SINAMICS G120

Frequency converter with the Control Units

CU240B-2
CU240B-2 DP

CU240E-2
CU240E-2 DP
CU240E-2 F
CU240E-2 DP-F
CU240E-2 PN
CU240E-2 PN-F

Operating Instructions · 04/2012

SINAMICS

Answers for industry.

SIEMENS

SIEMENS

SINAMICS

SINAMICS G120 Frequency converter with CU240B-2 and CU240E-2 Control Units

Operating Instructions

Change history

Introduction 1

Description 2

Installing 3

Typical commissioning scenarios 4

Basic commissioning 5

Adapt terminal strip 6

Configuring the fieldbus 7

Functions 8

Data backup and series commissioning 9

Service and maintenance 10

Alarms, faults and system messages 11

Technical data 12

Appendix A

Edition 04/2012, firmware V4.5

Original instructions
04/2012, FW V4.5
A5E02299792B 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
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the relevant information is not taken into account.

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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

Disclaimer of Liability

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

Siemens AG
Industry Sector
Postfach 48 48
90026 NÜRNBERG
GERMANY

A5E02299792B AC
℗ 06/2012 Technical data subject to change

Change history

Important changes with respect to the manual, edition 01/2011

New Power Modules	In Section
• PM230 Power Module with IP20 degree of protection • PM230 Power Module in push through design • PM240-2 Power Module with IP20 degree of protection • PM240-2 Power Module in push through design	Power Module (Page 15)

New functions in firmware V4.5	In Section
PROFINET interface	Communication via PROFINET (Page 94)
Know-how protection	Write and know-how protection (Page 259)

Revised descriptions	In Section
Supplemented by the assignment of Power Modules to line filters, line reactors, braking resistors, sine-wave filters and output reactors.	Modularity of the converter system (Page 13)
Descriptions of functions: • Converter control • Setpoint sources • Setpoint processing • Closed-loop motor control • PID technology controller • STO safety function	Functions (Page 141)

Table of contents

Change history 3

1 Introduction 11

1.1 About this manual 11

1.2 Guide through this manual 12

2 Description 13

2.1 Modularity of the converter system 13

2.2 Overview of Control Units 14

2.3 Power Module 15

2.4 Line filter 18

2.5 Line reactor 19

2.6 Output reactor 20

2.7 Sine-wave filter 22

2.8 Braking resistor 24

2.9 Brake Relay 25

2.10 Accessories for commissioning and operation 25

3 Installing 27

3.1 Procedure for installing the frequency inverter 27

3.2 Installing reactors and filters 28

3.3 Installing the Power Module 30
3.3.1 Installing Power Modules 30
3.3.2 Dimensions, hole drilling templates, minimum clearances, tightening torques 31
3.3.3 Dimension drawings PT 33
3.3.4 Connection overview for Power Module 34
3.3.5 Connecting the line supply and motor 35
3.3.6 EMC-compliant connection of the converter 37
3.3.7 Avoiding electromagnetic interference (EMI) 37

3.4 Installing Control Unit 42
3.4.1 Snapping the Control Unit onto the Power Module 42
3.4.2 Interfaces, connectors, switches, terminal blocks and LEDs of the CU 43
3.4.3 Terminal strips on CU240B-2 Control Units 44
3.4.4 Terminal strips on CU240E-2 Control Units 45
3.4.5 Wiring terminal strips 46
3.4.6 Select interface assignments 46
3.4.6.1 Pre-assignments and wiring of the inverter with CU240B-2 Control Units 47
3.4.6.2 Pre-assignments and wiring of the inverter with CU240E-2 Control Units 49

4 Typical commissioning scenarios 55

5 **Basic commissioning** **57**

5.1 Preparing for basic commissioning 57
5.1.1 Collecting motor data 57
5.1.2 Does the motor match the converter? 58
5.1.3 Wiring examples for the factory settings 59
5.1.4 Factory setting of the inverter control 61
5.1.5 U/f control or speed control? 62
5.1.6 Defining additional requirements for the application 63

5.2 Restoring the factory setting 64

5.3 Using the factory settings 65

5.4 Basic commissioning with the BOP-2 66
5.4.1 Changing settings using BOP-2 67
5.4.2 Basic commissioning 68
5.4.3 Additional settings 69

5.5 Basic commissioning with STARTER 70
5.5.1 Adapting interfaces 70
5.5.1.1 Adapting the USB interface 70
5.5.1.2 Accessing the converter via PROFINET 72
5.5.2 Generating a STARTER project 73
5.5.3 Go online and start wizard for basic commissioning 74
5.5.4 Switch on the motor via the control panel 76
5.5.5 Making additional settings 77
5.5.6 Trace function for optimizing the drive 78

6 **Adapt terminal strip** **81**

6.1 Digital inputs 82

6.2 Fail-safe input 84

6.3 Digital outputs 86

6.4 Analog inputs 87

6.5 Analog outputs 90

7 **Configuring the fieldbus** **93**

7.1 Communication via PROFINET 94
7.1.1 What do you need for communication via PROFINET? 95
7.1.2 Connect the converter to PROFINET 95
7.1.3 Configuring communication to the control 96
7.1.4 Select telegram 96
7.1.5 Activating diagnostics via the control 97

7.2 Communication via PROFIBUS 98
7.2.1 What do you need for communication via PROFIBUS? 98
7.2.2 Connect the frequency inverter to PROFIBUS 98
7.2.3 Configuring communication to the control 99
7.2.4 Setting the address 99
7.2.5 Select telegram 100

7.3 PROFIdrive profile for PROFIBUS and PROFINET 101
7.3.1 Cyclic communication 101
7.3.1.1 Control and status word 1 103

7.3.1.2 Control and status word 3 106
7.3.1.3 Extend telegrams and change signal interconnection 108
7.3.1.4 Data structure of the parameter channel 109
7.3.1.5 Slave-to-slave communication 114
7.3.2 Acyclic communication 114
7.3.2.1 Reading and changing parameters via data set 47 115

7.4 Communication via RS485 119
7.4.1 Integrating inverters into a bus system via the RS485 interface 119
7.4.2 Communication via USS 120
7.4.2.1 Basic settings for communication 120
7.4.2.2 Telegram structure 121
7.4.2.3 User data range of the USS telegram 122
7.4.2.4 USS parameter channel 123
7.4.2.5 USS process data channel (PZD) 128
7.4.2.6 Time-out and other errors 129
7.4.3 Communication over Modbus RTU 131
7.4.3.1 Basic settings for communication 131
7.4.3.2 Modbus RTU telegram 133
7.4.3.3 Baud rates and mapping tables 133
7.4.3.4 Write and read access via FC 3 and FC 6 137
7.4.3.5 Communication procedure 139

8 Functions 141

8.1 Overview of the inverter functions 141

8.2 Inverter control 143
8.2.1 Switching the motor on and off 143
8.2.2 Inverter control using digital inputs 145
8.2.3 Two-wire control: method 1 146
8.2.4 Two-wire control, method 2 147
8.2.5 Two-wire control, method 3 148
8.2.6 Three-wire control, method 1 149
8.2.7 Three-wire control, method 2 150
8.2.8 Running the motor in jog mode (JOG function) 151
8.2.9 Switching over the inverter control (command data set) 153

8.3 Command sources 156

8.4 Setpoint sources 156
8.4.1 Overview 156
8.4.2 Analog input as setpoint source 157
8.4.3 Specifying the motor speed via the fieldbus 158
8.4.4 Motorized potentiometer as setpoint source 158
8.4.5 Fixed speed as setpoint source 161

8.5 Setpoint calculation 163
8.5.1 Overview of setpoint processing 163
8.5.2 Invert setpoint 163
8.5.3 Inhibit direction of rotation 164
8.5.4 Minimum speed 164
8.5.5 Maximum speed 165
8.5.6 Ramp-function generator 165

8.6 Motor control 167

8.6.1 V/f control ... 167
8.6.1.1 Characteristics of U/f control ... 168
8.6.1.2 Selecting the U/f characteristic ... 169
8.6.1.3 Optimizing with a high break loose torque and brief overload ... 170
8.6.2 Closed-loop speed control ... 172
8.6.2.1 Properties of the sensorless vector control ... 172
8.6.2.2 Select motor control ... 173
8.6.2.3 Re-optimize the speed controller ... 173
8.6.2.4 Torque control ... 176

8.7 Protection functions ... 177
8.7.1 Inverter temperature monitoring ... 177
8.7.2 Motor temperature monitoring using a temperature sensor ... 178
8.7.3 Protecting the motor by calculating the motor temperature ... 181
8.7.4 Overcurrent protection ... 181
8.7.5 Limiting the maximum DC link voltage ... 182

8.8 Status messages ... 184
8.8.1 Overview, evaluating the inverter state ... 184
8.8.2 System runtime ... 184

8.9 Application-specific functions ... 185
8.9.1 Unit changeover ... 185
8.9.1.1 Changing over the motor standard ... 186
8.9.1.2 Changing over the unit system ... 187
8.9.1.3 Changing over process variables for the technology controller ... 188
8.9.1.4 Changing of the units with STARTER ... 188
8.9.2 Braking functions of the inverter ... 190
8.9.2.1 Comparison of electrical braking methods ... 190
8.9.2.2 DC braking ... 193
8.9.2.3 Compound braking ... 196
8.9.2.4 Dynamic braking ... 198
8.9.2.5 Braking with regenerative feedback to the line ... 201
8.9.2.6 Motor holding brake ... 202
8.9.3 Automatic restart and flying restart ... 208
8.9.3.1 Flying restart – switching on while the motor is running ... 208
8.9.3.2 Automatic switch-on ... 210
8.9.4 PID technology controller ... 214
8.9.4.1 Overview ... 214
8.9.4.2 Setting the controller ... 214
8.9.4.3 Optimizing the controller ... 216
8.9.5 Load torque monitoring (system protection) ... 218
8.9.6 Speed and load failure via digital input ... 220
8.9.7 Logical and arithmetic functions using function blocks ... 223

8.10 Safe Torque Off (STO) safety function ... 227
8.10.1 Function description ... 227
8.10.2 Prerequisite for STO use ... 228
8.10.3 Commissioning STO ... 228
8.10.3.1 Commissioning tool ... 228
8.10.3.2 Password ... 229
8.10.3.3 Resetting the safety function parameters to the factory setting ... 229
8.10.3.4 Changing settings ... 230
8.10.3.5 Interconnecting the "STO active" signal ... 231

8.10.3.6 Setting the signal filter 232
8.10.3.7 Setting forced dormant error detection 235
8.10.3.8 Activate settings 237
8.10.3.9 Checking the assignment of the digital inputs 238
8.10.3.10 Acceptance - completion of commissioning 239

8.11 Switchover between different settings 244

9 Data backup and series commissioning 247

9.1 Backing up and transferring settings using a memory card 248
9.1.1 Saving setting on memory card 249
9.1.2 Transferring the setting from the memory card 251
9.1.3 Safely remove the memory card 253

9.2 Backing up and transferring settings using STARTER 255

9.3 Saving settings and transferring them using an operator panel 257

9.4 Other ways to back up settings 258

9.5 Write and know-how protection 259
9.5.1 Write protection 261
9.5.2 Know-how protection 262
9.5.2.1 Settings for the know-how protection 263
9.5.2.2 Creating an exception list for the know-how protection 264
9.5.2.3 Replacing devices with active know-how protection 265

10 Service and maintenance 269

10.1 Overview of replacing converter components 269

10.2 Replacing the Control Unit 271

10.3 Replacing the Power Module 273

11 Alarms, faults and system messages 275

11.1 Operating states indicated on LEDs 277

11.2 Alarms 279

11.3 Faults 282

11.4 List of alarms and faults 287

12 Technical data 295

12.1 Technical data, CU240B-2 Control Unit 295

12.2 Technical data, CU240E-2 Control Unit 297

12.3 Technical data, Power Modules 300
12.3.1 Technical data, PM230 IP20 302
12.3.1.1 General data, PM230 - IP20 302
12.3.1.2 Power-dependent data, PM230, IP20 303
12.3.2 Technical data, PM240 309
12.3.2.1 General data, PM240 309
12.3.2.2 Power-dependent data, PM240 310
12.3.3 Technical data, PM240-2 315
12.3.3.1 General data, PM240-2 315
12.3.3.2 Power-dependent data PM240-2 316

12.3.4 Technical data, PM250 318
12.3.4.1 Power-dependent data, PM250 319
12.3.5 Technical data, PM260 321
12.3.5.1 Power-dependent data, PM260 322

A Appendix 323

A.1 Star-delta motor connection and application examples 323

A.2 Parameter 324

A.3 Interconnecting signals in the inverter 326
A.3.1 BICO technology: basic principles 326
A.3.2 BICO technology: example 328

A.4 Application Examples 330
A.4.1 Configuring PROFIBUS communication in STEP 7 330
A.4.1.1 Creating a STEP 7 project 330
A.4.1.2 Configuring communications to a SIMATIC control 331
A.4.1.3 Insert the frequency converter into the STEP 7 project 332
A.4.2 Configuring PROFINET communication in STEP 7 334
A.4.2.1 Communication via PROFINET - example 334
A.4.2.2 Configuring the system in HW Config 334
A.4.2.3 Inserting the converter into the SIMATIC Manager 337
A.4.2.4 Activate diagnostic messages via STEP 7 337
A.4.2.5 Go online with STARTER via PROFINET 338
A.4.3 STEP 7 program examples 339
A.4.3.1 STEP 7 program example for cyclic communication 340
A.4.3.2 STEP 7 program example for acyclic communication 342
A.4.4 Configuring slave-to-slave communication in STEP 7 346
A.4.5 Connecting fail-safe digital inputs 348

A.5 Documentation for accepting the safety functions 349
A.5.1 Machine documentation 349
A.5.2 Log of the settings for the basic functions, firmware V4.4 and V4.5 351

A.6 Additional information on the inverter 352

A.7 Mistakes and improvements 354

Index 355

Introduction 1

1.1 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, parameterize, and commission the inverters safely and in the correct manner.

What is described in the operating instructions?

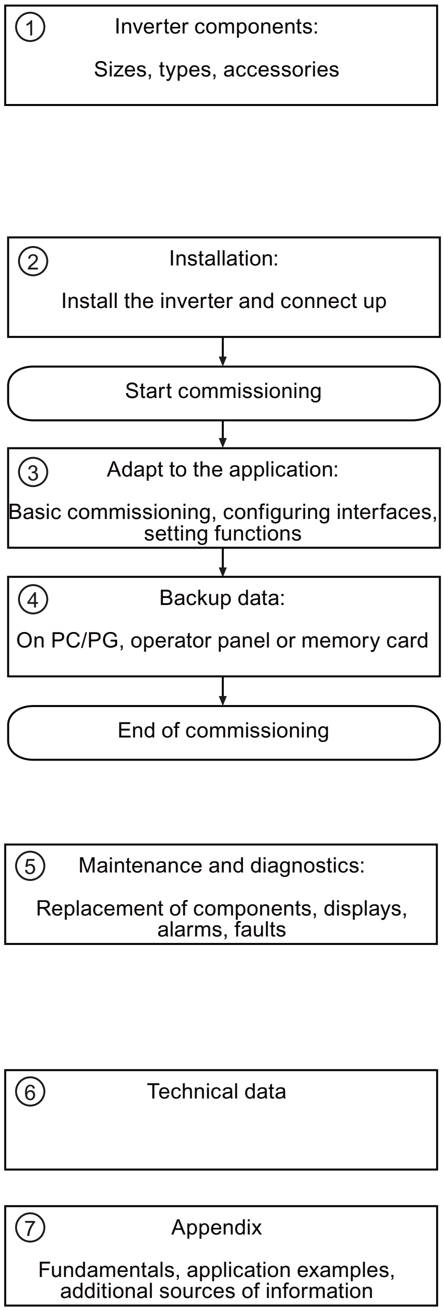
These operating instructions provide a summary of all of the information required to operate the inverter under normal, safe conditions.

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.

1.2 Guide through this manual

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



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

- Modularity of the converter system (Page 13)

② • Procedure for installing the frequency inverter (Page 27)

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

③ • Basic commissioning (Page 57)
- Adapt terminal strip (Page 81)
- Configuring the fieldbus (Page 93)
- Functions (Page 141)

④ • Data backup and series commissioning (Page 247)

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

- Service and maintenance (Page 269)
- Alarms, faults and system messages (Page 275)

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

- Technical data (Page 295)

⑦ The appendix contains some background information and explanatory examples:

- Appendix (Page 323)

Description

2

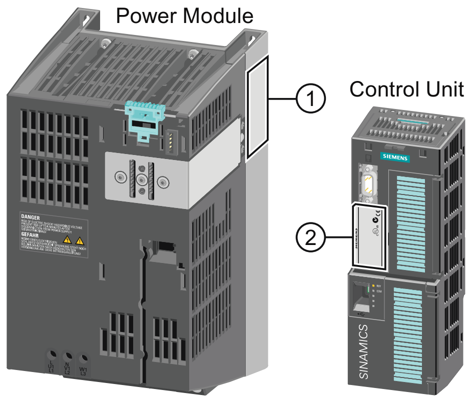
2.1 Modularity of the converter system

Thanks to their modular design, the converters can be used in a wide range of applications with respect to functionality and power.

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 Control Unit is used to control the converter locally or centrally.
- 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 no.: e.g. 6SL3224-0BE13-7UA0
- Version: e.g. A02

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

- Designation: e.g. Control Unit CU240E-2 DP-F
- Order no.: e.g. 6SL3244-0BB13-1PA0
- Version: e.g. A02 (hardware) 4.5 (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 18)
- Line reactor (Page 19)
- Output reactor (Page 20)
- Sine-wave filter (Page 22)
- Braking resistor (Page 24)
- Brake Relay to control a motor holding brake (Page 25).

2.2 Overview of Control Units

Table 2- 1 Control Units CU240B-2 …

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

Table 2- 2 Control Units CU240E-2 …

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

Shield connection kit for the Control Unit

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

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

Table 2- 3 Order numbers

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

2.3 Power Module

The SINAMICS Power Modules with degree of protection IP20 and through-hole technology (Push Through = PT) are available in the following versions:

- PM230 (3 AC 400 V for pumps and fans),
- PM240 (3 AC 400 V for standard applications with dynamic braking),
- PM240-2 (3 AC 400 V for standard applications with dynamic braking, 2nd generation),
- PM250 (3 AC 400 V with energy recovery),
- PM260 (3 AC 690 V with energy recovery),

Figure 2-1 Power Module, IP20 degree of protection

PM230, 3 AC 400 V

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

The PM230 IP20 or PT is available without a filter or with integrated class A line filter. They are designed for installation in a control cabinet. The PM230 are not designed for regenerative operation.

Range of order numbers: 6SL3210-1NE… (IP20), 6SL3211-1NE… (Push through)

PM240, 3 AC 400 V

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW): IP20	0,37 … 1,5	2,2 … 4	7,5 … 15	18,5 … 30	37 … 45	55 … 132	160 … 250

PM240 is available without a filter or with integrated class A line filter. The PM240 allows regenerative operation via an external braking resistor.

Range of order numbers: 6SL3224-0BE… and 6SL3224-0XE…

PM240-2, 3 AC 400 V

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (kW): IP20	0,55 … 3	--	--	--	--	--	--
Power range (kW): PT	2,2 … 3	--	--	--	--	--	--

PM240-2 is available without a filter or with integrated class A line filter. The PM240-2 allows regenerative operation via an external braking resistor.

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

PM250, 3 AC 400 V

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

PM250 is available without a filter or with integrated class A line filter. The PM250 allows regenerative operation with energy recovery into the line supply.

Range of order numbers: 6SL3225-0BE …

PM260, 3 AC 690 V

Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
Power range (LO) in kW	---	---	---	11 … 18,5	---	30 … 55	---

The PM260 is available without a filter or with integrated class A line filter, a sine-wave filter is installed on the motor side. The PM260 allows regenerative operation with energy feedback into the line supply.

Range of order numbers: 6SL3225-0BH…

Shield connection kit for Power Modules

Note

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

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

The shield connection kit offers optimum shield support and strain relief for line and motor cables. Refer to the following table for order numbers.

Adapter for rail mounting for 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.

Table 2- 4 Order numbers for shield connection kit and DIN rail mounting adapter

Frame size	Shield connection kit for		Adapter for mounting on DIN rails
	Power Modules PM240, PM250	PM260 Power Module	
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	-

2.4 Line filter

With an external line filter, the converter can achieve a higher radio interference class.

Examples:

Footprint line filter for Power Module PM240 FSA

Line filter for Power Module PM240 FSGX

External line filters for PM240

Table 2- 5 Class A according to EN 55011: 2009

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

Table 2- 6 Class B according to EN 55011: 2009

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

External line filters for PM250

Table 2- 7 Class B according to EN 55011: 2009

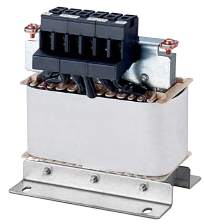
PM250, order number 6SL3225-…		Power	Line filter, class B
FSC	…0BE25-5AA0, …0BE27-5AA0, …0BE31-1AA0	7.5 kW … 15.0 kW	6SL3203-0BD23-8SA0

2.5 Line reactor

The line reactor protects the converter in the harsh environment of industrial plants and systems: The line reactor supports the overvoltage protection, smooths the harmonics in the line supply and bridges commutation dips.

Examples:

Footprint line reactor for Power Module PM240 FSA



Line reactor for Power Module PM240-2 FSA

NOTICE
If the relative short-circuit voltage of the infeed transformer is below 1%, you must install a line reactor in order to ensure the optimal service life of your converter.

Table 2- 8 Line reactors for PM240

PM240, order number 6SL3224-…		Power	Line reactor
FSA	…0BE13-7UA0, …0BE15-5UA0	0.37 kW … 0.55 kW	6SE6400-3CC00-2AD3
	…0BE17-5UA0, …0BE21-1UA0	0.75 kW … 1.1 kW	6SE6400-3CC00-4AD3
	…0BE21-5UA0	1.5 kW	6SE6400-3CC00-6AD3
FSB	…0BE22-2□A0, …0BE23-0□A0	2.2 kW … 3.0 kW	6SL3203-0CD21-0AA0
	…0BE24-0□A0	4.0 kW	6SL3203-0CD21-4AA0
FSC	…0BE25-5□A0, …0BE27-5□A0	7.5 kW … 11.0 kW	6SL3203-0CD22-2AA0
	…0BE31-1□A0	15.0 kW	6SL3203-0CD23-5AA0
FSD	…0BE31-5□A0, …0BE31-8□A0	18.5 kW … 22 kW	6SL3203-0CJ24-5AA0
	…0BE32-2□A0	30 kW	6SL3203-0CD25-3AA0
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	6SL3203-0CJ28-6AA0
FSF	…0BE37-5□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

Table 2- 9 Line reactors for PM240-2

PM240-2, order number 6SL321□-…		Power	Line reactor
FSA	…1PE11-8□L0, …1PE12-3□L0, …1PE13-2□L0, …1PE14-3□L0	0.55 kW … 1.5 kW	6SL3203-0CE13-2AA0
	…1PE16-1□L0, …1PE18-0□L0	2.2 kW … 3.0 kW	6SL3203-0CE21-0AA0

2.6 Output reactor

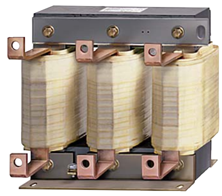
Output reactors for the PM240 Power Module and the PM250 Power Module

Output reactors reduce the voltage stress on the motor windings.

If you use long motor cables (shielded cable as of 50 m or 100 m unshielded cable), you must use an output reactor in order to reduce the load on the converter due to capacitive charging/discharging currents in the cables.

Examples:

Footprint output reactors for Power Modules PM240 FSA and FSB



Output reactor for Power Module PM240 FSGX

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

Table 2- 10 Output reactors for PM240 Power Module

PM240, order number 6SL3224-…		Power	Output reactor
FSA	…0BE13-7UA0, …0BE15-5UA0, …0BE17-5UA0, …0BE21-1UA0, …0BE21-5UA0	0.37 kW … 1.5 kW	6SE6400-3TC00-4AD2
FSB	…0BE22-2□A0, …0BE23-0□A0, …0BE24-0□A0	2.2 kW … 4.0 kW	6SL3202-0AE21-0CA0
FSC	…0BE25-5□A0, …0BE27-5□A0, …0BE31-1□A0	7.5 kW … 15.0 kW	6SL3202-0AJ23-2CA0
FSD	…0BE31-5□A0	18.5 kW	6SE6400-3TC05-4DD0
	…0BE31-8□A0	22 kW	6SE6400-3TC03-8DD0
	…0BE32-2□A0	30 kW	6SE6400-3TC05-4DD0
FSE	…0BE33-0□A0	37 kW	6SE6400-3TC08-0ED0
	…0BE33-7□A0	45 kW	6SE6400-3TC07-5ED0
FSF	…0BE34-5□A0	55 kW	6SE6400-3TC14-5FD0
	…0BE35-5□A0	75 kW	6SE6400-3TC15-4FD0
	…0BE37-5□A0	90 kW	6SE6400-3TC14-5FD0
	…0BE38-8UA0	110 kW	6SL3000-2BE32-1AA0
	…0BE41-1UA0	132 kW	6SL3000-2BE32-6AA0
FSGX	…0XE41-3UA0	160 kW	6SL3000-2BE33-2AA0
	…0XE41-6UA0	200 kW	6SL3000-2BE33-8AA0
	…0XE42-0UA0	250 kW	6SL3000-2BE35-0AA0

Table 2- 11 Output reactors for PM250 Power Module

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

2.7 Sine-wave filter

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

Example:

Sine-wave filter for converter with frame size FSF

The following applies when using a sine-wave filter:

- Operation is only permissible with pulse frequencies from 4 kHz to 8 kHz.
  Above 160 kW, only 4 kHz is permissible.
- The converter power is reduced by 5%.
- The maximum output frequency of the converter is 150 Hz at 380 V to 480 V.
- Operation and commissioning may only be performed with the motor connected, as the sine-wave filter is not no-load proof.
- An output reactor is superfluous.

Table 2- 12 Sine-wave filter for PM240 Power Module

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

Table 2- 13 Sine-wave filter for PM250 Power Module

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

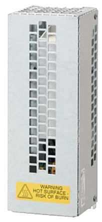
2.8 Braking resistor

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

The PM240 Power Module controls the braking resistor via its integrated braking module.

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

Examples:



Braking resistor for Power Module PM240-2 FSA

Footprint braking resistor for Power Module PM240 FSA

Table 2- 14 Braking resistors for PM240

PM240, order number 6SL3224-…		Power	Braking resistor
FSA	…0BE13-7UA0, …0BE15-5UA0	0.37 kW … 0.55 kW	6SE6400-4BD11-0AA0
	…0BE17-5UA0, …0BE21-1UA0	0.75 kW … 1.1 kW	
	…0BE21-5UA0	1.5 kW	
FSB	…0BE22-2□A0, …0BE23-0□A0	2.2 kW … 3.0 kW	6SL3201-0BE12-0AA0
	…0BE24-0□A0	4.0 kW	
FSC	…0BE25-5□A0, …0BE27-5□A0	7.5 kW … 11.0 kW	6SE6400-4BD16-5CA0
	…0BE31-1□A0	15.0 kW	
FSD	…0BE31-5□A0, …0BE31-8□A0	18.5 kW … 22 kW	6SE6400-4BD21-2DA0
	…0BE32-2□A0	30 kW	
FSE	…0BE33-0□A0, …0BE33-7□A0	37 kW … 45 kW	6SE6400-4BD22-2EA1
FSF	…0BE37-5□A0, …0BE35-5□A0	55 kW … 75 kW	6SE6400-4BD24-0FA0
	…0BE37-5□A0	90 kW	
	…0BE38-8UA0	110 kW	6SE6400-4BD26-0FA0
	…0BE41-1UA0	132 kW	
FSGX	…0XE41-3UA0	160 kW	6SL3000-1BE31-3AA0
	…0XE41-6UA0, …0XE42-0UA0	200 kW … 250 kW	6SL3000-1BE32-5AA0

Table 2- 15 Braking resistors for PM240-2

PM240-2, order number 6SL321□-…		Power	Braking resistor
FSA	…1PE11-8□L0, …1PE12-3□L0, …1PE13-2□L0, …1PE14-3□L0	0.55 kW … 1.5 kW	6SL3201-0BE14-3AA0
	…1PE16-1□L0, …1PE18-0□L0	2.2 kW … 3.0 kW	6SL3201-0BE21-0AA0

2.9 Brake Relay

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

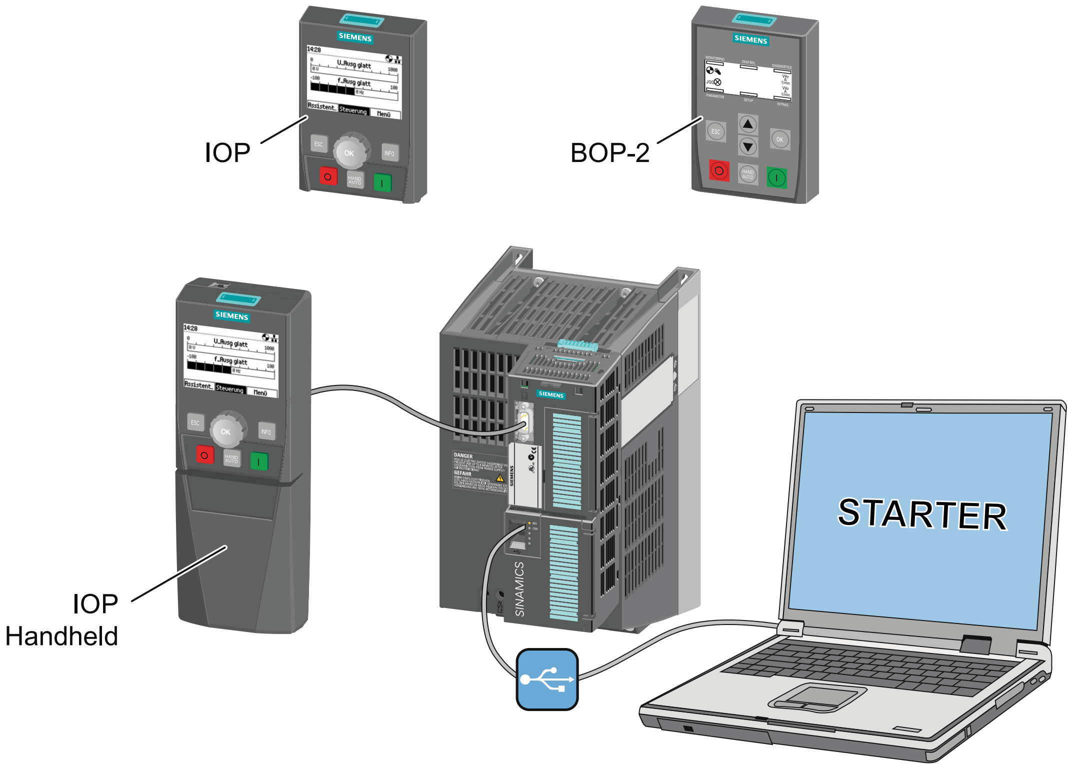
Order no.: 6SL3252-0BB00-0AA0

2.10 Accessories for commissioning and operation

Table 2- 16 Accessories for commissioning and controlling the converter as well as for data backup

Component or tool		Order number
Operator Panels for commissioning, diagnostics and controlling converters		
	BOP-2 - for snapping onto the frequency converter • Copies drive parameters • Two-line display • Guided commissioning	6SL3255-0AA00-4CA1
	IOP - to snap onto the frequency converter or with the handheld • Copies drive parameters • Plain text display • Menu-based operation and application wizards	6SL3255-0AA00-4JA0 IOP Handheld: 6SL3255-0AA00-4HA0
	IOP/BOP-2 Mounting Kit IP54/UL Type 12	6SL3256-0AP00-0JA0
PC tools		
	STARTER Commissioning tool (PC software) connected to the converter via USB cable Downloading: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	STARTER on DVD: 6SL3072-0AA00-0AG0
	PC Connection Kit Includes a STARTER DVD and USB cable 	6SL3255-0AA00-2CA0
	Drive ES Basic As an option to STEP7 with routing function across network boundaries	6SW1700-5JA00-5AA0

Component or tool			Order number
Memory cards: to save and transfer the converter settings			
		MMC card	6SL3254-0AM00-0AA0
		SD card	6ES7954-8LB00-0AA0



3 Installing

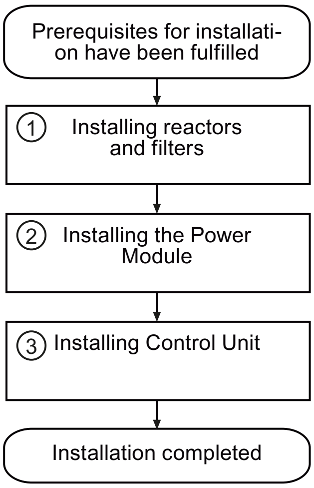
3.1 Procedure for installing the frequency inverter

Preconditions for installation

Check that the following preconditions are fulfilled before installing:

- Are the required components, tools and small parts available?
- Are the ambient conditions permissible? See Technical data (Page 295).

Installation sequence



① Installing reactors and filters (Page 28)

② Installing the Power Module (Page 30)

③ Installing Control Unit (Page 42)

You will find details on the installation in the Internet: Hardware Installation Manual (http://support.automation.siemens.com/WW/view/en/30563173/133300).

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

3.2 Installing reactors and filters

Fitting converter system components in space-saving manner

For the Power Modules FSA … FSC, the system components line reactor, line filter, output reactor, sine-wave filter and braking resistor can installed as base components.

For FSA, two base components are possible – and for FSB and FSC, one or two base components. For further details, please see the diagram below.

Note

Sine-wave filter

For frame sizes FSB and FSC, it is not permissible that the sine-wave filter is combined with other base components.

Line filter

For converters with integrated line filter, an external line filter is not required.

Available system components, depending on the Power Module (IP20 / PT)

System component	PM230	PM240	PM240-2	PM250	PM260
Line reactor	---	x	x	---	---
Line filter	x	x	---	x	---
Output reactor	---	x	---	x	---
Sine-wave filter	---	x	---	x	---
Braking resistor	---	x	x	---	---

Connecting the line reactor

- Line-side: via terminals
- Converter: via a prefabricated connecting cable

Connecting the line filter

- Line-side: via terminals
- Converter: via a prefabricated connecting cable

Connecting the output reactor

- Converter: via a prefabricated connecting cable
- To the motor: via terminals

Connecting the sine-wave filter

- Converter: via a prefabricated connecting cable
- To the motor: via terminals

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

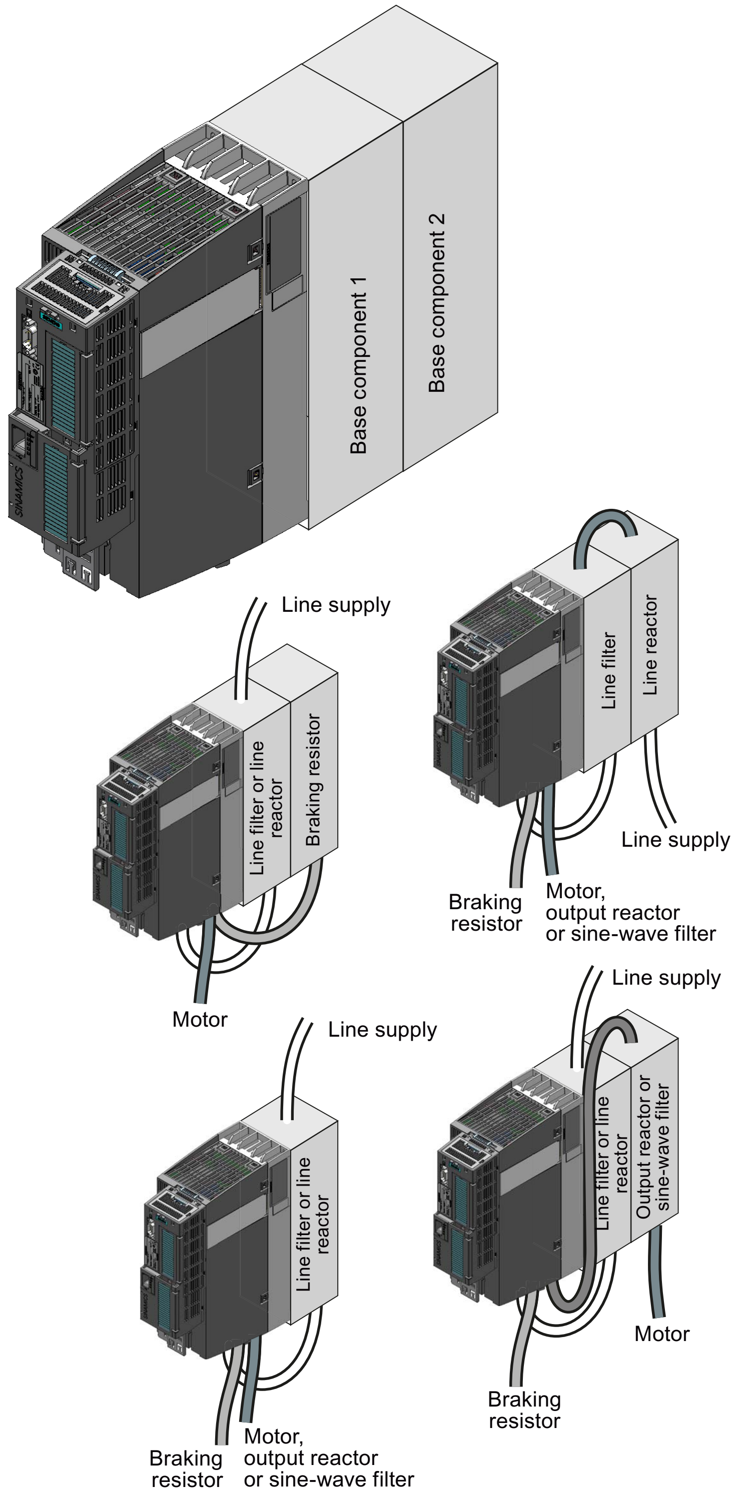
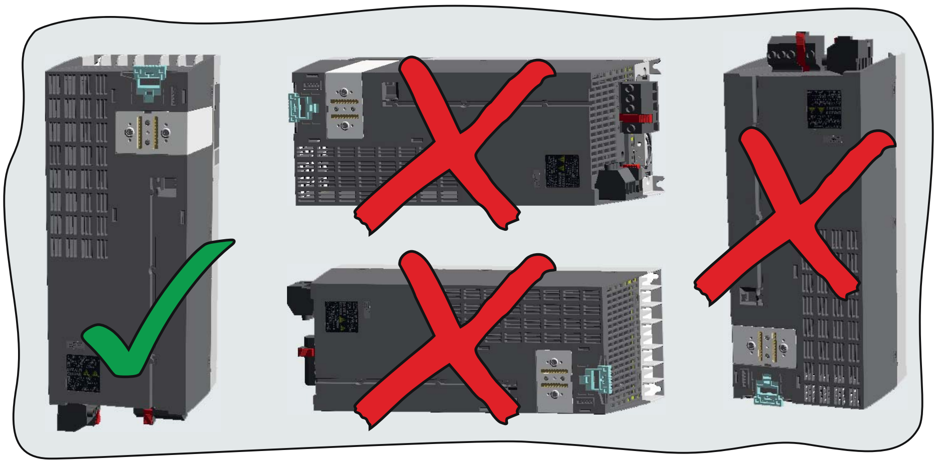


Figure 3-1 Base components and wiring options

3.3 Installing the Power Module

3.3.1 Installing Power Modules

Installing Power Modules with degree of protection IP20



- Install the Power Module vertically on a mounting plate in a control cabinet.
  The smaller frame sizes of the converter (FSA and FSB) can also be mounted on DIN rails using an adapter.
- When installing, observe the minimum clearances to other components in the control cabinet.
  These minimum clearances are necessary to ensure adequate cooling of the converter.
- Do not cover the ventilation openings the converter.

Installing additional components

Depending on the application, additional line reactors, filters, braking resistors, Brake Relay, etc. may be required (seeModularity of the converter system (Page 13)).

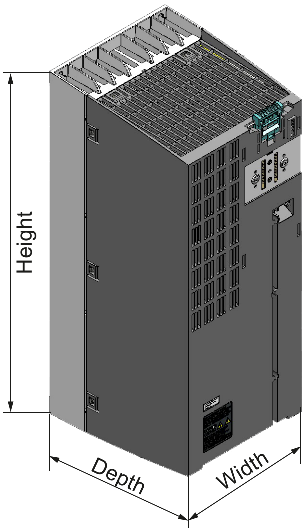
Please observe the mounting and installation instructions supplied with these components.

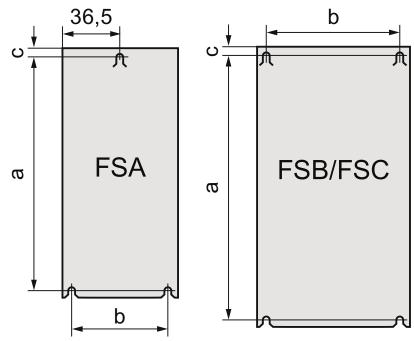
3.3.2 Dimensions, hole drilling templates, minimum clearances, tightening torques

Note

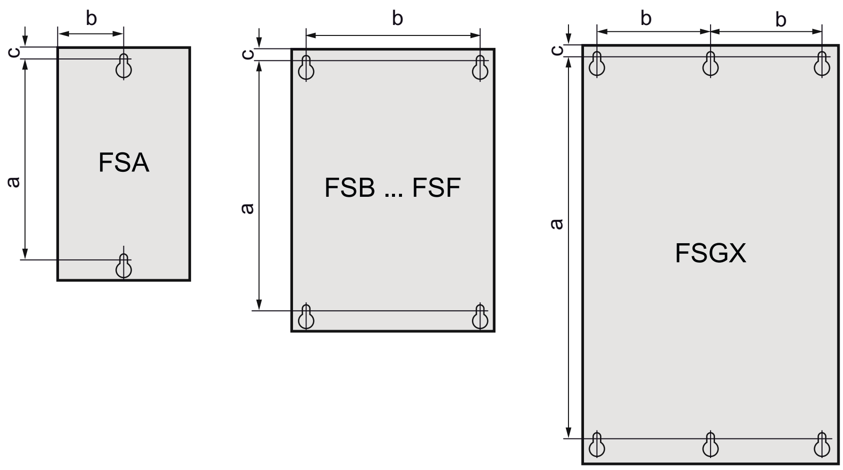
The total depth of the converter increases – with the exception of frame sizes FSGX (160 kW ... 250 kW) – by 39 mm as a result of the Control Unit – and an additional 12 mm or 27 mm respectively, if you use a BOP or IOP.

