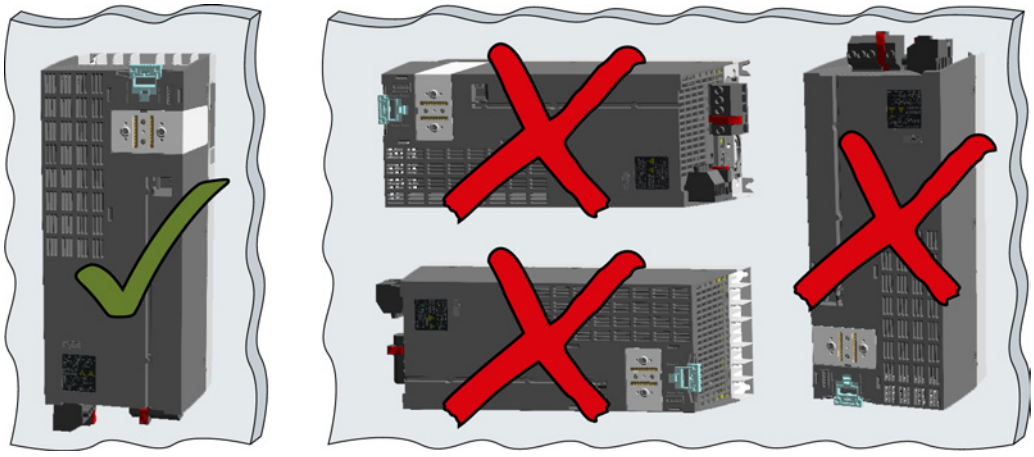
Mounting Power Modules with degree of protection IP20

Procedure

1
2

Proceed as follows to correctly mount the Power Module:

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



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

You have correctly mounted the Power Module.

Mounting Power Modules using through-hole technology

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

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

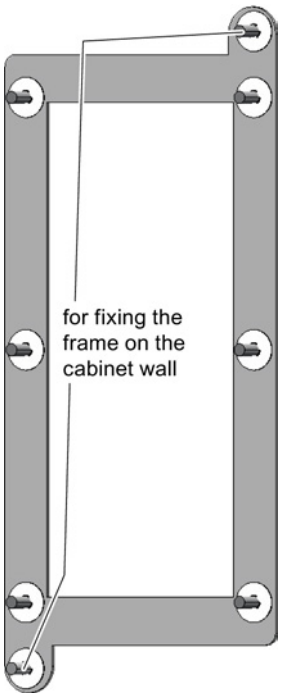
You must mount the inverter on unpainted metal surfaces in order to comply with EMC requirements.

Procedure

Proceed as follows to correctly mount the Power Module:

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

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



Mounting frame

You have correctly mounted the Power Module.

Mounting additional components

Depending on the application, the following additional components, for example, may be required (also refer to Section Identifying the converter (Page 25)):

- 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

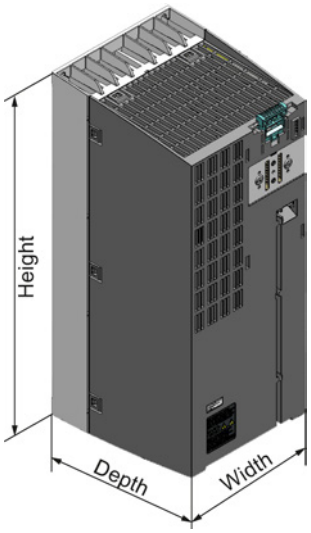
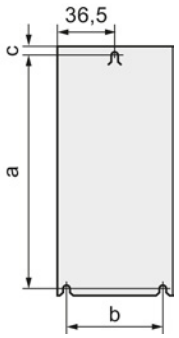
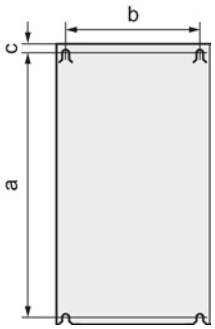
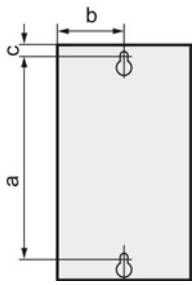
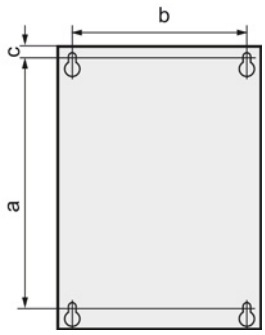
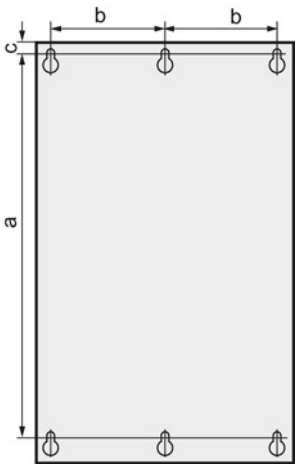
<table>
<tr><td>Defining the dimensions</td><td colspan="2">Drilling patterns for the PM240-2 Power Modules</td></tr>
<tr><td>
</td><td>FSA

</td><td>FSB, FSC

</td></tr>
<tr><td colspan="3">Drilling patterns for all other Power Modules</td></tr>
<tr><td>FSA

</td><td>FSB…FSF

</td><td>FSGX

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

Table 4- 2 Dimensions for PM240

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

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

2) Total depth of the inverter: See below.

Table 4- 3 Mounting hardware and clearances to other devices for PM240

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

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

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

Table 4- 4 Dimensions for PM240-2

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

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

2) Total depth of the inverter: See below.

Table 4- 5 Mounting hardware and clearances to other devices for PM240-2

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

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

Table 4- 6 Dimensions and clearances for the PM340 1AC

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

1) With shield connection kit: +84 mm

2) Total depth of the inverter: See below.

Table 4- 7 Mounting materials for PM340 1AC

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

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

Table 4- 8 Dimensions for PM250

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

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

2) Total depth of the inverter: See below.

Table 4- 9 Mounting hardware and clearances to other devices for PM250

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

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

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

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

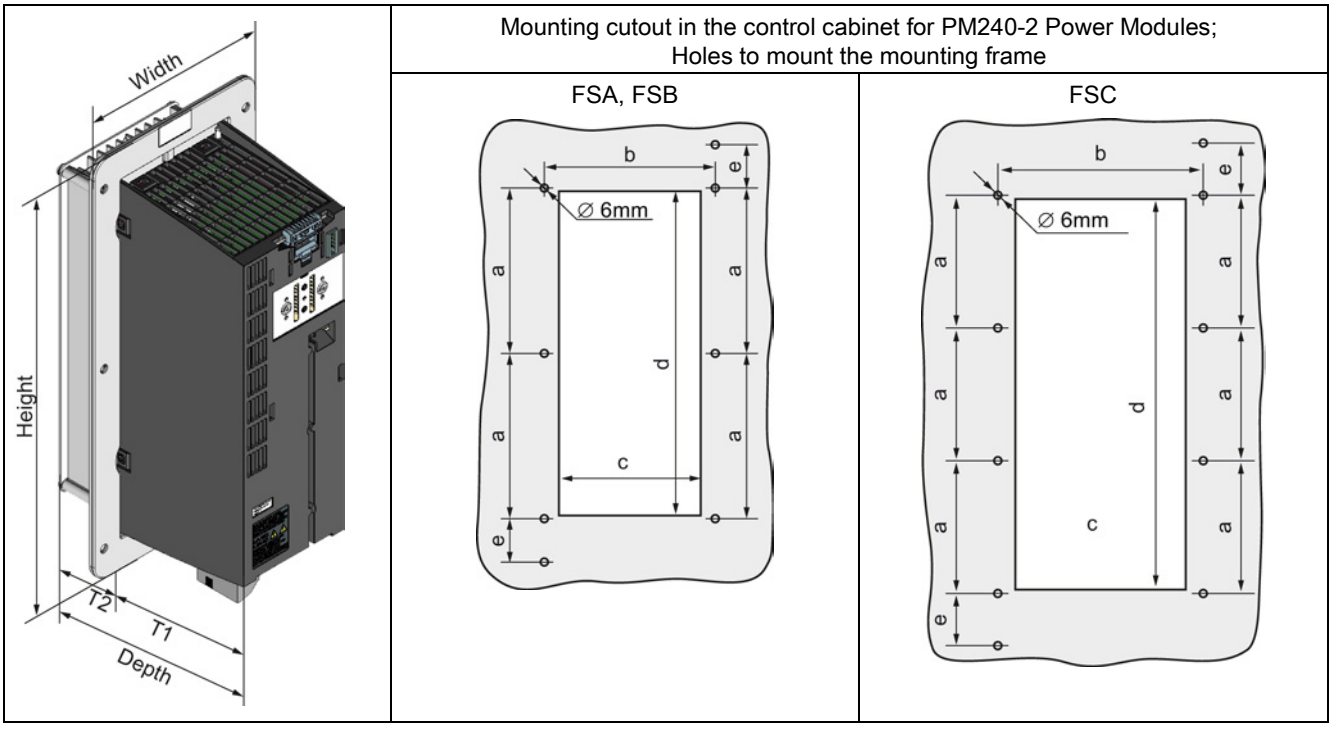


Table 4- 10 Dimensions for PM240-2 in push-through technology

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

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

2) Total depth of the inverter: See below.

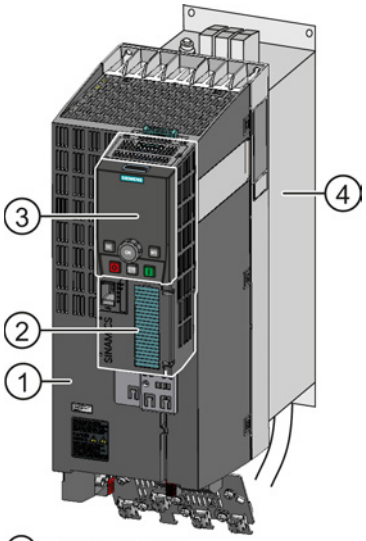
Table 4- 11 Mounting hardware and clearances to other devices for PM240-2 in push-through technology

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

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

Total depth of the inverter

Power Modules frame sizes FSA … FSF



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

① + ②

As a minimum, the inverter comprises a Power Module and 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 Permissible line supplies

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

Above an installation altitude of 2000 m, the permissible line supplies are restricted. See also: Restrictions for special ambient conditions (Page 348).

TN line system

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

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

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

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

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

Examples for Power Modules connected to a TN line supply

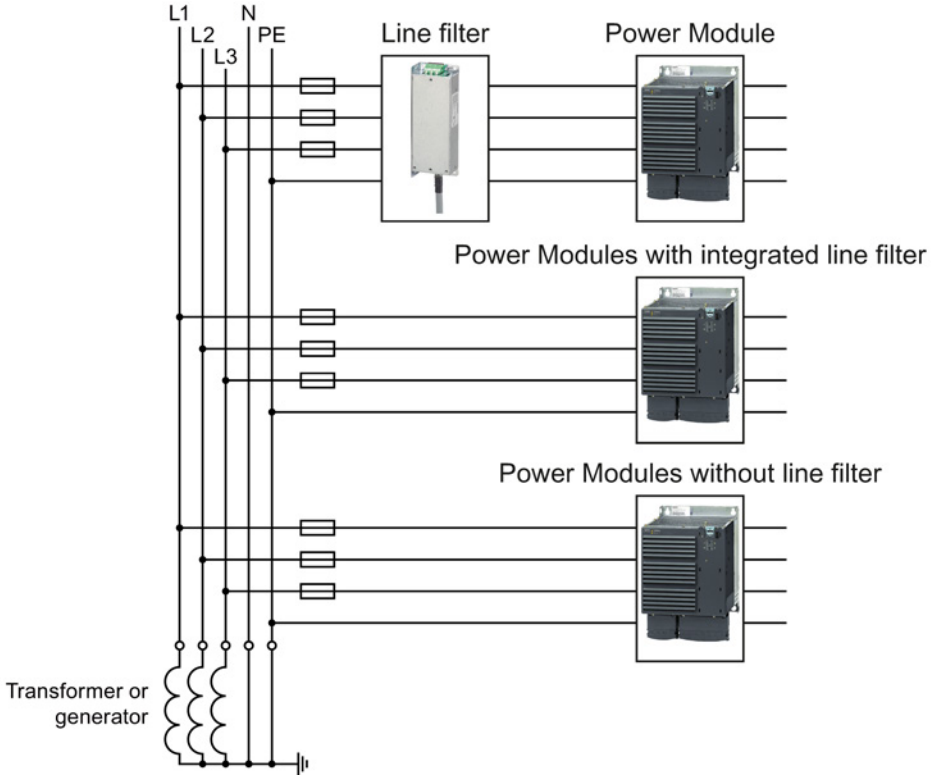


Figure 4-2 TN line supply with separate transfer of N and PE and with a grounded neutral point

TT system

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

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

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

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

Examples for Power Modules connected to a TT line supply

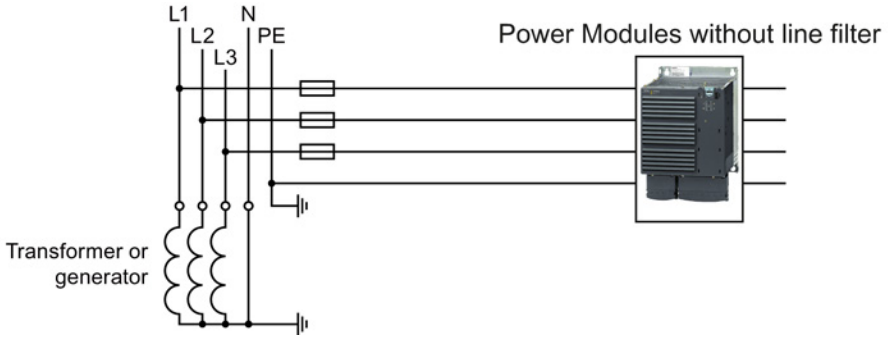


Figure 4-3 TT line system where the neutral conductor N is transferred

IT system

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

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

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

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

Examples for Power Modules connected to an IT line supply

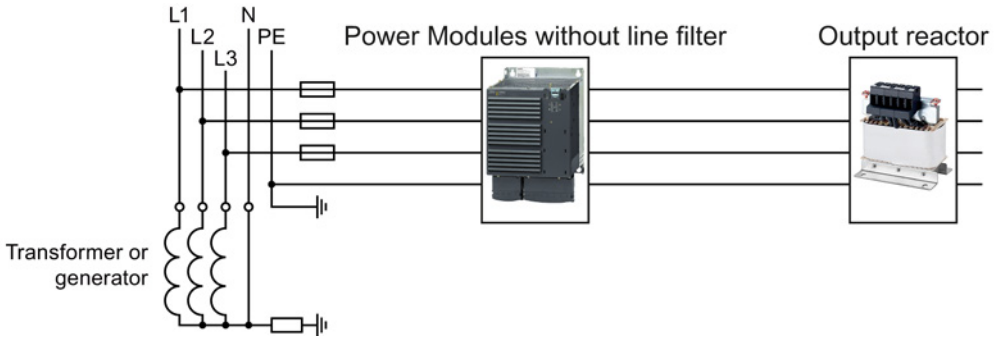


Figure 4-4 IT line supply where the neutral conductor N is transferred and with impedance with respect to the PE protective conductor

Behavior of the inverter when a ground fault occurs

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

4.3.3.2 Connecting the inverter

Connecting the Power Module to the motor and power supply

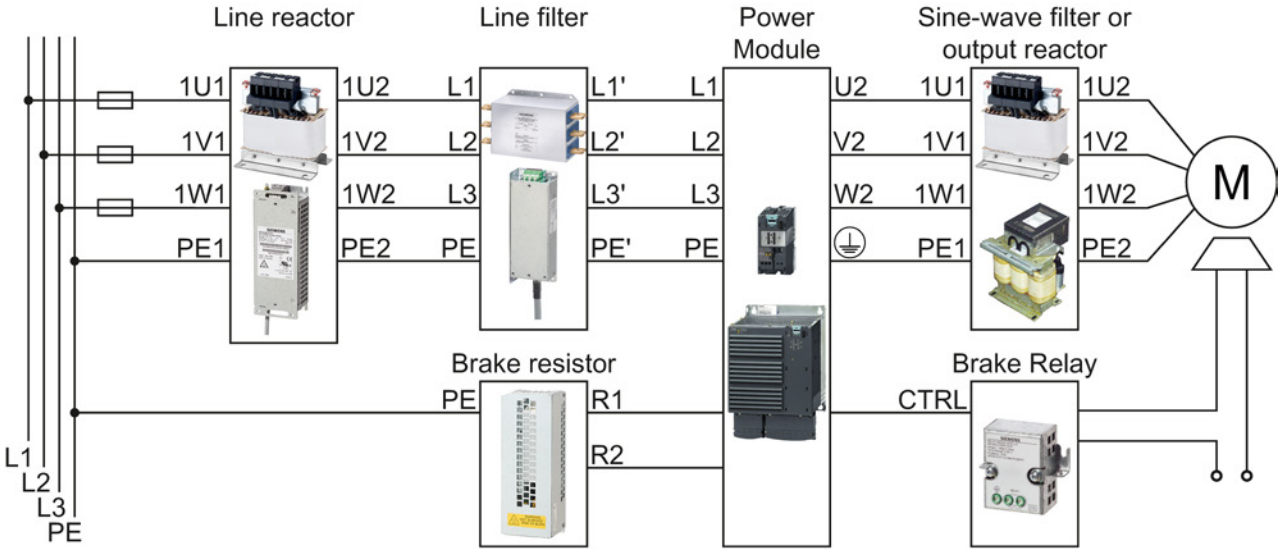


Figure 4-5 Connecting the PM240, PM240-2 and PM340 3AC Power Modules

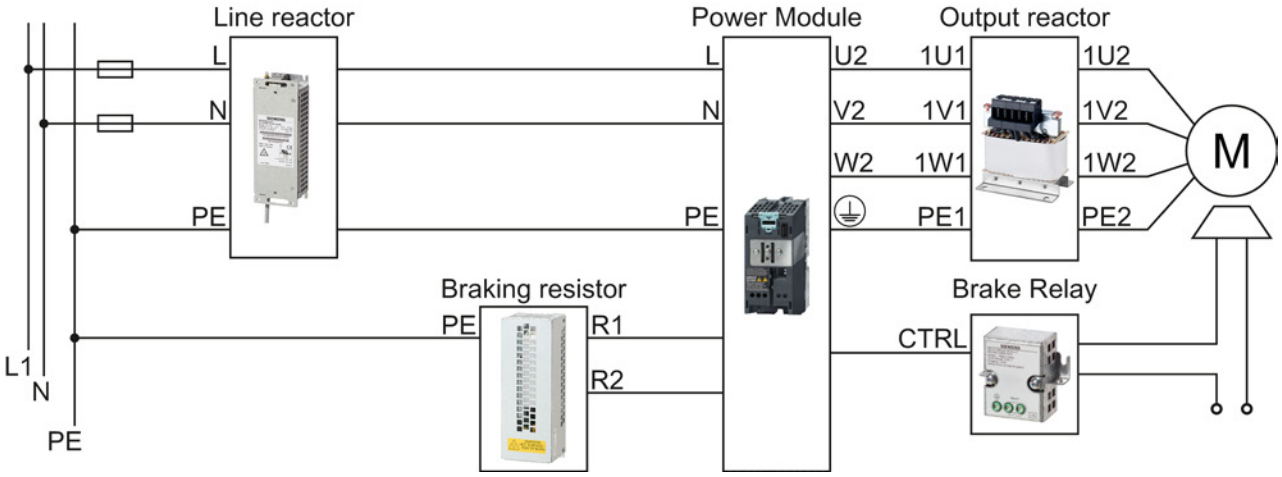


Figure 4-6 Connecting the PM340 1AC Power Module

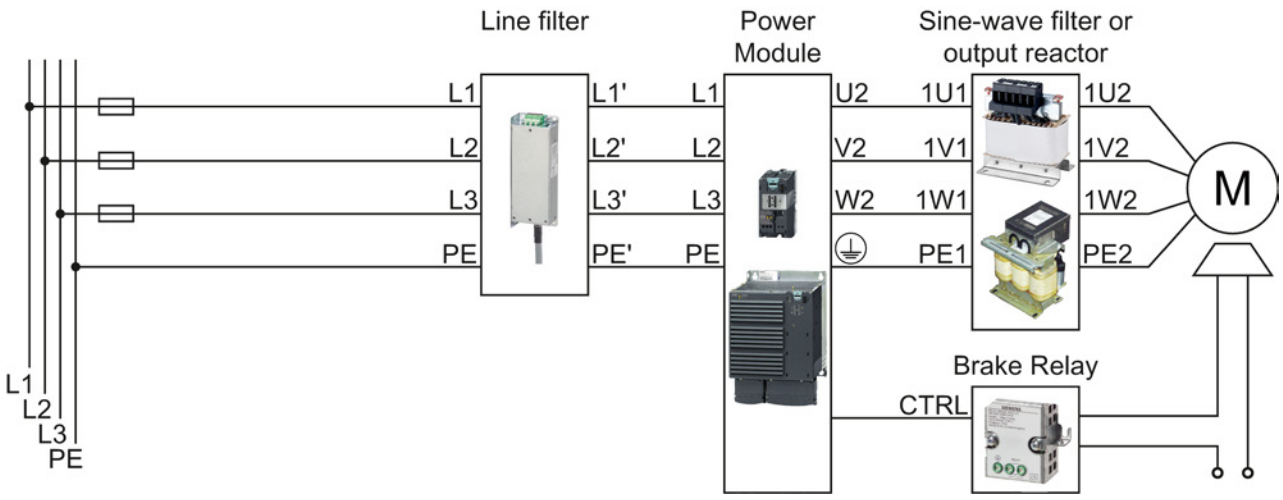


Figure 4-7 Connecting the PM250 Power Module

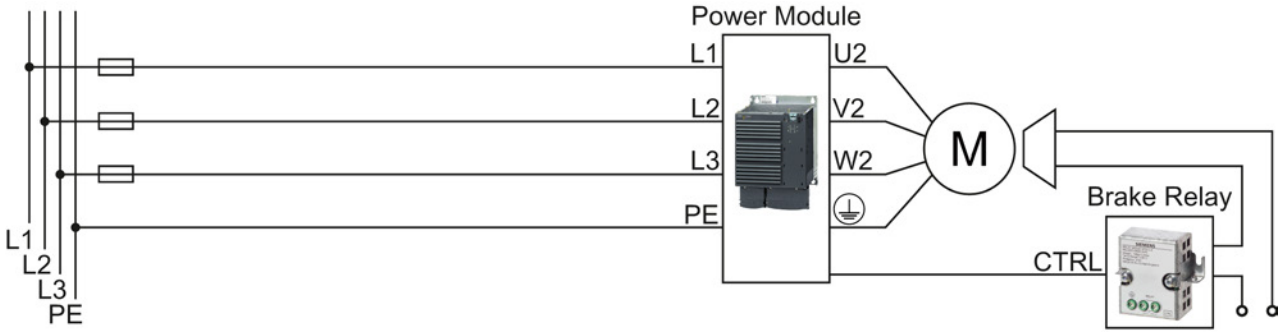


Figure 4-8 Connecting the PM260 Power Module



DANGER

Electric shock through contact with the motor connections

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

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

Connecting the line supply cable to the converter

Procedure



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

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

You have connected the line supply cable to the converter.

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 358).
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

1
2

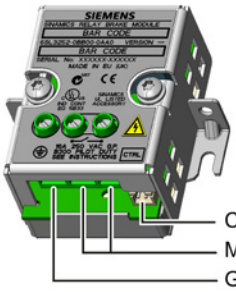
To connect the motor cable to the converter, proceed as follows:

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 75)
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.

4.3.3.3 Connecting a motor holding brake

Connecting a Brake Relay and a motor holding brake



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

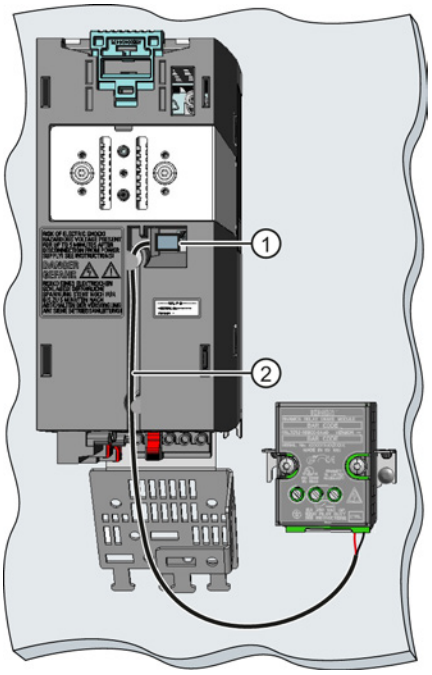
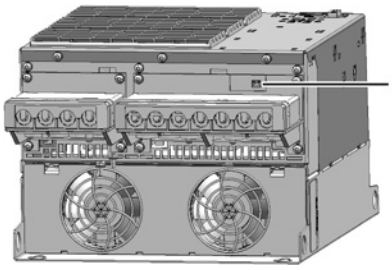
The Brake Relay can be mounted on a mounting plate, the cabinet panel or the inverter's shield connection kit.

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

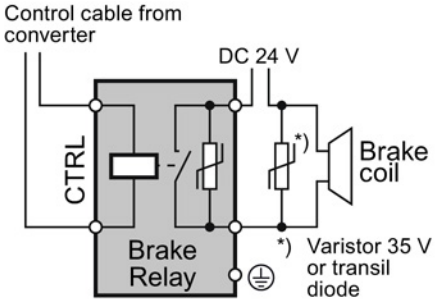
Procedure

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

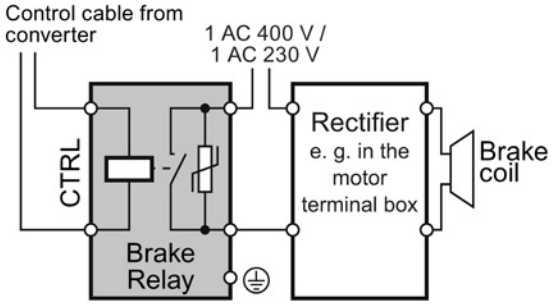
1. Connect the Brake Relay to the Power Module using the cable form provided.

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

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



24 V brake connection



440V brake connection

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

4.3.3.4 Connecting a braking resistor



⚠ WARNING

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

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

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

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



⚠ CAUTION

Risk of burns due to touching hot surfaces

The temperature of braking resistors increases substantially during operation.

- Do not touch the braking resistor during operation.

Procedure



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

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

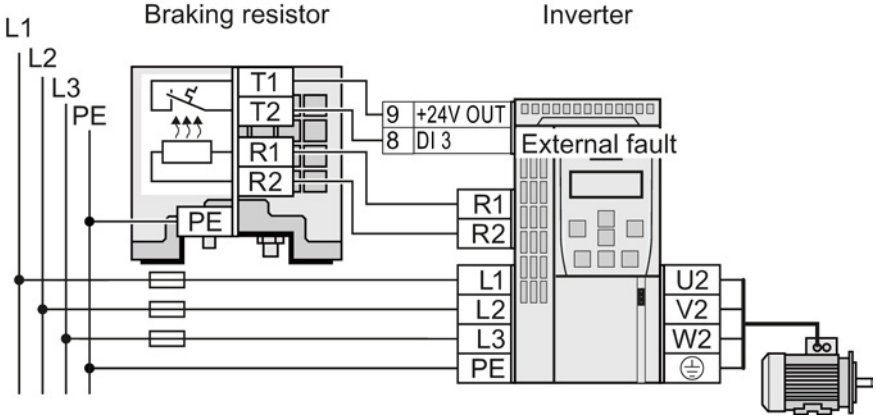


Figure 4-9 Braking resistor connections (example: temperature monitoring via DI 3)

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



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

4.4 Installing Control Unit



⚠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

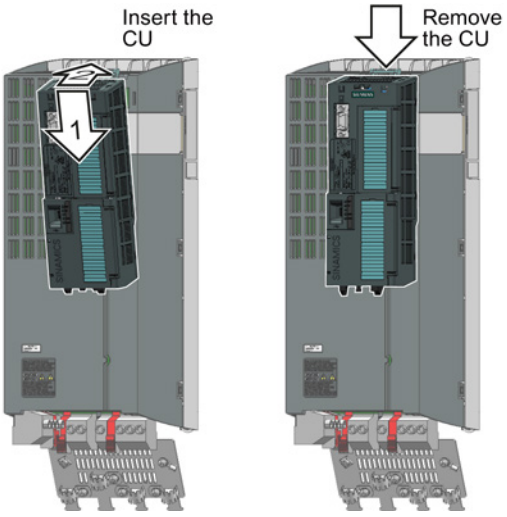
Installing the Control Unit on an IP20 Power Module

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.





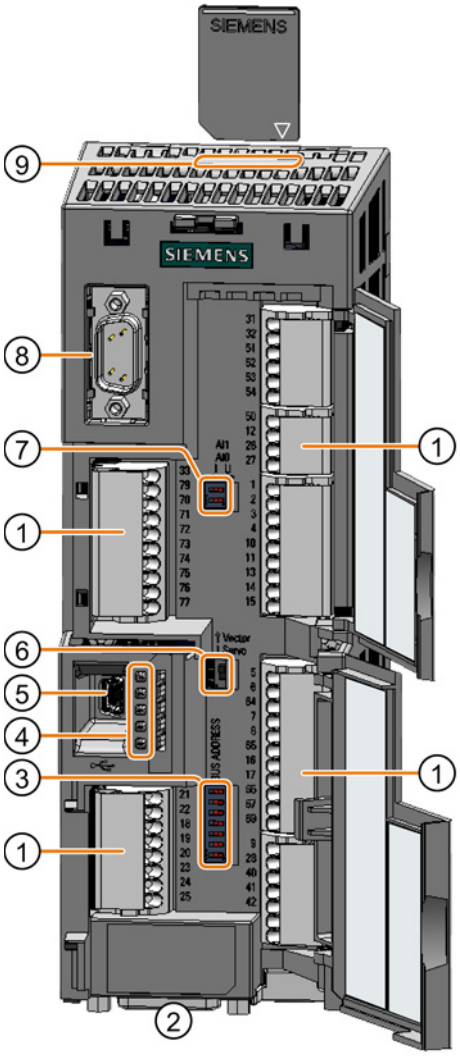
The Power Module and the Control Unit are now connected with one another.

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.

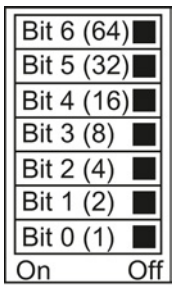


① Terminal strips

② Fieldbus interface

③ Selecting the fieldbus address:

- PROFIBUS
- USS
- Modbus RTU
- CanOpen



④ Status LED

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

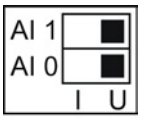
⑤ USB interface for connection to a PC

⑥ No function. Keep the switch in the "Vector" position.

⑦ Switch for analog inputs

I 0/4 mA … 20 mA

U -10/0 V … 10 V

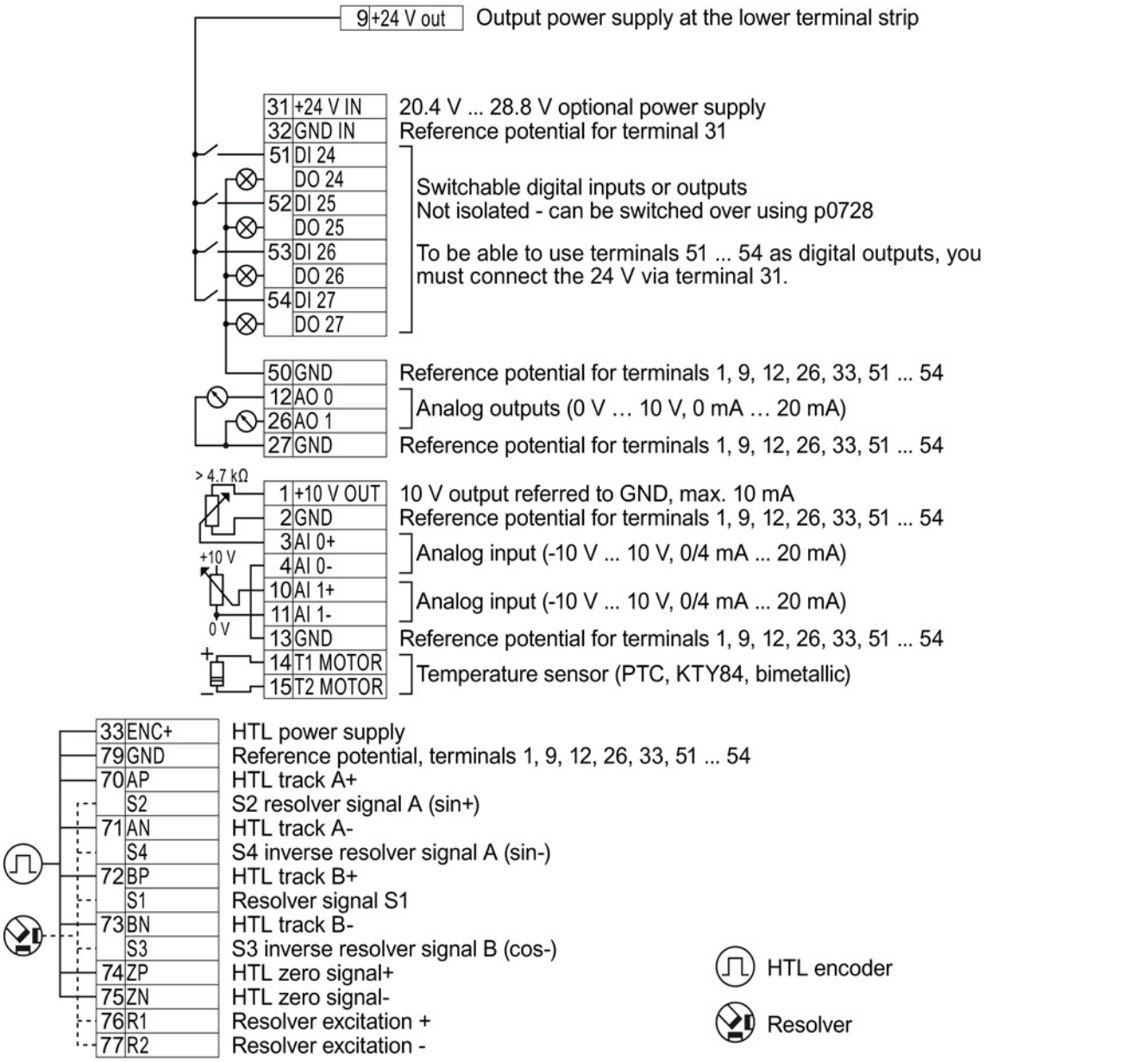


⑧ Connection to the operator panel

⑨ Memory card slot

4.4.3 Terminal blocks

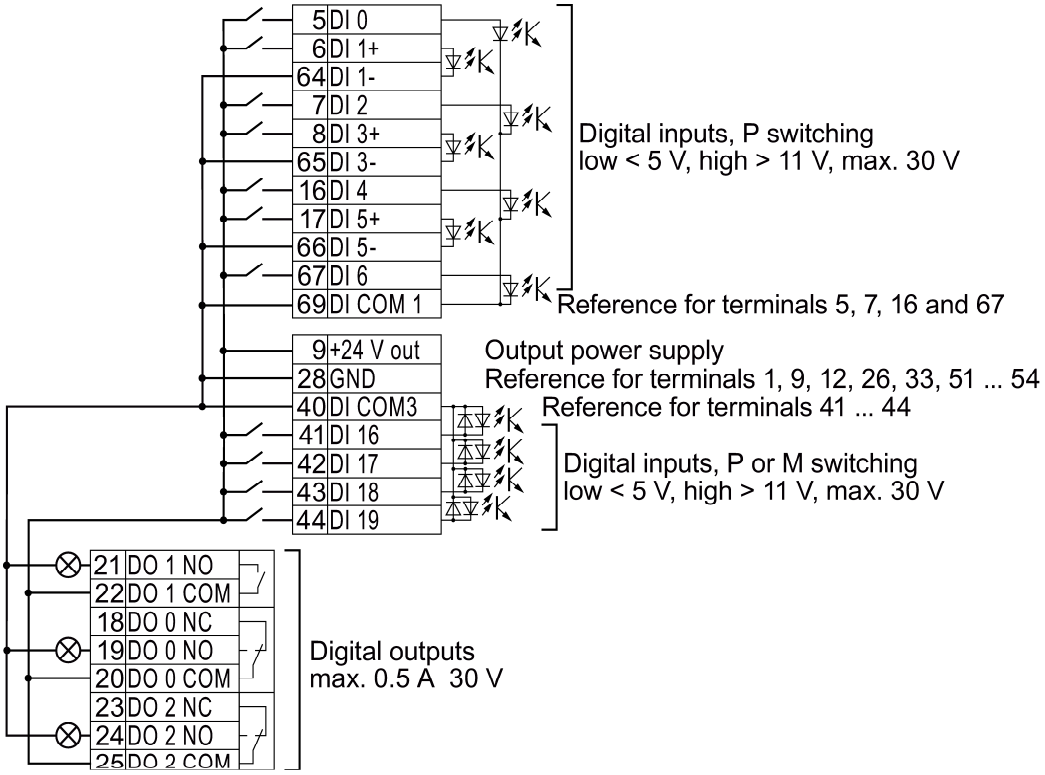
Terminal strips behind the upper front door



Interconnecting the analog inputs (terminals 3, 4 and 10, 11)

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



4.4.4 Factory setting of the terminals

The factory setting of the terminals depends on the Control Unit.

Control Units with USS or CANopen interface

The fieldbus interface is not active.

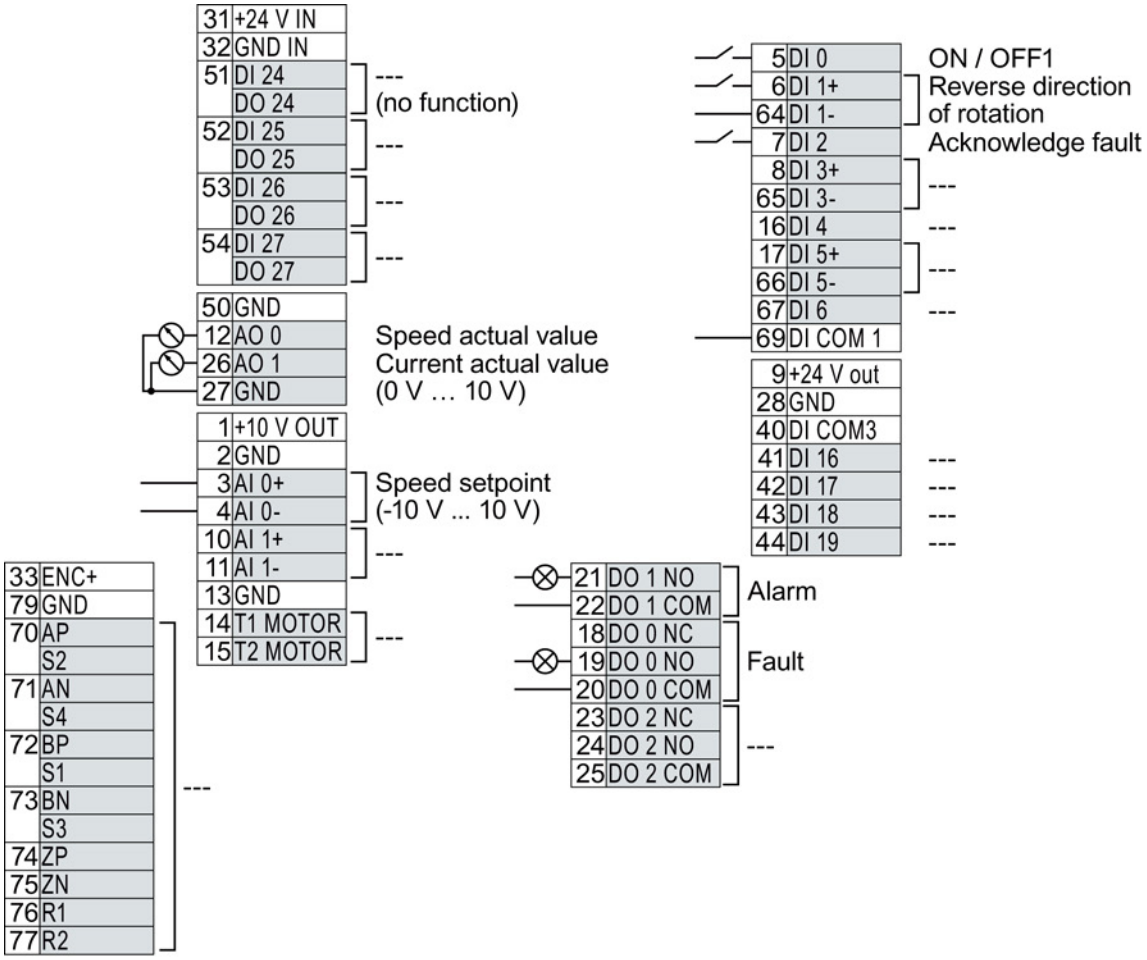


Figure 4-10 Factory setting of the CU250S-2 and CU250S-2 CAN Control Units

Control Units with PROFIBUS or PROFINET interface

The function of the fieldbus interface depends on DI 3.

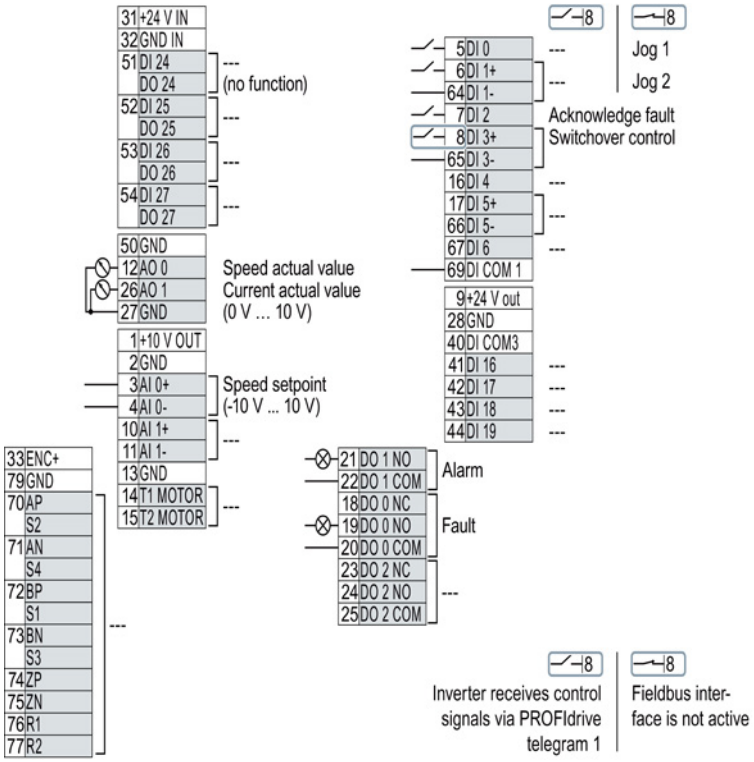


Figure 4-11 Factory setting of the CU250S-2 DP and CU250S-2 PN Control Units

Changing the function of terminals

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

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

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

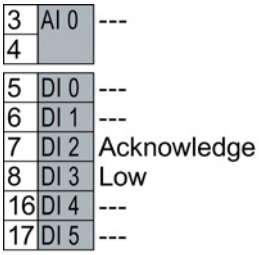
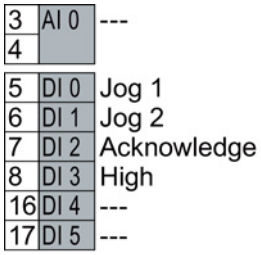
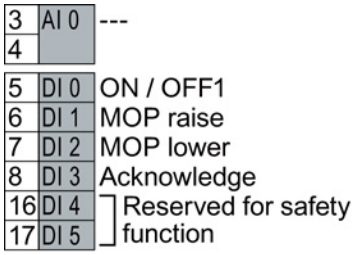
See also: Default settings of the terminals (Page 68).

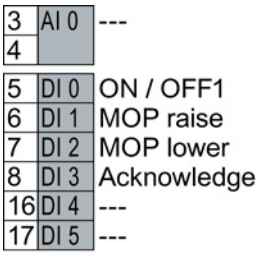
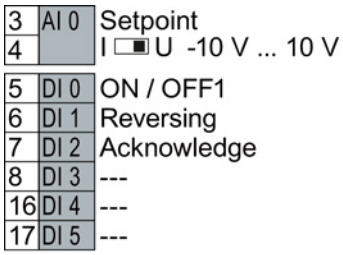
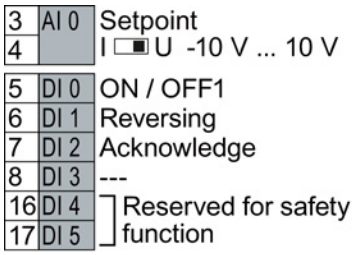
4.4.5 Default settings of the terminals

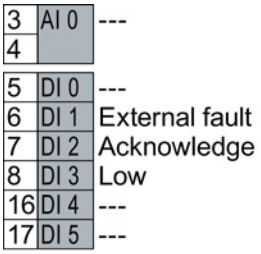
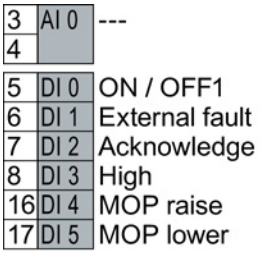
Available settings of the terminals

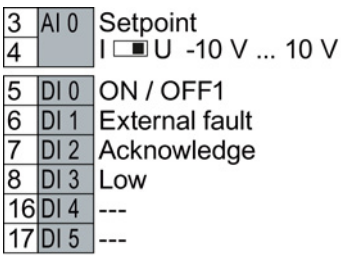
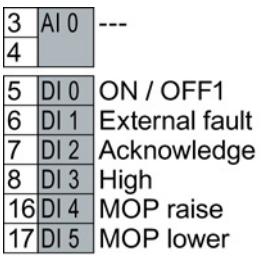
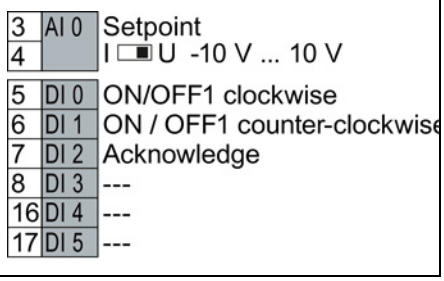
Default setting 1: Two fixed speeds Selected with • STARTER: Conveyor technology with 2 fixed frequencies • BOP-2: coN 2 SP	**Default setting 2: Two fixed speeds with safety function** Selected with • STARTER: Conveyor systems with Basic Safety • BOP-2: coN SAFE	**Default setting 3: Four fixed speeds**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

Default setting 4: PROFIBUS or PROFINET Selected with • STARTER: Conveyor systems with fieldbus • BOP2: coN Fb	**Default setting 5: PROFIBUS or PROFINET with safety function** Selected with • STARTER: conveyor systems with fieldbus and Basic Safety • BOP-2: coN Fb S	
PROFIdrive telegram 352 3 AI 0 --- 4 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 ---	PROFIdrive telegram 352 3 AI 0 --- 4 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4] Reserved for safety 17 DI 5] function	

Default setting 7: Switch over between fieldbus and jogging using DI 3 Selected with • STARTER: Fieldbus with data set switchover • BOP-2: FB cdS **Factory setting for inverters with PROFIBUS interface**		**Default setting 8: Motorized potentiometer (MOP) with safety function** Selected with • STARTER: MOP with Basic Safety • BOP-2: MoP SAFE
PROFIdrive telegram 1	Fieldbus interface is not active.	Fieldbus interface is not active.
		

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

<table>
<tr><td colspan="2">Default setting 14: Switch over between fieldbus and motorized potentiometer (MOP) using DI 3
Selected with
• STARTER: Process industry with fieldbus
• BOP-2: Proc Fb</td><td></td></tr>
<tr><td>PROFIdrive telegram 20
</td><td>Fieldbus interface is not active.
</td><td></td></tr>
</table>

<table>
<tr><td colspan="2">Default setting 15: Switch over between analog setpoint and motorized potentiometer (MOP) using DI 3
Selected with
• STARTER: Process industry
• BOP-2: Proc</td><td>Default setting 17: Two-wire control with method 2
Selected with
• STARTER: 2-wire (forward/backward 1)
• BOP-2: 2-wIrE 1
Default setting 18: Two-wire control with method 3
Selected with
• STARTER: 2-wire (forward/backward 2)
• BOP-2: 2-wIrE 2</td></tr>
<tr><td>Fieldbus interface is not active.
</td><td>Fieldbus interface is not active.
</td><td>Fieldbus interface is not active.
</td></tr>
</table>

Default setting 19: Three-wire control with method 1 Selected with • STARTER: 3-wire (enable/forward/backward) • BOP-2: 3-wIrE 1	**Default setting 20: Three-wire control with method 2** Selected with • STARTER: 3-wire (enable/on/reverse) • BOP-2: 3-wIrE 2	**Default setting 21: Fieldbus USS** Selected with • STARTER: USS fieldbus • BOP-2: FB USS **Default setting 22: CAN fieldbus** Selected with • STARTER: CAN fieldbus • BOP-2: FB CAN
Fieldbus interface is not active. 3 AI 0 Setpoint 4 I ⊏■ U -10 V ... 10 V 5 DI 0 Enable / OFF1 6 DI 1 ON clockwise 7 DI 2 ON counter-clockwise 8 DI 3 --- 16 DI 4 Acknowledge 17 DI 5 ---	Fieldbus interface is not active. 3 AI 0 Setpoint 4 I ⊏■ U -10 V ... 10 V 5 DI 0 Enable / OFF1 6 DI 1 ON 7 DI 2 Reversing 8 DI 3 --- 16 DI 4 Acknowledge 17 DI 5 ---	USS setting: 38400 baud, 2 PZD, PKW variable CANopen setting: 20 kBaud 3 AI 0 --- 4 5 DI 0 --- 6 DI 1 --- 7 DI 2 Acknowledge 8 DI 3 --- 16 DI 4 --- 17 DI 5 ---

4.4.6 Wiring the terminal strip

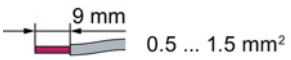
NOTICE
Damage to the inverter when using long signal cables Using long cables at the inverter's digital inputs and 24 V power supply can lead to overvoltage during switching operations. Overvoltages can damage the inverter. • If you use cables of more than 30 m at the digital inputs and 24 V power supply,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

Procedure

1
2

Proceed as follows to connect the terminal strips:

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

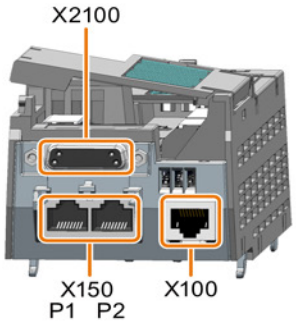
Solid or flexible cable	
Flexible conductor with non-insulated end sleeve	
Flexible conductor with partially-insulated end sleeve	
Two flexible cables with the same cross-section with partially insulated twin end sleeves	

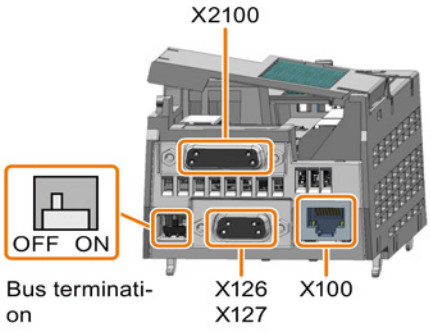
2. If you use shielded cables, then you must connect the shield to the mounting plate of the control cabinet or with the shield support of the inverter through a good electrical connection and a large surface area.
   See also: EMC installation guideline
   (http://support.automation.siemens.com/WW/view/en/60612658)
3. Use the shield connection plate (order number 6SL3264-1EA00-0LA0) of the Control Unit as strain relief.

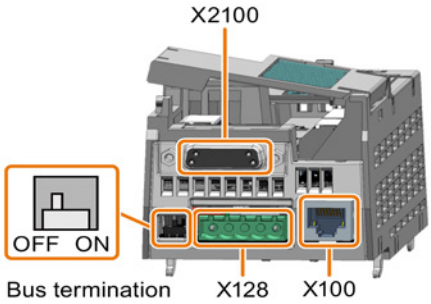
You have connected the terminal strip.

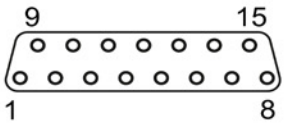
4.4.7 Assignment of the fieldbus and encoder interfaces

Interfaces at the lower side of the Control Unit



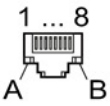






X2100 Encoder

		KTY84, PTC or bimetallic	HTL	TTL	SSI (RS422 standard)
1	Motor temperature sensing +	Temp +	---	---	---
2	SSI clock	---	---	---	Clock +
3	Inverse SSI clock	---	---	---	Clock -
4	5 V/24 V encoder supply	---	P-Encoder	P-Encoder	P-Encoder
5	5 V/24 V encoder supply	---	P-Encoder	P-Encoder	P-Encoder
6	Sense input encoder power supply	---	---	P-Sense	---
7	0 V, reference for encoder supply	---	M-Encoder	M-Encoder	M-Encoder
8	Motor temperature sensing -	Temp -	---	---	---
9	0 V, reference for sense input	---	---	M-Sense	---
10	Referencing signal	---	R +	R +	---
11	Inverse referencing signal	---	R -	R -	---
12	Inverse incremental signal B	---	B -	B -	---
13	Incremental signal B	---	B +	B +	---
14	Inverse incremental signal A/SSI data	---	A -	A -	Data -
15	Incremental signal A/SSI data	---	A +	A +	Data +



X100 DRIVE-CLiQ

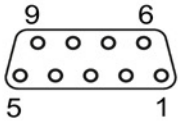
1 Transmit data +
2 Transmit data -
3 Receive data +
4 ---
5 ---
6 Receive data -
7 ---
8 ---
A + 24 V power supply

B M, reference for power supply



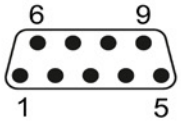
X150 P1
X150 P2
PROFINET

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



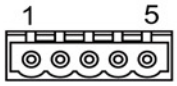
X126
CAN

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 ---



X127
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 ---

4.5 Installing encoders

Encoders for speed control

The encoder must be mounted on the motor shaft.

Table 4- 12 Permissible encoders

Encoder type	Terminal block 	SUB-D connector 	DRIVE-CLiQ interface 	
			Connection via SMC or SME	Connection via DRIVE-CLiQ
Resolver	✓		✓	
HTL encoder	✓	✓	✓	
TTL encoder		✓	✓	
Endat 2.1			✓	
sin/cos encoder			✓	
DRIVE-CLiQ encoder				✓
	For the connection, refer to Terminal blocks (Page 64)	For the connection, refer to Overview of the interfaces (Page 63)		

Table 4- 13 Permissible SMC/SME Sensor Modules and encoders that can be connected

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

Information about installing and connecting the Sensor Modules is provided in the "SINAMICS S120 Control Units and additional system components" manual, also see: S120 system components (http://support.automation.siemens.com/WW/view/en/68040800).

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 386).

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 Avoiding electromagnetic influence (EMI)

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

Control cabinet design

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

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

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

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

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

  Connect the interference suppression element directly at the coil.

Cable routing and shielding

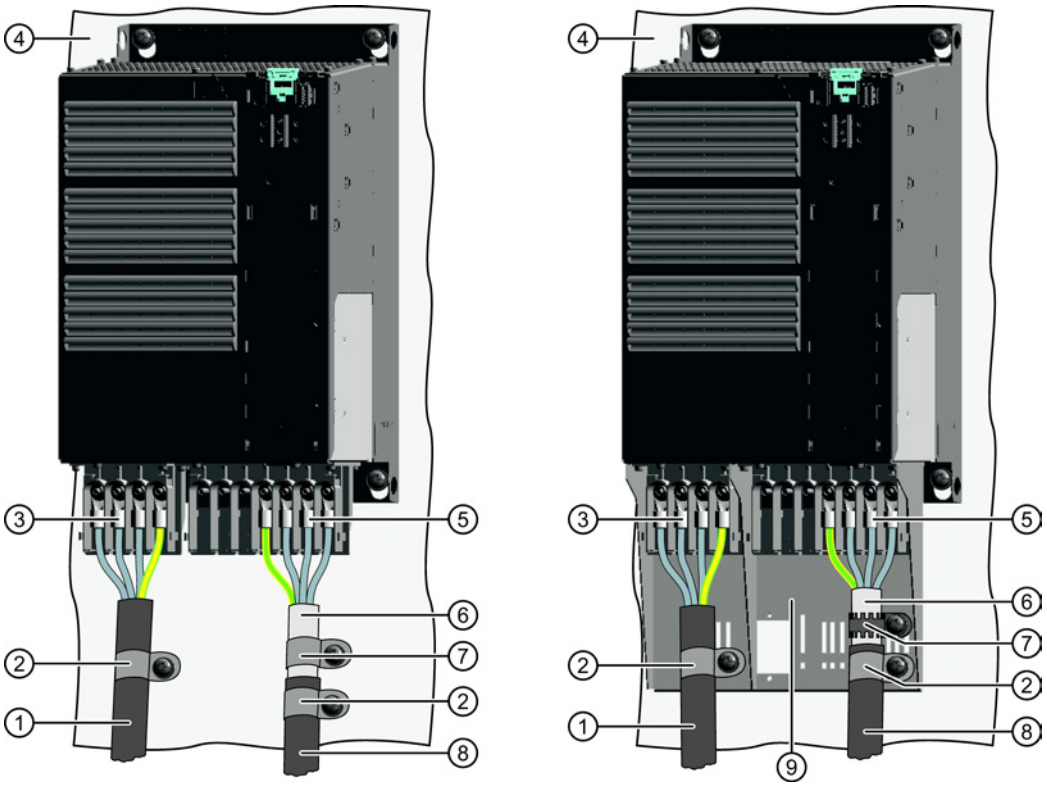
- Route all inverter power cables (line supply cables, connecting cables between the braking module and the associated braking resistance as well as the motor cables) separately away from signal and data cables. Maintain a minimum clearance of 25 cm. If cables can be separately routed, use metal partitions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

  Use the shield connection elements in the inverter for signal and data cables.