Dimensions and drilling patterns for PM230, PM240





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



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

Dimensions and clearances for PM230 and PM240-2 - degree of protection IP20, frame sizes FSA … FSC

Frame size	Dimensions (mm)						Clearances (mm)		
	Height[1)]	Width	Depth	a	b	c	Top	Bottom	Lateral
FSA	196	73	165	186	62.3	6	80	100	0[2)]
FSB	292	100	165	281	80	6	80	100	0[2)]
FSC	355	140	165	343	120	6	80	100	0[2)]
Fixing:	FSA/FSB: M4 screws, 2.5 Nm				FSC: M5 screws, 2.5 Nm				

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

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

Dimensions and clearances for PM240 and PM250 - degree of protection IP20, frame sizes FSA … FSC

Frame size	Dimensions (mm)						Clearances (mm)		
	Height[1)]	Width	Depth	a	b	c	Top	Bottom	Lateral
FSA	173	73	145	160	36.5	--	100	100	30[2)]
FSB	270	153	165	258	133	--	100	100	40[2)]
FSC	355	140	165	343	120	6	80	100	50[2)]
Fixing:	FSA/FSB: M4 screws, 2.5 Nm				FSC: M5 screws, 2.5 Nm				

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

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

Dimensions and clearances for PM230, PM240, PM250 and PM260 - IP20 degree of protection, frame sizes FSD … FSGX

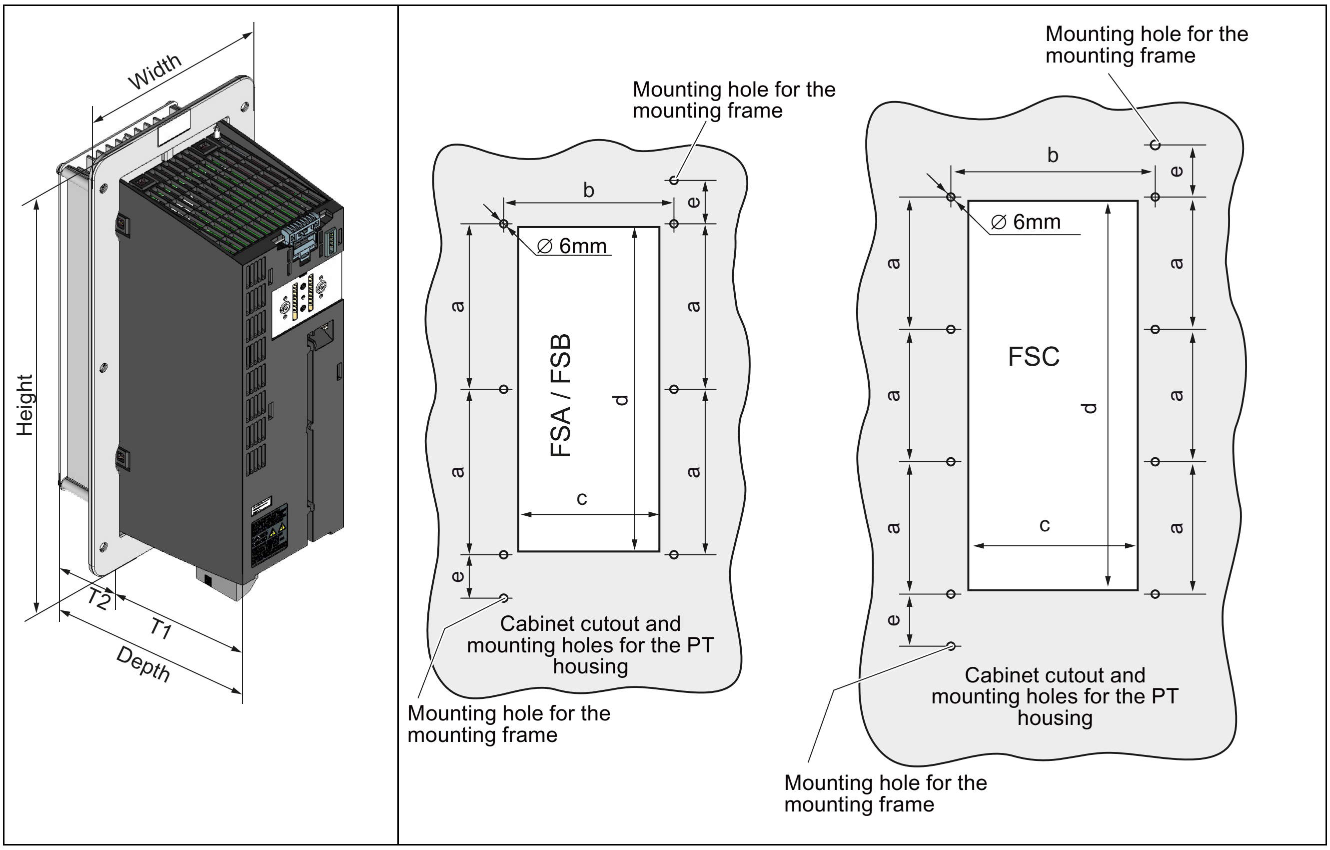
Frame size	Dimensions (mm)						Clearances (mm)		
	Height[1)]	Width	Depth	a	b	c	Top	Bottom	Lateral
FSD without filter	419	275	204	325	235	11	300	300	0[2)]
FSD with filter	512	275	204	419	235	11	300	300	0[2)]
FSE without filter	499	275	204	405	235	11	300	300	0[2)]
FSE with filter	635	275	204	541	235	11	300	300	0[2)]
FSF without filter	634	350	316	598	300	11	350	350	0[2)]
FSF with filter	934	350	316	899	300	11	350	350	0[2)]
FSGX	1533	326	547	1506	125	14.5	250	150	50
Fixing:	FSD/FSE: M6 screws, 6 Nm				FSF/FSGX: M8 screws, 13 Nm				

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

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

3.3.3 Dimension drawings PT

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



Dimensions and clearances for PM230 and PM240-2 - degree of protection IP20, frame sizes FSA … FSC

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

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

Clearances

For the cooling air, the Power Modules require a clearance of 100 mm at the bottom and a clearance of 80 mm at the top in order to be able to dissipate the heat. They can be mounted side by side. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm.

3.3.4 Connection overview for Power Module

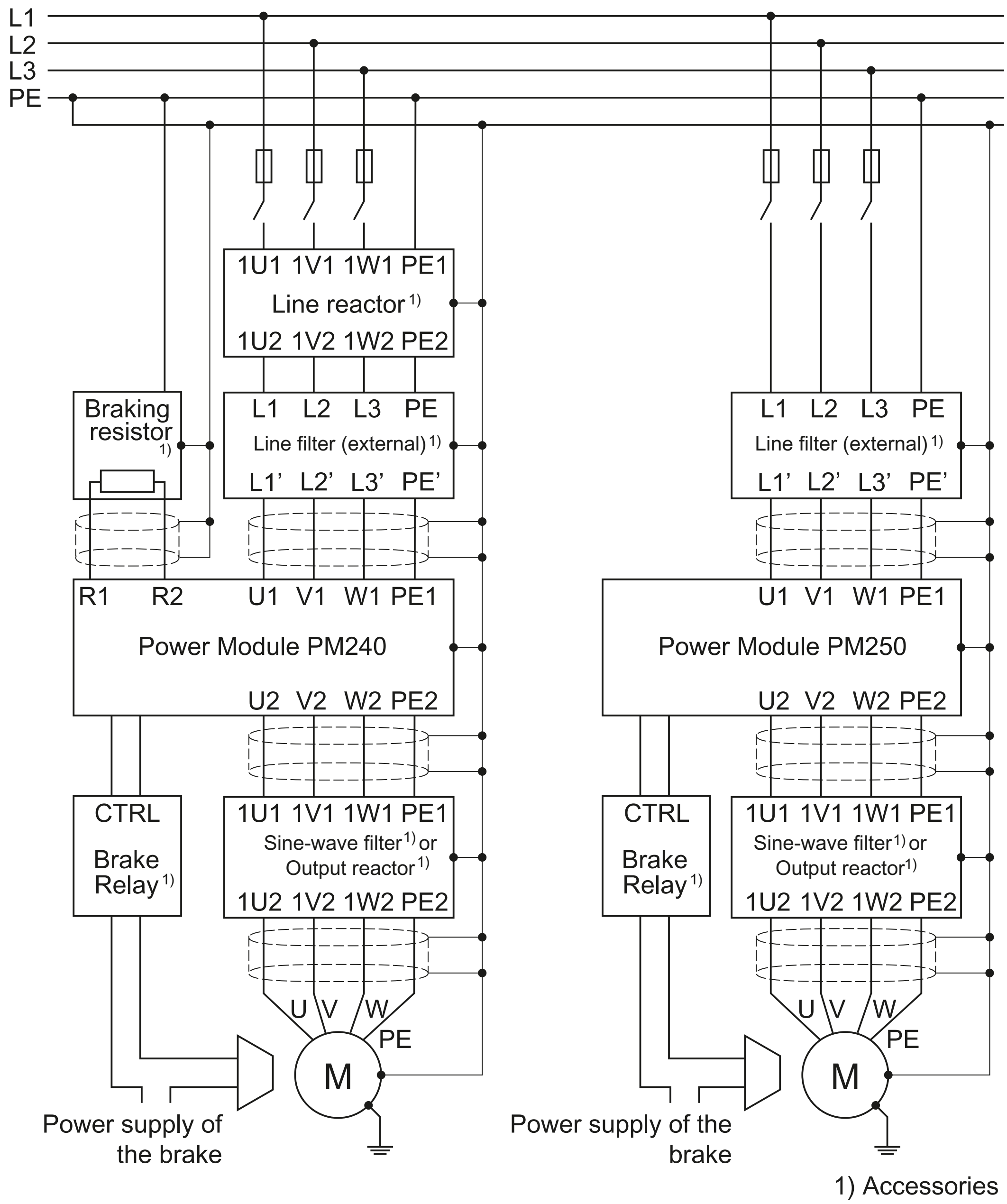


Figure 3-2 Connections for PM240 and PM250 Power Modules

In addition to the Power Modules shown above, you can also combine Control Units with a PM260 Power Module. The PM260 connection corresponds to that of a PM250, however, a sine-wave filter is integrated in the PM260.

The PM240, PM250 and PM260 Power Modules are available with and without integrated class A line filters. An external filter has to be installed for all Power Modules to satisfy more stringent EMC requirements (Class B).

3.3.5 Connecting the line supply and motor

If the converter and motor have been mounted according to the specifications, then you can connect up the devices. First connect the motor to the converter, and then the converter to the line supply.

The permissible cable cross sections and tightening torques are specified in SectionTechnical data (Page 295).

When doing this, observe the following warning information.

WARNING

Line and motor connections

The converter must be grounded on the line supply and motor side. If the converter is not correctly grounded, this can lead to extremely hazardous conditions which, under certain circumstances, can result in death.

The device must be disconnected from the electrical power supply before any connections with the device are established or in any way altered.

The converter terminals be at hazardous voltages even after the converter has been switched off. After disconnecting the line supply, wait at least 5 minutes until the device has discharged itself. Only then, carry out any installation and mounting work.

When connecting the converter to the line supply, ensure that the motor terminal box is closed.

If the LEDs at the converter do not light up or remain inactive, this does not mean that the converter is switched off or is de-energized (no current condition).

The short-circuit ratio of the power supply must be at least 100.

Make sure that the line voltage is in the permissible input voltage range for the converter - it is not permissible to connect the converter to a higher line voltage.

If you use a residual-current operated circuit breaker on the line side to protect against direct or indirect contact, a type B universal current residual-current operated circuit breaker (300 mA shutdown threshold for filtered Power Modules, 30 mA for unfiltered devices) must be used! If you do not use a residual-current operated circuit breaker, you must guarantee touch protection using other protective measures; for example isolating the electronic devices from the environment using double or reinforced insulation or by using a transformer.

CAUTION

Supply cable and signal lines

The signal lines must be routed separately from the supply cables to ensure that the system is not affected by inductive or capacitive interference.

Note

Converters without an integrated line filter can be connected to grounded (TN, TT) and non-grounded (IT) line supply systems. The converters with integrated line filter are suitable only for connection to TN line supply systems.

Note

Electrical protective equipment

Ensure that the appropriate circuit breakers / fuses for the converter's rated current are fitted between the line and converter (see catalog D11.1).

Connecting the motor

Unshielded cables with lengths up to 100 m are permissible to connect the motor. If you use shielded cables, 50 m is permissible for unfiltered converters and 25 m for filtered converters.

Additional information on the cable lengths is provided in Catalog D11.1.

Motor connection

Connect the motor in either the star or delta connection according to your particular application. Additional information on this is provided in the Section Star-delta motor connection and application examples (Page 323).

Also carefully observe the information provided by the motor manufacturer.

Connecting the motor to the converter

- If available, open the terminal covers of the converter.
- Connect the motor to terminals U2, V2 and W2.
  Carefully observe the regulations for EMC-compliant wiring:
  EMC-compliant connection of the converter (Page 37)
- Connect the protective conductor of the motor to the terminal ⏚ of the converter.

Connecting to the line supply

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

3.3.6 EMC-compliant connection of the converter

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

Converters with degree of protection IP20 must be installed and operated in an enclosed control cabinet.

Converters with degree of protection IP55 can also be installed 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 for the Power Module.

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

3.3.7 Avoiding electromagnetic interference (EMI)

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

Inverters with degree of protection IP20 must be installed and operated in an EMC-compliant cabinet.

Control cabinet design

- All metal parts and components of the control cabinet (side panels, rear panels, roof and base plates) must be connected to the control cabinet frame through a good electrical connection – this is best achieved using the highest possible surface area or a high number of individual screw connections
- The PE bar and the EMC shield bar must be connected to the control cabinet frame through a good electrical connection established through a large surface area.
- All of the metal enclosures of the devices and supplementary components installed in the cabinet – e.g. inverter or line filter – must be connected to the control cabinet frame through a good electrical connection through the largest possible surface area. The most favorable design is to mount these devices and supplementary components on a bare metal mounting plate with good conducting characteristics; this in turn is connected to the control cabinet frame through a good electrical connection and the largest possible surface area. It is especially important that they are connected to the PE and EMC shield bars.
- All of the connections must be implemented so that they are durable. Screw connections to painted or anodized metal components must either be established using special contact (serrated) washers that cut through the insulating surface and therefore establish a metallic conductor contact, or the insulating surface must be removed at the contact locations.
- Coils of contactors, relays, solenoid valves and motor holding brakes must be equipped with interference suppression elements in order to dampen high-frequency radiation when switching-off (RC elements or varistors with AC coils and free-wheeling diodes or varistors for DC coils). The protective circuit must be directly connected at the coil.

Cable routing and shielding

- All inverter power cables (line supply cables, connecting cables between the braking chopper and the associated braking resistance as well as the motor cables) must be separately routed away from signal and data cables. The minimum clearance should be approx. 25 cm. As an alternative, the decoupling can be realized in the control cabinet using metal partitions (separating elements) connected to the mounting plate through a good electrical connection
- The cables from the line supply to the line filter must be routed separately away from non-filtered power cables with a high noise level (e. g. cables between the line filter and inverter, connecting cables between the braking chopper and the associated braking resistor as well as motor cables)
- Signal and data cables as well as filtered line supply cables may only cross non-filtered power cables at right angles
- All cables should be kept as short as possible
- Signal and data cables and the associated equipotential bonding cables must always be routed in parallel with the smallest possible clearance between them
- Shielded motor cables must be used
- The shielded motor cable should be routed separately away from the cables to the motor temperature sensors (PTC/KTY)
- Signal and data cables must be shielded.
- Especially sensitive control cables - such as setpoint and actual value cables - should be routed without any interruption with optimum shield support at both ends
- Shields should be connected at both ends to the grounded enclosures through a good electrical connection and through a large surface area
- Cable shields should be connected as close as possible to where the cable enters the cabinet
- EMC shield bars should be used for power cables; the shield support elements provided in the inverter should be used for signal and data cables
- If at all possible, cable shields should not be interrupted by intermediate terminals
- Cable shields should be retained both for power cables as well as for signal and data cables using the appropriate EMC clamps. The shield clamps must connect the shield to the EMC shield bar or the shield support element for control cables through a low inductive connection through a large surface area.

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

Using two examples, the following diagram shows the EMC-compliant installation of Power Modules with and without shield plate.

Note

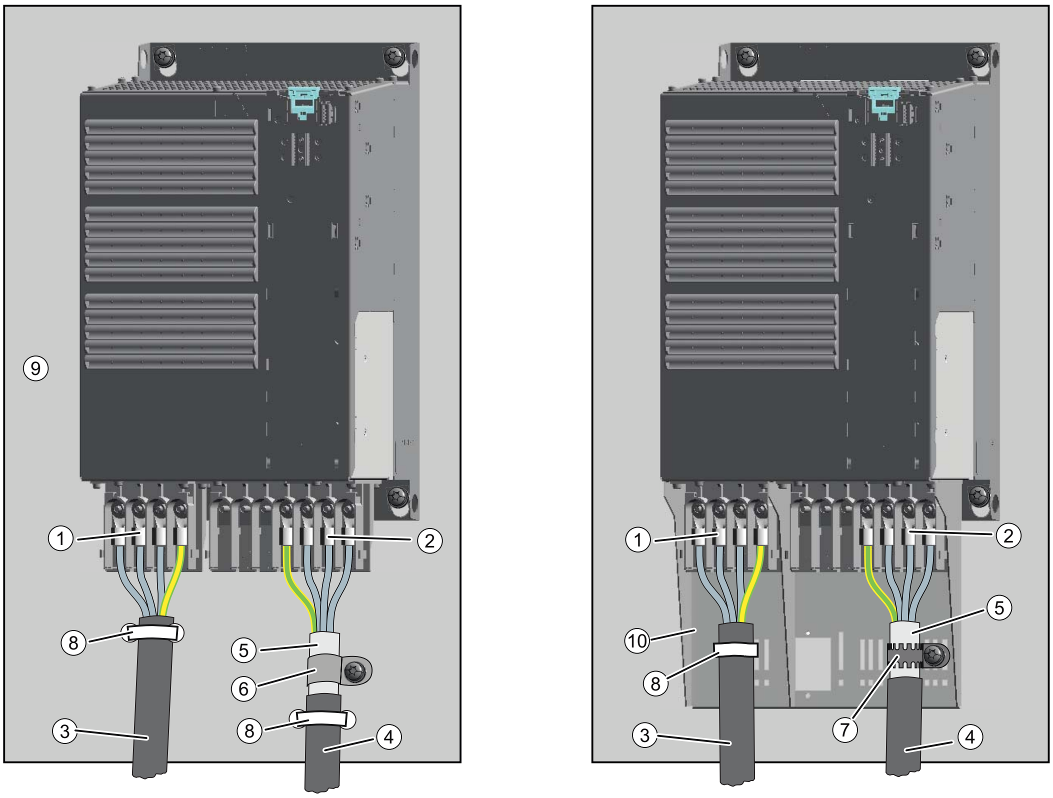
Power Modules PM240-2 and PM230, FSA … FSC

For an EMC-compliant installation, you must use the shield plate.

The shield of the control cable must be installed both on the shield plate of the CU and on the shield plate of the Power Module.

Note

The display in the following diagram is not to scale. The terminal cover cannot be removed. It was only taken out of the diagram to better show the cable connection.



① Line supply connection
② Motor connection
③ Power supply cable (unshielded)
④ Motor connection cable (shielded)
⑤ Cable shield
⑥ Cable clamps for a good conductive electrical connection through a large surface area between the shield and mounting plate
⑦ Serrated collar
⑧ Cable tie
⑨ Metal mounting plate (unpainted and with a good electrical conductivity)
⑩ Shield plate (option)

Figure 3-3 EMC-compliant wiring - on the left without shield plate, on the right with shield plate

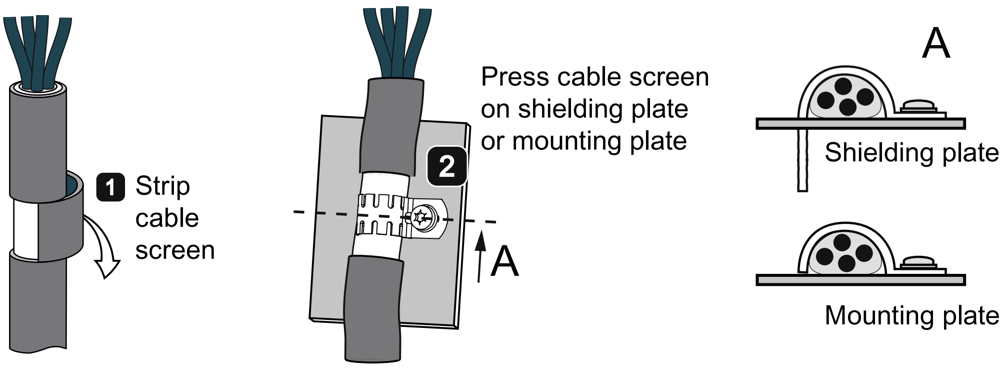


Figure 3-4 Shield connection - detail

Note

Connect a Power Module with integrated line filter with an unshielded cable to the mains power.

If you use an external line filter, you will need a shielded cable between the line filter and the Power Module.

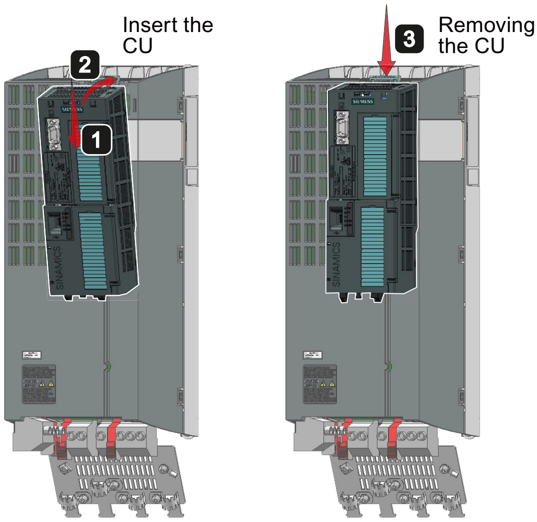
Shielding with shield plate:	Shield connection kits are available for all Power Module frame sizes (you will find more information in Catalog D11.1). The cable shields must be connected to the shield plate through the greatest possible surface area using shield clamps.
Shielding without shield plate:	EMC-compliant shielding can also be implemented without using a shield plate. In this case, you must ensure that the cable shields are connected to the ground potential through the largest possible surface area.
Braking resistor connection:	The braking resistor is connected using a shielded cable. Using a clamp, the shield should be connected to the mounting plate or to the shield plate through a good electrical connection and through the largest possible surface area.

3.4 Installing Control Unit

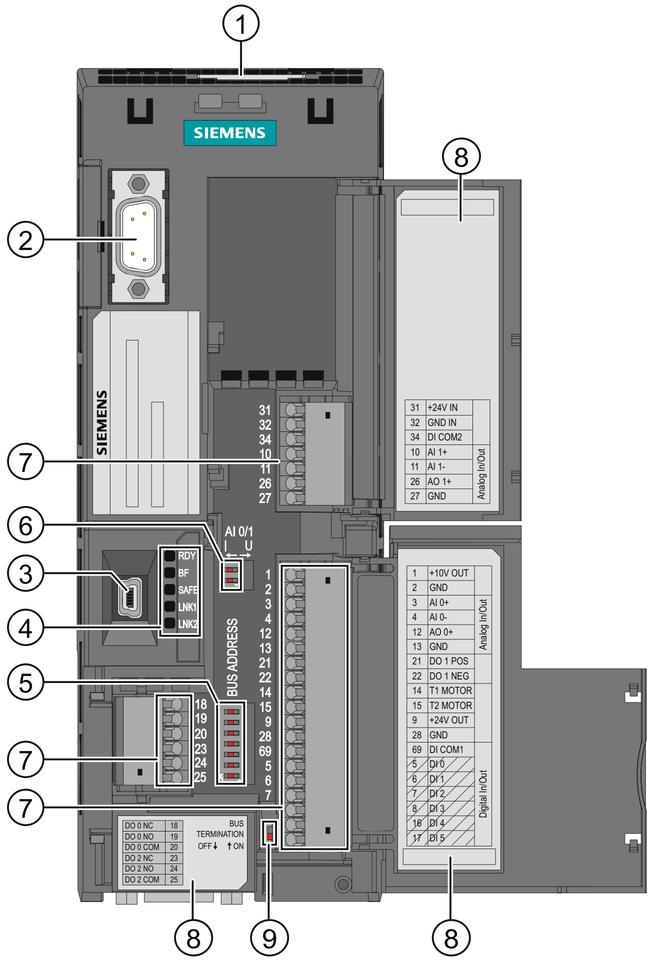
3.4.1 Snapping the Control Unit onto the Power Module

The Control Unit is inserted on and removed from the Power Module without requiring any tools. To gain access to the terminal strips, open the top and bottom front doors to the right. The terminal strips use spring-loaded terminals.

Installing the Control Unit on an IP20 Power Module



3.4.2 Interfaces, connectors, switches, terminal blocks and LEDs of the CU



1. Slot for memory card (MMC or SD)
2. Interface for Operator Panel
3. USB interface for STARTER
4. Status LED: RDY, BF, SAFE, LNK1, nur bei PROFINET, LNK2, nur bei PROFINET
5. DIP switch for fieldbus address (for PROFINET without function)

	On	Off
Bit 6 (64)		■
Bit 5 (32)		■
Bit 4 (16)		■
Bit 3 (8)		■
Bit 2 (4)		■
Bit 1 (2)		■
Bit 0 (1)		■

Example:

	On	Off
		■
		■
		■
8	■	
		■
2	■	
		■

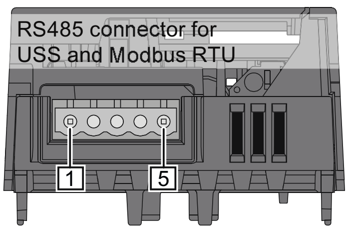
Address = 10

6. DIP switch for analog inputs
   I 0/4 mA ... 20 mA
   U -10/0 V ... 10 V

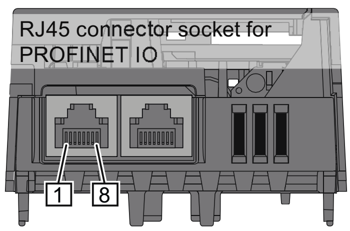
	I	U
AI 1		■
AI 0		■

7. Terminal strip
8. Terminal designation
9. Depending on the fieldbus:
   USS, Modbus: Bus termination
   PROFIBUS, PROFINET: no function

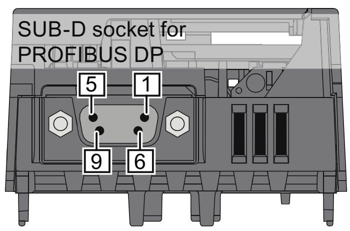
   ON / OFF



Pin	
1	0 V, reference potential
2	RS485P, Receive and Send (+)
3	RS485N, Receive and Send (-)
4	Cable shield
5	Not connected



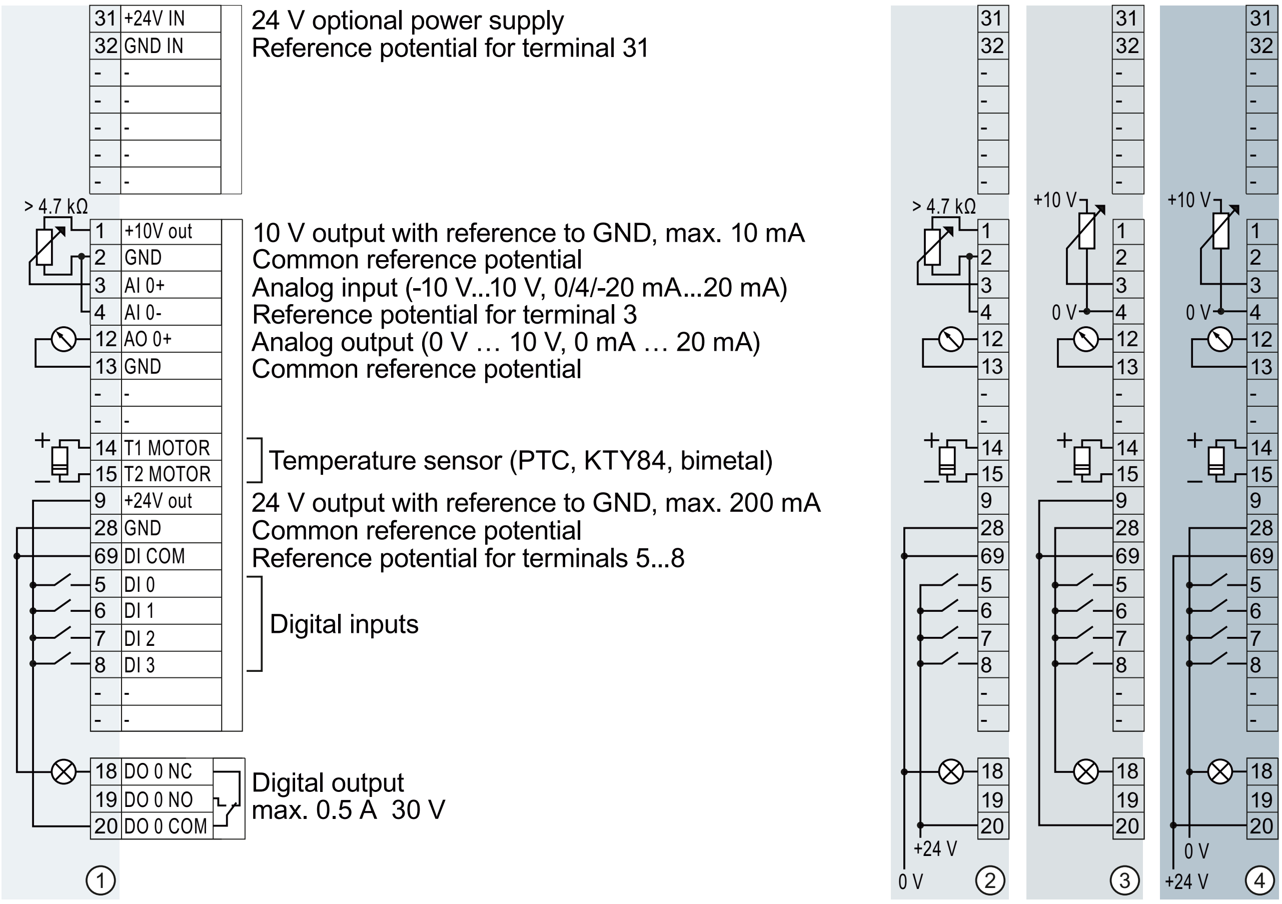
Pin	
1	RX+, receive data +
2	RX-, receive data -
3	TX+. Transmit data +
4	Not assigned
5	Not assigned
6	TX-, Transmit data -
7	Not assigned
8	Not assigned



Pin	
1	Shield, ground connection
2	Not assigned
3	RxD/TxD-P, Receive and Send (B/B')
4	CNTR-P, control signal
5	DGND, reference potential for data (C/C')
6	VP, supply voltage
7	Not assigned
8	RxD/TxD-N, Receive and Send (A/A')
9	Not assigned

Figure 3-5 Design of the Control Unit using the example of the CU240E-2

3.4.3 Terminal strips on CU240B-2 Control Units



You may use the internal 10V power supply or an external voltage source for the analog input.

The analog input can be switched over to an additional digital input.

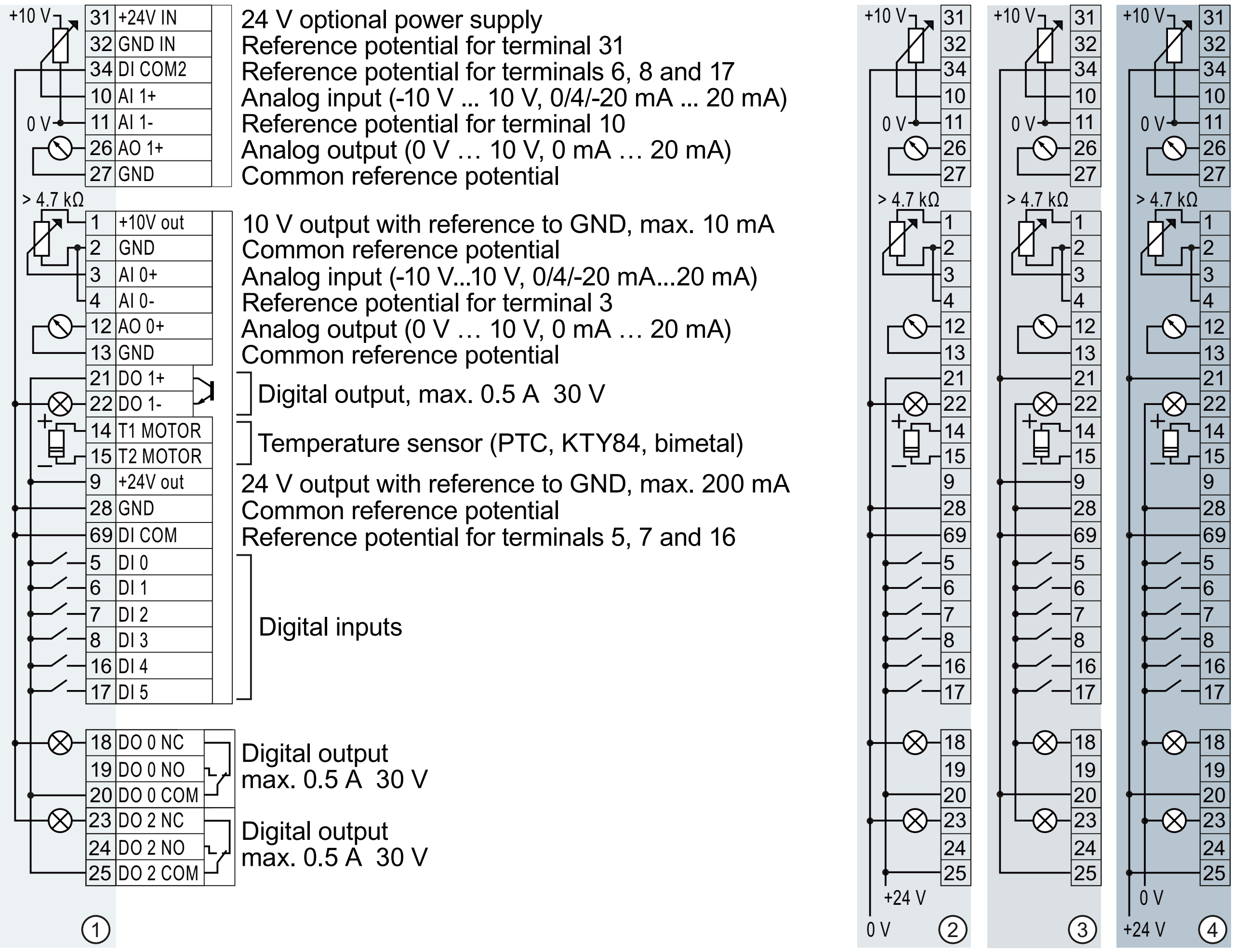
①	Wiring when using the internal power supplies.	DI = high, if the switch is closed.
②	Wiring when using external power supplies.	DI = high, if the switch is closed.
③	Wiring when using the internal power supplies.	DI = low, if the switch is closed.
④	Wiring when using external power supplies.	DI = low, if the switch is closed.

⚠ CAUTION

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240B-2 Control Unit (Page 295).

Define the meanings of the inputs and outputs during basic commissioning. Further information can be found in section Select interface assignments (Page 46).

3.4.4 Terminal strips on CU240E-2 Control Units



You may use the internal 10V power supply or an external voltage source for the analog input.

The analog inputs can be switched over to create additional digital inputs.

①	Wiring when using the internal power supplies.	DI = high, if the switch is closed.
②	Wiring when using external power supplies.	DI = high, if the switch is closed.
③	Wiring when using the internal power supplies.	DI = low, if the switch is closed.
④	Wiring when using external power supplies.	DI = low, if the switch is closed.

> **NOTICE**
>
> **CU240E-2 PN and CU240E-2 PN-F**
>
> The power supply output +24V-OUT, terminal 9, is equipped with electronic short-circuit protection. In the unlikely event of a short-circuit in operation, and in conjunction with unfavorable secondary conditions in the form of a high ambient temperature and the external 24 V supply is providing the maximum voltage, a short-circuit protection defect cannot be completely ruled out.

CAUTION
If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240E-2 Control Unit (Page 297).

Define the meanings of the inputs and outputs during basic commissioning. Further information can be found in Section Select interface assignments (Page 46).

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

Terminals	Designation	Fail-safe input when using the basic functions
16	DI4	F-DI0
17	DI5	

If you wish to use several fail-safe inputs of the converter, this is described in the Safety Integrated Function Manual. See also Section Additional information on the inverter (Page 352).

Further information on fail-safe inputs can be found in Section Fail-safe input (Page 84).

3.4.5 Wiring terminal strips

Solid or flexible cables are permitted as signal lines. Wire end ferrules must not be used for the spring-loaded terminals.

The permissible cable cross-section ranges between 0.5 mm² (21 AWG) and 1.5 mm² (16 AWG). When completely connecting-up the unit, we recommend cables with a cross-section of 1mm² (18 AWG).

Route the signal lines so that you can again completely close the front doors after connecting-up the terminal strip. 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.

3.4.6 Select interface assignments

Description

The converter offers different predefined assignments (macros) for its inputs and outputs and the fieldbus interface.

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

Procedure

- Wire up the converter according to the interface assignment most suitable for your application.

Further steps

- In the basic commissioning, select the default settings of the interfaces that best match your particular wiring.
- If necessary, after the basic commissioning, adjust the function of the inputs or outputs and the fieldbus interface.

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

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

Automatic/local - Changeover between fieldbus and jog mode

Factory setting for inverters with PROFIBUS or PROFINET interface.

Macro 7 — DI 3 = LOW — PROFIBUS DP fieldbus

Terminal	Input	Function	Function	Terminal	Output
5	DI 0	---	Fault	18	DO 0
6	DI 1	---		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW			
3	AI 0+	---	Speed	12	AO 0+
4			0 V ... 10 V	13	

PROFIBUS DP Telegram 1

DI 3 = HIGH — Jogging via DI 0 and DI 1

Terminal	Input	Function	Function	Terminal	Output
5	DI 0	Jog 1	Fault	18	DO 0
6	DI 1	Jog 2		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH			
3	AI 0+	---	Speed	12	AO 0+
4			0 V ... 10 V	13	

p1058 = Jog 1
p1059 = Jog 2

Refer also to section: Configuring communication to the control (Page 99).

Motorized potentiometer

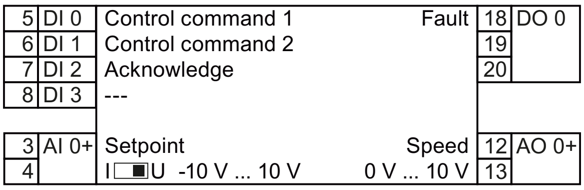
Macro 9 — Motorized potentiometer (MOP)

Terminal	Input	Function	Function	Terminal	Output
5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	MOP up		19	
7	DI 2	MOP down		20	
8	DI 3	Acknowledge			
3	AI 0+	---	Speed	12	AO 0+
4			0 V ... 10 V	13	

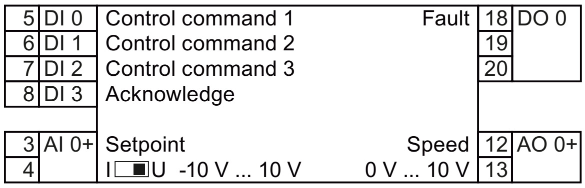
Two- or three-wire control

Macro 12 is the factory setting for converters with the Control Unit CU240B-2.

	Macro 12	Macro 17	Macro 18
Two-wire control	Method 1	Method 2	Method 3
Control command 1	ON/OFF1	ON/OFF1 right	ON/OFF1 right
Control command 2	Reversing	ON/OFF1 left	ON/OFF1 left



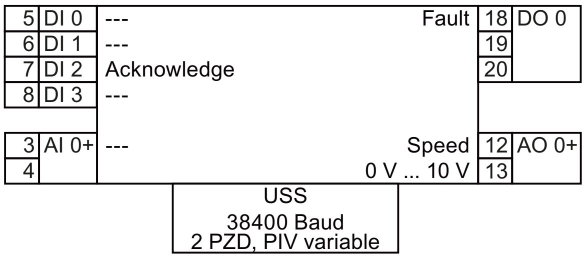
	Macro 19	Macro 20
Three-wire control	Method 1	Method 2
Control command 1	Enable/OFF1	Enable/OFF1
Control command 2	ON right	ON
Control command 3	ON left	Reversing



Communication with higher-level control via USS

Macro 21	Fieldbus USS

p2020 = Baud rate
p2022 = PZD number
p2023 = PKW number



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

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

Fixed speeds

Macro 1	Two-wire control with two fixed speeds

p1003 = Fixed speed 3
p1004 = Fixed speed 4

DI 4 and DI 5 = HIGH:
Frequency converter added
fixed speed 3 + fixed speed 4

5	DI 0	ON/OFF1 right	Fault	18	DO 0
6	DI 1	ON/OFF1 left		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	Fixed speed 3		22	
17	DI 5	Fixed speed 4			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Macro 2	Two fixed speeds with safety function

p1001 = Fixed speed 1
p1002 = Fixed speed 2

DI 0 and DI 1 = HIGH:
Motor rotates with
fixed speed 1 + fixed speed 2

5	DI 0	ON/OFF1 + fixed speed 1	Fault	18	DO 0
6	DI 1	Fixed speed 2		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	Reserved for safety function		22	
17	DI 5				
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Refer also to section: Safe Torque Off (STO) safety function (Page 227).

Macro 3	Four fixed speeds

p1001 = Fixed speed 1
p1002 = Fixed speed 2
p1003 = Fixed speed 3
p1004 = Fixed speed 4

Several DI = HIGH:
Frequency converter adds corresponding fixed speeds

5	DI 0	ON/OFF1 + fixed speed 1	Fault	18	DO 0
6	DI 1	Fixed speed 2		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	Fixed speed 3		22	
17	DI 5	Fixed speed 4			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

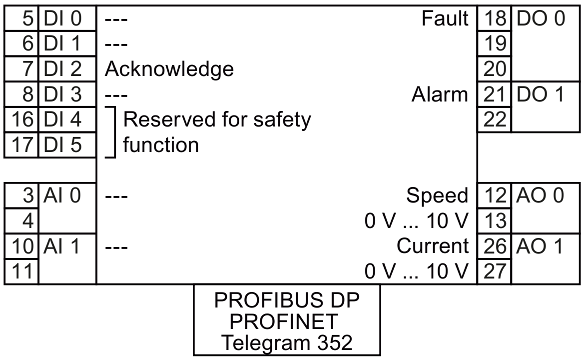
Macro 4	PROFIBUS DP or PROFINET fieldbus

5	DI 0	---	Fault	18	DO 0
6	DI 1	---		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

PROFIBUS DP
PROFINET
Telegram 352

Refer also to section: Configuring communication to the control (Page 99).

Macro 5	Fieldbus with safety function or PROFINET



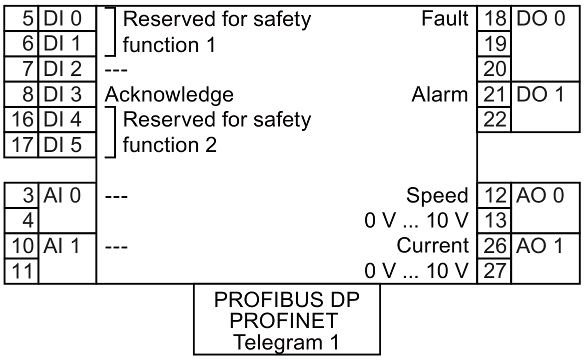
See also the following sections:

- Safe Torque Off (STO) safety function (Page 227)
- Configuring communication to the control (Page 99)

Two safety functions

This default setting is only possible for the CU240E-2 F, CU240E-2 DP-F and CU240E-2 PN-F Control Units.

Macro 6	PROFIBUS DP or PROFINET fieldbus with two safety functions



See also the following sections:

- Safe Torque Off (STO) safety function (Page 227)
- Configuring communication to the control (Page 99)

Automatic/local - Changeover between fieldbus and jog mode

Factory setting for converters with PROFIBUS or PROFINET interface:

Macro 7	DI 3 = LOW	Fieldbus PROFIBUS DP or PROFINET

5	DI 0	---	Fault	18	DO 0
6	DI 1	---		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW	Warning	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

PROFIBUS DP
PROFINET
Telegramm 1

DI 3 = HIGH	Jogging via DI 0 and DI 1

5	DI 0	Jog 1	Fault	18	DO 0
6	DI 1	Jog 2		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH	Warning	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

p1058 = Jog 1
p1059 = Jog 2

Refer also to section: Configuring communication to the control (Page 99).

Motorized potentiometer

Macro 8	Motorized potentiometer (MOP) with safety function

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	MOP up		19	
7	DI 2	MOP down		20	
8	DI 3	Acknowledge	Alarm	21	DO 1
16	DI 4	Reserved for safety function		22	
17	DI 5				
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Refer also to section: Safe Torque Off (STO) safety function (Page 227).

Macro 9	Motorized potentiometer (MOP)

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	MOP up		19	
7	DI 2	MOP down		20	
8	DI 3	Acknowledge	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Applications with analog setpoint

Macro 13	Setpoint via analog input and safety function

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	Reversing		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	Reserved for safety		22	
17	DI 5	function			
3	AI 0	Setpoint	Speed	12	AO 0
4		I U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Refer also to section: Safe Torque Off (STO) safety function (Page 227).

Process industry

Macro 14	DI 3 = LOW	PROFIBUS DP or PROFINET fieldbus

5	DI 0	---	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

PROFIBUS DP
PROFINET
Telegram 20

DI 3 = HIGH	Motorized potentiometer (MOP)

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH	Alarm	21	DO 1
16	DI 4	MOP up		22	
17	DI 5	MOP down			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Refer also to section: Configuring communication to the control (Page 99).

Macro 15	DI 3 = LOW	Analog setpoint			
5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	Setpoint	Speed	12	AO 0
4		I/U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

	DI 3 = HIGH	Motorized potentiometer (MOP)			
5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH	Alarm	21	DO 1
16	DI 4	MOP up		22	
17	DI 5	MOP down			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Two- or three-wire control

Macro 12 is the factory setting for converters with the Control Units CU240E-2 and CU240E-2 F.

	Macro 12	Macro 17	Macro 18
Two-wire control	Method 1	Method 2	Method 3
Control command 1	ON/OFF1	ON/OFF1 right	ON/OFF1 right
Control command 2	Reversing	ON/OFF1 left	ON/OFF1 left

5	DI 0	Control command 1	Fault	18	DO 0
6	DI 1	Control command 2		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	Setpoint	Speed	12	AO 0
4		I/U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

	Macro 19	Macro 20
Three-wire control	Method 1	Method 2
Control command 1	Enable/OFF1	Enable/OFF1
Control command 2	ON right	ON
Control command 3	ON left	Reversing

5	DI 0	Control command 1	Fault	18	DO 0
6	DI 1	Control command 2		19	
7	DI 2	Control command 3		20	
8	DI 3	Acknowledge	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	Setpoint	Speed	12	AO 0
4		I/U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Communication with a higher-level control via USS

Macro 21	Fieldbus USS
	p2020 = Baud rate
	p2022 = PZD number
	p2023 = PKW number

5	DI 0	---	Fault	18	DO 0
6	DI 1	---		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

USS
38400 Baud
2 PZD, PIV variable

4 Typical commissioning scenarios

Adapting the converter to the drive application

The converter must match the motor and the drive application to be able to optimally operate and protect the motor.

Although the converter can be parameterized for very specific applications, many standard applications function satisfactorily with just a few adaptations.

Use the factory settings ... where possible

In basic applications, the drive already functions with its factory settings. To do this, you must check whether the motor and application match the factory settings of the converter.

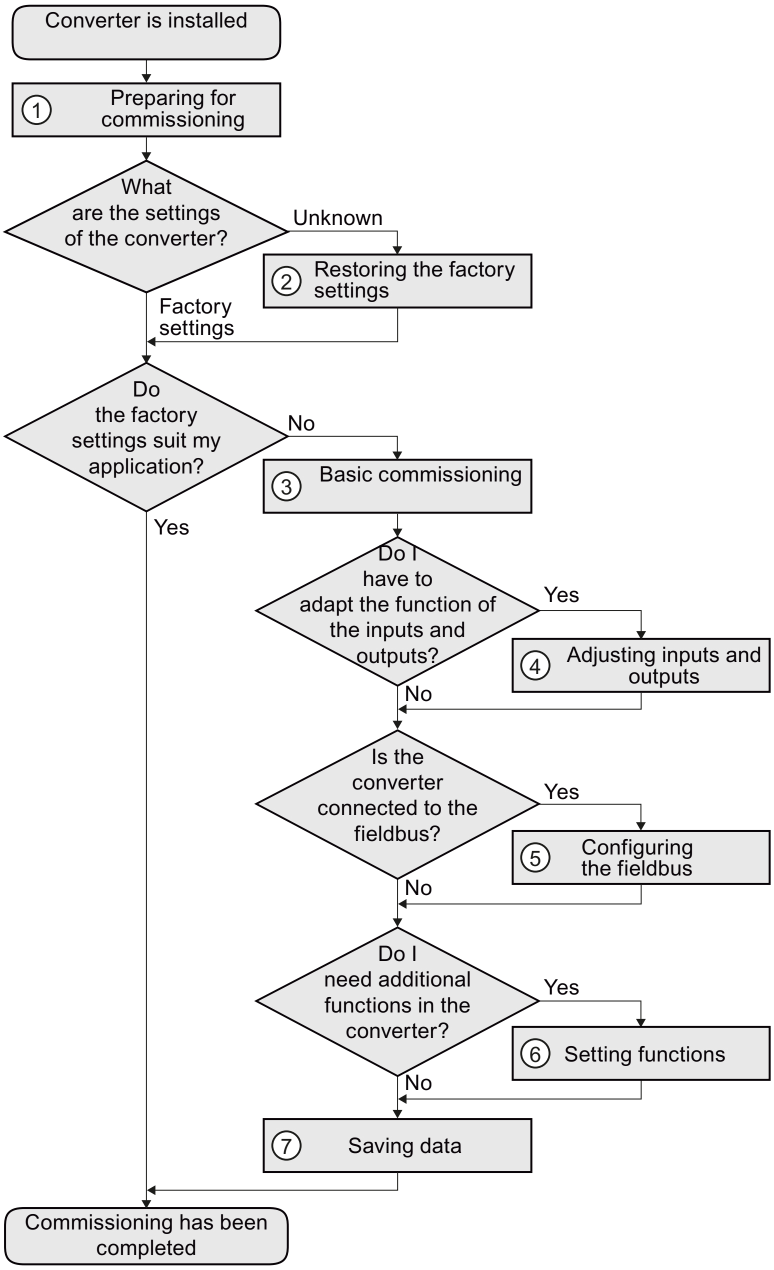
If, when making this check, you identify that you must adapt the factory settings, then you must commission the converter.

Only the basic commissioning is required ... for basic, standard applications

Most standard applications function after just a few adaptations made during the basic commissioning.

Commissioning guidelines

We recommend the following procedure for the commissioning of your converter:



① See (Page 57)

② See (Page 64)

③ Basic commissioning with STARTER (Page 70) or Operator Panel (Page 66)

④ See (Page 81)

⑤ See (Page 93)

⑥ See (Page 141)

⑦ See (Page 247)

Basic commissioning 5

5.1 Preparing for basic commissioning

Prerequisites: before you start

Before starting commissioning, you must answer the following questions:

- What data does my converter have?
- What is the data for the connected motor?
- What technological requirements must the drive fulfill?
- Via which converter interfaces does the higher-level control operate the drive?

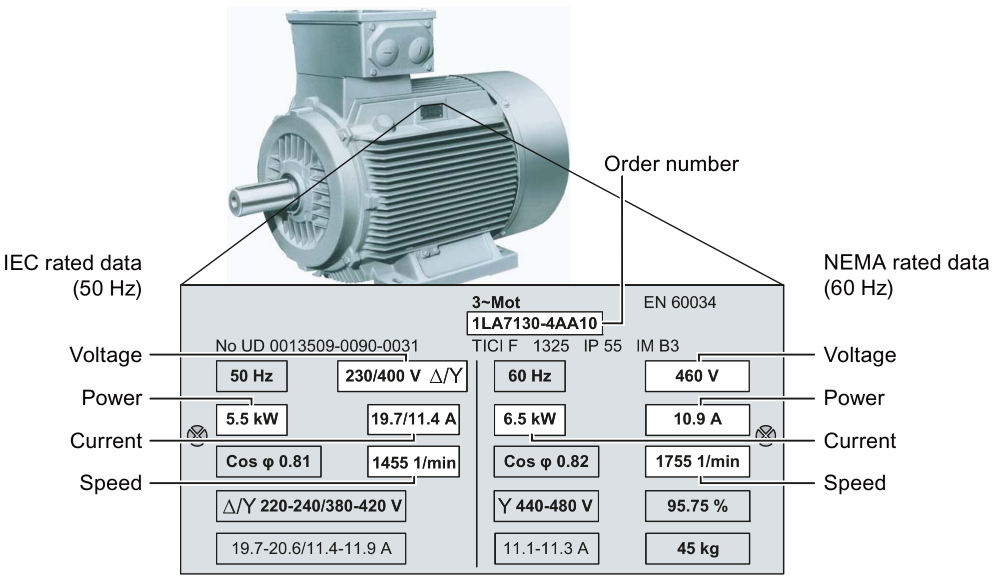
5.1.1 Collecting motor data

In which region of the world is the motor used?

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

Motor data of the rating plate

If you use the STARTER commissioning tool and a SIEMENS motor, then you only have to specify the order number of the motor - otherwise you must use the data from the motor rating plate.



NOTICE
Installation note The rating plate data that you enter must correspond to the connection type of the motor (star connection [Y]/delta connection [Δ]), i.e. for a delta motor connection, the delta rating plate data must be entered.

What is the prevailing temperature where the motor is operated?

- Motor ambient temperature if it differs from the factory setting = 20° C.

5.1.2 Does the motor match the converter?

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

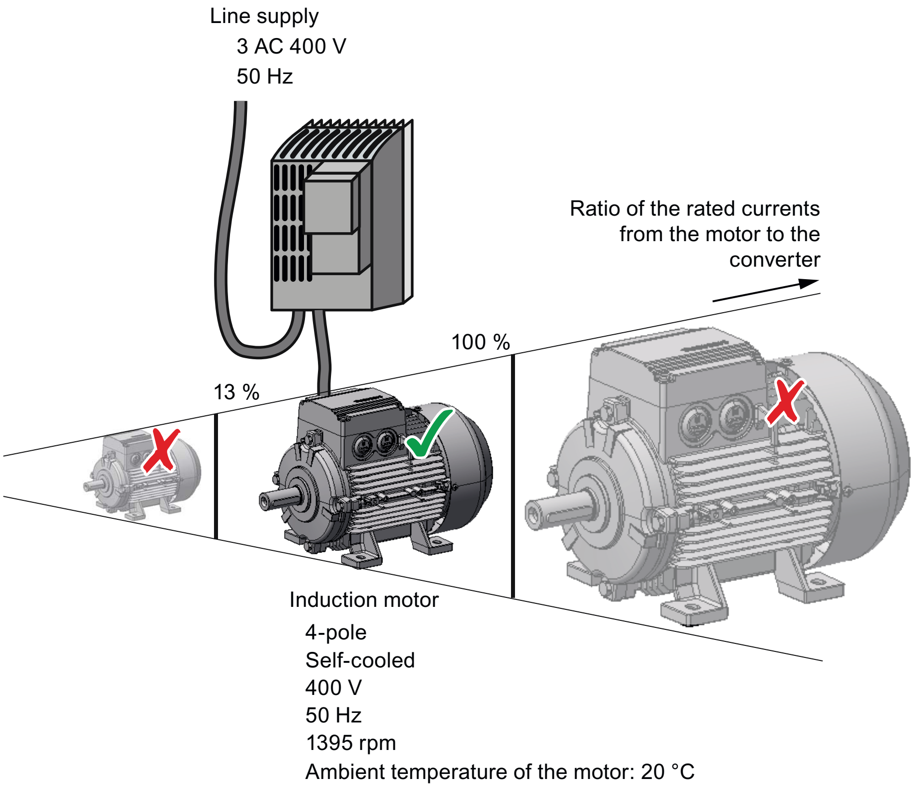


Figure 5-1 Motor data factory settings

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

5.1.3 Wiring examples for the factory settings

To ensure that the factory setting can be used, you must wire the terminal strip of your converter as shown in the following examples.

Pre-assignment of the terminal strip for the CU240B-2

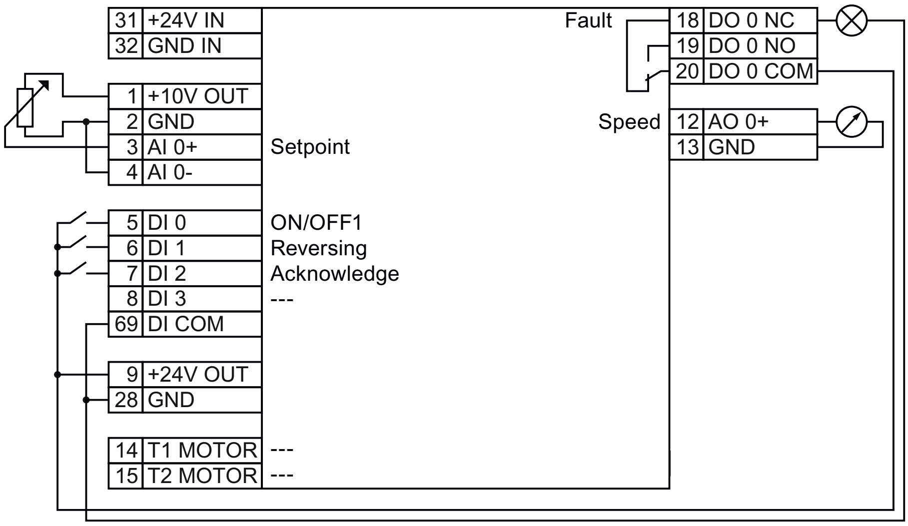


Figure 5-2 Wiring example to use the factory settings

Pre-assignment of the terminal strip for the CU240B-2 DP

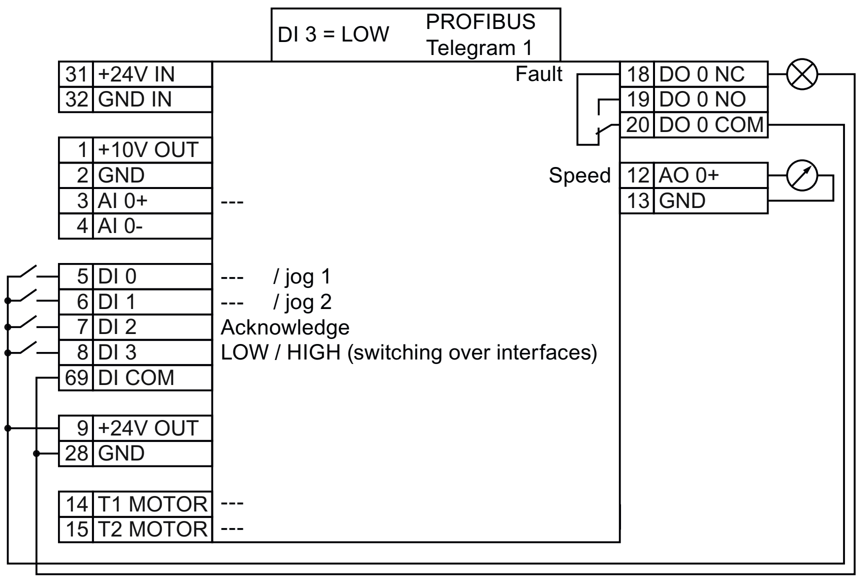


Figure 5-3 Wiring example to use the factory settings

Pre-assignment of the terminal strip for the CU240E-2 and CU240E-2 F

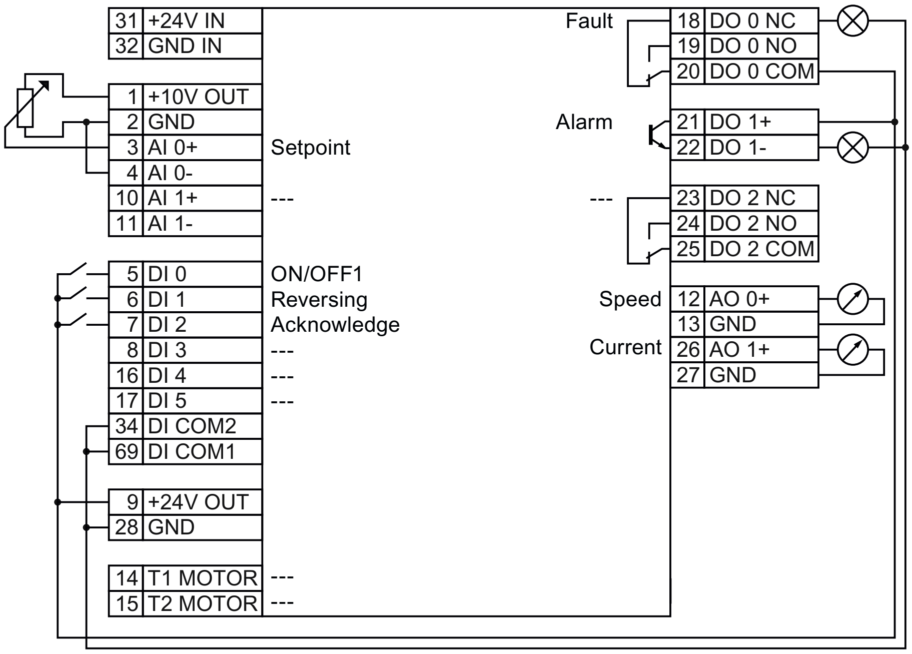


Figure 5-4 Wiring example to use the factory settings

Pre-assignment of the terminal strip for CU240E-2 DP, CU240E-2 DP-F, CU240E 2 PN and CU240E-2 PN-F

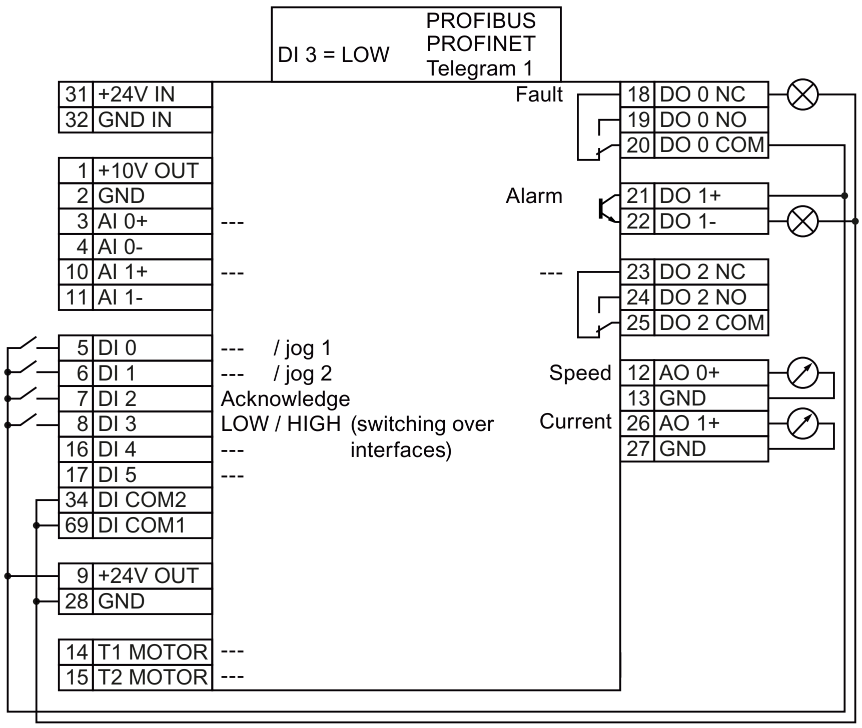


Figure 5-5 Wiring example to use the factory settings

5.1.4 Factory setting of the inverter control

Switching the motor on and off

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

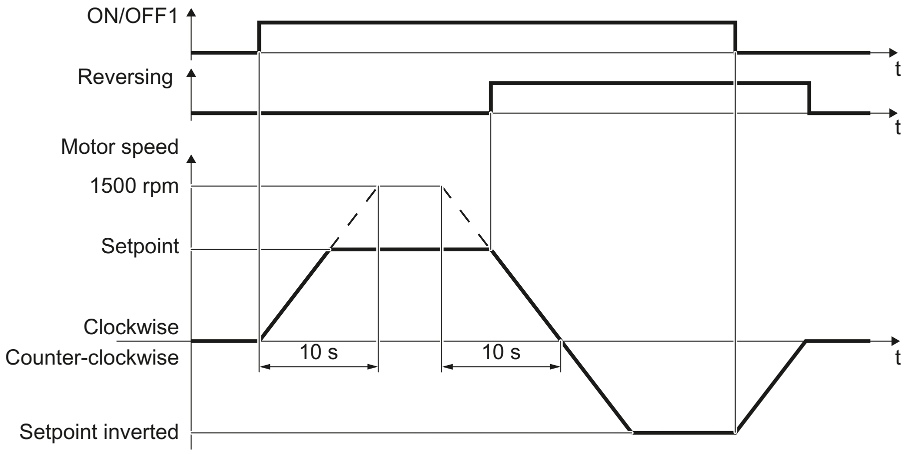


Figure 5-6 Switching on and switching off the motor and reversing in the factory setting

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.

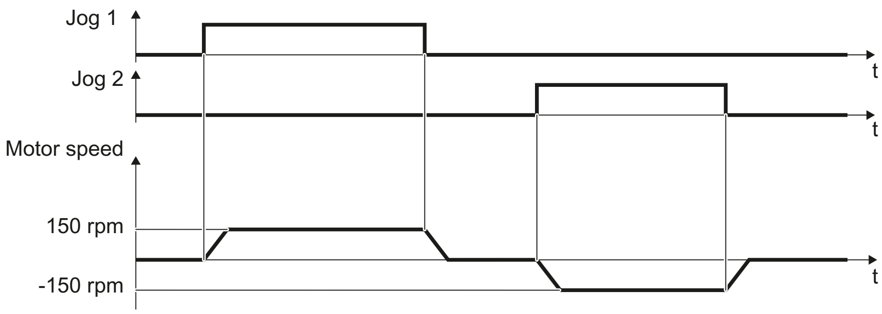


Figure 5-7 Jogging the motor in the factory setting

5.1.5 U/f control or speed control?

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

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

Criteria for selecting either U/f control or speed control

U/f control is suitable for most applications in which the speed of induction motors is to be changed. Examples of typical applications for U/f control include:

- Pumps
- Fan
- Compressors
- Horizontal conveyors

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

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

Examples of typical applications in which speed control is used:

- Hoisting gear and vertical conveyors
- Winders
- Extruders

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

- If the motor is too small in comparison to the inverter (the rated motor power may not be less than one quarter of the rated inverter power)
- If several motors are connected to one inverter
- If a power contactor is used between the inverter and motor and is opened while the motor is powered up
- If the maximum motor speed exceeds the following values:

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

5.1.6 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 > 0 makes sense in applications, where the motor should be operated with a speed = 0 after it has been switched on. Examples include fans or pumps.
- Maximum speed - factory setting 1500 [rpm]
  The converter limits the motor speed to this value.

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

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

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

5.2 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 when setting the parameters and you can no longer understand the individual settings that you made.
- You don't know whether the inverter was already operational

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

Reset settings of the safety functions

The settings of the safety functions are protected by a password. In order to reset all settings of the converter to the factory settings, you must begin with the safety functions.

Table 5- 1 Procedure

<table>
<tr><th>STARTER</th><th colspan="2">Operator Panel</th></tr>
<tr><td rowspan="4">1. Go online with STARTER
2. Call the safety functions screen form
3. In the dialog "Safety Integrated" select the button for restoring the factory setting.</td><td colspan="2">Set the following parameters:</td></tr>
<tr><td>p0010 = 30</td><td>Activate resetting of the settings.</td></tr>
<tr><td>p9761 = …</td><td>Enter the password for the safety functions</td></tr>
<tr><td>p0970 = 5</td><td>Starting resetting.
If the converter has reset the settings, p0970 = 5is set.</td></tr>
</table>

Final steps:

1. Switch off the converter power supply.
2. Wait until all LEDs on the converter go dark. Now switch on the converter supply voltage again. Your settings only become effective after this power-on reset.

Restoring the factory setting with STARTER or BOP-2

This function resets the settings in the inverter to the factory settings.

Note

The communication settings and the settings of the motor standard (IEC/NEMA) are retained even after restoring the factory setting.

Table 5- 2 Procedure

STARTER	BOP-2
1. Go online with STARTER 2. In STARTER, click on the button .	1. In the "Options" menu, select the "DRVRESET" entry 2. Confirm the reset using the OK key

5.3 Using the factory settings

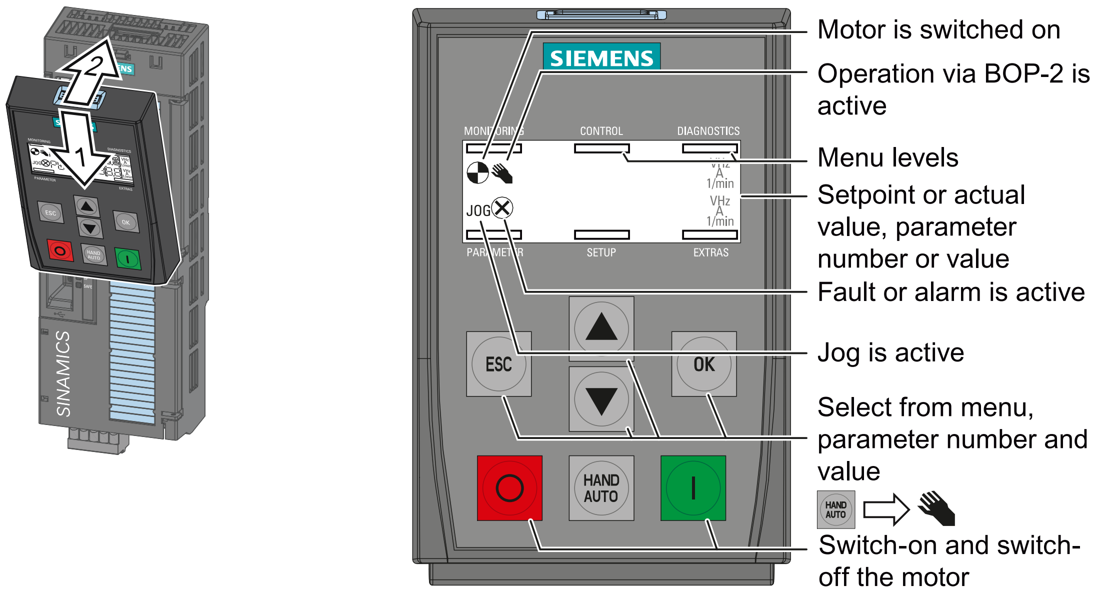
You only have to do the following, if the factory settings of the converter match your motor and your application.

1. Connect the converter in accordance with the wiring example. See Section: Wiring examples for the factory settings (Page 59)
2. If you operate the drive on a fieldbus, you have to do the following:
   - Configure your central controller according to the settings of the converter.
   - If required by the fieldbus, set the bus address on the converter. See also Section: Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43)

5.4 Basic commissioning with the BOP-2

Operator control and display elements of the BOP-2

The "Basic Operator Panel-2" (BOP-2) is an operation and display instrument of the converter. For commissioning, it is directly plugged onto the converter Control Unit.



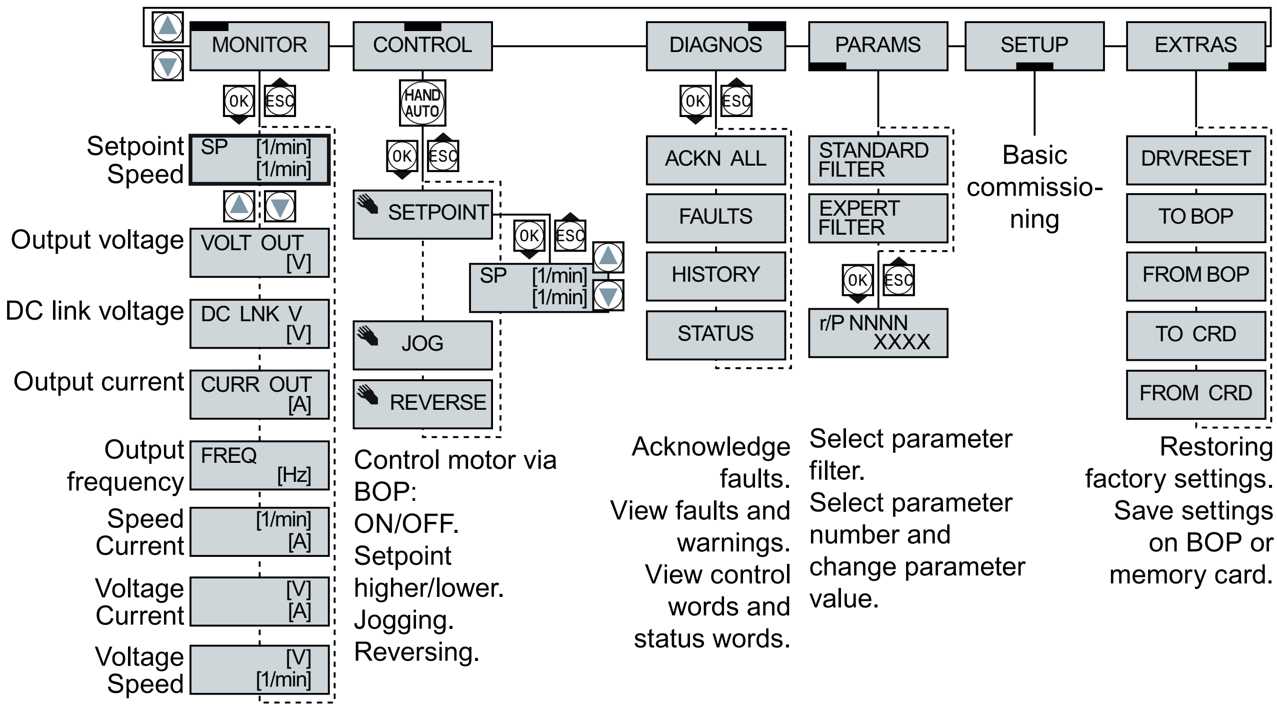


Figure 5-8 Menu of the BOP-2

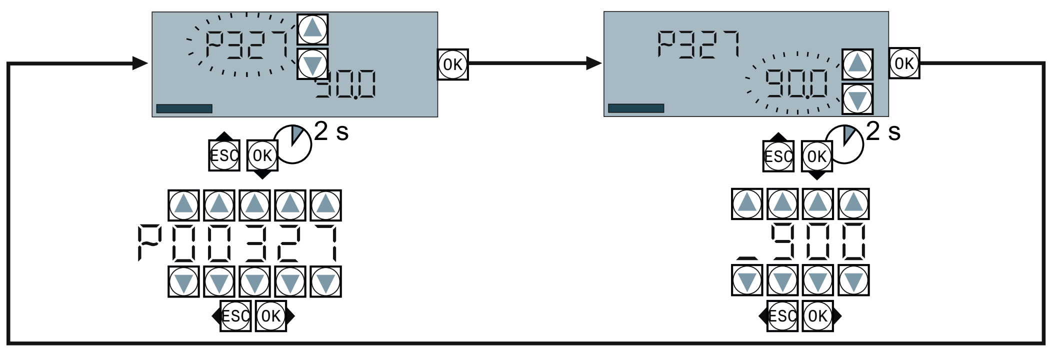
5.4.1 Changing settings using BOP-2

Changing settings using BOP-2

Using BOP2 you may change your converter settings by selecting a parameter number and changing the parameter value.

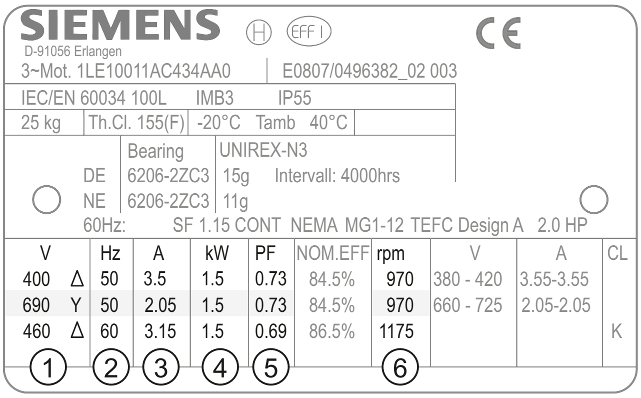
The converter immediately saves all settings which you made using the BOP-2 so that they are protected against power failure.

Procedure

<table>
<tr><th colspan="2">Select the parameter number</th><th colspan="2">Changing a parameter value</th></tr>
<tr><td colspan="4">
</td></tr>
<tr><td colspan="2">If the parameter number flashes in the display, you have two options for changing the number:</td><td colspan="2">If the parameter value flashes in the display, you have two options of changing the value:</td></tr>
<tr><td>1. option:</td><td>2. option:</td><td>1. option:</td><td>2. option:</td></tr>
<tr><td>• Increase or decrease the parameter number using the arrow keys until the number you want is displayed.</td><td>• Press and hold the OK key for more than two seconds and change the required parameter number digit by digit.</td><td>• Increase or decrease the parameter value using the arrow keys until the value you want is displayed.</td><td>• Press and hold the OK key for more than two seconds and enter the required value digit by digit.</td></tr>
<tr><td colspan="2">• Confirm the parameter number using the OK key.</td><td colspan="2">• Confirm the parameter value using the OK key.</td></tr>
</table>

5.4.2 Basic commissioning

Menu	Remark
SETUP (OK)	Set all of the parameters of the menu "SETUP". In the BOP-2, select the menu "SETUP".
RESET (OK)	Select reset if you wish to reset all parameters to the factory setting before the basic commissioning. nO → YES → OK
CTRL MOD P1300 (OK)	Select the motor control mode. The most important control modes are: VF LIN: V/f control with linear characteristic VF QUAD: V/f control with square law characteristic SPD N EN: Closed-loop speed control (sensorless vector control) TRQ N EN: Closed-loop torque control
EUR/USA P100 (OK)	② Standard: IEC or NEMA
MOT VOLT P304 (OK)	① Voltage
MOT CURR P305 (OK)	③ Current
MOT POW P307 (OK)	④ Power IEC standard (kW) ⑤ Power NEMA standard (HP)
MOT RPM P311 (OK)	⑥ Rated speed
MOT ID P1900 (OK)	We recommend the setting STIL ROT (identify motor data at standstill and with the motor rotating). If one of the following cases applies, select the setting STILL (identify motor data at standstill): • You have selected the "Speed control" control mode, but the motor cannot rotate freely, e.g. for mechanically limited traversing sections. • You have set "V/f control" as control mode.
MAc PAr P15 (OK)	Select the configuration for the inputs and outputs, as well as the correct fieldbus for your application. The predefined configurations can be found in the section titled Select interface assignments (Page 46).
MIN RPM P1080 (OK)	Minimum motor speed.
RAMP UP P1120 (OK)	Motor ramp-up time.
RAMP DWN P1121 (OK)	Motor ramp-down time.
FINISH (OK)	Confirm that the basic commissioning has been completed (Parameter p3900): nO → YES → OK



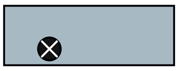
Motor data on the rating plate

Motor data identification and self-optimization

If you select the MOT ID (p1900) during basic commissioning, an alarm will be issued once the basic commissioning has been completed.

For the motor data identification, the motor must be cold. A motor in a warm operational condition supplies unusable measurement results.

⚠ CAUTION
Motor data identification for dangerous loads
Secure dangerous plant and system parts before starting the motor data identification, e.g. by fencing off the dangerous location or lowering a suspended load to the floor.

Menu / Button	Procedure
	The converter issues alarm A07991.
 ⇒  ⇒ 	• Switch over from AUTO to HAND. The BOP-2 displays the HAND icon. • Switch on the motor to enable the converter to identify the data of the connected motor.
	The converter identifies the motor data during standstill. This procedure takes several seconds. The converter switches off the motor after the motor data identification has been completed.
	If, in addition to the motor data identification, you have also selected a rotating measurement, the converter issues again alarm A07991.
	• Switch on again the motor to enable the converter to identify the data of the connected motor.
	The converter turns the motor and optimizes the speed controller. This procedure can take up to one minute. The converter switches off the motor after optimization has been completed.
	• Switch over from HAND to AUTO.

5.4.3 Additional settings

The Section Typical commissioning scenarios (Page 55) shows you what still has to be set after the basic commissioning in order to adapt the inverter to your application.

5.5 Basic commissioning with STARTER

Preconditions

You require the following to commission the converter using STARTER:

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

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

  Note

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

Going online via USB or fieldbus.

In the following, commissioning is described when the PC and converter are connected with one another via a USB cable.

With STARTER, you can access most converters not only via USB, but also via a fieldbus.

You must proceed as follows when you wish to commission the converter using STARTER via a fieldbus:

1. Configure the communication between the converter and PC.
   An example is provided in the section: Configuring PROFINET communication in STEP 7 (Page 334).
2. Go online with STARTER via the fieldbus.
3. Start commissioning with the section: Generating a STARTER project (Page 73).

5.5.1 Adapting interfaces

5.5.1.1 Adapting the USB interface

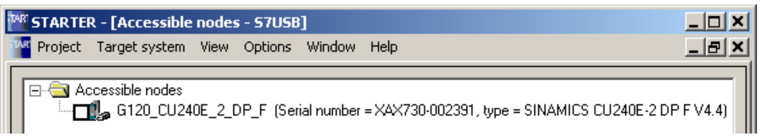
Procedure

- Switch on the converter power supply and connect the converter to the PC via USB.
- You must install the USB driver if you are connecting the converter and PC together for the first time. Windows 7 automatically installs the driver; for older Windows versions, you must confirm the automatic installation.

- Start the STARTER commissioning software.
- If you are using STARTER for the first time, you must check whether the USB interface is correctly set. To do this, click in STARTER on ("Accessible participants").

Case 1: USB interface OK - no setting is required

If the interface is correctly set, the following screen form shows the converter, which is directly connected to your computer via the USB interface.

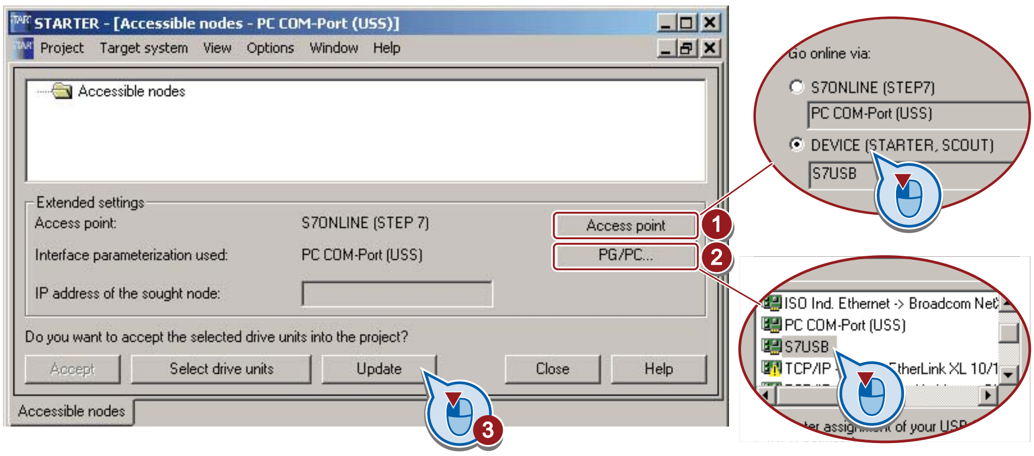


- Close this screen form, without selecting the converter(s) that has/have been found.
- Create your STARTER project.

Case 2: USB interface must be set

In this case, the message box "no other nodes found" is displayed.

- Set the following in the "Accessible participants" screen form:
  - ① Under "Access point activate "DEVICE (STARTER, Scout)"
  - ② Under " PG/PC" select "S7USB"
  - ③ Then click on "Update"



- Close this screen form, without selecting the converter(s) that has/have been found.
- Create your STARTER project.

5.5.1.2 Accessing the converter via PROFINET

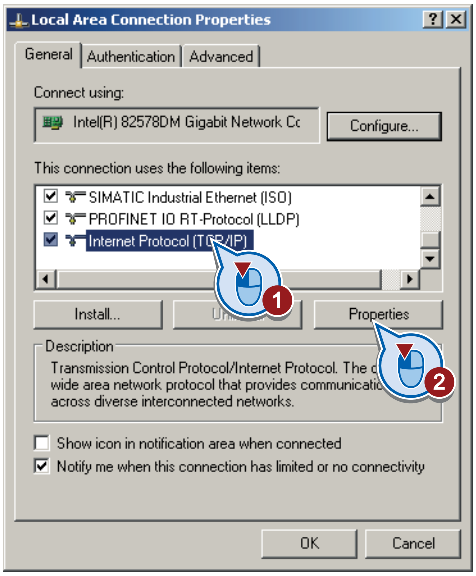
Addressing the supervisor

If you wish to access the converter using STARTER via PROFINET, then you must integrate the computer on which STARTER is installed, as supervisor in your network.

Once you have established the bus connection (see Section Communication via PROFINET (Page 94)), using the control port, you must assign an IP address and the address of the subnet mask of the network to your computer.

Go to "Start/Settings/Control Panel". There, select "Network Connections". Right-click to open the properties window of the LAN connection.

In this window, select "Internet Protocol (TCP/IP)" (①) and click on "Properties" (②). There, set 192.168.0.100 as the IP address of the supervisor and 255.255.255.0 as subnet mask.



Note

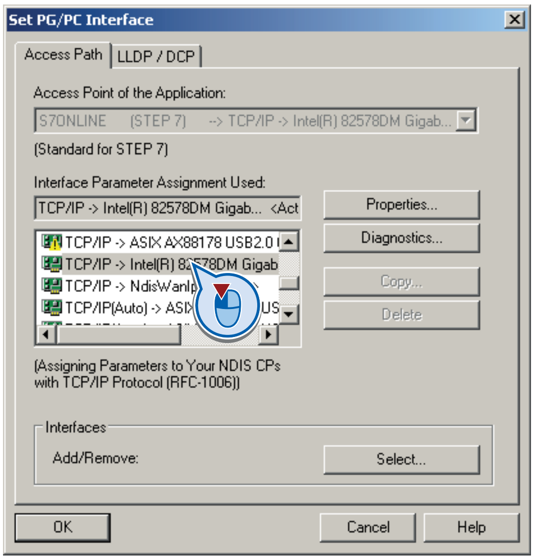
Addresses in company networks

If you are working in a company network, other settings may be required. In this case, ask your administrator about the IP address and the subnet mask.

Addressing the controller and devices

Open the SIMATIC Manager and assign the TCP/P interface to "Intel(R) PRO/100 VE Network Connection" via "Tools/PG/PC interface".

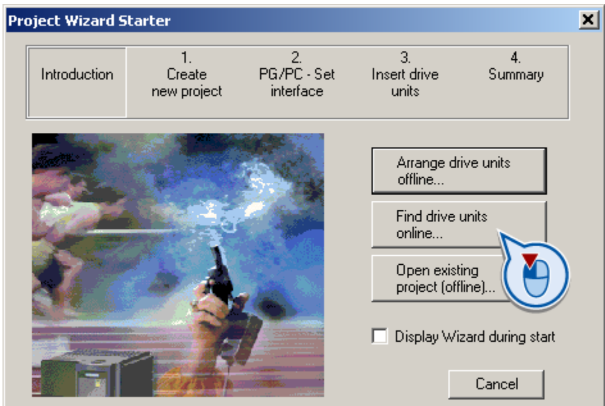
In the next step, create a new project, e.g. Profinet_G120_001.



5.5.2 Generating a STARTER project

Creating a STARTER project using project wizards

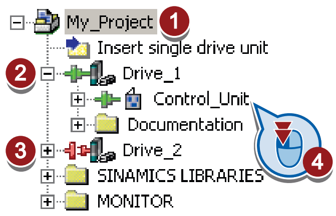
- Using "Project / New with wizard" create a new project.
- To start the wizard, click on "Search online for drive units ...".
- The wizard guides you through all of the settings that you need for your project.



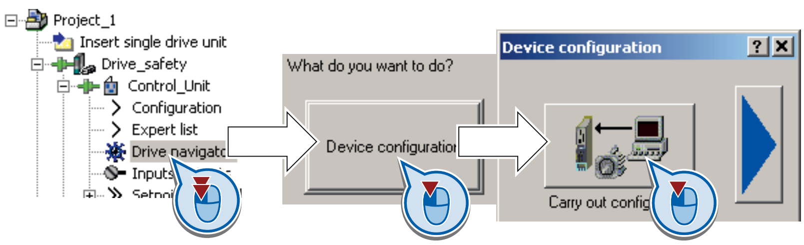
5.5.3 Go online and start wizard for basic commissioning

Procedure

- ① Select your project and go online: .
- In the next screen form, select the device or devices with which you wish to go online.
- In the next screen form, download the hardware configuration that you found online into your project (PG or PC).

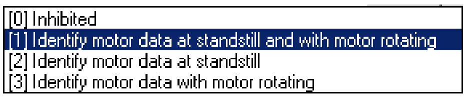


- STARTER shows you which converter it is accessing online and which offline:
  ② The converter is online
  ③ The converter is offline
- ④ When you are online, open the screen form of the control unit.
- Start the wizard for basic commissioning.



☑ Control structure	In the first step of the Wizard select the control mode. See also section: U/f control or speed control? (Page 62).
☑ Defaults of the setpoin	Select the default setting the interfaces of the converter. See also section: Select interface assignments (Page 46).
☑ Drive setting	Select the application for the converter: Low overload for applications that only require a low dynamic performance, e.g.: Pumps or fans. High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
☑ Motor	Select your motor.
☑ 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 is already entered.

If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".



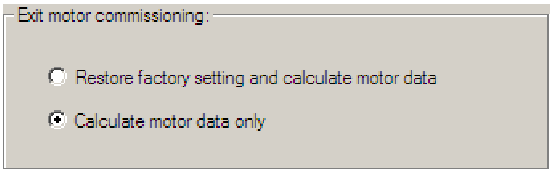
With this setting, the converter optimizes its speed controller.

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

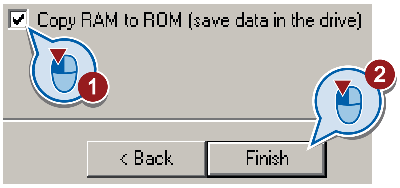
- You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
- You have set "U/f control" as control mode.

Set the most important parameters to suit your application.

We recommend the setting "Calculate motor data only".



① Set the checkmark for "RAM to ROM (save data in the drive)" to save your data in the converter so that it is not lost when the power fails.



② Close basic commissioning.

5.5.4 Switch on the motor via the control panel

After basic commissioning, the converter shows the warning A07791. You must now switch on the motor to start motor data identification.