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

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

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



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

① Line connection cable (unshielded) for Power Modules with integrated line filter.
If you use an external line filter, you will need a shielded cable between the line filter and the Power Module.
② Strain relief
③ Line supply connection
④ Metal mounting plate (unpainted and with a good electrical conductivity)
⑤ Motor connection
⑥ Cable shield
⑦ Cable clamps for establishing the connection between the shield and the mounting plate through a large surface area
⑧ Motor connection cable (shielded)
⑨ Shield plate (option)

Figure 4-12 EMC-compliant wiring of a Power Module frame size E as example

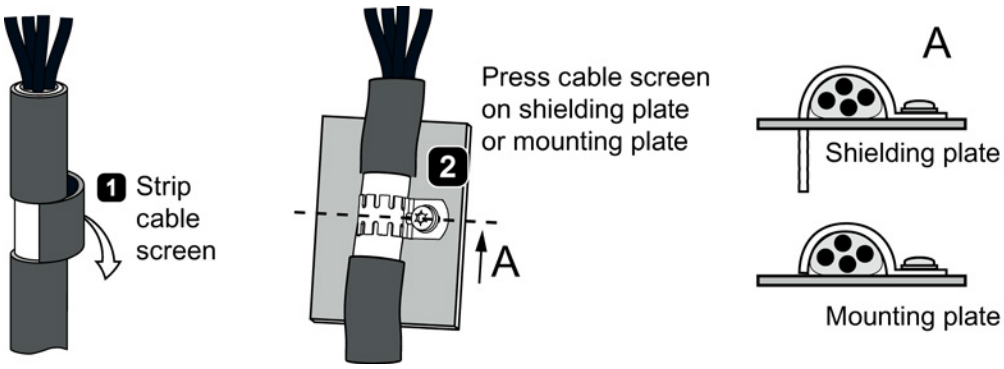


Figure 4-13 Shield connection - detail

Shielding with shield plate:

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

Shielding without shield plate:

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

EMC-compliant connection of the braking resistor

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

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

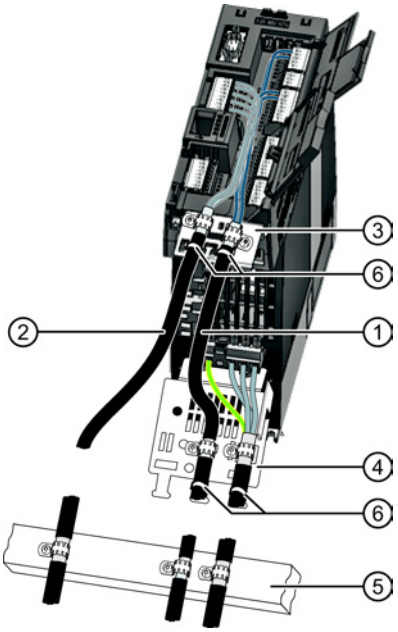
- Use shielded cables.
- Mount the shield plate of the Control Unit.

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).

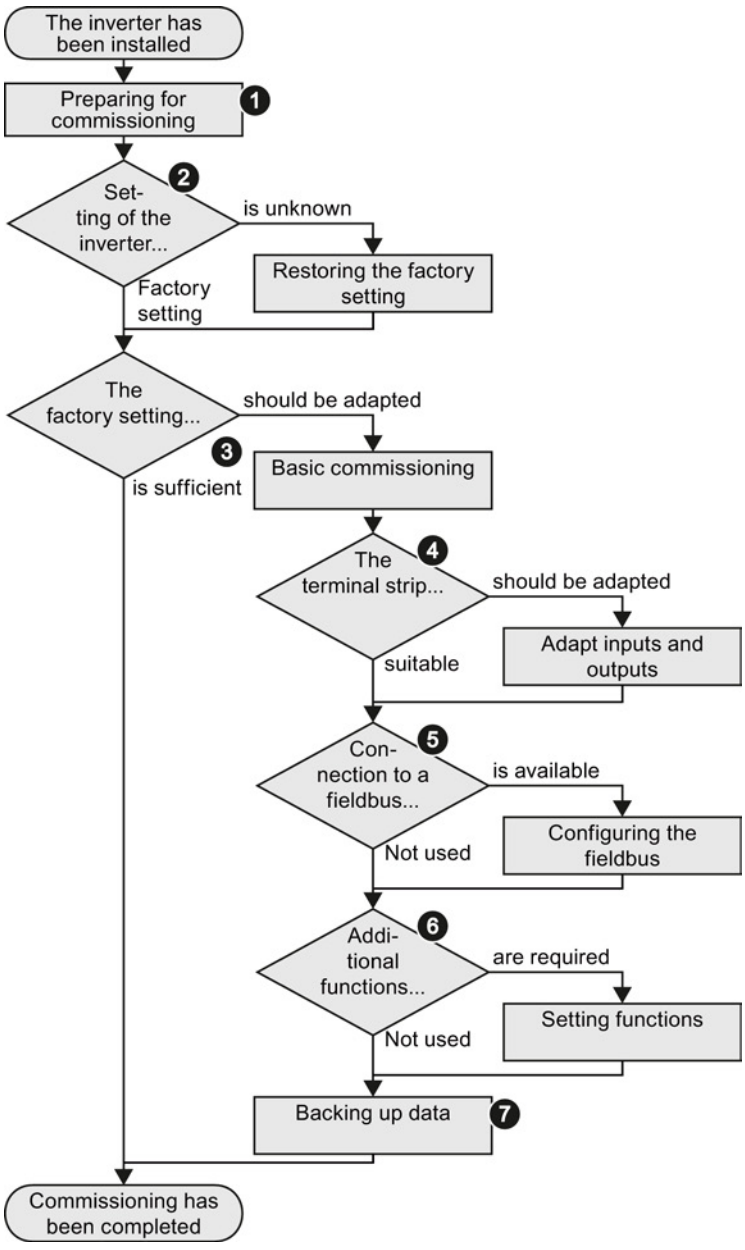
5 Commissioning

5.1 Commissioning guidelines

Procedure

Proceed as follows to commission the inverter:

1. Define the requirements of your application placed on the drive.
   → (Page 82) .
2. Reset the inverter when required to the factory setting.
   → (Page 88) .
3. Check whether the factory setting of the inverter is appropriate for your application.
   If not, start with the basic commissioning.
   → (Page 90).
4. Check whether you need to adapt the functions of the terminal strip that you specify in the basic commissioning.
   → (Page 99).
5. If necessary, adapt the communications interface in the inverter.
   → (Page 113) .
6. If necessary, set further functions in the inverter.
   → (Page 139) .
7. Save your settings.
   → (Page 255) .



You have commissioned the inverter.

5.2 Preparing for commissioning

Overview

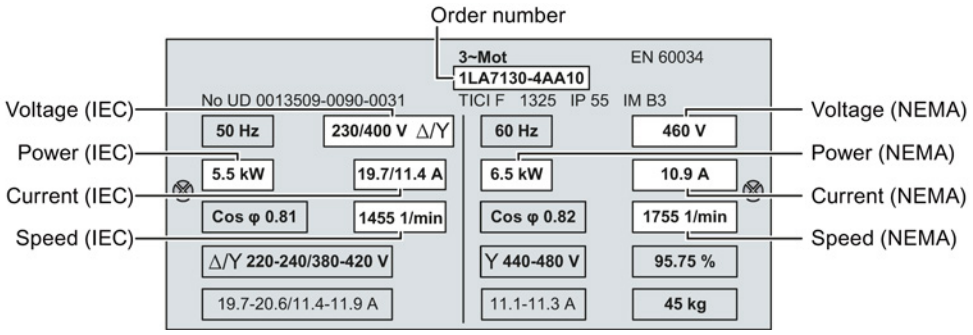
Before starting commissioning, you must know the answer to the following questions:

Inverter

- **What are the data specifications of my inverter?**
  → Identifying the converter (Page 25).
- **What inverter interfaces are active?**
  → Factory setting of the terminals (Page 66).
- **How is the inverter integrated in the higher-level control system?**
- **How is my inverter set?**
  → Inverter factory setting (Page 83).
- **What technological requirements must the drive fulfill?**
  → Selecting the control mode (Page 85).
  → Defining additional requirements for the application (Page 87).

Motor

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



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

5.2.1 Inverter factory setting

Motor

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

Switching the motor on and off

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

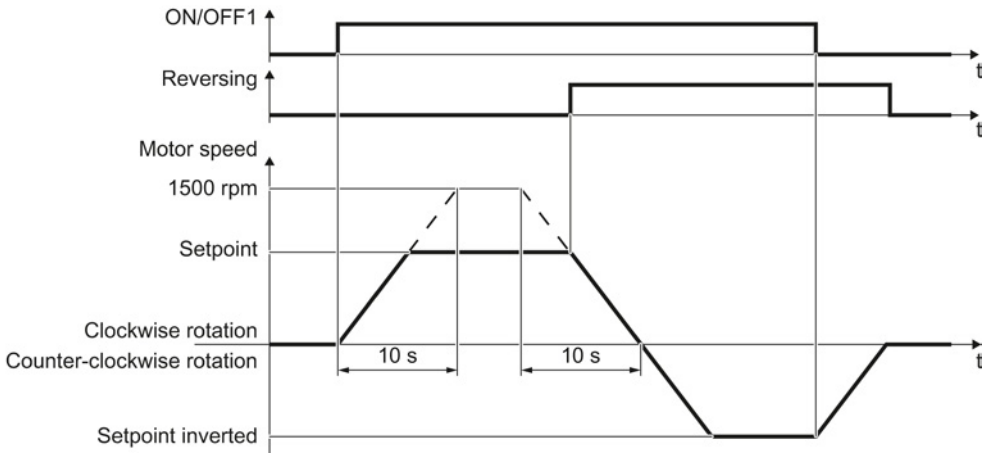


Figure 5-1 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

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

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

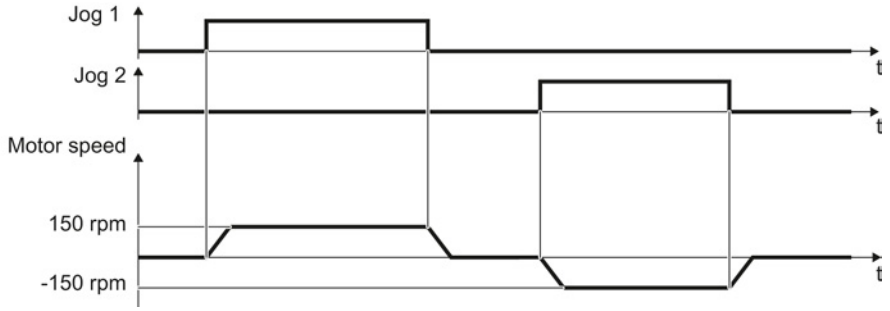


Figure 5-2 Jogging the motor in the factory setting

5.2.2 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.

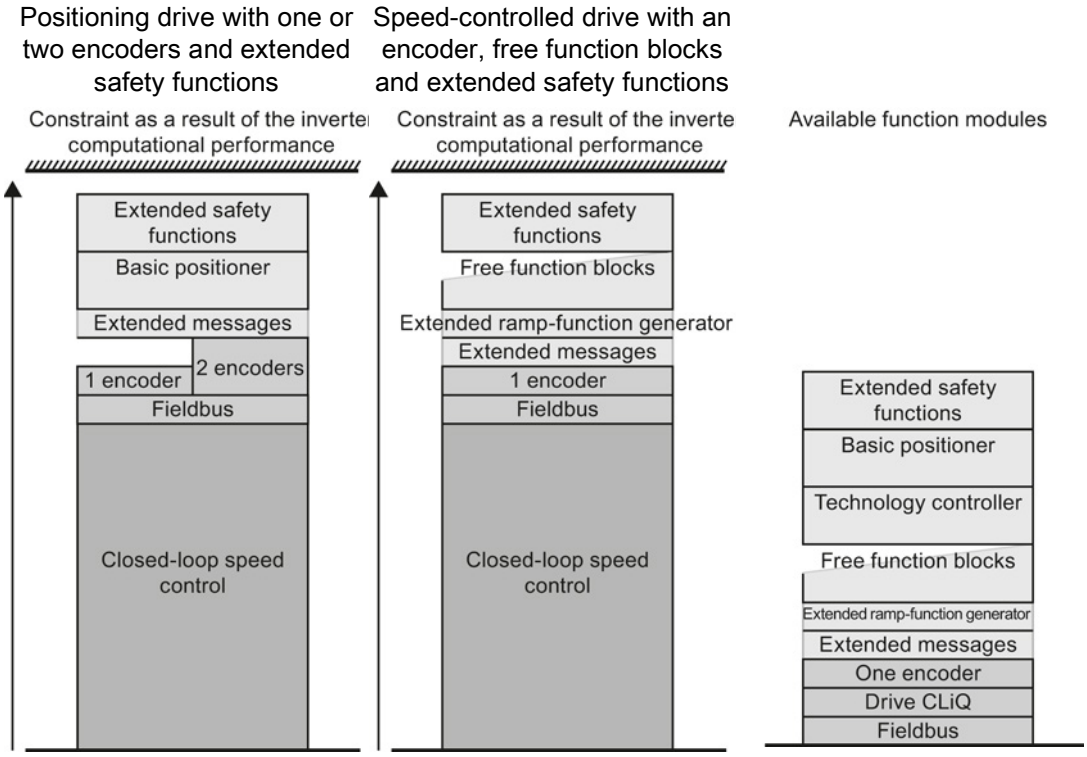
A function module is a set of inverter functions that can be released or inhibited all together.

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.

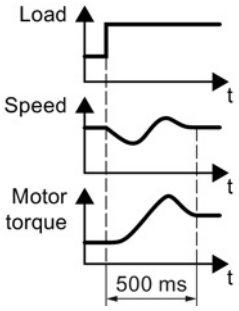
Every configured function module uses part of the computational performance of the inverter. If you enable all of the inverter function modules, then the inverter responds with a fault, because its available computational performance is exceeded.

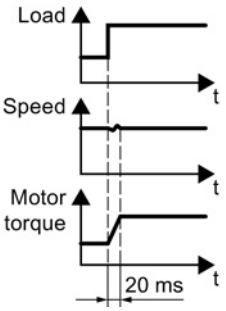
Only configure function modules that you actually require for your particular application.

5.2.3 Selecting the control mode

Suitable applications and typical control properties

	U/f control or FCC (flux current control) without an encoder	Vector control without an encoder	Vector control with an encoder
Application	Applications with continuous motion		

<table>
<tr><th></th><th>U/f control or FCC (flux current control) without an encoder</th><th>Vector control without an encoder</th><th>Vector control with an encoder</th></tr>
<tr><td>examples</td><td>• Pumps, fans, and compressors with flow characteristic
• Wet or dry blasting technology
• Mills, mixers, kneaders, crushers, agitators
• Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)
• Basic spindles</td><td>• Pumps and compressors with displacement machines
• Rotary furnaces
• Extruder
• Centrifuge</td><td>• Vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors)
• Escalators/moving stairways
• Lifter/lowerer
• Elevators
• Gantry cranes
• Cable railways
• Stacker cranes</td></tr>
<tr><td rowspan="2">Properties of the closed-loop motor control</td><td rowspan="2">• The closed-loop control is insensitive to inaccurate motor data settings, e.g. the motor temperature
• Can be commissioned with just a few settings.
• Responds to speed changes with a typical settling time of 100 ms … 200 ms
• Responds to load surges with a typical settling time of 500 ms


• U/f and FCC are suitable for the following cases:
– For motor power ratings < 45 kW
– For ramp-up times 0 → rated speed > 2 s
– For applications with increasing load torque without load impulses</td><td colspan="2">• The vector control uses the Power Module, the motor and the mechanical system with a high degree of efficiency (95 % line voltage at the PM240 or PM240-2).
• The vector control responds to speed changes with a typical settling time of < 100 ms.
• The vector control responds to load impulses with a typical settling time of 20 ms.


• We recommend vector control for motor power ratings > 45 kW
• The vector control is required in the following cases:
– For ramp-up times 0 → rated speed < 2 s
– For applications with fast and high load impulses
– For heavy duty starting using ≤ 90 % of the stall torque of the motor</td></tr>
<tr><td>• Typically achieves a torque accuracy of ± 5 % for 15 % … 100 % of the rated speed</td><td>• Extends the torque accuracy of ± 5 % to speeds < 15 % of the rated speed.</td></tr>
</table>

	U/f control or FCC (flux current control) without an encoder	Vector control without an encoder	Vector control with an encoder
Max. output frequency	240 Hz	200 Hz	
Field-weakening range	1:2 Maximum speed = 2x rated speed of the motor		1:3
Torque control	Torque control not possible	Torque control for speeds > 15 % of the rated speed	Torque control from speeds = 0.
Position control	Position control not possible	• Positioning cycles using the "Basic positioner" function > approx. 500ms • Memory card with "Basic positioner" license required	
		• The "Travel to fixed stop" function is not possible.	• No restrictions regarding the functions of the basic positioner
Motors that can be operated	The rated current of the motor must lie in the range of 13 % … 100 % of the rated current of the inverter.		

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 386).

5.2.4 Defining additional requirements for the application

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

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

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

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

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

5.3 Restoring the factory setting

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

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

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

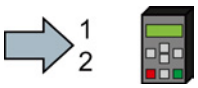
Procedure



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

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

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



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

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

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

Restoring the inverter to the factory setting

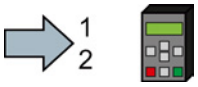
Procedure



Proceed as follows to reset the inverter to factory settings:

1. Go online.
2. Select button 

☐ You have reset the inverter to factory settings.



Proceed as follows to reset the inverter to factory settings:

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

☐ You have reset the inverter to factory settings.

5.4 Basic commissioning with STARTER

STARTER and STARTER screen forms

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

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

Preconditions for basic commissioning

You require the following to commission the inverter using STARTER:

- An installed drive (motor and inverter)
- A computer with Windows XP or Windows 7
- The latest version of STARTER. STARTER download (http://support.automation.siemens.com/WW/view/en/10804985/133100)
- An appropriate USB cable. If you are not using the USB interface, but the PROFINET interface of the inverter, you can find information in section: Manuals for your converter (Page 386).

Overview of basic commissioning

Commissioning using STARTER includes the following basic steps:

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

Steps 1 … 4 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.

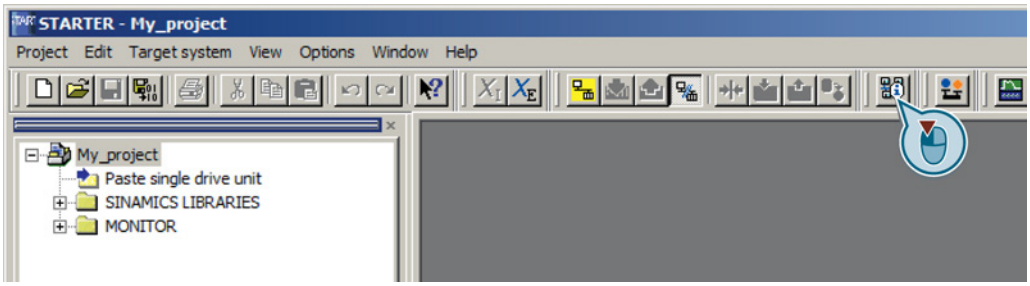
5.4.2 Transfer inverters connected via USB into the project

Procedure

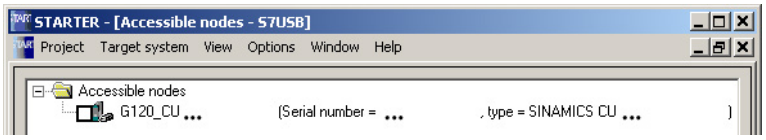
1
2

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.

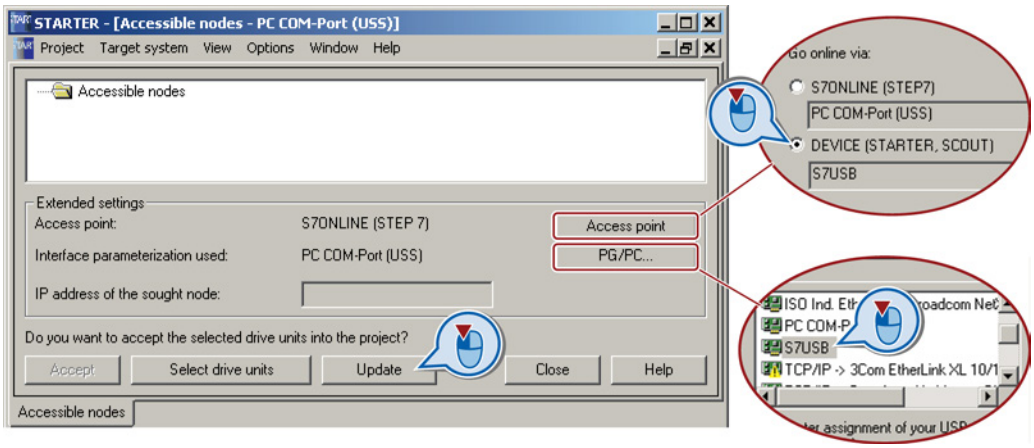
You have transferred an inverter accessible via the USB interface into your project.

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:

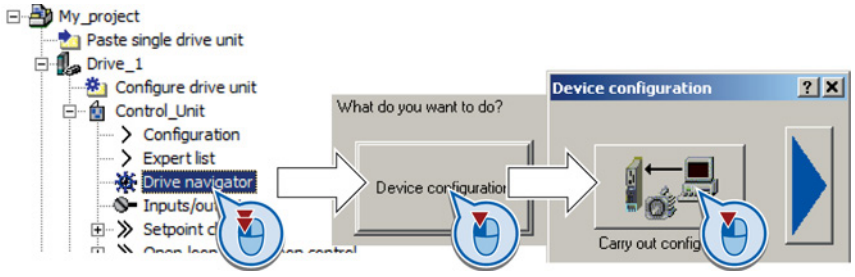
1. Starting basic commissioning
2. Configuring a drive
3. Loading the configured data into the drive

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

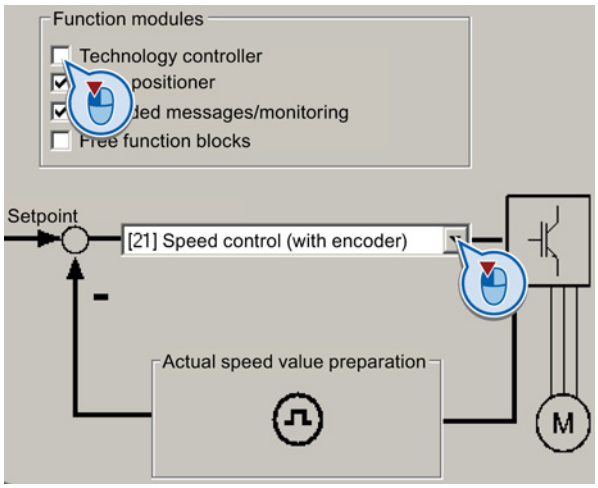
Procedure



To configure the drive, proceed as follows:

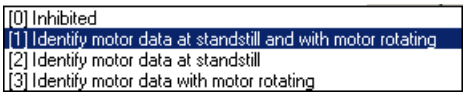
1. ☑ Control structure — Select the required function modules for your application.

   Select the control mode.



2. ☑ Defaults of the setpoin — Select the pre-assignment of the inverter interfaces.
   The possible configurations can be found in sections: Factory setting of the terminals (Page 66) and Default settings of the terminals (Page 68).
3. ☑ Drive setting — Select the application for the inverter:
   Low overload for applications that only require a low dynamic performance, e.g.: pumps or fans.
   High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4. ☑ Motor — Select your motor.
5. ☑ Motor data — Enter the motor data according to the rating plate of your motor.
   If you have selected a motor based on its order number, the data has already been entered.
6. ☑ Drive functions — If you have set the "Vector control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".

   With this setting, the inverter optimizes its speed controller.

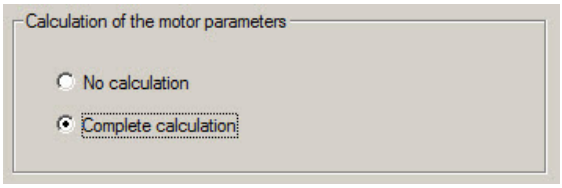


   If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":

   - You have selected "Vector control" as control mode; however, the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
   - You have set "V/f control" as control mode.

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

8. ☑ Calculation of the motc — We recommend the setting "Complete calculation".

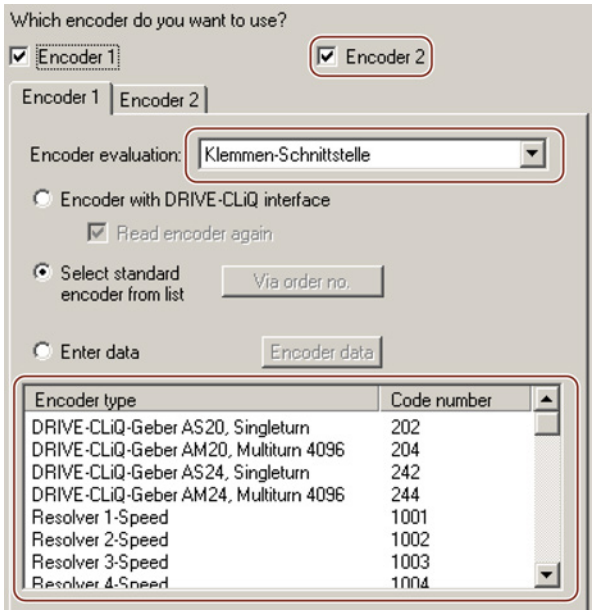


9. ☑ Encoder — Select whether the inverter evaluates one or two encoders.

Select the interface to which the encoder is connected.

Select a standard encoder from the list of encoder types.

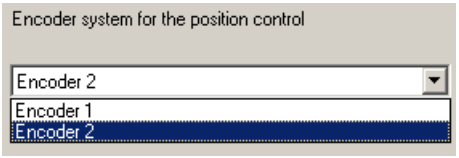
- Code number < 1000: Encoders with integrated DRIVE-CLiQ
- 100x: Resolvers with different pole pair numbers
- 2xxx: sin/cos encoder
- 3xxx: HTL/TTL encoders and SSI encoders



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 96).

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

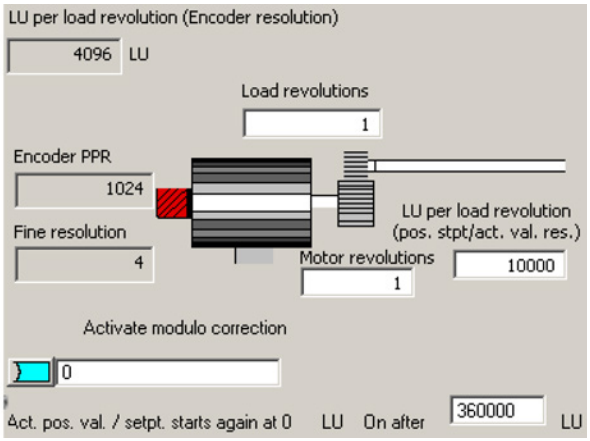
Select the encoder that you use for position sensing.



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

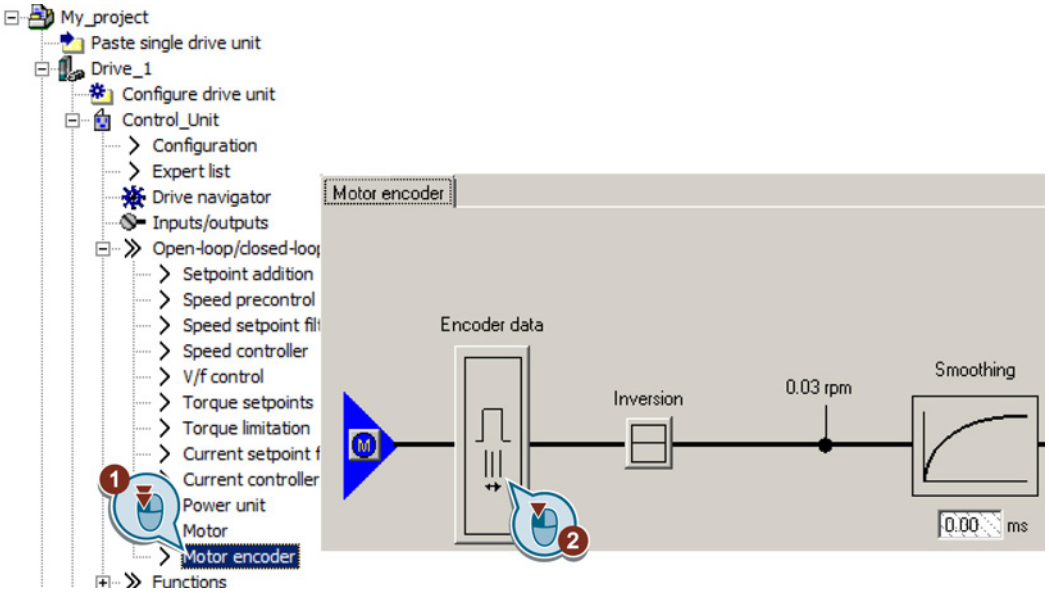
Preconditions

- 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 374).

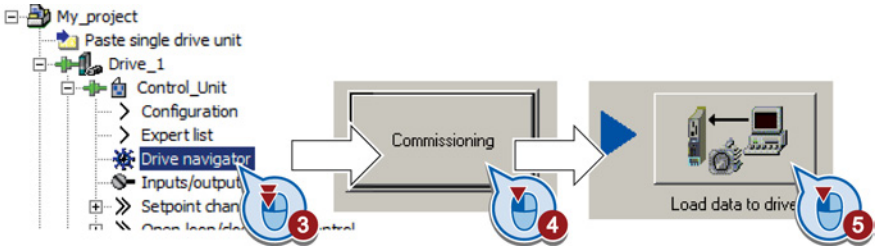
5.4.5 Loading the configured data into the drive

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 vector control will become unstable.

DANGER

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

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

Secure dangerous machine parts before starting motor data identification:

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

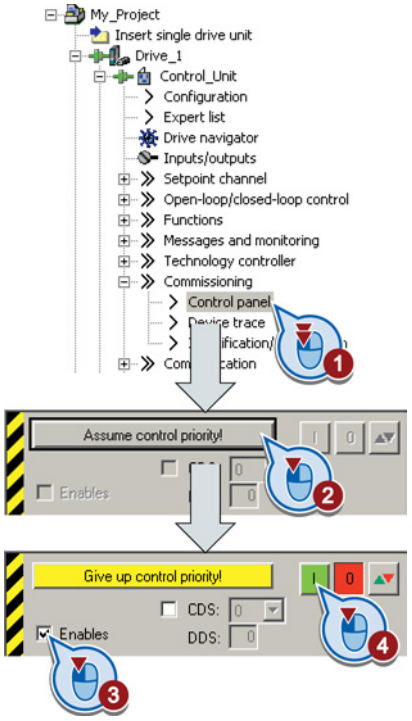
Procedure

1
2

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

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

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



You have now completed motor data identification.

Self-optimization of the closed-loop control

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

Adapt terminal strip

6

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

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

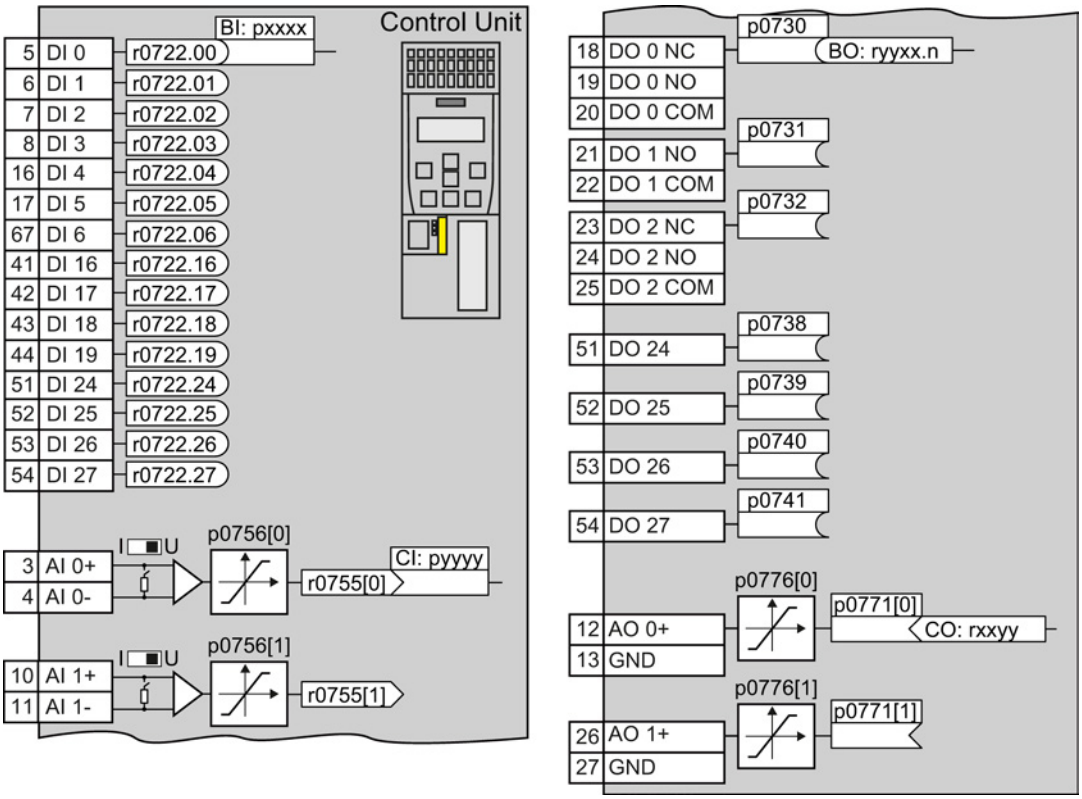
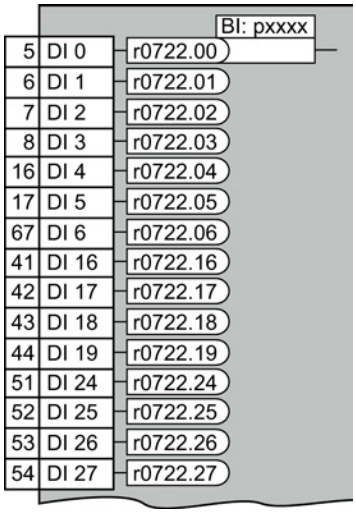


Figure 6-1 Internal interconnection of the inputs and outputs

6.1 Digital inputs

Changing the function of a digital input



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

See also Section: Interconnecting signals in the inverter (Page 370).

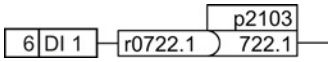
Binector inputs are marked with "BI" in the parameter list of the List Manual.

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

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

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

Changing the function of a digital input - Example



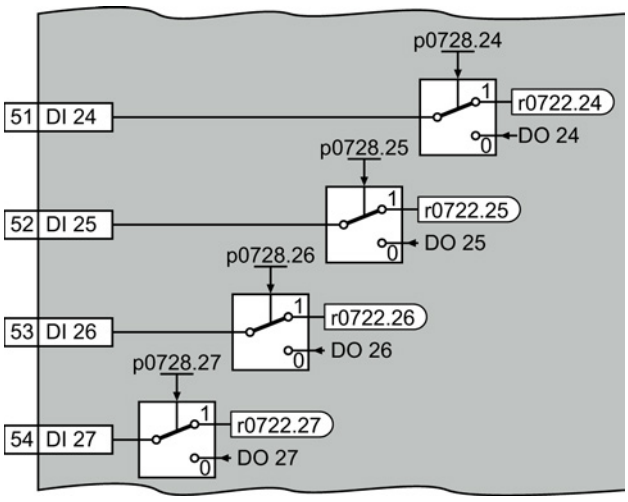
To acknowledge fault messages of the inverter using digital input DI 1, you must interconnect DI1 with the command to acknowledge faults (p2103): Set p2103 = 722.1.

Advanced settings

You can debounce the digital input signal using parameter p0724.

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

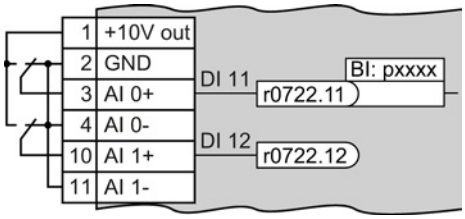
Using switchable terminals as digital inputs



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

To use a terminal that can be switched over as a digital input, set the corresponding bit of parameter p0728.x = 1.

Analog inputs as digital inputs



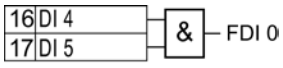
To use an analog input as additional digital input, you must connect the analog input as shown, and interconnect one of the status parameters r0722.11 or r0722.12 with a binector input of your choice.

6.2 Safety-related input

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

Defining the safety-related input

If you use the STO safety function, then you must configure the terminal strip during the basic commissioning for a safety-related input, e.g. with p0015 = 2 (see Section Terminal blocks (Page 64)).



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

See also Section: Safe Torque Off (STO) safety function (Page 238).

What devices can be connected?

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

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

Signal states

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

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

Fault detection

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

- Cable break
- Defective sensor

The inverter cannot detect the following faults:

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

Special measures when establishing connections

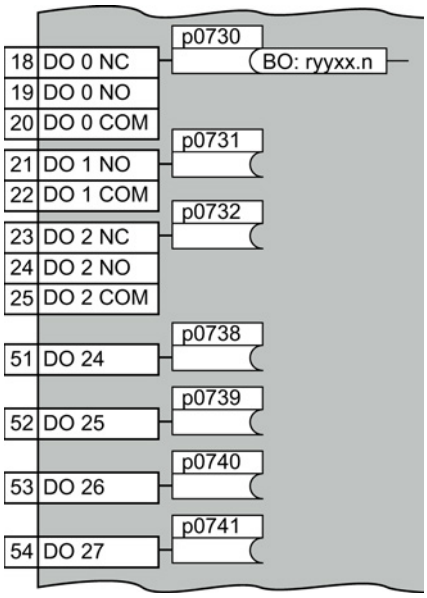
When routing cables over longer distances, e.g. between remote control cabinets, you have the following options to reduce the risk of damaged cables when your plant or machine is operating:

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

Examples of connecting a safety-related input can be found in Section: Setting an absolute encoder (Page 374).

6.3 Digital outputs

Changing the function of a digital output



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

See also Section: Interconnecting signals in the inverter (Page 370).

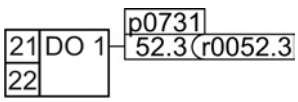
Binector outputs are marked with "BO" in the parameter list of the List Manual.

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

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

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

Changing the function of a digital output - Example



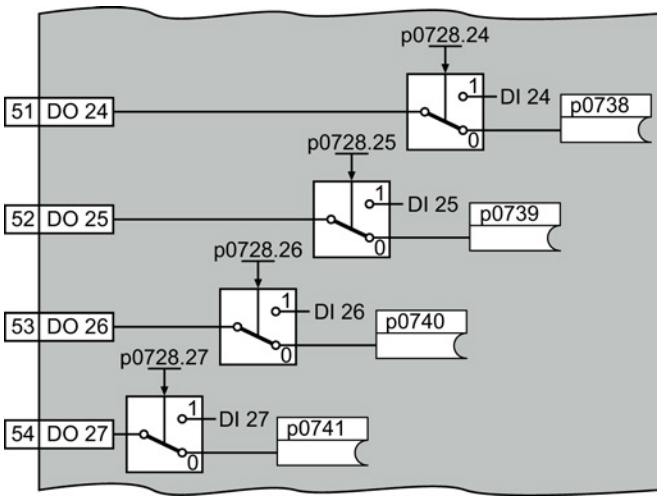
To output inverter fault messages via digital output DO 1, you must interconnect DO1 with the fault messages: Set p0731 = 52.3.

Advanced settings

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

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

Using switchable terminals as digital outputs

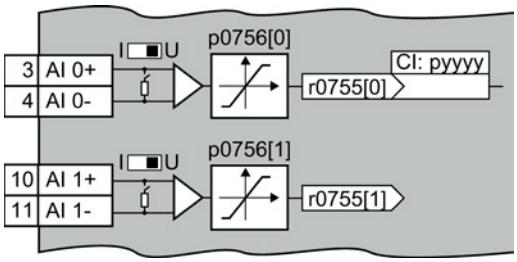


In the inverter factory setting, the switchable terminals are active as digital inputs.

To use a terminal that can be switched over as a digital output, set the corresponding bit of parameter p0728.x = 0.

6.4 Analog inputs

Overview



Changing the function of an analog input:

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

   See also Section: Interconnecting signals in the inverter (Page 370).

   Connector inputs are marked with "CI" in the parameter list of the List Manual.

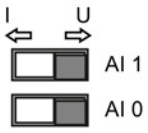
Defining the type of an analog input

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

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

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

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



Characteristics

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

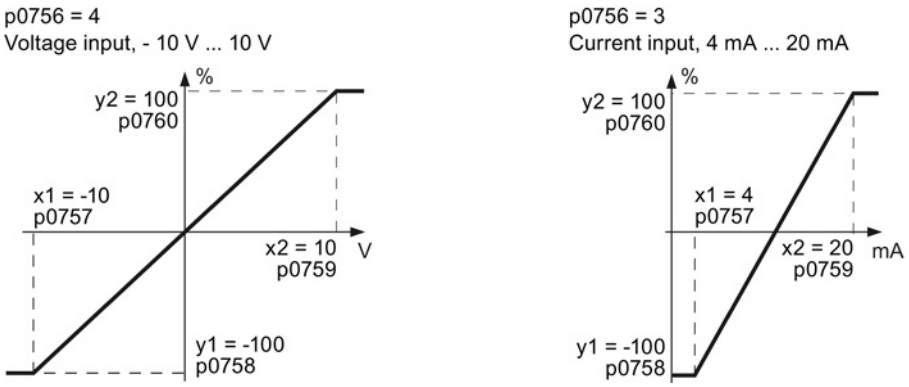


Figure 6-2 Examples for scaling characteristics

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

Adapting the characteristic

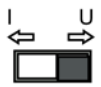
You must define your own characteristic if none of the default types match your particular application.

Example

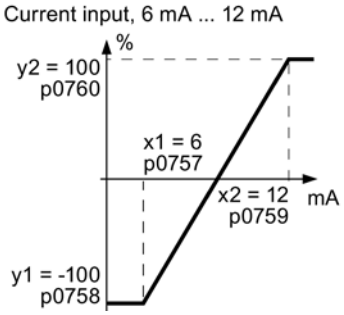
The inverter should convert a 6 mA … 12 mA signal into the value range -100 % … 100 % via analog input 0. The wire break monitoring of the inverter should respond when 6 mA is fallen below.

Precondition

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



Procedure



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

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

Defining the function of an analog input

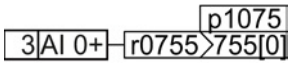
You define the analog input function by interconnecting a connector input of your choice with parameter p0755. Parameter p0755 is assigned to the particular analog input based on its index, e.g. parameter p0755[0] is assigned to analog input 0.

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

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

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

Defining the function of an analog input - example



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

Set p1075 = 755[0].

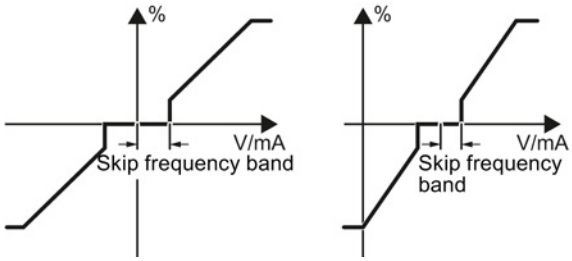
Advanced settings

Signal smoothing

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

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

Skip frequency band



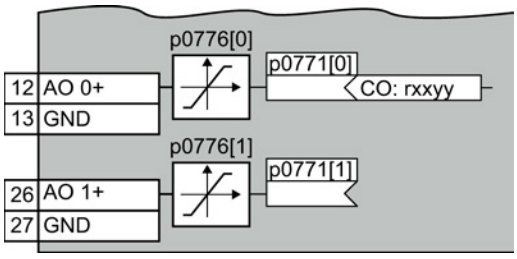
Skip frequency band of the analog input

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.

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

6.5 Analog outputs

Overview



Changing the function of an analog output:

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

   See also Section: Interconnecting signals in the inverter (Page 370).

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

Defining the analog output type

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

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

Characteristics

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

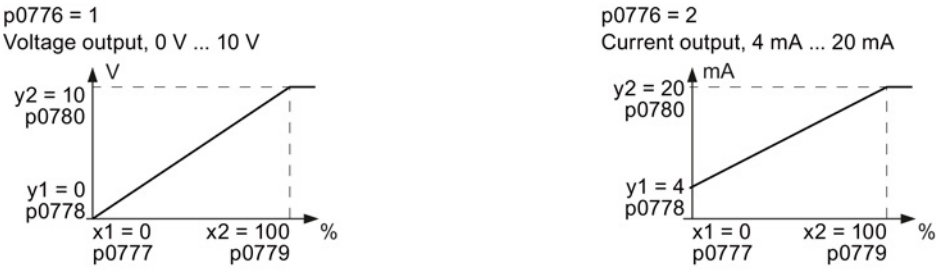


Figure 6-3 Examples for scaling characteristics

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

Table 6- 4 Parameters for the scaling characteristic

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

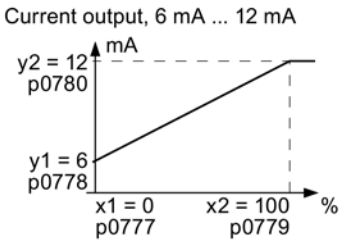
Setting the characteristic

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

Example:

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

Procedure



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

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

Defining the function of an analog output

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

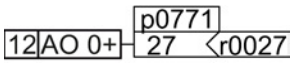
Table 6- 5 Connector outputs (CO) of the inverter (selection)

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

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

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

Defining the function of an analog output - example



To output the inverter output current via analog output 0, you must interconnect AO 0 with the signal for the output current:

Set p0771 = 27.

Advanced settings

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

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

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

7 Configuring the fieldbus

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			S7 communication 2)	Control Unit
	PROFIdrive	PROFIsafe 1)	PROFIenergy 2)		
PROFIBUS (Page 119)	✓	✓	---	✓	CU250S-2 DP
PROFINET (Page 114)	✓	✓	✓	✓	CU250S-2 PN
EtherNet/IP 2)	---			---	
USS 2)	---			---	CU250S-2
Modbus RTU 2)	---			---	
CANopen 2)	---			---	CU250S-2 CAN

1) Information on PROFIsafe can be found in the Safety Integrated function manual.

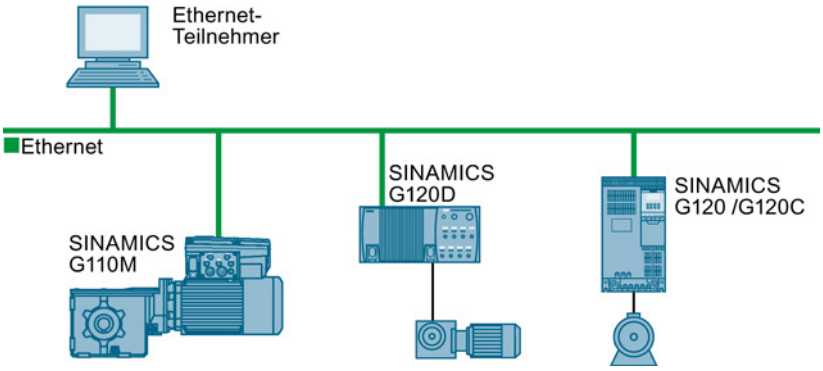
2) Information about these fieldbuses, profiles and communication types can be found in the Fieldbus Function Manual.

See also Section: Manuals for your converter (Page 386).

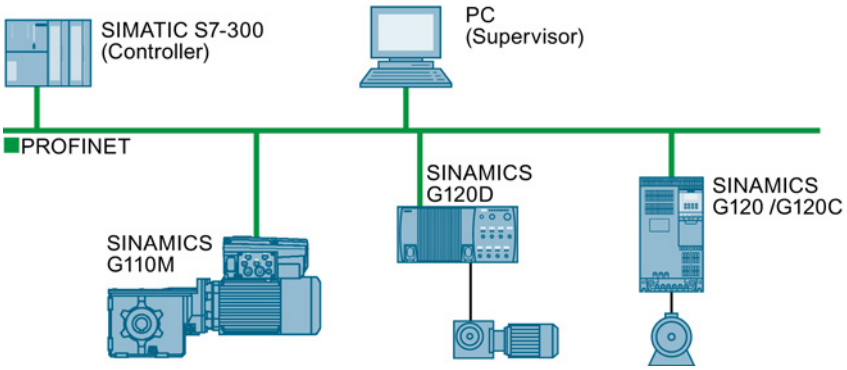
7.2 Communication via PROFINET

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

- The inverter as an Ethernet station (Page 386)



- PROFINET IO operation (Page 115)



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

– RT

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

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

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

– Diagnostic alarm
in accordance with the fault classes specified in the PROFIdrive profile. See Activating diagnostics via the control (Page 118).

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

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

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

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

This manual describes the control of the inverter using primary control. How to access the inverter as an Ethernet station is described in the Fieldbus function manual (Page 386) in the section "The inverter as an Ethernet station".

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 inverter correctly connected to the bus network?	See: Integrating inverters into PROFINET (Page 116)	
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 117)	See manuals for your inverter, fieldbus communication manual (Page 386)
Is the same telegram set in the converter as in the higher-level controller?	Set the telegram in the converter, see: Select telegram (Page 118)	
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 122)	

7.2.2 Integrating inverters into PROFINET

Procedure



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

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

   The position of the sockets and the pin assignment can be found in Section Overview of the interfaces (Page 63).

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

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

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

You have connected the inverter to the control using PROFINET.

7.2.3 Configuring communication to the control

Configuring the communication using SIMATIC S7 control

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

Additional information on this topic is provided in the "Fieldbuses" Function Manual, also see Manuals for your converter (Page 386).

Configuring the communication using a non-Siemens control

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

Installing GSDML

Procedure



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

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

     Insert a memory card into the converter.

     Set p0804 = 12.

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



You have now installed the GSDML.

7.2.4 Select telegram

PROFIdrive telegrams

If you have not activated the function "Basic positioner" in the inverter, the following telegrams will be available:

p0922 = 1: Standard telegram 1, PZD-2/2 (factory setting)
2: Standard telegram 2, PZD-4/4
3: Standard telegram 3, PZD-5/9
4: Standard telegram 4, PZD-6/14
20: Standard telegram 20, PZD-2/6
350: SIEMENS telegram 350, PZD-4/4
352: SIEMENS telegram 352, PZD-6/6
353: SIEMENS telegram 353, PZD-2/2, PKW-4/4
354: SIEMENS telegram 354, PZD-6/6, PKW-4/4
999: Extend telegrams and change signal interconnection (Page 131)

The following values apply if you have enabled the "Basic positioner" function in the inverter:

7: Standard telegram 7, PZD-2/2
9: Standard telegram 9, PZD-10/5
110: SIEMENS telegram 110, PZD-12/7
111: SIEMENS telegram 111, PZD-12/12
999: Factory setting. See also Extend telegrams and change signal interconnection (Page 131)

A more detailed depiction of the individual telegrams can be found in Section Cyclic communication (Page 122).

Selecting a telegram

Procedure



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

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



You have set a specific telegram in the inverter.

7.2.5 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.

You must select the functionality in the higher-level control (see Manuals for your converter (Page 386)) and activate it by booting 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 converter via the fieldbus.

Questions	Description	Examples
Is the inverter correctly connected to the PROFIBUS?	See Section: Integrating inverters into PROFIBUS (Page 119).	---
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring the communication using SIMATIC S7 control (Page 120)	See Manuals for your converter (Page 386)
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 120).	
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram (Page 121).	
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 122).	

7.3.2 Integrating inverters into PROFIBUS

Procedure



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

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

   The position of the sockets and the pin assignment can be found in Section Overview of the interfaces (Page 63).

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

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

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



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

Communication with the control, even when the line voltage is switched off

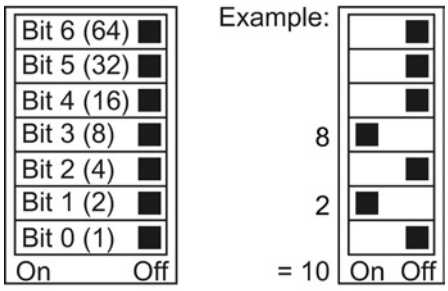
If, in your plant or system, communication with the control system should continue to function even when the line voltage is switched off, then you must externally supply the inverter/Control Unit with 24 V DC. To do this, use terminals 31 and 32 – or connector X01. You can find additional details in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

7.3.3 Configuring the communication using SIMATIC S7 control

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

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

7.3.4 Setting the address



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

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

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

Valid address range: 1 … 125

The positions of the address switches are described in Section: Overview of the interfaces (Page 63).

Procedure



To change the bus address, proceed as follows:

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

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



You have now changed the bus address.

7.3.5 Select telegram

PROFIdrive telegrams

If you have not activated the function "Basic positioner" in the inverter, the following telegrams will be available:

p0922 =
- 1: Standard telegram 1, PZD-2/2 (factory setting)
- 2: Standard telegram 2, PZD-4/4
- 3: Standard telegram 3, PZD-5/9
- 4: Standard telegram 4, PZD-6/14
- 20: Standard telegram 20, PZD-2/6
- 350: SIEMENS telegram 350, PZD-4/4
- 352: SIEMENS telegram 352, PZD-6/6
- 353: SIEMENS telegram 353, PZD-2/2, PKW-4/4
- 354: SIEMENS telegram 354, PZD-6/6, PKW-4/4
- 999: Extend telegrams and change signal interconnection (Page 131)

The following values apply if you have enabled the "Basic positioner" function in the inverter:

- 7: Standard telegram 7, PZD-2/2
- 9: Standard telegram 9, PZD-10/5
- 110: SIEMENS telegram 110, PZD-12/7
- 111: SIEMENS telegram 111, PZD-12/12
- 999: Factory setting. See also Extend telegrams and change signal interconnection (Page 131)

A more detailed depiction of the individual telegrams can be found in Section Cyclic communication (Page 122).

Selecting a telegram

Procedure



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

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

You have set a specific telegram in the inverter.

7.4 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 386).

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 7-1 Telegrams 1 … 352 for cyclic communication

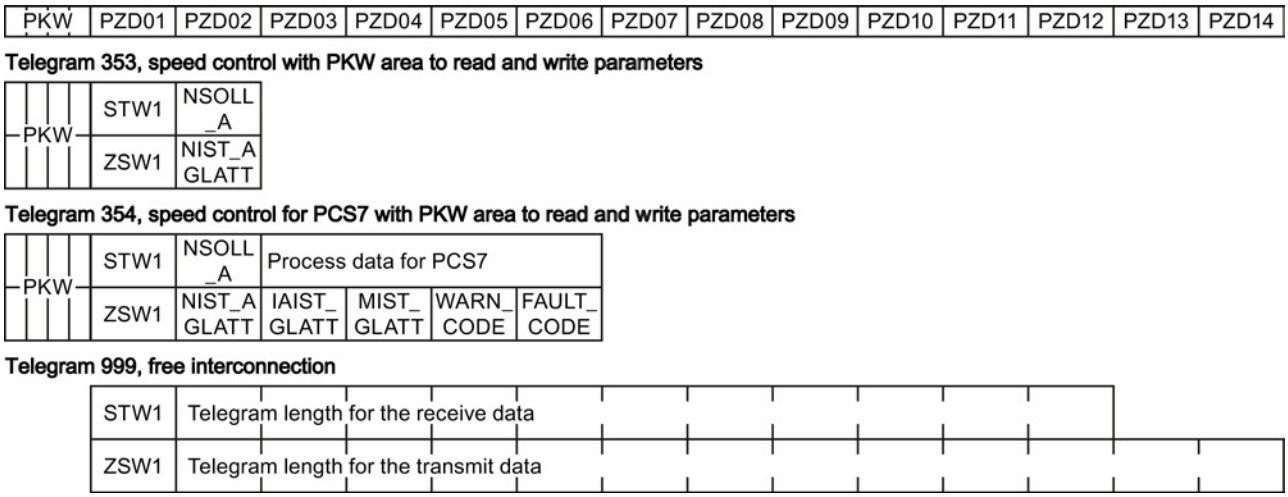


Figure 7-2 Telegrams 353 … 999 for cyclic communication

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

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.