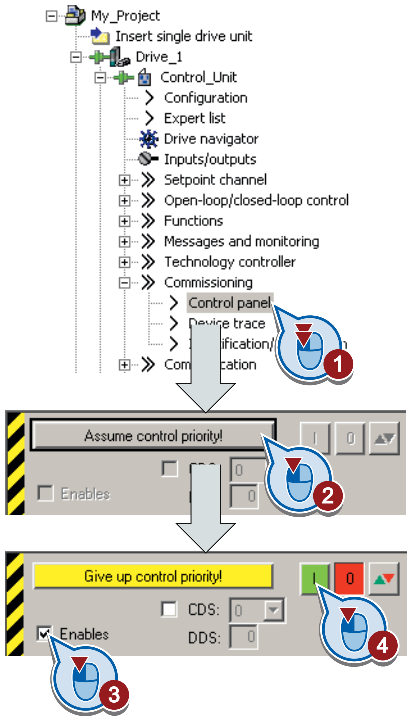
For the motor data identification, the motor must be cold. A motor in the warm operating state provides unusable measurement results.

Procedure

⚠ CAUTION
Motor data identification for dangerous loads
Secure dangerous plant and system parts before starting the motor data identification, e.g. by fencing off the dangerous location or lowering a suspended load to the floor.

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

  The converter now starts to identify the motor data. This measurement can take several minutes. After the measurement, the converter switches off the motor.
- Relinquish the master control after the motor data identification.



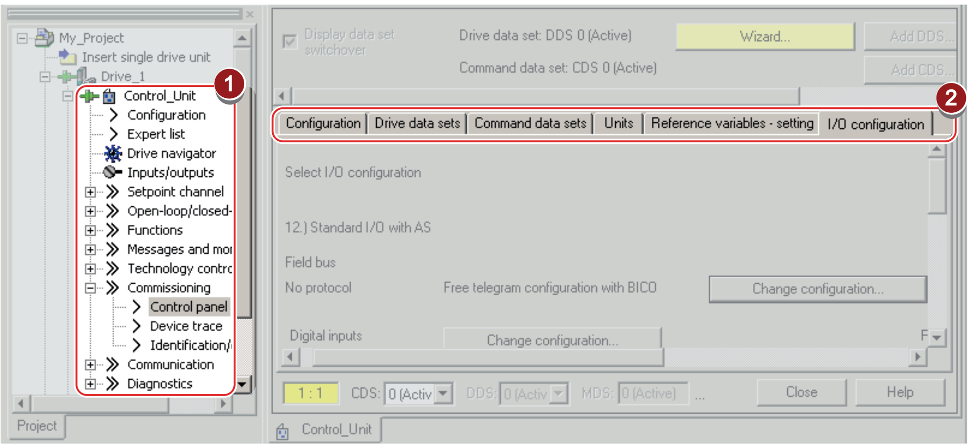
If, in addition to the motor data identification, you have also selected a rotating measurement with self-optimization of the speed control, then you must switch on the converter again as described above and wait for the optimization run to be completed.

5.5.5 Making additional settings

After the basic commissioning, you can adapt the inverter to your application as described in the Typical commissioning scenarios (Page 55).

STARTER offers two options:

1. 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.



2. 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

All of the changes that you make are temporarily saved in the inverter and are lost the next time the power supply is switched off. For your changes to be permanently saved in the inverter, you must save the changes using the button (RAM to ROM). Before you press the button, you need to mark the appropriate drive in the project navigator.

Go offline

You can now exit the online connection after the data backup (RAM to ROM) with "Disconnect from target system".

5.5.6 Trace function for optimizing the drive

Description

The trace function is used for converter 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 by . Alternatively, you can also specify the measurement period and then you can 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 speed actual 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.

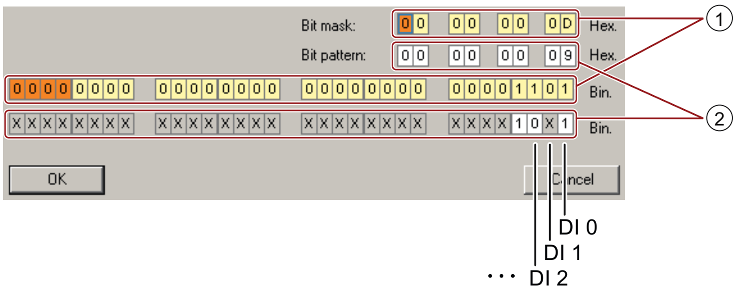
Example of a bit pattern as trigger:

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 line hex format, lower row binary format
② Define the bits for the trace trigger, upper line hex format, lower row binary format

Figure 5-9 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.

- Repeat measurement:
  This means that you place the measurements, which you wish to perform at different times, one above one another
- Arrange curves in tracks
  This means that you define as to whether all measured values are to be displayed with a common zero line – or whether each measured value is displayed with its own zero line.
- Measuring cursor on:
  This allows you to analyze the measuring intervals in detail

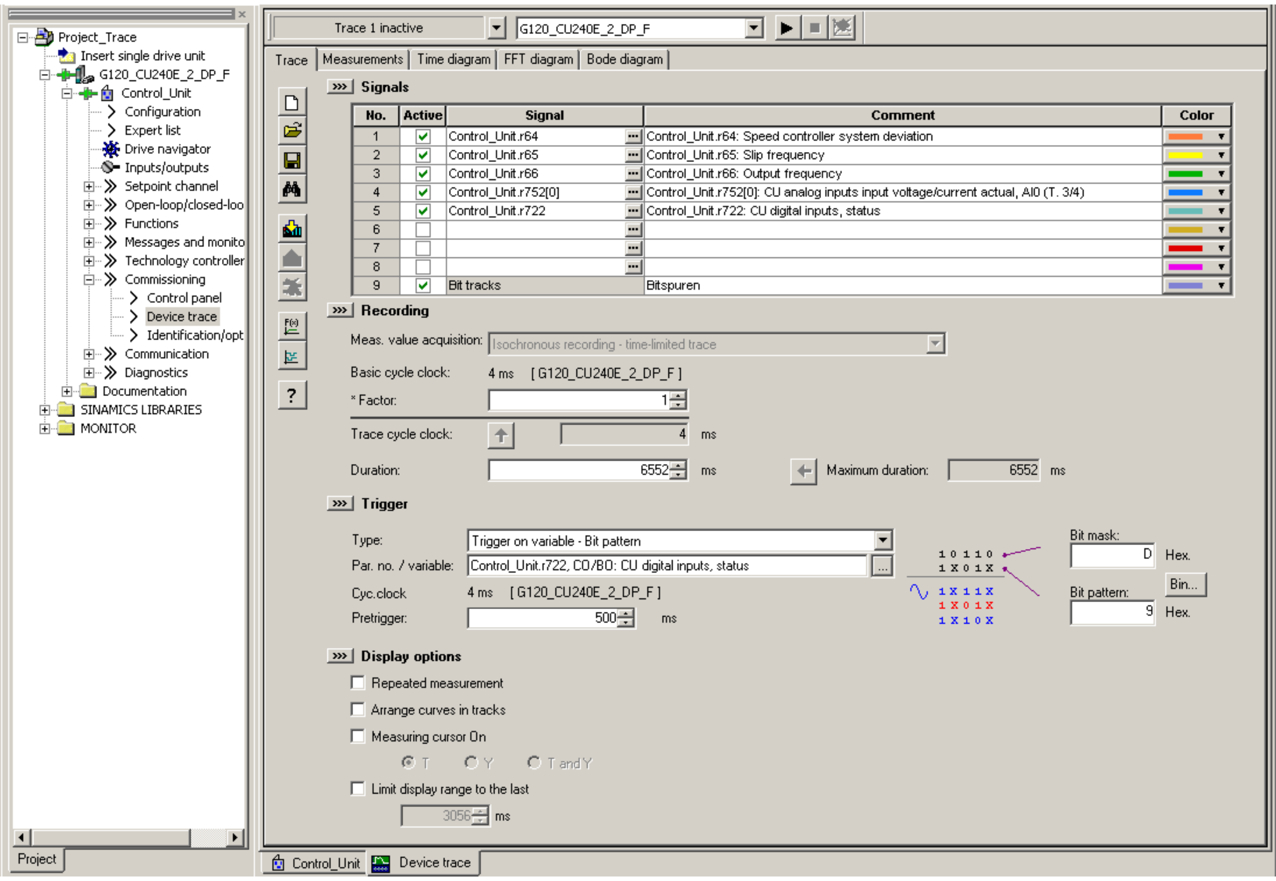


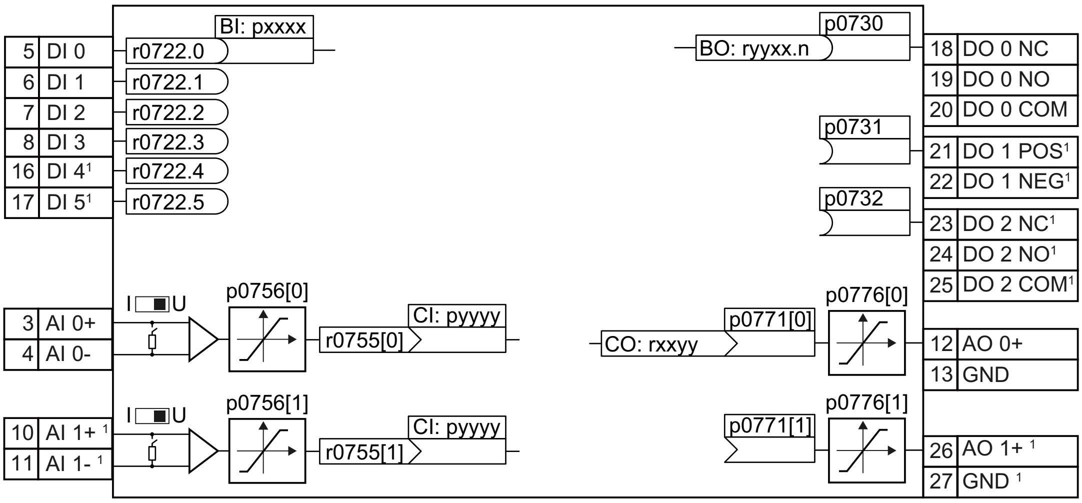
Figure 5-10 Trace dialog box

6 Adapt terminal strip

Before you adapt the inputs and outputs of the inverter, you should have completed the basic commissioning, see Chapter Basic commissioning (Page 57) .

In the basic commissioning, select an assignment of the inverter interfaces from several predefined configurations, see Section Select interface assignments (Page 46).

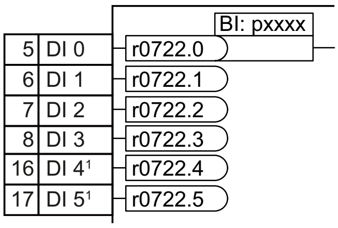
If none of the predefined configurations completely matches your application, then you must adapt the assignment of the individual inputs and outputs. You do this by changing the internal interconnection of an input or output using BICO technology (Page 326).



[1] Not available with Control Units CU240B-2 and CU240B-2 DP

Figure 6-1 Internal interconnection of the inputs and outputs

6.1 Digital inputs

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

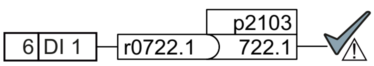
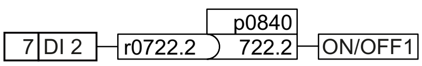
[1] Not available with CU240B-2 and CU240B-2 DP Control Units

Table 6- 1 Binector inputs (BI) of the converter (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-wire/three-wire control, control command 1
p1022	Fixed speed setpoint selection bit 2	p3331	Two-wire/three-wire control, control command 2
p1023	Fixed speed setpoint selection bit 3	p3332	Two-wire/three-wire control, control command 3
p1035	Motorized potentiometer, setpoint, raise		

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

Table 6- 2 Examples:

<table>
<tr><td></td><td>With Operator Panel</td><td>In STARTER</td></tr>
<tr><td>Acknowledge fault with digital input 1:

</td><td>Set p2103 = 722.1</td><td rowspan="2">Go online with STARTER and select "inputs/outputs". Change the input function via the corresponding screen form.</td></tr>
<tr><td>Switch-on motor with digital input 2:

</td><td>Set p0840 = 722.2</td></tr>
</table>

Advanced settings

You can debounce the digital input signal using parameter p0724.

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

Analog inputs as digital inputs

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

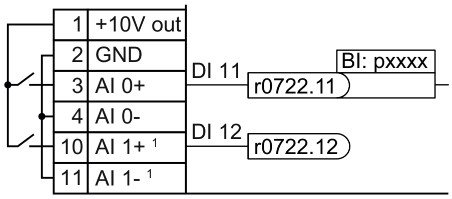


Figure 6-2 Additional digital inputs
[1]Not available with CU240B-2 and CU240B-2 DP Control Units

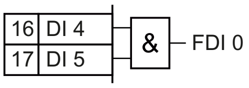
6.2 Fail-safe input

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

Specifying the fail-safe input

If you use the STO safety function, then you must configure the terminal strip during the basic commissioning for a fail-safe input, e.g. with p0015 = 2 (see Section Select interface assignments (Page 46)).

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

Terminals of the fail-safe digital input	Function
	You must enable STO to select the STO safety function via FDI 0. See also Section Safe Torque Off (STO) safety function (Page 227).

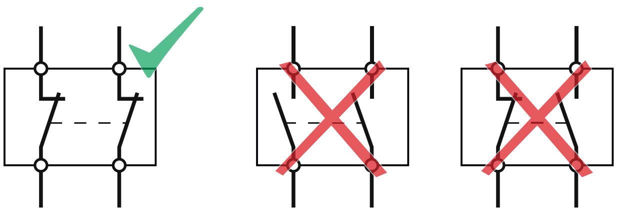
Connect devices

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

- Direct connection of safety sensors, e.g. EMERGENCY STOP command devices or light curtains.
- Pre-processing safety relays, e.g. fail-safe controllers.

Permitted sensors and signals

The fail-safe input of the converter is designed for connecting sensors with two NC contacts.



Permitted sensors

If you interconnect pre-processing safety relays via two separate cables with the converter, the two transferred must always have the same signal state.

The converter expects the following signals at its fail-safe input:

- High signal: Fail-safe input is not active.
- Low signal: Fail-safe input is active.

Special measures for wiring of a fail-safe input

The converter evaluates deviations in the two signals of the fail-safe input. The converter thus detects, for example the following faults:

- Cable break
- Defective sensor

The converter cannot detect the following faults:

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

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

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

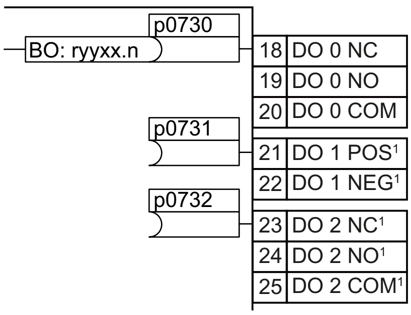
These special types of cable routing are normally required only if the cables are laid over larger distances, e.g. between remote control cabinets.

Examples of connecting a fail-safe input can be found in Section: Connecting fail-safe digital inputs (Page 348).

Note

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

6.3 Digital outputs

<table>
<tr><th>Digital output terminals</th><th>Changing the function of the digital output</th></tr>
<tr><td>
</td><td>Interconnect the digital output with a binector output of your choice.
Binector outputs are marked with "BO" in the parameter list of the List Manual.</td></tr>
</table>

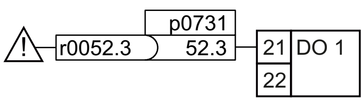
[1] Not available with CU240B-2 and CU240B-2 DP Control Units

Table 6- 3 Binector outputs of the converter (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)

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

Table 6- 4 Example:

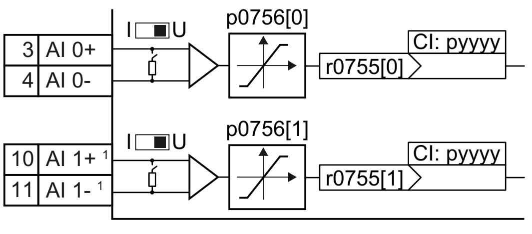
<table>
<tr><th></th><th>With Operator Panel</th><th>In STARTER</th></tr>
<tr><td>Signal fault via digital output 1.

</td><td>Set p0731 = 52.3</td><td>Go online with STARTER and select "inputs/outputs". Change the output function via the corresponding screen form.</td></tr>
</table>

Advanced settings

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

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

6.4 Analog inputs

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

[1] Not available with CU240B-2 and CU240B-2 DP Control Units

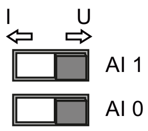
Define the analog input type

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

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

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

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



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

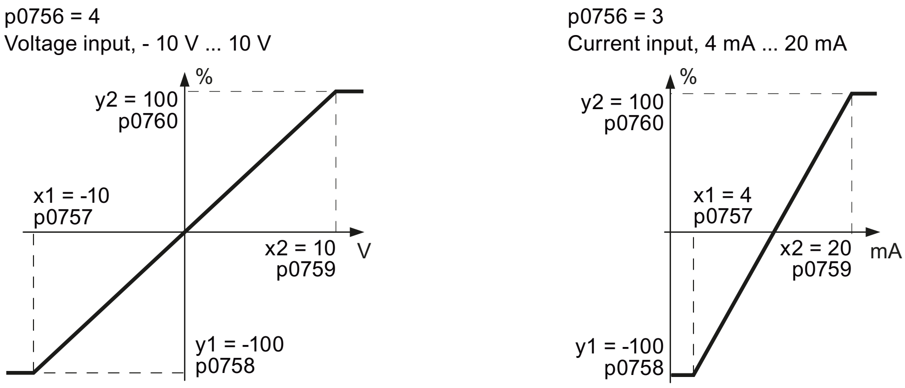


Figure 6-3 Examples for scaling characteristics

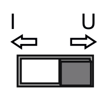
Table 6- 5 Parameters for the scaling characteristic and wire break monitoring

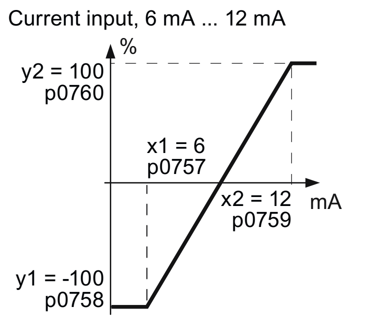
Parameter	Description
p0757	x-coordinate of 1st characteristic point [V or mA]
p0758	y coordinate of the 1st characteristic point [% of p200x] p200x are the parameters of the reference variables, e.g. p2000 is the reference speed.
p0759	x-coordinate of 2nd characteristic point [V or mA]
p0760	y-coordinate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

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.

Parameter	Description		
p0756[0] = 3	**Analog input type** Define analog input 0 as current input with wire break monitoring.	Set DIP switch for AI 0 to current input ("I"):	

Parameter	Description	
After changing p0756 to the value 3, the inverter sets the scaling characteristic parameters to the following values: p0757[0] = 4,0; p0758[0] = 0,0; p0759[0] = 20; p0760[0] = 100 Adapt the characteristic:		
p0761[0] = 6.0	**Analog inputs wire break monitoring, response threshold**	
p0757[0] = 6.0	**Analog inputs, characteristic (x_1, y_1)**	
p0758[0] = -100.0	6 mA corresponds to -100 %	
p0759[0] = 12.0	**Analog inputs, characteristic (x_2, y_2)**	
p0760[0] = 100.0	12 mA corresponds to 100 %	

Defining the analog input function

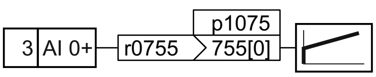
You define the analog input function by interconnecting a connector input of your choice with parameter p0755 . Parameter p0755 is assigned to the particular analog input via its index, e.g. parameter p0755[0] is assigned to analog input 0.

Table 6- 6 Connector inputs (CI) of the converter (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.

Table 6- 7 Example:

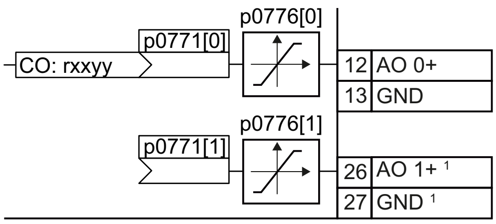
	With Operator Panel	In STARTER
Analog input 0 is the source for the additional setpoint. 	Set p1075 = 755[0]	Go online with STARTER and select "inputs/outputs". Change the input function via the corresponding screen form.

Advanced settings

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.

6.5 Analog outputs

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

[1] Not available with CU240B-2 and CU240B-2 DP Control Units

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

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

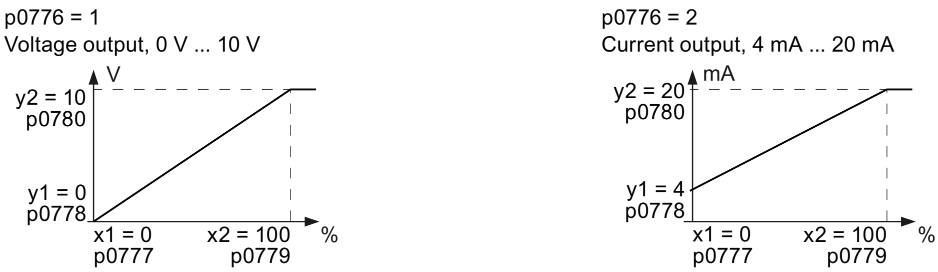


Figure 6-4 Examples for scaling characteristics

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

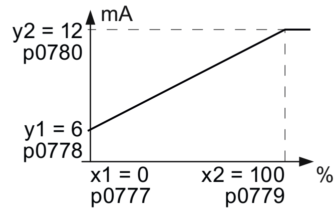
Table 6- 8 Parameters for the scaling characteristic

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]**

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

Example:

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

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0776[0] = 2</td><td colspan="2">Analog output, type
Define analog output 0 as current output.</td></tr>
<tr><td colspan="3">After changing p0776 to the value 2, the converter sets the scaling characteristic parameters to the following values:
p0777[0] = 0.0; p0778[0] = 4.0; p0779[0] = 100.0; p0780[0] = 20.0
Adapt the characteristic:</td></tr>
<tr><td>p0777[0] = 0.0</td><td rowspan="2">Analog output, characteristic (x_1, y_1)
0.0 % corresponds to 6 mA</td><td rowspan="4">Current output, 6 mA ... 12 mA

</td></tr>
<tr><td>p0778[0] = 6.0</td></tr>
<tr><td>p0779[0] = 100.0</td><td rowspan="2">Analog output, characteristic (x_2, y_2)
100 % corresponds to 12 mA</td></tr>
<tr><td>p0780[0] = 12.0</td></tr>
</table>

Defining the analog output function

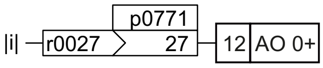
You define the analog output function by interconnecting parameter p0771 with a connector output of your choice. Parameter p0771 is assigned to the particular analog input via its index, e.g. parameter p0771[0] is assigned to analog output 0.

Table 6- 9 Connector outputs (CO) of the converter (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.

Table 6- 10 Example:

	With Operator Panel	In STARTER
Output the converter output current via analog output 0. 	Set p0771 = 27	Go online with STARTER and select "inputs/outputs". Change the output function via the corresponding screen form.

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

Advanced settings

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

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

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

7 Configuring the fieldbus

Fieldbus interfaces of the Control Units

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

Fieldbus	Profile	Control Unit	Interface
PROFIBUS (Page 98)	PROFIdrive and PROFIsafe [1]	CU240B-2 DP CU240E-2 DP CU240E-2 DP-F	Sub D socket
PROFINET (Page 94)		CU240E-2 PN CU240E-2 PN-F	Two RJ45 connectors
USS (Page 120)	-	CU240B-2 CU240E-2 CU240E-2 F	RS485 connector
Modbus RTU (Page 131)	-		
	[1] Information on PROFIsafe can only be found in the Safety Integrated Function Manual, also a see section: Additional information on the inverter (Page 352).		

7.1 Communication via PROFINET

The Control Unit provides the following functions

• IRT without isochronous mode	
• MRP	Media redundancy, not bumpless with 200 ms Precondition: Ring topology
• MRPD	Media redundancy, bumpless Precondition: IRT and the ring topology created in the control
• Diagnostic alarms	According to error classes specified in the PROFIdrive profile. See Activating diagnostics via the control (Page 97).
• Device replacement without removable data storage medium	Requirement: Topology created in the control
• Shared Device	Only for Control Units with fail-safe functions (see Safety Function Manual)

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

Additional information on PROFINET in the Internet

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

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

7.1.1 What do you need for communication via PROFINET?

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

Table 7- 1 Checklist for communication via PROFINET

Questions	Answer/description	Example
Is the converter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 95)	
Do the IP address and device name in the converter and control system match?	See Configuring communication to the control (Page 96)	See Configuring the system in HW Config (Page 334)
Is the same telegram set in the converter as in the higher-level control system?	Set the telegram in the converter, see: Select telegram (Page 96)	See: Configuring the system in HW Config (Page 334)
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 101)	See: STEP 7 program examples (Page 339)

7.1.2 Connect the converter to PROFINET

Connecting up

Connect the converter (IO device) and your PG/PC (IO supervisor) via PROFINET cables with the control.

See also Section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

Recommended PROFINET connectors and pin assignment

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

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

Laying and shielding the PROFINET cable

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

7.1.3 Configuring communication to the control

In order to establish communication between the converter and control system via PROFINET, you must load the device file of the converter "GSDML" into your control. You can then configure the communication.

Procedure

- Import the GSDML of the converter into thePROFINET-Controller, i.e. into your control system.
  You can obtain the GSDML of your converter in two ways:
  – You can find the GSDML of the SINAMICS converter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
  – The GSDML is saved in the converter. If you insert the memory card in the converter and set p0804 = 12 , the GSDML will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.
- Configure the communication between the control and the converter in your control.

7.1.4 Select telegram

During basic commissioning, you have defined a telegram for communication. In order to set a different telegram, you may need also adapt the assignment of the interfaces.

Procedure

Carry out the basic commissioning again

- Adapt the interface assignment
- Select the telegram.

Table 7- 2 Parameters for the interface assignment and the telegram selection

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0015</td><td colspan="2">Macro drive unit
Configure the interface in basic commissioning, and select a telegram. See also the section: Select interface assignments (Page 46).</td></tr>
<tr><td rowspan="2">p0922</td><td colspan="2">PROFIdrive Telegram selection (factory setting for converters with PROFIBUS- or PROFINETinterface: Standard telegram 1, PZD-2/2)
Set the send and receive telegram, see Cyclic communication (Page 101)</td></tr>
<tr><td>1:
20:
350:
352
353:
354:
999:</td><td>Standard telegram 1, PZD-2/2
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
Extend telegrams and change signal interconnection (Page 108)</td></tr>
</table>

7.1.5 Activating diagnostics via the control

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

The functionality must be selected in the control (see example ofHotspot-Text (Page 337) STEP 7) and activated by a ramp-up.

You can output the messages directly on an HMI panel via the control.

7.2 Communication via PROFIBUS

7.2.1 What do you need for communication via PROFIBUS?

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

Table 7- 3 Checklist for communication via PROFIBUS

Questions	Description	Examples
Is the converter correctly connected to the PROFIBUS?	See section: Connect the frequency inverter to PROFIBUS (Page 98).	---
Have you configured the communication between the converter and the higher-level control system?	See section: Configuring communication to the control (Page 99)	See also the section: Configuring PROFIBUS communication in STEP 7 (Page 330).
Do the bus addresses in the converter and the higher-level controller match?	See section: Setting the address (Page 99).	
Is the same telegram set in the higher-level controller and in the converter?	Adapt the telegram in the converter. See section: Select telegram (Page 100).	
Are the signals that the converter and the control system exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the control system to the converter. For the PROFIdrive-compliant interconnection in the converter, refer to Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 101).	See also the section: STEP 7 program examples (Page 339).

7.2.2 Connect the frequency inverter to PROFIBUS

Permissible cable lengths, routing and shielding the PROFIBUS cable

Information can be found on the Internet:

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

Recommended PROFIBUS connectors

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

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

Pin assignment at the converter

For the pin assignment at the converter refer to Section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

Note

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

You will have to supply the Control Unit with 24 VDC on terminals 31 and 32 if you require communication to take place with the controller even when the line voltage is switched off.

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

7.2.3 Configuring communication to the control

To be able to configure communication between the converter and control, you require the description file GSD of the converter.

Procedure

- Import the GSD of the converter into the PROFIBUS master, i.e. into your control system. You have two options for obtaining the GSD of your converter:
  - You can find the GSD of the SINAMICS converter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
  - The GSD is saved in the converter. If you insert the memory card in the converter and set p0804 = 12 , the GSD will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.
- Configure the communication between the control and the converter in your control.

7.2.4 Setting the address

You can set the converter's PROFIBUS address via the address switch on the CU via p0918 or in STARTER under "Control Unit/Communications/PROFIBUS".

Valid address range: 1 … 125

Procedure

Method	Description
Address switch	If you have specified a valid address using the address switches, this address will always be the one that takes effect and parameter p0918 cannot be changed. Position and settings of the address switches are described in section: Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).
P0918 / STARTER	**PROFIBUS address** (factory setting: 126) Setting in p0918 or via STARTER is effective only if you set all address switches to "OFF" (0) or "ON" (1).

CAUTION
For a modified bus address to be effective, you have to switch on and off the converter and - if need be - any external 24 V supply.

7.2.5 Select telegram

During basic commissioning, you have defined a telegram for communication. In order to set a different telegram, you may need also adapt the assignment of the interfaces.

Procedure

Carry out the basic commissioning again

- Adapt the interface assignment
- Select the telegram.

Table 7- 4 Parameters for the interface assignment and the telegram selection

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram. See also the section: Basic commissioning with the BOP-2 (Page 66).	
p0922	**PROFIdrive Telegram selection** (factory setting for converters with PROFIBUS- or PROFINETinterface: Standard telegram 1, PZD-2/2) Set the send and receive telegram, see Cyclic communication (Page 101)	
	1:	Standard telegram 1, PZD-2/2
	20:	Standard telegram 20, PZD-2/6
	350:	SIEMENS telegram 350, PZD-4/4
	352	SIEMENS telegram 352, PZD-6/6
	353:	SIEMENS telegram 353, PZD-2/2, PKW-4/4
	354:	SIEMENS telegram 354, PZD-6/6, PKW-4/4
	999:	Extend telegrams and change signal interconnection (Page 108)

7.3 PROFIdrive profile for PROFIBUS and PROFINET

7.3.1 Cyclic communication

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

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10	PZD11	PZD12

Telegram 1, speed control each with two PZDs in the receive and transmit directions (PZD 2/2)

STW1	NSOLL_A
ZSW1	NIST_A_ GLATT

Telegram 20, speed control VIK/NAMUR; each with two PZDs in the receive and six in the transmit direction (PZD 2/6)

STW1	NSOLL_A				
ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	PIST_ GLATT	MELD_ NAMUR

Telegram 350, speed control each with four PZDs in the receive and transmit directions (PZD 4/4)

STW1	NSOLL_A	M_LIM	STW3
ZSW1	NIST_A_ GLATT	IAIST_ GLATT	ZSW3

Telegram 352, speed control for PCS7; each with six PZDs in the receive and transmit directions (PZD 6/6)

STW1	NSOLL_A	Process data for PCS7			
ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE

Telegram 353, speed control each with two PZDs in the receive and transmit directions (PZD 2/2) and four words each to read and write parameters (PIV 4/4)

STW1	NSOLL_A
ZSW1	NIST_A_ GLATT

Telegram 354, speed control for PCS7; each with six PZDs in the receive and transmit directions (PZD 6/6) and four words each to read and write parameters (PIV 4/4)

STW1	NSOLL_A	Process data for PCS7			
ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE

Telegram 999, free interconnection via BiCo; PZD n/m (n/m = 1 ... 12)

STW1	Configurable telegram length for the receive data
ZSW1	Configurable telegram length for the transmit data

Figure 7-1 Telegrams for cyclic communication

Table 7- 5 Explanation of the abbreviations

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

Interconnection of the process data

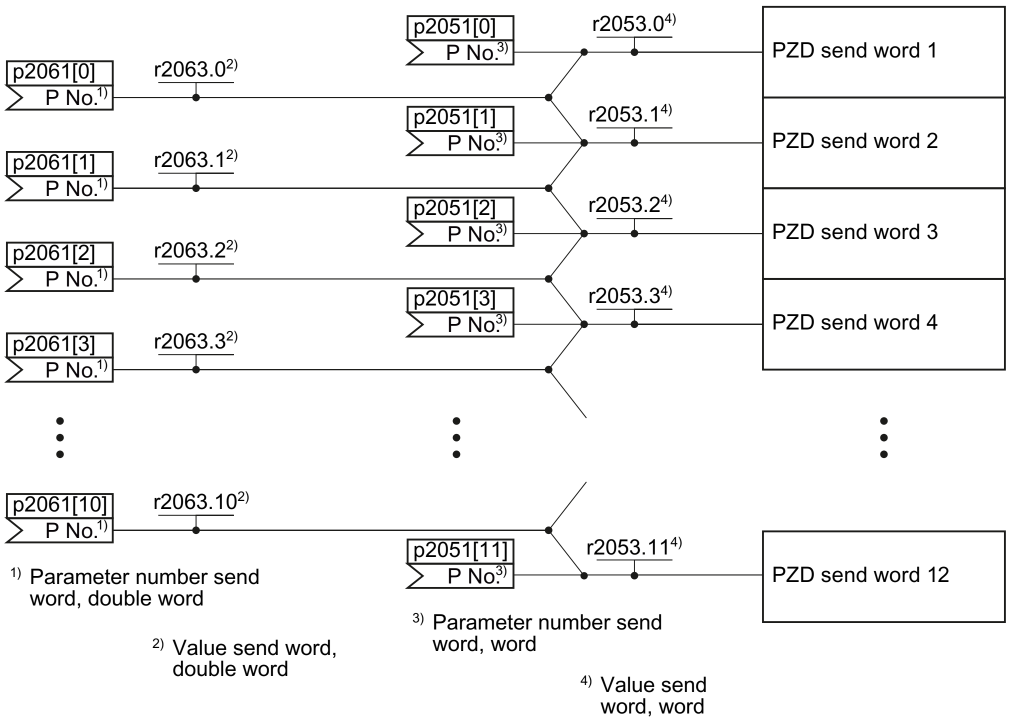


Figure 7-2 Interconnection of the send words

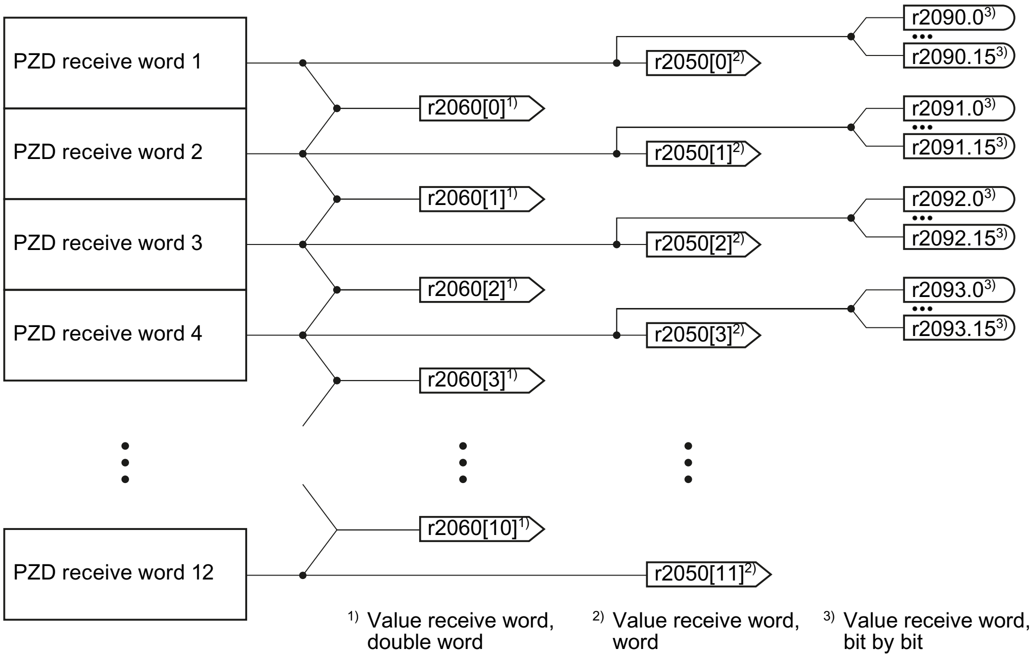


Figure 7-3 Interconnection of the receive words

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

If you require for your application an individual telegram (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 in the function diagrams 2420 and 2472.

7.3.1.1 Control and status word 1

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

Control word 1 (STW1)

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

Table 7- 6 Control word 1 and interconnection in the converter

Bit	Meaning		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The converter goes into the "ready" state. If, in addition bit 3 = 1, then the converter 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 converter 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 converter 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 the fault. If the ON command is still active, the converter switches to"closing lockout" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Converter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control from PLC		Control via fieldbus, converter accepts the process data from the fieldbus.	
11	---[1)]	0 = Direction reversal	Invert setpoint in the converter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

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

Status word 1 (ZSW1)

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

Table 7- 7 Status word 1 and interconnection with parameters in the converter

Bit	Meaning		Comments	Signal interconnection in the converter
	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 command = 1), no fault is active. With the command "Enable operation" (STW1.3), the converter 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 converter 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 command and a new ON command.	p2080[6] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgment is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint/actual value deviation within tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the converter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	0 = I, M or P limit reached		Comparison value for current, torque or power has been reached or exceeded.	p2080[11] = r1407.7
12	---[1)]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal converter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counterclockwise		Internal converter actual value < 0	
15	1 = CDS display	0 = Alarm, converter thermal overload		p2080[15] = r0836.0 / r2135.15

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

7.3.1.2 Control and status word 3

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

Control word 3 (STW3)

Control word 3 has the following default assignment. You can change the assignment with BICO technology.

Table 7- 8 Control word 3 and interconnection with parameters in the converter

Bit	Value	Significance Telegram 350	Explanation	Signal interconnection in the converter [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	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 converter sets all interconnections p1020, … to "0". Exception: p2106 = 1.

Status word 3 (ZSW3)

Status word 3 has the following standard assignment. You can change the assignment with BICO technology.

Table 7- 9 Status word 3 and interconnection with parameters in the converter

Bit	Value	Significance	Description	Signal interconnection in the converter
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		

7.3.1.3 Extend telegrams and change signal interconnection

Following selection of a telegram, the converter interconnects the corresponding signals with the fieldbus interface. The converter protects this interconnection against changes.

Extend telegram

If you want to extend a telegram, you have to do the following:

Table 7- 10 Procedure

Parameter	Description	
p0922 = 999	**PROFIdrive telegram selection**	
	999:	Free telegram configuration with BICO
p2079	**PROFIdrive PZD telegram selection extended** Set the suitable telegram:	
	1: 20: 350: 352: 353: 354:	Standard telegram 1, PZD-2/2 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
Now you can extend the telegram by interconnecting the PZD send words and PZD receive words with signals of your choice.		

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

Change the signal interconnection of the telegram

If you want to change the signal interconnection or extend telegrams, you have to do the following:

Table 7- 11 Procedure

Parameter	Description	
p0922 = 999	**PROFIdrive telegram selection**	
	999:	Free telegram configuration with BICO
p2079 = 999	**PROFIdrive PZD telegram selection extended**	
	999:	Free telegram configuration with BICO
Now you can freely interconnect all signals of the fieldbus interface.		

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

7.3.1.4 Data structure of the parameter channel

Structure of the parameter channel

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

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

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

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

Request and response IDs

Request and response IDs are written in bits 12 to 15 of the first word of the parameter channel. The possible identifiers and further explanations can be found in the following tables.

Overview of the request identifiers control → converter

Table 7- 12 Request identifiers control → converter

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

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

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

Overview of the response identifiers converter → control

The response identifier depends on the request identifier.

Table 7- 13 Response identifiers converter → 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	Request cannot be processed, task cannot be executed (with error number)
8	No master controller status / no authorization to change parameters of the parameter channel interface

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

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

Overview of the error numbers in response identifier 7 (request cannot be processed)

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

Table 7- 14 Error numbers for the response "Request cannot be processed"

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. Additional diagnosis in error value 2)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element that cannot be changed. Additional diagnosis in error value 2)
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 converter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)

No.	Description
6A hex	**Request not included / task is not supported.** (The valid request identifications can be found in table "Request identifications control → converter")
6B hex	**No change access for a controller that is enabled**. (Operating status of the converter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating status of the converter 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** (change request to a value that lies within the "absolute" limits, but is however above the currently valid upper limit, e.g. specified as a result of the converter power rating)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

Parameter number

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

Table 7- 15 Offset and page index of the parameter numbers

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

Indexed parameters

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

Parameter contents

Parameter contents can be parameter values or connector parameters. For interconnecting connector parameters please see section: Interconnecting signals in the inverter (Page 326).

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

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

Enter a connector parameter as follows:

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

Telegram examples

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

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

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

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

Figure 7-4 Telegram for a read request from p7841[2]

Write request: Change restart mode (p1210)

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

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

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

Figure 7-5 Telegram, to activate the automatic restart with p1210 = 26

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

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

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

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

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

7.3.1.5 Slave-to-slave communication

With "Slave-slave communication" (also called "Data Exchange Broadcast") it is possible to quickly exchange data between converters (slaves) without the master being directly involved, for instance to use the actual value of one converter as setpoint for other converters.

Note

Slave-to-slave communication in the current firmware version is only possible for converters with PROFIBUS communication.

For slave-to-slave communication, in the control system you must define which converter acts as publisher (sender) or subscriber (receiver) - and which data or data areas (access points) you wish to use for slave-to-slave communication. In the converters that operate as subscriber, you must define how the data transferred using slave-to-slave communication is processed. Using parameter r2077, in the converter, you can read-out the PROFIBUS addresses of the converters for which the slave-to-slave communication function is configured.

- **Publisher** Slave, which sends the data for slave-to-slave communication.
- **Subscriber** Slave, which receives the data from slave-to-slave communication from the publisher.
- **Links and access points** define the data that are used for slave-to-slave communication.

You must observe the following restrictions for the slave-to-slave communication function:

- a maximum of 12 PZD are permissible for each drive
- To a publisher, a maximum of 4 links are possible

An example of how you configure slave-to-slave communication between two converters in STEP 7 is provided in Section: Configuring slave-to-slave communication in STEP 7 (Page 346).

7.3.2 Acyclic communication

As well as cyclic communication, the converter also offers the option of acyclic communication for PROFIBUS DP and PROFINET. You can parameterize and diagnose the converter via acyclic communication. Acyclic communication takes place in parallel with cyclic communication, but with a lower priority.

The converter supports the following types of acyclic communication:

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

You can find a STEP 7 program example for acyclic data transfer in Section STEP 7 program example for acyclic communication (Page 342).

7.3.2.1 Reading and changing parameters via data set 47

Reading parameter values

Table 7- 16 Request to read parameters

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

Table 7- 17 Converter response to a read request

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

Changing parameter values

Table 7- 18 Request to change parameters

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

Table 7- 19 Response, if the converter has executed the change request

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

Table 7- 20 Response, if the converter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex, 01 hex or 02 hex	4
	Only for "Error" - **error value 1** You can find the error values in the table at the end of this section.		6
	Only if "number of error values" = 02 hex: **Error value 2** Error value 1 defines whether the converter sends error value 2 and what it means.		8
Values, parameter 2	...		
...	…		…
Values, parameter m	...		

Diagnostics

Table 7- 21 Error value in the parameter response

Error value 1	Meaning
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. Additional diagnostics in error value 2)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits. Additional diagnostics in error value 2)
03 hex	**Incorrect subindex** (access to a subindex that does not exist. Additional diagnostics in error value 2)
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. Additional diagnostics in error value 2)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element that cannot be changed. Additional diagnostics in error value 2)
09 hex	**Description data not available** (access to a description that does not exist, parameter value is available)
0B hex	**No master control** (change request but with no master control)
0F hex	**Text array does not exist** (although the parameter value is available, the access is made to a text array that does not exist)
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values. Additional diagnostics in error value 2)
15 hex	**Response too long** (the length of the actual response exceeds the maximum transfer length)

Error value 1	Meaning
16 hex	Illegal parameter address *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)*
17 hex	Illegal format (change request for an illegal or unsupported format)
18 hex	Number of values not consistent *(number of values of the parameter data to not match the number of elements in the parameter address)*
19 hex	Drive object does not exist (access to a drive object that does not exist)
6B hex	No change access for a controller that is enabled.
6C hex	Unknown unit.
6E hex	Change request is only possible when the motor is being commissioned (p0010 = 3).
6F hex	Change request is only possible when the power unit is being commissioned (p0010 = 2).
70 hex	Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).
71 hex	Change request is only possible if the converter is ready (p0010 = 0).
72 hex	Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).
73 hex	Change request possible only during commissioning of the safety functions (p0010 = 95).
74 hex	Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).
75 hex	Change request is only possible in a commissioning state (p0010 ≠ 0).
76 hex	Change request is not possible for internal reasons (p0010 = 29).
77 hex	Change request is not possible at download.
81 hex	Change request is not possible at download.
82 hex	Transfer of the control authority (master) is inhibited by BI: p0806.
83 hex	Requested BICO interconnection is not possible (BICO output does not supply a float value, however the BICO input requires a float value)
84 hex	Converter does not accept a change request (converter is busy with internal calculations, see r3996)
85 hex	No access methods defined.
86 hex	Write access only during commissioning of the data records (p0010 = 15) (operating status of the converter 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 (change request to a value that lies within the "absolute" limits, but is however above the currently valid upper limit, e.g. specified as a result of the converter power rating)
CC hex	Change request not permitted (change is not permitted as the access code is not available)

7.4 Communication via RS485

7.4.1 Integrating inverters into a bus system via the RS485 interface

Connecting to a network via RS485

Connect the inverter to your fieldbus via the RS485 interface. Position and assignment of the RS485 interface can be found in section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43). This connector has short-circuit proof, isolated pins.