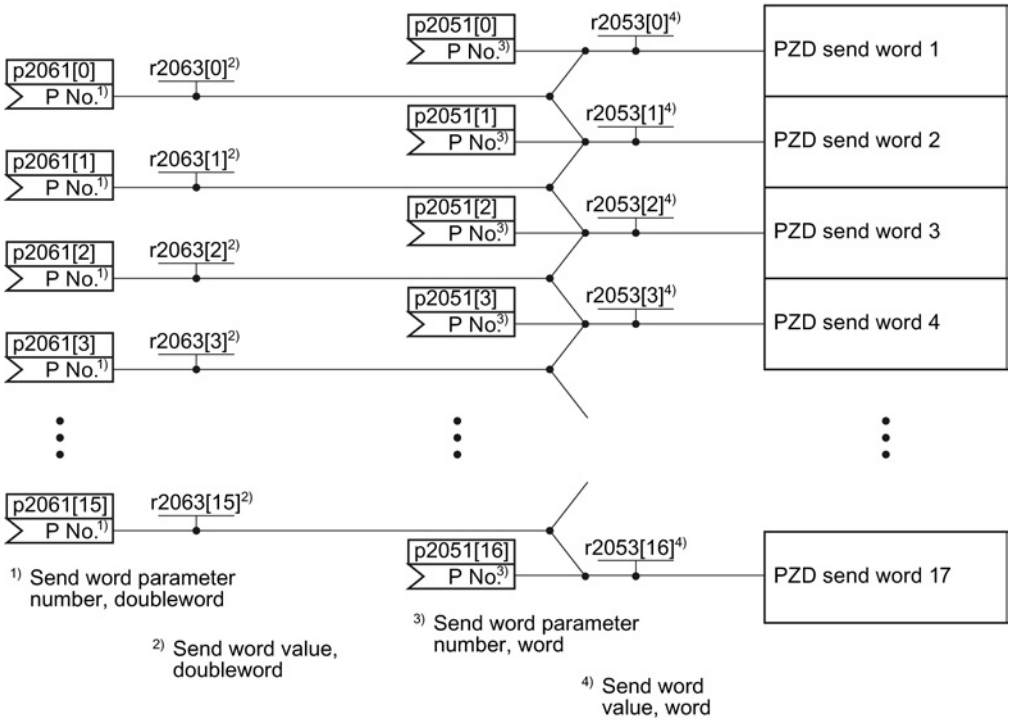


Figure 7-3 Interconnection of the send words

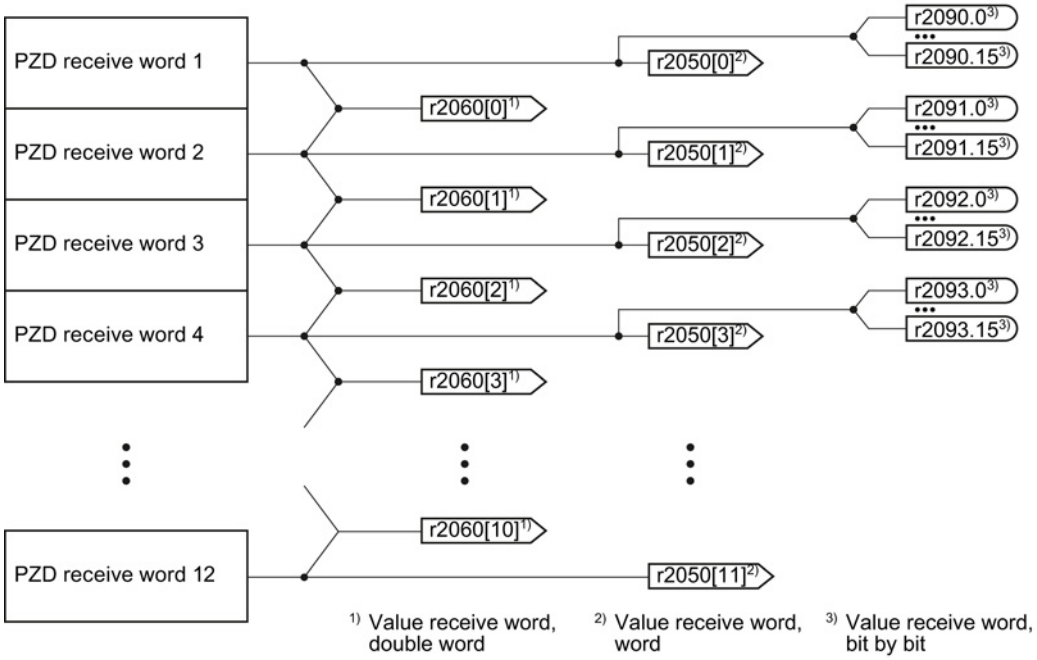


Figure 7-4 Interconnection of the receive words

7.4.1.1 Control and status word 1

Control word 1 (STW1)

The control word 1 is pre-assigned as follows.

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

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

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

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

Status word 1 (ZSW1)

The status word 1 is pre-assigned as follows.

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

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

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

7.4.1.2 Control and status word 3

Control word 3 (STW3)

The control word 3 is pre-assigned as follows.

- Bit 0… 15 manufacturer-specific

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

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

Status word 3 (ZSW3)

The status word 3 is pre-assigned as follows.

- Bit 0… 15 manufacturer-specific

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

7.4.1.3 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: 2: 3: 4: 20: 350: 352: 353: 354:	Standard telegram 1, PZD-2/2 Standard telegram 2, PZD-4/4 Standard telegram 3, PZD-5/9 Standard telegram 4, PZD-6/14 Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4
	The following values apply if you have enabled the "Basic positioner" function in the inverter:	
	7: 9: 110: 111:	Standard telegram 7, PZD-2/2 Standard telegram 9, PZD-10/5 SIEMENS telegram 110, PZD-12/7 SIEMENS telegram 111, PZD-12/12
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.	
p2051[0…16]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

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

Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

Procedure



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

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

You have freely interconnected the signals transferred in the telegram.

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

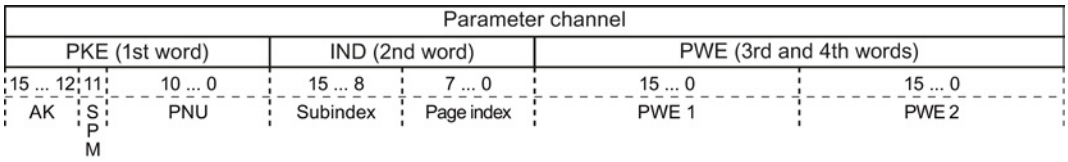
For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

7.4.1.4 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. 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.
Write the parameter number into the PNU (PKE bit 10 ... 0).

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

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

Indexed parameters

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

Parameter contents

Parameter contents can be parameter values or connectors.

Table 7- 4 Parameter values in the parameter channel

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

Table 7- 5 Connectors in the parameter channel

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

Telegram examples

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

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

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

| Parameter channel | | |

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

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

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

| Parameter channel | | |

8 Setting functions

8.1 Overview of the converter functions

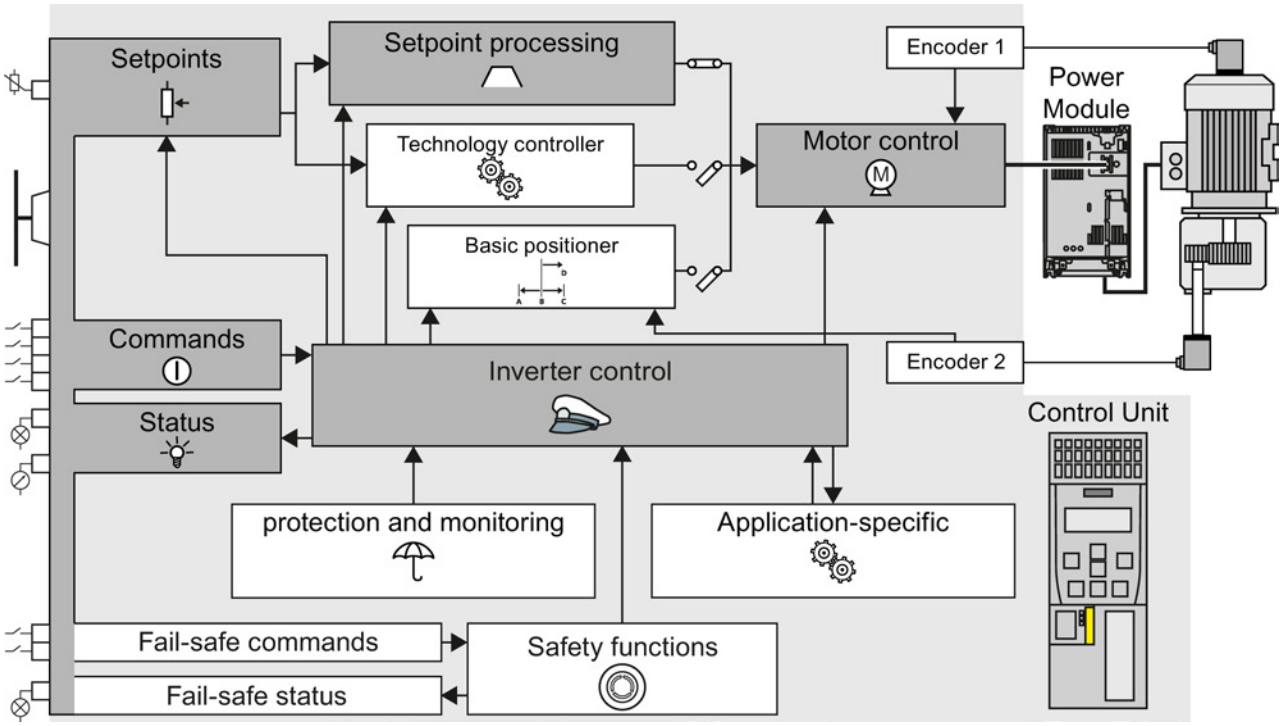
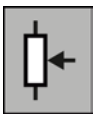
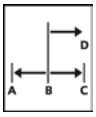


Figure 8-1 Overview of inverter functions

<table>
<tr><th colspan="2">Functions relevant to all applications</th><th colspan="2">Functions required in special applications only</th></tr>
<tr><td colspan="2">The functions that you require in each application are shown in a dark color in the function overview above.
You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.</td><td colspan="2">The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.</td></tr>
<tr><td></td><td>**Inverter control** is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to commands from the higher-level control system.
Inverter control (Page 141)</td><td></td><td>The **protection and monitoring** functions prevent damage to the motor, inverter and driven load, e.g. using temperature monitoring or torque monitoring.
Protection and monitoring functions (Page 180)</td></tr>
<tr><td>
</td><td>The **commands** from the higher-level control are sent to the inverter via digital inputs or the fieldbus. The inverter returns its **status signals** to the outputs of the Control Unit or to the fieldbus.
Adapt terminal strip (Page 99)
Configuring the fieldbus (Page 113)</td><td></td><td>The **application-specific** functions control, for example, a motor holding brake – or allow higher-level closed-loop pressure or temperature controls to be implemented using the technology controller.
Application-specific functions (Page 189)</td></tr>
<tr><td></td><td>You must define a **setpoint** , which defines the motor speed, for example.
Setpoints (Page 152)</td><td rowspan="2"></td><td rowspan="2">The **safety functions** fulfill increased requirements regarding the functional safety of the drive.
The basic functions safely switch off the drive torque.
Safe Torque Off (STO) safety function (Page 238)
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 352).
The extended safety functions are described in the "Safety Integrated Function Manual", also refer to Section: Manuals for your converter (Page 386).</td></tr>
<tr><td></td><td>The **setpoint calculation** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value.
Setpoint calculation (Page 160)</td></tr>
<tr><td></td><td>The **motor closed-loop control** ensures that the motor follows the speed setpoint. You can select either vector control or U/f control.
Motor control (Page 169)</td><td></td><td>The **basic positioner** traverses an axis with position control to a target position.
You require a license to use the basic positioner, also refer to Section: Activating licensed functions (Page 352).
The basic positioner is described in the "Function Manual, Basic Positioner", also see Section: Manuals for your converter (Page 386).</td></tr>
</table>

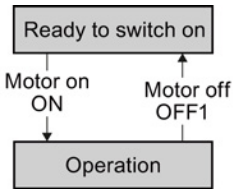
8.2 Inverter control

8.2.1 Switching the motor on and off



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

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



Converter states and commands for switching the motor on and off

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

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

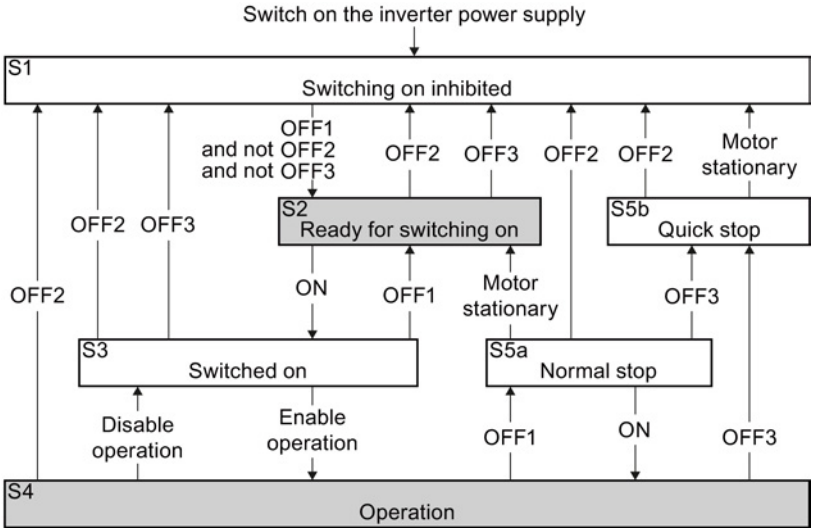


Figure 8-2 Internal sequence control of the converter when the motor is switched on and off

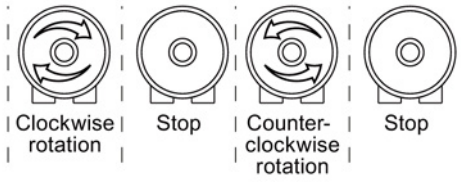
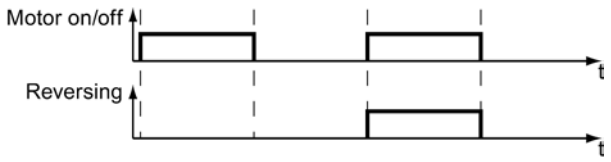
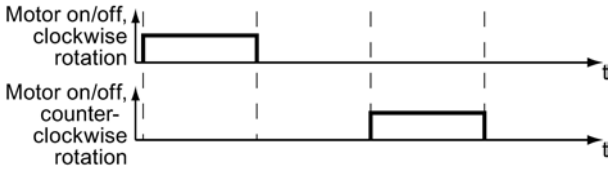
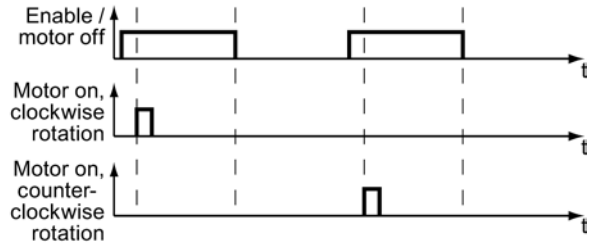
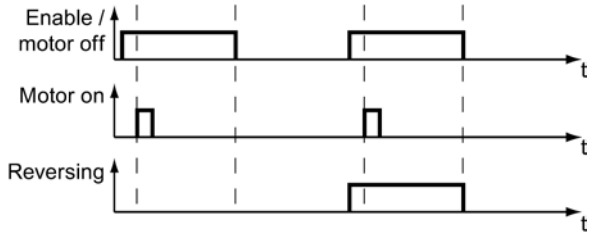
The abbreviations S1 … S5b to identify the converter states are defined in the PROFIdrive profile.

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

8.2.2 Inverter control using digital inputs

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

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

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

8.2.3 Two-wire control: method 1

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

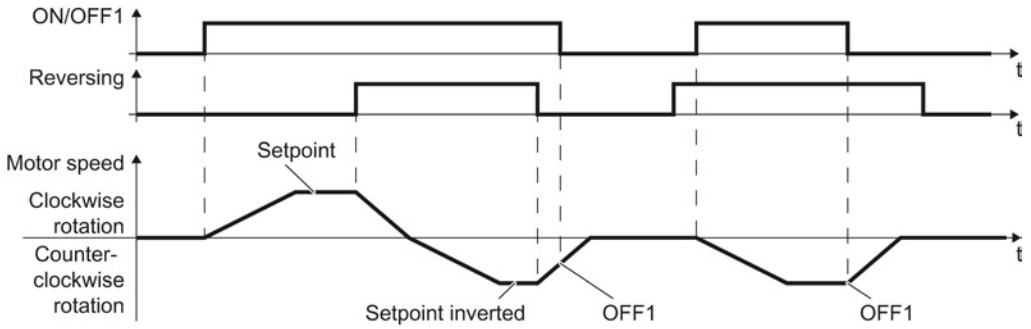


Figure 8-3 Two-wire control, method 1

Table 8- 2 Function table

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

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

8.2.4 Two-wire control, method 2

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

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

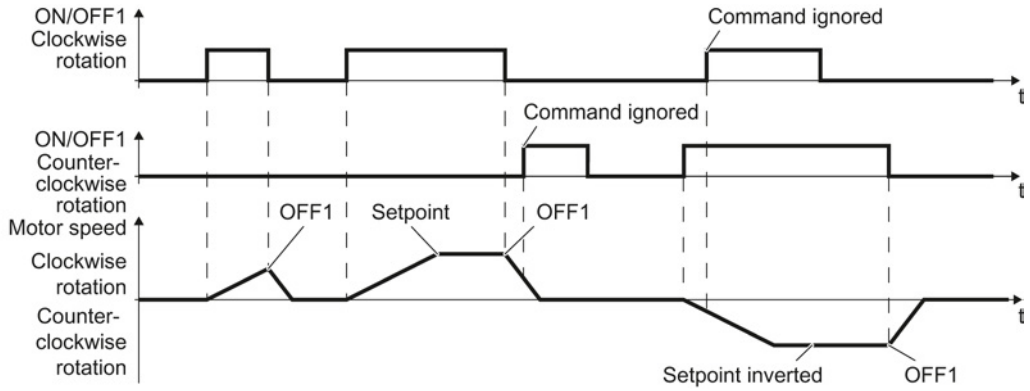


Figure 8-4 Two-wire control, method 2

Table 8- 3 Function table

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

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

8.2.5 Two-wire control, method 3

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

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

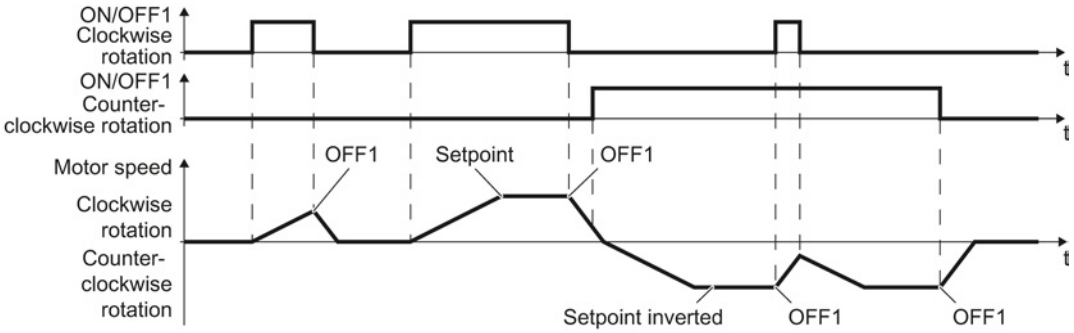


Figure 8-5 Two-wire control, method 3

Table 8- 4 Function table

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

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 18</td><td colspan="3">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1 clockwise rotation</td><td>ON/OFF1 counter-clockwise rotation</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice.</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 1 (ON/OFF1 clockwise rotation)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 2 (ON/OFF1 counter-clockwise rotation)
Example: p3331[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON/OFF1 counter-clockwise command via DI 0.</td></tr>
</table>

8.2.6 Three-wire control, method 1

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

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

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

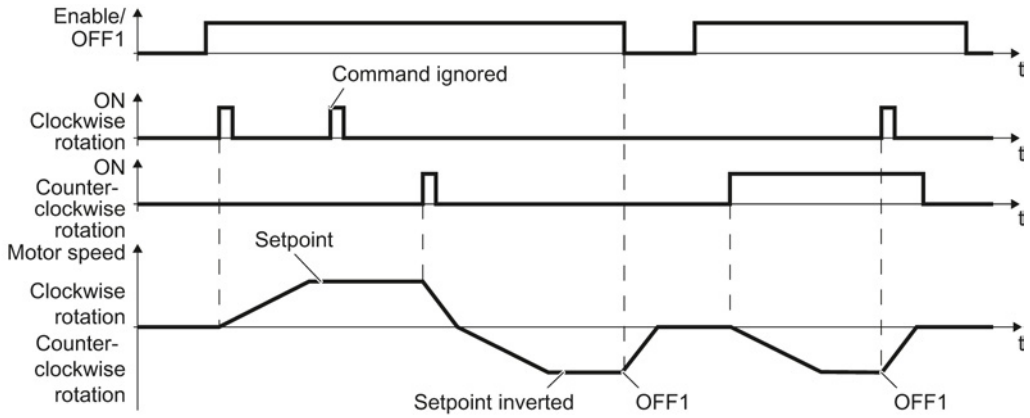


Figure 8-6 Three-wire control, method 1

Table 8- 5 Function table

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

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

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).

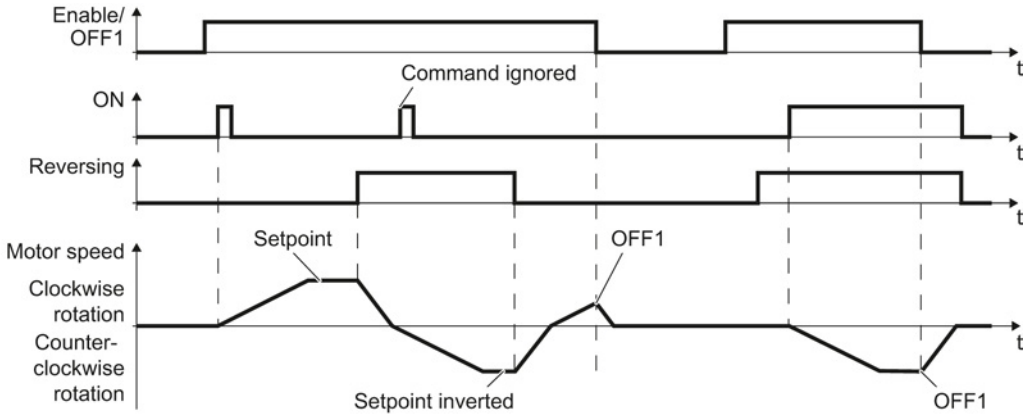


Figure 8-7 Three-wire control, method 2

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 Interconnecting control commands with digital inputs of your choice (DI x).				
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (enable/OFF1)			
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON) Example: p3331[0] = 722.0 ⇒ if CDS 0 (index[0]) is selected, the inverter receives its ON command via DI 0.			
p3332[0 … n] = 722.x	**BI: 2/3 wire control command 3** (reversing)			

8.2.8 Running the motor in jog mode (JOG function)

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

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

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

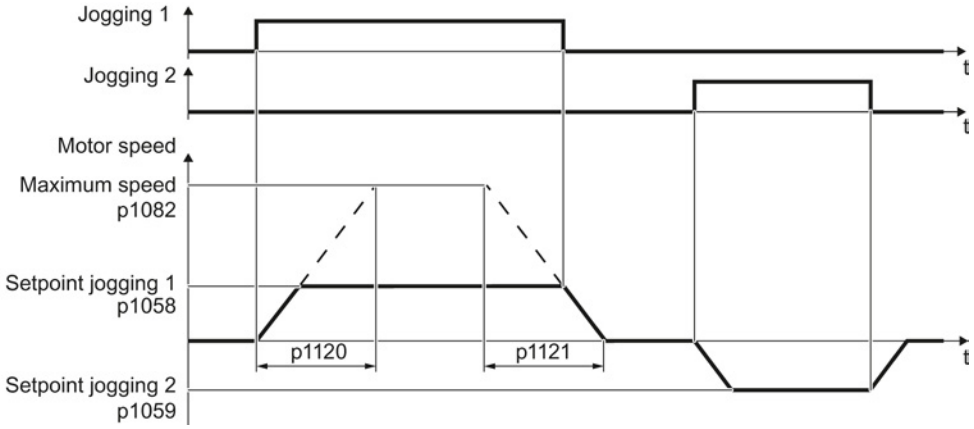
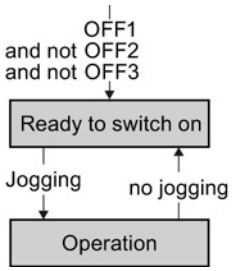


Figure 8-8 Behavior of the motor when "jogging"

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



Jog settings

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

8.2.9 Switching over the inverter control (command data set)

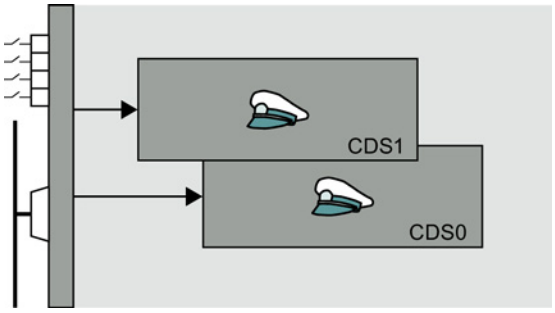
In several applications, the inverter must be able to be operated from different, higher-level control systems.

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

Command data set (CDS)

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

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



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

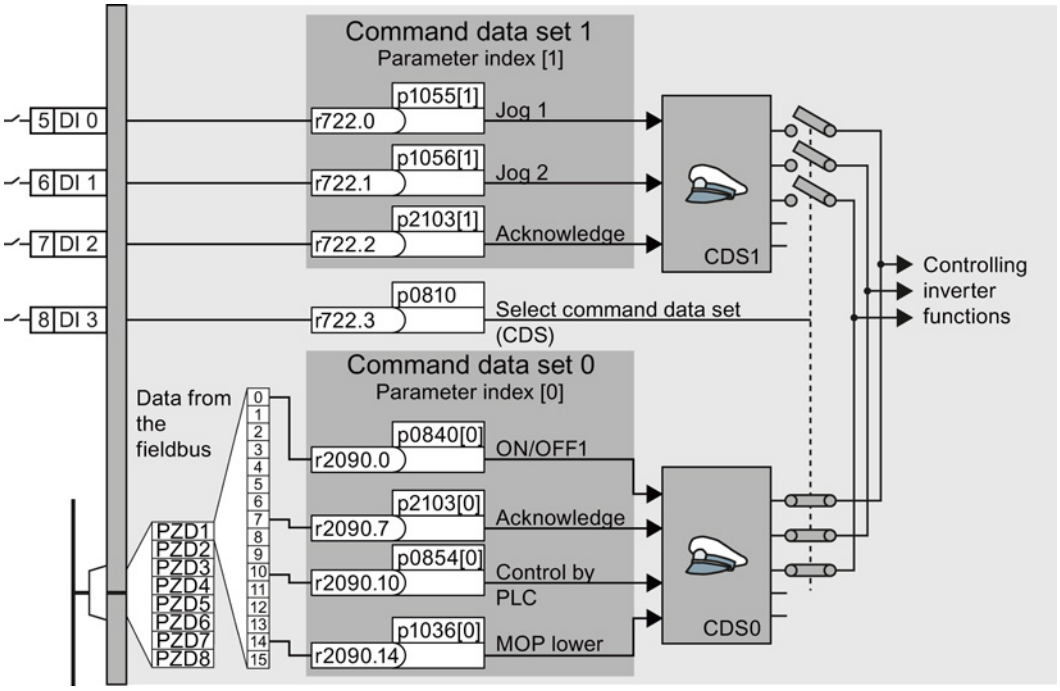


Figure 8-9 Example: Switching over the control via terminal strip to control via PROFIBUS or PROFINET

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

Note

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

Advanced settings

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

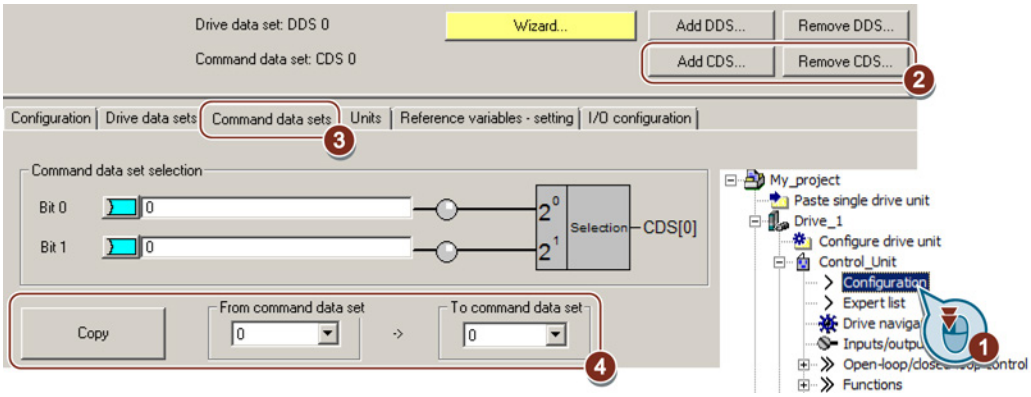


Figure 8-10 Editing command data sets in STARTER

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

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

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

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

8.3 Setpoints

8.3.1 Overview

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

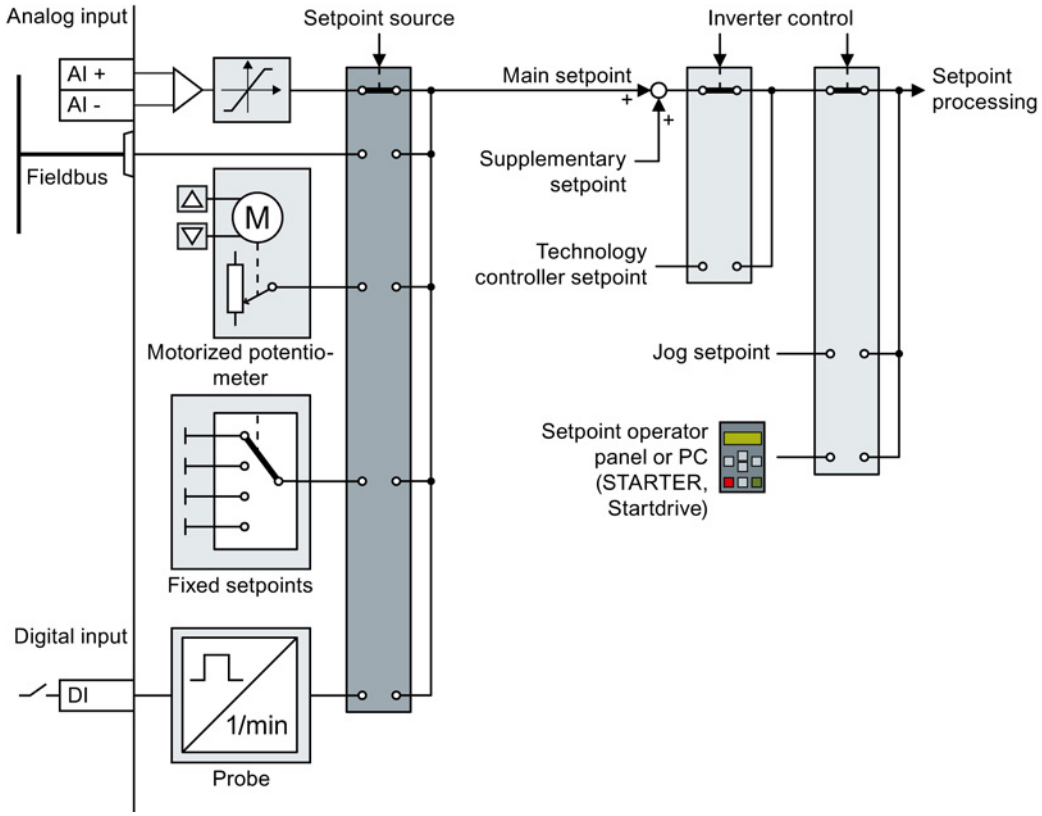


Figure 8-11 Setpoint sources for the inverter

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

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

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

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

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

8.3.2 Analog input as setpoint source

Interconnecting an analog input

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

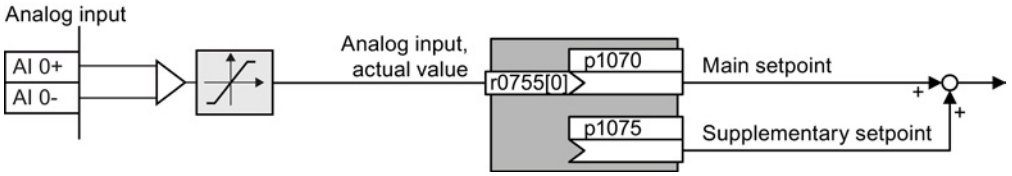


Figure 8-12 Example: Analog input 0 as setpoint source

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

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

You must adapt the analog input to the connected signal, e.g. ± 10 V or 4 … 20 mA. You will find additional information in the section: Analog inputs (Page 105).

8.3.3 Specifying the setpoint via the fieldbus

Interconnecting the fieldbus with the main setpoint

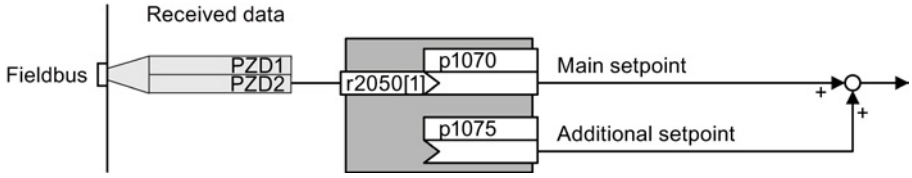


Figure 8-13 Fieldbus as setpoint source

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

Table 8- 8 Setting the fieldbus as setpoint source

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

8.3.4 Motorized potentiometer as setpoint source

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

Interconnecting the motorized potentiometer (MOP) with the setpoint source

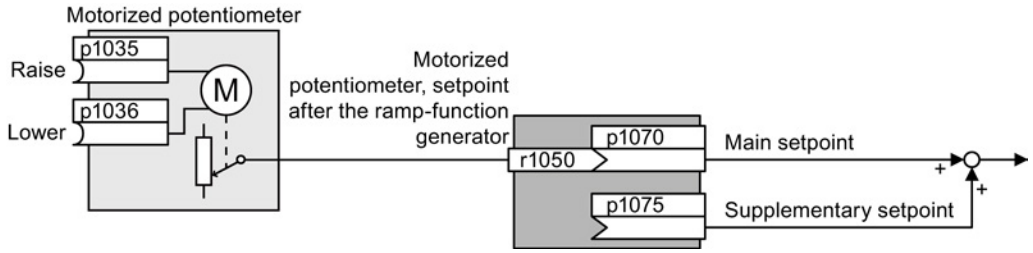


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 9 Basic setup of motorized potentiometer

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

Table 8- 10 Setting the MOP as setpoint source

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

Adapting the behavior of the motorized potentiometer

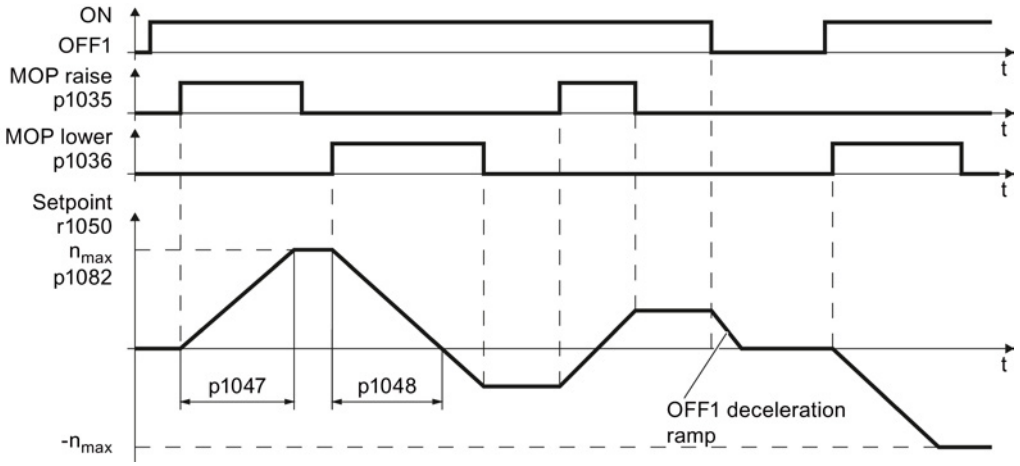


Figure 8-15 Function chart of motorized potentiometer

Table 8- 11 Extended setup of motorized potentiometer

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

Parameter	Description
p1043	**Motorized potentiometer, accept setting value** (factory setting: 0) Signal source for accepting the setting value. The motorized potentiometer accepts the setting value p1044 on signal change p1043 = 0 → 1.
p1044	**MOP setting value** (factory setting: 0) Signal source for the setting value.

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

8.3.5 Fixed speed as setpoint source

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

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

Interconnecting the fixed speeds with a main setpoint

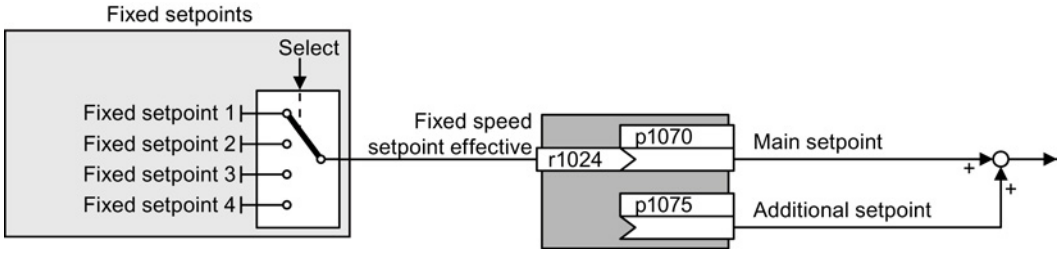


Figure 8-16 Fixed speeds as setpoint source

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

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

Select direct or binary fixed setpoint

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

1. Direct selection:

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

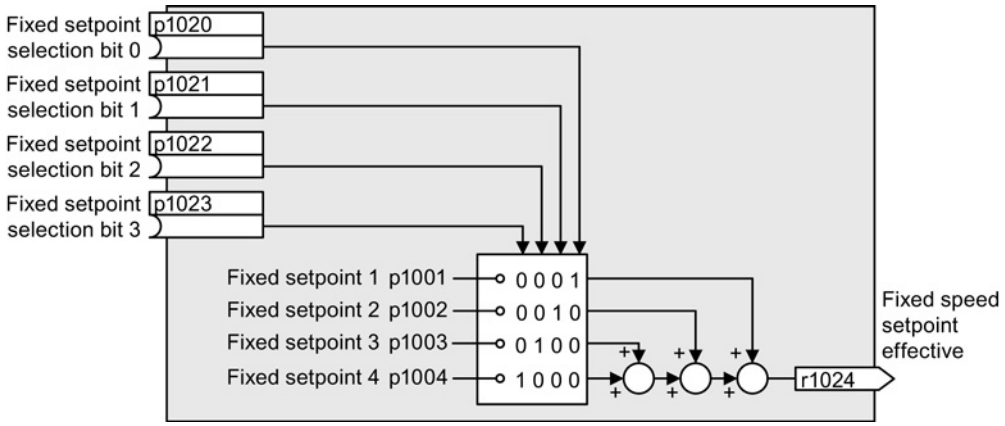


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

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

2. Binary selection:

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

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

Parameter for setting the fixed setpoints

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

Example: Select two fixed setpoints directly

The motor should operate at different speeds as follows:

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

Table 8- 13 Settings for the example

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

Table 8- 14 Resulting fixed setpoints for the example above

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

8.3.6 Pulse input as source of setpoint value

Interconnecting the digital input as setpoint source

Using the "probe" function ("pulse train"), the inverter converts a pulse signal at one of the digital inputs DI 24 … DI 27 into an analog signal. The inverter evaluates a signal with a max. frequency of 32 kHz.

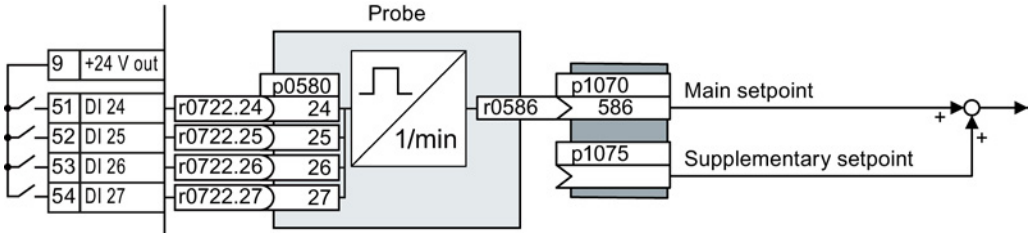


Figure 8-18 Pulse signal of the digital input as setpoint source

The "probe" function ("pulse train") creates an analog value from a pulse train at a digital input of the inverter.

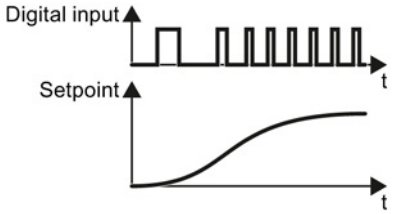


Figure 8-19 Converting the pulse signal at the digital input into an analog value

Parameter	Description
p1070 = 586	**Main setpoint** (factory setting depending on the Control Unit) Interconnect the result of the speed calculation with the main setpoint.
p1075 = 586	**Supplementary setpoint** (factory setting 0) Interconnect the result of the speed calculation with the supplementary setpoint.

When you use this function, you cannot use any of the digital inputs to monitor the speed.
See also: Speed deviation monitoring (Page 222).

Setting the probe

Parameter	Description
p0490	**Probe** [1] **invert** (factory setting 0000bin) The 3rd bit of the parameter value inverts the input signal of digital input 3 for the probe.
p0580	**Probe** [1] **input terminal** (factory setting 0) Interconnect the probe input with a digital input.
p0581	**Probe** [1] **edge**(factory setting 0 Edge to evaluate the probe signal for measuring speed actual value 0: 0/1 edge 1: 1/0 edge
p0582	**Probe** [1] **Pulses per revolution** (factory setting 1) Number of pulses per revolution.
p0583	**Probe** [1] **Maximum measurement time** (factory setting 10 s) Maximum measurement time for the probe. If there is no new pulse before the maximum measuring time elapses, the inverter sets the actual speed value in r0586 to zero. The time is restarted with the next pulse.
p0585	**Probe** [1] **Gear ratio** (factory setting 1) The inverter multiplies the measured speed by the gear ratio before displaying it in r0586.
r0586	**Probe** [1] **Speed actual value** Result of the speed calculation.

8.4 Setpoint calculation

8.4.1 Overview of setpoint processing

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

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

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

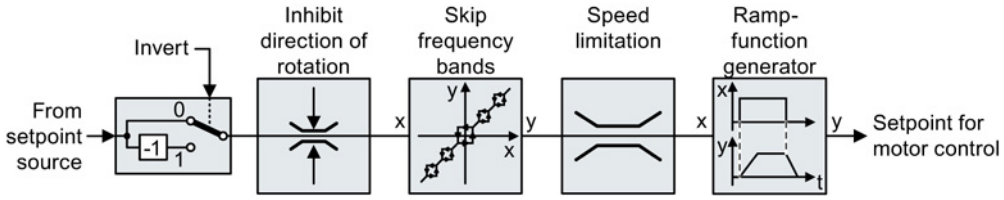
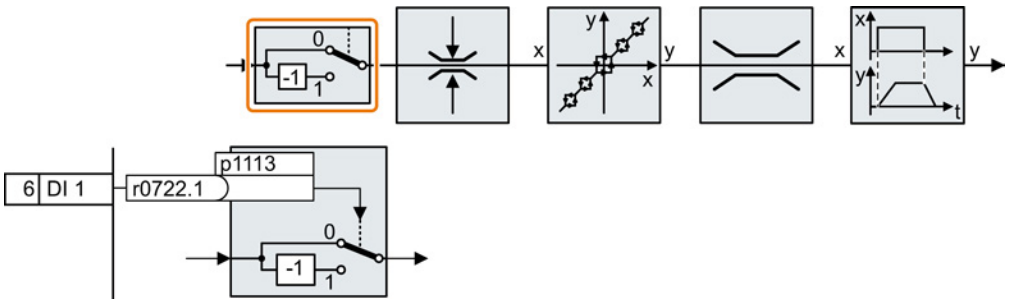


Figure 8-20 Setpoint processing in the converter

8.4.2 Invert setpoint

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



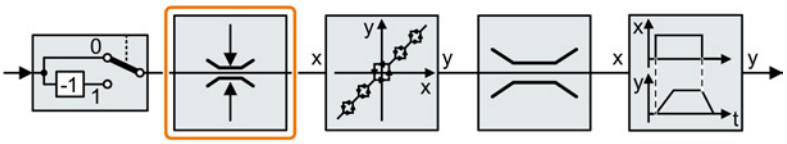
In order to invert the setpoint through the digital input DI 1, connect the parameter p1113 with a binary signal, e.g. the digital input 1.

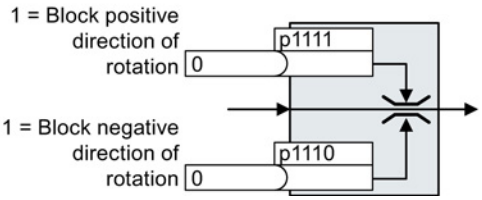
Table 8- 15 Examples of settings to invert the setpoint

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

8.4.3 Inhibit direction of rotation

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





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

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

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

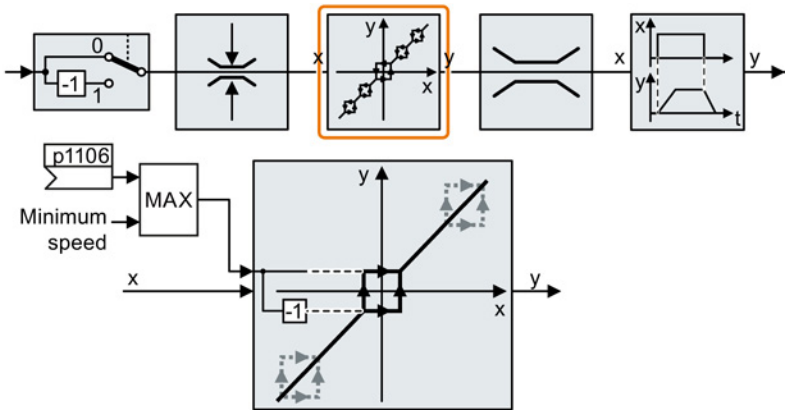
8.4.4 Skip frequency bands and minimum speed

Skip frequency bands

The converter has four skip frequency bands that prevent continuous motor operation within a specific speed range. You can find additional information in function diagram 3050 of the List Manual, see also: Manuals for your converter (Page 386).

Minimum speed

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



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

Table 8- 17 Setting the minimum speed

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

NOTICE

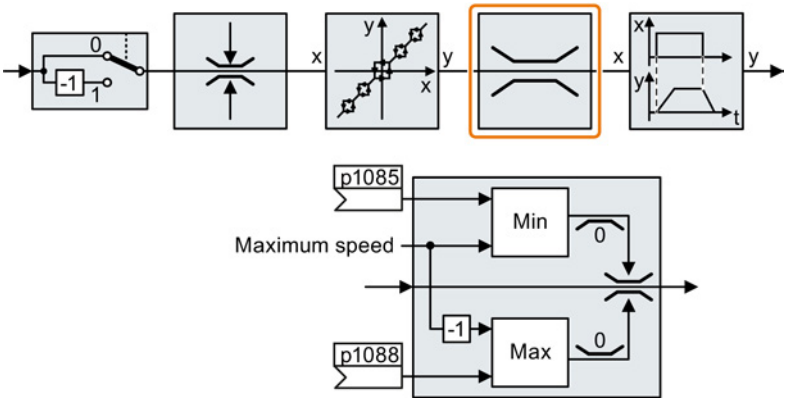
Material damage caused by motor rotating in the incorrect direction

If you are using an analog input as speed setpoint source, then for a setpoint = 0 V, noise voltages can be superimposed on the analog input signal. After the on command, the motor accelerates up to the minimum frequency in the direction of the random polarity of the noise voltage. A motor rotating in the wrong direction can cause significant material damage to the machine or system.

- Inhibit the motor direction of rotation that is not permissible.

8.4.5 Speed limitation

The maximum speed limits the speed setpoint range for both directions of rotation.



The converter generates a message (fault or alarm) when the maximum speed is exceeded.

If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 8- 18 Parameters for the speed limitation

Parameter	Description
p1082	**Maximum speed** (factory setting: 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting: 210,000 rpm)
p1085	**CI: Speed limit, positive direction of rotation** (factory setting: 1083)
p1086	**Speed limit, negative direction of rotation** (factory setting: -210,000 rpm)
p1088	**CI: Speed limit, negative direction of rotation** (factory setting: 1086)

8.4.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

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

- Extended ramp-function generator

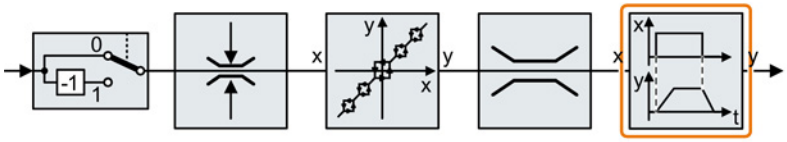
  The extended ramp-function generator limits acceleration and jerk. The motor accelerates especially gently. The extended ramp-function generator can also solve problems in machines with high breakaway torques.

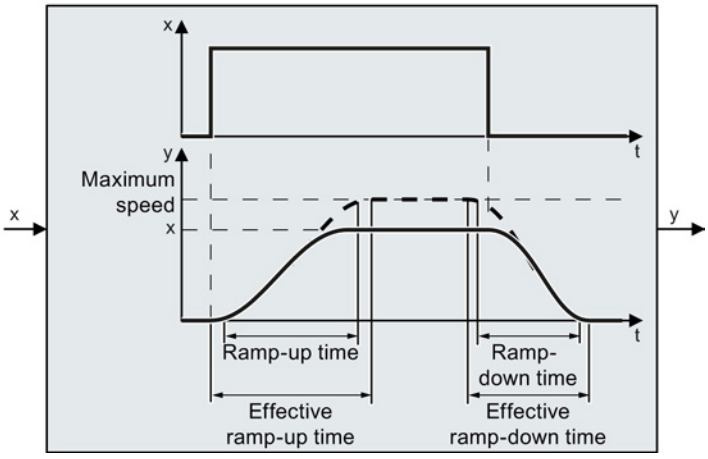
- Basic ramp-function generator

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

Extended ramp-function generator

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



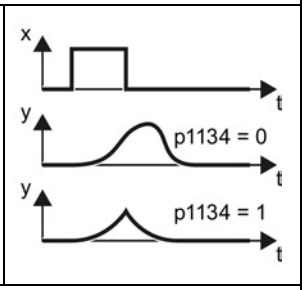


Initial and final rounding permit smooth, jerk-free acceleration and braking.

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

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

Table 8- 19 Additional parameters to set the extended ramp-function generator

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

You can find more information in function diagram 3070 and in the parameter list of the List Manual.

Setting the extended ramp-function generator

Procedure



Proceed as follows to set the extended ramp-function generator:

1. Enter the highest possible speed setpoint.
2. Switch on the motor.

3. Evaluate your drive response.
   – If the motor accelerates too slowly, then reduce the ramp-up time.

     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
   – If the motor accelerates too fast, then extend the ramp-up time.
   – Increase the initial rounding if the acceleration is jerky.
   – We recommend that you set the final rounding to the same value as the initial rounding.
4. Switch off the motor.
5. Evaluate your drive response.
   – If the motor decelerates too slowly, then reduce the ramp-down time.

     The minimum ramp-down time that makes sense depends on your particular application. Depending on the Power Module used, for an excessively short ramp-down time, the converter either reaches the motor current, or the DC link voltage in the converter becomes too high. Depending on the converter setting, the real braking time exceeds the set ramp-down time, or the converter goes into a fault condition when braking.
   – Extend the ramp-down time if the motor is braked too quickly or the converter goes into a fault condition when braking.
6. Repeat steps 1 … 5 until the drive behavior meets the requirements of the machine or plant.

You have set the extended ramp-function generator.

Basic ramp-function generator

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

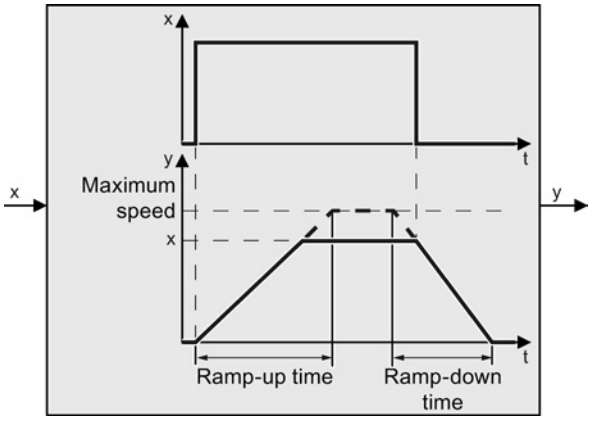


Table 8- 20 Parameters for setting the ramp-function generator

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

Changing the ramp-up and ramp-down times in operation

The ramping up and down time of the ramp-function generator can be changed during operation. The scaling value can come e.g. from the field bus.

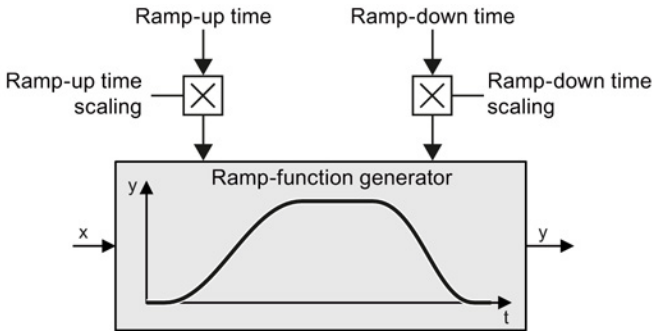


Table 8- 21 Parameters for setting the scaling

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

Example

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

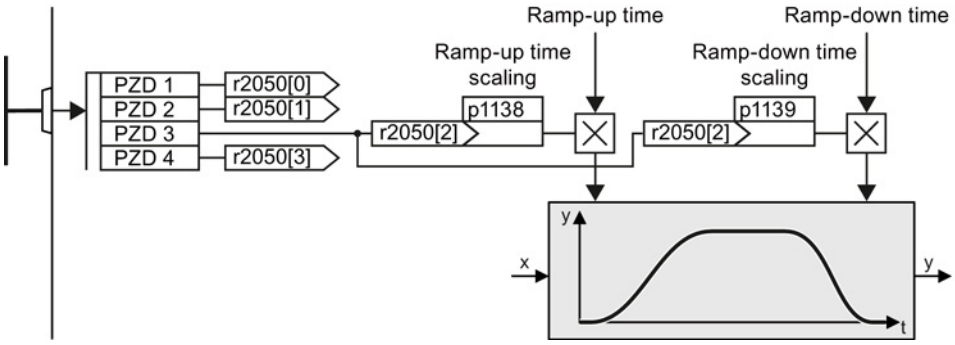


Figure 8-21 Example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system. See also Section: Extend telegrams and change signal interconnection (Page 131).
- The controller sends the scaling value to the inverter in PZD 3.

Procedure

1 2 To interconnect the scaling of the ramp-up and ramp-down times with PZD receive word 3 from the fieldbus in the inverter, proceed as follows:

1. Set p1138 = 2050[2].

   This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 3.

2. Set p1139 = 2050[2].

   This means that you have interconnected the scaling factor for the ramp-down time with PZD receive word 3.

The inverter receives the value for scaling the ramp-up and ramp-down times via PZD receive word 3.

8.5 Motor control



Decision-making criteria for the control mode that is suitable for your application is provided in Section Selecting the control mode (Page 85)

8.5.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

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

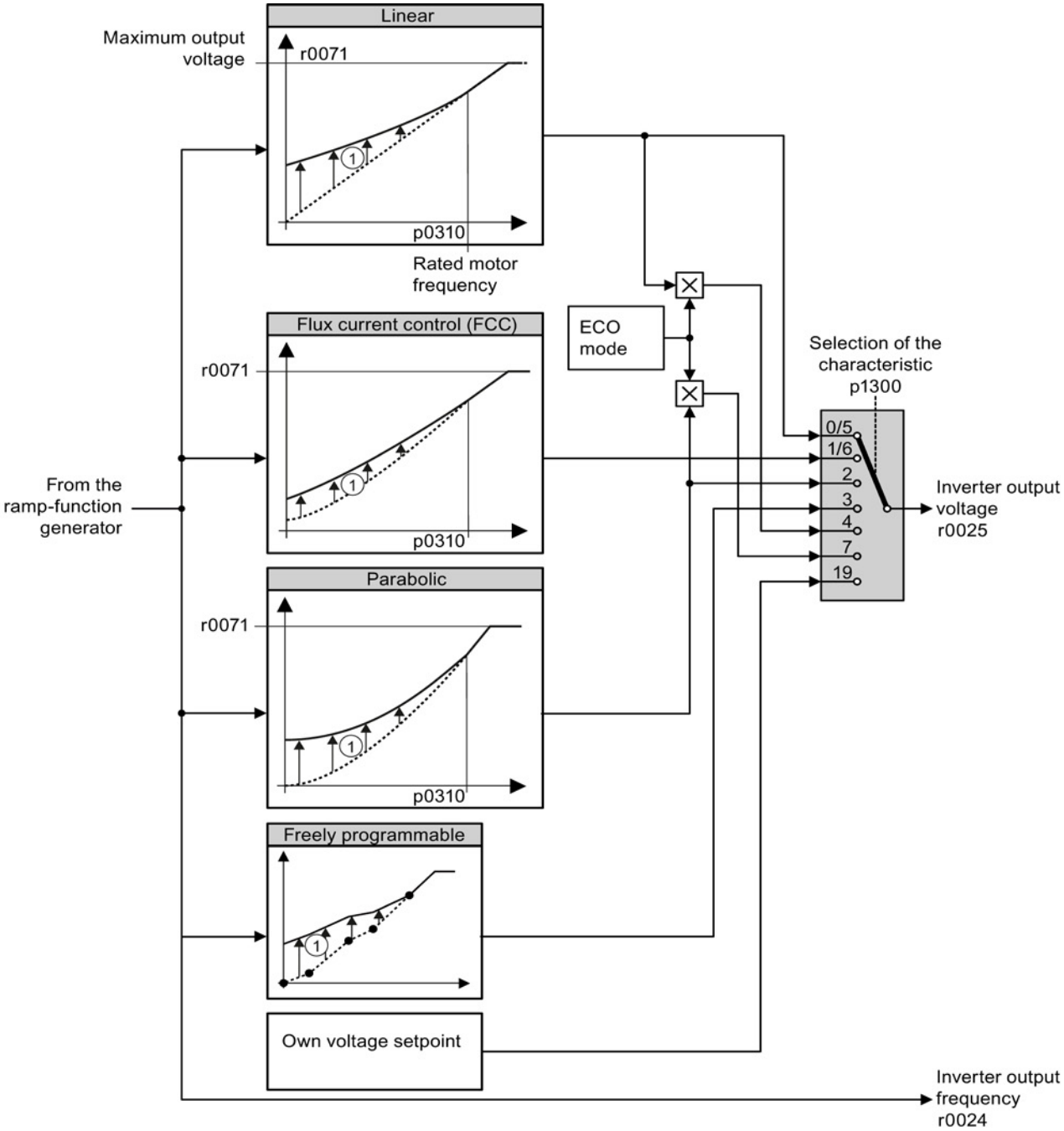
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

8.5.1.1 Characteristics of U/f control

The converter has several U/f characteristics. Based on the characteristic, as the frequency increases, the converter increases the voltage at the motor.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective for frequencies < rated frequency

Figure 8-22 U/f characteristics of the converter

The converter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum converter output voltage.