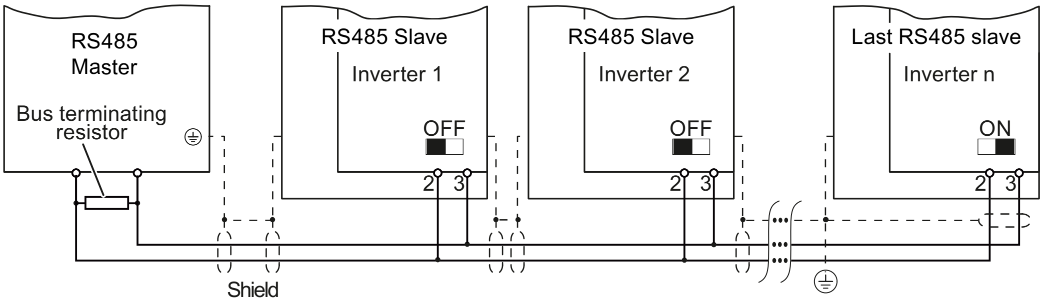


Figure 7-7 Communication network via RS485

You must switch-in the bus terminating resistor for the first and last participants. The position of the bus terminating resistor can be found in section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

You can disconnect one or more slaves from the bus (by unplugging the bus connector) without interrupting the communication for the other stations, but not the first or last.

NOTICE
When the bus is operating, the first and last bus station must be continuously connected to the supply.

Note

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

You will have to supply the Control Unit with 24 VDC on terminals 31 and 32 if you require communication to take place with the controller even when the line voltage is switched off.

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

7.4.2 Communication via USS

Using the USS protocol (protocol of the universal serial interface), users can set up a serial data connection between a higher-level master system and several slave systems (RS 485 interface). Master systems include programmable logic controllers (e.g. SIMATIC S7-200) or PCs. The inverters are always slaves on the bus system.

Communication using the USS protocol takes place over the RS485 interface with a maximum of 31 slaves.

The maximum cable length is 1200 m (3300 ft)

Information about how to connect the inverter to the USS fieldbus is provided in Section: Integrating inverters into a bus system via the RS485 interface (Page 119).

7.4.2.1 Basic settings for communication

Setting the address

You can set the converter's USS address via the address switch on the CU via p2021 or in STARTER under "Control Unit/Communications/fieldbus".

Valid address range: 1 … 30

Procedure

Method	Description
Address switch	If you have specified a valid address using the address switch, this address will always be the one that takes effect and parameter p2021 cannot be changed. The positions and settings of the address switches are described in section: Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).
p2021 / STARTER	**Fieldbus address** (factory setting: 0) The setting in p2021 or via STARTER is only effective if the address, set using the address switch, is invalid (0 or >30).

CAUTION
For a modified bus address to be effective, you have to switch the converter and - if need be - any external 24 V supply off and on.

Additional settings

Parameter	Description
P0015 = 21	**Macro drive device** Select the I/O configuration
p2020	**Setting the baud rate** Value / Baud rate: 4 2400; 5 4800; 6 9600; 7 19200; 8 38400 Value / Baud rate: 9 57600; 10 76800; 11 93750; 12 115200; 13 187500
p2022	**Fieldbus interface USS PZD number** Sets the number of 16-bit words in the PZD part of the USS telegram Setting range: 0… 8 (0 … 8 words)
p2023	**Fieldbus interface USS PIV number** Sets the number of 16-bit words in the PIV part of the USS telegram Setting range: • 0, 3, 4: 0, 3 or 4 words • 127: variable length
p2040	**Fieldbus interface monitoring time [ms]** Sets the monitoring time to monitor the process data received via the fieldbus. If no process data are received within this time, an appropriate message is output

7.4.2.2 Telegram structure

Overview

A USS telegram comprises a sequence of elements, which are sent in a defined sequence. Each element contains 11 bits.

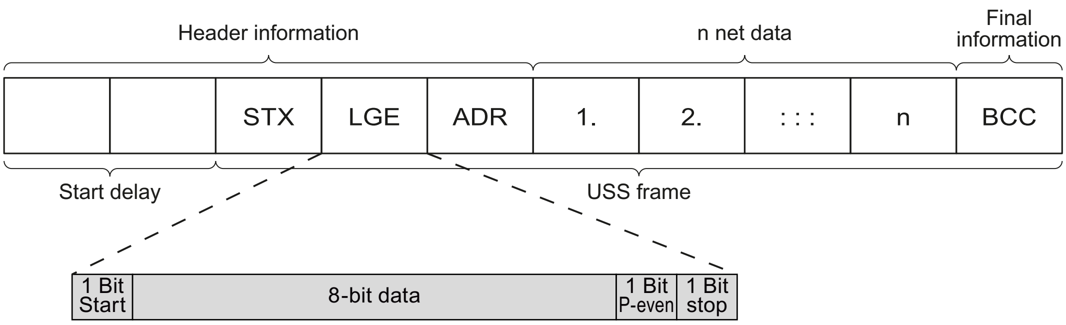


Figure 7-8 Structure of a USS telegram

Telegram part	Description
Start delay / response delay	There is always a start and/or response delay between two telegrams (see alsoTime-out and other errors (Page 129))
STX	An ASCII character (02 hex) indicates the beginning of the message.
LGE	The telegram length "LGE" is calculated as follows: LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte)
ADR	7: Special telegram; 6: Mirror telegram; 5: Broadcast bit; 4 3 2 1 0: Address • Bit 7 = 0: Normal data exchange. Bit 7 =1, to transfer telegrams that require a net data structure different from the device profile. • Bit 6 = 0: Normal data exchange. Bit 6 = 1: Testing the bus connection: The converter returns the telegram unchanged to the master. • Bit 5 = 0: Normal data exchange. (Bit 5 = 1: Not supported in the converter.) • Bits 0 ... 4: Address of the converter.
Net data	See section User data range of the USS telegram (Page 122).
BCC	Checksum (exclusive or) across all telegram bytes – with the exception of BCC.

7.4.2.3 User data range of the USS telegram

The user data area consists of the following elements:

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

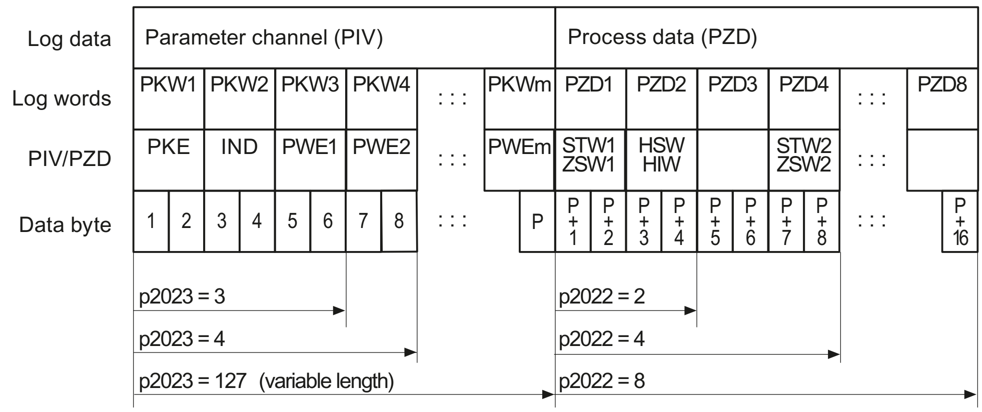


Figure 7-9 USS telegram - user data structure

Parameter channel

In parameter p2023 you specify the length of the parameter channel.

Parameter channel with fixed and variable length

- P2023 = 0
  With this setting, no parameter values are transferred.
- P2023 = 3
  You can select this setting if you only want to read or write 16-bit data or alarm signals.
- P2023 = 4:
  If you want to read or write 32-bit values (for example indexed parameters or bit parameter, e.g. r0722.2), then this setting is required. In this case, the send or receive telegram always contains 4 words, even if only 3 would be required. The values are enter right-justified in the 4th word.
- P2023 = 127:
  If you set p2023 = 27 (variable length), the send and response telegrams are as long as the task actually requires.

Process data

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

7.4.2.4 USS parameter channel

Structure of the parameter channel

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

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

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

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

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

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

Request and response IDs

Request and response IDs are written in bits 12 to 15 of the first word of the parameter channel. The possible identifiers and further explanations can be found in the following tables.

Overview of the request identifiers control → converter

Table 7- 22 Request identifiers control → converter

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

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

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

Overview of the response identifiers converter → control

The response identifier depends on the request identifier.

Table 7- 23 Response identifiers converter → 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	Request cannot be processed, task cannot be executed (with error number)
8	No master controller status / no authorization to change parameters of the parameter channel interface

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

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

Overview of the error numbers in response identifier 7 (request cannot be processed)

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

Table 7- 24 Error numbers for the response "Request cannot be processed"

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. Additional diagnosis in error value 2)
04 hex	No array (access with a subindex to non-indexed parameters)
05 hex	Incorrect data type (change request with a value that does not match the data type of the parameter)
06 hex	Setting not permitted, only resetting (change request with a value not equal to 0 without permission)
07 hex	Descriptive element cannot be changed (change request to a descriptive element that cannot be changed. Additional diagnosis in error value 2)
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 converter)
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 control → converter")
6B hex	No change access for a controller that is enabled. (Operating status of the converter prevents a parameter change)
86 hex	Write access only for commissioning (p0010 = 15) (operating status of the converter 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 (change request to a value that lies within the "absolute" limits, but is however above the currently valid upper limit, e.g. specified as a result of the converter power rating)
CC hex	Change request not permitted (change is not permitted as the access code is not available)

Parameter number

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

Table 7- 25 Offset and page index of the parameter numbers

Parameter number	Offset	Page index								
		Hex	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0

Indexed parameters

For indexed parameters, you must write the index number as hex value into the sub-index (IND bit 7 … 0).

Parameter contents

Parameter contents can be parameter values or connector parameters. For connector parameters you need two words. For interconnecting connector parameters please see section: Interconnecting signals in the inverter (Page 326).

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

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

Enter a connector parameter right-justified as follows:

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

Telegram examples, length of the parameter channel = 4

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

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

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

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

Figure 7-10 Telegram for a read request from p7841[2]

Write request: Change restart mode (p1210)

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

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

<table>
<tr><td colspan="64">Parameter channel</td></tr>
<tr><td colspan="16">PKE, 1st word</td><td colspan="16">IND, 2nd word</td><td colspan="16">PWE1 - high, 3rd word</td><td colspan="16">PWE2 - low, 4th word</td></tr>
<tr><td colspan="4">15 ... 12</td><td>11</td><td colspan="11">10 ... 0</td><td colspan="8">15 ... 8</td><td colspan="8">7 ... 0</td><td colspan="16">15 ... 0</td><td colspan="16">15 ... 0</td></tr>
<tr><td colspan="4">AK</td><td></td><td colspan="11">Parameter number</td><td colspan="8">Page index</td><td colspan="8">Subindex</td><td colspan="16">Parameter value (bit 16 ... 31)</td><td colspan="16">Parameter value (bit 0 ... 15)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
</table>

Figure 7-11 Telegram, to activate the automatic restart with p1210 = 26

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

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

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

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

Figure 7-12 Telegram, to assign DI 2 with ON/OFF1

7.4.2.5 USS process data channel (PZD)

Description

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

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

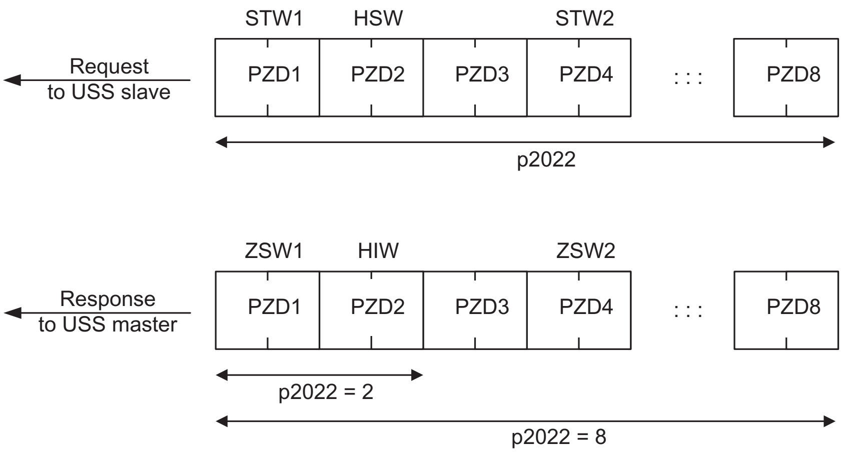


Figure 7-13 Process data channel

The first two words are:

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

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

You define the sources of the PZD using parameter p2051.

For further information, please refer to the Parameter Manual.

7.4.2.6 Time-out and other errors

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

Table 7- 26 Character runtime

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

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

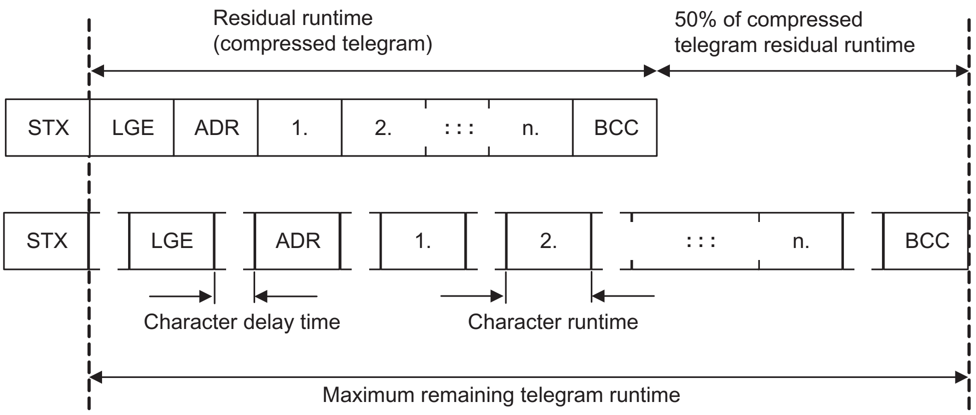


Figure 7-14 Telegram runtime as the sum of the residual runtime and character delay times

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

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

The slave only responds after the response delay has expired.

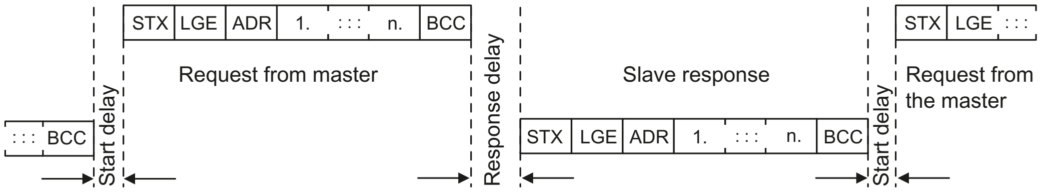


Figure 7-15 Start delay and response delay

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

Table 7- 27 Duration of the start delay

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

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

Telegram monitoring of the master

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

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

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

Telegram monitoring of the converter

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

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

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

7.4.3 Communication over Modbus RTU

Overview of communication using Modbus

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

Modbus offers three transmission modes:

- Modbus ASCII
  Data is transferred in ASCII code. The data can therefore be read directly by humans, however, the data throughput is lower in comparison to RTU.
- Modbus RTU
  Modbus RTU (RTU: Remote Terminal Unit): Data is transferred in binary format and the data throughput is greater than in ASCII code.
- Modbus TCP
  This type of data transmission is very similar to RTU, except that TCP/IP packages are used to send the data. TCP port 502 is reserved for Modbus TCP. Modbus TCP is currently undergoing definition as a standard (IEC PAS 62030 (pre-standard)).

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

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

Communication settings

- Communication using Modbus RTU takes place over the RS485 interface with a maximum of 247 slaves.
- The maximum cable length is 1200 m (3281 ft).
- Two 100 kΩ resistors are provided to polarize the receive and send cables.

> **CAUTION**
>
> **It is not permitted to change over the units!**
>
> The "Unit changeover (Page 185)" function is not permissible with this bus system!

7.4.3.1 Basic settings for communication

Setting the address

You can set the converter's Modbus-RTU address via the address switches on the CU via p2021 or in STARTER under "Control Unit/Communications/fieldbus".

Valid address range: 1 … 247

Procedure

Method	Description
Address switch	If you have specified a valid address using the address switch, this address will always be the one that takes effect and parameter p2021 cannot be changed. The positions and settings of the address switches are described in section: Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).
p2021 / STARTER	**Fieldbus address** (factory setting: 1) The setting in p2021 or via STARTER is effective only if you set all address switches to "OFF" (0).

CAUTION
For a modified bus address to be effective, you have to switch the converter and - if need be - any external 24 V supply off and on.

Additional settings

Parameter	Description
P0015 = 21	**Macro drive unit** Selecting the I/O configuration
p2030 = 2	**Fieldbus protocol selection** 2: Modbus
p2020	**Fieldbus baud rate** Baud rates from 4800 bit/s to 187500 bit/s can be set for communication, factory setting = 19200 bit/s.
p2024	**Modbus timing** (see Section "Baud rates and mapping tables (Page 133)") • **Index 0: Maximum slave telegram processing time:** The time after which the slave must have sent a response to the master. • **Index 1: Character delay time:** Character delay time: Maximum permissible delay time between the individual characters in the Modbus frame. (Modbus standard processing time for 1.5 bytes). • **Index2: Inter-telegram delay:** Maximum permissible delay time between Modbus telegrams. (Modbus standard processing time for 3.5 bytes).
p2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface
p2040	**Process data monitoring time** Determines the time after which an alarm is generated if no process data are transferred. **Note:** This time must be adapted depending on the number of slaves and the baud rate set for the bus (factory setting = 100 ms).

7.4.3.2 Modbus RTU telegram

Description

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

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

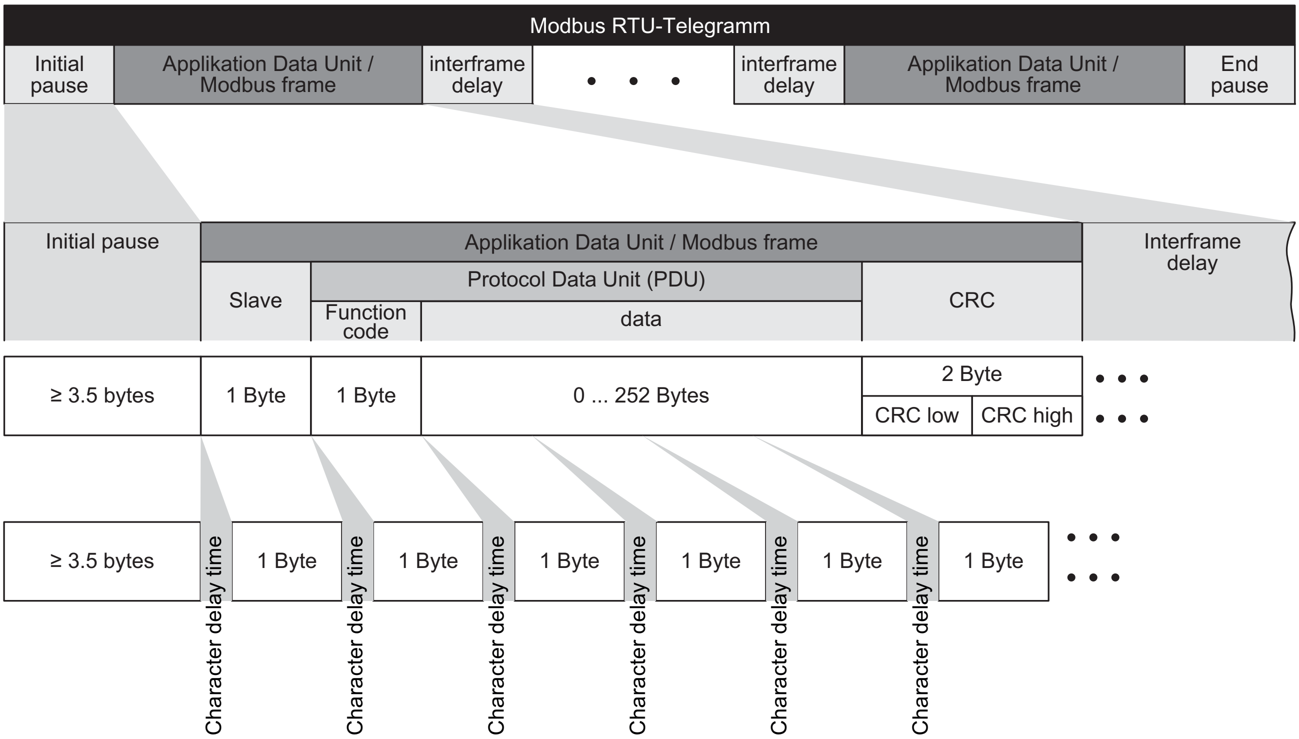


Figure 7-16 Modbus with delay times

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

7.4.3.3 Baud rates and mapping tables

Permissible baud rates and telegram delay

The Modbus RTU telegram requires a pause for the following cases:

- Start detection
- Between the individual frames
- End detection

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

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

Table 7- 28 Baud rates, transmission times, and delays

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

Note

The factory setting for p2024[1] and p2024[2] is 0. The particular values are pre-assigned depending on the protocol selection (p2030) or the baud rate.

Modbus register and Control Unit parameters

Since the Modbus protocol can only handle register or bit numbers for addressing the memory, assignment to the appropriate control words, status words and parameters is performed on the slave side.

The converter supports the following addressing ranges:

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

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

The registers 40100 to 40111 are described as process data. A telegram monitoring time can be activated in p2040 for these registers.

Note

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

Table 7- 29 Assigning the Modbus register to the parameters of the Control Unit

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Process data							
Control data							
40100	Control word	R/W	--	1			Process data 1
40101	Main setpoint	R/W	--	1			Process data 2
Status data							
40110	Status word	R	--	1			Process data 1
40111	Main actual value	R	--	1			Process data 2
Parameter data							
Digital outputs							
40200	DO 0	R/W	--	1	HIGH	LOW	p0730, r747.0, p748.0
40201	DO 1	R/W	--	1	HIGH	LOW	p0731, r747.1, p748.1
40202	DO 2	R/W	--	1	HIGH	LOW	p0732, r747.2, p748.2
Analog outputs							
40220	AO 0	R	%	100	-100.0 … 100.0		r0774.0
40221	AO 1	R	%	100	-100.0 … 100.0		r0774.1
Digital inputs							
40240	DI 0	R	--	1	HIGH	LOW	r0722.0
40241	DI 1	R	--	1	HIGH	LOW	r0722.1
40242	DI 2	R	--	1	HIGH	LOW	r0722.2
40243	DI 3	R	--	1	HIGH	LOW	r0722.3
40244	DI 4	R	--	1	HIGH	LOW	r0722.4
40245	DI 5	R	--	1	HIGH	LOW	r0722.5
Analog inputs							
40260	AI 0	R	%	100	-300.0 … 300.0		r0755 [0]
40261	AI 1	R	%	100	-300.0 … 300.0		r0755 [1]
40262	AI 2	R	%	100	-300.0 … 300.0		r0755 [2]
40263	AI 3	R	%	100	-300.0 … 300.0		r0755 [3]
Converter identification							
40300	Powerstack number	R	--	1	0 … 32767		r0200
40301	Converter firmware	R	--	0.0001	0.00 … 327.67		r0018
Converter data							
40320	Rated power of the power unit	R	kW	100	0 … 327.67		r0206
40321	Current Limit	R/W	%	10	10.0 … 400.0		p0640
40322	Rampup time	R/W	s	100	0.00 … 650.0		p1120
40323	Ramp-down time	R/W	s	100	0.00 … 650.0		p1121
40324	Reference speed	R/W	RPM	1	6.000 … 32767		p2000
Converter diagnostics							
40340	Speed setpoint	R	RPM	1	-16250 … 16250		r0020
40341	Speed actual value	R	RPM	1	-16250 … 16250		r0022

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

7.4.3.4 Write and read access via FC 3 and FC 6

Function codes used

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

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

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

All valid register addresses are permitted as a start address. If a register address is invalid, exception code 02 (invalid data address) is returned. An attempt to read a write-only register or a reserved register is replied to with a normal telegram in which all values are set to 0.

Using FC 03, it is possible to address more than 1 register with one request. The number of addressed registers is contained in bytes 4 and 5 of the read request.

Number of registers

If more than 125 registers are addressed, exception code 03 (Illegal data value) is returned. If the start address plus the number of registers for an address are outside of a defined register block, exception code 02 (invalid data address) is returned.

Table 7- 30 Structure of a read request for slave number 17

Example		
	Byte	Description
11 h	0	Slave address
03 h	1	Function code
00 h	2	Register start address "High" (register 40110)
6D h	3	Register start address "Low"
00 h	4	No. of registers "High" (2 registers: 40110; 40111)
02 h	5	Number of registers "Low"
xx h	6	CRC "Low"
xx h	7	CRC "High"

The response returns the corresponding data set:

Table 7- 31 Slave response to the read request

Example	Byte	Description
11 h	0	Slave address
03 h	1	Function code
04 h	2	No. of bytes (4 bytes are returned)
11 h	3	Data of first register "High"
22 h	4	Data of first register "Low"
33 h	5	Data of second register "High"
44 h	6	Data of second register "Low"
xx h	7	CRC "Low"
xx h	8	CRC "High"

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

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

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

Table 7- 32 Structure of a write request for slave number 17

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

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

Table 7- 33 Slave response to the write request

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

7.4.3.5 Communication procedure

Procedure for communication in a normal case

Normally, the master sends a telegram to a slave (address range 1 ... 247). The slave sends a response telegram to the master. This response telegram mirrors the function code, and the slave enters its own address in the telegram, which enables the master to assign the slave.

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

Communication errors

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

Logical error

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

Table 7- 34 Overview of exception codes

Exception code	Modbus name	Remark
01	Illegal function code	An unknown (not supported) function code was sent to the slave.
02	Illegal Data Address	An invalid address was requested.
03	Illegal data value	An invalid data value was detected.
04	Server failure	Slave has terminated during processing.

Maximum processing time, p2024[0]

For error-free communication, the slave response time (time within which the Modbus master expects a response to a request) must have the same value in the master and the slave (p2024[0] in the converter).

Process data monitoring time (setpoint timeout), p2040

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

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

Note

This time must be adapted depending on the number of slaves and the baud rate set for the bus (factory setting = 100 ms).

Functions

8

Before you set the inverter functions, you should have completed the following commissioning steps:

- Basic commissioning (Page 57)
- If necessary: Adapt terminal strip (Page 81)
- If necessary: Configuring the fieldbus (Page 93)

8.1 Overview of the inverter functions

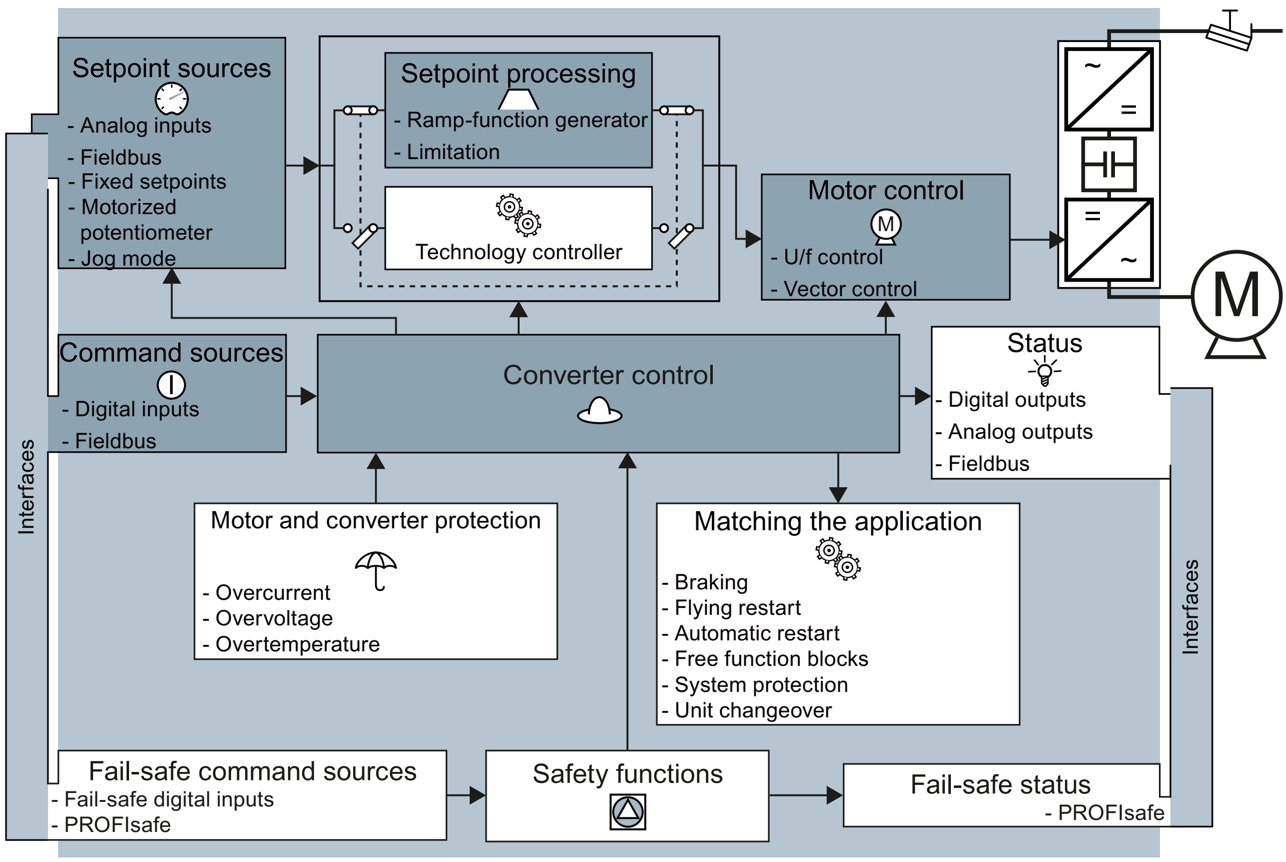


Figure 8-1 Overview of inverter functions

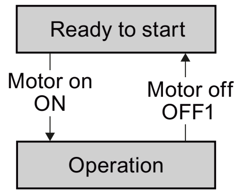
Functions relevant to all applications	Functions required in special applications only
The functions that you require in each application are shown in a dark color in the function overview above. You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.	The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.
Inverter control is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to external control signals. Inverter control (Page 143)	The **production functions** avoid overloads and operating states that could cause damage to the motor, inverter and driven load. The motor temperature monitoring, for example, is set here. Protection functions (Page 177)
The **command source** defines where the control signals are received from to switch on the motor, e.g. via digital inputs or a fieldbus. Command sources (Page 156)	The **status messages** provide digital and analog signals at the Control Unit outputs or via the fieldbus. Examples include the current speed of the motor or fault message issued by the inverter. Status messages (Page 184)
The **setpoint source** defines how the speed setpoint for the motor is specified, e.g. via an analog input or a fieldbus. Setpoint sources (Page 156)	The functions **matching the application** allow you to control a motor holding brake or implement a higher-level pressure or temperature control using the technology controller, for example. Application-specific functions (Page 185)
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 163)	The **safety functions** are used in applications that must fulfill special requirements in terms of functional safety. Safe Torque Off (STO) safety function (Page 227)
The **motor closed-loop control** ensures that the motor follows the speed setpoint. Motor control (Page 167)	

8.2 Inverter control

8.2.1 Switching the motor on and off

After switching on the supply voltage, 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.
- After the OFF1 command, the converter brakes the motor with the ramp-down time of the ramp-function generator. 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 OFF1command, 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 an OFF3 command, 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, e.g. when it involves collision protection.

The following diagram shows the internal sequence control of the converter when switching the motor on and off.

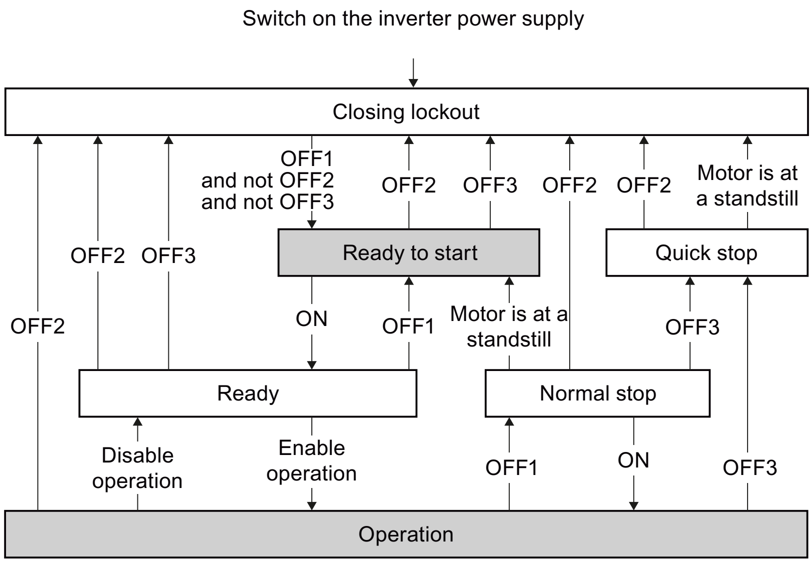


Figure 8-2 State overview of the converter

Table 8- 1 Explanation of the converter states

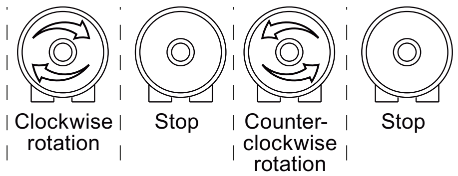
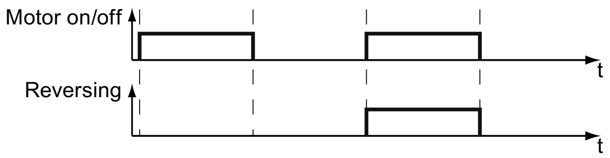
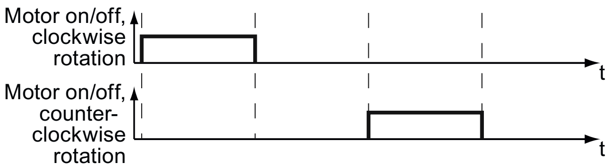
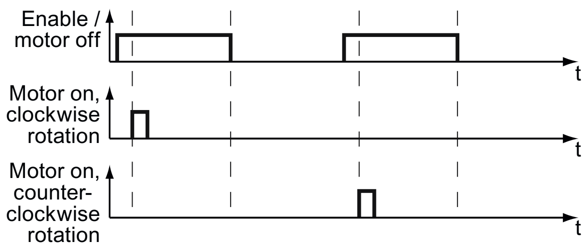
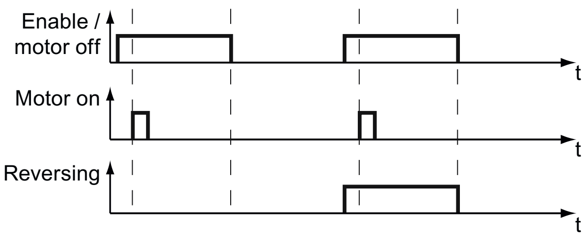
State	Explanation
Closing lockout	In this state, the converter does not respond to the ON command. The converter goes into this state under the following conditions: • The ON command was active when switching on the converter. Exception: When the automatic start function is active, the ON command must be active after switching on the power supply. • The OFF2 or OFF3 command is selected.
Ready to start	This state is required to switch on the motor.
Ready	The converter waits for the operating enable. If the converter is controlled via a fieldbus, then you must set the operating enable in a control word bit. If the converter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.
Operation	The motor is switched on.
Normal stop	The motor was switched off with an OFF1 command and brakes with the ramp-down time of the ramp-function generator.
Quick stop	The motor was switched off with an OFF3 command and brakes with the OFF3 ramp-down time.

8.2.2 Inverter control using digital inputs

If you are controlling the inverter using digital inputs, you use parameter p0015 during basic commissioning to define how the motor is switched on and off and how it is changed over from clockwise to counter-clockwise rotation.

Five different methods are available for controlling the motor. Three of the five methods just require two control commands (two-wire control). The other two methods require three control commands (three-wire control).

Table 8- 2 Two-wire control and three-wire control

Behavior of the motor		
	**Control commands**	**Typical application**
	**Two-wire control, method 1** 1. Switch 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. Issue enable for switching on motor and switch off motor (OFF1). 2. Switch on motor (ON), clockwise rotation. 3. Switch on motor (ON), counter-clockwise rotation.	Traction drives with control via joystick
	**Three-wire control, method 2** 1. Issue enable for switching on motor and switch off motor (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.

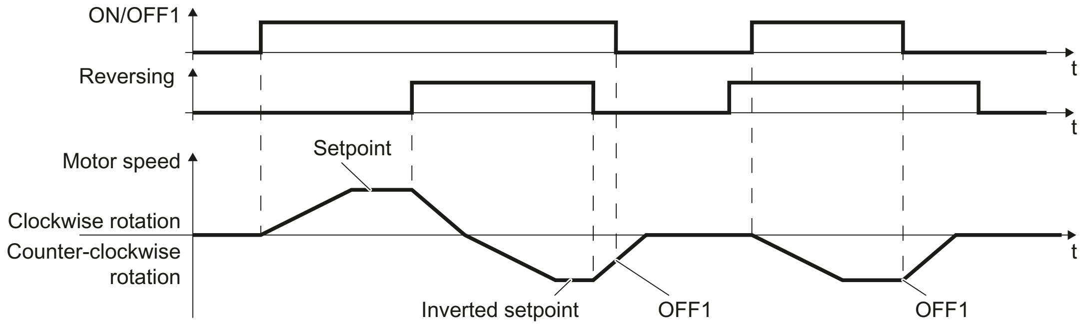


Figure 8-3 Two-wire control, method 1

Table 8- 3 Function table

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

Table 8- 4 Parameter

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 12</td><td colspan="3">Macro drive unit (factory setting for inverters without PROFIBUS interface)</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1</td><td>Reversing</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p0840[0 … n] = 722.x</td><td colspan="3">BI: ON/OFF1 (ON/OFF1)</td></tr>
<tr><td>p1113[0 … n] = 722.x</td><td colspan="3">BI: Setpoint inversion (reversing)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p0840 = 722.3</td><td colspan="3">DI 3: ON/OFF1.
Also see Section Digital inputs (Page 82).</td></tr>
</table>

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.

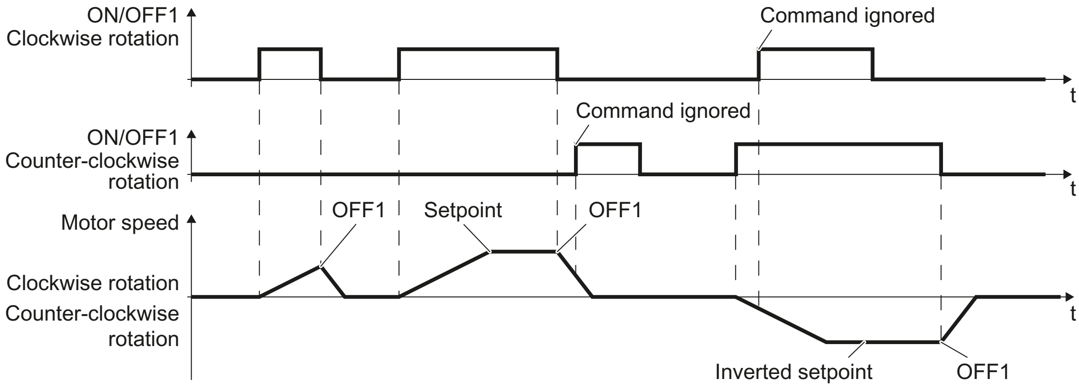


Figure 8-4 Two-wire control, method 2

Table 8- 5 Function table

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

Table 8- 6 Parameter

Parameter	Description		
p0015 = 17	**Macro drive unit**		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1 clockwise rotation	ON/OFF1 , counter-clockwise rotation
Advanced setting Interconnecting control commands with digital inputs of your choice (DI x).			
p3330[0 … n] = 722.x	**BI: 2-3-WIRE Control Command 1** (ON/OFF1 clockwise rotation)		
p3331[0 … n] = 722.x	**BI: 2-3-WIRE Control Command 2** (ON/OFF1 , counter-clockwise rotation)		
Example			
p3331 = 722.0	DI 0: ON/OFF1 Counter-clockwise rotation Also see Section Digital inputs (Page 82).		

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.

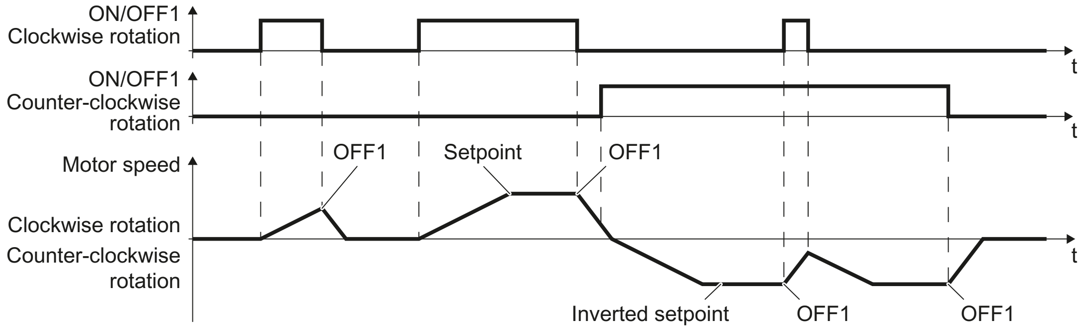


Figure 8-5 Two-wire control, method 3

Table 8- 7 Function table

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

Table 8- 8 Parameter

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 18</td><td colspan="3">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1 clockwise rotation</td><td>ON/OFF1 , counter-clockwise rotation</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2-3-WIRE Control Command 1 (ON/OFF1 clockwise rotation)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2-3-WIRE Control Command 2 (ON/OFF1 , counter-clockwise rotation)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p3331[0 … n] = 722.2</td><td colspan="3">DI 2: ON/OFF1 Counter-clockwise rotation
Also see Section Digital inputs (Page 82).</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 canceling 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).

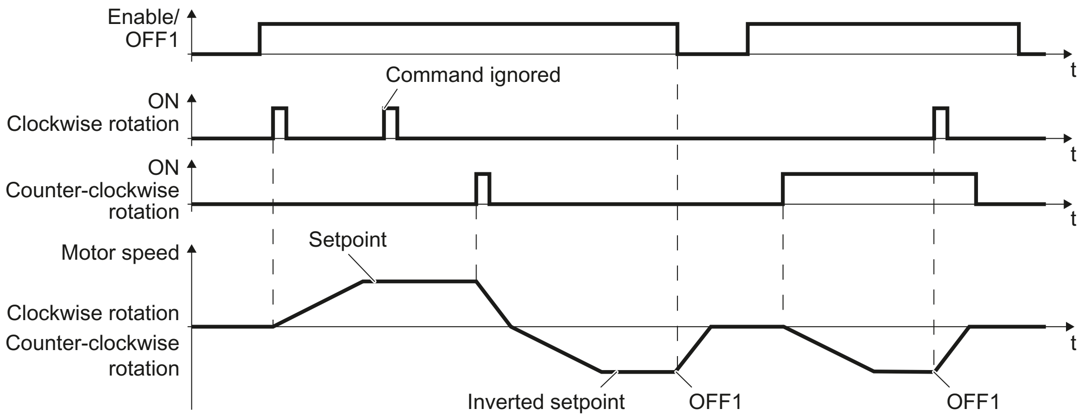


Figure 8-6 Three-wire control, method 1

Table 8- 9 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 rotation of motor.
1	0	0→1	ON: Counter-clockwise rotation of motor.
1	1	1	OFF1: The motor stops.

Table 8- 10 Parameter

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 19</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable/OFF1</td><td>ON clockwise rotation</td><td>ON , counter-clockwise rotation</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 2 (ON clockwise rotation)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 3 (ON , counter-clockwise rotation)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3332 = 722.0</td><td colspan="4">DI 0: ON Counter-clockwise rotation.
Also see Section Digital inputs (Page 82).</td></tr>
</table>

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 canceling 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).