If the converter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the output voltage at the rated motor frequency also depends on the following variables:

- Ratio between the converter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible output voltage as a function of the input voltage is provided in the technical data, also see Section Technical data (Page 319).

8.5.1.2 Selecting the U/f characteristic

Table 8- 22 Linear and parabolic characteristics

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 8- 23 Characteristics for special applications

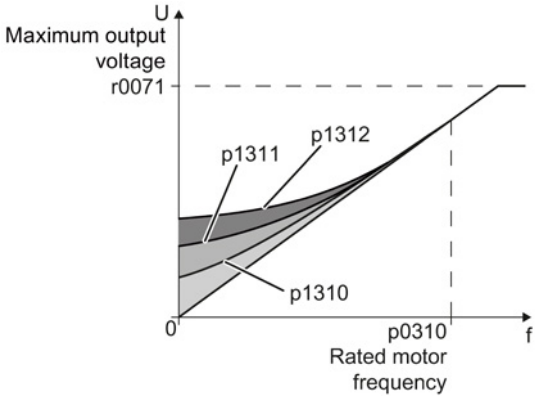
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage.	ECO mode	p1300 = 4 or p1300 = 7
The inverter must keep the motor speed constant under all circumstances.	Drives in the textile sector	When the maximum current limit is reached, the inverter only reduces the stator voltage but not the speed.	Precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	-	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

8.5.1.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.



Procedure



Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.

4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Voltage boost when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

8.5.2 Vector control

Sensorless vector control

Using a motor model, the vector control calculates the load and the motor slip. As a result of this calculation, the converter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Vector control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

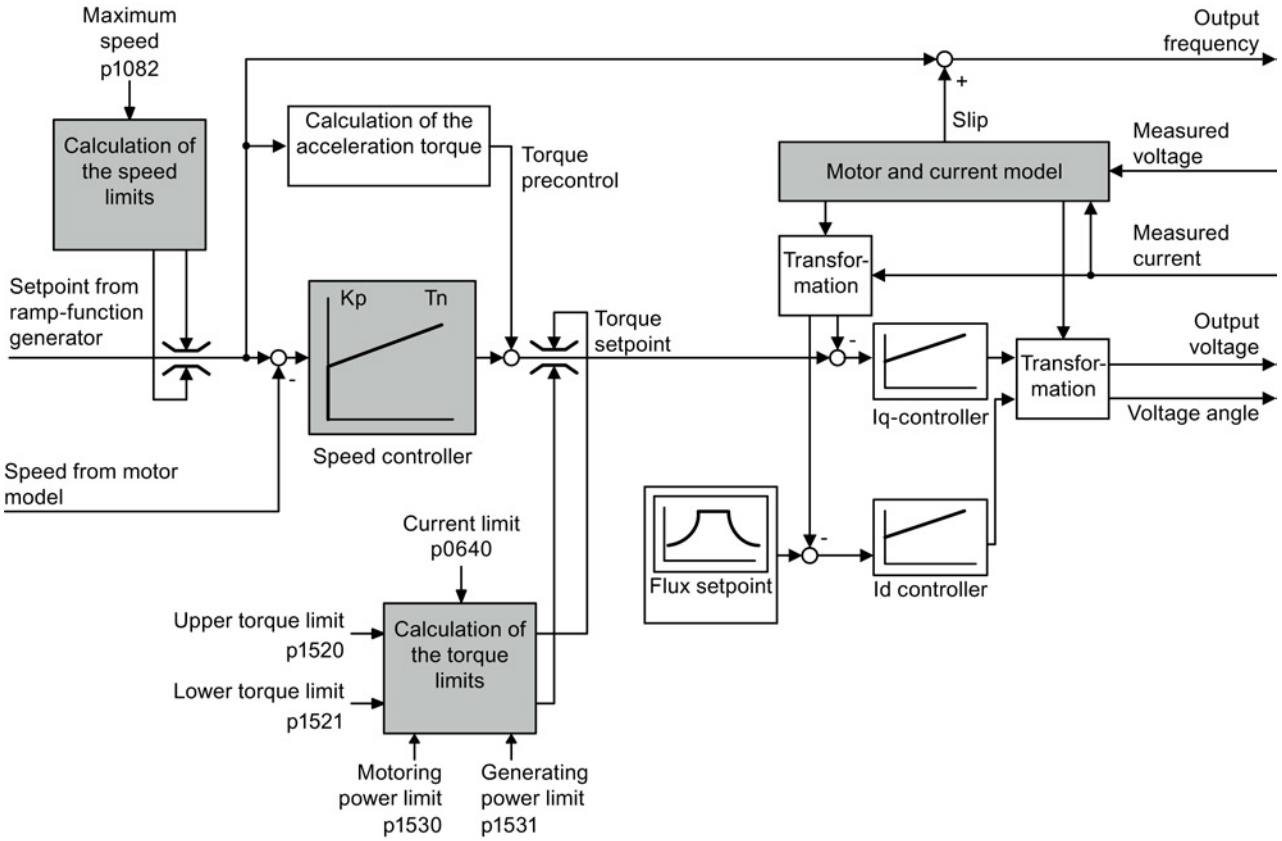


Figure 8-23 Simplified function diagram of sensorless vector control

You can find additional information on the vector control in the List Manual in function diagrams 6020 ff.

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. 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

Vector control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected vector control as control mode in the basic commissioning, you will have already set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement). If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Set p1300 = 20.

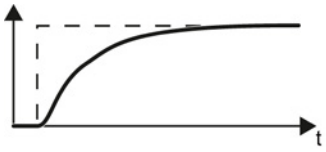
Select vector control with encoder

Set p1300 = 21.

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 section for STARTER and the operator panel.

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

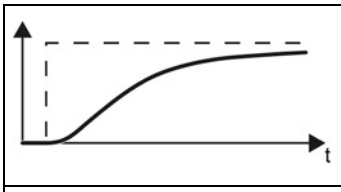
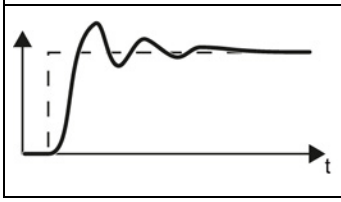
Optimizing the speed controller

Procedure



To optimize the speed controller, proceed as follows:

1. Temporarily set the times of the ramp-function generator p1120 = 0 and p1121 = 0.
2. Temporarily set the pre-control of the speed controller p1496 = 0.
3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.
4. Optimize the controller by adjusting the controller parameters K_P and T_N.

	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**The actual value quickly approaches the setpoint, but overshoots too much.** • Decrease the proportional component K_P and increase the integration time T_N.

5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.
6. Set the pre-control of the closed-loop speed controller to p1496 = 100%.

You have optimized the speed controller.

8.5.2.4 Advanced settings

K_p- and T_n adaptation

The K_p- and T_n adaptation suppresses possible speed controller oscillations. During basic commissioning, the inverter optimizes the speed controller 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.

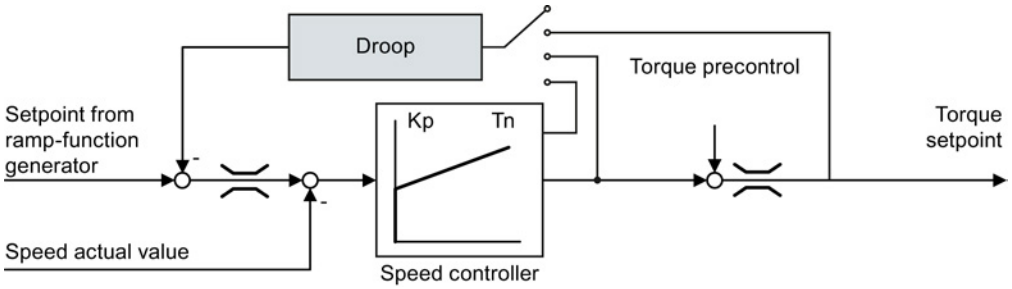


Figure 8-24 Effect of droop in the speed controller

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, 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) 0: Droop feedback not connected 1: Droop from the torque setpoint 2: Droop from the speed control output 3: Droop from the integral output, speed controller
p1489	**Droop feedback scaling** (factory setting: 0,05) 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 90).

Table 8- 24 The most important torque control parameters

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

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

8.6 Protection and monitoring functions



The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter as well as the motor. Further, the frequency inverter protects itself against an excessively high DC link voltage when the motor is regenerating.

8.6.1 Inverter temperature monitoring

The inverter temperature is essentially defined by the following effects:

- The ambient temperature
- The ohmic losses increasing with the output current
- Switching losses increasing with the pulse frequency

Monitoring types

The inverter monitors its temperature using the following monitoring types:

- I^2t monitoring (alarm A07805, fault F30005)

  The I^2t monitoring calculates the inverter utilization on the basis of a current reference value predefined by the factory.

  – Actual current > reference value: The actual value of the utilization increases.

  – Actual current < reference value: The actual value of the utilization decreases or remains = 0.
- Measuring the chip temperature of the Power Module (alarm A05006, fault F30024)
- Measuring the heat sink temperature of the Power Module (alarm A05000, fault F30004)

Inverter response to thermal overload

Parameter	Description
r0036	**Power unit overload I^2t** [%]
r0037	**Power unit temperatures** [°C]
p0290	**Power unit overload response** Factory setting and the ability to be changed depends on the hardware. The dependency is described in the List Manual. A thermal overload is present if the inverter temperature is greater than that specified in p0292. You define how the inverter responds if there is a risk of thermal overload using this parameter. The details are described below.
p0292	**Power unit temperature warning threshold** (factory setting: Heat sink [0] 5 °C, power semiconductor [1] 15 °C) The value is set as a difference to the shutdown temperature.
p0294	**Power unit warning at I2t overload** (factory setting: 95 %)

Overload response for p0290 = 0

The inverter responds depending on the control mode that has been set:

- In vector control, the inverter reduces the output current.
- In U/f control, the inverter reduces the speed.

Once the overload condition has been removed, the inverter re-enables the output current or speed.

If the measure cannot prevent an inverter thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 1

The inverter immediately switches off the motor with fault F30024.

Overload response for p0290 = 2

We recommend this setting for drives with square-law torque characteristic, e.g. fans.

The inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter reduces its pulse frequency starting at p1800.

   In spite of the temporarily reduced pulse frequency, the base load output current remains unchanged at the value that is assigned to p1800.

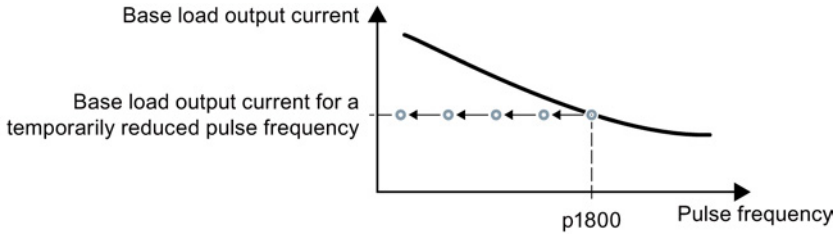


   Figure 8-25 Derating characteristic and base load output current for overload

   Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

2. If it is not possible to temporarily reduce the pulse frequency, or the risk of thermal overload cannot be prevented, then stage 2 follows:
   - In vector control, the inverter reduces its output current.
   - In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 3

If you operate the inverter with increased pulse frequency, then the inverter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

In spite of the temporarily reduced pulse frequency, the maximum output current remains unchanged at the value that is assigned to the pulse frequency setpoint. Also see p0290 = 2.

Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

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

Overload response for p0290 = 12

The inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter reduces its pulse frequency starting at p1800.

   There is no current derating as a result of the higher pulse frequency setpoint.

   Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

2. If it is not possible to temporarily reduce the pulse frequency, or the risk of inverter thermal overload cannot be prevented, then stage 2 follows:

   – In vector control, the inverter reduces the output current.

   – In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 13

We recommend this setting for drives with high starting torque, e.g. horizontal conveyors or extruders.

If you operate the inverter with increased pulse frequency, then the inverter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

There is no current derating as a result of the higher pulse frequency setpoint.

Once the overload condition has been removed, the inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

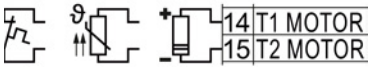
If it is not possible to temporarily reduce the pulse frequency, or the measure cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

8.6.2 Motor temperature monitoring using a temperature sensor

Connecting the temperature sensor

It is permissible to use one of the following sensors to protect the motor against overtemperature:

- Temperature switch (e.g. bimetallic switch)
- PTC sensor
- KTY84 sensor



Connect the temperature sensor of the motor to terminals 14 and 15 of the inverter.

Temperature switch



The converter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

PTC sensor



The converter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The converter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the converter shuts down with fault F07016.

KTY84 sensor

NOTICE
Motor overheating due to incorrectly connected KTY sensor If a KTY sensor is connected with incorrect polarity, the motor can become damaged due to overheating, as the converter cannot detect a motor overtemperature condition. • Connect the KTY sensor with the correct polarity.



Using a KTY sensor, the converter monitors the motor temperature and the sensor itself for wire-break or short-circuit:

- Temperature monitoring:
  The converter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The converter switches off with fault in the following cases:
    - motor temperature > p0605
    - motor temperature > p0604 and p0610 ≠ 0

- Sensor monitoring (A07015 or F07016):
  - Wire-break:
    The converter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.
  - Short-circuit:
    The converter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Natural cooling - with fan on the motor shaft (factory setting) 1: Forced ventilation - with a separately driven fan 2: Liquid cooling 128: No fan
p0601	**Motor-temperature sensor type** 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130° C)
p0605	**Motor temperature fault threshold** (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	**Motor overtemperature response** (factory setting: 12) Determines the behavior as soon as the motor temperature reaches the warning threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); the converter reduces the current limit and starts the timer. Shutdown with fault (F07011). 2: Alarm (A07910); the converter starts the timer. Shutdown with fault (F07011). 12: As for 2, but the converter considers the last shutdown temperature to calculate the motor temperature.
p0640	**Current limit** (input in A)

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

8.6.3 Protecting the motor by calculating the motor temperature

The converter calculates the motor temperature based on a thermal motor model. Use the parameters below to set further variables for the temperature calculation of the motor.

Table 8- 25 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description
p0601	**Motor temperature sensor type** (factory setting: 0) 0: No sensor

Parameter	Description	
p0604	**Mot_temp_mod 2/KTY Warning threshold** (factory setting: 130 °C) Threshold for monitoring the motor temperature.. After exceeding the threshold, the converter reports fault F07011.	
p0605	**Mot_temp_mod 1/2 Threshold** (factory setting: 145 °C) Timer for monitoring the motor temperature in motortemperature model 2.. The converter starts the timer when the temperature warning threshold is exceeded (p0604).	
p0610	**Motor overtemperature response** (factory setting: 12) Determines the behavior as soon as the motor temperature reaches the warning threshold p0604.	
	0:	Warning (A07910), no fault.
	1:	Warning (A07910); current limit will be reduced and timer started. Shutdown with fault (F07011).
	2:	Warning (A07910); timer is started. Shutdown with fault (F07011).
	12:	As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0611	**I2t motor model thermal time constant** (factory setting: 0 s) The parameter is only effective for synchronous motors. On selecting a motor from the motor list (p0301), the converter sets up the parameter value automatically.	
p0612	**Mot_temp_mod activation**	
	.00	1 signal: Activate motor temperature model 1 (I2t) for permanently excited synchronous motors
	.01	1 signal: Activate motor temperature model 2 for asynchronous motors
	.02	1 signal: Activate motor temperature model 3 for 1FK7 encoderless synchronous motors
	.09	1 signal: Activate motor temperature model 2 expansions
p0615	**Mot_temp_mod 1 (I2t) Interference threshold** (factory setting: 180 °C) Interference threshold for monitoring the motor temperature in motortemperature model 1. After exceeding the interference threshold, the converter reports fault F07011.	
p0621	**Identification of stator resistance (Rs) when switched on again** (factory setting: 0) The converter measures the current stator resistance and from this calculates the current motor temperature as the start value of the thermal motor model.	
	0:	No Rs identification
	1:	Rs identification on first switching on the motor
	2:	Rs identification each time the motor is switched on
p0622	**Motor excitation time for Rs_ident on switching on again** The converter sets the parameter value to the corresponding result of the motor data identification.	
p0625	**Motor ambient temperature during commissioning** (factory setting: 20 °C) Motor ambient temperature given in °C at the time of motor data identification.	

More information on temperature calculation can be found in function plans 8016 and 8017 and the list manual.

8.6.4 Overcurrent protection

The vector control ensures that the motor current remains within the set torque limits.

If you use U/f control, you cannot set any torque limits. The U/f control prevents too high a motor current by influencing the output frequency and the motor voltage (I-max controller).

I_max controller

Requirements

The torque of the motor must decrease at lower speeds, which is the case, for example, with fans.

The load must not drive the motor continuously, e.g. when lowering hoisting gear.

Function

The I-max controller influences the output frequency and the motor voltage.

If the motor current reaches the current limit during acceleration, the I-max controller extends the acceleration operation.

If the load of the motor is so large during stationary operation that the motor current reaches the current limit, the I-max controller reduces the speed and the motor voltage until the motor current is in the permissible range again.

If the motor current reaches the current limit during deceleration, the I-max controller extends the deceleration operation.

Settings

You only have to change the factory settings of the I-max controller if the drive tends to oscillate when it reaches the current limit or if it is shut down due to overcurrent.

Table 8- 26 I-max controller parameters

Parameter	Description
p0305	**Rated motor current**
p0640	**Motor current limit**
p1340	**Proportional gain of the I-max controller for speed reduction**
p1341	**Integral time of the I-max controller for speed reduction**
r0056.13	**Status: I-max controller active**
r1343	**Speed output of the I-max controller** Shows the amount to which the I-max controller reduces the speed.

For more information about this function, see function diagram 6300 in the List Manual.

8.6.5 Limiting the maximum DC link voltage

How does the motor generate overvoltage?

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

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

"DC-link overvoltage".

Protecting the motor and inverter against overvoltage

The Vdc_max control can be used with the PM230, PM240, PM240-2 and PM330 Power Modules. To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Electrically braking the motor (Page 196).

There are two different groups of parameters for the Vdc_max control, depending on whether the motor is being operated with U/f control or vector control.

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**Vdc_max control Vdc monitoring configuration** (factory setting: 1) 1: Enable Vdc_max control
r1282	r1242	**Vdc_max control activation level** Shows the value of the DC-link voltage above which the Vdc_max control is active
p1283	p1243	**Vdc_max control dynamic factor** (factory setting: 100 %) Scaling control parameters p1290, p1291 and p1292
p1284	---	**Vdc_max controller time threshold** Setting for the monitoring time of the Vdc_max controller.
p1290	p1250	**Vdc_max control proportional gain** (factory setting: 1)
p1291	p1251	**Vdc_max control integral time** (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1292	p1252	**Vdc_max control rate time** (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
p1294	p1254	**Vdc_max control automatic sensing ON level** (factory setting p1294: 0, factory setting p1254: PM330/PM240 = 1, PM230 = 0) Activates or deactivates automatic detection of the switch-on levels of the Vdc_max control. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the switch-in thresholds of the Vdc_max control. Set this parameter to the actual value of the input voltage.

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

8.7 Application-specific functions



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

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

Refer to the following sections for detailed descriptions.

8.7.1 Unit changeover

Description

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

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

Specifically, you have the following options:

- Changing over the motor standard (Page 191) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 191)
- Changing over process variables for the technology controller (Page 192)

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 192).

Restrictions for the unit changeover function

- The values on the rating plate of the inverter or motor cannot be displayed as percentage values.
- Using the unit changeover function several times (for example, percent → physical unit 1 → physical unit 2 → percent) may lead to the original value being changed by one decimal place as a result of rounding errors.
- If the unit is changed over into percent and the reference value is then changed, the percentage values relate to the new reference value.
  Example:
  - For a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a speed of 1200 rpm.
  - If the reference speed is changed to 3000 rpm, then the value of 80% is kept and now means 2400 rpm.

Reference variables for unit changeover

p2000 Reference frequency/speed

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

p2005 Reference angle

p2006 Reference temperature

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- 27 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm^2	lb ft^2	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm^2	lb ft^2	kgm^2

*) Factory setting

8.7.1.2 Changing over the unit system

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

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

Note

Special features

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

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

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

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

8.7.1.3 Changing over process variables for the technology controller

Note

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

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

Changing over process variables of the technology controller

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

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

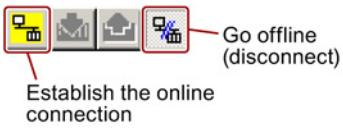
8.7.1.4 Switching units with STARTER

Precondition

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

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

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

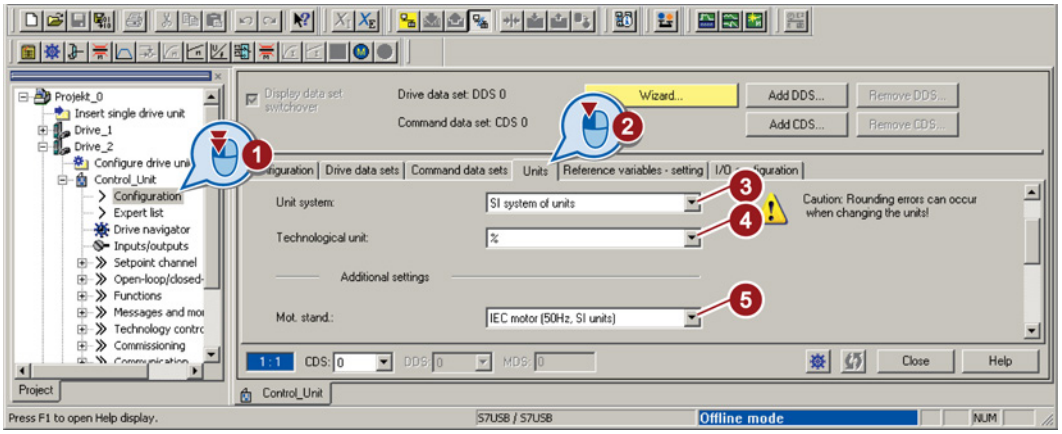


Procedure

1
2

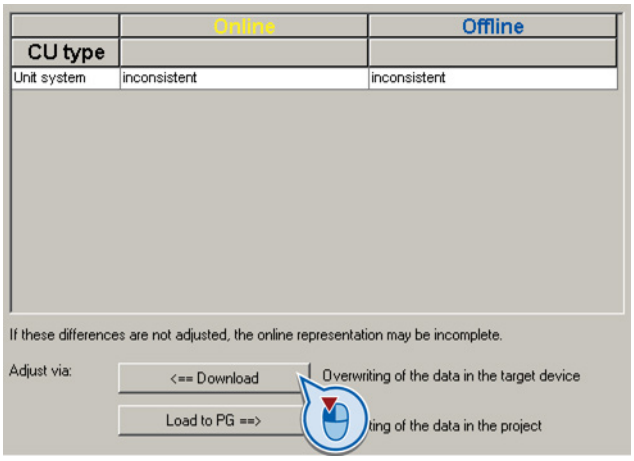
To change over the units with STARTER, proceed as follows:

1. Select the configuration
2. Go to the "Units" tab in the configuration screen form to change over the units
3. Changing over the system of units
4. Select process variables of the technology controller
5. Adapting to the line supply



6. Save your settings.
7. Go online.

   The inverter signals that offline, other units and process variables are set than in the inverter itself.
8. Accept these settings in the inverter.



You have changed over the units.

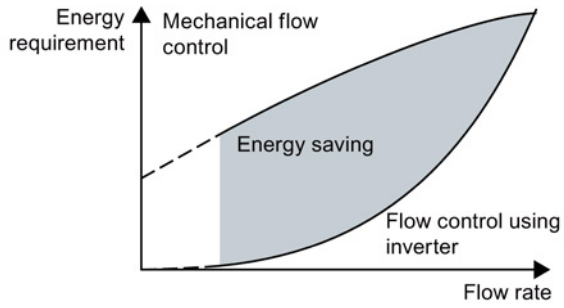
8.7.2 Calculating the energy saving

Background

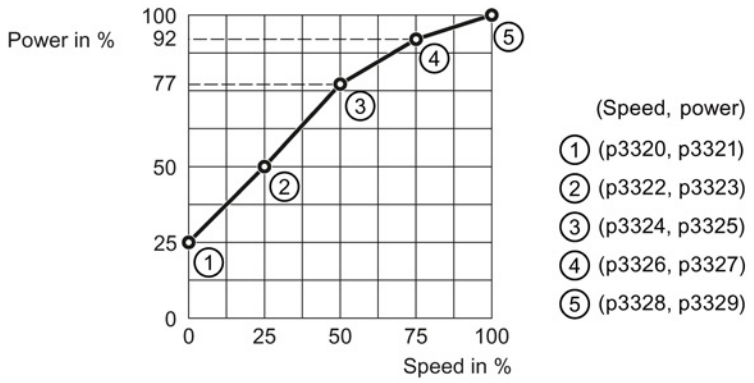
Fluid flow machines, which are used to control the flow rate using valves or throttles, run continuously at their rated speed. The lower the flow rate, the lower the system efficiency. The efficiency is the lowest when valves or throttles are completely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

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

Function



The inverter calculates the energy saving of flow control using the inverter compared to mechanical flow control based on the flow characteristics saved. The calculation is suitable for fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors.

Parameter	Description
p3320 … p3329	**Flow characteristic**  Factory setting of the flow characteristic

Parameter	Description	
r0039	**Energy display** (kWh)	
	[0]	**Energy balance** Energy usage since the last reset
	[1]	Energy drawn since the last reset
	[2]	Energy fed back since the last reset
p0040	**Reset energy consumption display** A signal change 0 → 1 sets r0039[0…2] = 0 and r0041 = 0.	
r0041	**Energy consumption saved** (kWh) Energy saved referred to 100 operating hours. For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.	

Adapting the flow characteristic

Precondition

You require the following data to calculate the system-specific flow characteristic:

- Flow characteristics of the system manufacturer
- System characteristics for 5 different flow rates

Procedure



Proceed as follows to adapt the operating characteristic:

1. For a drive connected directly to the line supply, calculate the corresponding speeds required for 5 different flow rates.
2. Based on the flow characteristic of the system, calculate the power that the drive requires for the different flow rates.
3. Enter the values into the characteristic.



You have adapted the flow characteristic, and you now obtain a precise result for the energy saving.

8.7.3 Electrically braking the motor

Regenerative power

If a motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it works as a generator. The motor converts mechanical power by generating electrical power.

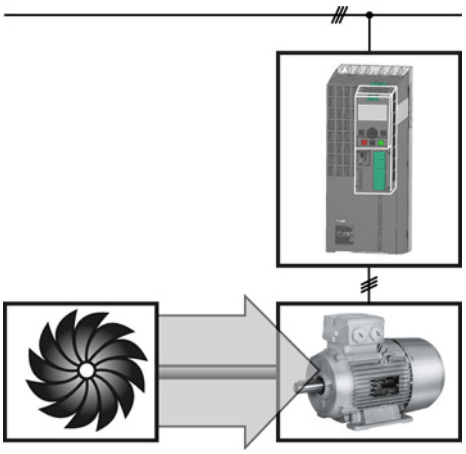
When the motor operates as a generator, it attempts to transfer the power generated to the inverter.

Main features of the braking functions

DC braking

DC braking prevents the motor operating as generator. The inverter impresses a DC current in the motor. The DC current brakes the motor. The motor converts the mechanical power of the load into heat.

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



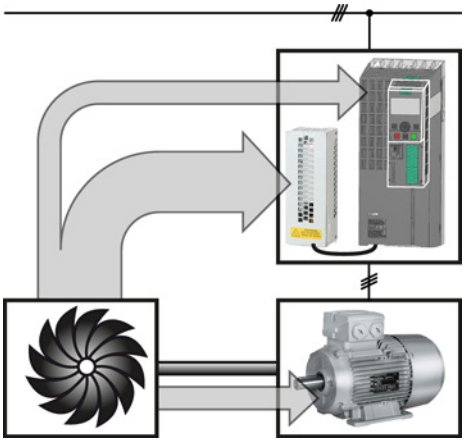
Compound braking

One version of DC braking. The inverter brakes the motor with a defined ramp-down time and superimposes a DC current on the output current.

Dynamic braking

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

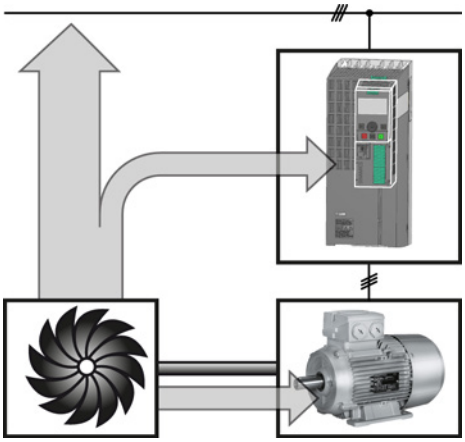
- *Advantages:* defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* braking resistor required; regenerative power is dissipated as heat



Braking with regenerative feedback into the line supply

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

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



What braking method is suitable for what application?

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

8.7.3.1 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Function

NOTICE

Motor damage caused by overheating

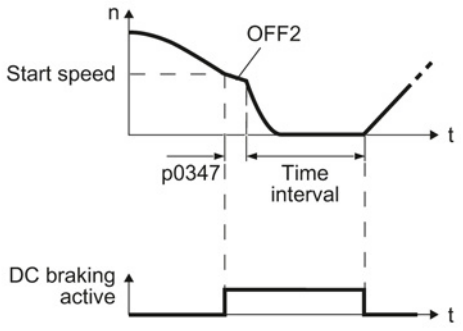
The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor.

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

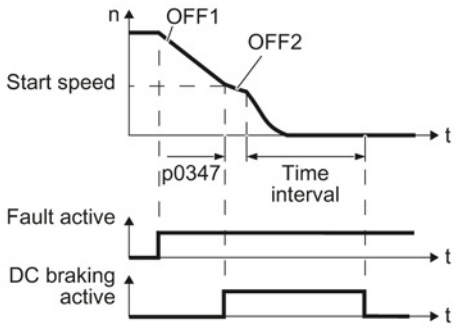
With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

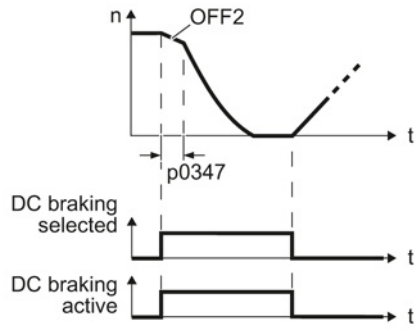
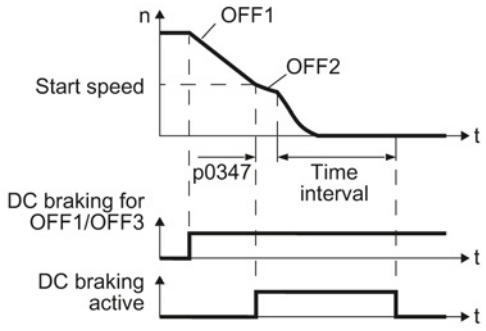
The DC-braking function is possible only for induction motors.

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



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



DC braking initiated using a control command Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)	DC braking when switching off the motor Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14
	

DC braking when falling below a starting speed

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

DC braking when a fault occurs

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

DC braking initiated by a control command

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

DC braking when the motor is switched off

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

Settings for DC braking

Parameter	Description
p0347	**Motor de-excitation time** (calculated after the basic commissioning) The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.
p1230	**DC braking activation** (factory setting: 0) Signal source to activate DC braking • 0 signal: Deactivated • 1 signal: Active
p1231	**Configuring DC braking** (factory setting: 0)
	0 No DC braking 4 General release for DC braking 5 DC braking for OFF1/OFF3 14 DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)
p1233	**DC braking duration** (factory setting 1 s)
p1234	**DC braking start speed** (factory setting 210000 rpm)
r1239	**DC braking status word**
	.08 DC braking active .10 DC braking ready .11 DC braking selected .12 DC braking selection internally locked .13 DC braking for OFF1/OFF3

Table 8- 28 Configuring DC braking when faults occur

Parameter	Description
p2100	**Set fault number for fault response** (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	**Fault response setting** (factory setting 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response. The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault.	

8.7.3.2 Compound braking

Typical applications for compound braking include:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

For these applications, the motor is normally operated with a constant speed, and is only braked down to standstill after longer periods of time.

Principle of operation

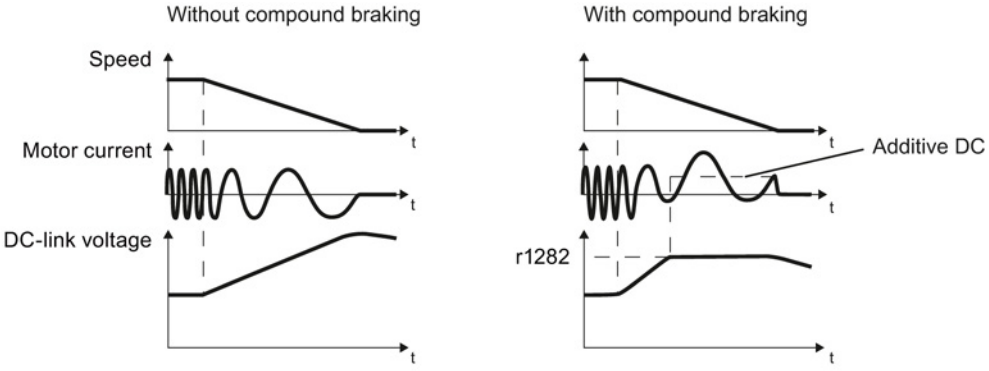


Figure 8-26 Motor brakes with and without active compound braking

Compound braking prevents the DC-link voltage increasing above a critical value. The inverter activates compound braking depending on the DC-link voltage. Above a DC-link voltage threshold (r1282), the inverter adds a DC current to the motor current. The DC current brakes the motor and prevents an excessive increase in the DC-link voltage.

Note

Compound braking is possible only with the U/f control.

Compound braking does not operate in the following cases:

- The "flying restart" function is active
- DC braking is active
- Vector control is selected

Setting and enabling compound braking

Parameter	Description
p3856	**Compound braking current (%)** With the compound braking current, the magnitude of the DC current is defined, which is additionally generated when stopping the motor for operation with U/f control to increase the braking effect. p3856 = 0 Compound braking locked p3856 = 1 … 250 Current level of the DC braking current as a % of the rated motor current (p0305) Recommendation: p3856 < 100% × (r0209 - r0331) / p0305 / 2
r3859.0	**Compound-braking status word** r3859.0 = 1: Compound braking is active

NOTICE
Motor damage from overheating with compound braking The motor will overheat if braking lasts too long or the motor is braked too often. This may damage the motor. Monitor the motor temperature. If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

8.7.3.3 Dynamic braking

Typical applications for dynamic braking include:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

For these applications, dynamic motor behavior with different speeds or continuous change of direction is required.

Principle of operation



⚠ CAUTION

Burns when touching a hot braking resistor

A braking resistor reaches high temperatures during operation. Touching the braking resistor may result in burns.

- Do not touch a braking resistor during operation.

The inverter controls the braking chopper depending on its DC-link voltage. The DC-link voltage increases as soon as the inverter absorbs the regenerative power when braking the motor. The braking chopper converts this power into heat in the braking resistor. This prevents the DC-link voltage from increasing above the limit value $U_{DC\ link,\ max}$.

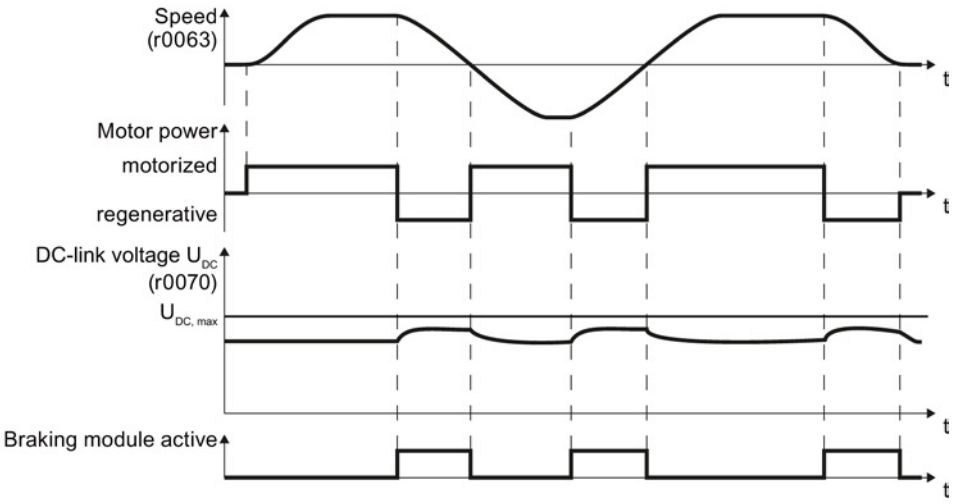


Figure 8-27 Simplified representation of dynamic braking with respect to time

Procedure: Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 8- 29 Parameter

Parameter	Description	
p0219	**Braking power of the braking resistor** (factory setting: 0 kW) Set the maximum braking power that the braking resistor must handle in your particular application. Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor. **Example**: In your particular application, the motor brakes every 10 seconds. In so doing, the braking resistor must handle a braking power of 1 kW for 2 s. Use a braking resistor with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the maximum braking power to: p0219 = 1 (kW).	
p0844	**No coast down/coast down (OFF2) signal source 1**	
	p0844 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the inverter.

8.7.3.4 Braking with regenerative feedback to the line

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

- Hoist drives
- Centrifuges
- Unwinders

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

The inverter can feed back up to 100% of its power into the line supply (referred to "High Overload" base load, see Section Technical data, PM250 (Page 339)).

Setting the braking with regenerative feedback to the line

Parameter	Description
Limiting the regenerative feedback for U/f control (p1300 < 20)	
p0640	**Motor series overload factor** (factory setting: 0.00 A, default for basic commissioning) It is only possible to limit the regenerative power with V/f control by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault F07806.
Limiting feedback with vector control (p1300 ≥ 20)	
p1531	**Regenerative power limit** (factory setting: 0.01 kW)

8.7.4 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The converter has internal logic to optimally control a motor holding brake.

Function after OFF1 and OFF3 command

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

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

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

  If the actual speed falls below the threshold p1226, the inverter starts the time p1228.
- As soon as the first of the two times (p1227 or p1228) has elapsed, the inverter issues the command to close the brake.

  The motor comes to a standstill but remains switched on.
- After the brake closing time p1217, the inverter switches off the motor.
  The motor holding brake must close within this time.

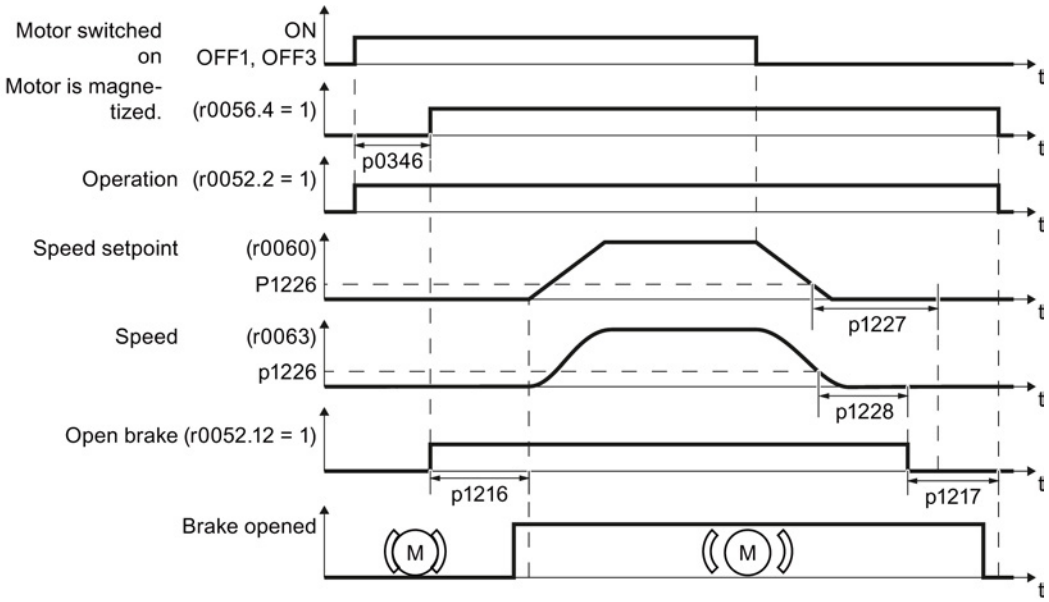


Figure 8-28 Controlling the motor holding brake when the motor is switched on and off

Function after OFF2

The brake closing time is not taken into account after an OFF2 command:

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

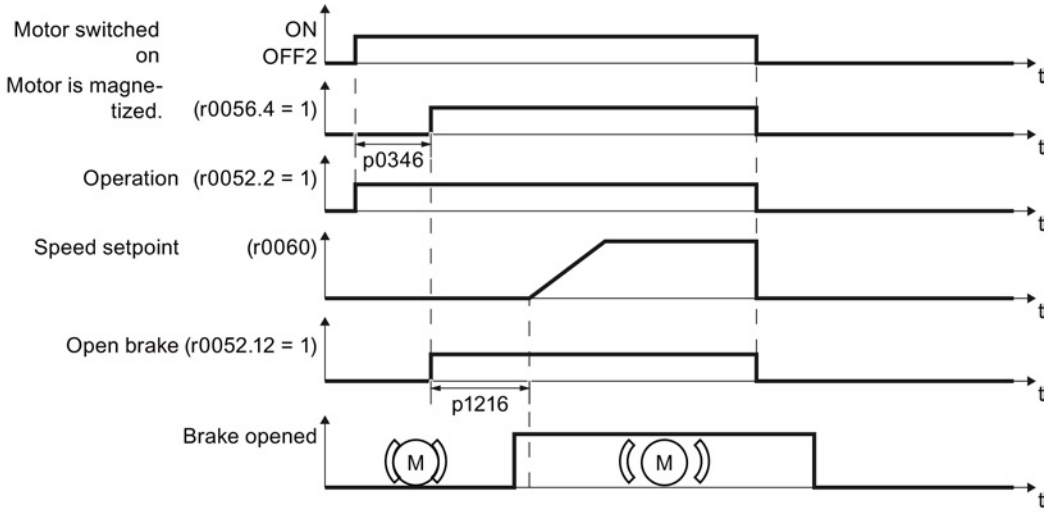


Figure 8-29 Controlling the motor holding brake after OFF2

Commissioning a motor holding brake



DANGER

Danger to life due to falling loads

For applications such as lifting equipment, cranes or elevators, there is a danger to life if the "Motor holding brake" function is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any dangerous loads, e.g. by applying the following measures:
  - Lower the load down to the floor
  - Cordon off the hazardous area so that nobody can enter it

Precondition

The motor holding brake is connected to the inverter.

Procedure

Proceed as follows to commission the "Motor holding brake" function using an operator panel.



1. Set p1215 = 1.

   The "Motor holding brake" function" is enabled.
2. Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero.
3. Take the opening and closing times of the connected brake from the technical data for the motor holding brake.
   - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
   - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
4. Set the following parameters in the inverter to match the opening and closing times of the brake:
   - Opening time ≤ p1216.
   - Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   - If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.

     In this case, increase the opening time p1216.
   - After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   - U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   - Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   - If the brake closes too late, the load briefly sags before the brake closes.

     In this case, increase the closing time p1217.
   - After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.



You have commissioned the "Motor holding brake" function.

Table 8- 30 Setting the control logic of the motor holding brake

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

Table 8- 31 Advanced settings

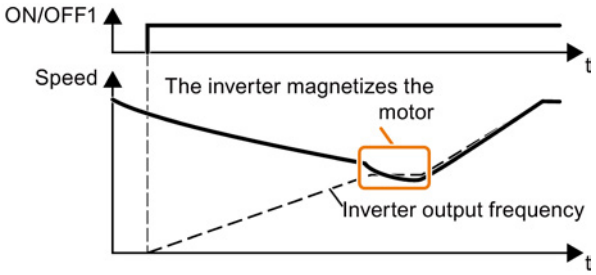
Parameter	Description
p0346	**Magnetizing time** (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.
p0855	**Open motor holding brake (imperative)** (factory setting 0)
p0858	**Close motor holding brake (imperative)** (factory setting 0)
p1226	**Stationary state detection speed threshold** (factory setting 20 rpm) When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started
p1227	**Stationary state detection monitoring time** (factory setting 300 s)
p1228	**Pulse deletion delay time** (factory setting 0.01 s)
p1351	**Starting frequency, motor holding brake** (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.
p1352	**Starting frequency for motor holding brake** (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	**Speed controller torque set value for motor holding brake** (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

8.7.5 Flying restart – switching on while the motor is running

If you switch on the motor while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (overcurrent fault F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

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

After the ON command, the "flying restart" function initially synchronizes the converter output frequency to the motor speed and then accelerates the motor up to the setpoint.



If the converter simultaneously drives several motors, then you must only use the "flying restart" function if the speed of all of the motors is always the same (group drive with a mechanical coupling).

Table 8- 32 Basic setting

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

Table 8- 33 Advanced settings

Parameter	Description
p1201	**Flying restart enable signal source** (factory setting 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
p1202	**Flying restart search current** (factory setting 100%) Defines the search current with respect to the motor magnetizing current (r0331), which flows in the motor while the flying restart function is being used.
p1203	**Flying restart search speed factor** (factory setting 100%) The value influences the speed with which the output frequency is changed during the flying restart. A higher value results in a longer search time. If the converter does not find the motor, reduce the search speed (increase p1203).

8.7.6 Automatic switch-on

The automatic restart includes two different functions:

- The inverter automatically acknowledges faults.
- After a fault occurs or after a power failure, the inverter automatically switches-on the motor again.

The inverter interprets the following events as power failure:

- The inverter signals fault F30003 (DC-link undervoltage), as the line supply voltage of the inverter has briefly failed.
- The inverter power supply has failed for a long enough time so that the inverter has been switched-off.

⚠WARNING

Injuries from the automated machine restart

When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. The movements that the machine executes may result in serious injuries.

- Block the machine to prevent unintentional access.
- Before working on the machine switch the automatic restart mechanism off.

Setting the automatic restart function

If it is possible that the motor is still rotating for a longer period of time after a power failure or after a fault, then in addition, you must activate the "flying restart" function, see Flying restart – switching on while the motor is running (Page 209).

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

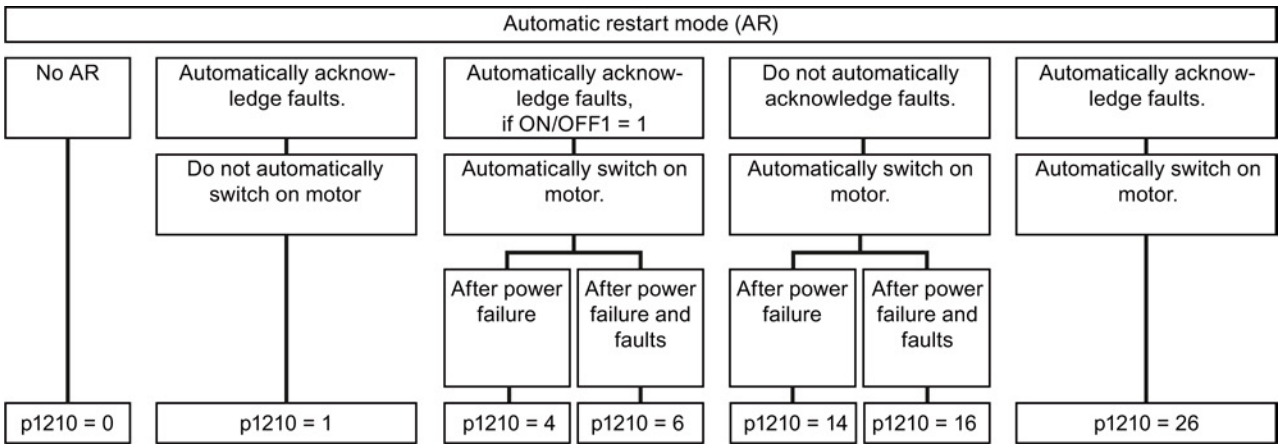
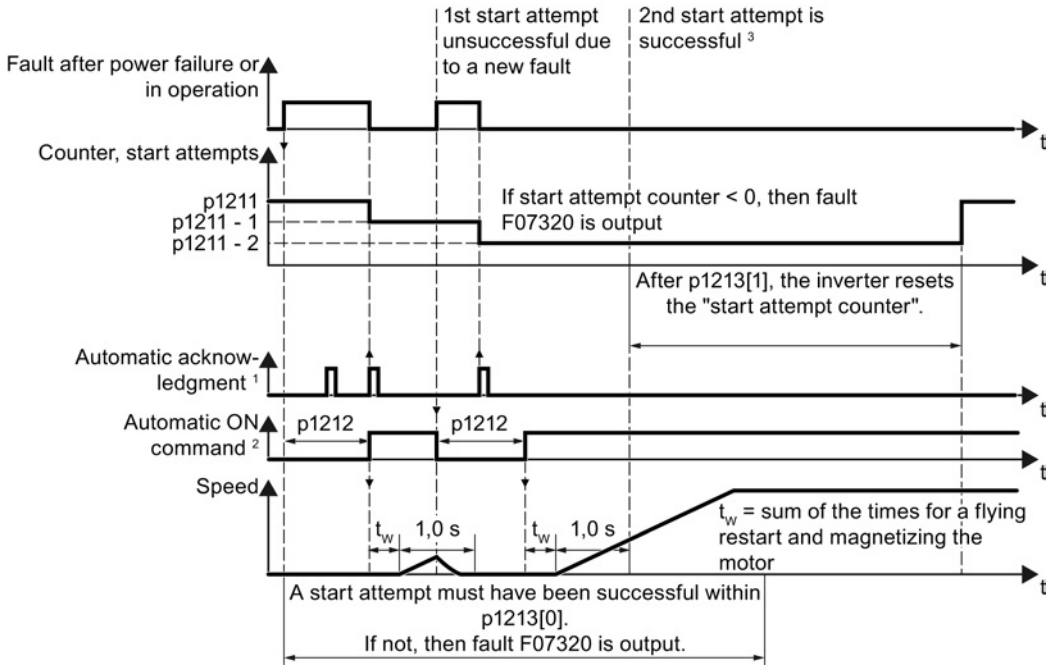


Figure 8-30 Automatic restart modes

The principle of operation of the other parameters is explained in the following diagram and in the table below.



1) The inverter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: Always.
- p1210 = 4 or 6: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).
- p1210 = 14 or 16: Never.

2) The inverter attempts to automatically switch the motor on under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).

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

Figure 8-31 Time response of the automatic restart

Parameter for setting the automatic restart

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

Parameter	Explanation
p1211	**Automatic restart start attempts** (factory setting: 3) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. You define the maximum number of start attempts using p1211. After each successful acknowledgement, the inverter decrements its internal counter of start attempts by 1. For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts. The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled: • After a successful start attempt, the time in p1213[1] has expired. • After fault F07320, switch off the motor (OFF1) and acknowledge the fault. • You change the start value p1211 or the mode p1210.
p1212	**Automatic restart wait time start attempt** (factory setting: 1.0 s) This parameter is only effective for the settings p1210 = 4, 6, 26. Examples for setting this parameter: 1. After a power failure, a certain time must elapse before the motor can be switched-on, e.g. because other machine components are not immediately ready. In this case, set p1212 longer than the time, after which all of the fault causes have been removed. 2. In operation, the inverter develops a fault condition. The lower you select p1212, then the sooner the inverter attempts to switch-on the motor again.
p1213[0]	**Automatic restart monitoring time for restart** (factory setting: 60 s) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. With this monitoring function, you limit the time in which the inverter may attempt to automatically switch-on the motor again. The monitoring function starts when a fault is identified and ends with a successful start attempt. If the motor has not successfully started after the monitoring time has expired, fault F07320 is signaled. Set the monitoring time longer than the sum of the following times: + p1212 + Time that the inverter requires to start the motor on the fly. + Motor magnetizing time (p0346) + 1 second You deactivate the monitoring function with p1213 = 0.
p1213[1]	**Automatic restart monitoring time to reset the fault counter** (factory setting: 0 s) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time. The monitoring function starts with a successful start attempt and ends after the monitoring time has expired. If the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch on the motor again, you must acknowledge the fault and set ON/OFF1 = 1.

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

Advanced settings

If you with to suppress the automatic restart function for certain faults, then you must enter the appropriate fault numbers in p1206[0 … 9].

Example: p1206[0] = 07331 ⇒ No restart for fault F07331.

Suppressing the automatic restart only functions for the setting p1210 = 6, 16 or 26.

⚠WARNING

Injury and property damage

In the case of communication via the fieldbus interface, the motor restarts with the setting p1210 = 6, 16, 26 even if the communication link is interrupted. This means that the control cannot stop the motor. To avoid this dangerous situation, you must enter the fault code of the communications fault in parameter p1206.

Example: A communication failure via PROFIBUS is signaled using fault code F01910. You should therefore set p1206[n] = 1910 (n = 0 … 9).

8.7.7 Kinetic buffering (Vdc min control)

Kinetic buffering increases the drive availability. The kinetic buffering utilizes the kinetic energy of the load to buffer line dips and failures. During a line dip, the inverter keeps the motor in the switched-on state for as long as possible. One second is a typical, maximum buffer time.

Preconditions

The following prerequisites must be fulfilled to practically use the "kinetic buffering" function:

- The driven load has a sufficiently high inertia.
- The application allows a motor to be braked during a power failure.

Function

When the line supply dips or is interrupted, the DC link voltage in the inverter decreases. At an adjustable threshold, kinetic buffering intervenes ($V_{DC\ min}$ control). The $V_{DC\ min}$ control forces the load to go into slightly regenerative operation. As a consequence, the inverter covers its power loss and the losses in the motor with the kinetic energy of the load. The load speed decreases; however, during kinetic buffering, the DC voltage remains constant. After the line supply returns, the inverter immediately resumes normal operation.

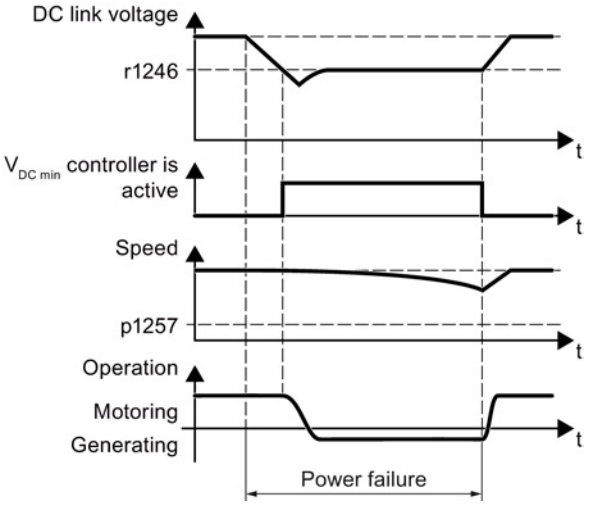


Figure 8-32 Principle mode of operation of kinetic buffering

Parameter	Description	
r0056.15	**Status word closed-loop control**	
	0 signal	$V_{DC\ min}$ controller is not active
	1 signal	$V_{DC\ min}$ controller is active (kinetic buffering)
p0210	**Device supply voltage** (factory setting: 400 V)	
p1240	V_{DC} **controller configuration** (factory setting: 1)	
	0	Inhibit V_{DC} controller
	1	Enable $V_{DC\ max}$ controller
	2	Enable $V_{DC\ min}$ controller (kinetic buffering)
	3	Enable $V_{DC\ min}$ controller and $V_{DC\ max}$ controller
p1245	$V_{DC\ min}$ **controller activation level** (kinetic buffering) (factory setting: 76 %)	
r1246	$V_{DC\ min}$ **controller activation level**[V] r1246 = p1245 × √2 × p0210	
p1247	$V_{DC\ min}$ **controller dynamic factor** (factory setting: 300 %)	
p1255	$V_{DC\ min}$ **controller time threshold** (factory setting: 0 s) Maximum duration of the kinetic buffering If kinetic buffering lasts longer than that specified in the parameter value, the inverter outputs fault F7406. A value of 0 deactivates the monitoring.	
p1257	$V_{DC\ min}$ **controller speed threshold** (factory setting: 50 rpm) When fallen below, the inverter outputs fault F7405.	

8.7.8 PID technology controller

8.7.8.1 Overview

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

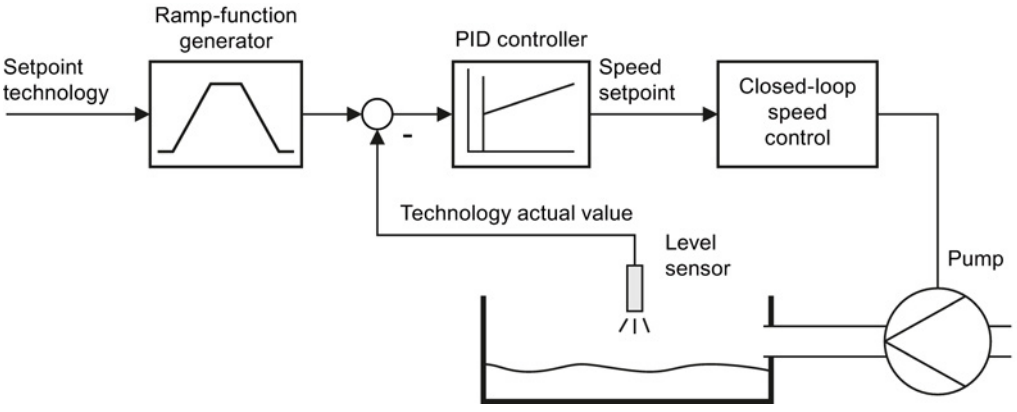


Figure 8-33 Example: Technology controller as a level controller

8.7.8.2 Setting the controller

Simplified representation of the technology controller

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

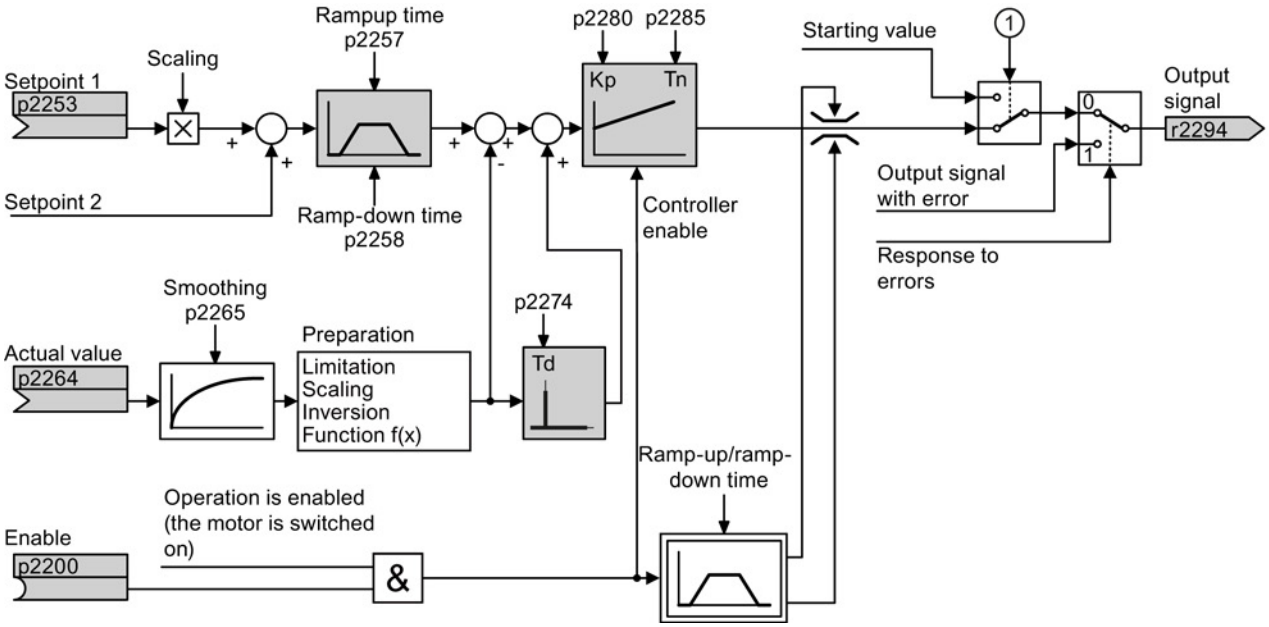


Figure 8-34 Simplified representation of the technology controller

① The inverter uses the start value if the following conditions are met simultaneously:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

Setting the technology controller

Parameter	Remark
p2200 = 1	Enable technology controller.
p1070 = 2294	Interconnect the main speed setpoint with the output of the technology controller.
p2253	Define the setpoint for the technology controller. Example: p2253 = 2224: The inverter interconnects the fixed setpoint p2201 with the setpoint of the technology controller. p2220 = 1: The fixed setpoint p2201 is selected.
p2264	Define the setpoint for the technology controller.
p2257, p2258	Define the ramp-up and ramp-down times [s]
p2274	Differentiation time constant [s] The differentiation improves the rise time characteristics for very slow controlled variables, e.g. a temperature control. p2274 = 0: The differentiation is switched off.
p2280	Proportional gain K_P
p2285	Integral time T_N [s] Without an integral time, the controller cannot completely equalize deviations between the setpoint and actual value. p2285 = 0: The integral time is switched off.

Advanced settings

Parameter	Remark
Limiting the output of the technology controller In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application. Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.	
p2297 = 2291	Interconnect the upper limit with p2291.
p2298 = 2292	Interconnect the lower limit with p2292.
p2291	Upper limit for the technology controller output e.g.: p2291 =100
p2292	Lower limit for the technology controller output e.g.: p2292 = 0
Manipulating the actual value of the technology controller	
p2267, p2268	Limit the actual value
p2269	Scale the actual value
p2271	Invert the actual value
p2270	Actual value

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

8.7.8.3 Optimizing the controller

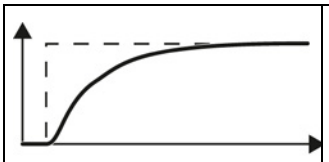
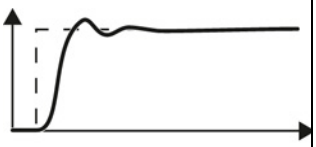
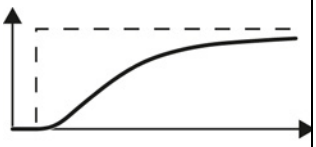
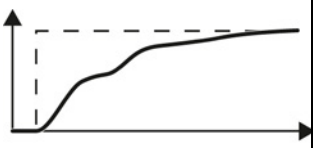
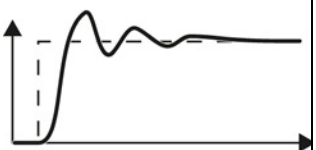
Setting the technology controller from a practical perspective

Procedure

1
2

Proceed as follows to set the technology controller:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

	**Optimum controller response for applications that do not permit any overshoot.** The actual value approaches the setpoint without any significant overshoot.
	**Optimum controller behavior for fast correction and quick compensation of disturbance components.** The actual value approaches the setpoint and slightly overshoots, maximum 10% of the setpoint step.
	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**Actual value only slowly approaches the setpoint with slight oscillation.** • Increase the proportional component K_P and reduce the rate time T_D (differentiating time).
	**The actual value quickly approaches the setpoint, but overshoots too much.** • Decrease the proportional component K_P and increase the integration time T_N.

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

You have now set the technology controller.

8.7.9 Monitoring the load torque (system protection)

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

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

Load torque monitoring functions

The inverter monitors the motor torque in different ways:

- No-load monitoring
  The inverter generates a message if the motor torque is too low.
- Blocking protection:
  The inverter generates a message if the motor speed cannot track the speed setpoint despite generating maximum torque.
- Stall protection
  The inverter generates a message if the motor stalls and no longer generates a torque.
- Speed-dependent torque monitoring
  The inverter measures the actual torque and compares it with a set speed/torque characteristic.

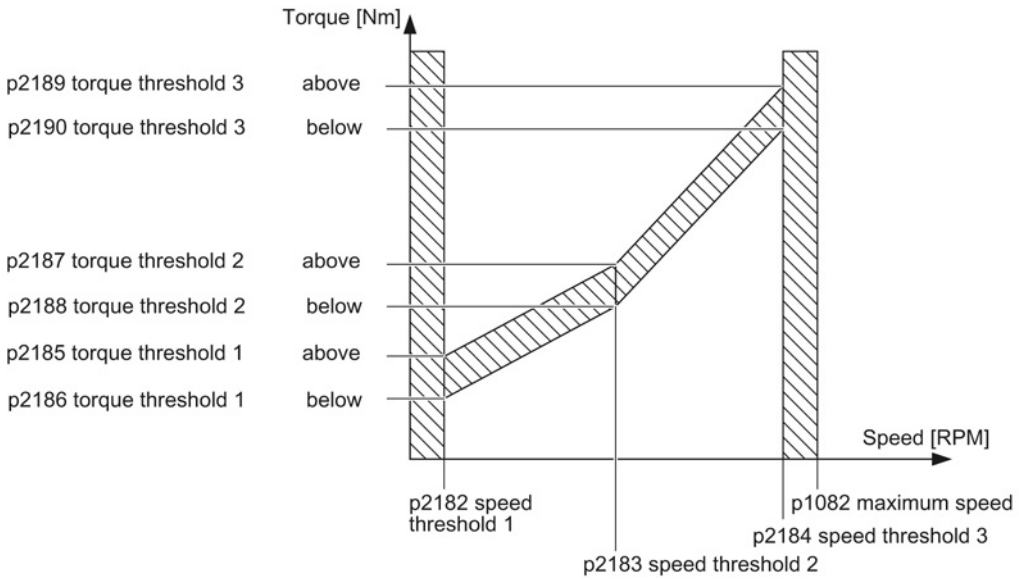


Figure 8-35 Load torque monitoring

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

Additional information about these functions is provided in the function diagrams 8012 and 8013 as well as in the parameter list of the List Manual.

8.7.10 Load failure monitoring

Load failure

Using this function, the inverter monitors the speed or velocity of a machine component. The inverter evaluates whether an encoder signal is present. If the encoder signal fails for a time that can be adjusted, then the inverter signals a fault.

Examples of how the function can be used:

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



Figure 8-36 Function plan and time response of load-interruption monitoring

Parameter	Description
p2192	**Load monitoring delay time** (factory setting 10 s) After the motor is switched on, if the "LOW" signal is present at the associated digital input for longer than this time, the inverter signals a load failure (F07936).
p2193 = 1…3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring is deactivated 1: Torque monitoring (see Monitoring the load torque (system protection) (Page 219)) and load failure 2: Speed deviation monitoring (see below) and load failure 3: Load failure monitoring
p3232 = 722.x	**Load monitoring failure detection** (factory setting: 1) Connect the load monitoring to a DI x digital input of your choice.

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

8.7.11 Speed deviation monitoring

Speed deviation

Using this function, the inverter calculates and monitors the speed or velocity of a machine component. The inverter analyzes an encoder signal, calculates a speed from the signal, compares it to the motor speed and reports any excessive deviation between the encoder signal and the motor speed.

Examples of how the function can be used:

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

You require a transmitter for this function, e.g. a proximity switch. The inverter analyzes an encoder signal at max. 32 kHz.

To use the function, you must connect the encoder to one of the digital inputs DI 24 ... DI 27 and connect the relevant digital input with the function in the inverter.

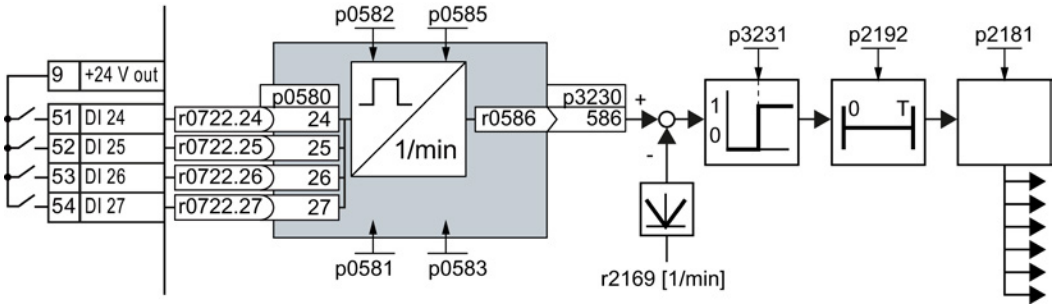


Figure 8-37 Speed deviation monitoring

When you use this monitoring function, you cannot use any of the digital inputs as setpoint source. See also: Pulse input as source of setpoint value (Page 158).

The inverter determines the speed deviation from the calculated speed r0586 and the speed list value r2169. p2181 determines the response of the inverter if the deviation is excessive.

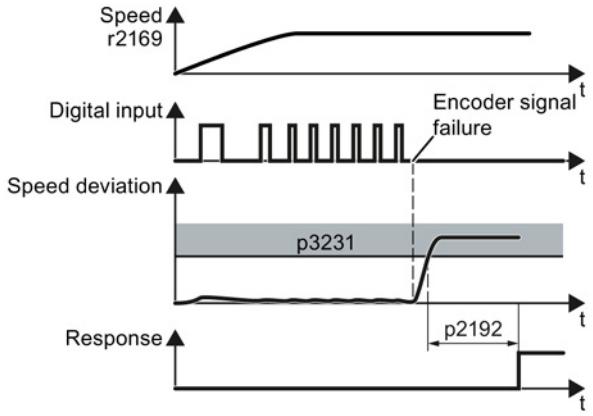


Figure 8-38 Time response of monitoring speed deviation

Parameter	Description
p0490	**Invert probe** [1] (factory setting 0000bin) Using the 3rd bit of the parameter value, invert the input signals of digital input 3 for the probe.
p0580	**Probe** [1] **Input terminal** (factory setting 0) Connect input of probe with a digital input.
p0581	**Probe** [1] **Edge** (factory setting 0) Edge for analyzing the probe signal for measuring speed list value 0: 0/1 edge 1: 1/0 edge
p0582	**Probe** [1] **Pulse per revolution** (factory setting 1) Number of pulses per revolution
p0583	**Probe** [1] **Maximum measurement time** (factory setting 10 s) Maximum measurement time for the probe If there is no new pulse before the maximum measuring time elapses, the inverter sets the actual speed value in r0586 to zero. The time is restarted with the next pulse.
p0585	**Probe** [1] **Gear ratio** (factory setting 1) The inverter multiplies the measured speed by the gear ratio before displaying it in r0586.
r0586	**Probe** [1] **Speed list value** Result of the speed calculation
p2181	**Load monitoring response** (factory setting 0) Response for evaluating load monitoring.
	0 Load monitoring disabled
	1 A07920 for speed too low
	2 A07921 for speed too high
	3 A07922 for speed outside tolerance
	4 F07923 for speed too low
	5 F07924 for speed too high
	6 F07925 for speed outside tolerance
p2192	**Load monitoring delay time** (factory setting 10 s) Delay time for evaluating load monitoring.
p2193 = 2	**Load monitoring configuration** (factory setting: 1) 2: Speed deviation and load failure monitoring.
p3230 = 586	**Load monitoring actual speed value** (factory setting 0) Result of the speed calculation with the evaluation of the speed monitoring.
p3231	**Load monitoring speed deviation** (factory setting 150 rpm) Permissible speed deviation of load monitoring.

[1] The "Probe" subfunction calculates the speed from the pulse signal of the digital input.

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

8.7.12 Free function blocks

8.7.12.1 Overview

The free function blocks permit configurable signal processing in the inverter.

The following free function blocks are available:

- AND, OR, XOR, and NOT logic
- RSR (RS flip-flop), DSR (D flip-flop) flip-flops
- Timers MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), and PST (pulse stretching)
- ADD (adder), SUB (subtractor), MUL (multiplier), DIV (divider), AVA (absolute value generated), NCM (comparator), and PLI (polyline) arithmetic functions
- LIM (limiter), PT1 (smoothing), INT (integrator), DIF (differentiator) controllers
- NSW (analog) BSW (binary) switches
- LVM limit value monitoring

The number of free function blocks in the inverter is limited. You can only use a function block once. The inverter has 3 adders, for instance. If you have already configured three adders, then no other adders are available.

8.7.12.2 Runtime groups and run sequence

In order to activate a free function block, you must assign it to a runtime group.

There are 6 runtime groups, which the inverter calculates with different time slices.

Table 8- 34 Permissible runtime groups of the free function blocks

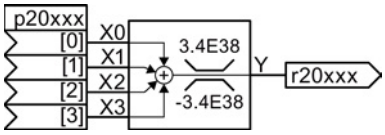
Runtime group	1	2	3	4	5	6
Time slice	8 ms	16 ms	32 ms	64 ms	128 ms	256 ms
AND, OR, XOR, NOT, RSR, DSR, BSW	✓	✓	✓	✓	✓	✓
ADD, SUB, MUL, DIV, AVA, NCM, PLI, MFP, PCL, PDE, PDF, PST, NSW, LIM, PT1, INT, DIF, LVM	-	-	-	-	✓	✓

✓: You can assign the free function blocks to this runtime group
-: A free function block is not possible in this runtime group

You can define a run sequence (0 … 32000) within a runtime group. The inverter calculates the function blocks in an ascending run sequence.

8.7.12.3 List of the free function blocks

ADD (adder)

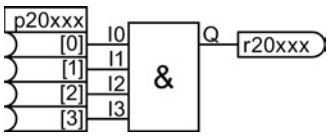


Y = X0 + X1 + X2 + X3

The function block adds inputs X0 … X3, and limits the result in the range -3.4E38 … 3.4E38.

	ADD 0	ADD 1	ADD 2
X0 … X3	p20094[0 … 3]	p20098[0 … 3]	p20308[0 … 3]
Y	r20095	r20099	r20309
Runtime group	p20096	p20100	p20310
Run sequence	p20097	p20101	p20311

AND (AND block)



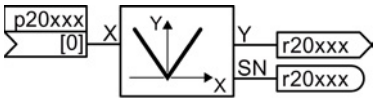
Q = I1 & I2 & I3 & I4

If a value of 1 is available at all inputs I0 … I3, then Q = 1.

In all other cases, output Q = 0.

	AND 0	AND 1	AND 2	AND 3
I0 … I3	p20030[0 … 3]	p20034[0 … 3]	p20038[0 … 3]	p20042[0 … 3]
Q	r20031	r20035	r20039	r20043
Runtime group	p20032	p20036	p20040	p20044
Run sequence	p20033	p20037	p20041	p20045

AVA (absolute value generator)



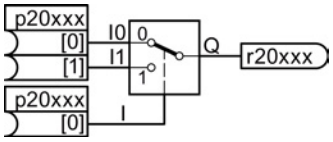
Y = abs(X)

This function block calculates the absolute value of the value present at input X.

When X < 0, then the inverter sets SN = 1.

	AVA 0	AVA 1
X	p20128[0]	p20133[0]
Y	r20129	r20134
SN	r20130	r20135
Runtime group	p20131	p20136
Run sequence	p20132	p20137

BSW (binary changeover switch)



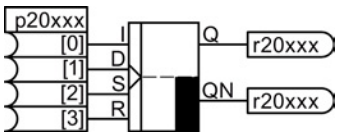
This function block switches one of two binary input variables to the output:

When I = 0, then Q = I0.

When I = 1, then Q = I1.

	BSW 0	BSW 1
I0, I1	p20208[0, 1]	p20213[0, 1]
I	p20209[0]	p20214[0]
Q	r20210	r20215
Runtime group	p20211	p20216
Run sequence	p20212	p20217

DFR (D flip-flop)



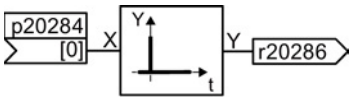
D flip-flop, reset dominant.

Table 8- 35 Truth table

D	I	S	R	Q	QN
0	0	0	0	No change	
1	↑	0	0	1	0
0	↑	0	0	0	1
0	0	1	0	1	0
0	0	0	1	0	1
0	0	1	1	0	1

	DFR 0	DFR 1	DFR 2
I, D, S, R	p20198[0 … 3]	p20203[0 … 3]	p20329[0 … 3]
Q	r20199	r20204	r20330
QN	r20200	r20205	r20331
Runtime group	p20201	p20206	p20332
Run sequence	p20202	p20207	p20333

DIF (differentiator)

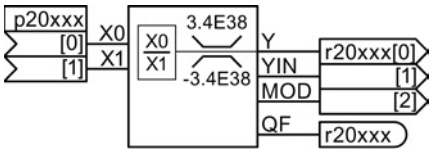


$Y_n = (X_n - X_{n-1}) \times T_D / T_{zyk}$

Output Y is proportional to the rate of change of input X.

	DIF 0
T_D	p20285
Runtime group	p20287
Run sequence	p20288

DIV (divider)



Y = X0 / X1

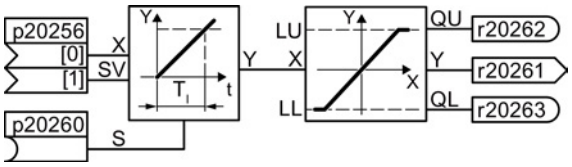
The function block divides the inputs and limits the result in the range -3.4E38 … 3.4E38. With a division of 0/0, Y remains unchanged.

Significance of other outputs:

- YIN: Integer quotient
- MOD = (Y - YIN) × X0 (remainder of the division)
- QF: The inverter sets QF = 1 when output value Y exceeds the permissible value range or for division by zero.

	DIV 0	DIV 1
X0, X1	p20118[0, 1]	p20123[0, 1]
Y, YIN, MOD	p20119[0 … 2]	p20124[0 … 2]
QF	r20120	r20125
Runtime group	p20121	p20126
Run sequence	p20122	p20127

INT (integrator)



$Y_n = Y_{n+1} + T_{cyc} / T_I \times X_n$

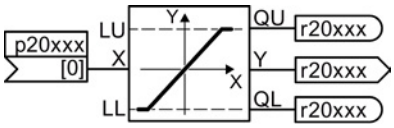
The rate of change of output quantity Y is proportional to input quantity X.

The inverter limits output Y to values LU and LO. Also see limiter LIM.

As long as S = 1, then the inverter sets Y = SV.

INT 0			
LU	p20257	Runtime group	p20264
LO	p20258	Run sequence	p20265
T_I	p20259		

LIM (limiter)



Y = LU, if X ≥ LU

Y = X, if LL < X < LU

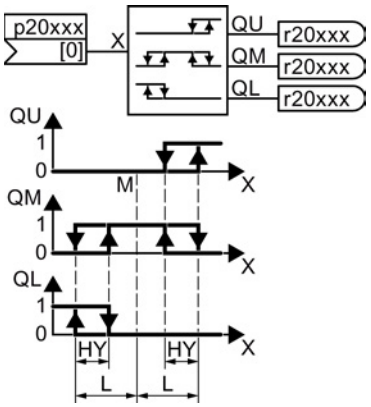
Y = LL, if X ≤ LL

The function block limits output Y to values within LL … LO.

	LIM 0	**LIM 1**
X	p20228[0]	p20236[0]
LU	p20229	p20237
LL [1]	p20230	p20238
Y	r20231	r20239
QU	r20232	r20240
QL	r20233	r20241
Runtime group	p20096	p20100
Run sequence	p20097	p20101

[1] LU must be less than LO

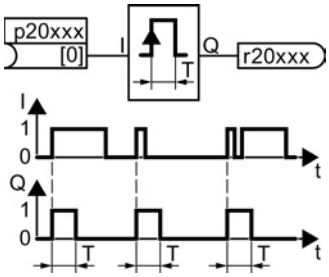
LVM (limit monitor)



The function block monitors an input quantity by comparing it with reference quantities.

	LVM 0	LVM 1
X	p20266[0]	p20275[0]
M	p20267	p20276
L	p20268	p20277
HY	p20269	p20278
QU	r20270	r20279
QM	r20271	r20280
QL	r20272	r20281
Runtime group	p20096	p20100
Run sequence	p20097	p20101

MFP - pulse generator



The pulse generator generates a pulse with a fixed duration.

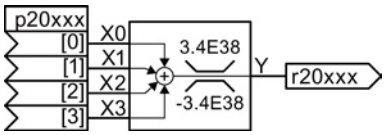
The rising edge of a pulse at input I sets output

Q = 1 for pulse duration T.

The pulse generator cannot be subsequently triggered.

	MFP 0	MFP 1	MFP 2	MFP 3
I	p20138[0]	p20143[0]	p20354[0]	p20359[0]
T	p20139	p20144	p20355	p20360
Q	r20140	p20145	p20356	p20361
Runtime group	p20141	p20146	p20357	p20362
Run sequence	p20142	p20147	p20358	p20363

MUL (multiplier)

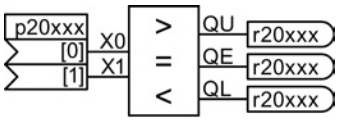


Y = X0 × X1 × X2 × X3

The function block multiplies inputs X0 … X3, and limits the result in the range -3.4E38 … 3.4E38.

	MUL 0	MUL 1
X0 … X3	p20110[0 … 3]	p20114[0 … 3]
Y	r20111	r20115
Runtime group	p20112	p20116
Run sequence	p20113	p20117

NCM (numeric comparator)



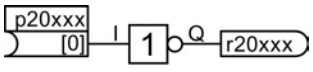
The function block compares two inputs with one another.

Table 8- 36 Function table

Comparing inputs	QU	QE	QL
X0 > X1	1	0	0
X0 = X1	0	1	0
X0 < X1	0	0	1

	NCM 0	NCM 1
X0, X1	p20312[0, 1]	p203182[0, 1]
QU	r20313	r20319
QE	r20314	r20320
QL	r20315	r20321
Runtime group	p20316	p20322
Run sequence	p20317	p20323

NOT (inverter)



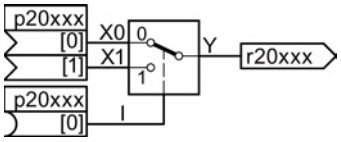
The function block inverts the input:

I = 0 ⇒ Q = 1

I = 1 ⇒ Q = 0

	NOT 0	NOT 1	NOT 2	NOT 3	NOT 4	NOT 5
I	p20078[0]	p20082[0]	p20086[0]	p20090[0]	p20300[0]	p20304[0]
Q	r20079	r20083	r20087	r20091	r20301	r20305
Runtime group	p20080	p20084	p20088	p20092	p20302	p20306
Run sequence	p20081	p20085	p20089	p20093	p20303	p20307

NSW (numeric changeover switch)



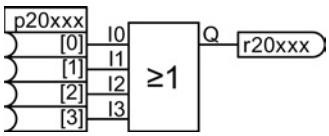
This function block switches one of two numeric input variables to the output:

When I = 0, then Y = X0.

When I = 1, then Y = X1.

	NSW 0	NSW 1
X0, X1	p20218[0, 1]	p20223[0, 1]
I	p20219[0]	p20224[0]
Y	r20220	r20225
Runtime group	p20221	p20226
Run sequence	p20222	p20227

OR (OR block)



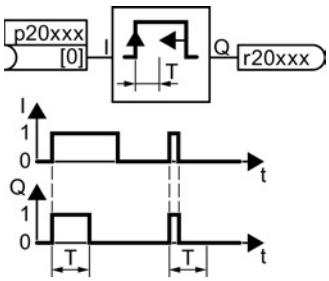
Q = I1 v I2 v I3 v I4

If a value of 0 is available at all inputs I0 … I3, then Q = 0.

In all other cases, output Q = 1.

	OR 0	OR 1	OR 2	OR 3
I0 … I3	p20046[0 … 3]	p20050[0 … 3]	p20054[0 … 3]	p20058[0 … 3]
Q	r20047	r20051	r20055	r20059
Runtime group	p20048	p20052	p20056	p20060
Run sequence	p20049	p20053	p20057	p20061

PCL (pulse shortener)



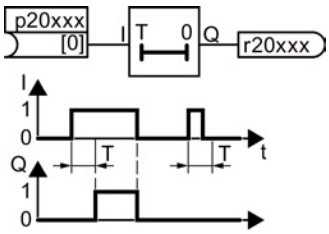
The pulses shortener limits the pulse duration.

The rising edge of a pulse at input I, sets Q =1.

When I = 0 or if pulse duration T has expired, then function block sets Q = 0.

	PCL 0	PCL 1
I	p20148[0]	p20153[0]
T	p20149	p20154
Q	r20150	r20155
Runtime group	p20151	p20156
Run sequence	p20152	p20157

PDE (ON delay)

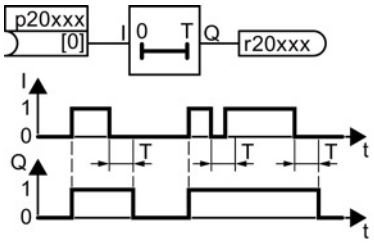


The rising edge of a pulse at input I sets output Q = 1 after pulse delay time T.

When I = 0, then the function block sets Q = 0.

	PDE 0	PDE 1	PDE 2	PDE 3
I	p20158[0]	p20163[0]	p20334[0]	p20339[0]
T	p20159	p20164	p20335	p20340
Q	r20160	r20165	r20336	r20341
Runtime group	p20161	p20166	p20337	p20342
Run sequence	p20162	p20167	p20338	p20343

PDF (OFF delay)



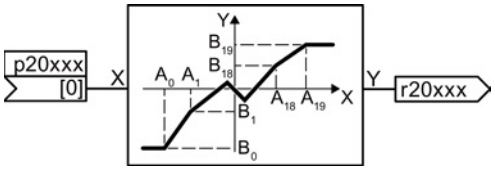
When I = 1, then the function block sets Q = 1.

The falling edge of a pulse at input I sets output Q = 0 after OFF delay time T.

When input I returns to 1 before time T has expired, output Q remains 1.

	PDF 0	PDF 1	PDF 2	PDF 3
I	p20168[0]	p20173[0]	p20344[0]	p20349[0]
T	p20169	p20174	p20345	p20350
Q	r20170	r20175	r20346	r20351
Runtime group	p20171	p20176	p20347	p20352
Run sequence	p20172	p20177	p20348	p20353

PLI (polyline)



The function block adapts output Y to input X along 20 interpolation points (A_0,B_0) … (A_{19},B_{19}).

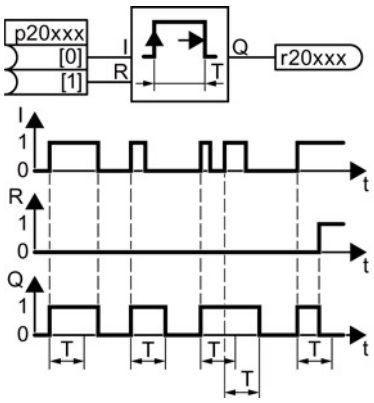
The function block linearly interpolates between the interpolation points. The characteristic is horizontal outside A_0 and A_{19}.

The values A_0 … A_{19} must be in ascending order.

Interpolation points that are not required must be set to the values of the last interpolation point required.

	PLI 0	**PLI 1**
X	p20372[0]	p20378[0]
Y	r20373	r20379
A_0 … A_{19}	p20374[0 … 19]	p20380[0 … 19]
B_0 … B_{19}	p20375[0 … 19]	p20381[0 … 19]
Runtime group	p20376	p20382
Run sequence	p20377	p20383

PST (pulse stretcher)



The function block generates a pulse with a defined length.

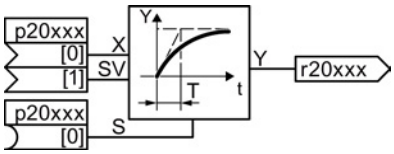
The rising edge of a pulse at input I sets output Q = 1.

When I = 0 and pulse duration T has expired, then function block sets Q = 0.

When reset input R = 1, then the function block sets Q = 0.

	PST 0	**PT 1**
I, R	p20178[0, 1]	p20183[0, 1]
T	p20179	p20184
Q	r20180	r20185
Runtime group	p20181	p20186
Run sequence	p20182	p20187

PT1 (smoothing element)



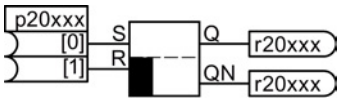
Y(t) = X × (1 - exp(-t / T))

The function block smooths input signal X with time constant T. T defines the gradient of the increase in output quantity Y.

If set input S = 1, then Y = SV.

	PT1 0	PT1 1
X, SV	p20244[0, 1]	p20250[0, 1]
S	p20245[0]	p20251[0]
T	p20246	p20252
Y	r20247	r20253
Runtime group	p20248	p20254
Run sequence	p20249	p20255

RSR (RS flip-flop)



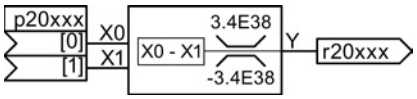
RS flip-flop, reset dominant.

Table 8- 37 Truth table

S	R	Q	QN
0	0	No change	
1	0	1	0
0	1	0	1
1	1	0	1

	RSR 0	RSR 1	RSR 2
S, R	p20188[0, 1]	p20193[0, 1]	p20324[0, 1]
Q	r20189	r20194	r20325
QN	r20190	r20195	r20326
Runtime group	p20191	p20196	p20327
Run sequence	p20192	p20197	p20328

SUB (subtracter)

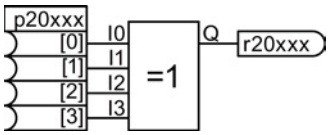


Y = X0 - X1

The function block subtracts input X1 from input X0 and limits the result in the range -3.4E38 … 3.4E38.

	SUB 0	SUB 1
X0, X1	p20102[0, 1]	p20106[0, 1]
Y	r20103	r20107
Runtime group	p20104	p20108
Run sequence	p20105	p20109

XOR (EXCLUSIVE OR block)



The function block logically combines the binary quantities at inputs I according to a logical exclusive or function.

Table 8- 38 Truth table

I0	I1	I2	I3	Q
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0

	XOR 0	XOR 1	XOR 2	XOR 3
I0 … I3	p20062[0 … 3]	p20066[0 … 3]	p20070[0 … 3]	p20074[0 … 3]
Q	r20063	r20067	r20071	r20075
Runtime group	p20064	p20068	p20072	p20076
Run sequence	p20065	p20069	p20073	p20077

8.7.12.4 Scaling

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 %.

If you interconnect the output signal of a free function block with a function that requires physical input quantities, then the inverter converts the scaled signal into the physical quantity.

Scaling parameters of physical quantities

Speed	100 % ≙ p2000 (reference speed)
	Example: p2000 = 3000 rpm, actual speed 2100 rpm ⇒ the scaled input quantity = 2100 / 3000 = 0.7.
Voltage	100 % ≙ p2001 reference voltage
Current	100 % ≙ p2002 reference current
Torque	100 % ≙ p2003 reference torque
Power	100 % ≙ p2004 reference power
Angle	100 % ≙ p2005 reference angle
Temperature	100 % ≙ p2006 reference temperature
	Example: p2006 = 100 °C, actual temperature = 120 °C. ⇒ the scaled input quantity = 120 °C / 100 °C = 1.2.

The allocation of parameters and scaling parameters is provided in the parameter description of the List Manual.

Limits

The inverter expects limits within the free function blocks as scaled values:

Scaled limit = physical limit value / value of the reference parameter

8.7.12.5 Activating free function block

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

Activating and interconnecting free function blocks

Precondition

You have configured the inverter with the "Free function blocks" function module. See also: Basic commissioning with STARTER (Page 90).

Procedure



Proceed as follows to activate a free function block and interconnect it with signals:

1. Activating the function block: Assign the function block to a runtime group of your choice.

   Example: Assign ADD 0 to runtime group 1: p20096 = 1.

2. If you have assigned several function blocks to the same runtime group, define a sensible run sequence within the runtime group.

   Example: Calculate ADD 0 before ADD 1: p20097 < p20101.

3. 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.

8.7.12.6 Further information

Example

You can find an example for using the free function blocks in Chapter Interconnecting signals in the inverter (Page 370).

Application description for the free function blocks

See also: FAQ (http://support.automation.siemens.com/WW/view/en/85168215)

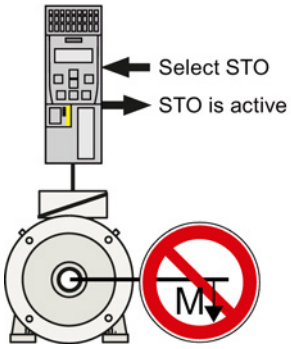
8.8 Safe Torque Off (STO) safety function

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

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Manuals for your converter (Page 386).

8.8.1 Function description

How does the STO safety function work?



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

Table 8- 39 The principle of operation of STO

	Safe Torque Off (STO)	Standard inverter functions linked with STO
1.	The inverter recognizes the selection of STO via a safety-relevant input or via the PROFIsafe safe communication.	---
2.	The inverter prevents energy from being fed to the motor. When STO is active, the motor does not generate any torque.	If you use a motor holding brake, the inverter closes the brake.
3.	The inverter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	---

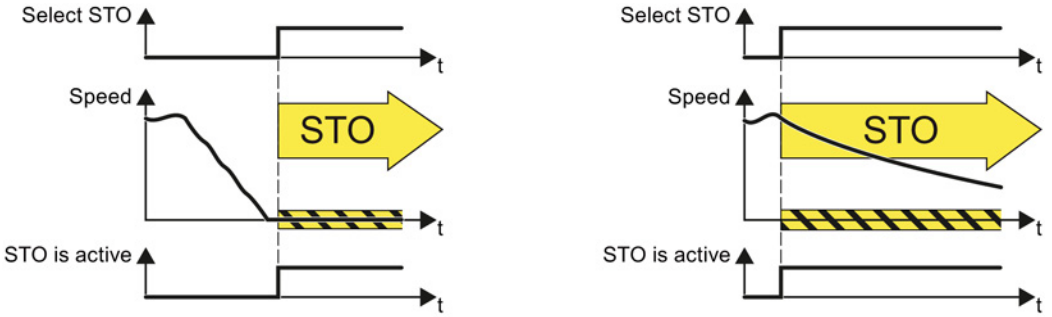


Figure 8-39 Functionality of STO when motor is rotating and at a standstill

If the motor is still rotating when STO is selected, then it coasts down to standstill.

The STO safety function is standardized

The STO function is defined in IEC/EN 61800-5-2:

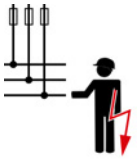
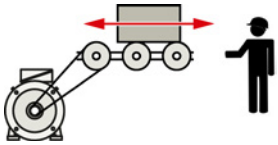
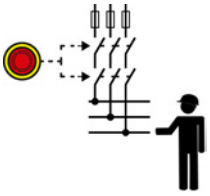
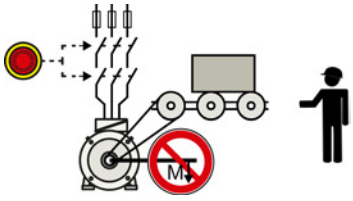
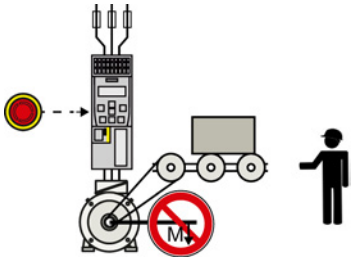
"[…] [The inverter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)."

The STO inverter function complies with what is defined in the standard.

The distinction between Emergency Off and Emergency Stop

"Emergency Off" and "Emergency Stop" are commands that minimize different risks in the machine or plant.

The STO function is suitable for achieving an emergency stop but not an emergency off.

Risk:	Risk of electric shock: 	Risk of unexpected motion: 
Measure to minimize risk:	**Safe switch off** Switching off the electric power supply for the installation, either completely or partially.	**Safely stop and safely prevent restarting** Stopping or preventing the dangerous movement
Command:	**Emergency Off**	**Emergency Stop**
Classic solution:	Switch of the power supply: 	Switch-of the drive power supply: 
Solution with the STO safety function integrated in the drive:	STO is not suitable for safely switching of an electric voltage.	Select STO:  It is permissible that you switch of the inverter supply voltage as well. However, switching off the voltage is not required as a risk-reduction measurement.

Application examples for the STO function

The STO function is suitable for applications where the motor is already at a standstill or will come to a standstill in a short, safe period of time through friction. STO does not shorten the run-on of machine components with high inertia.

Examples	Possible solution
When the Emergency Stop button is pressed, a stationary motor should not unintentionally start.	• Wire the Emergency Stop button to a safety-related input of the inverter. • Select STO via the safety-related input.
A central emergency stop button must prevent the unintentional acceleration of several motors that are at a standstill.	• Evaluate the Emergency Stop button in a central control. • Select STO via PROFIsafe.

8.8.2 Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

8.8.3 Commissioning STO

8.8.3.1 Commissioning tools

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

If you use a PC tool for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 40 PC-based commissioning tools

Tool	Can be downloaded at no charge	Order number
STARTER	STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3072-0AA00-0AG0
Startdrive	Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)	6SL3072-4CA02-1XG0

Commissioning the safety functions with STARTER is subsequently described.

A tutorial is available for Startdrive: Startdrive tutorial (http://support.automation.siemens.com/WW/view/en/73598459).

8.8.3.2 Protection of the settings from unauthorized changes

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

Table 8- 41 Parameter

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

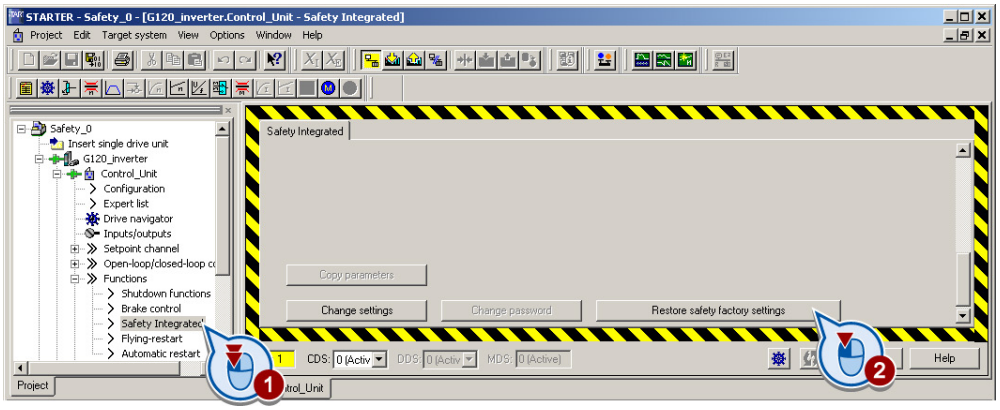
8.8.3.3 Resetting the safety function parameters to the factory setting

Procedure

1
2

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

1. Go online with STARTER
2. Open the screen form for the safety functions ①.



3. Press the button to restore the factory settings ②.
4. Enter the password,for the safety functions.
5. Confirm saving parameters (RAM to ROM).
6. Go offline with STARTER .
7. Switch off the inverter supply voltage.
8. Wait until all LED on the inverter go dark. Now switch on the inverter supply voltage again (power on reset).

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

Parameters	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	30	Parameter reset
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Password confirmation** Confirming the new Safety Integrated password.	
p0970	**Reset drive parameters**	
	5	Starts a safety parameter reset. After the reset, the inverter sets p0970 = 0.

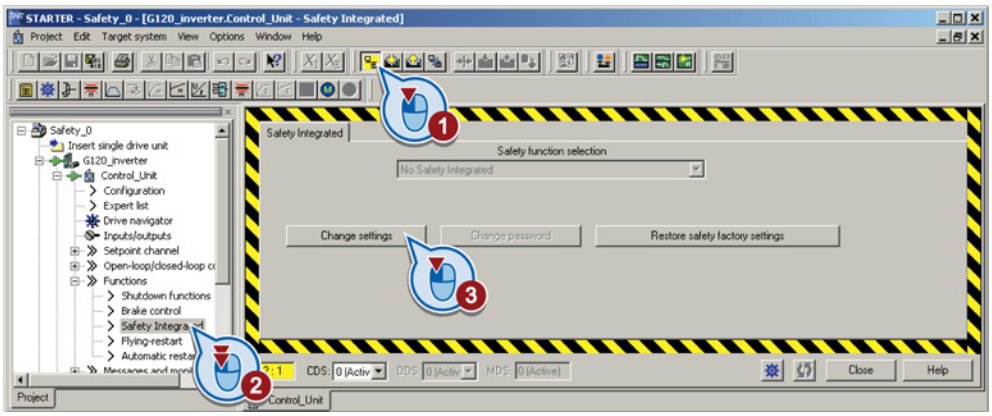
8.8.3.4 Changing settings

Procedure



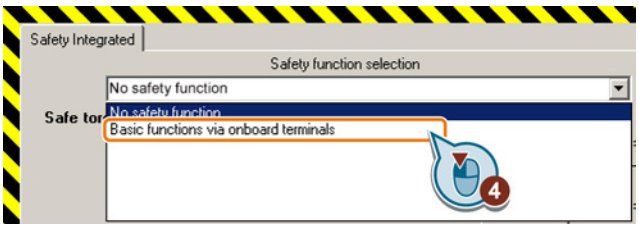
To start commissioning the safety functions, proceed as follows:

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



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

4. Selecting "STO via terminal":



You have completed the following commissioning steps:

- You have started to commission the safety functions.
- You have selected the basic functions with control via onboard terminals of the inverter.

Table 8- 42 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 386).

8.8.3.5 Interconnecting the "STO active" signal

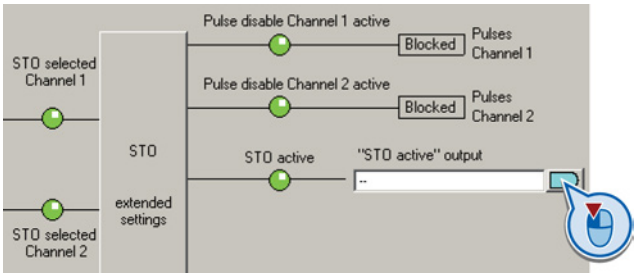
If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

Procedure

1
2

To interconnect the "STO active" checkback signal, proceed as follows:

1. Select the button for the feedback signal.



2. In the following selection menu, select the appropriate setting for your particular application.

You have interconnected the "STO active" checkback signal. The inverter signals "STO active" to the higher-level control after STO has been selected.

Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

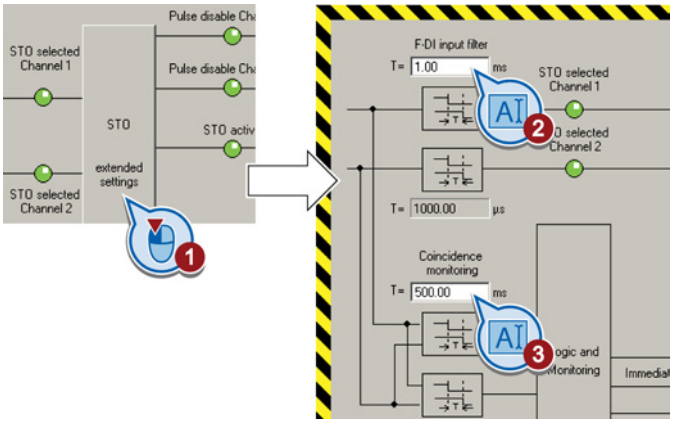
8.8.3.6 Setting the filter for safety-related inputs

Procedure

1
2

To set the input filter and simultaneity monitoring of the safety-related input, proceed as follows:

1. Select the advanced settings for STO.



2. Set the debounce time for the F-DI input filter.
3. Set the discrepancy for the simultaneity monitoring.
4. Close the screen form.

You have set the input filter and the simultaneity monitoring of the safety-related input.

Description of the signal filter

The following are available for the signal processing of the 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.

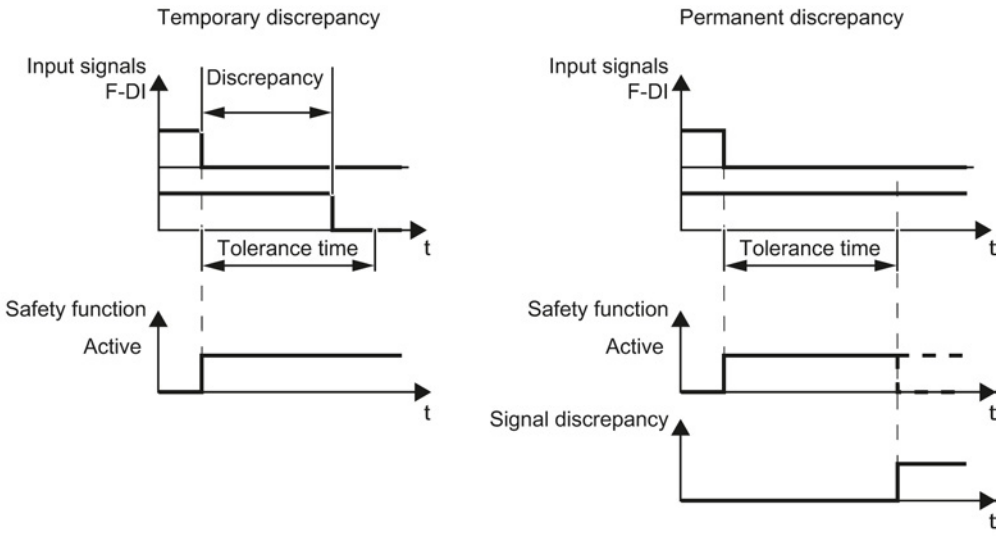


Figure 8-40 Tolerance regarding discrepancy

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.

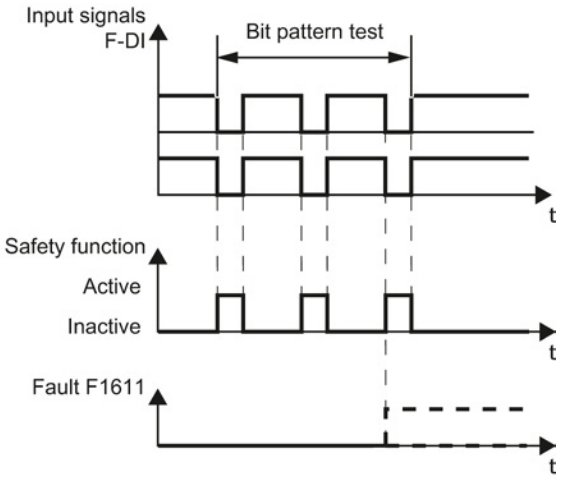


Figure 8-41 Inverter response to a bit pattern test

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.

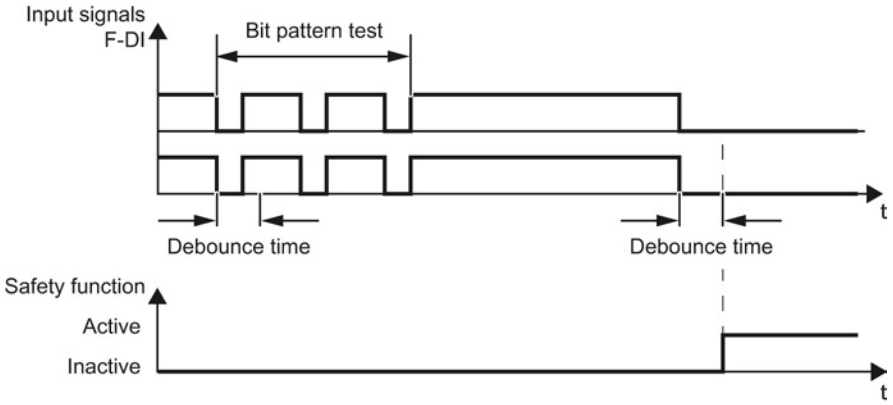


Figure 8-42 Filter for suppressing temporary signal changes

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

If you use an input as a standard input, set the debounce time using parameter p0724 .

If you use an input as a fail-safe input, set the debounce time as described above.

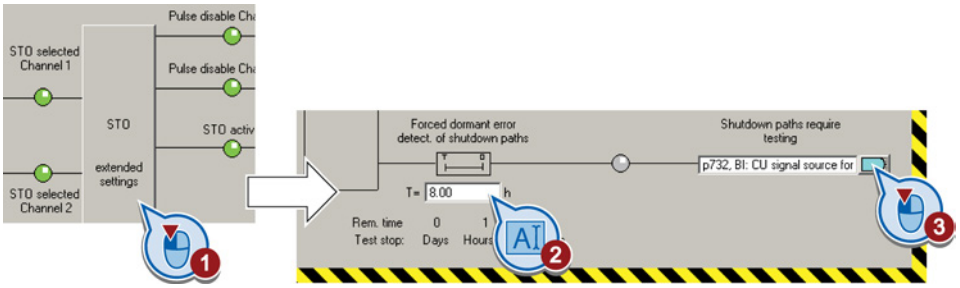
8.8.3.7 Setting the forced checking procedure (test stop)

Procedure

1
2

To set the forced checking procedure (test stop) of the basic functions, proceed as follows:

1. Select the advanced settings for STO.



2. Set the monitoring time to a value to match your application.
3. Using this signal, the inverter signals that a forced checking procedure (test stop) is required.

   Interconnect this signal with an inverter signal of your choice.

You have set the forced checking procedure (test stop) for the basic functions.

Description

The forced checking procedure (test stop) of the basic functions is an inverter self test. The inverter checks its circuits to switch off the torque. If you are using the Safe Brake Relay, for a forced checking procedure, the inverter also checks the circuits of this component.

You start the forced checking procedure each time that the STO function is selected.

Using a timer block, the inverter monitors as to whether the forced checking procedure is regularly performed.

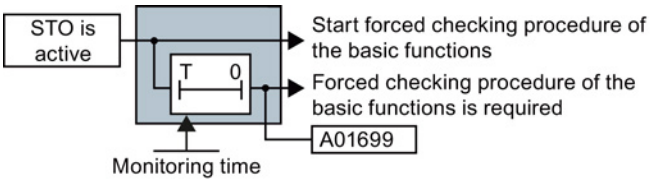


Figure 8-43 Starting and monitoring the forced checking procedure (test stop)

Parameter	Description
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection.
r9660	**Forced dormant error detection remaining time** Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced dormant error detection is required** Signals for the higher-level control system.

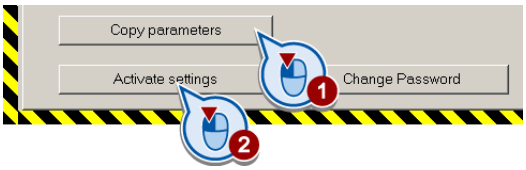
8.8.3.8 Activate settings

Activate settings

Procedure

To activate the settings for the safety functions, proceed as follows:

1. Press the "Copy parameters" button, to create a redundant image of your inverter settings.



2. Press the "Activate settings" button.
3. If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
4. Confirm the prompt for saving your settings (copy RAM to ROM).
5. Switch off the inverter supply voltage.
6. Wait until all LEDs on the inverter go dark (no voltage condition).
7. Switch on the inverter supply voltage again.

Your settings are now active.

Parameter	Description
p9700 = D0 hex	**SI copy function** (factory setting: 0) Starting the SI parameter copy function.
p9701 = DC hex	**Confirm data change** (factory setting: 0) Confirm SI basic parameter change.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

8.8.3.9 Checking the assignment of the digital inputs

Checking the connection of digital inputs

The simultaneous connection of digital inputs with a safety function and a "standard" function may lead to the drive behaving in unexpected ways.

If you control the safety functions in the inverter using digital inputs, you must check whether these digital inputs are connected to a "standard" function.

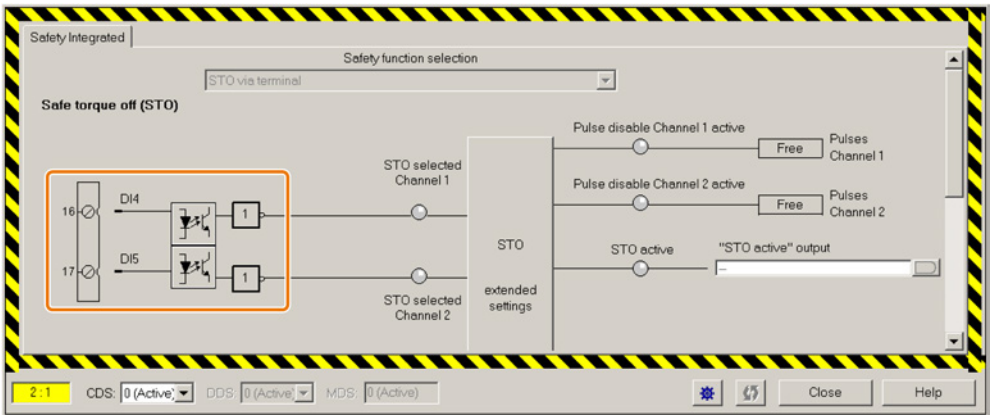


Figure 8-44 Example: Assignment of digital inputs DI 4 and DI 5 with STO

Procedure

1
2

In order to prevent the safety-related inputs of the safety functions unintentionally controlling "standard" functions in the inverter, proceed as follows:

1. Select the inputs/outputs in STARTER in the project navigator.
2. Select the screen for the digital inputs.
3. Remove all digital input interconnections that you use as safety-related input F-DI:
4. If you use the CDS dataset switchover, you must delete the digital input connections for all CDS.

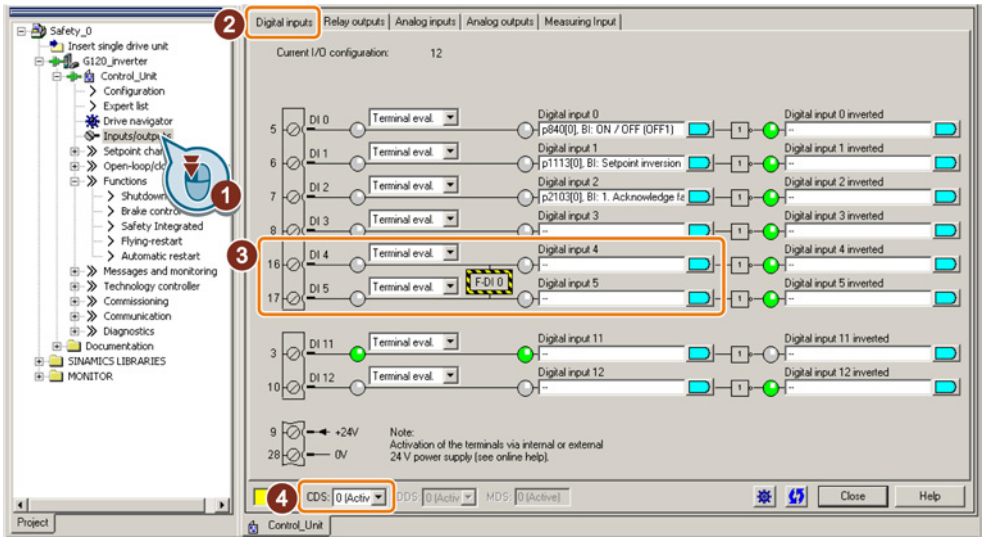


Figure 8-45 Removing the DI 4 and DI 5 digital-input connections

You have now prevented safety-related inputs in the safety functions controlling "standard" functions in the inverter.