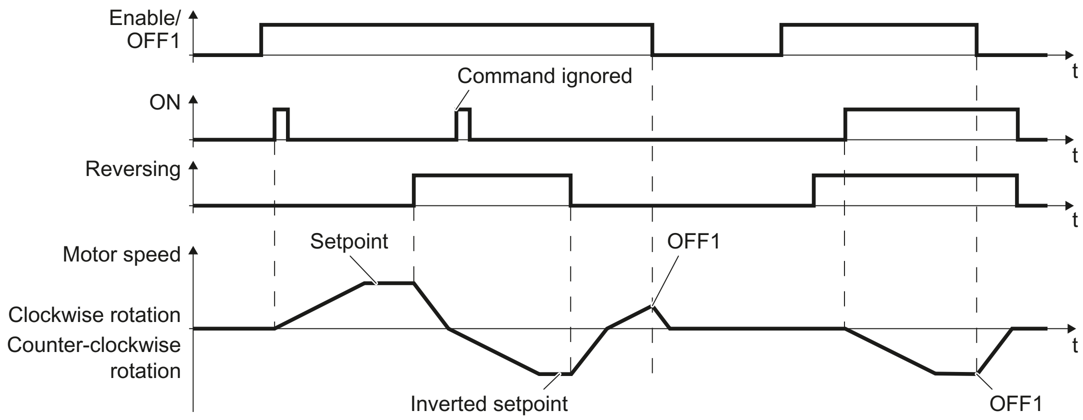


Figure 8-7 Three-wire control, method 2

Table 8- 11 Function table

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

Table 8- 12 Parameter

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 20</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable/OFF1</td><td>ON</td><td>Reversing</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 2 (ON)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2-3-WIRE Control Command 3 (reversing)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3331 = 722.0</td><td colspan="4">DI 0: ON.
Also see Section Digital inputs (Page 82).</td></tr>
</table>

8.2.8 Running the motor in jog mode (JOG function)

The "Jog" function is typically used to a slowly move a machine part, e.g. a conveyor belt. The function is frequently used when the converter is temporarily not operated via the fieldbus, but via digital inputs instead.

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 counterclockwise rotation and clockwise rotation.

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

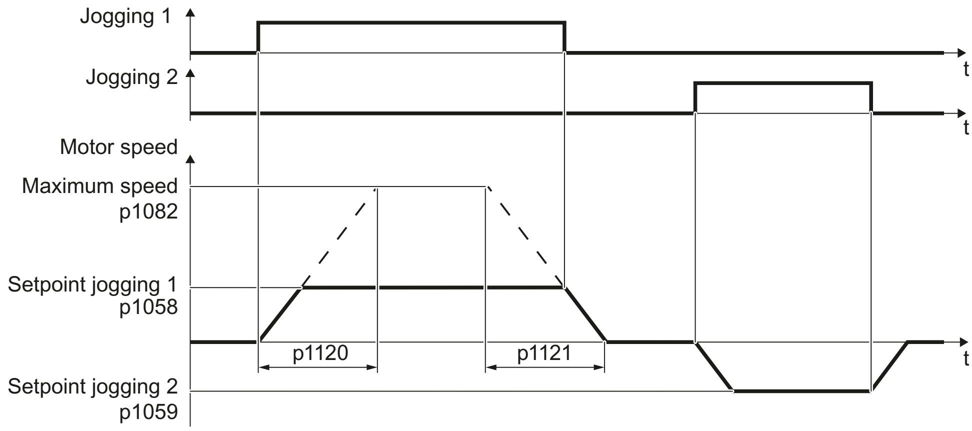
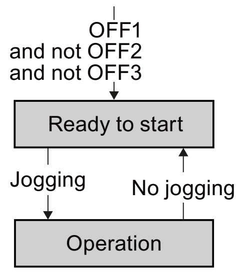


Figure 8-8 Behavior of the motor when "jogging",

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



Setting jogging

Table 8- 13 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	**Jogging bit 0:** Select jogging 1 via digital input 0	
p1056 = 722.1	**Jogging 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: Switchover from automatic to manual operation

A motor is switched on and off and its speed varied either from a central control system via a fieldbus or from a local control box.

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 known as a command data set.

Example:

Command data set 0: Controlling the inverter via the fieldbus
Command data set 1: Controlling the inverter via terminal strip

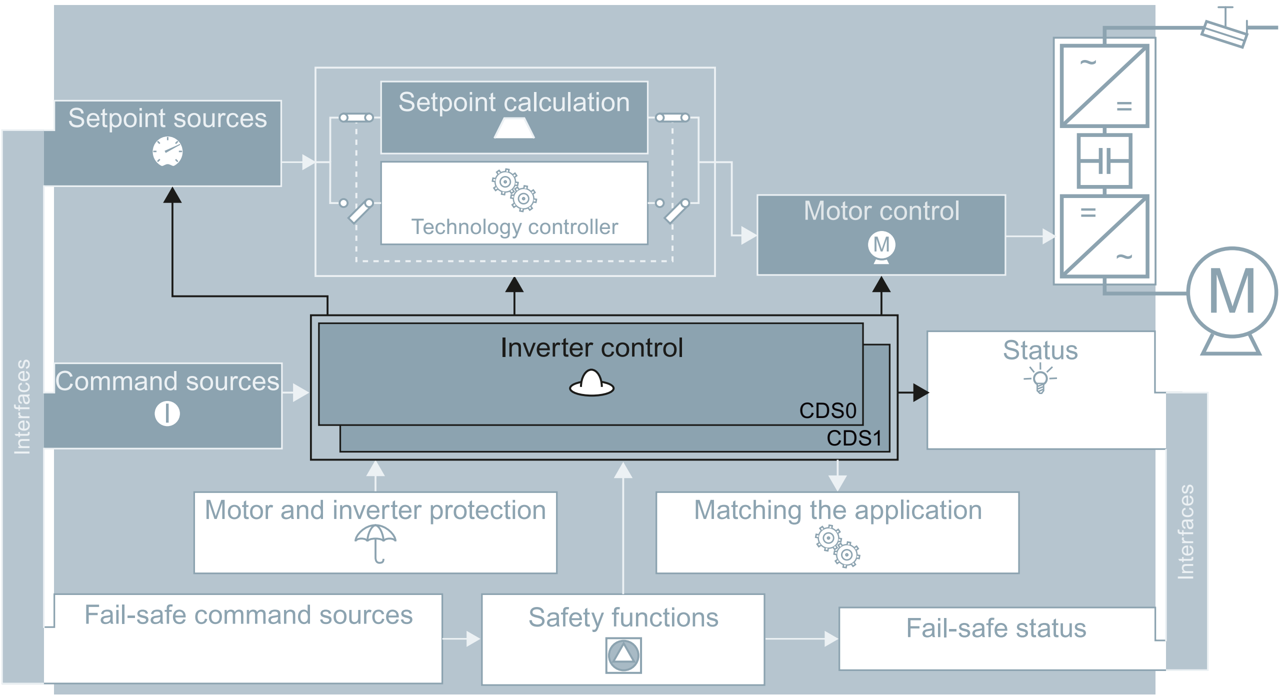


Figure 8-9 Command data sets (CDS): Different setting of the inverter control

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

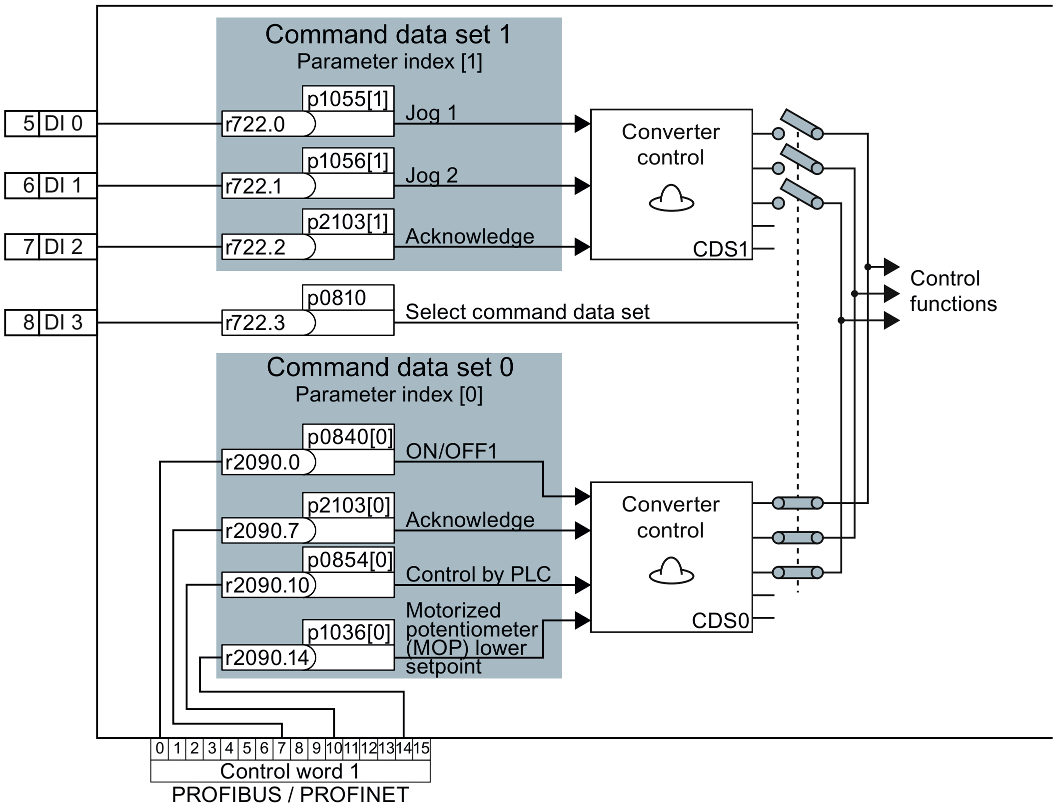


Figure 8-10 Example for the various command data sets

You obtain the interconnection as in the example above, if you configured the interfaces of the inverter with p0015 = 7 in the basic commissioning, also see Section Select interface assignments (Page 46).

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

Note

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

Advanced settings

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

Table 8- 14 Defining the number of command data sets

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**

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

Table 8- 15 Selecting a command data set

Parameter	Description
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**

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

Table 8- 16 Parameters for copying the command data sets

Parameter	Description
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.

8.3 Command sources

The command source is the interface via which the inverter receives its control commands. You define the assignment of the inverter interfaces when carrying out the basic commissioning.

Change command source

You have two options to change the command sources:

1. Carry out the basic commissioning again and select a different assignment of the inverter interfaces.
2. Adapt the function of individual digital inputs or change the fieldbus interface. You can find more information on this in Sections Adapt terminal strip (Page 81) and Configuring the fieldbus (Page 93).

8.4 Setpoint sources

8.4.1 Overview

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

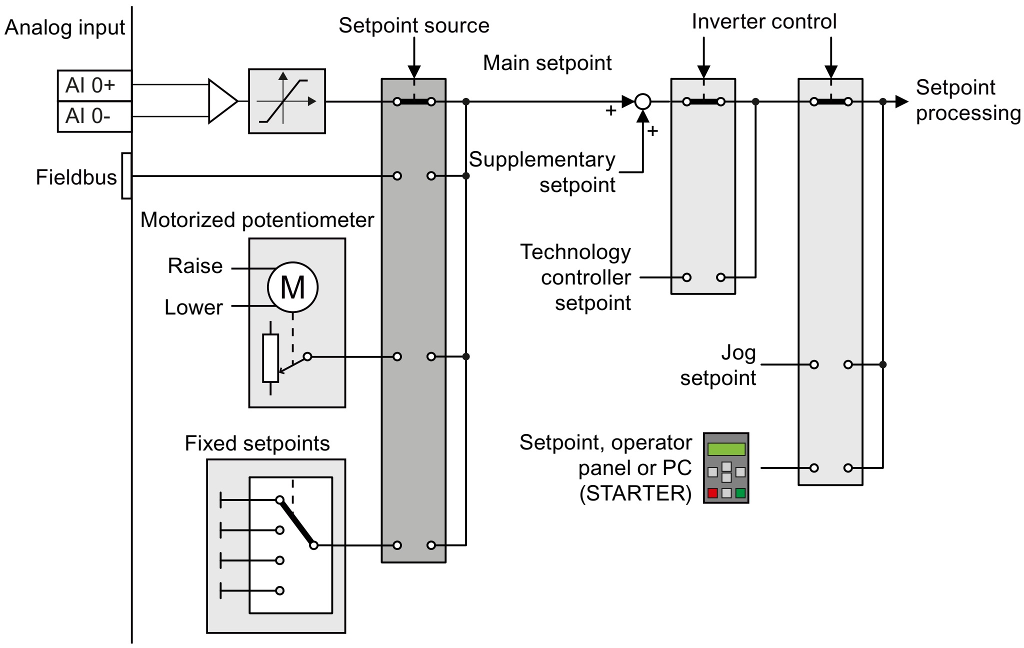


Figure 8-11 Setpoint sources for the inverter

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

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

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

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

- When the technology controller is active, it's output specifies the motor speed.
- When jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

In the basic commissioning, you have already selected a setpoint source. Refer also to Section: Select interface assignments (Page 46).

However, you can change this setting. The setpoint sources will be described in more detail on the following pages.

8.4.2 Analog input as setpoint source

Procedure

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.

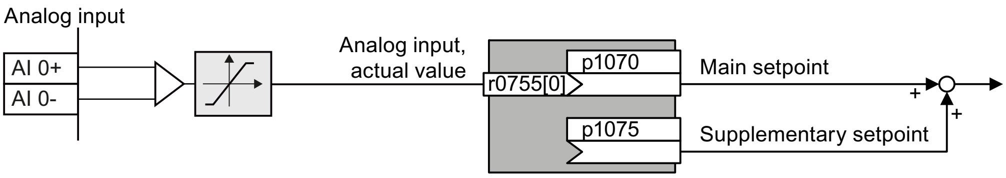


Figure 8-12 Example: Analog input 0 as setpoint source

Table 8- 17 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 87).

8.4.3 Specifying the motor speed via the fieldbus

If you enter the setpoint via a fieldbus, you must connect the converter to a higher-level control. For additional information, see chapter Configuring the fieldbus (Page 93).

Interconnecting the fieldbus with the main setpoint

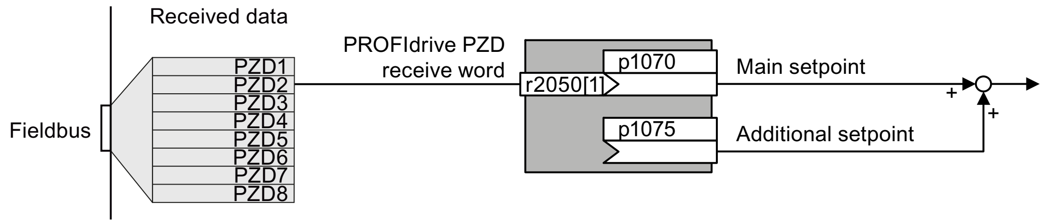


Figure 8-13 Fieldbus as setpoint source

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

Table 8- 18 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.

8.4.4 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

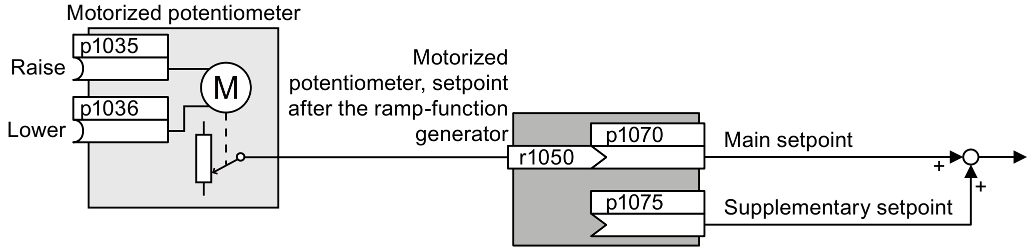


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 19 Setting the MOP as setpoint source

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

Adapting the behavior of the motorized potentiometer

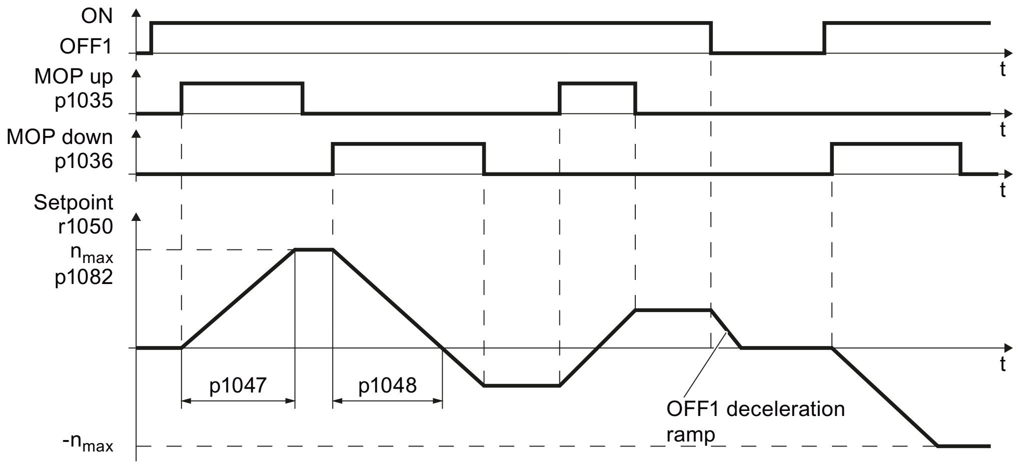


Figure 8-15 Function chart of motorized potentiometer

Table 8- 20 Basic setup of motorized potentiometer

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

Table 8- 21 Extended setup of motorized potentiometer

Parameter	Description
p1030	**MOP configuration** (factory setting 00110 bin) **Parameter value with four independently adjustable bits 00 … 03** **Bit 00:** Save setpoint after switching off motor 0: After the motor is switched on, p1040 is specified as the setpoint 1: Setpoint is saved after the motor is switched off and set to the saved value once it is switched on **Bit 01:** Configure ramp-function generator in automatic mode (1-signal via BI: p1041) 0: No ramp-function generator in automatic mode (ramp-up/-down time = 0) 1: With ramp-function generator in automatic mode In manual mode (0-signal via BI: p1041) the ramp-function generator is always active **Bit 02:** Configure initial rounding 0: No 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) This is automatically preassigned when commissioning
p1038	**MOP minimum speed** (factory setting 0 rpm) This is automatically preassigned when commissioning
p1044	**MOP setting value** (factory setting 0) Signal source for the setting value.

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

8.4.5 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.

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

Interconnecting the fixed speeds with a main setpoint

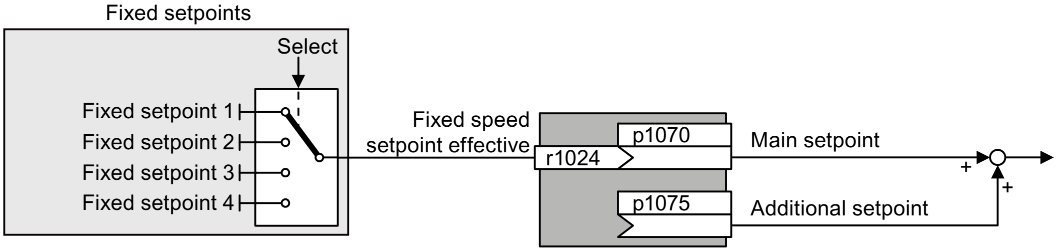


Figure 8-16 Fixed speeds as setpoint source

Table 8- 22 Setting the fixed speeds as 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

Direct or binary selection of the fixed setpoints

The converter has up to 16 different fixed setpoints. The fixed setpoints can be selected via digital inputs or the fieldbus.

The various fixed setpoints can be selected in two ways:

1. Direct selection:
   You set four different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.
   Direct selection is the most suitable method for controlling the converter via the digital inputs.
2. Binary selection:
   You set 16 different fixed setpoints. You precisely select one of these fixed setpoints by a combination of four selection bits.
   The binary selection is the preferred solution for a central control and connecting the converter to a fieldbus.
   Additional information about binary selection can be found in function diagram 3010 of the List Manual.

Direct selection of fixed setpoints

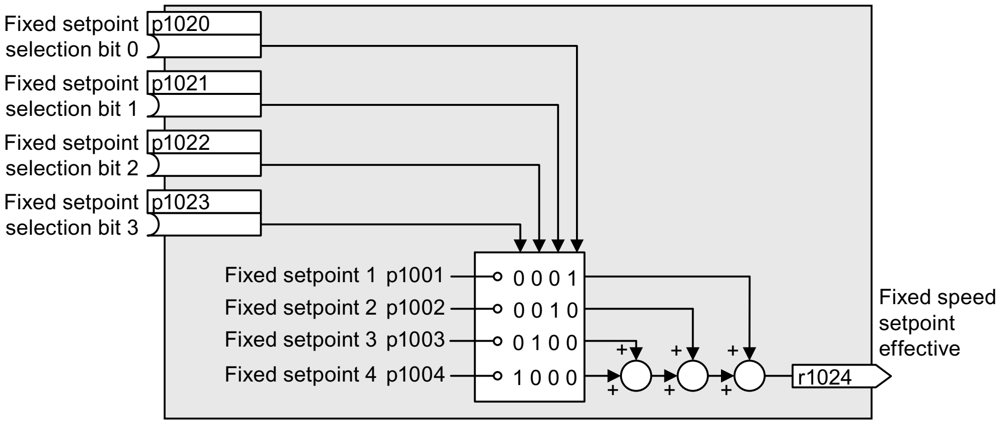


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

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

Example: Direct selection of two fixed speed setpoints

The motor is to operate at two different speeds as follows:

- The motor is switched on with digital input 0 and then accelerates to 300 rpm.
- When digital input 1 is selected, the motor accelerates up to a speed of 2000 rpm.
- The motor reverses when selecting digital input 3.

Table 8- 23 Settings for the example

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

Table 8- 24 Resulting fixed setpoints for the example above

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

8.5 Setpoint calculation

8.5.1 Overview of setpoint processing

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

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Minimum speed to avoid standstill when the motor is switched on.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

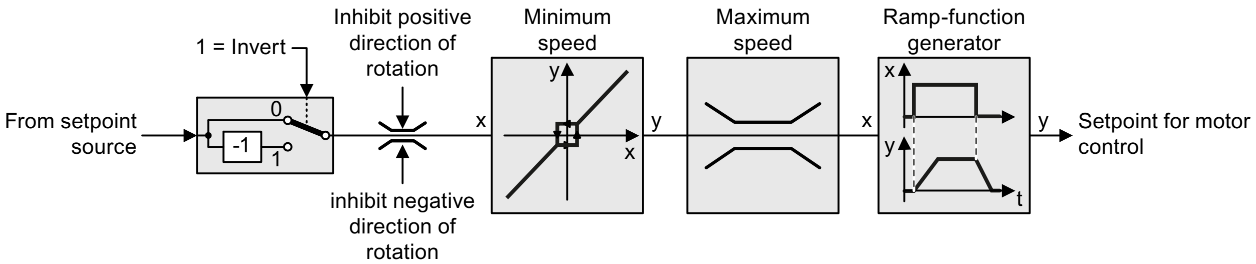


Figure 8-18 Setpoint processing in the inverter

8.5.2 Invert setpoint

Procedure

Interconnect parameter p1113 with a binary signal, e.g. digital input 1.

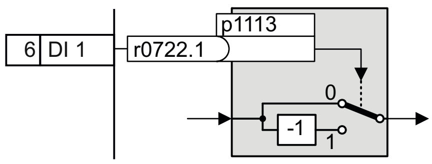


Table 8- 25 Examples of settings to invert the setpoint

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

8.5.3 Inhibit direction of rotation

Procedure

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

If you want to permanently inhibit one of the directions of rotation, then you must set the corresponding parameter to 1.

With the value 0, the converter enables the direction of rotation.

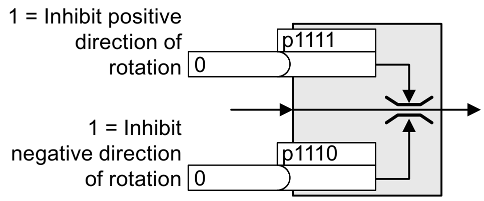


Table 8- 26 Examples of settings to inhibit the direction of rotation

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

8.5.4 Minimum speed

Function

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

Speeds, where the absolute value is less than the minimum speed, can only be passed through when accelerating or braking.

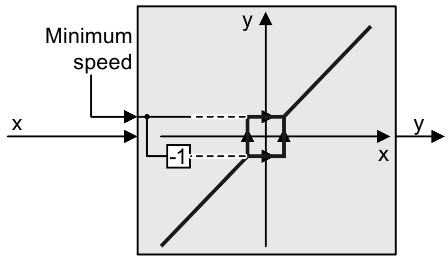


Table 8- 27 Setting the minimum speed

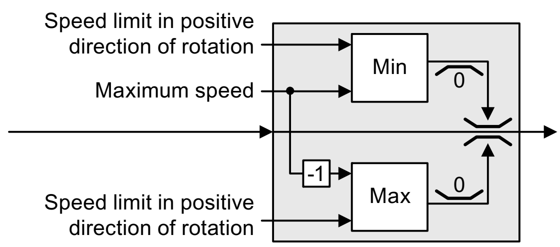
Parameter	Description
p1080	Minimum speed

8.5.5 Maximum speed

Function

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

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



The maximum speed also acts as a reference value for several other functions, e.g. the ramp-function generator.

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

Table 8- 28 Parameters for minimum and maximum speed

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

8.5.6 Ramp-function generator

Function

The ramp-function generator in the setpoint channel limits the speed of changes to the speed setpoint. The ramp-function generator does the following:

- The soft acceleration and braking of the motor reduces the stress on the mechanical system of the driven machine.
- Acceleration and braking distance of the driven machine (e.g. a conveyor belt) are independent of the motor load.

The ramp-up and ramp-down times of the ramp-function generator can be set independently of each other. The times that you select depend on the 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).

When the motor is switched on/off via ON/OFF1, the motor also accelerates/decelerates in accordance with the times set in the ramp-function generator.

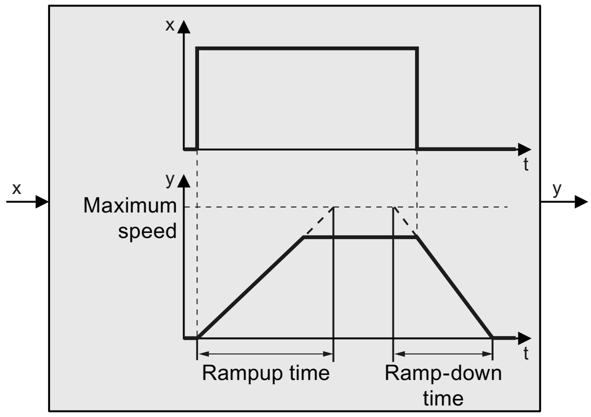


Table 8- 29 Parameters for minimum and maximum speed

Parameter	Description
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.

Note

Excessively short ramp-up and ramp-down times mean that the motor reaches its current limit when accelerating or braking. In this case, the set times are exceeded.

Extended ramp-function generator

In the extended ramp-function generator, the acceleration process can be made "softer" using initial and final rounding via parameters p1130 … p1134. Here, the ramp-up and ramp-down times of the motor are increased by the rounding times.

Rounding does not affect the ramp-down time in the event of a quick stop (OFF3).

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

8.6 Motor control

Decision-making criteria for the control mode that is suitable for your application is provided in Section U/f control or speed control? (Page 62).

8.6.1 V/f control

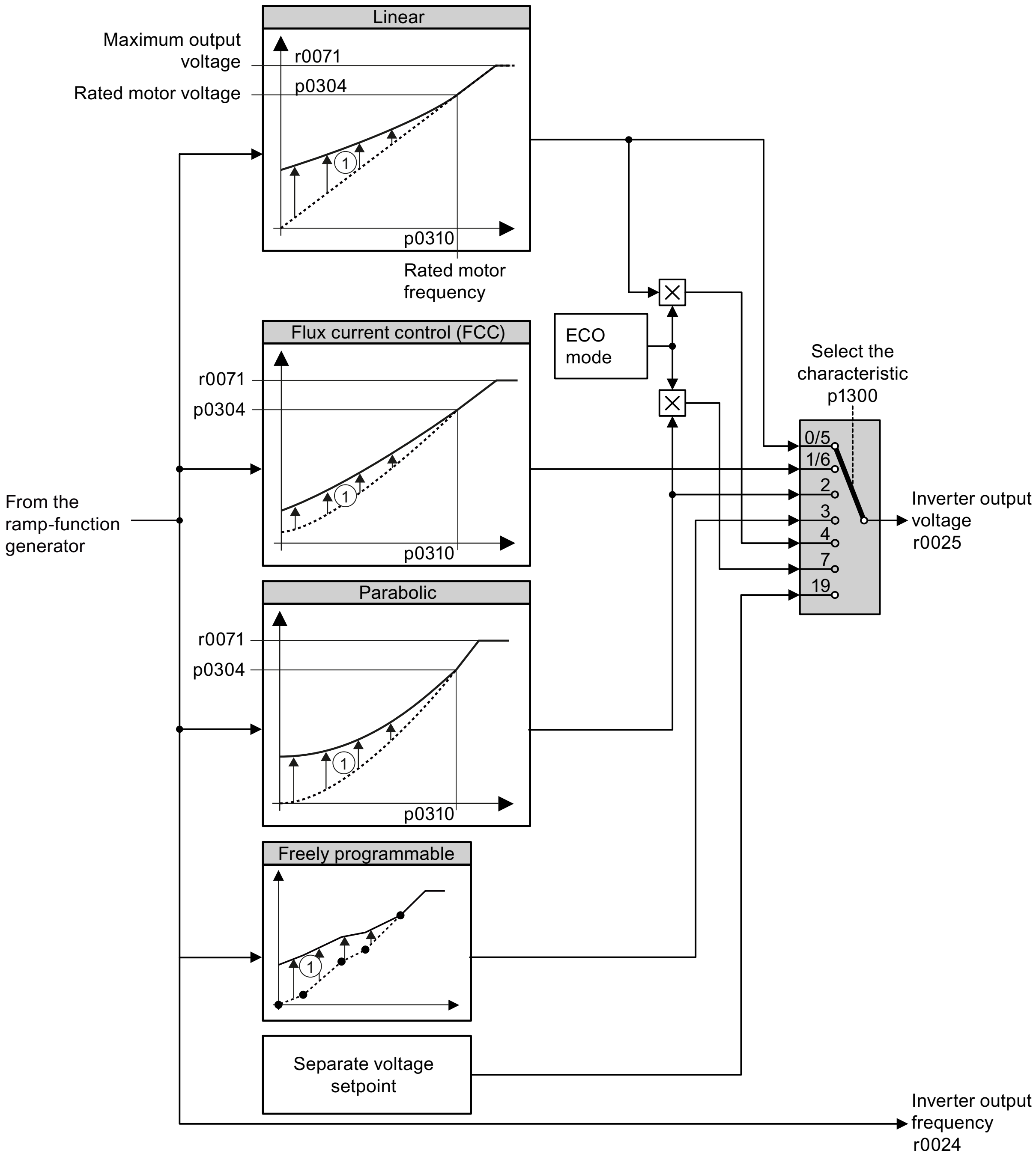
V/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint. The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of 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.

V/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 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.

The characteristic is selected during commissioning, using p1300.

8.6.1.1 Characteristics of U/f control

The inverter has several U/f characteristics. Based on the characteristic, as the speed increases the inverter increases its output voltage.



① Voltage boost as a function of speed and torque

Figure 8-19 U/f characteristics of the inverter

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

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

The voltage boost of the characteristic improves motor behavior at low speeds.

8.6.1.2 Selecting the U/f characteristic

Procedure

With the Operator Panel:

- Select the suitable characteristic curve and set parameter p1300.

Using STARTER:

- Go online with STARTER.
- Select the U/f characteristic curve in one of the screen forms "speed controller" or "U/f control".

Table 8- 30 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 with a low power rating. 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- 31 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, then the inverter again reduces its output voltage.	ECO mode	p1300 = 4 or p1300 = 7
The inverter must keep the motor speed constant under all circumstances.	Drives in the textile sector	When the maximum current limit is reached, the inverter only reduces the stator voltage but not the speed.	precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	Operating the inverter with a synchronous motor	-	Parameterizable 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.

8.6.1.3 Optimizing with a high break loose torque and brief overload

Voltage boost of the 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.

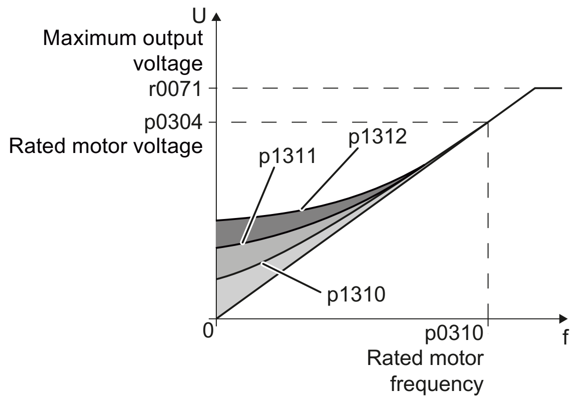


Table 8- 32 Parameters for the voltage boost

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").

Procedure

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 .

- Power-up the motor with an average speed.
- Reduce the speed to just a few revolutions per minute.
- Check whether the motor rotates smoothly.
- If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
- Accelerate the motor to the maximum speed with maximum load and check whether the motor follows the setpoint.
- If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

In most cases, your motor will now behave satisfactorily. You will only have to increase parameter p1312 for applications with a noticeable break loose torque.

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

8.6.2 Closed-loop speed control

8.6.2.1 Properties of the sensorless vector control

Sensorless vector control

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

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

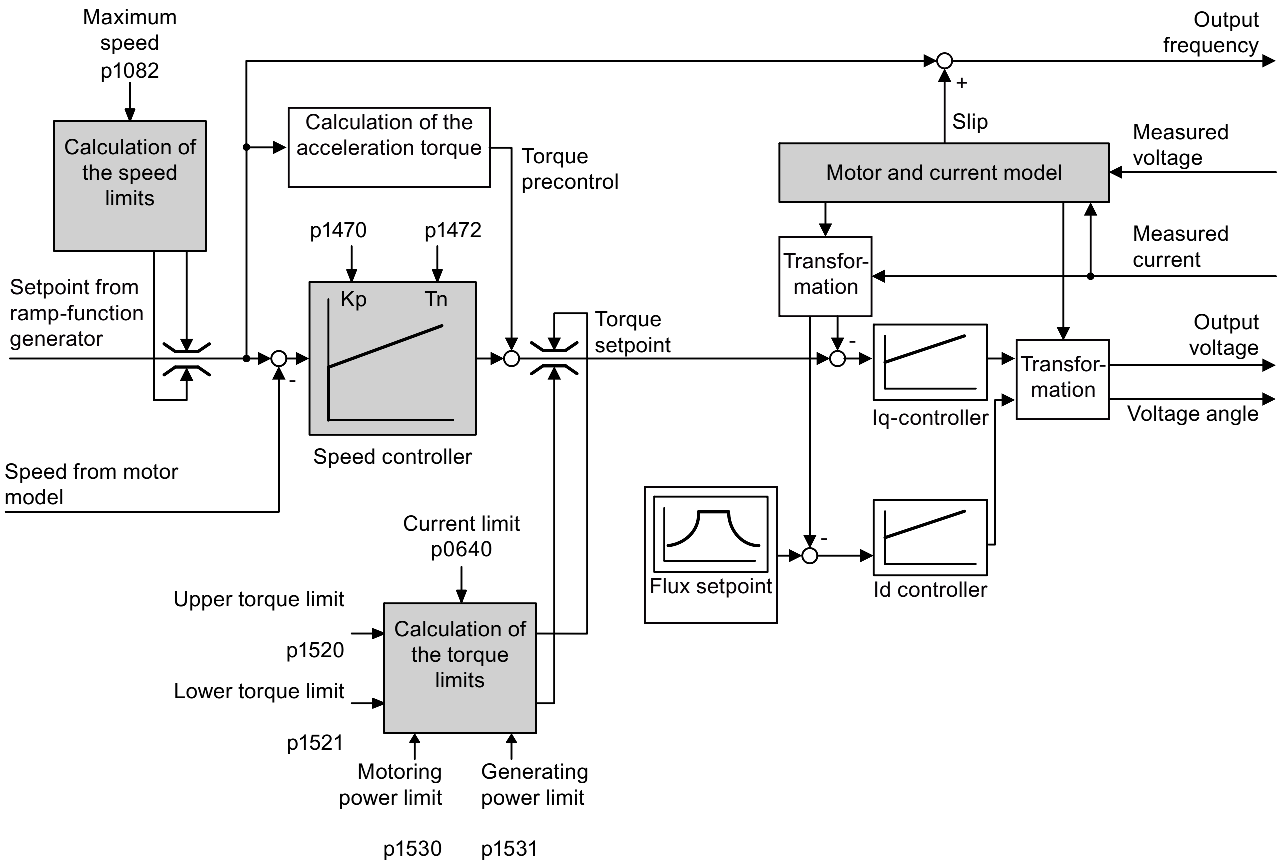


Figure 8-20 Simplified function diagram of sensorless vector control

8.6.2.2 Select motor control

Speed control is already preset

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

- The maximum speed for your application.
- The motor and current model: If the motor data in the converter correspond to the motor data on the rating plate, then the motor and current model in the converter are correct and the vector control can operate satisfactorily.
- The converter 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 converter has a preset speed controller with self-optimization (rotating measurement).
  If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Procedure

With an Operator Panel:

- Set p1300 = 20.

Using STARTER:

- Go online with STARTER.
- Select speed control without encoder in the "Speed controller" or "V/f control" mask.

8.6.2.3 Re-optimize the speed controller

In the following cases you will need to manually optimize the speed controller:

- Your application does not permit self-optimization because the motor cannot rotate freely.
- You are dissatisfied with the result of the converter self-optimization.
- The converter interrupted the self-optimization with a fault message.

Procedure

- Temporarily set the ramp-up and ramp-down time of the ramp-function generator to zero.

With an Operator Panel:	Using STARTER:
• Set p1120 = 0 and p1121 = 0.	• Go online with STARTER. • Set the times to 0 in the "Ramp-function generator" screen form.

- Temporarily set the pre-control of the speed controller to zero.

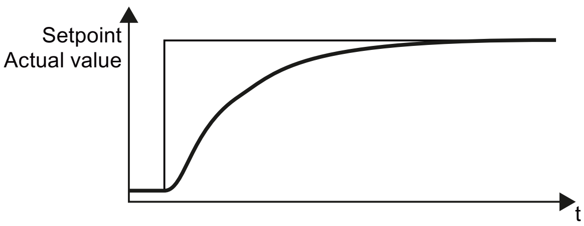
With an Operator Panel:	Using STARTER:
• Set p1496 = 0.	• Go online with STARTER. • Set the precontrol to 0 in the "Speed controller" screen form.

- Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.
- Optimize the speed controller by changing controller parameters K_P and T_N until the drive runs optimally (see the diagrams below).

With an Operator Panel:	Using STARTER:
• K_P = p1470 • T_N = p1472	• Go online with STARTER. • Set the controller in the "Speed controller" screen form.

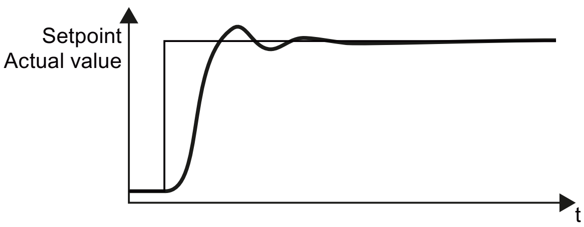
- Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.
- Set the pre-control of the speed controller back to 100 %.

Table 8- 33 Optimum control response



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

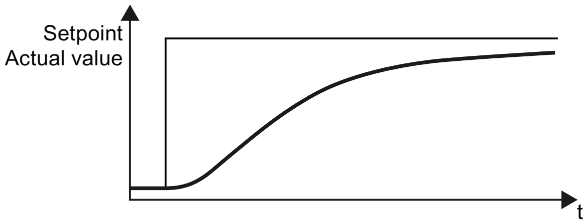
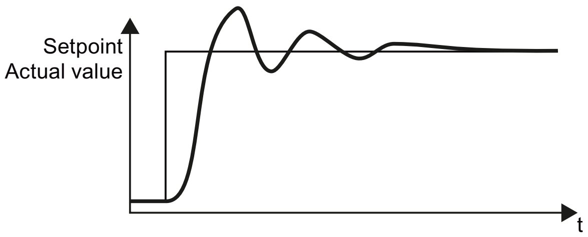
The actual value approaches the setpoint, without any significant overshoot.



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

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).

Table 8- 34 Optimizing the control response

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

8.6.2.4 Torque control

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

Typical applications for torque control

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

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

Commissioning the torque control

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

You can find the basic commissioning in the following sections:

- Basic commissioning with the BOP-2 (Page 66)
- Basic commissioning with STARTER (Page 70)

Table 8- 35 The most important torque control parameters

Parameter	Description
P1300 = …	Control type: 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.

8.7 Protection functions

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

8.7.1 Inverter temperature monitoring

The inverter protects itself against overtemperature with different monitoring functions:

1. I2t monitoring (alarm A07805, fault F30005)
   The I^2t monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a %. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
2. Monitoring the chip temperature of the power unit (alarm A05006 - fault F30024)
   The inverter monitors the difference in temperature between the power chip (IGBT) and the heat sink. The measured values are in r0037[1] [°C].
3. Heat sink monitoring (alarm A05000, fault F30004)
   The inverter monitors the heat sink temperature of the Power Module. The values are in r0037[0] [°C].

Inverter response

The inverter temperature is essentially determined by the resistive losses of the output current and the switching losses which occur when pulsing the motor. Parameter p0290 defines how the inverter responds to an excessively high temperature.

Parameter	Description
P0290	**Power unit overload response** (factory setting for SINAMICS G120 inverters with Power Module PM260: 0; factory setting for all of the inverters: 2) Setting the reaction to a thermal overload of the power unit: 0: Reduce output current (in vector control mode) or speed (in V/f mode) 1: No reduction, shutdown when overload threshold is reached (F30024) 2: Reduce pulse frequency and output current (in vector control mode) or pulse frequency and speed (in V/f mode) 3: Reduce pulse frequency
P0292	**Power unit temperature warning threshold** (factory setting: Heat sink [0] 5°C, power semiconductor [1] 15°C) The value is set as a difference to the shutdown temperature.

8.7.2 Motor temperature monitoring using a temperature sensor

Connecting the temperature sensor

You can use one of the following sensors to protect the motor against overtemperature:

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

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

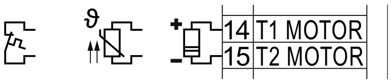


Figure 8-21 Connecting the motor temperature sensor at the inverter

Temperature switch

The inverter evaluates the temperature switch as follows:

- Overtemperature alarm (A07910):
  The inverter interprets a resistance ≥ 100 Ω as an open-circuit temperature switch and responds with an alarm.
- Overtemperature fault (F07011):
  If p0610 = 1 or p0610 = 2, in addition to an alarm, the inverter responds to this with a fault.

PTC sensor

The inverter evaluates the PTC sensor as follows:

- Overtemperature alarm (A07910):
  For a resistance > 1650 Ω, the inverter responds with an alarm.
- Overtemperature fault (F07011):
  If p0610 = 1 or p0610 = 2, in addition to an alarm, the inverter responds to this with a fault.
- Alarm and fault, sensor monitoring (A07015 or F07016):
  – The inverter interprets a resistance < 20 Ω as short-circuit.
  – The inverter responds to the short circuit with an alarm. If the alarm is present longer than 100 milliseconds, then this is followed by a fault.

KTY84 sensor

CAUTION
Ensure the correct polarity when connecting the KTY sensor: If a KTY sensor sensor is connected with the incorrect polarity, this can destroy the motor due to overheating, as the inverter cannot detect a motor overtemperature condition.

The inverter evaluates the KTY sensor as follows:

- Temperature measurement:
  The inverter determines the motor temperature in the range from -48 °C ... +248 °C.
- Overtemperature alarm (A07910):
  The inverter signals an alarm for a motor temperature > p0604.
- Overtemperature fault (F07011):
  The inverter signals a fault in the following cases:
  - Always for a motor temperature > p0605.
  - In addition, for a motor temperature > p0604, if p0610 = 1 or p0610 = 2.
- Alarm and fault, sensor monitoring (A07015 or F07016):
  - Wire-break:
    The inverter interprets a resistance > 2120 Ω as a wire break.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as short-circuit.
  - The inverter responds to a wire break or short circuit with an alarm. If the alarm is present longer than 100 milliseconds, then this is followed by a fault.