8.8.3.10 Acceptance - completion of commissioning

What is an acceptance?

The machine manufacturer is responsible in ensuring that his plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions or have them checked by specialist personnel, which represent an increased risk of injury to personnel or material damage. This acceptance or validation is, for example, also specified in the European machinery directive and essentially comprises two parts:

- Checking the safety-relevant functions and machine parts.
  → **Acceptance test**.
- Generate an "Acceptance report" that describes the test results.
  → **Documentation**.

Supply information for the validation, e.g. the harmonized European standards EN ISO 13849-1 and EN ISO 13849-2.

Acceptance test of the machine or plant

The acceptance test checks whether the safety-relevant functions in the plant or machine function correctly. The documentation of the components used in the safety functions can also provide information about the necessary tests.

Testing the safety-related functions includes e.g. the following:

- Are all safety equipment such as protective door monitoring devices, light barriers or emergency-off switches connected and ready for operation?
- Does the higher-level control respond as expected to the safety-relevant feedback signals of the inverter?
- Do the inverter settings match the configured safety-relevant function in the machine?

Acceptance test of the inverter

The acceptance test of the inverter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the inverter checks whether the integrated drive safety functions are set up correctly for the planned safety function of the machine.

You can find examples for the acceptance test of integrated drive safety functions in section: Recommended acceptance test (Page 380).

Documentation of the inverter

The following must be documented for the inverter:

- The results of the acceptance test.
- The settings of the integrated drive safety functions.

  The commissioning tool STARTER logs the settings of the integrated drive functions, if necessary. See also Section: Documents for acceptance (Page 251).

The documentation must be signed.

Who may perform the acceptance test of the inverter?

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner are authorized to perform the acceptance testing of the inverter.

Reduced acceptance test after function expansions

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

Measure	Acceptance test	
	Acceptance test	Documentation
Functional expansion of the machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement inverter data • Add function table • Log the new checksums • Countersignature
Transfer of inverter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	• Add machine description • Check checksums • Check firmware versions

Documents for acceptance

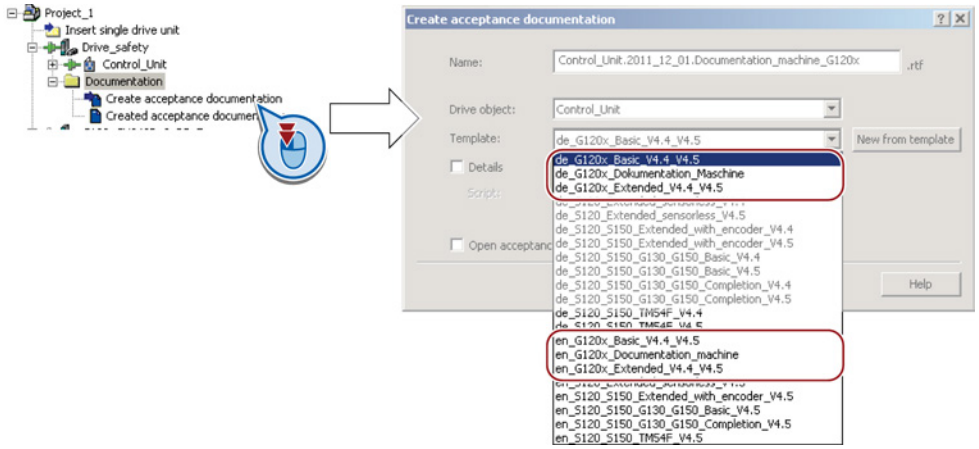
The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

Procedure

1
2

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

1. In STARTER, select "Create acceptance documentation":



STARTER has templates in German and English.

2. Select the suitable template and create a report for each drive of your machine or system:

– Template for the machine documentation:

  de_G120x_Dokumentation_Maschine: German template.

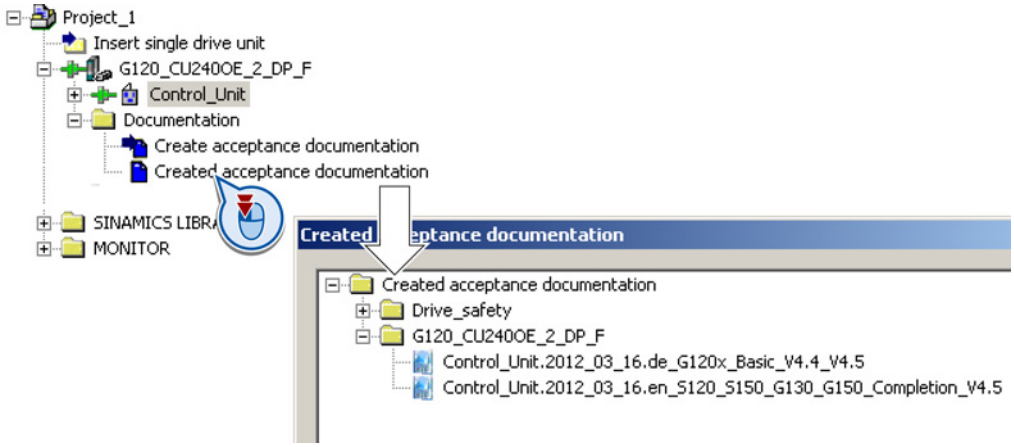
  en_G120x_Documentation_machine: English template.

– Report of the settings for the basic functions, from firmware version V4.4 onwards:

  de_G120x_Basicc_V4.4…: German report.

  en_G120x_Basic_V4.4…: English report.

3. You load the created reports for archiving and the machine documentation for further processing:



4. Archive the reports and the machine documentation.

You have generated the documents to accept the safety functions.

The reports and the machine documentation can also be found in the section: Acceptance tests for the safety functions (Page 380).

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.

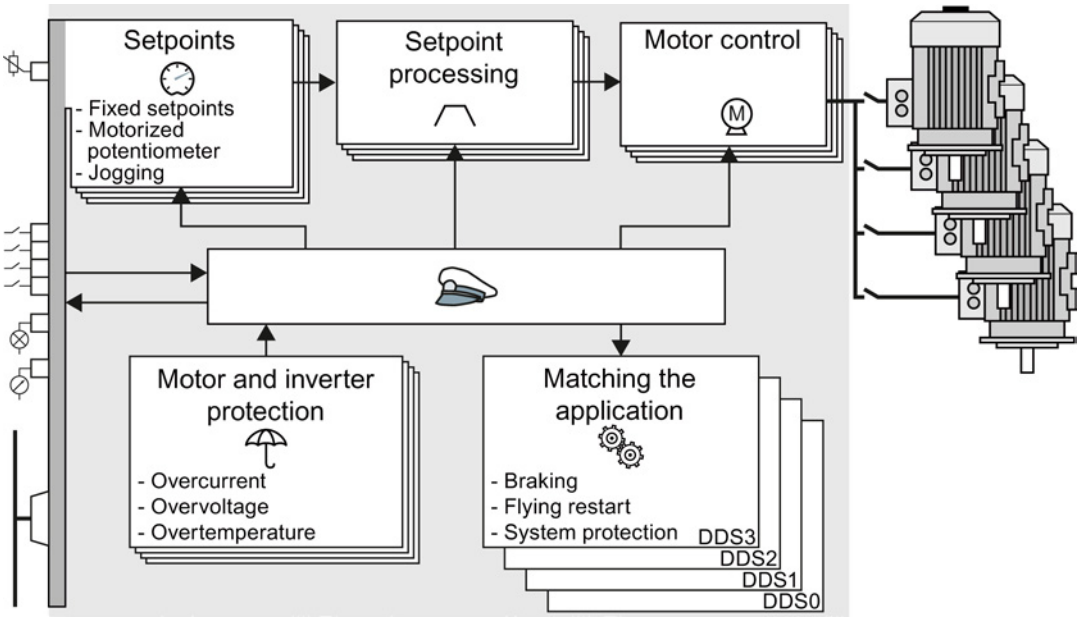


Figure 8-46 Switching over between different settings using drive data sets (DDS)

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

Table 8- 43 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- 44 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: CDS0: p0820[0], p0821[0] CDS1: p0820[1], p0821[1] …
p0821[0…n]	**Drive data set selection DDS bit 1**	
p0826	**Motor changeover, motor number** Each drive data set is assigned a motor number: p0826[0] = motor number for drive data set 0. … p0826[3] = motor number for drive data set 3. If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation. If you operate different motors on one inverter, then you must number the motors in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.	
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- 45 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	**Source drive data set**
p0819[1]	**Target drive data set**
p0819[2] = 1	**Start copy operation**

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

9 Backing up data and series commissioning

External data backup

After commissioning, your settings are saved in the converter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the converter. Without backup, your settings could be lost if the converter developed a defect (see also Replacing the Control Unit without data backup (Page 280)).

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

Note

Data backup using operator panels with USB connection with the PG/PC is not possible

If the converter is connected to a PG/PC via a USB cable, you can save any data on the memory card using an operator panel.

- Before you save data to the memory card using an operator panel, disconnect the USB connection between the PG/PC and converter.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Precondition

The Control Unit to which the settings are transferred has the same order number and the same or a higher firmware version as the source Control Unit.

Overview

You must proceed as follows to carry out series commissioning:

1. Commission the first converter.
2. Back up the settings of the first converter to an external storage medium.
3. Transfer the settings of the first converter to another converter via the storage medium.

9.1 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 27).

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

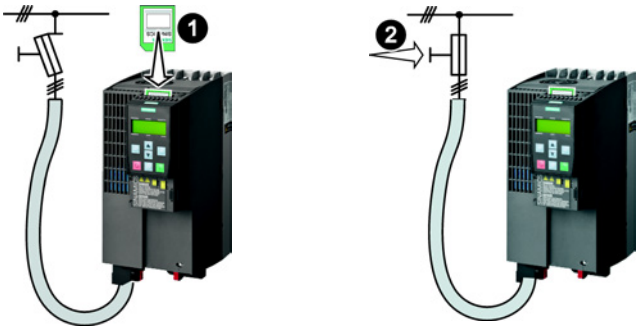
- The inverter power supply has been switched off.
- No USB cable is inserted in the inverter.

Procedure

1
2

Proceed as follows to automatically backup your settings:

1. Insert an empty memory card into the inverter.
2. Then switch-on the inverter power supply.



After the power supply has been switched on, the inverter copies its changed settings to the memory card.

Note

If the memory card is not empty, then the inverter accepts the data from the memory card. This data then overwrites the data in the inverter.

- Only use empty memory cards to automatically backup your settings.

Manually backing up

Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.



Procedure

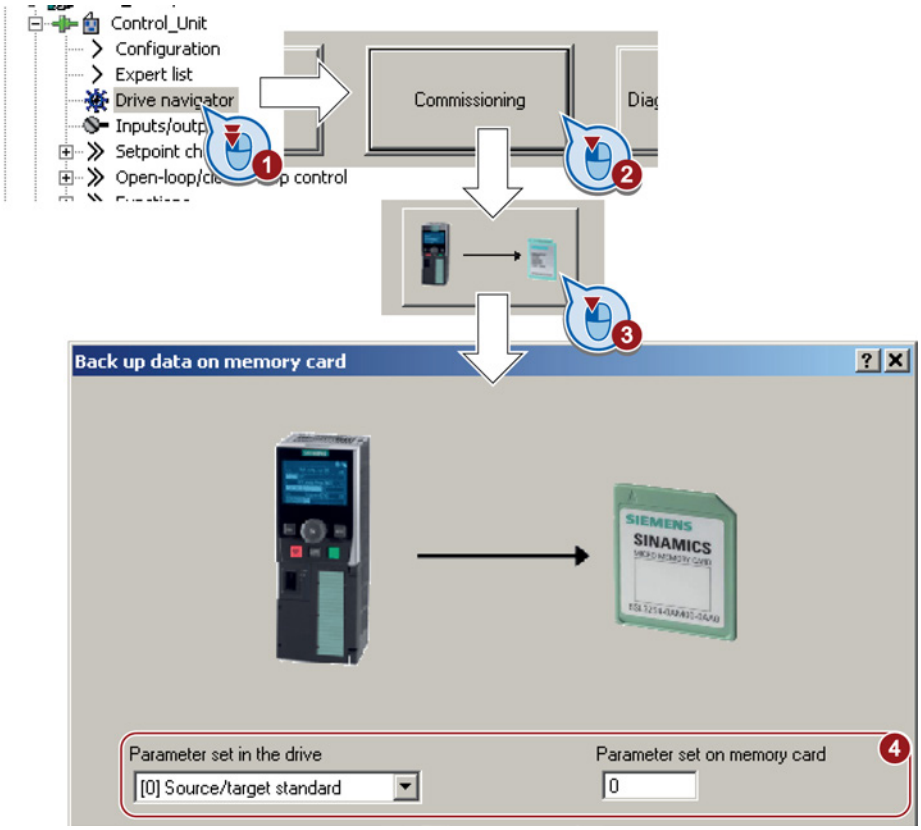


Proceed as follows to back up your settings on a memory card:

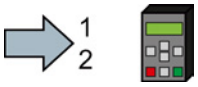
1. Go online with STARTER, e.g. via a USB cable.

   In STARTER, press the "Copy RAM to ROM" button .

   In your drive, select "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.

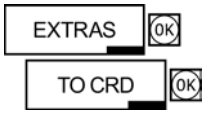


You have backed up the settings of the inverter on the memory card.



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

1. Remove the USB cable if one is inserted in the inverter.
2. Plug a BOP-2 onto the inverter.
3. Go to the menu level "EXTRAS".
4. In the menu, select "EXTRAS" - "TO CRD".



You have backed up the settings of the inverter on the memory card.

9.1.2 Transferring the setting from the memory card

Automatically transferring

Precondition

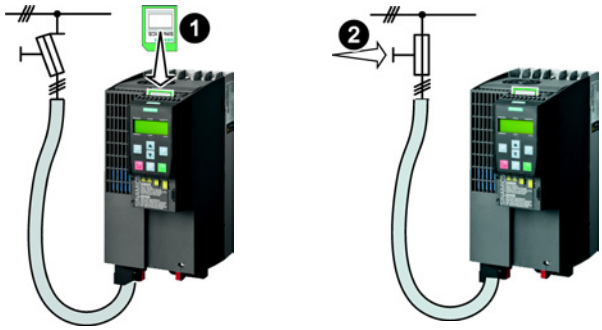
The inverter power supply has been switched off.

Procedure



Proceed as follows to automatically transfer your settings:

1. Insert the memory card into the inverter.
2. Then switch on the inverter power supply.



If there is valid parameter data on the memory card, then the inverter accepts the data from the memory card.

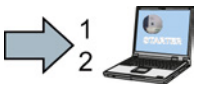
Manually transferring

Preconditions

- The inverter power supply has been switched on.
- No memory card is inserted in the inverter.

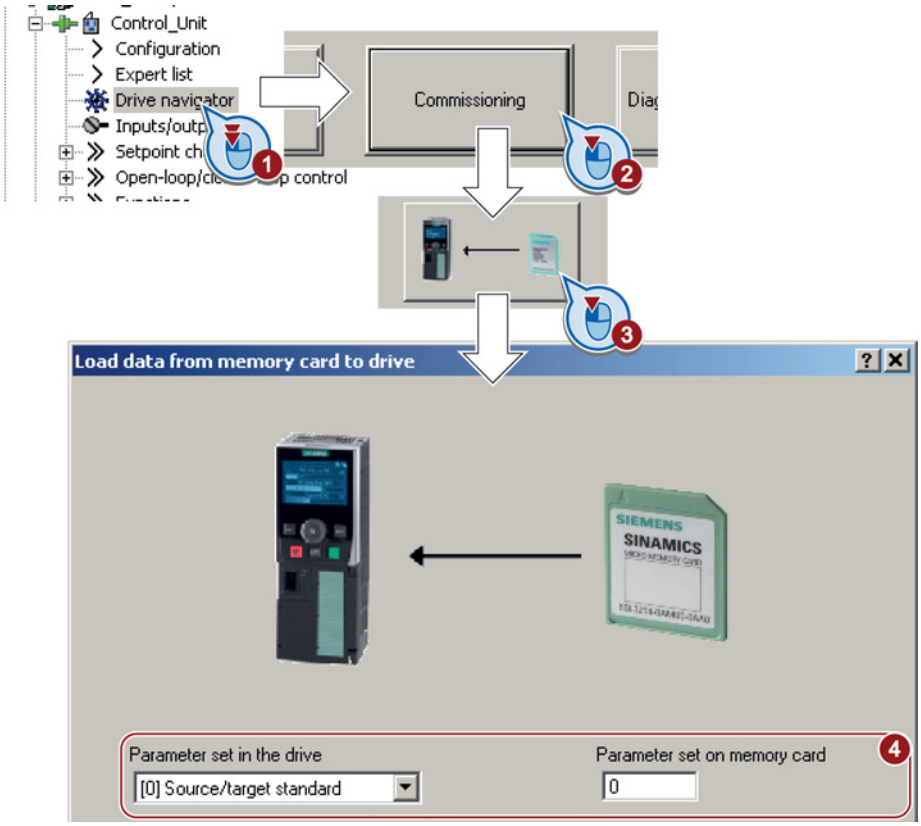


Procedure



Proceed as follows to transfer settings from a memory card to the inverter:

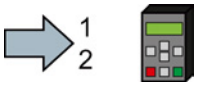
1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.



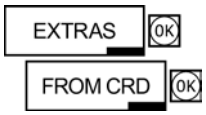
5. Close the screen forms.
6. Go offline with STARTER.
7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark.
9. Switch on the inverter power supply again.

   Your settings become effective after this power-on reset.

You have now transferred your settings from a memory card to the inverter.



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



1. Remove the USB cable if one is inserted in the inverter.
2. Attach the BOP-2 operator panel to the inverter.
3. Go to the menu level "EXTRAS".
4. Start data transfer in the menu "EXTRAS" - "FROM CRD".
5. Switch off the inverter power supply.
6. Wait until all LEDs on the inverter are dark.
7. Switch on the inverter power supply again.
8. Your settings take effect after this power-on reset.

You have written the settings from the memory card to the inverter.

9.1.3 Safely remove the memory card

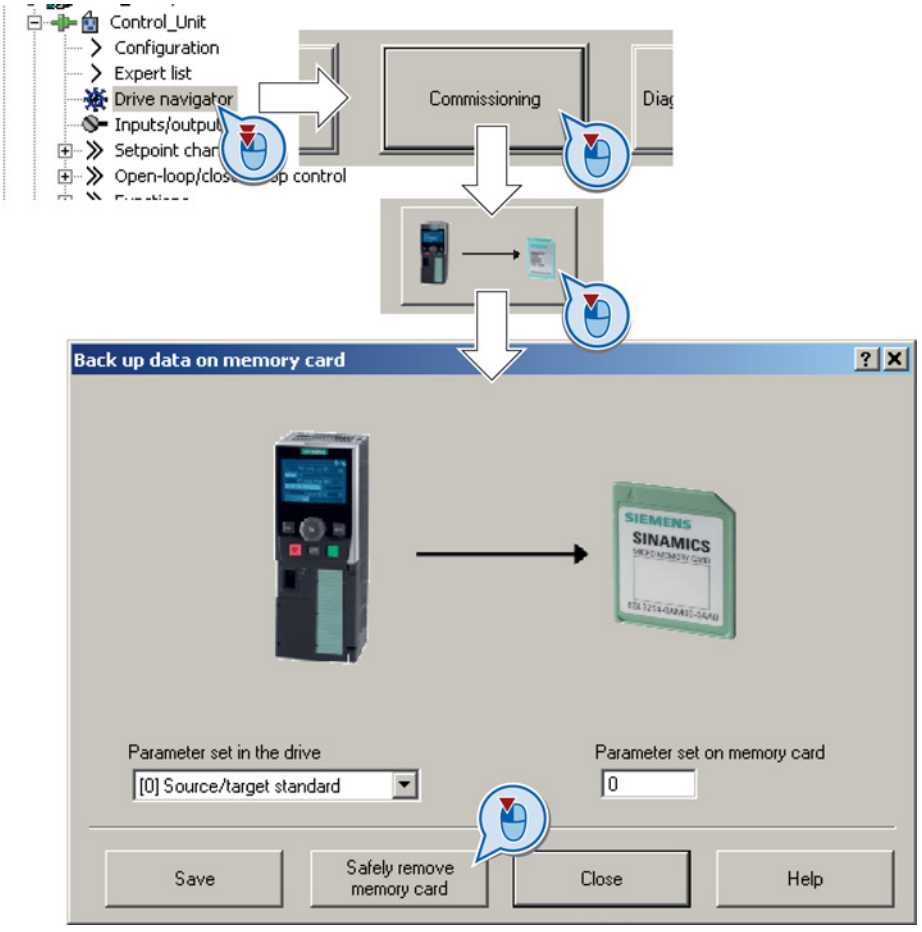
NOTICE
Data loss from improper handling of the memory card If you remove the memory card when the converter is switched on without implementing the "safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting. • Only remove the memory card using the "safe removal" function.

Procedure



To safely remove the memory card using STARTER, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



2. Click on the button to safely remove the memory card.
3. Remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card from the inverter.

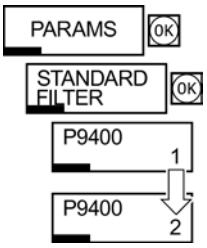
Safely removing a memory card using the BOP-2

Procedure



To safely remove the memory card using BOP-2, proceed as follows:

1. Go to parameter p9400. If a memory card is correctly inserted, then p9400=1.
2. Set 9400 = 2. BOP-2 shows "BUSY" for a few seconds and then jumps either to p9400 = 3 or p9400 = 100.
3. For p9400 = 3, remove the memory card from the inverter.
4. For p9400 = 100, it is not permissible that you remove the memory card.
   In this case, again set p9400 = 2.





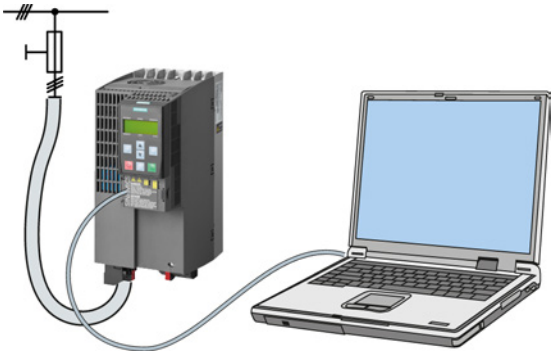
You have now safely removed the memory card using the BOP-2:

9.2 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 42).

Inverter → PC/PG

Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

PC/PG → inverter

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

Procedure without enabled safety functions

To load the settings from the PG to the inverter, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. To save the data in the inverter so that it is not lost when the power fails, select the "Copy RAM to ROM" button: .
4. Go offline with STARTER : .

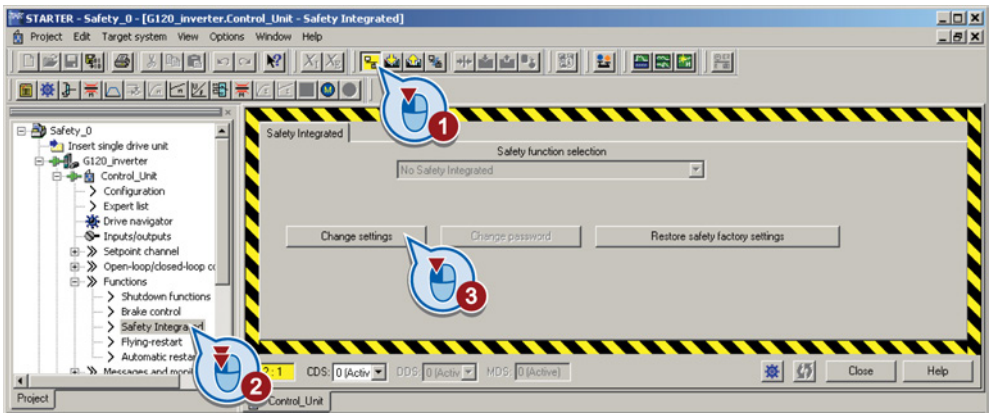
You have transferred the settings from the PG to the inverter.

Procedure with enabled safety functions

1
2

To load the settings from the PG to the inverter and to activate the safety functions, proceed as follows:

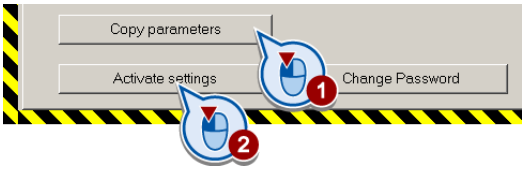
1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. Call the STARTER screen form for the safety functions.



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 variable speed drive to the BOP-2 or vice versa.

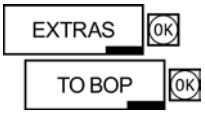


Inverter → BOP-2

Procedure

To back up the settings on the BOP-2, proceed as follows:

1. Attach the operator panel to the inverter.
2. Start data transfer in the menu "EXTRAS" - "TO BOP".



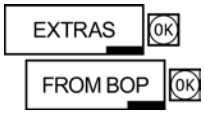
You have backed up the settings on the BOP-2.

BOP-2 → inverter

Procedure

To transfer the settings to the inverter, proceed as follows:

1. Attach the operator panel to the inverter.
2. Start data transfer in the menu "EXTRAS" - "FROM BOP".
3. Switch off the inverter power supply.
4. Wait until all LEDs on the inverter are dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.



You have transferred the settings to the inverter.

9.4 Other ways to back up settings

In addition to the default setting, the inverter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

9.5 Write and know-how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

9.5.1 Write protection

Write protection prevents converter settings from being inadvertently changed. If you work with the STARTER, the write protection is only effective online. The offline project of the Starter is not write-protected.

The write protection applies to all user interfaces, and thus also to parameter changes via a fieldbus.

The write protection is not password-protected.

Activate and deactivate write protection

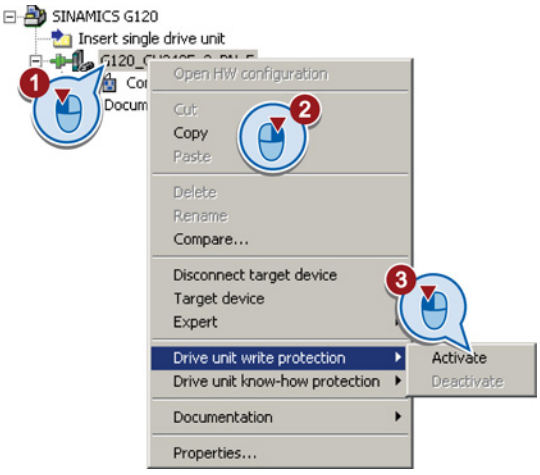
Precondition

You are online with STARTER.

Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the converter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate or deactivate write protection.
4. Press the "Copy RAM to ROM" button . Otherwise, your settings will be lost when the converter is switched off.



You have activated or deactivated write protection.

Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.



The confirmation prompt is not issued, if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

Exceptions to write protection

Some functions are excluded from write protection, e.g.:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Restoring the factory setting
- Importing settings from an external data backup, e.g. upload from a memory card to the converter.

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

9.5.2 Know-how protection

Know-how protection

The know-how protection is used to encrypt configuring/engineering know-how, and protect it against being changed or copied.

The settings of the converter are protected by a password.

If the password is lost, only default settings are possible.

The active know-how protection provides the following:

- All setting parameters are invisible.
- Parameters cannot be changed with a commissioning tool, e.g. operator panel or STARTER.
- It is not possible to download the converter settings with the Starter or via a memory card
- It is not possible to use the trace function in the STARTER.
- Deleting the alarm history
- The STARTER dialog screens are disabled. The expert list in the STARTER contains only display parameters.

In the case of active know-how protection, support by technical support personnel is only possible with the consent of the machine manufacturer.

Copy protection

In conjunction with the copy protection, the converter settings can be coupled only to a single, pre-defined hardware.

The know-how protection with copy protection is possible only with the recommended Siemens memory card; also see Section: Overview of Control Units (Page 27)

Exception list

The active know-how protection permits an exception list for parameters to be defined that the customer may access.

If you remove the parameter for the password from the exception list, the know-how protection can only be undone by reverting to the factory settings.

Actions that are possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Show message history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters that are accessible even though know-how protection is active)

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Commissioning the converter with know-how protection

Procedure - overview

1. Commission the converter.
2. Create the exception list (Page 272).
3. Activate the know-how protection (Page 270).
4. Save the settings in the converter by copying RAM to ROM with  or via p0971 = 1.
5. Save the project with  on the PG/PC. Also back up any other project-related data (machine type, password, etc.) that may be required for the support of the end customer.

9.5.2.1 Settings for the know-how protection

Activating know-how protection

Preconditions

- You are online with STARTER.

  If you have created a project offline on your computer, you must download it to the inverter and go online.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 27).

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 267)).
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

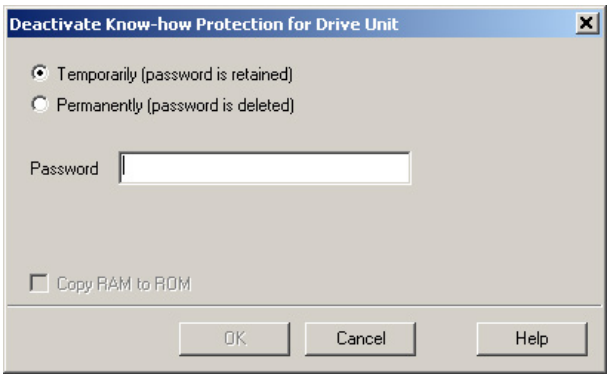
- You are online with STARTER.
- You have inserted the recommended Siemens card. See also Section: Overview of Control Units (Page 27).

Procedure

1
2

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
   - Temporary status: Know-how protection is active again after switching the power supply off and on.



   - Final status: If you select "Copy RAM to ROM", the inverter immediately deletes the password. If you do not select "Copy RAM to ROM", the inverter deletes the password the next time the supply voltage is switched off.
3. Enter the password and exit the screen form with OK.

You have deactivated know-how protection.

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

9.5.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure



Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ( ).
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

Corrective maintenance 10

10.1 Overview of replacing converter components

Permissible replacement of components

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

Replacing the Power Module		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • Same frame size • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
			
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the inverter's settings.	

⚠ WARNING

Risk of injury due to uncontrolled drive motion

Replacing inverters of different types can result in uncontrolled motion of the drive.

- In all cases that are not permitted according to the table above, recommission the drive after replacing an inverter.

Special issue relating to communication via PROFINET: Device replacement without removable data storage medium

The inverter supports the PROFINET functionality, replacing the device without data storage medium.

Precondition

The topology of the PROFINET IO system with the IO device involved is configured in your higher-level control system.

Replacing the device

The Control Unit can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the inverter – or having to reassign the device names with a PG.

Details of the device replacement without removable storage medium can be found in the PROFINET system description (http://support.automation.siemens.com/WW/view/en/19292127).

10.2 Replacing a Control Unit with enabled safety function

Replacing a Control Unit with data backup on a memory card

Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

Procedure



To replace the Control Unit, proceed as follows:

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

     The loaded settings are not compatible with the inverter.

     Clear the alarm with p0971 = 1 and recommission the drive.
   - Fault F01641:

     Acknowledge the message.

     Carry out a **reduced** acceptance test; see Section: Reduced acceptance test after component replacement (Page 291).



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

Replacing a Control Unit with data backup in the PC

Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using STARTER.

Procedure



To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Open the right project for the drive in STARTER.
8. Go online and transfer the settings from the PC to the inverter by pressing the  button.
   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
9. In STARTER, select the screen form for the safety functions.
10. Select the "Change settings" button.
11. Select the "Activate settings" button.
12. Save your settings (copy RAM to ROM).
13. Switch off the inverter power supply.
14. Wait until all LEDs on the inverter go dark.
15. Switch on the inverter power supply again (power on reset).
16. Perform a **reduced** acceptance test, see the section Reduced acceptance test after component replacement (Page 291).



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

Replacing the Control Unit with data backup in the operator Panel

Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

Procedure



To replace the Control Unit, proceed as follows:

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
8. Transfer the settings from the Operator Panel to the inverter.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs alarm A01028.
    - Alarm A01028:

      The loaded settings are not compatible with the inverter.

      Clear the alarm with p0971 = 1 and recommission the drive.
    - No alarm A01028: Proceed with the next step.
11. Switch off the inverter power supply.
12. Wait until all LEDs on the inverter go dark.
13. Switch on the inverter power supply again (power on reset).

    The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0010 to 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 to 0.
18. Back up the settings so they are powerfail proof.
    - BOP-2 in the menu "EXTRAS" - "RAM-ROM".
    - IOP in the menu "SAVE RAM TO ROM".
19. Switch off the inverter power supply.
20. Wait until all LEDs on the inverter go dark.
21. Switch on the inverter power supply again (power on reset).
22. Perform a **reduced** acceptance test, see the section Reduced acceptance test after component replacement (Page 291).



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 257)
- Transferring the setting from the memory card (Page 260)

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the inverter cannot be replaced as described in "Overview of replacing converter components (Page 273)".

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 270)
  - 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 270)
  - 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 270)
  - 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 270)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

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

10.6 Replacing a Power Module with enabled safety function



DANGER

Danger from touching energized Power Module connections

After switching off the mains voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.

- Check the safe isolation of the Power Module connections before carrying out installation work.

NOTICE

Material damage from swapping the motor's connection lines

The direction in which the motor rotates switches if you swap the two phases of the motor line. A motor running backwards may damage the machine or installation.

- Connect the three phases of the motor lines in the right order.
- After replacing the Power Module, check the direction in which the motor rotates.

Procedure



To replace the Power Module, proceed as follows:

1. Switch off the main voltage of the Power Module.
   You can leave any external 24 V supply to the Control Unit switched on.
2. Remove the connecting cables of the Power Module.
3. Remove the Control Unit from the Power Module.
4. Replace the Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.
7. Switch on the line supply and, if necessary, the 24 V supply for the Control Unit.
8. The inverter reports F01641.
9. Perform a reduced acceptance test, see the Section Reduced acceptance test after component replacement (Page 291).



You have successfully replaced the Power Module.

10.7 Replacing a Power Module without the safety function being enabled

Procedure



Proceed as follows to exchange a Power Module:

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



DANGER
Risk of electric shock from touching inverter connections
After the power supply has been switched off, it takes up to 5 min. until the capacitors in the inverter have discharged so that the remaining voltage is non-hazardous.
Check the voltage at the inverter connections, before removing the connection cables.

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

NOTICE
Material damage when interchanging the motor connecting cables
The direction in which the motor rotates switches if you exchange the two phases of the motor line.
Connect the three phases of the motor lines in the right order.
After exchanging the power module check the direction in which the motor rotates.

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



You have successfully replaced the Power Module.

10.8 Upgrading firmware

When upgrading the firmware, you replace the inverter firmware by a later version. Only update the firmware to a later version if you require the expanded functional scope of the newer version.

Precondition

- The firmware version of your inverter is at least V4.5.
- You have the memory card with the firmware that matches the inverter.
- Inverter and memory card have different firmware versions.

Procedure

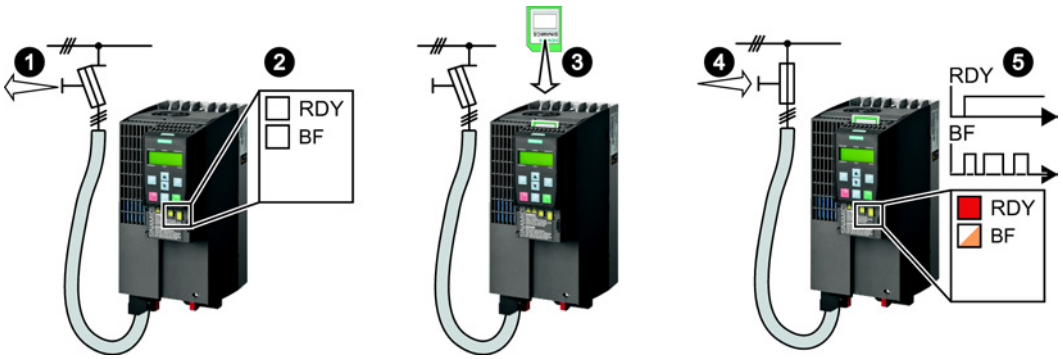


Proceed as follows to upgrade the inverter firmware to a later version:

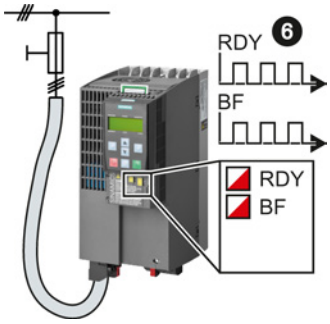
1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter go dark.
3. Insert the card with the matching firmware into the inverter slot until it latches into place.
4. Switch on the inverter power supply.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).



Note

Corrupted firmware if the power supply fails during the transfer

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

- Do not switch off the inverter power supply as long as data is being transferred.

7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark.

   Decide whether you will withdraw the memory card from the inverter:

   – You leave the memory card in the inverter:

     When the memory card still does not contain any data backup of the inverter settings, in the next step, the inverter writes its settings to the memory card.

     When the memory card already contains a data backup of the inverter settings, in the next step, the inverter takes the settings from the memory card.

     Note

     The inverter takes the settings from the memory card

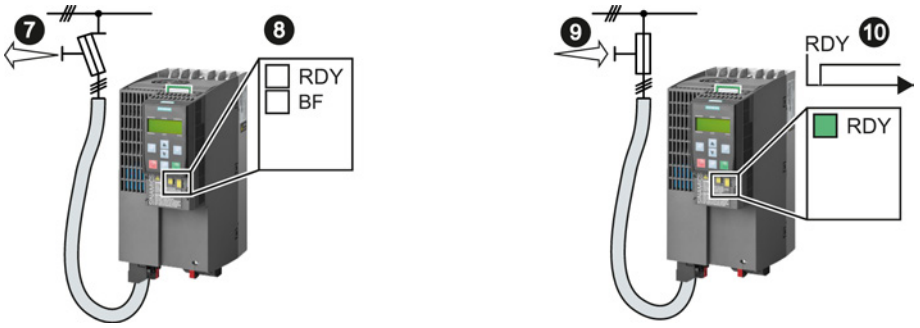
     The next steps can change the inverter settings.

     - If the memory card already contains settings, check as to whether these settings match the inverter.
     - Remove the memory card if these settings do not match the inverter.

   – You remove the memory card:

     The inverter keeps its settings.

9. Switch on the inverter power supply.
10. If the firmware upgrade was successful, after several seconds the inverter LED RDY turns green.



You have successfully updated the firmware to a more recent version. When upgrading, your settings in the inverter are kept.

Memory cards with license

If the memory card includes a license, e.g. for the basic positioner, then the memory card must remain inserted after the firmware has been updated.

10.9 Firmware downgrade

When downgrading the firmware, you replace the inverter firmware by an older version. Only downgrade the firmware to an older version if, after replacing an inverter, you require the same firmware in all of your inverters.

Precondition

- The firmware version of your inverter is at least V4.6.
- You have the memory card with the firmware that matches the inverter.
- Inverter and memory card have different firmware versions.
- You have backed up your settings on the memory card, in an operator panel or in a PC.

Procedure

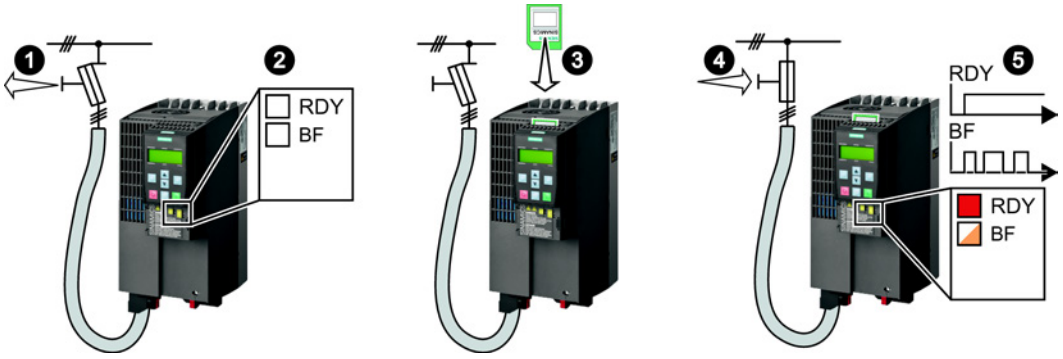


Proceed as follows to downgrade the inverter firmware to an older version:

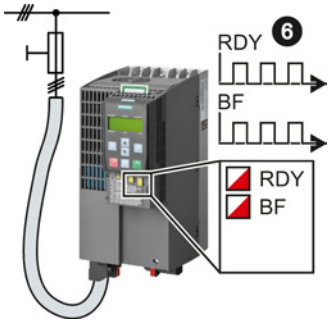
1. Switch off the inverter power supply.
2. Wait until all LEDs on the inverter go dark.
3. Insert the card with the matching firmware into the inverter slot until it latches into place.
4. Switch on the inverter power supply.
5. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes approximately 5 … 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The LED BF flashes orange with a variable frequency.



6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).



Note

Corrupted firmware if the power supply fails during the transfer

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

- Do not switch off the inverter power supply as long as data is being transferred.

7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark.

   Decide whether you will withdraw the memory card from the inverter:

   – You leave the memory card in the inverter:

     When the memory card already contains a data backup of the inverter settings, in the next step, the inverter takes the settings from the memory card.

     Note

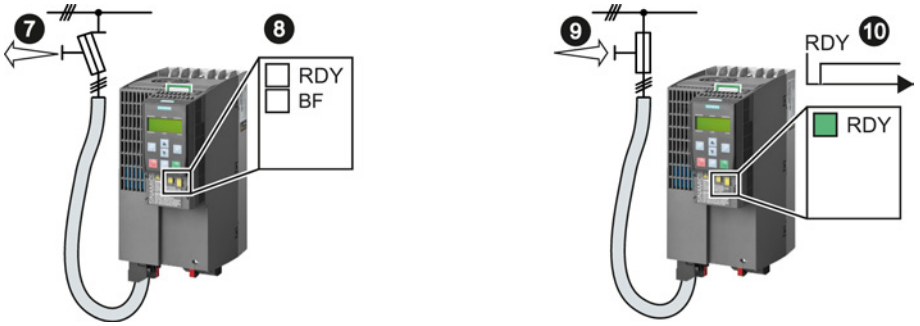
     The inverter takes the settings from the memory card

     The next steps can change the inverter settings.

     - If the memory card already contains settings, check as to whether these settings match the inverter.
     - Remove the memory card if these settings do not match the inverter.

   – You remove the memory card:

     The inverter is reset to the factory setting.
9. Switch on the inverter power supply.
10. If the firmware downgrade was successful, after several seconds the inverter LED RDY turns green.



    After the firmware has been downgraded, the inverter has been reset to the factory settings.
11. If the memory card does not contain a data backup of the inverter settings, then you must transfer your settings to the inverter from another data backup.

    See also Section: Backing up data and series commissioning (Page 255).

You have downgraded the firmware of the inverter to an older version and have transferred the backed up settings into the inverter.

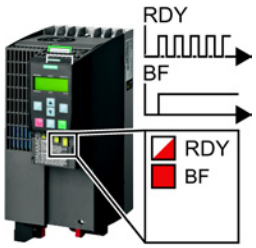
Memory cards with license

If the memory card includes a license, e.g. for the basic positioner, then the memory card must remain inserted after the firmware has been updated.

10.10 Correcting an unsuccessful firmware upgrade or downgrade

How does the inverter signal an unsuccessful upgrade or downgrade?

The inverter signals an unsuccessful firmware upgrade or downgrade by a quickly flashing LED RDY and the lit LED BF.



Correcting an unsuccessful upgrade or downgrade

You can check the following to correct an unsuccessful firmware upgrade or downgrade:

- Does the firmware version of your inverter fulfill the preconditions?
  - For an upgrade, as a minimum V4.5.
  - For a downgrade, as a minimum V4.6.
- Have you correctly inserted the card?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

10.11 Reduced acceptance test after component replacement

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Table 10- 1 Reduced acceptance test after component replacement

Measure	Acceptance test	Documentation
Replacing the Control Unit or the inverter with an identical type	An acceptance test for the safety functions is not required. Only check the motor's direction of rotation.	• Supplement inverter data • Log the new checksum • Countersignature
Replacing a Power Module with an identical type		Supplement the hardware version in the inverter data.
Replacing the motor with an identical pole pair number		No change.
Replacing the gearbox with an identical ratio		
Replacing the Safe Brake Relay	Check the SBC function.	Supplement the hardware version in the inverter data.
Replacing the safety-related peripherals (e.g. Emergency Stop switch).	Check the control of the safety functions affected by the components that have been replaced.	No change.
Inverter firmware update.	An acceptance test for the safety functions is not required. Check as to whether the firmware update was successful and the inverter functions as expected.	• Supplement firmware version in the inverter data • Log the new checksum • Countersignature

See also Section: Reduced acceptance test after function expansions (Page 251).

10.12 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 292)".

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 293)".

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 92).

10.12.1 Replacing the encoder - same encoder type

Procedure



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 75).
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 386).



You have replaced the encoder.

10.12.2 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 75).
11. Switch on the supply voltages.
12. Check that the drive functions correctly.



You have replaced the encoder with another encoder type.

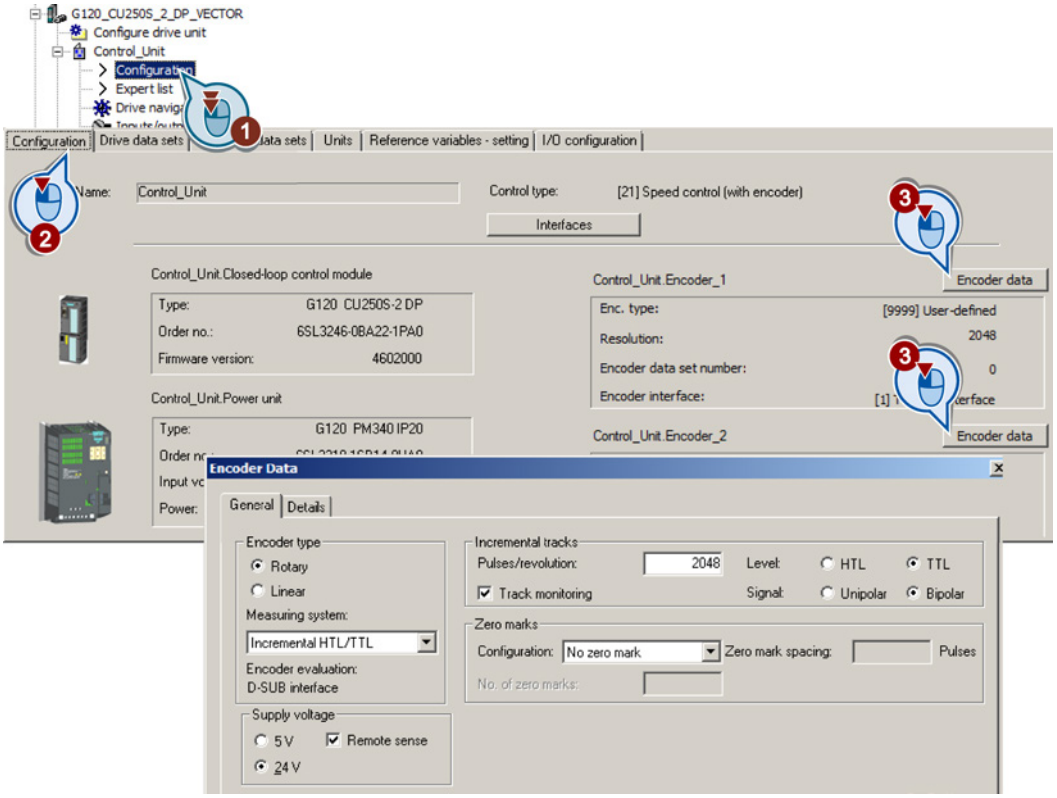
Changing the encoder data

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.

10.13 If the converter no longer responds

If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

Case 1

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

Procedure



Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018:
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.



You have restored the inverter factory settings.

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

Procedure



Proceed as follows to restore the inverter factory settings:

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter go dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter factory settings.

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 converter has the following diagnostic types:

- LED

  The LED at the front of the converter immediately informs you about the most important converter states.

- Alarms and faults

  The converter signals alarms and faults via

  – the fieldbus

  – the terminal strip with the appropriate setting

  – a connected operator panel, or

  – STARTER

  Alarms and faults have a unique number.

- Identification & maintenance data (I&M)

  If requested, the converter sends data to the higher-level control via PROFIBUS or PROFINET:

  – Converter-specific data

  – Plant-specific data

11.1 Operating states indicated on LEDs

The LED RDY (Ready) is temporarily orange after the power supply voltage is switched-on. As soon as the color of the LED RDY changes to either red or green, the LEDs signal the inverter state.

Signal states of the LED

In addition to the signal states "on" and "off" there are two different flashing frequencies:

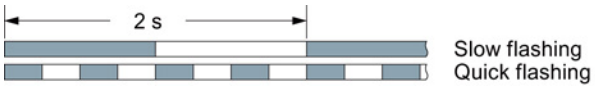


Table 11- 1 Inverter diagnostics

LED		Explanation
RDY	BF	
GREEN - on	Not relevant	There is presently no fault
GREEN - slow		Commissioning or reset to factory settings
RED - on	YELLOW - variable frequency	Firmware update in progress
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
RED - fast	Not relevant	There is presently a fault
GREEN/RED - slow		Licensing is not sufficient, for details, see Activating licensed functions (Page 352)

Table 11- 2 Communication diagnostics via PROFINET

LNK LED	Explanation
GREEN - on	The communication via PROFINET is in order.
GREEN - slow	Device naming is active.
Off	No communication via PROFINET.

Table 11- 3 Communication diagnostics via RS485

LED		Explanation
BF	RDY	
off	Not relevant	Data is being exchanged between the inverter and control
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
	All other states	The bus is active, however the inverter is not receiving any process data
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
	All other states	No bus connection available
YELLOW - variable frequency	RED - on	Firmware update in progress

Table 11- 4 Communication diagnostics via PROFIBUS DP

LED		Explanation
BF	RDY	
GREEN - on	Not relevant	Data is being exchanged between the inverter and control
off		PROFIBUS interface is not being used.
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
	All other states	Bus fault - configuration fault
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
	All other states	Bus error - no data exchange - inverter searches for baud rate - no connection
YELLOW - variable frequency	RED - on	Firmware update in progress

LED BF display for CANopen

In addition to the signal states "on" and "off" there are three different flashing frequencies:

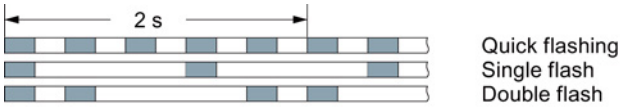


Table 11- 5 Communication diagnostics via CANopen

LED		Explanation
BF	RDY	
GREEN - on	Not relevant	Data is being exchanged between the inverter and control ("operational")
GREEN - fast		Bus state "Pre-Operational"
GREEN - single flash		Bus state "Stopped"
RED - on		No bus
RED - single flash		Alarm - limit reached
RED - double flash		Error event in control (Error Control Event)
RED - slow	RED - slow	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
YELLOW - variable frequency	RED - on	Firmware update in progress

Table 11- 6 Diagnostics of the safety functions

SAFE LED	Meaning
YELLOW - on	One or more safety functions are enabled, but not active.
YELLOW - slow	One or more safety functions are active; no safety function faults have occurred.
YELLOW - rapid	The converter has detected a safety function fault and initiated a STOP response.

11.2 System runtime

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

Principle of operation

The inverter starts the system runtime as soon as the inverter is supplied with power. The system runtime stops when the inverter is switched off.

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

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

If r2114[0] has reached a value of 86,400,000 ms (24 hours), the inverter sets r2114[0] the value 0 and increases the value of r2114[1] by 1.

Using system runtime, you can track the chronological sequence of faults and alarms over time. When a corresponding message is triggered, the inverter transfers the parameter values r2114 to the corresponding parameters of the alarm or fault buffer.

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

You cannot reset the system runtime.

11.3 Alarms

Alarms have the following properties:

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

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

Alarm buffer

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

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

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

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

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).
The converter uses an internal time calculation to save the alarm times. More information on the internal time calculation can be found in Chapter System runtime (Page 301).

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

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

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

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

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

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 11-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

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

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

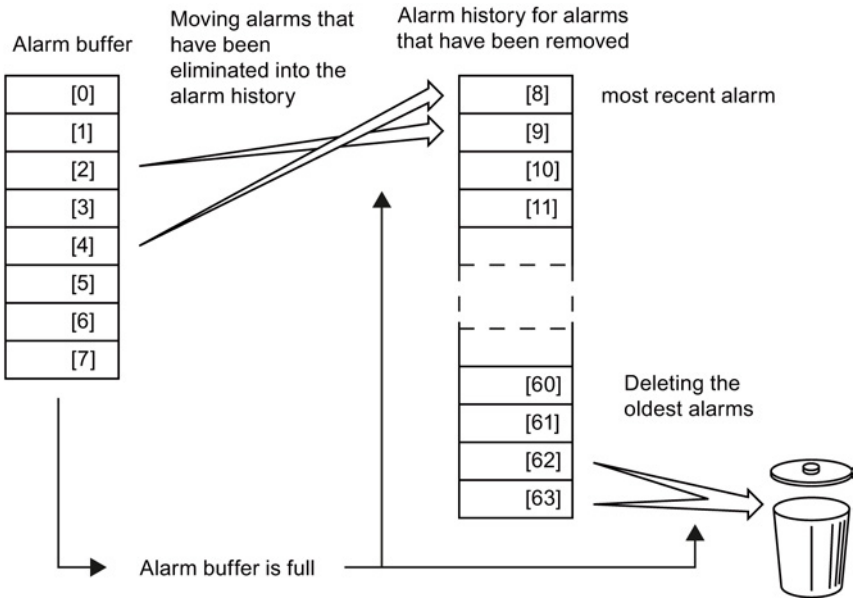


Figure 11-4 Shifting alarms that have been removed into the alarm history

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

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

Parameters of the alarm buffer and the alarm history

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

Extended settings for alarms

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

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

11.4 Faults

A fault indicates a severe fault during inverter operation.

The inverter signals a fault as follows:

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

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

Every fault has a unique fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	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 301).

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

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

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

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

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

Figure 11-7 Complete fault buffer

Acknowledgement

You have multiple options to acknowledge a fault, e.g.:

- PROFIdrive control word 1, bit 7 (r2090.7)
- Acknowledge via the operator panel
- Switch-off the inverter power supply and switch-on again.

Faults detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again. The list of faults in the List Manual contains a note on this limited acknowledgment possibility.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The acknowledgment has no effect as long as none of the causes for the faults in the buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgment of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

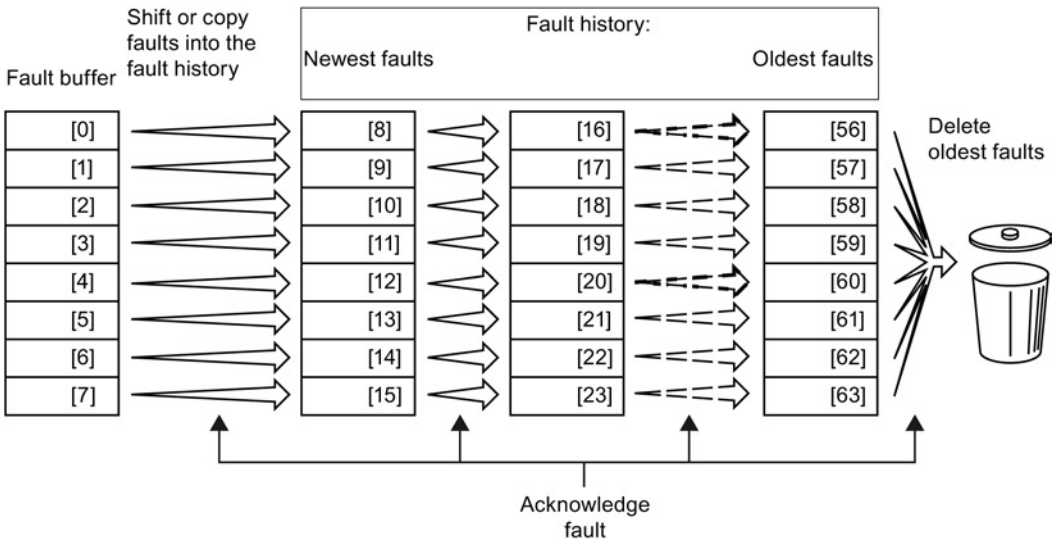


Figure 11-8 Fault history after acknowledging the faults

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

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

The inverter shifts the values previously saved in the fault history by eight indexes. Faults, which were saved in indexes 56 … 63 before the acknowledgment, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Parameter	Description
r0945	**Fault code** Displays the numbers of faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgment. The fault buffer is deleted with p0952 = 0.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred

Parameter	Description
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

Extended settings for faults

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

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

11.5 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 7 The most important alarms and faults of the safety functions

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

Table 11- 8 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

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

Number	Cause	Remedy
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 11- 9 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	1. Switch the module off and on again. 2. After this fault has been output, the module is booted with the factory settings. 3. Recommission the inverter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB). Check the module parameters and recommission if necessary.
F01033	Switching over units: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Switching over units: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
A01053	System overload measured	The maximum computing power of the Control Unit was exceeded. The following measures reduce the load on the Control Unit: • Use only one data record (CDS and DDS) • Only use the safety features of the basic functions • De-activate the technology controller • Use the simple ramp-function generator rather than the extended ramp-function generator • Do not use any free function components • Reduce the sampling time of the free function blocks
F01054	System limit exceeded	
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
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. Check the DRIVE-CLiQ cables at the Control Unit.