Parameters for the temperature monitoring

Table 8- 36 Setting the monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Self-ventilated - with fan on the motor shaft (factory setting) 1: Forced ventilation - with a separately driven fan 2: Self-ventilated and inner cooling (open-circuit cooling) 3: Forced ventilated and inner cooling (open-circuit cooling)
p0601	**Motor temperature sensor type** 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130 °C)
p0605	**Motor temperature fault threshold** (Factory setting: 145 °C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	**Motor overtemperature response** Determines the response when the motor temperature reaches the alarm threshold p0604. 0: Alarm (A07910), but no response of the motor. 1: Alarm (A07910) and reduction of the current limit (factory setting) - this reduces the motor speed. 2: Fault (F07011) and shutdown.
p0640	**Current limit** (input in A)

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

8.7.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode (P1300 ≥ 20) and functions by calculating a thermal motor model.

Table 8- 37 Parameter to sense the temperature without using a temperature sensor

Parameters	Description
P0621 = 1	**Motor temperature measurement after restarting** 0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on
P0622	**Magnetization time of the motor for temperature measurement after starting** *(set automatically as the result of motor data identification)*
P0625 = 20	**Ambient motor temperature** Enter the ambient motor temperature in°C at the instant that the motor data is acquired (factory setting: **20°C**). The difference between the motor temperature and motor environment (P0625) must lie within a tolerance range of approx. ± 5 °C.

8.7.4 Overcurrent protection

During vector control, the motor current remains within the torque limits set there.

During U/f control, the maximum current controller (I_{max} controller) protects the motor and inverter against overload by limiting the output current.

Method of operation of I_{max} controller

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, i.e. it is being driven by the connected machine, the I_{max} controller increases the speed and stator voltage of the motor to reduce the current.

Note

The inverter load is only reduced if the motor torque decreases at lower speeds (e.g. for fans).

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

Settings

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

Table 8- 38 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 I_{max} controller Shows the amount to which the I-max controller reduces the speed.

For more information about this function, see function diagram 1690 in the List Manual.

8.7.5 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 electric power flows back into the converter and causes V_{DC} in the converter to increase.

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

Protecting the motor and converter against overvoltage

The V_{DCmax} controller prevents – as far as the application permits – the DC link voltage from reaching critical levels. The V_{DCmax} controller increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the converter as is covered by the losses in the converter.

The V_{DCmax} controller is not suitable for applications in which the motor is permanently in the regenerative mode, e.g. in hoisting gear or when large flywheel masses are braked. Further information on converter braking methods can be found in Section Braking functions of the inverter (Page 190).

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

Table 8- 39 V_{DCmax} controller parameters

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**V_{DC} controller or V_{DC} monitoring configuration**(factory setting: 1)1: Enable V_{DCmax} controller
r1282	r1242	**V_{DCmax} controller switch-on level** Shows the value of the DC-link voltage above which the V_{DCmax} controller is active
p1283	p1243	**V_{DCmax} controller dynamic factor** (factory setting: 100 %) scaling of the control parameters P1290, P1291 and P1292
p1290	p1250	**V_{DCmax} controller proportional gain** (factory setting: 1)
p1291	p1251	**V_{DCmax} controller reset time** (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1292	p1252	**V_{DCmax} controller rate time** (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
p1294	p1254	**V_{DCmax}-controller automatic recording ON-signal level**(factory setting p1294: 0, factory setting p1254: 1)Activates or deactivates automatic detection of the switch-on levels of the V_{DCmax}controller. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the intervention thresholds of the V_{DCmax} controller. Set this parameter to the actual value of the input voltage.

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

8.8 Status messages

8.8.1 Overview, evaluating the inverter state

Information about the inverter state (alarms, faults, actual values) can be output via inputs and outputs and also via the communication interface.

Details on evaluating the inverter state via inputs and outputs are provided in Section Adapt terminal strip (Page 81).

The evaluation of the inverter state via the communication interface is realized using the inverter status word. Details on this are provided in the individual sections of Chapter Configuring the fieldbus (Page 93).

8.8.2 System runtime

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

Principle of operation

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

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

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

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

Using system runtime, you can track the sequence of faults and alarms over time. When a corresponding message is triggered, parameter values r2114 are transferred unchanged to the corresponding parameters of the alarm or fault buffer, see chapter entitled Alarms, faults and system messages (Page 275).

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

You cannot reset the system runtime.

8.9 Application-specific functions

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

- Unit changeover
- Braking functions
- Automatic restart and flying restart
- Basic process control functions
- Logical and arithmetic functions using function blocks that can be freely interconnected

Please refer to the following sections for detailed descriptions.

8.9.1 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 186) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 187)
- Changing over process variables for the technology controller (Page 188)

NOTICE
The motor standard, the unit system as well as the process variables can only be changed offline. The procedure is described in Section Changing of the units with STARTER (Page 188).

Note

Restrictions for the unit changeover function

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

Reference variables for unit changeover

p2000 Reference frequency/speed

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

p2005 Reference angle

p2007 Reference acceleration

8.9.1.1 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- 40 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

8.9.1.2 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. In order to perform internal calculations and output values that are changed back over to physical variables, however, an important factor is whether the changeover process relates 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".

8.9.1.3 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.

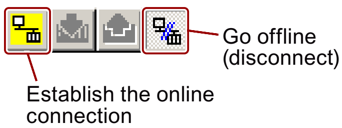
The parameters affected by changing over units of the technology controller belong to unit group 9_1. For details, please refer to the section titled "Unit group and unit choice" in the List Manual.

8.9.1.4 Changing of the units with STARTER

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

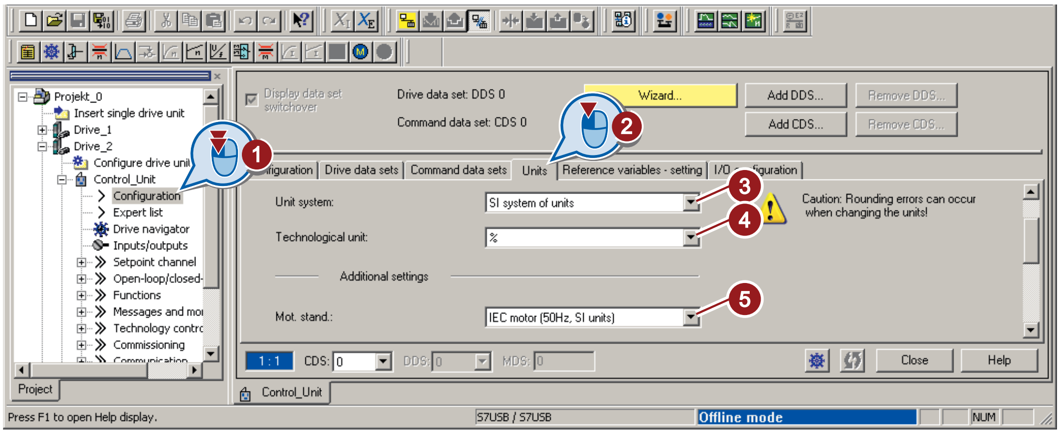
STARTER shows whether you change settings online in the converter or change offline in the PC (Online mode / Offline mode).

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



Procedure

- Go to the "Units" tab in the configuration screen form to change over the units.



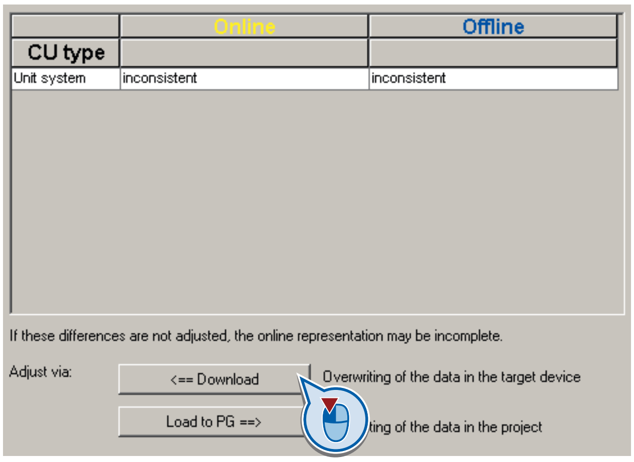
③ Changing over the unit system

④ Selecting process variables of the technology controller

⑤ adapting to the line supply

Figure 8-22 Unit changeover

- Save your settings and go online. In this case, the converter detects that other units or process variables have been set offline than are actually in the converter; the converter displays this in the following screen form:
- Accept these settings in the converter.



8.9.2 Braking functions of the inverter

A differentiation is made between mechanically braking and electrically braking a motor:

- Mechanical brakes are generally motor holding brakes that are closed when the motor is at a standstill. Mechanical operating brakes, that are closed while the motor is rotating are subject to a high wear and are therefore often only used as an emergency brake.
  If your motor is equipped with a motor holding brake, then you should use the inverter functions to control this motor holding brake, see Section Motor holding brake (Page 202).
- The motor is electrically braked by the inverter. An electrical braking is completely wear-free. Generally, a motor is switched off at standstill in order to save energy and so that the motor temperature is not unnecessarily increased.

8.9.2.1 Comparison of electrical braking methods

Regenerative power

If an induction motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it operates as a generator. The motor converts mechanical power into electrical power. Examples of applications, in which regenerative operation briefly occurs, include:

- Grinding disk drives
- Fans

For certain drive applications, the motor can operate in the regenerative mode for longer periods of time, e.g.:

- Centrifuges
- Hoisting gear and cranes
- Conveyor belts with downward movement of load (vertical or inclined conveyors)

Depending on the Power Module used, the converter offers the following options to convert the regenerative power of the motor into heat or to feed it back into the line:

- DC braking (Page 193)
  For Power Modules **PM230, PM240, PM250** and **PM260**
- Compound braking (Page 196)
  For Power Module **PM240**
- Dynamic braking (Page 198)
  For Power Module **PM240**
- Braking with regenerative feedback to the line (Page 201)
  For Power Modules **PM250** and **PM260**

Main features of the braking functions

DC braking

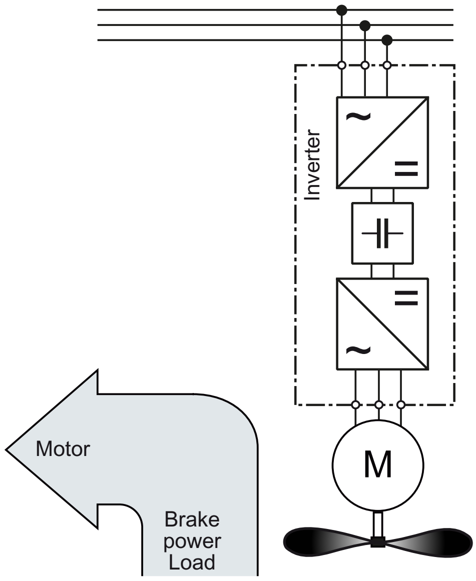
The motor converts the regenerative power into heat.

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

Compound braking

The motor converts the regenerative power into heat.

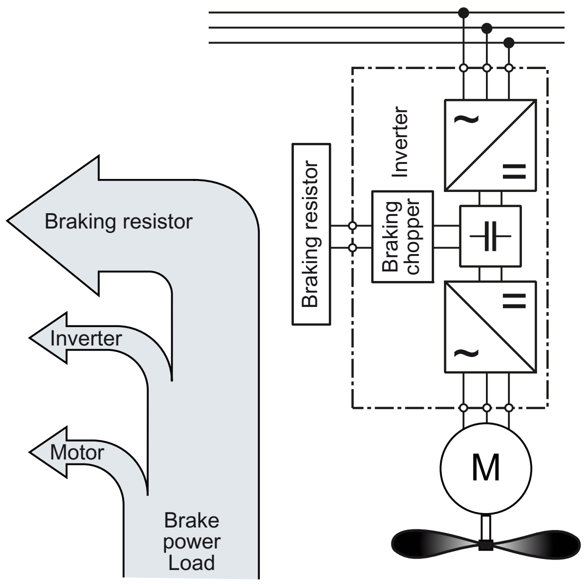
- *Advantage:* Defined braking characteristics, the motor brakes without the inverter having to convert any regenerative energy
- *Disadvantages:* significant motor temperature rise; no constant braking torque; regenerative power is dissipated as heat; does not function when the line supply fails



Dynamic braking

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

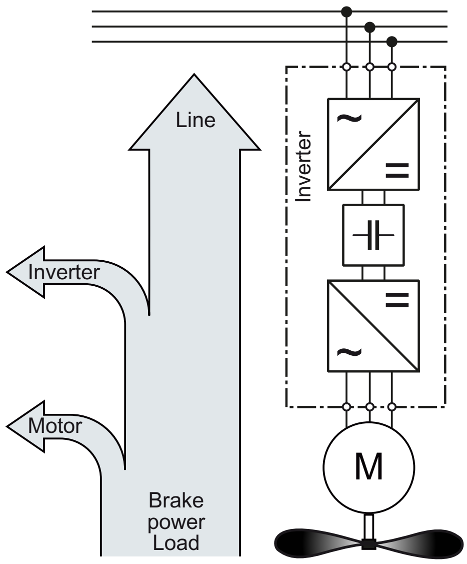
- *Advantages:* defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- *Disadvantages:* Braking resistor required; regenerative power is dissipated as heat



Braking with regenerative feedback into the line supply

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

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



Braking method depending on the application

Table 8- 41 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, PM250, PM260
Grinding machines, conveyor belts	DC braking, compound braking	PM240
Centrifuges, vertical conveyors, hoisting gear, cranes, winders	Dynamic braking	PM240
	Braking with regenerative feedback into the line supply	PM250, PM260

8.9.2.2 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

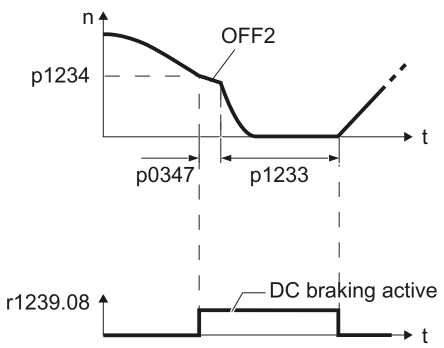
Whether DC braking or ramp-down with an OFF1 command is more effective depends on the motor properties.

Principle of operation

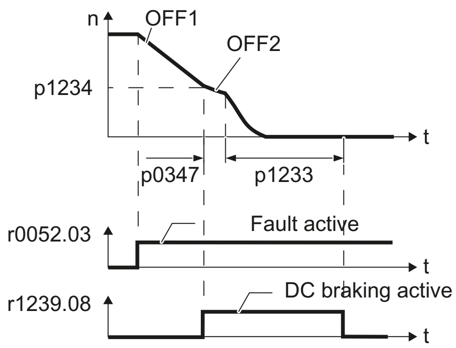
With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to demagnetize the motor - and then impresses the braking current for the duration of the DC braking.

The following operating modes are available for DC braking.

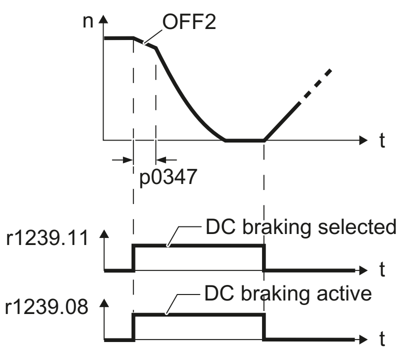
DC braking when the start speed for DC braking is fallen below
Precondition: P1230 = 1 and p1231 = 14)



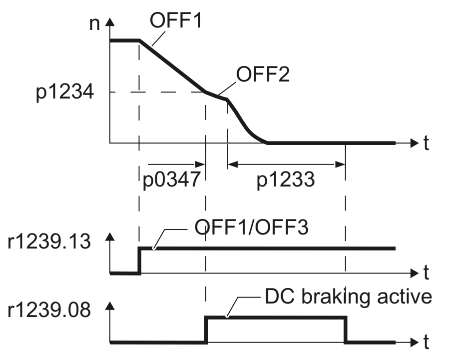
DC braking when a fault occurs
Precondition: Fault number and fault reaction assigned via p2100 and p2101



Activating DC braking independent of the speed using a control command
Precondition: p1231 = 4



DC braking when the motor is switched off
Precondition: P1231 = 5 or p1230 = 1 and p1231 = 14



DC braking when the start speed for DC braking is fallen below

DC braking is automatically activated as soon as the motor speed falls below the start speed for DC braking. However, the motor speed must have first exceeded the start speed for DC braking. Once the DC braking time is complete, the inverter switches to normal operation. If p1230 is set to 0, DC braking can also be canceled before the time defined in p1233.

DC braking when a fault occurs

If a fault occurs, where the configured response is DC braking, then the inverter first brakes the motor along the down ramp until the start speed for DC braking is reached, and then starts DC braking.

Activating DC braking independent of the speed using a control command

DC braking starts independent of the motor speed, as soon as the control command for braking (e.g. via DI3: P1230 = 722.3) is issued. If the braking command is revoked, the inverter returns to normal operation and the motor accelerates to its setpoint.

Note: The value of p1230 is displayed in r1239.11.

DC braking when the motor is switched off

If the motor is switched off with OFF1 or OFF3, the inverter first brakes the motor along the down ramp until the start speed for DC braking is reached, and then starts DC braking. The motor is then switched into a torque-free condition (OFF2).

Note

In the following operating modes, it is possible that the motor is still rotating after DC braking. This is the reason that in these operating modes "Flying restart (Page 208)" must be activated:

- DC braking when the start speed for DC braking is fallen below
- Activating DC braking independent of the speed using a control command
- DC braking when the motor is switched off

The DC braking function can only be set for induction motors.

⚠ CAUTION
DC braking converts some of the kinetic energy of the motor and load into heat in the motor (temperature rise). The motor will overheat if the braking operation lasts too long or the motor is braked too often.

DC braking parameters

Table 8- 42 Parameters for configuring DC braking

Parameter	Description
p1230	**Activate DC braking (BICO parameter)** The value for this parameter (0 or 1) can be either entered directly or specified by means of an interconnection with a control command.
p1231	**Configure DC braking** • p1231 = 0, no DC braking • p1231 = 4, general enabling of DC braking • p1231 = 5, DC braking for OFF1/3, independent of p1230 • P1231 = 14, enables DC braking for the case that the motor speed falls below the start speed for DC braking.

Table 8- 43 Parameters for configuring DC braking in the event of faults

Parameter	Description
p2100	**Set fault number for fault reaction** (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 reaction setting** (factory setting: 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. The associated fault response must be assigned the same index in p2101. In the List Manual of the inverter - in the "Faults and alarms" list - possible fault responses are listed for every fault. The entry "DCBRAKE" means that for this particular fault, DC braking can be set as fault response.	

Table 8- 44 Additional parameters for setting DC braking

Parameter	Description
p1232	**DC braking braking current** (factory setting: 0 A) Setting the braking current for the DC braking.
p1233	**DC braking duration** (factory setting: 1 s)
p1234	**DC braking start speed** (factory setting: 210000 rpm) DC braking starts – assuming that it has been correspondingly parameterized (p1230/p1231) – as soon as the actual speed falls below this threshold.
p0347	**Motor de-excitation** The parameter is calculated via p0340 = 1, 3. The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.

8.9.2.3 Compound braking

Compound braking is typically used for applications in which the motor is normally operated at a constant speed and is only braked down to standstill in longer time intervals, e.g.:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

Principle of operation

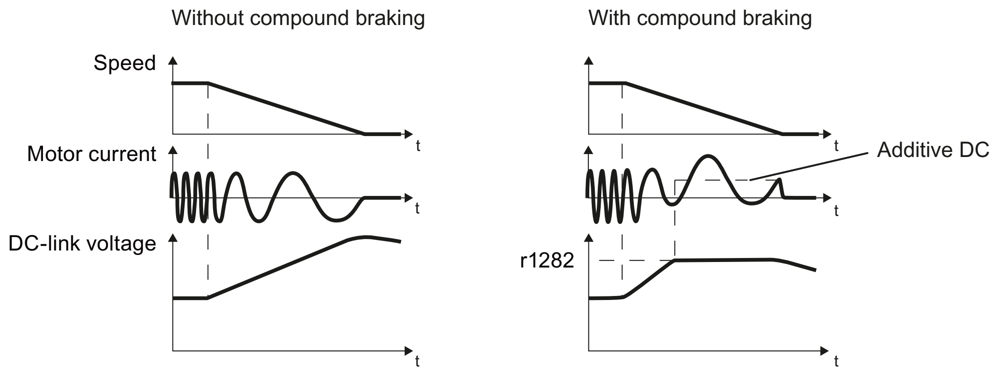


Figure 8-23 Motor brakes with and without active compound braking

Compound braking prevents the DC link voltage increasing above a critical value. The inverter activates compound braking depending on the DC link voltage. Above a DC link voltage threshold (r1282), the inverters 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 only active in conjunction with the V/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

Parameterizing compound braking

Table 8- 45 Parameters to enable and set 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 V/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	**Status word, compound braking** r3859.0 = 1: Compound braking is active

> ⚠ **CAUTION**
>
> Compound braking converts part of the kinetic energy of the motor and load into motor heat (temperature rise). The motor can overheat if braking lasts too long or the drive is braked too frequently.

8.9.2.4 Dynamic braking

Dynamic braking is typically used in applications in which dynamic motor behavior is required at different speeds or continuous direction changes, e.g.:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

Principle of 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 therefore prevents the DC link voltage increasing above the limit value $V_{DC\ link,\ max}$.

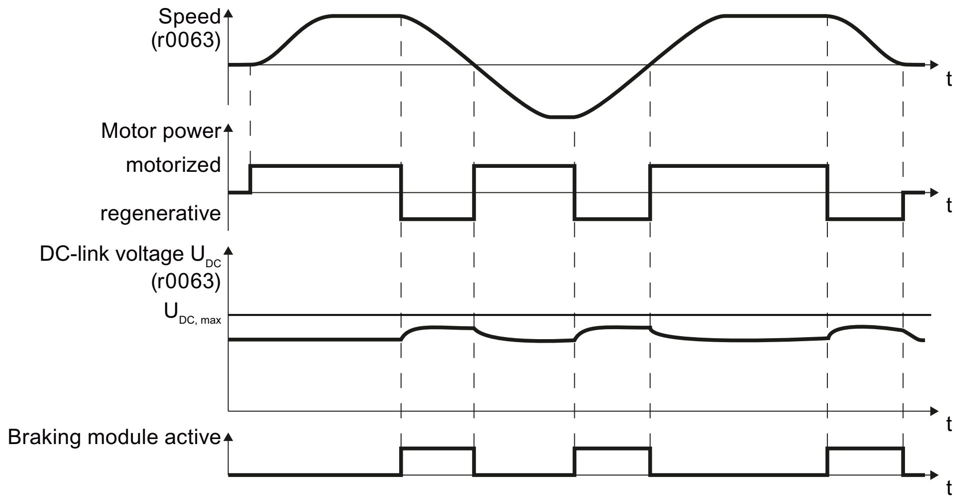


Figure 8-24 Simplified representation of dynamic braking with respect to time

Braking resistor connection

- Connect the braking resistor to terminals R1 and R2 of the Power Module
- Ground the braking resistor directly to the control cabinet's grounding bar. It is not permissible that the braking resistor is grounded via the PE terminals on the Power Module.
- If you must observe the EMC guidelines, pay special attention to the shielding.

- Evaluate the braking resistor's temperature monitoring (terminals T1 and T2) such that the motor is switched off when the resistor experiences overtemperature.
  You can do this in the following two ways:
  – Use a contactor to disconnect the converter from the line as soon as the temperature monitoring responds.
  – Connect the contact of the temperature monitoring function of the braking resistor with a free digital input of your choice on the converter. Set the function of this digital input to the OFF2 command.

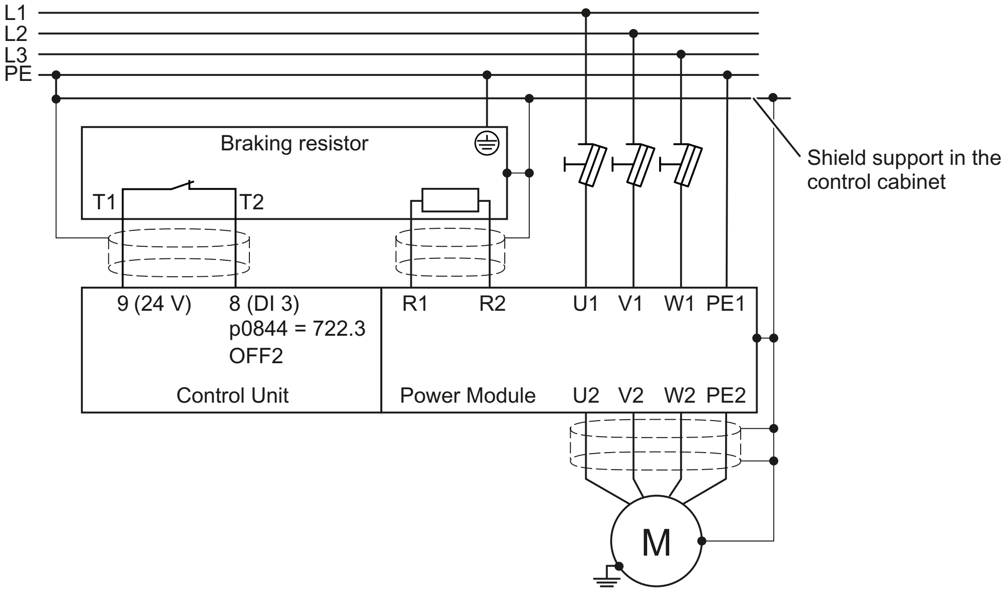


Figure 8-25 Braking resistor connection (example: Temperature monitoring via DI 3)

You will find more information about the braking resistor in the installation instructions for Power Module PM240
(http://support.automation.siemens.com/WW/view/en/30563173/133300).

⚠ WARNING
If an unsuitable braking resistor is used, this could result in a fire and severely damage the converter. The temperature of braking resistors increases during operation. For this reason, avoid coming into direct contact with braking resistors. Maintain sufficient clearances around the braking resistor and ensure that there is adequate ventilation.

Procedure: Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 8- 46 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 converter 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**	
	p0840 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the converter.

8.9.2.5 Braking with regenerative feedback to the line

Regenerative braking is typically used in applications where braking energy is generated either frequently or for longer periods of time, e.g.:

- Centrifuges
- Unwinders
- Cranes and hoisting gear

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

The inverter can feed back up to 100% of its power into the line supply (referred to "High Overload" base load, see Section Technical data, Power Modules (Page 300)).

Parameterization of braking with regenerative feedback to the line

Table 8- 47 Settings for braking with regenerative feedback to the line

Parameter	Description
Limiting the regenerative feedback for V/f control (P1300 < 20)	
p0640	**Motor overload factor** Limiting the regenerative power is not directly possible with V/f control, but can be achieved indirectly by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault message F07806.
Limiting feedback with vector control (P1300 ≥ 20)	
P1531	**Regenerative power limit** The maximum regenerative load is entered as negative value via p1531. (-0.01 … -100000.00 kW). Values higher than the rated value of the power unit (r0206) are not possible.

8.9.2.6 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.

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

A motor holding brake can also be useful in several applications for pumps or fans to ensure that the powered-down motor does not rotate in the wrong direction through a liquid or air flow.

Connecting a Brake Relay and a motor holding brake

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

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

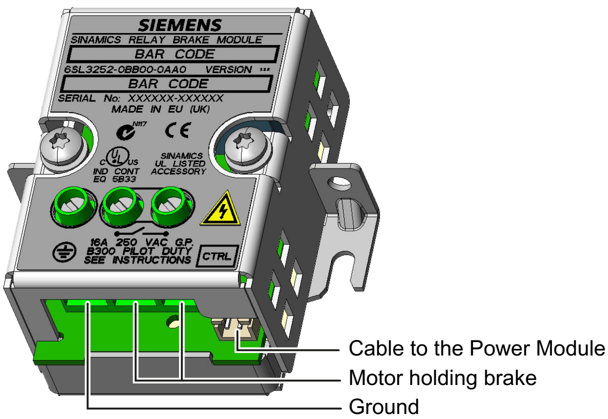
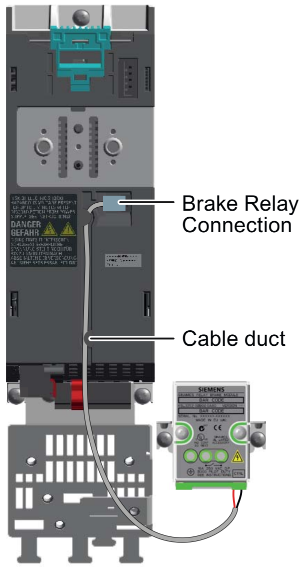
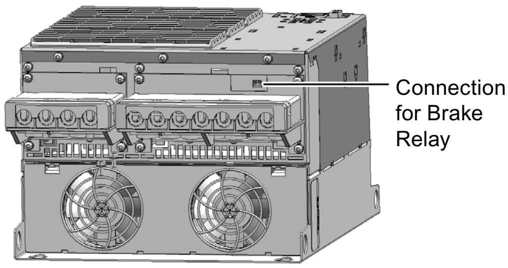


Figure 8-26 Brake Relay connections

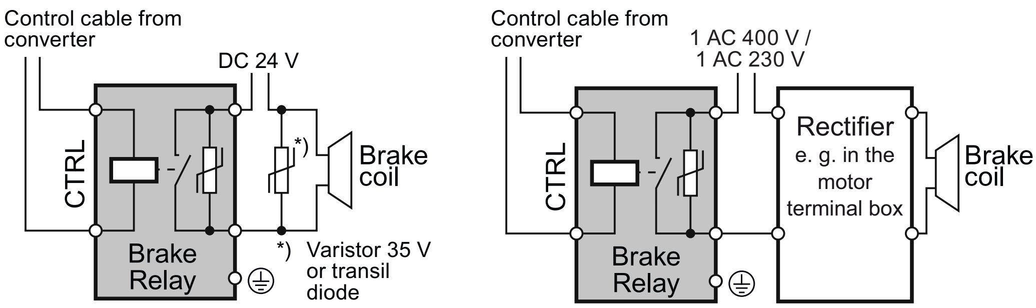
- Connect the Brake Relay to the Power Module using the cable form provided.
- Power Modules FSA … FSC:
  - Connect the Brake Relay at the connector on the front of the Power Module.
  - Route the control cable in the guide on the Power Module.



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



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



24 V brake connection

440V brake connection

Principle of operation after OFF1 and OFF3 command

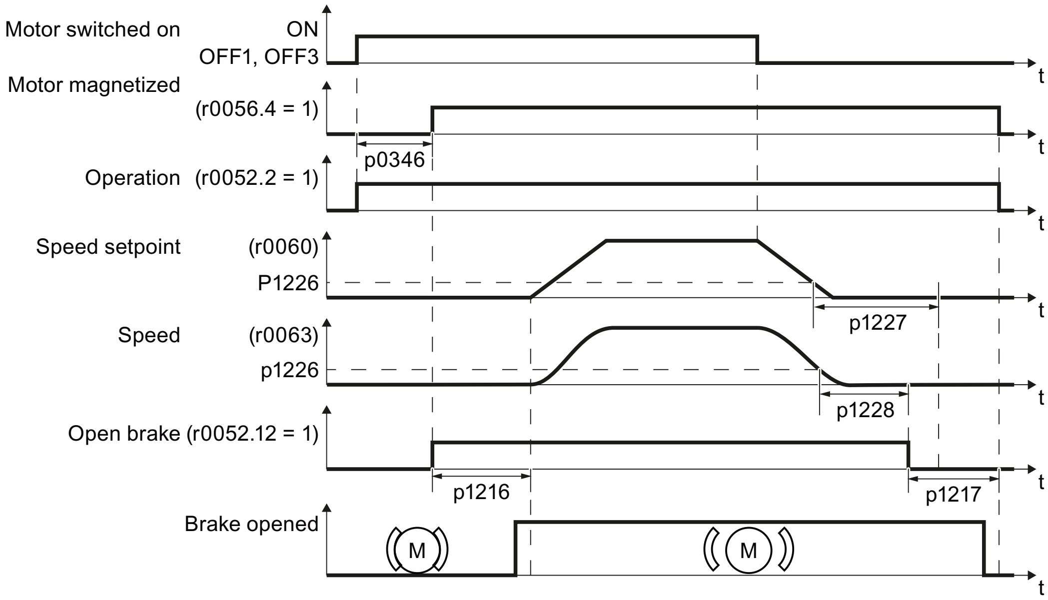


Figure 8-27 Controlling the motor holding brake when the motor is switched on and off

The motor brake is controlled as shown in the following diagram:

1. After the ON command (switch on motor), the inverter magnetizes the motor. At the end of the magnetizing time (p0346), the inverter issues the command to open the brake.
2. The motor remains at a standstill until the end of the brake opening time p1216. The motor holding brake must open within this time.
3. At the end of the brake opening time the motor accelerates to its speed setpoint.
4. After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
5. If the speed setpoint and the current speed fall below threshold p1226, the monitoring time p1227 or p1228 is started.
6. As soon as the first of the two monitoring 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.
7. At the end of the brake closing time p1217, the motor is switched off.
   The motor holding brake must close within this time.

Principle of operation after OFF2 or STO command

For the following signals, the brake closing time is not taken into account:

- OFF2 command
- For fail-safe applications, in addition, after "Safe Torque Off" (STO)

After these control commands, the signal to close the motor holding brake is immediately output independent of the motor speed. The inverter does not monitor the motor speed until the brake closes.

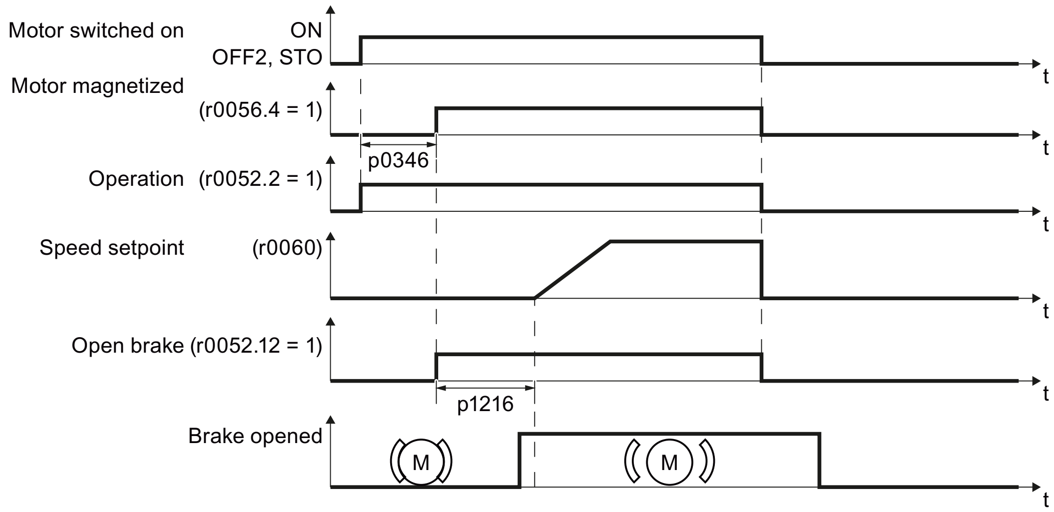


Figure 8-28 Controlling the motor holding brake after an OFF2 command or STO

Commissioning

> ⚠ WARNING
>
> The following applications require special settings of the motor holding brake. In these cases, the motor holding brake control may only be commissioned by experienced personnel:
>
> - All applications that involve moving and transporting people
> - Hoisting gear
> - Elevators
> - Cranes

- Before commissioning, secure any dangerous loads (e.g. loads on inclined conveyors)
- Suppress the motor holding brake control, e.g. by disconnecting the control cables
- When opening the motor holding brake, ensure that a torque is established that prevents the load from briefly dropping.
  - Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero
  - V/f control (p1300 = 0 to 3):
    Set the boost parameters p1310 and p1311.
    Define the motor torque when switching on using p1351 and p1352.
  - Vector control (p1300 ≥ 20):
    Define the motor torque when switching on using p1475.
- Assigning parameters for the opening and closing times of the motor holding brake.
  It is extremely important that electromechanical brakes are controlled with the correct timing in order to protect the brakes against long-term damage. The exact values can be found in the technical data of the connected brake. Typical values:
  - 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.
- Reestablish the control of the motor holding brake.
  r0052.12 ("Motor holding brake open") controls the brake.

Table 8- 48 Control logic parameters 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- 49 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 of motor holding brake** (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.
p1352	**Starting frequency for motor holding brake** (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	**Speed controller torque set value for motor holding brake** (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

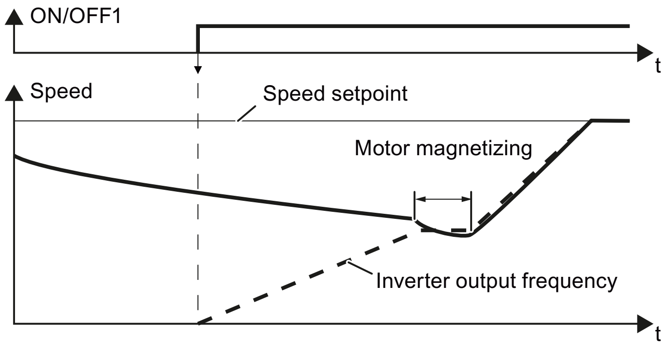
8.9.3 Automatic restart and flying restart

8.9.3.1 Flying restart – switching on while the motor is running

If you switch on the motor while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (overcurrent fault F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

- The motor rotates after a brief line interruption.
- A flow of air 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 inverter output frequency to the motor speed and then accelerates the motor up to the setpoint.



Principle of operation of the "flying restart" function

If the inverter 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- 50 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- 51 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 inverter does not find the motor, reduce the search speed (increase p1203).

8.9.3.2 Automatic switch-on

The automatic restart includes two different functions:

1. The inverter automatically acknowledges faults.
2. After a fault occurs or after a power failure, the inverter automatically switches-on the motor again.

This automatic restart function is primarily used in applications where the motor is controlled locally via the inverter's inputs. In applications with a connection to a fieldbus, the central control should evaluate the feedback signals of the drives, specifically acknowledge faults or switch-on the motor.

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**
>
> When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. This is especially critical after longer power failures.
>
> Reduce the risk of accidents in your machine or system to an acceptable level by applying suitable measures, e.g. protective doors or covers.

Commissioning the automatic restart

- 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 208).
- Using p1210, select the automatic restart mode that best suits your application.

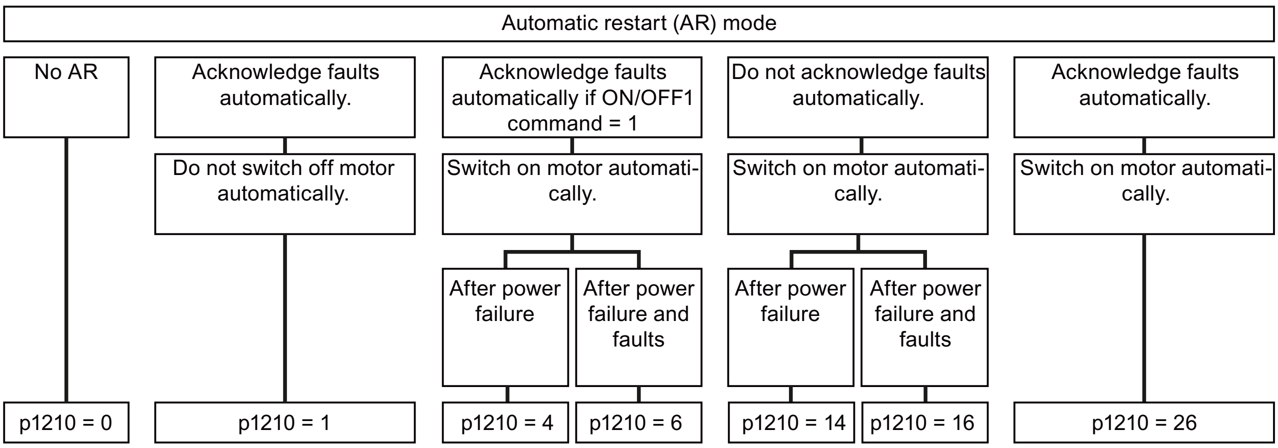
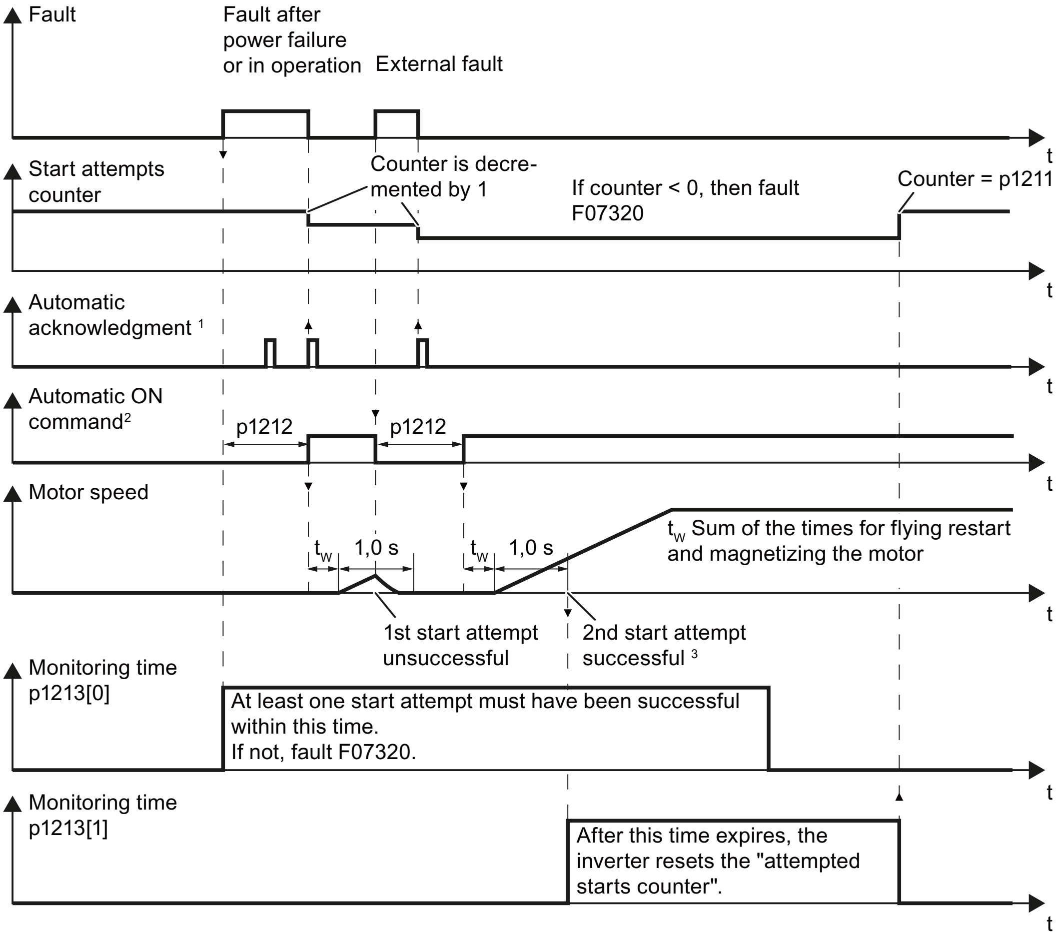


Figure 8-29 Selecting the automatic restart mode

- Set the parameters of the automatic restart function.
  The method of operation of the parameters is explained in the following diagram and in the table.



[1] The inverter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: always.
- p1210 = 4 or 6: If the command to switch on the motor is available at a digital input or via the fieldbus (ON/OFF1 command = HIGH).
- p1210 = 14 or 16: never.

[2] The inverter attempts to automatically switch-on the motor under the following conditions:

- p1210 = 1: never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch on the motor is available at a digital input or via the fieldbus (ON/OFF1 command = HIGH).

[3] The start attempt is successful if flying restart has been completed and the motor has been magnetized (r0056.4 = 1) and one additional second has expired without a new fault having occurred.

Figure 8-30 Time response of the automatic restart

Table 8- 52 Setting the automatic restart

<table>
<tr><th>Parameter</th><th colspan="2">Explanation</th></tr>
<tr><td rowspan="2">p1210</td><td colspan="2">Automatic restart mode (factory setting: 0)</td></tr>
<tr><td>0:
1:
4:
6:
14:
16:
26:</td><td>Disable automatic restart
Acknowledge all faults without restarting
Restart after power failure without further restart attempts
Restart after fault with further restart attempts
Restart after power failure after manual fault acknowledgement
Restart after fault after manual fault acknowledgement
Acknowledgement of all faults and restart with ON command</td></tr>
<tr><td>p1211</td><td colspan="2">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 fault 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, withdraw the ON command and acknowledge the fault.
• You change the start value p1211 or the mode p1210.</td></tr>
<tr><td>p1212</td><td colspan="2">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.</td></tr>
</table>

Parameter	Explanation
p1213[0]	**Automatic restart monitoring time for restart** (factory setting: 60 s) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. With this monitoring function, you limit the time in which the inverter may attempt to automatically switch-on the motor again. The monitoring function starts when a fault is identified and ends with a successful start attempt. If the motor has not successfully started after the monitoring time has expired, fault F07320 is signaled. Set the monitoring time longer than the sum of the following times: + P1212 + time that the inverter requires to start the motor on the fly. + Motor magnetizing time (p0346) + 1 second You deactivate the monitoring function with p1213 = 0.
p1213[1]	**Automatic restart monitoring time to reset the fault counter** (factory setting: 0 s) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time. The monitoring function starts with a successful start attempt and ends after the monitoring time has expired. If the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch on the motor again, you must acknowledge the fault and issue a new ON command.