Number	Cause	Remedy
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The Modbus master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
F03505	Analog input, wire break	Check the wiring for interruptions. Check the level of the injected signal. The input current measured by the analog input can be read out in r0752.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed? See also: Inverter temperature monitoring (Page 180)
F06310	Supply voltage (p0210) incorrectly set	Check the set supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the motor temperature sensor fault evaluation (p0607 = 0).
F07086 F07088	Switching over units: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.

Number	Cause	Remedy
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	DC link voltage maximum controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down time of the ramp-function generator (p1121, p1135). • Deactivate the Vdc_max controller. See also Section: Limiting the maximum DC link voltage (Page 187).
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. Check the following: • Line voltage • Infeed Reduce the lower DC link voltage threshold (p1248).
F07404	DC link voltage monitoring V_{DCmax}	The DC link voltage monitoring p1284 has responded. Check the following: • Line voltage • Braking resistor • Device supply voltage (p210) 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: • Increase the current limit (p0640). • Reduce the load. • 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. Check the motor phase sequence (wiring, p1820). Adjust the encoder. Replace the encoder. Carry out motor data identification. 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. Check the motor phase sequence (wiring, p1820). Adjust the encoder. Replace the encoder. Carry out pole position identification.
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).

Number	Cause	Remedy
F07801	Motor overcurrent	Check current limits (p0640). Vector control: Check current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 … p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short-circuit and ground fault. Check the motor regarding the star/delta connection and rating plate parameterization. Check power unit / motor combination. Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit. See also: Inverter temperature monitoring (Page 180)
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short-circuit detected	• Check the inverter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: Remove the causes of these alarms.
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for this fault.
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).
F07901	Motor overspeed	Activate the precontrol for the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.
F07902	Motor stalled	Check whether the motor data has been set correctly and perform a motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.

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). Check the following: • Has the contactor feedback signal been incorrectly connected (p1235)? • Contactor feedback signal logic (r1239.1 = 1: "Closed", r1239.1 = 0: "Open"). 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). Check the following: • Has the contactor feedback signal been incorrectly connected (p1235)? • Contactor feedback signal logic (r1239.1 = 1: "Closed", r1239.1 = 0: "Open"). 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. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
F7966	Check commutation angle	Carry out pole position identification.
F7969	Pole position identification incorrect	An error has occurred during the pole position identification. Check the following: • Motor connection • Motor data
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor identification activated	Switch on the motor and identify the motor data.

Number	Cause	Remedy
F07995	Pole position identification unsuccessful	An error has occurred during the pole position identification. Check the following: • Motor connection • Motor data
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller into the RUN mode. • If the fault occurs repeatedly, check the monitoring time set p2044.
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.
A08800	PROFIenergy energy-saving mode active	The PROFIenergy energy-saving mode is active. 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 352).
F13010	Licensing is not sufficient	Options requiring a license are used in the inverter, and the licensing is not sufficient.
F13010	Licensing, function module not licensed.	At least one function module requiring a license is not licensed. Deactivate the function module that is not licensed.
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.

Number	Cause	Remedy
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Inverter overtemperature	Check whether the inverter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency. See also: Inverter temperature monitoring (Page 180)
F30005	I2t inverter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341. See also: Inverter temperature monitoring (Page 180)
F30011	Line phase failure	Check the input fuses of the inverter. Check the motor feeder cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30027	Time monitoring for DC link pre-charging	Check the line voltage at the input terminals. Check the line voltage setting (p0210).

Number	Cause	Remedy
F30024	Overtemperature, thermal model	• Adapt the duty cycle. • Check whether the fan is running. • Check whether the ambient temperature is in the permissible range. • Check the motor load. • Reduce the pulse frequency. • Reduce the current of the DC current braking. See also: Inverter temperature monitoring (Page 180)
F30035	Overtemperature, intake air	• Check whether the fan is running. • Check the fan filter elements. • Check whether the ambient temperature is in the permissible range.
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: • Check the motor load. • Check the line phases
A30049	Internal fan defective	Check the internal fan and if required replace.
F30059	Internal fan defective	Check the internal fan and if required replace.
A30502	DC link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.
A50001	PROFINET configuration error	A PROFINET controller is attempting to establish a connection with an incorrect configuration telegram. Check to see whether "Shared Device" is activated (p8929 = 2).
A50010	PROFINET name of station invalid	Correct name of station (p8920) and activate (p8925 = 2).
A50020	PROFINET: Second controller missing	"Shared Device" is activated (p8929 = 2). However, only the connection to a PROFINET controller is available.
For further information, please refer to the List Manual.		

For further information, please refer to the List Manual.

11.6 Identification & maintenance data (I&M)

I&M data

The inverter supports the following identification and maintenance (I&M) data.

I&M data	Format	Explanation	Associated parameters	Example for the content
I&M0	u8[64] PROFIBUS u8[54] PROFINET	Inverter-specific data, read only	-	See below
I&M1	Visible String [32]	Plant/system identifier	p8806[0 … 31]	"ak12-ne.bo2=fu1"
	Visible String [22]	Location code	p8806[32 … 53]	"sc2+or45"
I&M2	Visible String [16]	Date	p8807[0 … 15]	"2013-01-21 16:15"
I&M3	Visible String [54]	Any comment	p8808[0 … 53]	-
I&M4	Octet String[54]	Check signature to track changes for Safety Integrated. This value can be changed by the user. The test signature is reset to the value generated by the machine is p8805 = 0 is used.	p8809[0 … 53]	Values of r9781[0] and r9782[0]

When requested, the inverted transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7, STARTER or TIA-Portal.

I&M0

Designation	Format	Example for the content	Valid for PROFINET	Valid for PROFIBUS
Manufacturer-specific	u8[10]	00 … 00 hex	---	✓
MANUFACTURER_ID	u16	42d hex (=Siemens)	✓	✓
ORDER_ID	Visible String [20]	„6SL3246-0BA22-1FA0“	✓	✓
SERIAL_NUMBER	Visible String [16]	„T-R32015957“	✓	✓
HARDWARE_REVISION	u16	0001 hex	✓	✓
SOFTWARE_REVISION	char, u8[3]	„V“ 04.70.19	✓	✓
REVISION_COUNTER	u16	0000 hex	✓	✓
PROFILE_ID	u16	3A00 hex	✓	✓
PROFILE_SPECIFIC_TYPE	u16	0000 hex	✓	✓
IM_VERSION	u8[2]	01.02	✓	✓
IM_SUPPORTED	bit[16]	001E hex	✓	✓

12 Technical data

12.1 Technical data, CU250S-2 Control Unit

Feature	Data	
Order numbers	6SL3246-0BA22-1BA0	With RS485 interface for the following protocols: • USS • Modbus RTU
	6SL3246-0BA22-1PA0	With PROFIBUS interface
	6SL3246-0BA22-1FA0	With RJ45 connector for the following fieldbuses: • PROFINET • EtherNet/IP
	6SL3246-0BA22-1CA0	With CANopen interface.
Operating voltage	You have two options for the Control Unit power supply: • Supply from the Power Module. The sum of all of the currents of the following interfaces is limited to 0.8 A: – Encoder power supply – DRIVE-CLiQ – Power supply for the operator panel – Analog outputs – 24 V output voltage (terminal 9) – 24 V PROFIBUS teleservice – Resolver excitation If a short-circuit occurs at the output terminals when the CU is fully loaded, then the Power Module overcurrent protection acts, and the inverter is tripped with overcurrent (Power Module and Control Unit). • External supply via terminals 31 and 32 with 20.4 ... 28.8 VDC. Use a power supply with (PELV = Protective Extra Low Voltage according to EN 61800-5-1), Class 2. The 0 V of the power supply must be connected low-resistant with 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.

Feature	Data		
Output voltages	+24 V out (terminal 9)		18 V … 26.8 V (max. 200 mA)
	+10 V out (terminal 1)		9.5 V … 10.5 V (max. 10 mA)
	HTL encoder (terminal 33)		24 V, max. 200 mA
	HTL encoder (pins 4 and 5 of the Sub-D connector on the lower side of the Control Unit)		24 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 • Electrically isolated	
	4 can be switched over	• DI 24 … DI 27 • Not isolated	
	Common data	• Low < 5 V, high > 11 V • 30 V maximum input voltage • 5.5 mA current consumption • SIMATIC-compatible • 10 ms response time for debounce time p0724 = 0	
Pulse input	4 (DI 24 ... 27)	Maximum frequency 32 kHz	
Analog inputs	2 (AI 0, AI 1)	• Differential inputs • Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V • 120 Ω input resistance at 0 mA … 20 mA • 12-bit resolution • 13 ms ± 1 ms response time • 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 VDC / max. 0.5 A with resistive load	
	4 can be switched over	• DO 24 … DO27: Transistor outputs • Max. 0.1 A per output • An external power supply is required via terminals 31 and 32 • 2 ms update time	
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.		
Analog outputs	2 (AO 0, AO 1)	• 0 V … 10 V or 0 mA … 20 mA • Reference potential: "GND" • 16-bit resolution • 4 ms update time	

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 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. • 1.8 V_{rms} excitation voltage for ü = 0.5 • 8 kHz excitation frequency, synchronized to the current controller clock cycle 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 • Switching threshold 1650 Ω
	KTY84	• Short-circuit monitoring < 50 Ω • 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. • Maximum input voltage 30 V, 5.5 mA • Response time: – Typical: 5 ms + debounce time p9651 – Typical, if debounce time = 0: 6 ms – Worst-case scenario: 15 ms + debounce time – Worst case, if debounce time = 0: 16 ms
	The data of the extended functions of the safety functions can be found in the Safety Integrated Function Manual, see also Section: Manuals for your converter (Page 386).	
PFH	5 × 10E-8	Probability of failure of the safety functions (probability of failure per hour – PFH)
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 27).	
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.

Note

Short-term voltage dips in the external 24 V supply (≤ 3 ms and ≤ 95% of the rated voltage)

When the mains voltage of the inverter is switched off, the inverter responds to short-term voltage dips in the external 24 V supply with fault F30074. Communication via fieldbus, however, remains in effect in this case.

Permissible encoder cable lengths

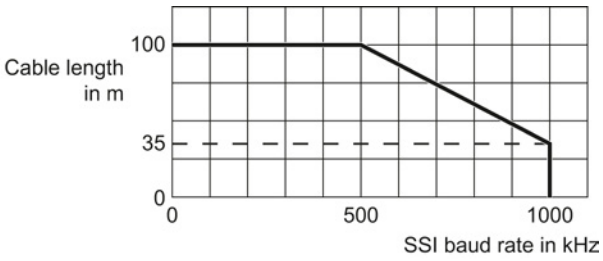
Permissible cable lengths depend on the encoder type and the encoder cable.

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

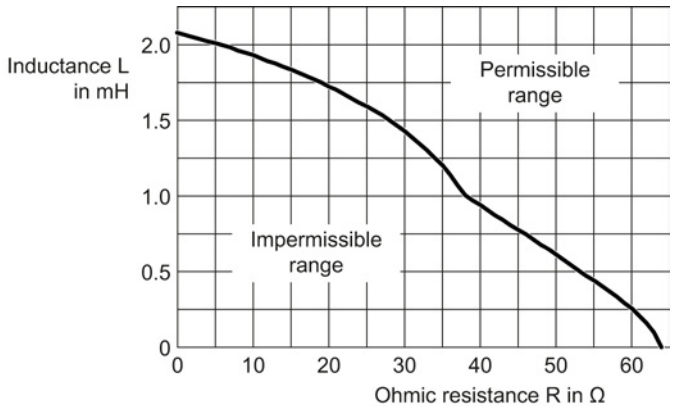


Figure 12-1 Connectable impedances with an excitation frequency of f = 8kHz

12.2 Technical data, Power Modules

Note

Please note that the base load (100% power or current) for "Low Overload" is higher than the base load for "High Overload".

The load cycles shown in the diagram are examples. We recommend the "SIZER" engineering software to select the inverter based on duty cycles. See Configuring support (Page 387).

Definitions

- **LO base load input current**

  100% of the permissible input current for a load cycle according to Low Overload.
- **LO base load output current**

  100% of the permissible output current for a load cycle according to Low Overload.
- **LO base load power**

  100 % of the inverter power for 100 % LO base load output current.
- **HO base load input current**

  100% of the permissible input current for a load cycle according to High Overload.
- **HO base load output current**

  100% of the permissible output current for a load cycle according to High Overload.
- **HO base load power**

  100 % of the inverter power for 100 % HO base load output current.

If not specified otherwise, the power and current data always refer to a load cycle according to Low Overload.

12.2.1 Technical data, PM240

Permissible inverter overload

The inverters have different load capabilities, "High Overload" and "Low Overload", depending on the expected.

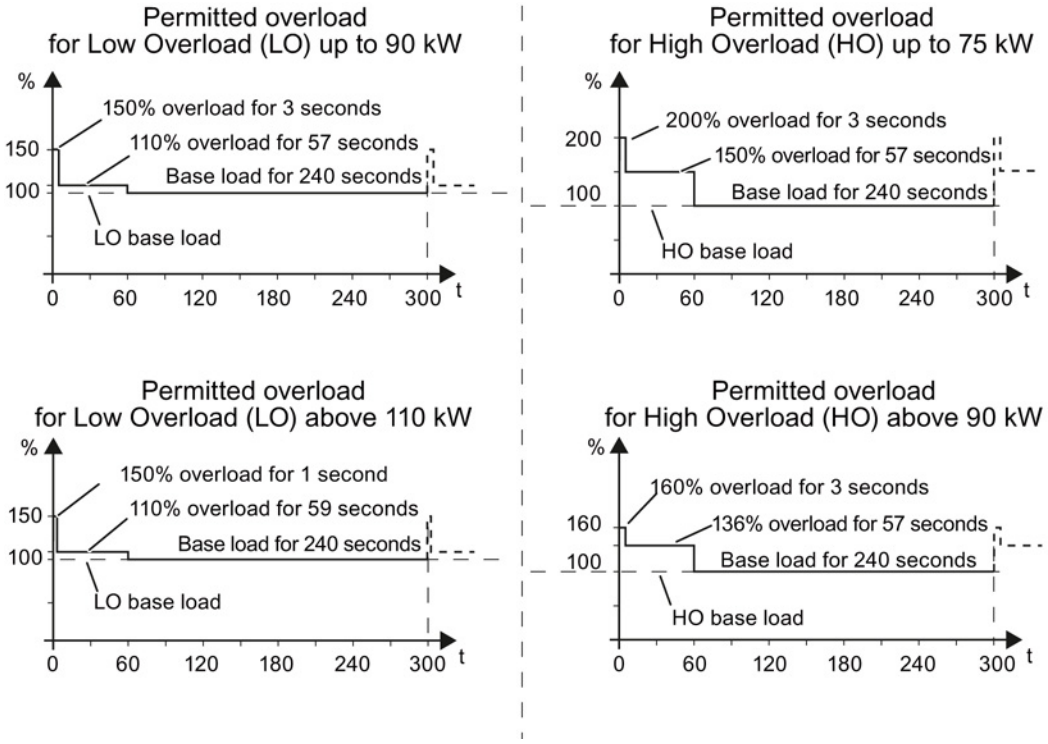


Figure 12-2 Load cycles, Low Overload" and "High Overload"

12.2.1.1 General data, PM240

Property	Version
Line voltage	380 V … 480 V 3-ph. AC ± 10 %
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)
Input frequency	50 Hz … 60 Hz, ± 3 Hz
Output frequency	0 … 550 Hz, depending on the control mode
Power factor λ	0,7 ... 0,85
Inrush current	< LO base load input current
Pulse frequency (factory setting)	4 kHz for 0.37 kW ... 90 kW 2 kHz for 110 kW ... 250 kW The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments. Details, see manuals for your inverter, Hardware Installation Manual PM240 (Page 386)

Property	Version		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20 chassis units		
Operating temperature at	LO base load power without derating	All power ratings	0 °C … +40 °C
	HO base load power without derating	0.37 kW ... 110 kW	0 °C … +50 °C
	HO base load power without derating	132 kW … 200 kW	0 °C … +40 °C
	LO/HO base load power with derating:	All power ratings	Up to 60° C
Storage temperature	-40 °C … +70 °C		
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Relative humidity	< 95% - condensation not permissible		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: 0.37 kW ... 132 kW 160 kW ... 250 kW with derating: all power ratings	up to 1000 m above sea level up to 2000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 348)
Standards	UL, cUL, CE, C-tick, SEMI F47 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.

Note

The values for Low Overload (LO) are identical with those of the rated values.

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
LO base load power		0.37 kW	0.55 kW	0.75 kW
LO base load input current		1.6 A	2.0 A	2.5 A
LO base load output current		1.3 A	1.7 A	2.2 A
HO base load power		0.37 kW	0.55 kW	0.75 kW
HO base load input current		1.6 A	2.0 A	2.5 A
HO base load output current		1.3 A	1.7 A	2.2 A
Fuse according to UL (from SIEMENS)		3NE1813-0, 16 A	3NE1813-0, 16 A	3NE1813-0, 16 A
Fuse according to UL (Class J, K-1 or K-5)		10 A	10 A	10 A
Power loss		0.097 kW	0.099 kW	0.102 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cables		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.2 kg	1.2 kg	1.2 kg

Table 12- 3 PM240, IP20, frame sizes A, 3-ph. 380 V AC… 480 V

Order No. - without filter	6SL3224-…	…0BE21-1UA0	…0BE21-5UA0
LO base load power		1.1 kW	1.5 kW
LO base load input current		3.9 A	4.9 A
LO base load output current		3.1 A	4.1 A
HO base load power		1.1 kW	1.5 kW
HO base load input current		3.8 A	4.8 A
HO base load output current		3.1 A	4.1 A
Fuse according to UL (from SIEMENS)		3NE1813-0, 16 A	3NE1813-0, 16 A
Fuse according to UL (Class J, K-1 or K-5)		10 A	10 A
Power loss		0.108 kW	0.114 kW
Required cooling air flow		4.8 l/s	4.8 l/s
Cross section of line and motor cables		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.1 kg	1.1 kg

Table 12- 4 PM240, IP20, frame sizes B, 3-ph. 380 V AC… 480 V

Order No. - without filter **6SL3224-…**	**…0BE22-2UA0**	**…0BE23-0UA0**	**…0BE24-0UA0**
Order No. - with filter **6SL3224-…**	**…0BE22-2AA0**	**…0BE23-0AA0**	**…0BE24-0AA0**
LO base load power	2.2 kW	3 kW	4 kW
LO base load input current	7.6 A	10.2 A	13.4 A
LO base load output current	5.9 A	7.7 A	10.2 A
HO base load power	2.2 kW	3 kW	4 kW
HO base load input current	7.6 A	10.2 A	13.4 A
HO base load output current	5.9 A	7.7 A	10.2 A
Fuse according to UL (from SIEMENS)	3NE1813-0, 16 A	3NE1813-0, 16 A	3NE1814-0, 20 A
Fuse according to UL (Class J, K-1 or K-5)	16 A	16 A	20 A
Power loss	0.139 kW	0.158 kW	0.183 kW
Required cooling air flow	24 l/s	24 l/s	24 l/s
Cross section of line and motor cables	1.5 … 6 mm^2 16 … 10 AWG	1.5 … 6 mm^2 16 … 10 AWG	1.5 … 6 mm^2 16 … 10 AWG
Tightening torque for line and motor cables	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 **6SL3224-…**	**…0BE25-5UA0**	**…0BE27-5UA0**	**…0BE31-1UA0**
Order No. - with filter **6SL3224-…**	**…0BE25-5AA0**	**…0BE27-5AA0**	**…0BE31-1AA0**
LO base load power	7.5 kW	11 kW	15 kW
LO base load input current	21.9 A	31.5 A	39.4 A
LO base load output current	18 A	25 A	32 A
HO base load power	5.5 kW	7.5 kW	11 kW
HO base load input current	16.7 A	23.7 A	32.7 A
HO base load output current	13.2 A	19 A	26 A
Fuse according to UL (from SIEMENS)	3NE1814-0, 20 A	3NE1814-0, 20 A	3NE1803-0, 35 A
Fuse according to UL (Class J, K-1 or K-5)	20 A	20 A	35 A
Power loss	0.240 kW	0.297 kW	0.396 kW
Required cooling air flow	55 l/s	55 l/s	55 l/s
Cross section of line and motor cables	4 … 10 mm^2 12 … 8 AWG	4 … 10 mm^2 12 … 8 AWG	4 … 10 mm^2 12 … 8 AWG
Tightening torque for line and motor cables	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight without filter	6.5 kg	6.5 kg	6.5 kg
Weight with filter	7 kg	7 kg	7 kg

Table 12- 6 PM240, IP20, frame sizes D, 3-ph. 380 V AC… 480 V

Order No. - without filter	**6SL3224-…**	**…0BE31-5UA0**	**…0BE31-8UA0**	**…0BE32-2UA0**
Order No. - with filter	**6SL3224-…**	**…0BE31-5AA0**	**…0BE31-8AA0**	**…0BE32-2AA0**
LO base load power		18.5 kW	22 kW	30 kW
LO base load input current		46 A	53 A	72 A
LO base load output current		38 A	45 A	60 A
HO base load power		15 kW	18.5 kW	22 kW
HO base load input current		40 A	46 A	56 A
HO base load output current		32 A	38 A	45 A
Fuse according to UL (from SIEMENS)		3NE1817-0	3NE1818-0	3NE1820-0
Fuse according to UL (Class J)		50 A, 600 V	---	---
Power loss		0.44 kW 0.42 kW	0.55 kW 0.52 kW	0.72 kW 0.69 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		10 … 35 mm^2 7 … 2 AWG	10 … 35 mm^2 7 … 2 AWG	16 … 35 mm^2 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		13 kg	13 kg	13 kg
Weight with filter		16 kg	16 kg	16 kg

Table 12- 7 PM240, IP20, frame sizes E, 3-ph. 380 V AC… 480 V

Order No. - without filter	**6SL3224-…**	**…0BE33-0UA0**	**…0BE33-7UA0**
Order No. - with filter	**6SL3224-…**	**…0BE33-0AA0**	**…0BE33-7AA0**
LO base load power		37 kW	45 kW
LO base load input current		88 A	105 A
LO base load output current		75 A	90 A
HO base load power		30 kW	37 kW
HO base load input current		73 A	90 A
HO base load output current		60 A	75 A
Fuse according to UL (from SIEMENS)		3NE1021-0	3NE1022-0
Fuse according to UL		---	---
Power losses without filter		0.99 kW	1.2 kW
Power losses with filter		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cables		25 … 35 mm^2 3 … 2 AWG	25 … 35 mm^2 3 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter		16 kg	16 kg
Weight with filter		23 kg	23 kg

Table 12- 8 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

Order No. - without filter **6SL3224-…** **Order No. - with filter** **6SL3224-…**	**…0BE34-5UA0** **…0BE34-5AA0**	**…0BE35-5UA0** **…0BE35-5AA0**	**…0BE37-5UA0** **…0BE37-5AA0**
LO base load power	55 kW	75 kW	90 kW
LO base load input current	129 A	168 A	204 A
LO base load output current	110 A A	145 A	178 A
HO base load power	45 kW	55 kW	75 kW
HO base load input current	108 A	132 A	169 A
HO base load output current	90 A	110 A	145 A
Fuse according to UL (from SIEMENS) Fuse according to UL (Class J)	3NE1224-0 150 A, 600 V	3NE1225-0 200 A, 600 V	3NE1227-0 250 A, 600 V
Power losses without filter	1.4 kW	1.9 kW	2.3 kW
Power losses with filter	1.5 kW	2.0 kW	2.4 kW
Required cooling air flow	94 l/s	94 l/s	117 l/s
Cross section of line and motor cables	35 … 120 mm^2 2 … 4/0 AWG	70 … 120 mm^2 2/0 … 4/0 AWG	95 … 120 mm^2 3/0 … 4/0 AWG
Tightening torque for line and motor cables	13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight without filter Weight with filter	36 kg 52 kg	36 kg 52 kg	36 kg 52 kg

Table 12- 9 PM240, IP20, frame sizes F, 3-ph. 380 V AC… 480 V

Order No. - without filter **6SL3224-…**	**…0BE38-8UA0**	**…0BE41-1UA0**
LO base load power	110 kW	132 kW
LO base load input current	234 A	284 A
LO base load output current	205 A	250 A
HO base load power	90 kW	110 kW
HO base load input current	205 A	235 A
HO base load output current	178 A	205 A
Fuse according to UL (from SIEMENS) Fuse according to UL	3NE1227-0 300 A, 600 V, Class J	3NE1230-0 400 A, 600 V, Class J
Power loss	2.4 kW	2.5 kW
Required cooling air flow	117 l/s	117 l/s
Cross section of line and motor cables	95 … 120 mm^2 3/0 … 4/0 AWG	95 … 120 mm^2 3/0 … 4/0 AWG
Tightening torque for line and motor cables	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight	39 kg	39 kg

Table 12- 10 PM240 frame sizes GX, 3-ph. 380 V AC… 480 V

Order No. - without filter 6SL3224-…	…0XE41-3UA0	…0XE41-6UA0	…0XE42-0UA0
LO base load power	160 kW	200 kW	240 kW
LO base load input current	297 A	354 A	442 A
LO base load output current	302 A	370 A	477 A
HO base load power	132 kW	160 kW	200 kW
HO base load input current	245 A	297 A	354 A
HO base load output current	250 A	302 A	370 A
Fuse according to IEC Fuse according to UL (from SIEMENS)	3NA3254 3NE1333-2	3NA3260 3NE1333-2	3NA3372 3NE1436-2
Power loss,	3.9 kW	4.4 kW	5.5 kW
Required cooling air flow	360 l/s	360 l/s	360 l/s
Cross section of line and motor cables	95 ... 2 x 240 mm^2 3/0 … 2 x 600 AWG	120 ... 2 x 240 mm^2 4/0 … 2 x 600 AWG	185 ... 2 x 240 mm^2 6/0 … 2 x 600 AWG
Tightening torque for line and motor cables	14 Nm / 120 lbf in	14 Nm / 120 lbf in	14 Nm / 120 lbf in
Weight	176 kg	176 kg	176 kg

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

Relationship between pulse frequency and output base-load current reduction

Table 12- 13 Current reduction depending on pulse frequency

LO base load	Output base-load current at pulse frequency of							
	2 kHz	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW	A	A	A	A	A	A	A	A
0.37	--	1.30	1.11	0.91	0.78	0.65	0.59	0.52
0.55	--	1.70	1.45	1.19	1.02	0.85	0.77	0.68
0.75	--	2.20	1.87	1.54	1.32	1.10	0.99	0.88
1.1	--	3.10	2.64	2.17	1.86	1.55	1.40	1.24
1.5	--	4.10	3.49	2.87	2.46	2.05	1.85	1.64
2.2	--	5.90	5.02	4.13	3.54	2.95	2.66	2.36
3.0	--	7.70	6.55	5.39	4.62	3.85	3.47	3.08
4.0	--	10.20	8.67	7.14	6.12	5.10	4.59	4.08
7.5	--	18.00	16.20	13.30	11.40	9.50	8.60	7.60
11.0	--	25.00	22.10	18.20	15.60	13.00	11.70	10.40
15.0	--	32.00	27.20	22.40	19.20	16.00	14.40	12.80
18.5	--	38.00	32.30	26.60	22.80	19.00	17.10	15.20
22	--	45.00	38.25	31.50	27.00	22.50	20.25	18.00
30	--	60.00	52.70	43.40	37.20	31.00	27.90	24.80
37	--	75.00	63.75	52.50	45.00	37.50	33.75	30.00
45	--	90.00	76.50	63.00	54.00	45.00	40.50	36.00
55	--	110.0	93.50	77.00	--	--	--	--
75	--	145.0	123.3	101.5	--	--	--	--
90	--	178.0	151.3	124.6	--	--	--	--
110	205.0	178.0	--	--	--	--	--	--
132	250.0	205.0	--	--	--	--	--	--
160	302.0	250.0	--	--	--	--	--	--
200	370.0	302.0	--	--	--	--	--	--
250	477.0	370.0	--	--	--	--	--	--

12.2.2 Technical data, PM240-2

Permissible inverter overload

The inverters have different load capabilities, "High Overload" and "Low Overload", depending on the expected.

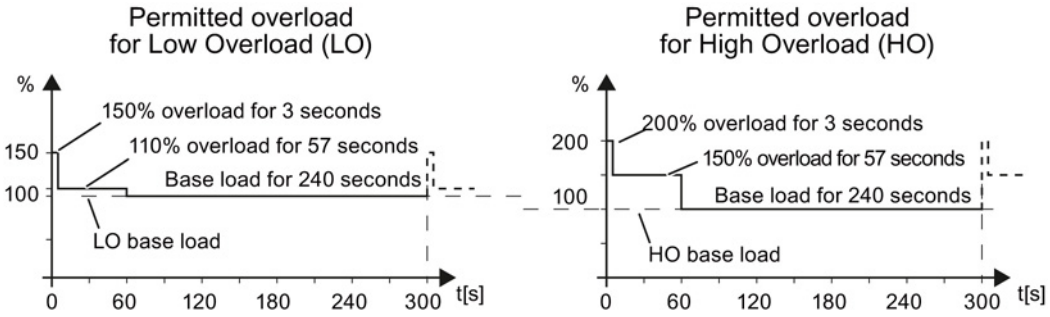


Figure 12-3 Load cycles, Low Overload" and "High Overload"

12.2.2.1 General data, PM240-2 - 400V

If not specified otherwise, the data listed here apply up to installation altitudes of 2000 m above sea level.
You can find the values for higher installation altitudes under "Restrictions for special ambient conditions (Page 348)".

Property	Version
Line voltage	3 AC 380 V … 480 V -20 %, +10 %
Output voltage	3 AC 0 V … 0.95 * input voltage (max.) for U/f control systems 3 AC 0 V … 0.90 * input voltage (max.) for vector control
Input frequency	50 Hz … 60 Hz, ± 3 Hz
Output frequency	0 … 550 Hz, depending on the control mode
Line impedance	Uk ≥ 1%, a line reactor is required for lower values
Power factor λ	0.7 at Uk = 1 %
Inrush current	< LO base load input current
Overvoltage category	The inverter insulation is designed for surge voltages according to EN 60664-1 according to the following categories: Overvoltage category III: Supply circuits Overvoltage category II: Non-supply circuits
Pulse frequency	4 kHz (factory setting) Can be adjusted in 2 kHz steps from 4 kHz … 16 kHz. The output current is reduced if you increase the pulse frequency.
Short-circuit current rating (SCCR)	65 kA When fused using a type J or 3NE1 fuse, rated voltage 600 V AC with the rated current of the specific inverter.
Electromagnetic compatibility	Devices with integrated filter are in accordance with IEC 61800-3 and are suitable for category C2 environments.
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper

Property	Version		
Degree of protection	Chassis devices PT devices	IP20 when installed in a control cabinet according to EN60529 IP54 at the control cabinet panel	acc. to EN60529
Operating temperature at	LO base load power without derating		-5 °C … +40 °C
	HO base load power without derating		-5 °C … +50 °C
	LO/HO base load power with derating:		-5 °C … + 60° C
Storage temperature	-40 °C … +70 °C		
Relative humidity	< 95% - condensation not permissible		
Pollution	Protected according to degree of pollution 2 to EN 61800-5-1		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2 • Vibration during operation according to Class 3M2 to EN 60721-3-3		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	Details see Section Restrictions for special ambient conditions (Page 348).
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

12.2.2.2 Power-dependent data PM240-2

Table 12- 14 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter Order No. - with filter	6SL3210… 6SL3210…	…1PE11-8UL1 …1PE11-8AL1	…1PE12-3UL1 …1PE12-3AL1	…1PE13-2UL1 …1PE13-2AL1
LO base load power LO base load input current LO base load output current		0,55 kW 2,3 A 1,7 A	0,75 kW 2,9 A 2,2 A	1,1 kW 4,1 A 3,1 A
HO base load power HO base load input current HO base load output current		0,37 kW 2,0 A 1,3 A	0,55 kW 2,6 A 1,7 A	0,75 kW 3,3 A 2,2 A
Fuse according to IEC Fuse according to UL		3NA3 804 (4A) 4 A Class J	3NA3 804 (4A) 4 A Class J	3NA3 801 (6 A) 6 A Class J
Power losses without filter Power losses with filter		0,04 kW 0,04 kW	0,04 kW 0,04 kW	0,04 kW 0,04 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cables		1 … 2,5 mm^2 18 … 14 AWG	1 … 2,5 mm^2 18 … 14 AWG	1 … 2,5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in
Weight without filter Weight with filter		1,4 kg 1,5 kg	1,4 kg 1,5 kg	1,4 kg 1,5 kg

Table 12- 15 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3210…**	**…1PE14-3UL1**	**…1PE16-1UL1**	**…1PE18-0UL1**
Order No. - with filter	**6SL3210…**	**…1PE14-3AL1**	**…1PE16-1AL1**	**…1PE18-0AL1**
LO base load power		1,5 kW	2,2 kW	3,0 kW
LO base load input current		5,5 A	7,7 A	10,1 A
LO base load output current		4,1 A	5,9 A	7,7 A
HO base load power		1,1 kW	1,5 kW	2,2 kW
HO base load input current		4,7 A	6,1 A	8,8 A
HO base load output current		3,1 A	4,1 A	5,9 A
Fuse according to IEC		3NA3 803 (10 A)	3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A Class J	10 A Class J	15 A Class J
Power losses without filter		0,07 kW	0,1 kW	0,12 kW
Power losses with filter		0,07 kW	0,1 kW	0,12 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cables		1 … 2,5 mm^2 18 … 14 AWG	1,5 … 2,5 mm^2 16 … 14 AWG	1,5 … 2,5 mm^2 16 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in	0,5 Nm / 4 lbf in
Weight without filter		1,4 kg	1,4 kg	1,4 kg
Weight with filter		1,5 kg	1,5 kg	1,5 kg

Table 12- 16 PM240-2, PT, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**…1PE18-0UL1**
Order No. - with filter	**6SL3211…**	**…1PE18-0AL1**
LO base load power		3,0 kW
LO base load input current		10,1 A
LO base load output current		7,7 A
HO base load power		2,2 kW
HO base load input current		8,8 A
HO base load output current		5,9 A
Fuse according to IEC		3NA3 805 (16 A)
Fuse according to UL		15 A Class J
Power losses without filter		0,12 kW [1)]
Power losses with filter		0,12 kW [1)]
Required cooling air flow		7 l/s
Cross section of line and motor cables		1,5 … 2,5 mm^2 16 … 14 AWG
Tightening torque for line and motor cables		0,5 Nm / 4 lbf in
Weight without filter		1,7 kg
Weight with filter		---

1) approx. 0.1 kW through the heatsink

Table 12- 17 PM240-2, IP20, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3210…** **6SL3210…**	**…1PE21-1UL0** **…1PE21-1AL0**	**…1PE21-4UL0** **…1PE21-4AL0**	**…1PE21-8UL0** **…1PE21-8AL0**
LO base load power LO base load input current LO base load output current		4,0, kW 13,3 A 10,2 A	5,5 kW 17,2 A 13,2 A	7,5 kW 22,2 A 18,0 A
HO base load power HO base load input current HO base load output current		3,0 kW 11,6 A 7,7 A	4,0 kW 15,3 A 10,2 A	5,5 kW 19,8 A 13,7 A
Fuse according to IEC Fuse according to UL		3NE 1814-0 (20 A) 20 A Class J	3NE 1815-0 (25 A) 25 A Class J	3NE 1803-0 (35 A) 35 A Class J
Power losses without filter Power losses with filter		0,11 kW 0,11 kW	0,15 kW 0,15 kW	0,2 kW 0,2 kW
Required cooling air flow		9,2 l/s	9,2 l/s	9,2 l/s
Cross section of line and motor cables		1,5 … 6 mm^2 16 … 10 AWG	1,5 … 6 mm^2 16 … 10 AWG	1,5 … 6 mm^2 16 … 10 AWG
Tightening torque for line and motor cables		0,6 Nm / 5 lbf in	0,6 Nm / 5 lbf in	0,6 Nm / 5 lbf in
Weight without filter Weight with filter		2,9 kg 3,1 kg	2,9 kg 3,1 kg	3,0 kg 3,2 kg

Table 12- 18 PM240-2, PT, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - without filter **Order No. - with filter**	**6SL3211…** **6SL3211…**	**...1PE21-8UL0** **...1PE21-8AL0**
LO base load power LO base load input current LO base load output current		7,5 kW 22,2 A 18,0 A
HO base load power HO base load input current HO base load output current		5,5 kW 19,8 A 13,7 A
Fuse according to IEC Fuse according to UL		3NE 1803-0 (35 A) 35 A Class J
Power losses without filter Power losses with filter		0,2 kW [1)] 0,2 kW [1)]
Required cooling air flow		9,2 l/s
Cross section of line and motor cables		1,5 … 6 mm^2 16 … 10 AWG
Tightening torque for line and motor cables		0,6 Nm / 5 lbf in
Weight without filter Weight with filter		3,6 kg 3,9 kg

1) approx. 0.18 kW through the heatsink

Table 12- 19 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 base load power		11,0 kW	15,0 kW
LO base load input current		32,6 A	39,9 A
LO base load output current		26,0 A	32,0 A
HO base load power		7,5 kW	11,0 kW
HO base load input current		27,0 A	36,0 A
HO base load output current		18,0 A	26,0 A
Fuse according to IEC		3NE 1817-0 (50 A)	3NE 1817-0 (50 A)
Fuse according to UL		50 A Class J	50 A Class J
Power losses without filter		0,3 kW	0,37 kW
Power losses with filter		0,3 kW	0,37 kW
Required cooling air flow		18,5 l/s	18,5 l/s
Cross section of line and motor cables		6 …16 mm^2 10 … 6 AWG	6 …16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1,3 Nm / 12 lbf in	1,3 Nm / 12 lbf in
Weight without filter		4,7 kg	4,8 kg
Weight with filter		5,3 kg	5,4 kg

Table 12- 20 PM240-2, PT, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - without filter	**6SL3211…**	**...1PE23-3UL0**
Order No. - with filter	**6SL3211…**	**...1PE23-3AL0**
LO base load power		15,0 kW
LO base load input current		39,9 A
LO base load output current		32,0 A
HO base load power		11,0 kW
HO base load input current		36,0 A
HO base load output current		26,0 A
Fuse according to IEC		3NE 1817-0 (50 A)
Fuse according to UL		50 A Class J
Power losses without filter		0,37 kW [1)]
Power losses with filter		0,37 kW [1)]
Required cooling air flow		18,5 l/s
Cross section of line and motor cables		6 …16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1,3 Nm / 12 lbf in
Weight without filter		5,8 kg
Weight with filter		6,3 kg

1) approx. 0.35 kW through the heatsink

Current derating depending on the pulse frequency

Table 12- 21 Current derating depending on the pulse frequency [1] for 400 V devices

Order number	LO base load output current for a pulse frequency of … [A]						
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
6SL3210-1PE11-8□L1	**1,7**	1,4	1,2	1,0	0,9	0,8	0,7
6SL3210-1PE12-3□L1	**2,2**	1,9	1,5	1,3	1,1	1,0	0,9
6SL3211-1PE13-2□L1	**3,1**	2,6	2,2	1,9	1,6	1,4	1,2
6SL3210-1PE14-3□L1	**4,1**	3,5	2,9	2,5	2,1	1,8	1,6
6SL3210-1PE16-1□L1	**5,9**	5,0	4,1	3,5	3,0	2,7	2,4
6SL321□-1PE18-0□L1	**7,7**	6,5	5,4	4,6	3,9	3,5	3,1
6SL3210-1PE21-1□L0	**10,2**	8,7	7,1	6,1	5,1	4,6	4,1
6SL3210-1PE21-4□L0	**13,2**	11,2	9,2	7,9	6,6	5,9	5,3
6SL321□-1PE21-8□L0	**18,0**	15,3	12,6	10,8	9,0	8,1	7,2
6SL3210-1PE22-7□L0	**26,0**	22,1	18,2	15,6	13,0	11,7	10,4
6SL321□-1PE23-3□L0	**32,0**	27,2	22,4	19,2	16	14,4	12,8

[1] The permissible motor cable length also depends on the cable type and the selected pulse frequency.

12.2.3 Technical data, PM250

Permissible inverter overload

The inverters have different load capabilities, "High Overload" and "Low Overload", depending on the expected.

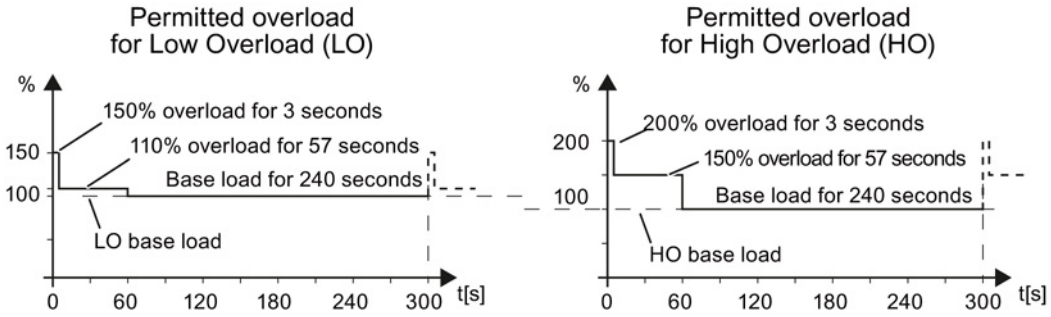


Figure 12-4 Load cycles, Low Overload" and "High Overload"

12.2.3.1 General data, PM250

Property	Version	
Line voltage	380 V … 480 V 3-ph. AC ± 10 %	
Output voltage	0 V 3-ph. AC … input voltage x 0.87 (max.)	
Input frequency	47 Hz … 63 Hz	
Power factor λ	0.9	
Inrush current	< LO base load input current	
Pulse frequency (factory setting)	4 kHz The pulse frequency can be adjusted up to 16 kHz in 2 kHz steps. The higher the pulse frequency, the lower the available output current. For details, see Power-dependent data, PM250 (Page 340).	
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments.	
Braking methods	DC braking, energy recovery (up to 100% of the output power)	
Degree of protection	IP20 chassis units	
Operating temperature at	LO base load power without derating	0 °C … +40 °C
	HO base load power without derating	0 °C … +50 °C
	LO/HO base load power with derating:	Up to 60° C
	For details, see Restrictions for special ambient conditions (Page 348).	
Storage temperature	-40 °C … +70 °C	
Relative humidity	< 95% - condensation not permissible	
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007	
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995	

Property	Version		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 348)
Standards	UL, CE, CE, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.		

12.2.3.2 Power-dependent data, PM250

Note

The values for Low Overload (LO) are identical with those of the rated values.

Table 12- 22 PM250, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - with filter	6SL3225-…	0BE25-5AA0	0BE27-5AA0	0BE31-1AA0
LO base load power		7.5 kW	11 kW	15 kW
LO base load input current		18 A	25 A	32 A
LO base load output current		18 A	25 A	32 A
HO base load power		5. 5 kW	7.5 kW	11 kW
HO base load input current		13.2 A	19 A	26 A
HO base load output current		13.2 A	19 A	26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power loss		0.24 kW	0.30 kW	0.31 kW
Required cooling air flow		38 l/s	38 l/s	38 l/s
Cross section of line and motor cables		2.5 … 10 mm^2 14 … 8 AWG	4.0 … 10 mm^2 12 … 8 AWG	4.0 … 10 mm^2 12 … 8 AWG
Tightening torque for line and motor cables		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight		7.5 kg	7.5 kg	7.5 kg

Table 12- 23 PM250, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - with filter	6SL3225-…	0BE31-5AA0	0BE31-8AA0	0BE32-2AA0
LO base load power		18.5 kW	22 kW	30 kW
LO base load input current		36 A	42 A	56 A
LO base load output current		38 A	45 A	60 A
HO base load power		15 kW	18.5 kW	22 kW
HO base load input current		30 A	36 A	42 A
HO base load output current		32 A	38 A	45 A
Fuse according to IEC Fuse according to UL		3NA3820 50 A, Class J	3NA3822 63 A, Class J	3NA3824 80 A, Class J
Power loss		0.44 kW	0.55 kW	0.72 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		10 … 35 mm^2 7 … 2 AWG	10 … 35 mm^2 7 … 2 AWG	16 … 35 mm^2 6 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		15 kg	15 kg	16 kg

Table 12- 24 PM250, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - with filter	6SL3225-…	0BE33-0AA0	0BE33-7AA0
LO base load power		37 kW	45 kW
LO base load input current		70 A	84 A
LO base load output current		75 A	90 A
HO base load power		30 kW	37 kW
HO base load input current		56 A	70 A
HO base load output current		60 A	75 A
Fuse according to IEC Fuse according to UL		3NA3830 100 A, Class J	3NA3832 125 A, Class J
Power loss		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cables		25 … 35 mm^2 3 … 2 AWG	25 … 35 mm^2 3 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		21 kg	21 kg

Table 12- 25 PM250, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - with filter 6SL3225-…	0BE34-5AA0	0BE35-5AA0	0BE37-5AA0
LO base load power	55 kW	75 kW	90 kW
LO base load input current	102 A	135 A	166 A
LO base load output current	110 A	145 A	178 A
HO base load power	45 kW	55 kW	75 kW
HO base load input current	84 A	102 A	135 A
HO base load output current	90 A	110 A	145 A
Fuse according to IEC Fuse according to UL	3NA3836 160 A, Class J	3NA3140 200 A, Class J	3NA3144 250 A, Class J
Power loss	1.5 kW	2.0 kW	2.4 kW
Required cooling air flow	94 l/s	94 l/s	117 l/s
Cross section of line and motor cables	35 … 120 mm^2 2 … 4/0 AWG	35 … 120 mm^2 2 … 4/0 AWG	35 … 120 mm^2 2 … 4/0 AWG
Tightening torque for line and motor cables	13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight	51 kg	51 kg	51 kg

Relationship between pulse frequency and current reduction

Table 12- 26 Current reduction depending on pulse frequency

Rated Power (LO)	Base load current (LO)	Base load current (LO) at pulse frequency of					
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW	A	A	A	A	A	A	A
7.5	18.0	12.5	11.9	10.6	9.20	7.90	6.60
11	25.0	18.1	17.1	15.2	13.3	11.4	9.50
15	32.0	24.7	23.4	20.8	18.2	15.6	12.8
18.5	38.0	32.3	26.6	22.8	19.0	17.1	15.2
22	45.0	38.3	31.5	27.0	22.5	20.3	18.0
30	60.0	51.0	42.0	36.0	30.0	27.0	24.0
37	75.0	63.8	52.5	45.0	37.5	33.8	30.0
45	90.0	76.5	63.0	54.0	45.0	40.5	36.0
55	110	93.5	77.0	--	--	--	--
75	145	123	102	--	--	--	--
90	178	151	125	--	--	--	--

12.2.4 Technical data, PM260

Permissible inverter overload

The inverters have different load capabilities, "High Overload" and "Low Overload", depending on the expected.

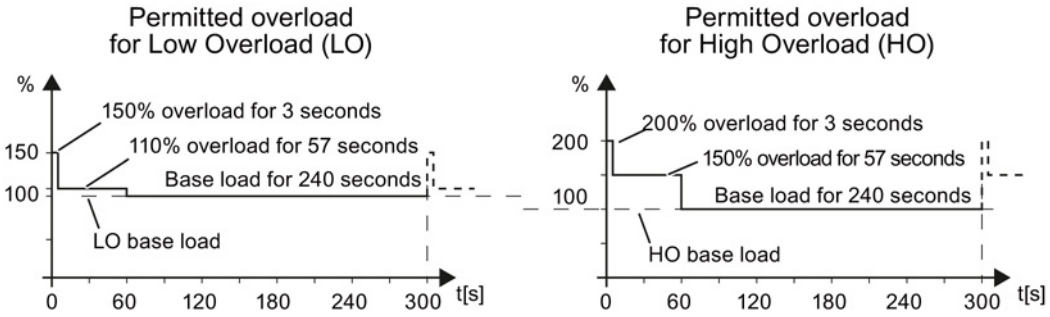


Figure 12-5 Load cycles, Low Overload" and "High Overload"

12.2.4.1 General data, PM260

Property	Version	
Line voltage	660 V ... 690 V 3-ph. AC ± 10% The power units can also be operated with a minimum voltage of 500 V –10 %. In this case, the power is linearly reduced.	
Input frequency	50 Hz … 60 Hz, ± 3 Hz	
Power factor λ	0.9	
Inrush current	< LO base load input current	
Pulse frequency	16 kHz	
Electromagnetic compatibility	The devices comply with EN 61800-3: 2004 suitable for Category C1 and C2 environments.	
Braking methods	DC braking, energy recovery (up to 100% of the output power)	
Degree of protection	IP20 chassis units	
Operating temperature at	LO base load power without derating	0 °C … +40 °C
	HO base load power without derating	0 °C … +50 °C
	LO/HO base load power with derating:	Up to 60° C
	For details, see Restrictions for special ambient conditions (Page 348).	
Storage temperature	-40 °C … +70 °C	
Relative humidity	< 95% - condensation not permissible	
Pollution	Protected according to pollution degree 2 to EN 61800-5-1: 2007	
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995	

Property	Version		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without derating: with derating:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 348)
Standards	CE, C-TICK		

12.2.4.2 Power-dependent data, PM260

Note

The values for Low Overload (LO) are identical with those of the rated values.

Table 12- 27 PM260, IP20, Frame Sizes D - 3 AC 660 V … 690 V

Order No. - without filter Order No. - with filter	6SL3225-… 6SL3225-…	0BH27-5UA1 0BH27-5AA1	0BH31-1UA1 0BH31-1AA1	0BH31-5UA1 0BH31-5AA1
LO base load power LO base load input current LO base load output current		11 kW 13 A 14 A	15 kW 18 A 19 A	18.5 kW 22 A 23 A
HO base load power HO base load input current HO base load output current		7.5 kW 10 A 10 A	11 kW 13 A 14 A	15 kW 18 A 19 A
Fuse		20 A	20 A	32 A
Power losses without filter Power losses with filter				
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cables		2.5 … 16 mm^2 14 … 6 AWG	4 … 16 mm^2 12 … 6 AWG	6 … 16 mm^2 10 … 6 AWG
Tightening torque for line and motor cables		1.5 Nm / 53 lbf in	1.5 Nm / 53 lbf in	1.5 Nm / 53 lbf in
Weight without filter Weight with filter		22 kg 23 kg	22 kg 23 kg	22 kg 23 kg
Sound pressure level		< 64 dB(A)	< 64 dB(A)	< 64 dB(A)

Table 12- 28 PM260, IP20, Frame Sizes F - 3 AC 660 V … 690 V

Order No. - without filter	**6SL3225-…**	0BH32-2UA1	0BH33-0UA1	0BH33-7UA1
Order No. - with filter	**6SL3225-…**	0BH32-2AA1	0BH33-0AA1	0BH33-7AA1
LO base load power		30 kW	37 kW	55 kW
LO base load input current		34 A	41 A	60 A
LO base load output current		35 A	42 A	62 A
HO base load power		22 kW	30 kW	37 kW
HO base load input current		26 A	34 A	41 A
HO base load output current		26 A	35 A	42 A
Fuse		50 A	50 A	80 A
Power losses without filter Power losses with filter				
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cables		10 … 35 mm^2 8 … 2 AWG	16 … 35 mm^2 6 … 2 AWG	25 … 35 mm^2 4 … 2 AWG
Tightening torque for line and motor cables		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight without filter Weight with filter		56 kg 58 kg	56 kg 58 kg	56 kg 58 kg
Sound pressure level		< 70 dB(A)	< 70 dB(A)	< 70 dB(A)

12.2.5 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 … 550 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 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.		
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20 chassis units as supplied from the factory. IP00 after removing the terminal cover.		
Operating temperature	Without power reduction: HO without power reduction:	0 °C … +40 °C >+40 °C … +55 °C	For details, see Restrictions for special ambient conditions (Page 348).
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 • Transport in the transport packaging according to Class 2M3 to EN 60721-3-2: 1997 • Vibration during operation according to Class 3M2 to EN 60721-3-3: 1995		
Installation altitude	without power reduction: with power reduction:	up to 1000 m above sea level up to 4000 m above sea level	For details, see Restrictions for special ambient conditions (Page 348)
Standards	UL, cUL, CE 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

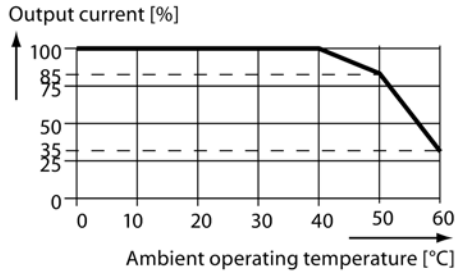
Table 12- 29 PM340, IP20, Frame Size A, 1 AC 200 V … 240 V

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 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cables		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight without filter		1.2 kg	1.3 kg	1.3 kg

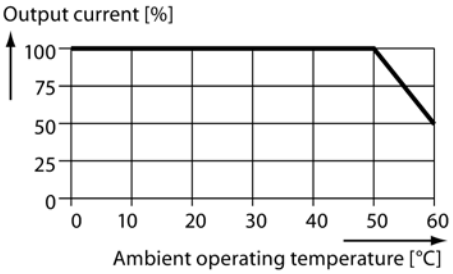
12.3 Restrictions for special ambient conditions

Current de-rating depending on the ambient operating temperature

Low Overload



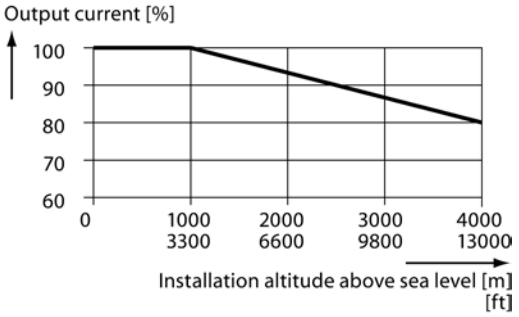
High Overload



NOTICE
Restrictions for the permissible ambient operating temperature as a result of the Control Unit or operator panel For the permissible ambient operating temperature, also observe possible restrictions as a result of the Control Unit or an operator panel.

Current derating depending on the installation altitude

Above 1000 m above sea level you must reduce the inverter output current corresponding to the adjacent curve as a result of the lower cooling power of the air.



Permissible line supplies depending on the installation altitude

- Installation altitude up to 2000 m above sea level
  - Connection to every supply system permitted for the inverter.
- Installation altitudes between 2000 m and 4000 m above sea level
  - Connection to a TN system with grounded neutral point.
  - TN systems with grounded line conductor are not permitted.
  - The TN line system with grounded neutral point can also be supplied using an isolation transformer.
  - The phase-to-phase voltage does not have to be reduced.

Also observe restrictions related to the connection of components.

Appendix

A

A.1 New and extended functions

Table A- 1 New functions and function changes in Firmware 4.6

	Function	SINAMICS						
			G120				G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB … FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During basic commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-
6	Communication via EtherNet/IP	✓	✓	-	✓	✓	✓	✓
7	Skip frequency band for analog input • A symmetrical skip frequency band can be set for each analog input around the 0 V range.	✓	✓	✓	✓	✓	✓	-
8	Changing the control of the motor holding brake	✓	-	✓	✓	✓	✓	-
9	Safety function SBC (Safe Brake Control) • Secure control of a motor holding brake when using the "Safe Brake Module" option	-	-	-	-	✓	-	-
10	Safety function SS1 (Safe Stop 1) without speed monitoring	-	-	-	-	✓	-	-
11	Straightforward selection of standard motors • Selection of 1LA... and 1LE... motors with an operator panel using a list containing code numbers	✓	✓	✓	✓	✓	✓	✓
12	Firmware update via memory card	✓	✓	✓	✓	✓	✓	✓

	Function	SINAMICS						
			G120				G120D	
13	Safety info channel • BICO source r9734.0…14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓

Table A- 2 New functions and function changes in Firmware 4.6.6

	Function	SINAMICS						
			G120				G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM330 IP20 GX	-	✓	-	-	-	-	-

Table A- 3 New functions and function changes in Firmware 4.7

	Function	SINAMICS								
			G120					G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC
1	Supporting the identification & maintenance datasets (I&M1 … 4)	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Fall in pulse rate with increased drive power required by the motor • The inverter temporarily lowers the pulse frequency if required when the motor is started up, and simultaneously increases the current limit.	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	S7 communication • Direct data exchange from the inverter and human machine interface (HMI) • Increase in communication performance with the engineering tools and support of the S7 routing	✓	✓	✓	✓	✓	✓	✓	✓	-
4	The basic functions of Safety Integrated are unrestrictedly available in all control types with 1FK7 encoderless permanent-field synchronous motors	-	-	-	-	-	-	✓	-	-
5	Direct selection of the 1FK7 encoderless permanent-field synchronous motors using the order number with allocated code number • It is not necessary to input individual motor data	-	-	-	-	-	-	✓	-	-

	Function	SINAMICS								
			G120					G120D		
6	Pulse input as source of setpoint value • The inverter calculates its speed setpoint from a sequence of pulses at the digital input.	-	-	-	-	-	✓	-	-	-
7	Dynamic IP address assignment (DHCP) and temporary device names for PROFINET	✓	✓	✓	-	✓	✓	✓	✓	✓
8	PROFIenergy Slave profile 2 and 3	✓	✓	✓	-	✓	✓	✓	✓	✓
9	Uniform behavior for component replacement • After a component is replaced, an inverter with activated Safety Integrated will report what type of component has been replaced using a unique code.	✓	✓	-	-	✓	✓	✓	✓	✓
10	Improved direct-component control in PM230 • Optimized efficiency for pump and fan applications	-	-	✓	-	-	-	-	-	-
11	Rounding down of BACnet and macros	-	-	✓	-	-	-	-	-	-

A.2 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 353) 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 356).
6. Switch the inverter off and on again.

You have activated the function.

A.2.2 Creating or displaying the license key

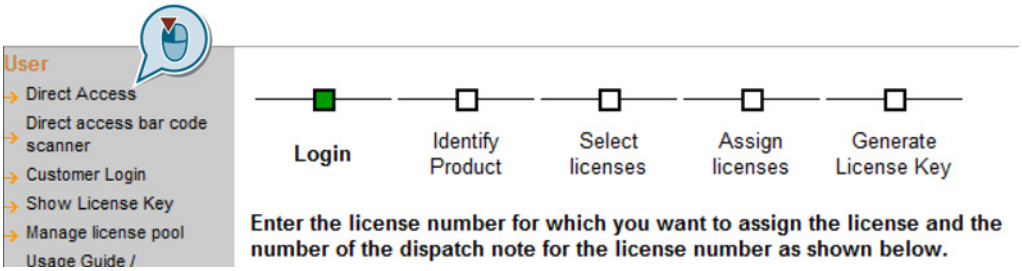
In order to create a license key for a new license – or to display which licenses are saved on a card, use the, "WEB License Manager" (http://www.siemens.com/automation/license (https://workplace.automation.siemens.com/pls/swl-pub/SWL_MAIN_MENU.NAVIGATION_HEAD?a_lang_id=E&a_action=)).

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:



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

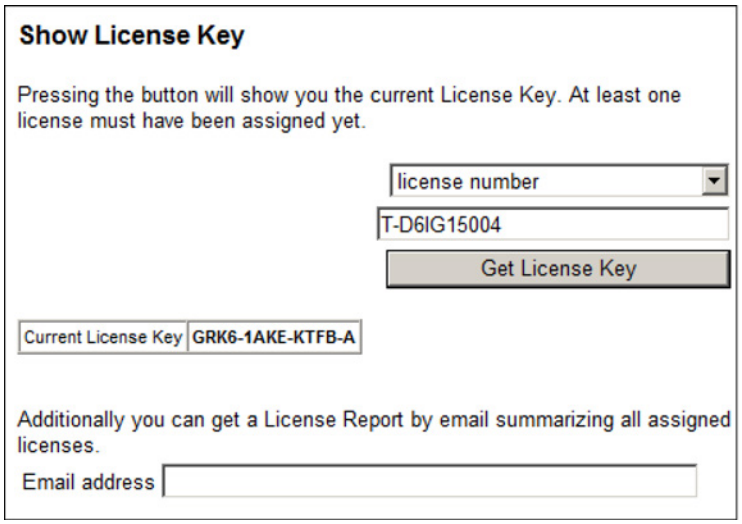
Procedure

1
2

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.

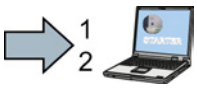
Note

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

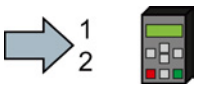
Procedure



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.

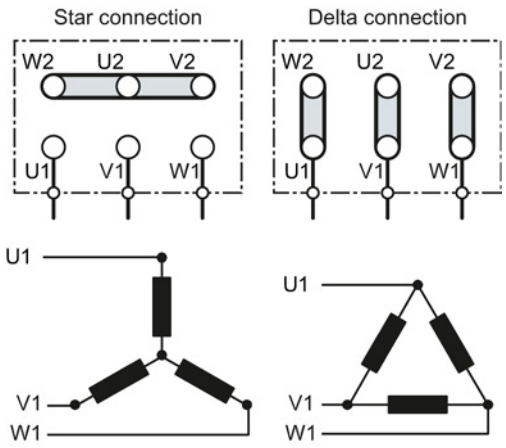
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

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- 4 **How to switch to commissioning mode or restore the factory setting**

Parameter	Description
p0010	**Commissioning parameters** 0: Ready (factory setting) 1: Carry out basic commissioning 3: Carry out motor commissioning 5: Technological applications and units 15: Define number of data sets 30: Factory setting - initiate restore factory settings

Table A- 5 **How to determine the firmware version of the Control Unit**

Parameter	Description
r0018	**Firmware version is displayed**

Table A- 6 **How to select the command and setpoint sources for the inverter**

Parameter	Description
p0015	Additional information is available in Section Terminal blocks (Page 64).

Table A- 7 **How to set the ramp-up and ramp-down**

Parameter	Description
p1080	**Minimum speed** 0.00 [rpm] factory setting
p1082	**Maximum speed** 1500.000 [rpm] factory setting
p1120	**Ramp-up time** 10.00 [s]
p1121	**Ramp-down time** 10.00 [s]

Table A- 8 **This is how you set the closed-loop type**

Parameter	Description
p1300	0: U/f control with linear characteristic 1: U/f control with linear characteristic and FCC 2: U/f control with parabolic characteristic 3: U/f control with adjustable characteristic 4: U/f control with linear characteristic and ECO 5: U/f control for drives requiring a precise frequency (textile area) 6: U/f control for drives requiring a precise frequency and FCC 7: U/f control with parabolic characteristic and ECO 19: U/f control with independent voltage setpoint 20: Speed control (without encoder) 22: Torque control (without encoder)

Not all Power Modules offer for selection all the listed control modes. The control modes permitted for your device are offered during the commissioning.

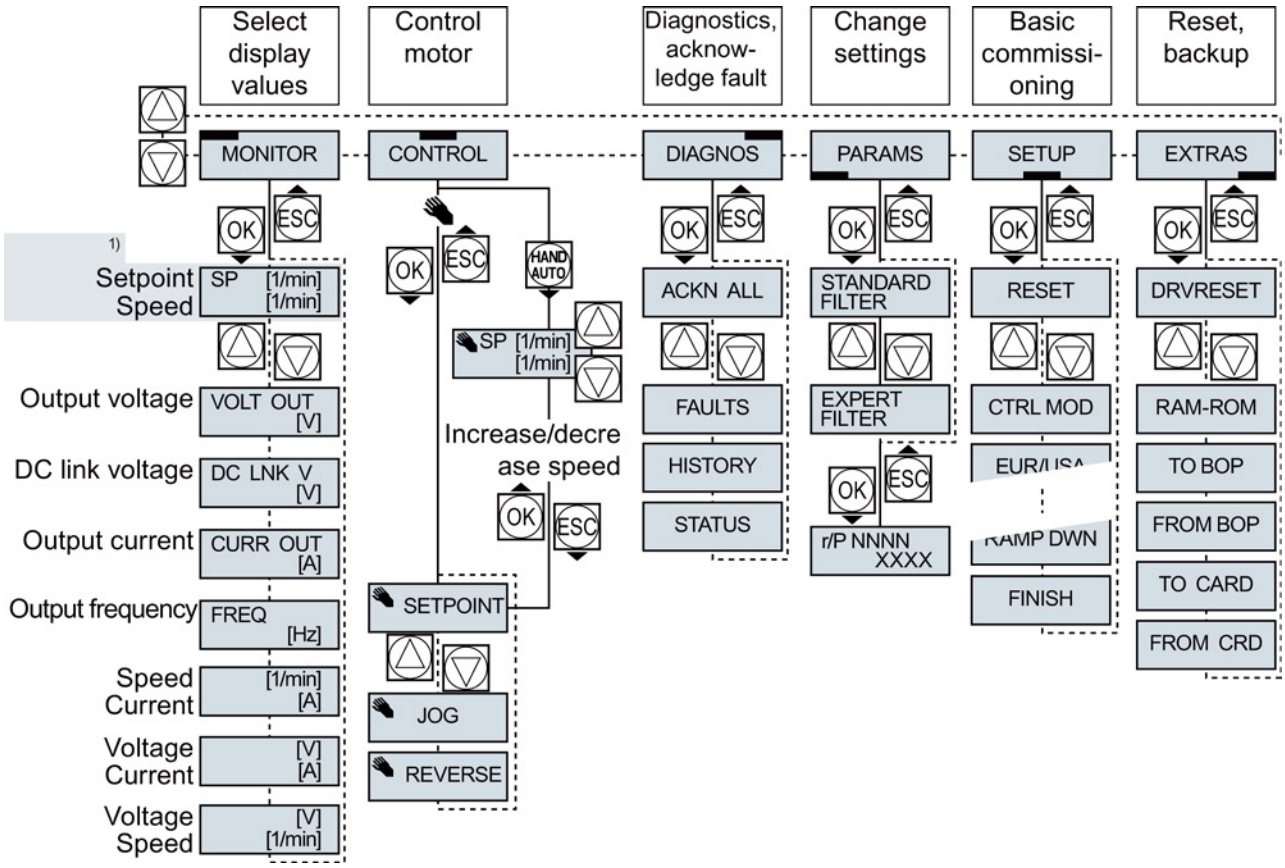
Table A- 9 **This is how you optimize the starting behavior of the U/f control for a high break loose torque and overload**

Parameter	Description
p1310	**Voltage boost to compensate ohmic losses** The voltage boost is active from standstill up to the rated speed. It is at its highest at speed 0 and continually decreases as the speed increases. Value of the voltage boost at speed 0 in V: 1.732 × rated motor current (p0305) × stator resistance (r0395) × p1310 / 100%
p1311	**Voltage boost when accelerating** The voltage boost is effective from standstill up to the rated speed. It is independent of the speed and has a value in V of: 1.732 × rated motor current (p0305) × stator resistance (p0350) × p1311 / 100%
p1312	**Voltage boost when starting** Setting to additionally boost the voltage when starting, however only when accelerating for the first time.

Table A- 10 How to change the inverter pulse frequency

Parameter	Description
p1800	**Setting the inverter pulse frequency** The pulse frequency depends on the power unit. You can find the setting limits and the factory setting in Section Technical data, Power Modules (Page 324). If you increase the pulse frequency, the inverter output current decreases (the maximum output current is displayed in r0076). If you use a sine-wave filter, you can only set the pulse frequency to values that are permissible for the filter. When operated with an output reactor, the pulse frequency is limited to a maximum of 4 kHz.

A.5 Handling the BOP 2 operator panel



1) Status display once the power supply for the inverter has been switched on.

Figure A-1Menu of the BOP-2

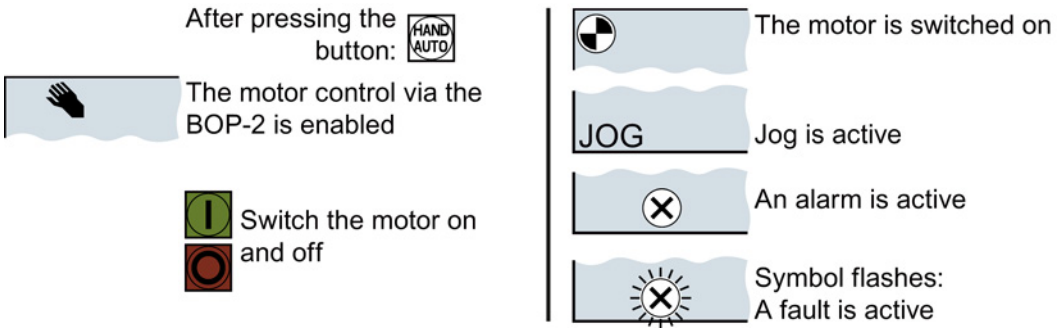


Figure A-2 Other keys and symbols of the BOP-2

A.5.1 Changing settings using BOP-2

Changing settings using BOP-2

You can modify the settings of your inverter by changing the values of the its parameters. The inverter only permits changes to "write" parameters. Write parameters begin with a "P", e.g. P45.

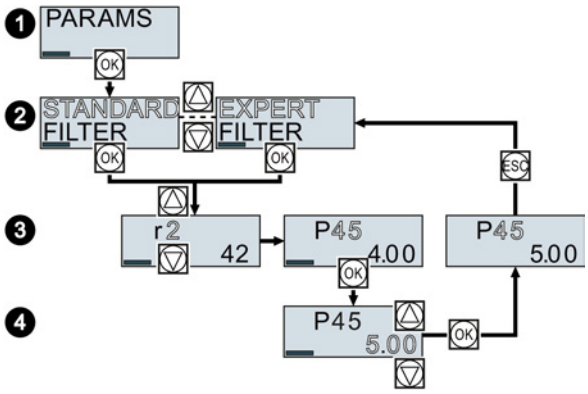
The value of a read-only parameter cannot be changed. Read-only parameters begin with an "r", for example: r2.

Procedure

1
2

To change write parameters using the BOP-2, proceed as follows:

1. Select the menu to display and change parameters.
   Press the OK key.
2. Select the parameter filter using the arrow keys.
   Press the OK key.
   - STANDARD: The inverter only displays the most important parameters.
   - EXPERT: The inverter displays all of the parameters.



3. Select the required number of a write parameter using the arrow keys.
   Press the OK key.
4. Select the value of the write parameter using the arrow keys.
   Accept the value with the OK key.

You have now changed a write parameter using the BOP-2.

The inverter saves all the changes made using the BOP-2 so that they are protected against power failure.

A.5.2 Changing indexed parameters

Changing indexed parameters

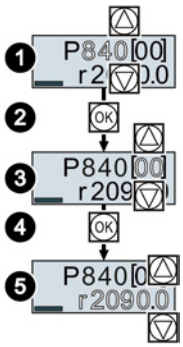
For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

Procedure



To change an indexed parameter, proceed as follows:

1. Select the parameter number.
2. Press the OK key.
3. Set the parameter index.
4. Press the OK key.
5. Set the parameter value for the selected index.





You have now changed an indexed parameter.

A.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.

Precondition

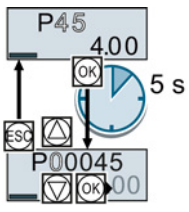
The parameter number is flashing in the BOP-2 display.

Procedure



To select the parameter number directly, proceed as follows:

1. Press the OK button for longer than five seconds.
2. Change the parameter number digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter number, press the OK button.





You have now entered the parameter number directly.

Entering the parameter value directly

The BOP-2 offers the option of setting the parameter value digit by digit.

Precondition

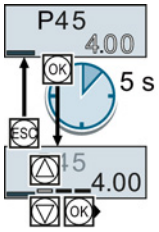
The parameter value flashes in the BOP-2 display.

Procedure

1
2

To select the parameter value directly, proceed as follows:

1. Press the OK button for longer than five seconds.
2. Change the parameter value digit-by-digit.
   If you press the OK button then the BOP-2 jumps to the next digit.
3. If you have entered all of the digits of the parameter value, press the OK button.

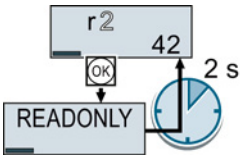


You have now entered the parameter value directly.

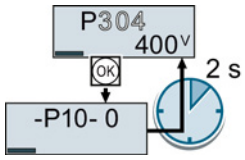
A.5.4 A parameter cannot be changed

When must you not change a parameter?

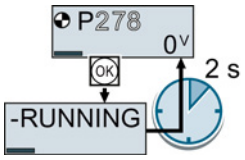
The converter indicates why it currently does not permit a parameter to be changed:



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.

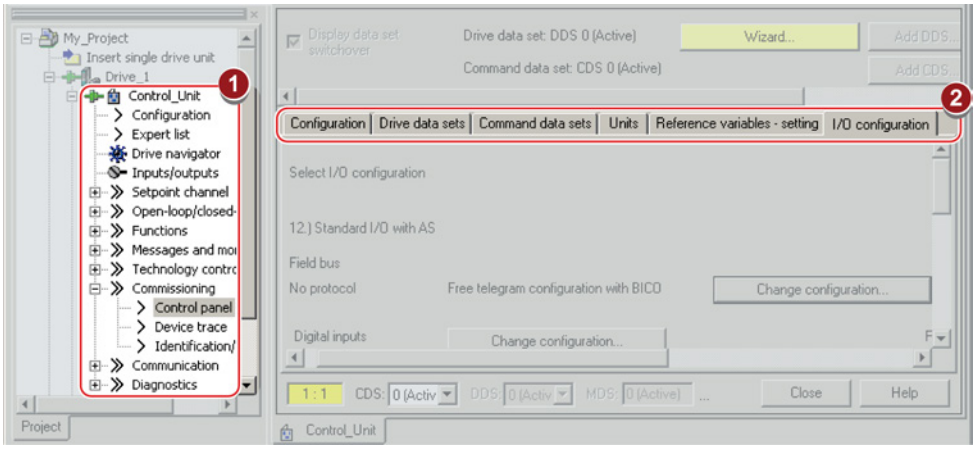
A.6 Handling STARTER

A.6.1 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Commissioning guidelines (Page 81).

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.

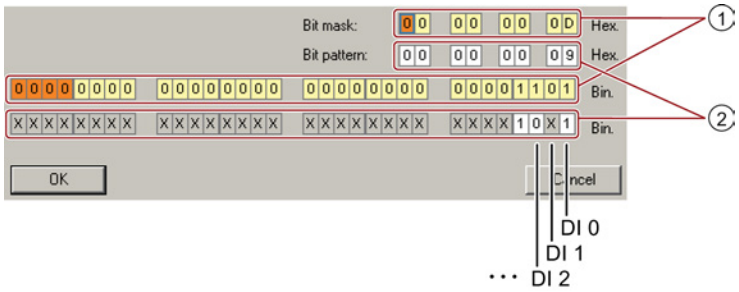
Example of a bit pattern as trigger:

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.

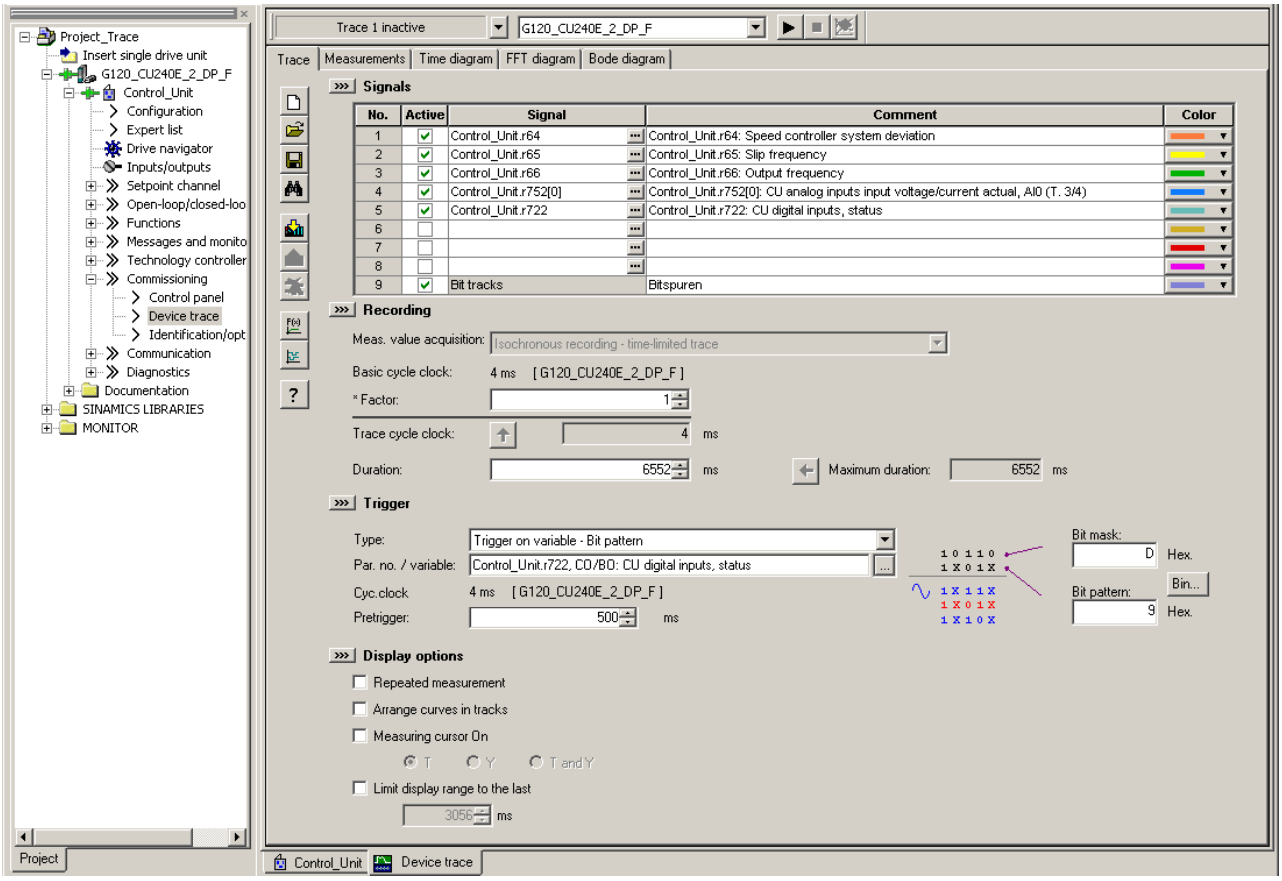


Figure A-4Trace dialog box

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.

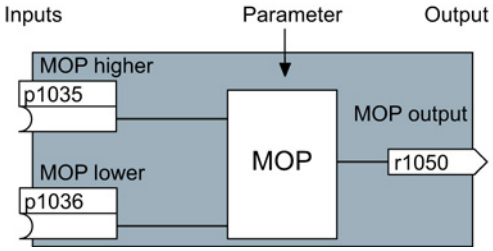


Figure A-5 Example of a block: Motorized potentiometer (MOP)

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.

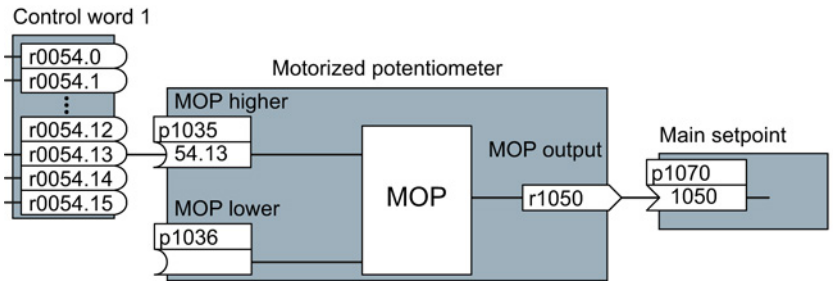


Figure A-6 Example: Signal interconnection of two blocks for digital input 0

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)

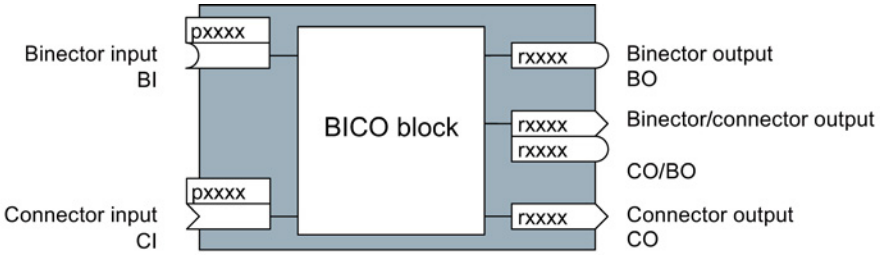


Figure A-7 Symbols for binector and connector inputs and outputs

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

Moving a basic control logic into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).

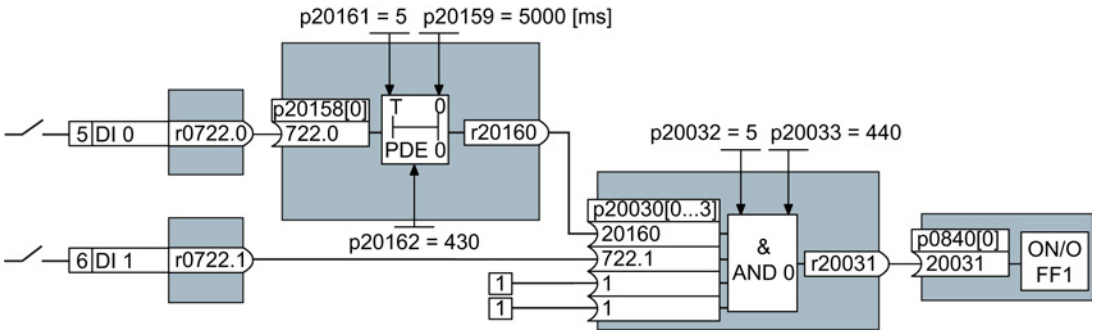


Figure A-8 Example: Signal interconnection for control logic

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

Setting the control logic

Parameter	Description
p20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
p20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
p20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
p20158 = 722.0	Connect the status of DI 0 to the input of the time block r0722.0 = Parameter that displays the status of digital input 0.
p20030[0] = 20160	Interconnecting the time block to the 1st input of the AND
p20030[1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input r0722.1 = Parameter that displays the status of digital input 1.
p0840 = 20031	Interconnect the AND output to ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter p0840[0] is the input of the "ON/OFF1" block of the inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

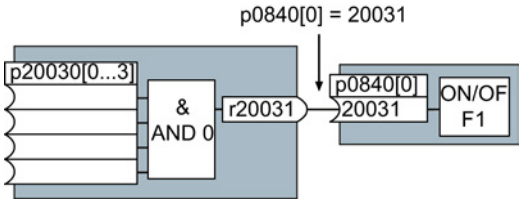


Figure A-9 Interconnecting blocks by setting p0840[0] = 20031

Principle for interconnecting blocks

Always interconnect the input (connector or binector input) with the signal source.

A.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- 11 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 p0421 = 4096
SSI telegram	25 bit, without parity		⑦	p0447 = 25
Code type	Gray		⑧	p429.0 = 0

① … ⑧: See the following descriptions

Configuring an encoder

When configuring the encoder, you must select an encoder type that has the best possible fit to the real encoder.

Precondition

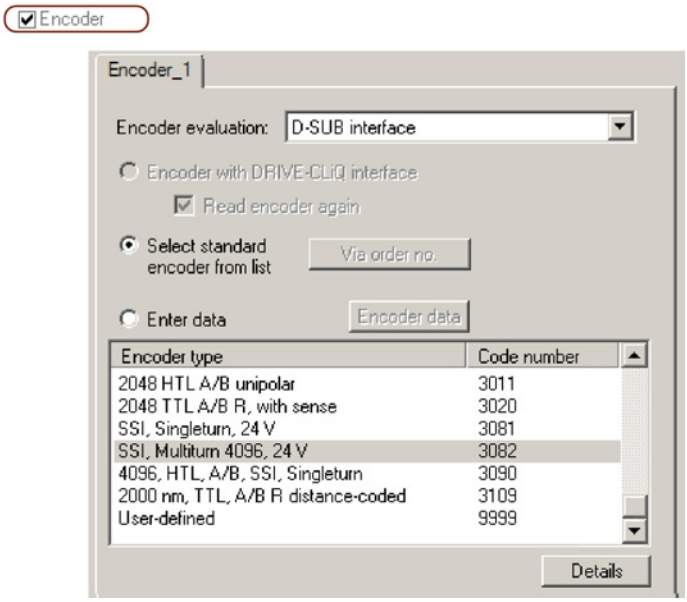
You have started to configure the drive.

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

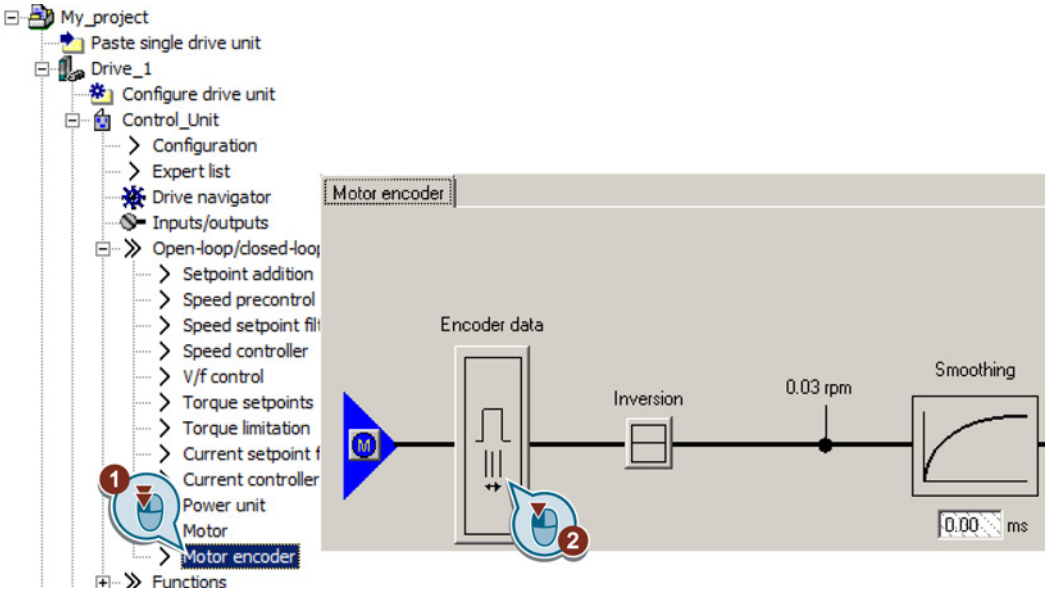
- You have now configured an absolute encoder.
- You have completely configured the drive.

Procedure

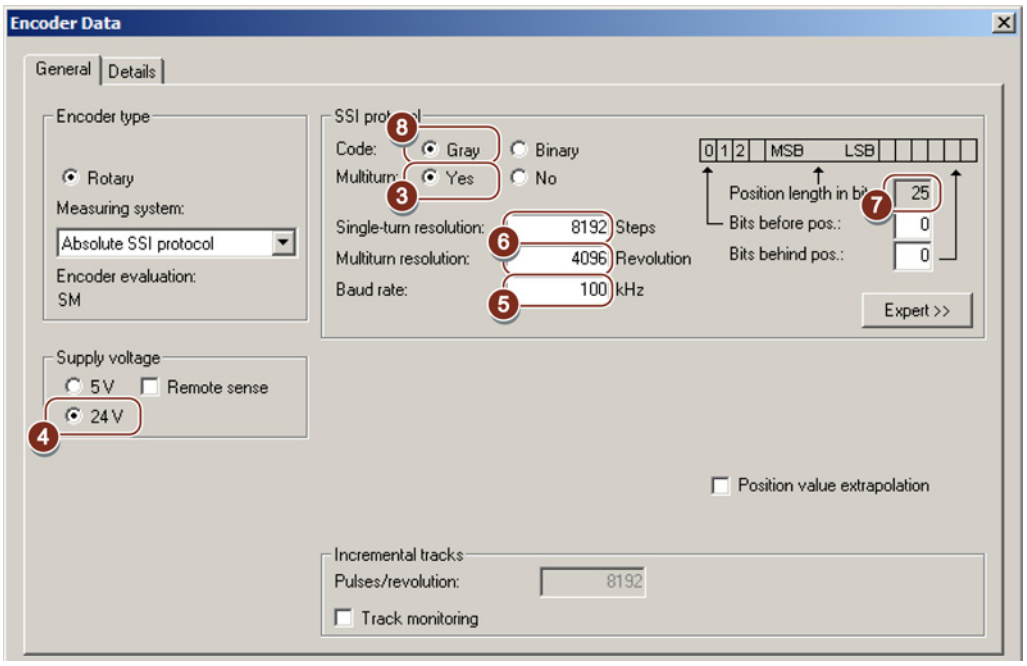


Proceed as follows to adapt the encoder data:

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



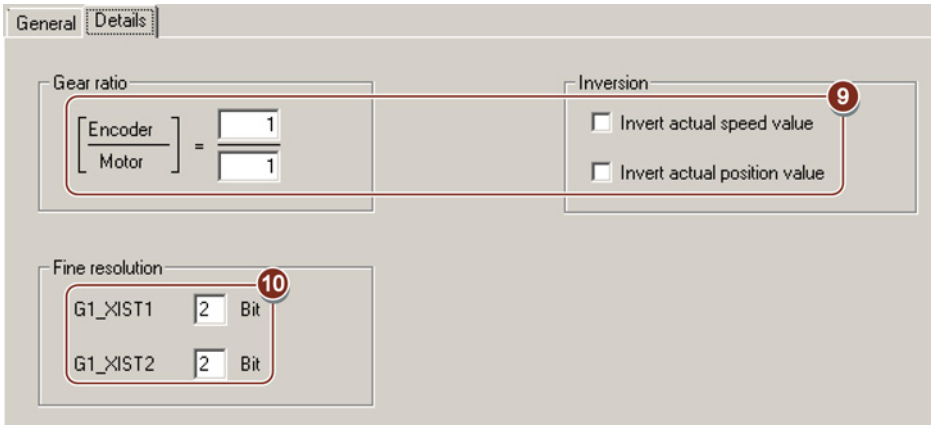
3. … 10. In the "Encoder data" screen form, adapt the settings corresponding to the data sheet of your encoder.



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 Connecting a safety-related input

The following examples show the interconnection of the safety-related input accordance with PL d to EN 13849-1 and SIL2 according to IEC61508. You can find further examples and information in the Safety Integrated Function Manual.

The inverter allows a PM-switching output as well as a PP-switching output to be connected.

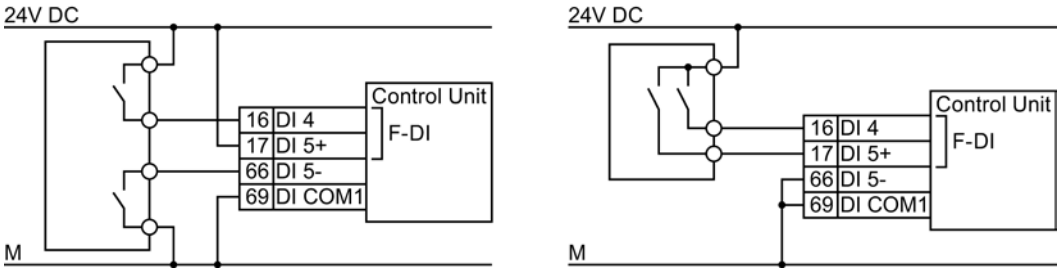


Figure A-10 Connecting a PM-switching and a PP-switching output

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.

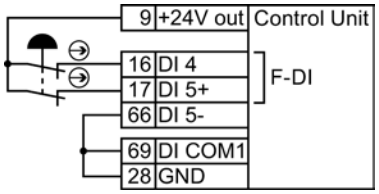


Figure A-11 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

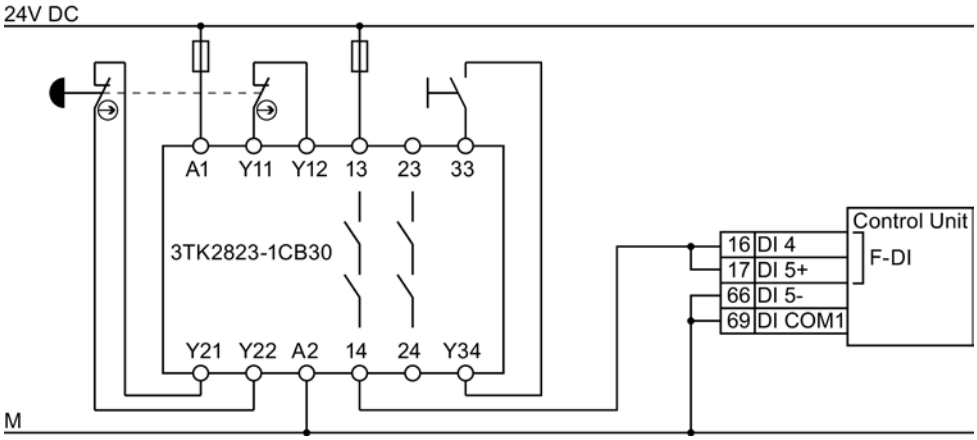


Figure A-12 Connecting a safety relay connection of a safety relay, e.g. SIRIUS 3TK28

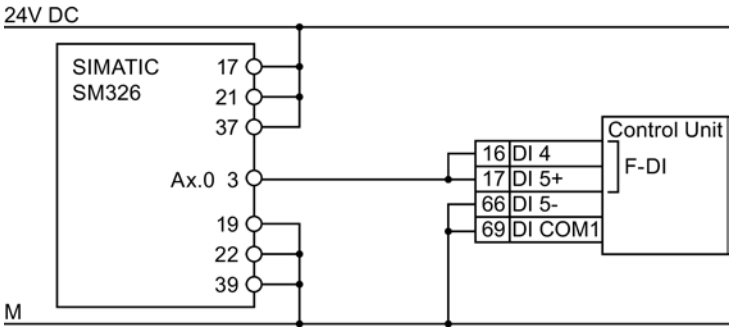


Figure A-13 Connecting an F-DO module connection of an F digital output module, e.g. SIMATIC F digital output module

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 386).

A.9 Acceptance tests for the safety functions

A.9.1 Recommended acceptance test

The following descriptions for the acceptance test are recommendations that illustrate the principle of acceptance. You may deviate from these recommendations if you check the following once you have completed commissioning:

- Correct assignment of the interfaces of each converter with the safety function:
  - Fail-safe inputs
  - PROFIsafe address
- Correct setting of the STO safety function.

Note

Perform the acceptance test with the maximum possible velocity and acceleration in order to test the expected maximum braking distances and braking times.

Note

Non-critical alarms

The following alarms are issued following each system ramp-up and are not critical for acceptance:

- A01697
- A01796

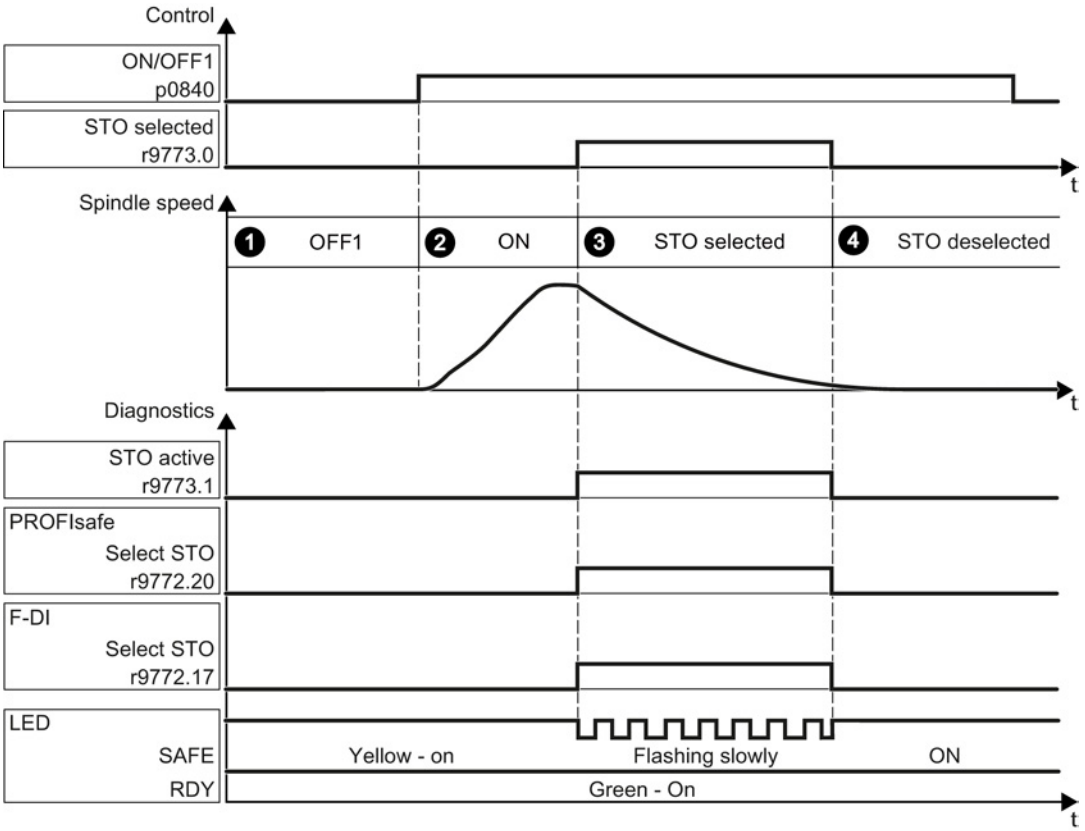


Figure A-14 Acceptance test for STO (basic functions)

Procedure



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

				Status
1.	**The inverter is ready**			
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			
	• STO is not active (r9773.1 = 0).			
2.	**Switch on motor**			
	2.1.	Enter a speed setpoint ≠ 0.		
	2.2.	Switch on the motor (ON command).		
	2.3.	Check that the correct motor is running.		
3.	**Select STO**			
	3.1.	Select STO while the motor is running *Test each configured activation, e.g. via digital inputs and PROFIsafe.*		
	3.2.	Check the following:		
		When controlled by PROFIsafe	For control via terminal	
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)	
		• If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill.		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
		• The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).		
4.	**Deselect STO**			
	4.1.	Deselect STO.		
	4.2.	Check the following:		
		• STO is not active (r9773.1 = 0).		
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		



You have performed the acceptance test of the STO function.

A.9.2 Machine documentation

Machine or plant description

Designation	…
Type	…
Serial number	…
Manufacturer	…
End customer	…
Block diagram of the machine and/or plant: … … … … … … …	

Inverter data

Table A- 12 Hardware version of the safety-related inverter

Labeling the drive	Order number and hardware version of the inverter
…	…
…	…

Function table

Table A- 13 Active safety functions depending on the operating mode and safety equipment

Operating mode	Safety equipment	Drive	Selected safety function	Checked
…	…	…	…	
…	…	…	…	
Example:				
Automatic	*Protective door closed*	*Conveyor belt*	---	---
	Protective door open	*Conveyor belt*	*STO*	
	Emergency Stop button pressed	*Conveyor belt*	*STO*	

Acceptance test reports

File name of the acceptance reports	
…	…
…	…

Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Acceptance test reports	…	…	…	…
PLC program	…	…	…	…
Circuit diagrams	…	…	…	…

Countersignatures

Commissioning engineer

This confirms that the tests and checks have been carried out properly.

Date	Name	Company/dept.	Signature
…	…	…	…

Machine manufacturer

This confirms that the settings recorded above are correct.

Date	Name	Company/dept.	Signature
…	…	…	…

A.9.3 Log the settings for the basic functions, firmware V4.4 ... V4.7

Drive = <pDO-NAME_v>

Table A- 14 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v>

Table A- 15 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 16 Checksums

Name	Number	Value
SI module identifier, Control Unit	r9670	<r9670_v>
SI module identifier, Power Module	r9672	<r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 17 Settings of the safety functions

Name		Number	Value
SI enable, functions integrated in the drive		p9601	<p9601_v>
Only for the CU250S-2 Control Unit	SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
F-DI switch over discrepancy time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>

Table A- 18 Safety logbook

Name	Number	Value
SI checksum to check changes	r9781[0]	<r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.10 Manuals and technical support

A.10.1 Manuals for your converter

Table A- 19 Manuals for your inverter

Information 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) **SINAMICS Manual Collection** Documentation on DVD, order number 6SL3097-4CA00-0YG0
+++	**Operating instructions** for the SINAMICS G120 inverter with a CU250S-2 Control Unit	(this manual)		
+++	**Function Manual, basic positioner**	Commissioning the basic positioner.	English, German, Chinese	
+++	**Function Manual for Safety Integrated** for the inverters SINAMICS G110M, G120, G120C, G120D and SIMATIC ET 200pro FC-2	Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter.		
+++	**Fieldbus Function Manual** for the SINAMICS G120, G120C and G120D inverters	Configuring fieldbuses.		
+++	**List Manual**	Complete list of all parameters, alarms and faults. Graphic function diagrams.		
+	**Getting Started Guide** for the following SINAMICS G120 Power Modules: • PM240, PM250 and PM260 • PM240-2	Installing the Power Module.	English	
+	**Installation Instructions** for reactors, filters and braking resistors	Installing components.		
+++	**Hardware Installation Manual** for the following SINAMICS G120 Power Modules: • PM240 • PM240-2 • PM250 • PM260	Installing power modules, reactors and filters. Maintaining power modules.	English, German	

Information depth	Manual	Contents	Available languages	Download or order number
+++	**Operating Instructions** for the following Operator Panels: • BOP-2 • IOP	Operating operator panels, installing door assembly kit for IOP.	English, German	
+++	**Manual** SINAMICS S110 Manual PM340 Power Module	Installing the PM340 Power Module. Technical data 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- 20 Support when configuring and selecting the inverter

Manual or tool	Contents	Available languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G inverters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC Technology	English, German, Italian, French	You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)

A.10.3 Product Support

You can find additional information on the product and more in the Internet under: Product support (http://www.siemens.com/automation/service&support).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

A.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:docu.motioncontrol@siemens.com)

Index

8

87 Hz characteristic, 358

A

Absolute encoder, 375
Absolute value generator, 225
Acceptance test, 250
  Complete, 250
  Reduced scope, 291
  Reduced scope of, 251
  STO (basic functions), 382
  Test scope, 251
Acceptance test record, 250
Acyclic communication, 137
ADD, 225
Adder, 225
Additional components, 46
Adjustable parameters, 359
Agitators, 86
Alarm, 297, 302
Alarm buffer, 302
Alarm code, 302
Alarm history, 303
Alarm time, 302
Alarm value, 302
Ambient temperature, 82, 185
Analog input, 64, 66
  Function, 99, 107, 111
Analog output, 64, 66
  Function, 99, 110
AND, 225
AND block, 225
Application
  Reading and writing parameters cyclically via PROFIBUS, 137
ASCII code
  Licensing, 357
Automatic mode, 150
Automatic restart, 210
AVA, 225

B

Base components, 44
Basic functions, 102
Basic positioner, 140
BF (Bus Fault), 298, 299
BICO block, 370
Bimetallic switch, 183
Binary changeover switch, 226
Binectors, 371
Bit pattern test, 245
Block, 370
Blocking protection, 219
BOP-2
  Menu, 362
  Symbols, 362
Brake Relay, 59
Braking
  Regenerative, 204
Braking functions, 196
Braking method, 196, 197
Braking module, 203
Braking resistor, 38, 203
Break loose torque, 360
BSW, 226
Bus fault, 299
Bus termination, 63

C

Cable railways, 86
Catalog, 387
CDS (Command Data Set), 150, 249
Centrifuge, 86, 198, 201, 204
Chain conveyors, 86
Changing parameters (STARTER), 366
Characteristic
  Additional, 172
  Linear, 171
  parabolic, 171
  square-law, 171
Checklist
  PROFIBUS, 119
  PROFINET, 115
Circuit diagram, 384
Clockwise rotation, 143
Closed-loop speed control (vector control), 174
Closed-loop torque control, 179
Command Data Set, 150
Command source, 140
  Selecting, 359

Commissioning
Accessories, 42
Guidelines, 81
Communication
Acyclic, 137
Comparator, 230
Compound braking, 201, 202
Compressor, 86
Computational performance, 85
Configuring support, 387
Connectors, 371
Consistency, 244
Consistent signals, 244
Contact bounce, 245
Control mode, 360
Control terminals, 66
Control Units, 25
Control word
Control word 1, 126
Control word 3, 129
Control word 3 (STW3), 129
Controlling the motor, 143
Conveyor belt, 86, 198
Conveyor systems, 93
Copy
Series commissioning, 251
Copy parameters (series commissioning), 251
Correction manual, 389
Counter-clockwise rotation, 143
Countersignatures, 384
Crane, 206
Crushers, 86
Current derating, 338
Current input, 105
Current reduction, 342

D

D flip-flop, 226
Data backup, 255, 260, 264, 266, 384
Data set 47 (DS), 137
Data set changeover, 249
Data transfer, 260, 264, 266
DC braking, 129, 199, 199, 200
DC-link overvoltage, 187
DC-link voltage, 187
Delta connection (Δ), 82, 358
Derating
Installation altitude, 348
DFR, 226
DI (Digital Input), 102, 248
DIF, 227
Differentiator, 227
Digital input, 64, 66, 143
Function, 99
Digital inputs
Multiple assignment, 248
Digital output, 64, 66
Function, 99, 103
Dimensions, 47, 50
DIP switch
Analog input, 105
Direct data exchange, 137
Direction of rotation, 160
Direction reversal, 143
Discrepancy, 244
Filter, 244
Tolerance time, 244
Display parameters, 359
DIV, 227
Divider, 227
Door mounting kit, 42
Download, 260, 264, 266
Drilling patterns, 47, 50
Drive Data Set, DDS, 253
Drive Data Sets, 253
Drive ES Basic, 42
Droop, 177
Dynamic braking, 203

E

Elevator, 86, 206
EMC, 75
Emergency Stop button, 240
EN 61800-5-2, 239
Encoder, 175
Encoder cables, 79
Encoder data, 376
End customer, 383
Energy recovery option, 204
Energy-saving display, 194
Escalator, 86
EXCLUSIVE OR block, 235
Extended functions, 102
Extruder, 86, 182

F

Factory assignment, 66
Factory settings, 88
Restoring the, 88, 89, 241
Fan, 86

Fans, 93, 181
Fault, 297, 305
  Acknowledge, 305, 306
  Motor, 296
Fault buffer, 305
Fault case, 305
Fault code, 305
Fault history, 306
Fault time, 305
  received, 305
  removed, 305
Fault value, 305
F-DI (Fail-safe Digital Input), 102
F-digital output module, 379
FFC (Flux Current Control), 171
Field weakening, 358
Fieldbus interfaces, 63
Filter
  Contact bounce, 245
  Discrepancy, 244
  On/off test, 245
Fine resolution, 377
Firmware, 25
Firmware downgrade, 288
Firmware update, 291
Firmware version, 5, 273, 349, 350, 350, 359, 383
Flip-flop, 226, 234
Flow control, 215
Flying restart, 209
Forced dormant error detection, 247
  setting, 247
Formatting, 256
Free function blocks, 224
Function module, 84
Function table, 383
Functional expansions, 251
Functions
  BOP-2, 362
  Technological, 140

G

Gantry crane, 86
Getting Started, 386
Grinding machine, 198, 201
GSDML (Generic Station Description Markup Language), 117

H

Hardware Installation Manual, 386
Hoist drive, 204
Hoisting gear, 203, 206
Horizontal conveyors, 182, 201, 203
Hotline, 388

I

I_max controller, 186
I2t monitoring, 180
Inclined conveyors, 203
IND (page index), 135
Industry Mall, 387
Installation, 43
Installation altitude, 348
INT, 228
Integrator, 228
Interfaces, 63
Interlock, 372
Inverter, 230
  does not respond, 295
  Update, 291
Inverter components, 273
Inverter control, 140
IT system, 52

J

JOG function, 149

K

Kinetic buffering, 214
Kneaders, 86
Know-how protection, 256, 269
KTY84 sensor, 183

L

LED
  BF, 298, 299
  LNK, 298
  RDY, 298
  SAFE, 300
LED (light emitting diode), 297
Level control, 215
License, 140, 256
License key
  Create, 353
  Displaying, 353
  Entering in STARTER, 356

Entry using the BOP-2, 357
Licensing
ASCII code, 357
Lifter, 86
LIM, 228
Limit monitor, 229
Limiter, 228
Line dip, 214
Line filter, 31
Line supply cable, 58
Line supply type, 52
Linear characteristic, 171
List Manual, 386
LNK (PROFINET Link), 298
Load failure, 221, 222
Load torque, 219
Lowerer, 86
LVM, 229

M

Machine description, 383
Macro p15, 82
Manual Collection, 386
Manual mode, 150
Manuals
Download, 386
Function Manual for Safety Integrated, 386
Inverter accessories, 386
Overview, 386
Manufacturer, 383
Maximum cable length
DRIVE-CLiQ, 322
Encoder, 322
PROFIBUS, 119
Maximum cable lengths
PROFINET, 116
Maximum current controller, 186
Maximum speed, 87, 160, 360
Memory cards, 27
Menu
BOP-2, 362
Operator panel, 362
MFP, 229
Mills, 86
Minimum speed, 87, 160, 162, 360
Mistakes manual, 389
Mixers, 86
MLFB (order number), 383
MMC (memory card), 256
MOP (motorized potentiometer), 154
Motor cable, 59
Motor control, 140
Motor data, 82
Identify, 97, 176, 179
Motor fault, 296
Motor holding brake, 205, 206
Motor standard, 191
Motor temperature, 185
Motor temperature sensor, 64, 66, 184
Motorized potentiometer, 154
Mounting, 45
MUL, 230
Multiple assignment
Digital inputs, 248
Multiplier, 230
Multiturn encoder, 375

N

NCM, 230
Neutral conductor, 52
No-load monitoring, 219
NOT, 230
NSW, 231
Numeric changeover switch, 231

O

OFF delay, 232
OFF1 command, 143
OFF3 ramp-down time, 165
ON command, 143
ON delay, 232
On/off test, 245
Operating instruction, 23
Operating instructions, 386
Operating mode, 383
Operation, 142
Operator panel
BOP-2, 42, 362
Door mounting kit, 42
Handheld, 42
IOP, 42
Menu, 362
Optimizing the closed-loop speed controller, 176
OR, 231
OR block, 231
Order number, 25
Overload, 186, 360
Overview
Manuals, 386
Overvoltage, 187

P

p15 macro, 82
Page index, 135
Parabolic characteristic, 171
Parameter channel, 132
  IND, 135
Parameter index, 135
Parameter number, 135, 364
Parameter types, 359
Parameter value, 365
Password, 241
PC Connection Kit, 42
PCL, 231
PDE, 232
PDF, 232
PELV, 319
PFH (Probability of failure per hour), 321
PID controller, 216
Plant description, 383
PLC functionality, 372
PLC program, 384
PLI, 233
Polyline, 233
Power distribution systems, 52
Power failure, 210
Power Module, 25
Power on reset, 88, 89, 241, 248, 276, 277
Power-up time, 87
Pressure control, 215
Probe, 158, 223
Procedure, 23
Process variables of the technology controller, 192
PROFIBUS, 119
PROFIdrive, 113
PROFIenergy, 113
PROFIsafe, 113
Protection functions, 140
Protective conductor, 52
PST, 233
PT1, 234
PTC sensor, 183
Pulse cancelation, 126
Pulse enable, 126
Pulse frequency, 181, 182, 338, 342, 361
Pulse generator, 229
Pulse shortener, 231
Pulse stretcher, 233
Pulse train, 158
Pump, 86, 93

Q

Questions, 388
Quick stop, 141

R

Radio interference class, 31
Ramp-down, 360
Ramp-down time, 87, 165, 167, 360
  Scaling, 167
Ramp-function generator, 160, 164
Ramp-up, 360
Rampup time,
Ramp-up time
  Scaling, 167
RDY (Ready), 298
Ready, 142
Ready to switch on, 142
Regenerative feedback, 29, 204
Regenerative power, 196
Replace
  Control Unit, 291
  Gear unit, 291
  Hardware, 291
  Motor, 291
  Power Module, 291
Reset
  Parameter, 88, 89, 241
Reversing, 160
Roller conveyors, 86
Rotary furnace, 86
Rounding, 165
Rounding OFF3, 165
RS flip-flop, 234
RSR, 234
Run sequence, 224
Runtime group, 224

S

S7 communication, 113
SAFE, 300
Safe Brake Relay, 39, 247
Safety function, 140
Safety Integrated Function Manual, 378
Safety relay, 378
Safety-related input, 102
Saw, 198, 201
Scaling
  Analog input, 106
  Analog output, 109

SD (memory card), 256
Formatting, 256
MMC, 256
Self-test, 247
Sensor
Electromechanical, 378
Sensor Module, 41, 74, 74, 387
Sequence control, 141
Serial number, 383
Series commissioning, 251, 255
Setpoint processing, 140, 160
Setpoint source, 140
Selecting, 153, 154, 359
Settling time, 86
Shield connection kit, 30
Short-circuit monitoring, 184
Signal cables, 79
Signal interconnection, 370
Signal states, 298
Sine-wave filter, 36
SIZER, 387
Skip frequency band, 108, 160
SMC (Sensor Module Cabinet), 41, 74
SMC: Sensor Module Cabinet, 74
SME (Sensor Module External), 41, 74
SME: Sensor Module External, 74
Smoothing element, 234
Speed
change with BOP-2, 362
Limiting, 160
Speed deviation, 221, 222
Speed monitoring, 221, 222
Spindle, 86
Square-law characteristic, 171
Stacker crane, 86
Stall protection, 219
Star connection (Y), 358
STARTER, 42, 90, 240, 264, 366
Download, 42, 42
STARTER commissioning tool, 240
STARTER PC tool, 240
Starting characteristics
Optimization, 172
State overview, 141
Status word
Status word 1, 128
Status word 3, 130
STO (Safe Torque Off), 238
Acceptance test, 382
Selecting, 238
Storage medium, 255
STW1 (control word 1), 126
SUB, 235
Subindex, 135
Subtracter, 235
Suggestions for improvement manual, 389
Support, 388
Switch off
Motor, 141
OFF1 command, 141
OFF2 command, 141
OFF3 command, 141
Switch on
Motor, 141
ON command, 141
Switching on inhibited, 126, 142
Switching over units, 189
Switching-on a motor with BOP-2, 362
Switch-off signal paths, 247
Symbols, 23
System runtime, 301

T

Technical data
Control Unit, 319
Technology controller, 129, 192, 215
Telegram
paste, 118, 121
Temperature calculation, 184
Temperature monitoring, 180, 184
Temperature sensor, 64, 66
Temperature switch, 183
Terminal block, 72, 99
Terminal strip
Factory setting, 66
Overview, 64
Test signals, 245
Three-wire control, 143
Time slice, 224
TN line system, 52
Torque accuracy, 86
Torque monitoring
Speed-dependent, 219
Trace function, 367
TT system, 52
Two-wire control, 143
Type plate
Control Unit, 25
Power Module, 25

U

U/f control, 169, 360
UL, 331
Unit system, 191
Unwinders, 204
Update
    Firmware, 291
Upgrading the firmware, 285
Upload, 257, 264, 266
USB cable, 42
USB interface, 91
Use for the intended purpose, 25
User interfaces, 63

V

VDC min controller, 214
Vector control, 176, 179, 360
    Sensorless, 174
Version
    Control Unit, 25
    Firmware, 383
    Hardware, 383
    Power Module, 25
    Safety function, 383
Vertical conveyors, 203
Voltage boost, 172, 360
voltage input, 105

W

Winders, 204
Wire breakage, 244
Wire-break monitoring, 106, 184
Write protection, 267

X

XOR, 235

Z

ZSW1 (status word 1), 128
ZSW3 (status word 3), 130

Further information

SINAMICS inverters:
www.siemens.com/sinamics

Safety Integrated:
www.siemens.com/safety-integrated

PROFINET:
www.siemens.com/profinet

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