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

In the case of communication via the field bus interface, the motor restarts with the setting p1210 = 6 even if the communication link is interrupted. This means that the motor cannot be stopped via the open-loop control. To avoid this dangerous situation, you must enter the fault code of the communications error 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).

8.9.4 PID technology controller

8.9.4.1 Overview

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

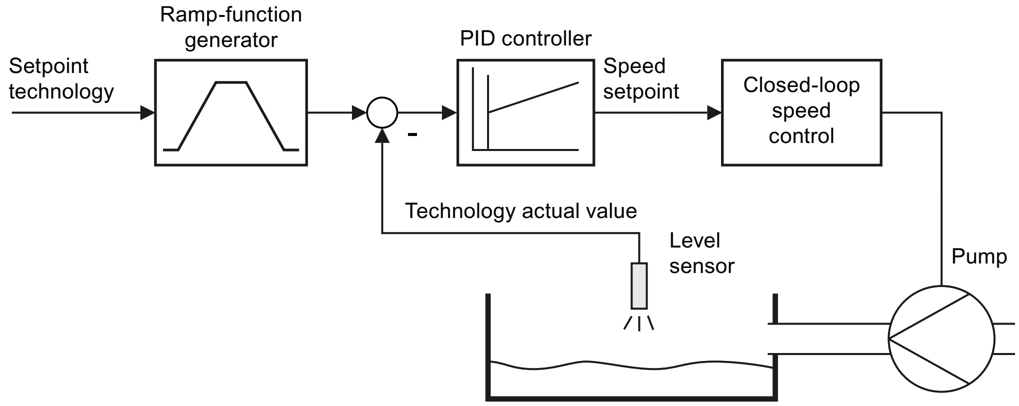


Figure 8-31 Example: technology controller as a level controller

8.9.4.2 Setting the controller

Simplified representation of the technology controller

The technology controller is designed as a PID controller, which makes it highly flexible.

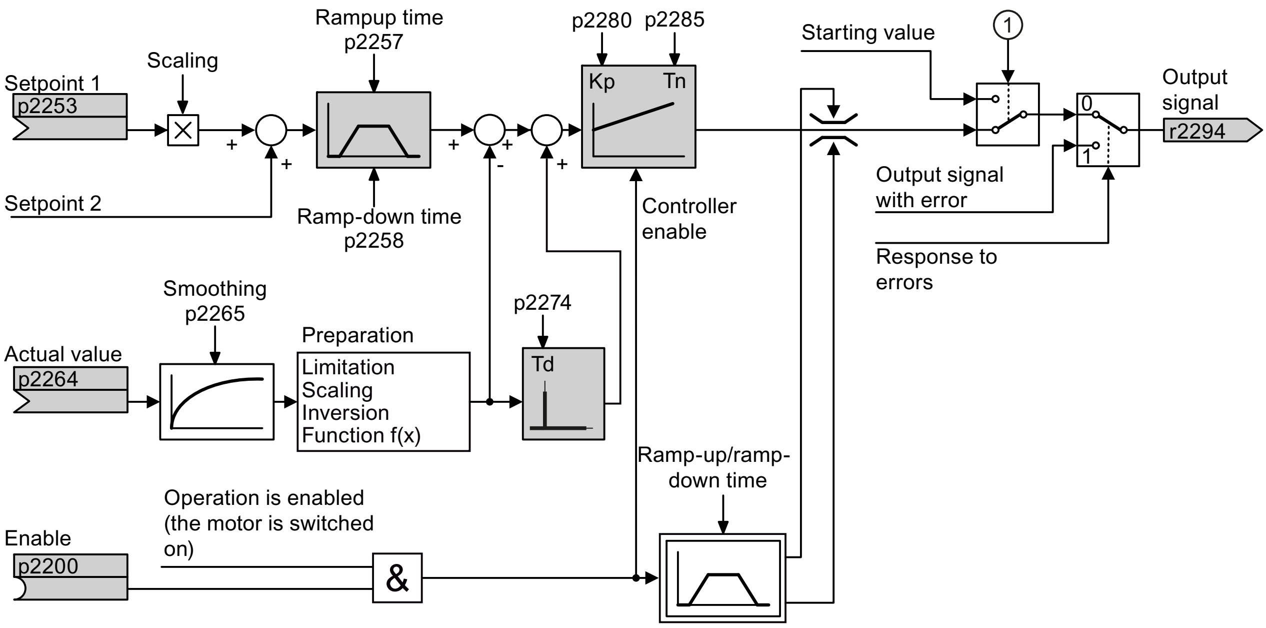


Figure 8-32 Simplified representation of the technology controller

Table 8- 53 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 actual value for the technology controller. Example: For p2264 = 755[0], analog input 0 is the source for the actual value.
p2257, p2258	Define the ramp-up and ramp-down times [s]
p2274	Differentiation time constant [s] The differentiation improves the rise time characteristics for very slow controlled variables, e.g. a temperature control. p2274 = 0: The differentiation is switched off.
p2280	Proportional gain K_P
p2285	Integral time T_N [s] Without an integral time, the controller cannot completely equalize deviations between the setpoint and actual value. p2285 = 0: The integral time is switched off.

Advanced settings

Table 8- 54 Settings

Parameter	Remark
Limiting the output of the technology controller In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application. Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.	
p2297 = 2291	Interconnect the upper limit with p2291.
p2298 = 2292	Interconnect the lower limit with p2292.
p2291	Upper limit for the technology controller output e.g.: p2291 =100
p2292	Lower limit for the technology controller output e.g.: p2292 = 0
Manipulating the actual value of the technology controller	
p2267, p2268	Limit the actual value
p2269	Scale the actual value
p2271	Invert the actual value
p2270	Actual value

You can find additional information in function block diagram 7958 of the List Manual.

8.9.4.3 Optimizing the controller

Setting PID controllers from a practical perspective

- Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
- Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
  The slower the process to be controlled response, 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.

Table 8- 55 Optimum control response

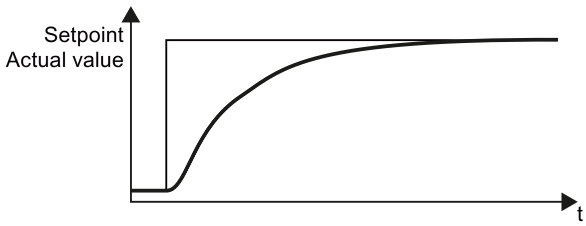
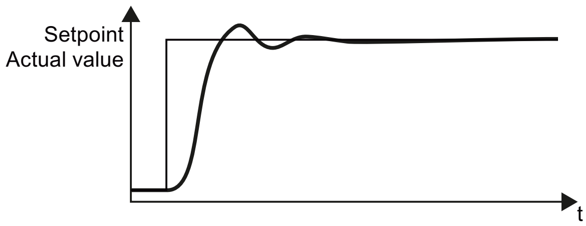
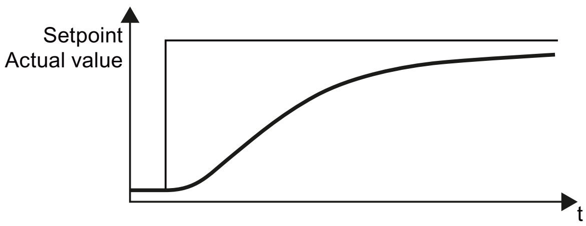
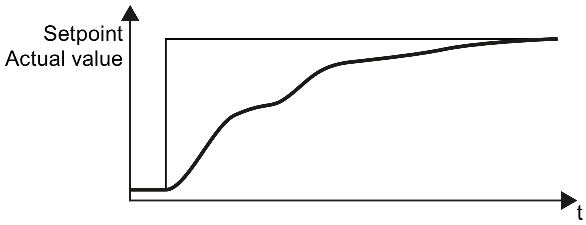
	**Optimum controller response for applications that do not permit any overshoot.** The actual value approaches the setpoint, without any significant overshoot.
	**Optimum controller behavior for fast correction and quick compensation of noise components.** The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).

Table 8- 56 Optimizing the control response



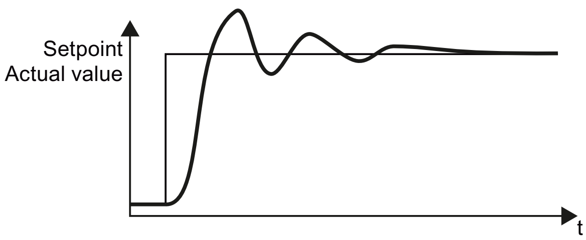
The actual value only slowly approaches the setpoint.

- 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.

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

8.9.5 Load torque monitoring (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 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 converter monitors the torque of the motor in different ways:

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

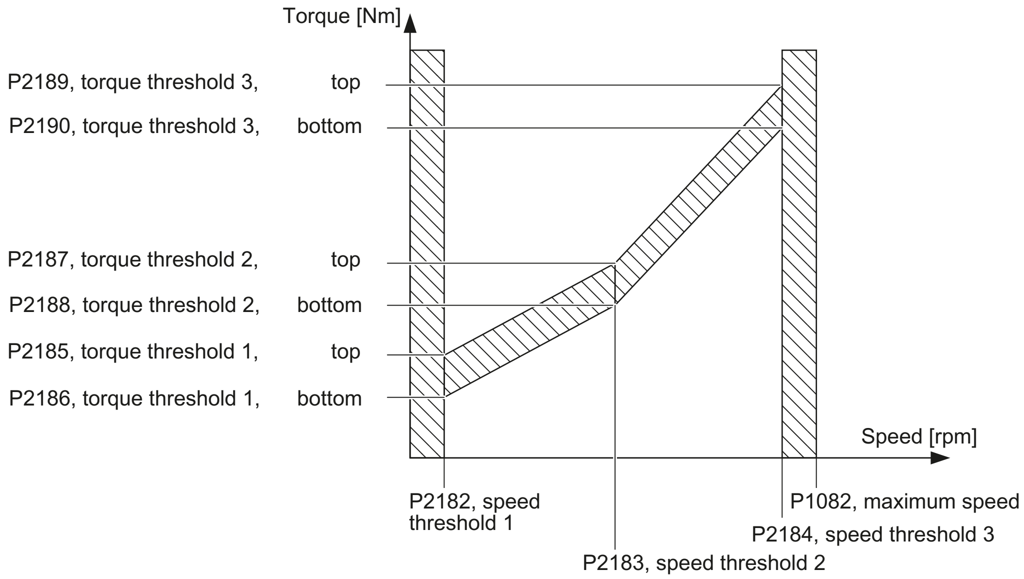


Table 8- 57 Parameterizing the monitoring functions

Parameter	Description
No-load monitoring	
P2179	**Current limit for no-load detection** If the converter 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"

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

8.9.6 Speed and load failure via digital input

With this function you can directly monitor not only the motor speed but also the speed of the driven load. Examples include:

- Gearbox monitoring, e.g. in traction drives or hoisting gear
- Drive belt monitoring, e.g. in fans or conveyor belts
- Monitoring for blocked driven load

Speed or velocity monitoring functions

There are two ways of directly monitoring speed in your application:

1. Load failure monitoring: The inverter evaluates whether the sensor signal is present.
2. Speed deviation monitoring: The inverter calculates a speed from the signal of the connected sensor and compares it with the internal motor control signal.

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

Load failure monitoring

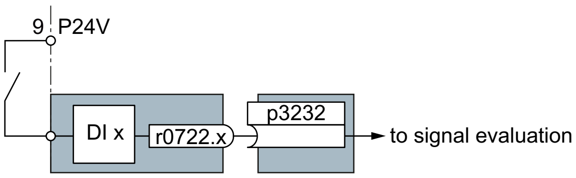


Figure 8-33 Load failure monitoring by means of a digital input

Table 8- 58 Setting load failure monitoring

Parameter	Description
p2193 = 1 to 3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring is disabled 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring
p2192	**Load monitoring delay time** (factory setting 10 s) If, after the motor is switched on, the "LOW" signal is present on the associated digital input for longer than this time, a load failure is assumed (F07936)
p3232 = 722.x	**Load monitoring failure detection** (factory setting: 1) Interconnect the load monitoring with a digital input of your choice.

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

Speed deviation monitoring

This function is only available for Control Units CU240E-2, CU240E-2 DP, CU240E-2 F and CU240E-2 DP-F. The monitoring sensor is connected to digital input 3.

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

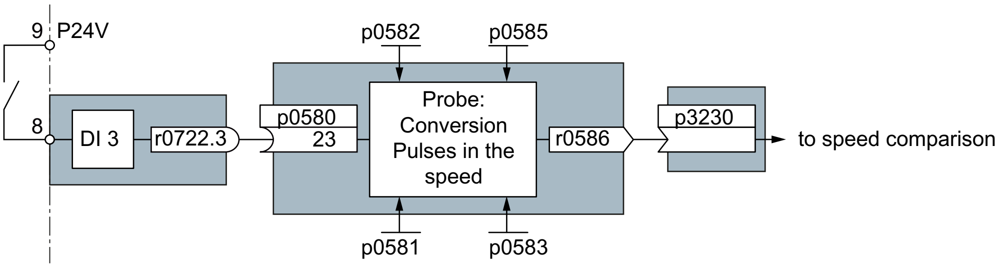


Figure 8-34 Speed deviation monitoring by means of digital input DI3

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

The calculated speed is compared with the actual speed value from the motor control and, if an (adjustable) deviation is detected, a response (also adjustable) is triggered.

Table 8- 59 Setting speed deviation monitoring

Parameter	Description
P2193 = 2	**Load monitoring configuration** (factory setting: 1) 2: Speed and load failure monitoring.
P2192	**Load monitoring delay time** (factory setting 10 s) Setting of the delay time for evaluating load monitoring.
P2181	**Load monitoring response** (factory setting 0) Setting of the response for evaluating load monitoring.
P3231	**Load monitoring speed deviation** (factory setting 150 rpm) Permissible speed deviation of load monitoring.
P0580 = 23	**Probe input terminal** (factory setting 0) Interconnection of speed calculation with DI 3.
P0581	**Probe edge** (factory setting 0) Setting the edge for evaluation of the probe signal to measure actual speed value 0: 0/1 edge 1: 1/0 edge
P0582	**Probe pulses per revolution** (factory setting 1) Setting of the number of pulses per revolution.
P0583	**Maximum probe measuring time** (factory setting 10 s) Setting the maximum measuring time for the probe. If there is no new pulse before the maximum measuring time elapses, the actual speed value in r0586 is set to zero. With the next pulse, the time is restarted.
P0585	**Probe gear factor** (factory setting 1) The inverter multiplies the measured speed by the gear factor and then displays it in r0586.

Parameter	Description
P0490	**Invert probe** (factory setting 0000bin) The 3rd bit of the parameter value inverts the input signals of digital input 3 for the probe.
p3230 = 586	**Load monitoring actual speed value** (factory setting 0) Interconnection of the speed calculation result with speed monitoring evaluation.

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

8.9.7 Logical and arithmetic functions using function blocks

Additional signal interconnections in the converter can be established by means of free function blocks. Every digital and analog signal available via BICO technology can be routed to the appropriate inputs of the free function blocks. The outputs of the free function blocks are also interconnected to other functions using BICO technology.

Among others, the following free function blocks are available:

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

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

Activating the free blocks

None of the free function blocks in the converter are used in the factory setting. In order to be able to use a free function block, you must perform the following steps:

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

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

Table 8- 60 Runtime groups and possible assignments of the free function blocks

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

✓: The block can be assigned to the runtime group
-: The block cannot be assigned to this runtime group

Analog signal scaling

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

As soon as you have interconnected the scaled output signal of a free function block to functions, which require physical input quantities - e.g. the signal source of the upper torque limit (p1522) - then the signal is automatically converted into the physical quantity.

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

• Speeds	P2000	Reference speed	(≙100 %)
• Voltage values	P2001	Reference voltage	(≙100 %)
• Current values	P2002	Reference current	(≙100 %)
• Torque values	P2003	Reference torque	(≙100 %)
• Power values	P2004	Reference power	(≙100 %)
• Angle	P2005	Reference angle	(≙100 %)
• Acceleration	P2007	Reference acceleration	(≙100 %)
• Temperature	100 °C ≙ 100 %		

Scaling examples

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

Note

Limits within the function blocks should be entered as scaled values. The scaled value can be calculated as follows using the reference parameter: Scaled limit value = physical limit value / value of the reference parameter.

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

Example: Logic combination of two digital inputs

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

1. Activate a free OR block by assigning it to a runtime group, and define the run sequence.
2. Interconnect the status signals of the two digital inputs DI 0 and DI 1 via BICO to the two inputs of the OR block.
3. Finally, interconnect the OR block output with the internal ON command (P0840).

Table 8- 61 Parameters for using the free function blocks

Parameter	Description
P20048 = 1	**Assignment of block OR 0 to runtime group 1** (factory setting: 9999) The block OR 0 is calculated in the time slice with 8 ms
P20049 = 60	Definition of run sequence within runtime group 1 (factory setting: 60) Within one runtime group, the block with the smallest value is calculated first.
P20046 [0] = 722.0	**Interconnection of first OR 0 input (factory setting: 0)** The first OR 0 input is linked to digital input 0 (r0722.0)
P20046 [1] = 722.1	**Interconnection of second OR 0 input (factory setting: 0)** The second OR 0 input is linked to digital input 1 (r0722.1)
P0840 = 20047	**Interconnection of OR 0 output (factory setting: 0)** The OR 0 output (r20047) is connected with the motor's ON command

Example: AND operation

An example of an AND logic operation, explained in detail, including the use of a time block is provided in the BICO technology: example (Page 328)chapter.

You can find additional information in the following manuals:

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

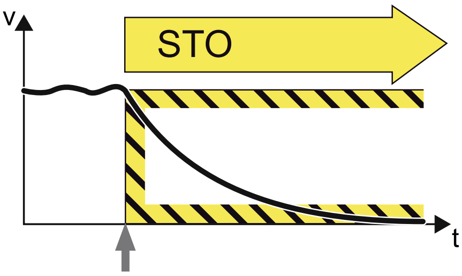
8.10 Safe Torque Off (STO) safety function

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

You will find a detailed description of all safety functions and control using PROFIsafe in the Safety Integrated Function Manual, see Section Additional information on the inverter (Page 352).

8.10.1 Function description

Definition according to EN 61800-5-2:
"The STO function prevents energy from being supplied to the motor, which can generate a torque."



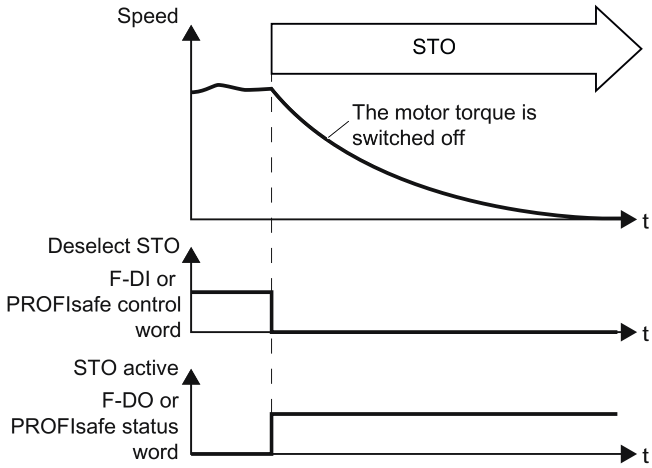
Examples of how the function can be used

Example	Solution option
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	• Wire the Emergency Stop button with a fail-safe input. • Select STO via the fail-safe input.
A central Emergency Stop button ensures that several drives cannot unintentionally start.	• Evaluating an Emergency Stop pushbutton in a central control. • Select STO via PROFIsafe.

How does STO function in detail?

The converter recognizes the selection ofSTO via a fail-safe input or via the safe communicationPROFIsafe.

The converter then safely switches off the torque of the connected motor.



If no motor holding brake is present, the motor coasts to a standstill.

If you use a motor holding brake, the converter closes the brake immediately after selecting STO.

8.10.2 Prerequisite for STO use

In order to use the STO safety function, your machine should have already performed a risk assessment (e.g. in compliance with EN ISO 1050, "Safety of machinery - Risk assessment - Part 1: Principles"). The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

8.10.3 Commissioning STO

8.10.3.1 Commissioning tool

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

If you use STARTER for commissioning, then you set the functions using the graphic screen forms and you do not have to work with parameters. In this case, you can ignore the parameter tables in the following sections.

Table 8- 62 STARTER commissioning tool (PC software)

Download	Order number
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	6SL3255-0AA00-2CA0 PC Connection Kit, includes STARTER DVD and USB cable

8.10.3.2 Password

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

Note

If you want to change the parameters of the safety functions, but do not know the password, please contact customer support.

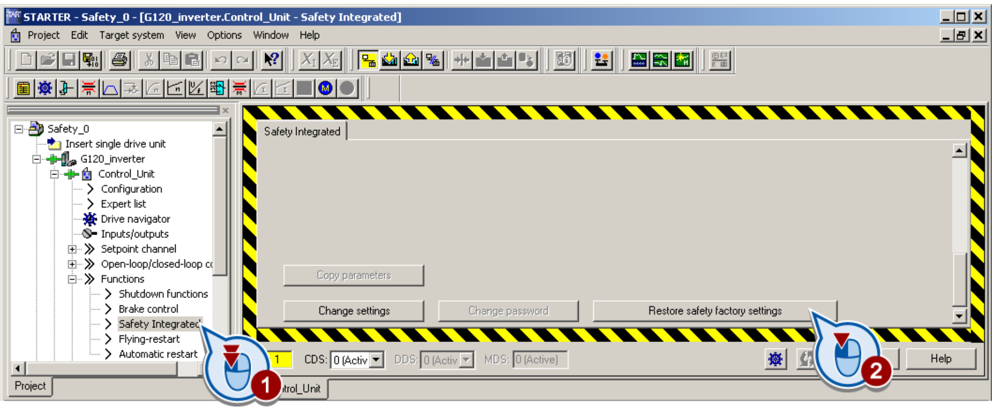
Table 8- 63 Parameter

Parameter	Description
p9761	**Entering a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.
p9762	**New password**
p9763	**Confirm password**

8.10.3.3 Resetting the safety function parameters to the factory setting

Proceed as follows if you wish to reset the safety function parameters to the factory setting, without influencing the standard parameters:

- Go online with STARTER .
- ① Open the screen form of the safety functions.



- ② Select the button to restore the factory settings.
- Enter the password,for the safety functions.
- Confirm saving parameters (RAM to ROM).
- Go offline with STARTER .
- Switch off the converter supply voltage.
- Wait until all of the LED on the converter go dark. Now switch on the converter power supply again (power on reset).

Table 8- 64 Parameter

Parameter	Description	
p0010	**Drive, commissioning parameter filter**	
	0	Ready
	95	Safety Integrated commissioning
p0970	**Reset drive parameters**	
	0	Inactive
	5	Starts a safety parameter reset. After the reset, the converter sets p0970 = 0.

8.10.3.4 Changing settings

Procedure

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

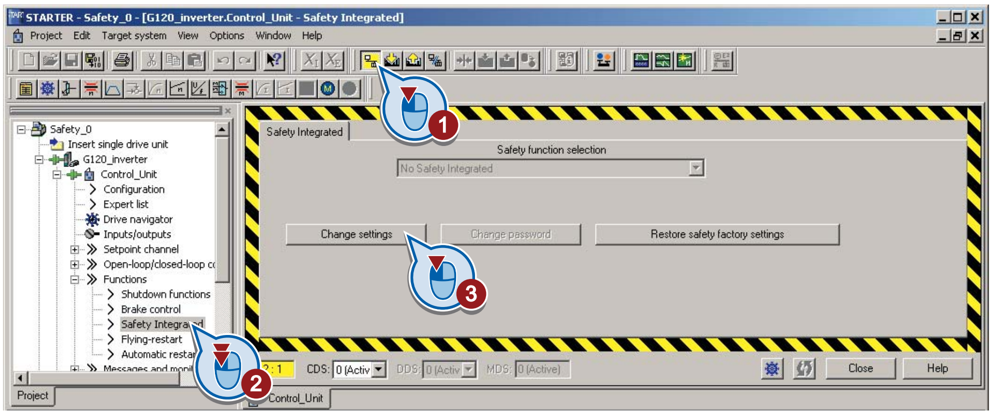


Table 8- 65 Parameter

Parameter	Description
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning

- Selecting "STO via terminal":

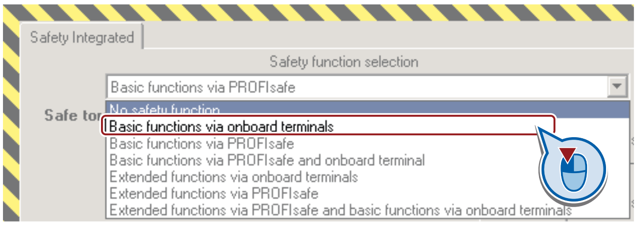


Table 8- 66 Parameter

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 the section: Additional information on the inverter (Page 352).

8.10.3.5 Interconnecting the "STO active" signal

Procedure

- If you require the status signal "STO active" in your higher-level controller, interconnect it accordingly.

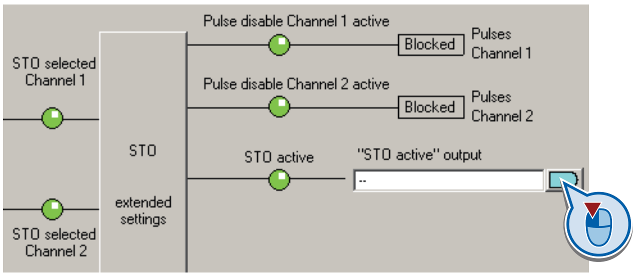


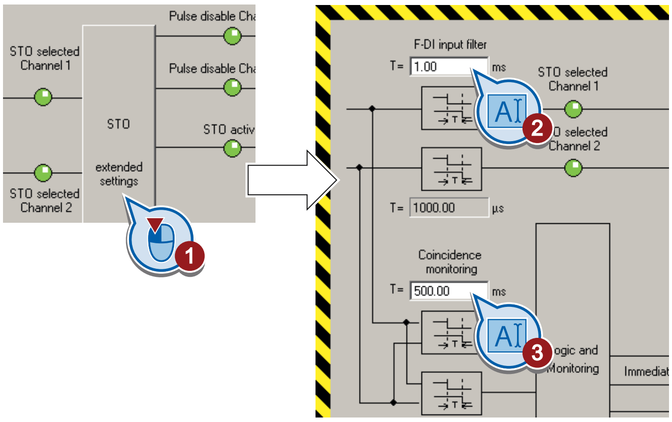
Table 8- 67 Parameter

Parameter	Description
r9773.01	**1 signal**: STO active in drive

8.10.3.6 Setting the signal filter

Procedure

- ① Select the advanced settings for STO.



- ② Set the debounce time for the F-DI input filter.
- ③ Set the discrepancy for the monitoring for simultaneous operation.
- Close the screen form.

Description

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 converter 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 converter tolerates brief discrepancies.

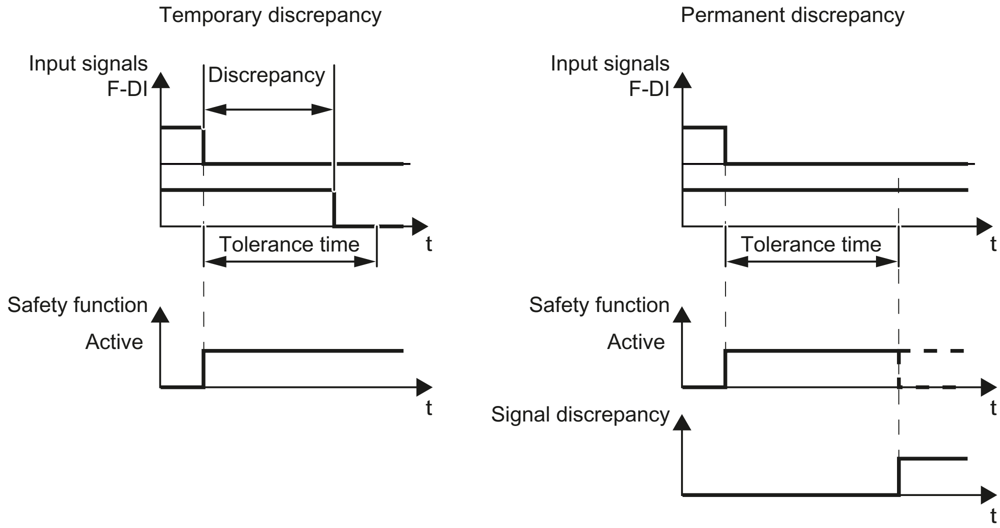


Figure 8-35 Tolerance regarding discrepancy

The tolerance time does not extend the converter response time. The converter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

Filter to suppress short signals

The converter normally responds immediately to signal changes at its fail-safe inputs. This is not required in the following cases:

1. When you interconnect a fail-safe input of the converter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the converter responds.
2. 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 converter with a fail-safe output of a control module, the converter 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 converter responds with a fault.

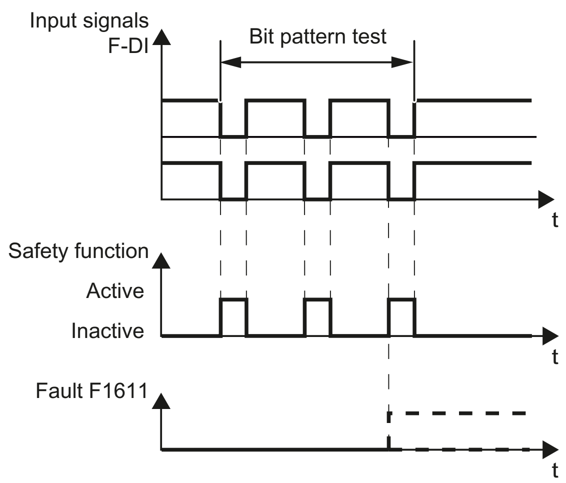


Figure 8-36 Converter response to a bit pattern test

An adjustable signal filter in the converter suppresses temporary signal changes using bit pattern test or contact bounce.

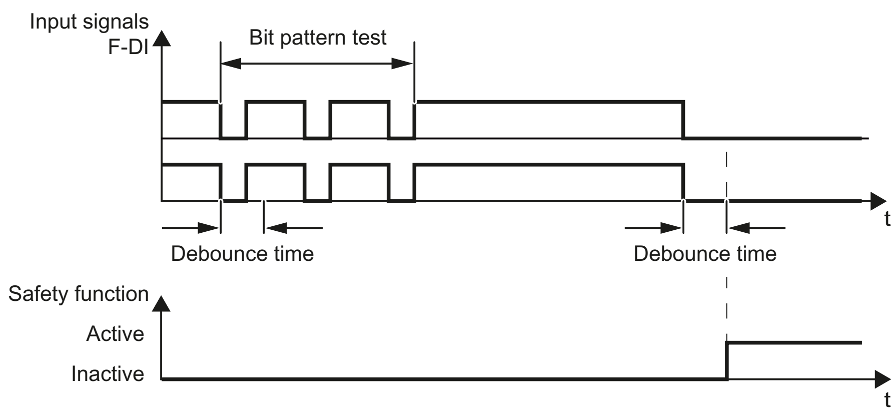


Figure 8-37 Filter for suppressing temporary signal changes

Note

The filter increases the converter response time. The converter only selects its safety function after the debounce time has elapsed.

Table 8- 68 Parameters for the filters

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to changeover 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.

Note

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.

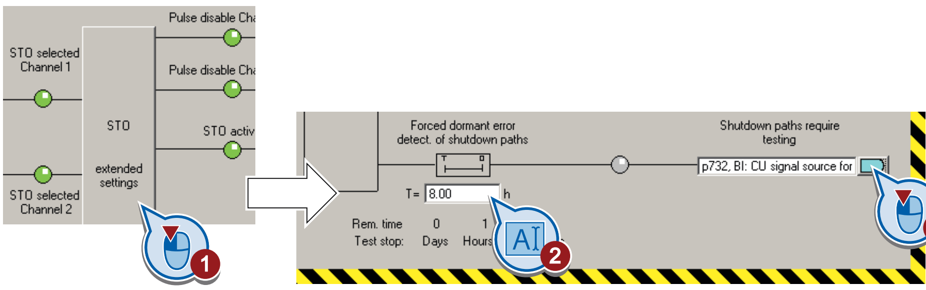
If you use an input as a standard input, set the debounce time using parameter p0724 .

If you use an input as a fail-safe input, set the debounce time as described above.

8.10.3.7 Setting forced dormant error detection

Procedure

- ① Select the advanced settings for STO.



- ② Set the monitoring time to a value to match your particular application.
- ③ Using this signal, the converter signals that a forced checking procedure is required. Interconnect this signal - for example - with a digital output of your choice.

Description

To meet the requirements of the standards ISO 13849-1 and IEC 61508 in terms of timely fault detection, the converter must test its safety-related circuits regularly - at least once a year - to ensure that they are functioning correctly.

Forced checking procedure of the basic functions

The forced checking procedure of the basic functions is the regular self-test of the converter that causes the converter to check its circuits to switch-off the torque.

The converter executes a forced checking procedure under the following circumstances:

- every time the supply voltage is connected.
- every time after the STOfunction has been selected.

The converter monitors the regular forced checking procedure.

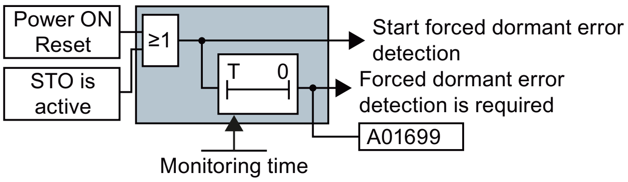


Figure 8-38 Triggering and monitoring the forced checking procedure

Table 8- 69 Parameters for the forced checking procedure

Parameter	Description
p9659	**Forced checking procedure timer** (Factory setting: 8 h) Monitoring time for the forced checking procedure.
r9660	**Forced checking procedure remaining time** Displays the remaining time until the forced checking procedure and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced checking procedure is required** Signals for the higher-level control system.

Time of the forced checking procedure

In the case of warning A01699 , you must initiate a forced checking procedure at the next opportunity. These alarms do not affect the operation of your machine.

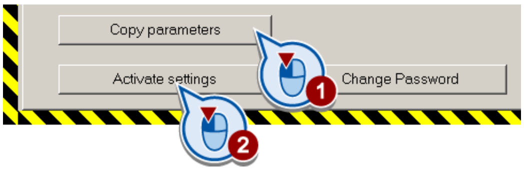
- Stop the drive.
- Select function STO or switch off the converter supply voltage temporarily and on again.

Examples for the times when forced checking procedure is performed:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent).

8.10.3.8 Activate settings

- ① Copy the parameters of the safety functions in order to create a redundant image of the settings.



- ② Activate the settings.
- 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.
  Further information can be found in the section Password (Page 229).
- Confirm the prompt for saving your settings (copy RAM to ROM).
- Switch off the converter supply voltage.
- Wait until all of the LEDs on the converter go dark. Now switch on the converter supply voltage again. Your settings only become effective after this power-on reset.

Parameter

Table 8- 70 Parameters for the forced dormant error detection

Parameter	Description
p9700 = 57 hex	**SI copy function** (factory setting: 0) Start copy function SI parameter.
p9701 = AC hex	**Confirm data change** (factory setting: 0)Confirm data change overall.
p0010 = 0	**Drive commissioning parameter filter** 0: Ready

8.10.3.9 Checking the assignment of the digital inputs

- Check whether the digital inputs used as fail-safe input are also assigned a further function.

NOTICE
Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the motor.

- Remove multiple assignments of the digital inputs:

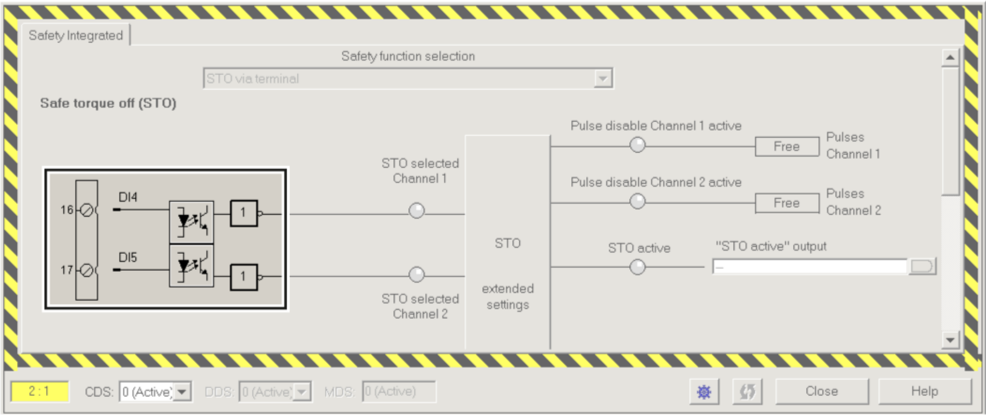


Figure 8-39 Example: automatic assignment of digital inputs DI 4 and DI 5 with STO

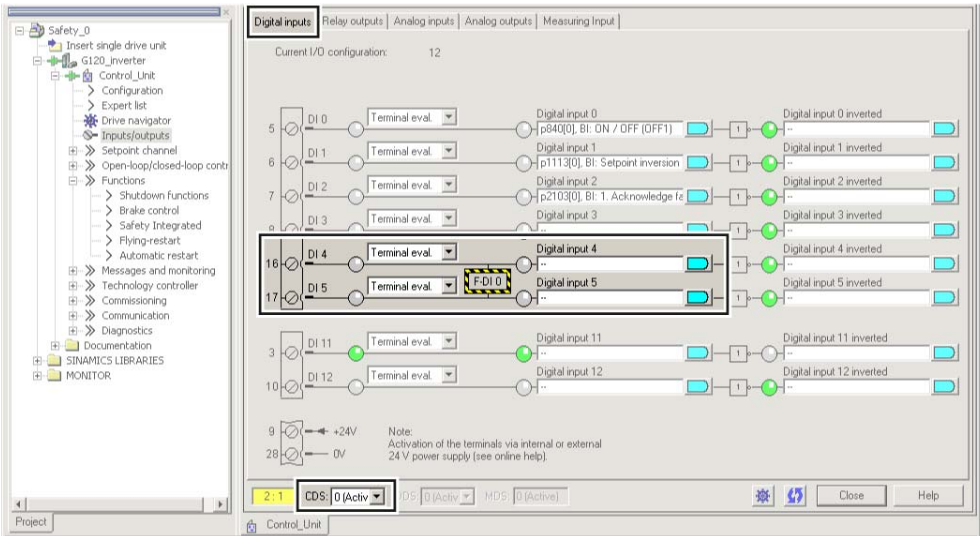


Figure 8-40 Remove pre-assignment of digital inputs DI 4 and DI 5

- When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

8.10.3.10 Acceptance - completion of commissioning

Requirements for an acceptance are derived from the EC Machinery Directive and ISO 13849-1:

- You must check safety-related functions and machine parts after commissioning.
- You must create an "acceptance report" showing the test results.

Prerequisites for the acceptance test

- The machine is properly wired.
- All safety equipment such as protective door monitoring devices, light barriers or emergency-off switches are connected and ready for operation.
- Commissioning of the open-loop and closed-loop control has been completed. These include, for example:
  - Configuration of the setpoint channel.
  - Closed loop control in the higher-level controller.
  - Motor control.

Authorized persons

Authorization within the scope of the acceptance test is a person authorized by the machine manufacturer who, on account of his or her technical qualifications and knowledge of the safety functions, is in a position to perform the acceptance test in the correct manner.

Full acceptance tests

The full acceptance tests for the safety functions include the following:

1. Acceptance test
   - Check the safety functions in the machine or in the plant/system
2. Documentation
   - Described the safety-relevant components and functions of the machine or plant
   - Logging of the settings of the safety functions
   - Countersigning documentation

Reduced acceptance

A full acceptance test is necessary only after first commissioning. An acceptance test with a reduced scope is sufficient for expansions of the safety functions.

The acceptance test must be carried out individually for each drive as far as the machine allows it.

Table 8- 71 Reduced scope of acceptance test for function expansions

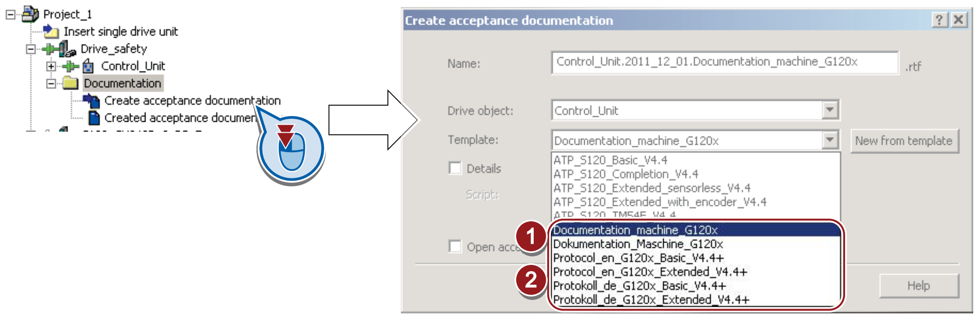
Measure	Acceptance test	
	Acceptance test	Documentation
Replacing the Control Unit or the Power Modules.	Yes.	• Add hardware data • Add configuration • Add firmware versions • Add checksums • Countersignature
Hardware replacement of safety-related distributed I/O devices (e.g. emergency off switch).	Yes, but only for the replaced components.	• Add hardware data • Add configuration • Add firmware versions
Firmware - upgrading the Control Unit.	Yes.	Supplement: • Add version data • Add new safety functions • Add checksums • Countersignature.
Functional expansion of the machine (additional drive).	Yes, but only for the additional functions.	• Add safety functions for each drive • Add function table • Add checksums • Countersignature.
Functional expansion of a drive (e.g. enable STO).	Yes, but only for the additional functions.	• Add safety functions for each drive • Add function table • Add checksums • Countersignature.
Transfer of converter parameters to other identical machines by means of series commissioning.	Yes, but only for the interfaces F-DI or PROFIsafe.	• Add machine description • Check firmware versions • Check checksums

Documents for acceptance

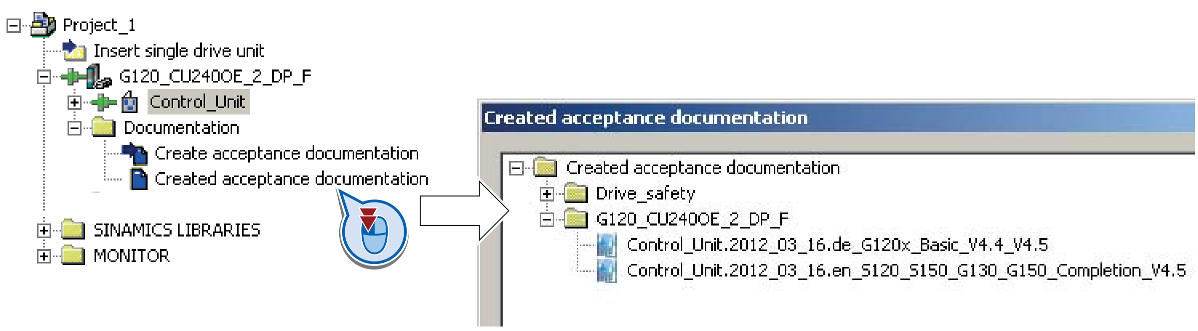
The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

Procedure

- In STARTER create the acceptance documentation.



- ① This template contains a recommendation for your machine or plant documentation.
  Dokumentation_Maschine_G120x: German template.
  Documentation_machine_G120x: English template.
- ② Select the suitable template for the basic functions and create a report for each drive of your machine or plant.
  For firmware version V4.4 and higher:
  Protokoll_de_G120x_Basic_V4.4+: German template.
  Protocol_en_G120x_Basic_V4.4+: English template.
- You load the created reports for archiving and the machine documentation for further processing:



- Archive the acceptance reports and the machine documentation.

The reports and the machine documentation can also be found in the section: Documentation for accepting the safety functions (Page 349).

Recommended acceptance test

The following descriptions for the acceptance test are recommendations and describe the principle of acceptance. You can deviate from the recommendations, if, after completion of the commissioning, you check the following:

- 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 occur each time the system boots, and are not critical for the acceptance:

- A01697
- A01796

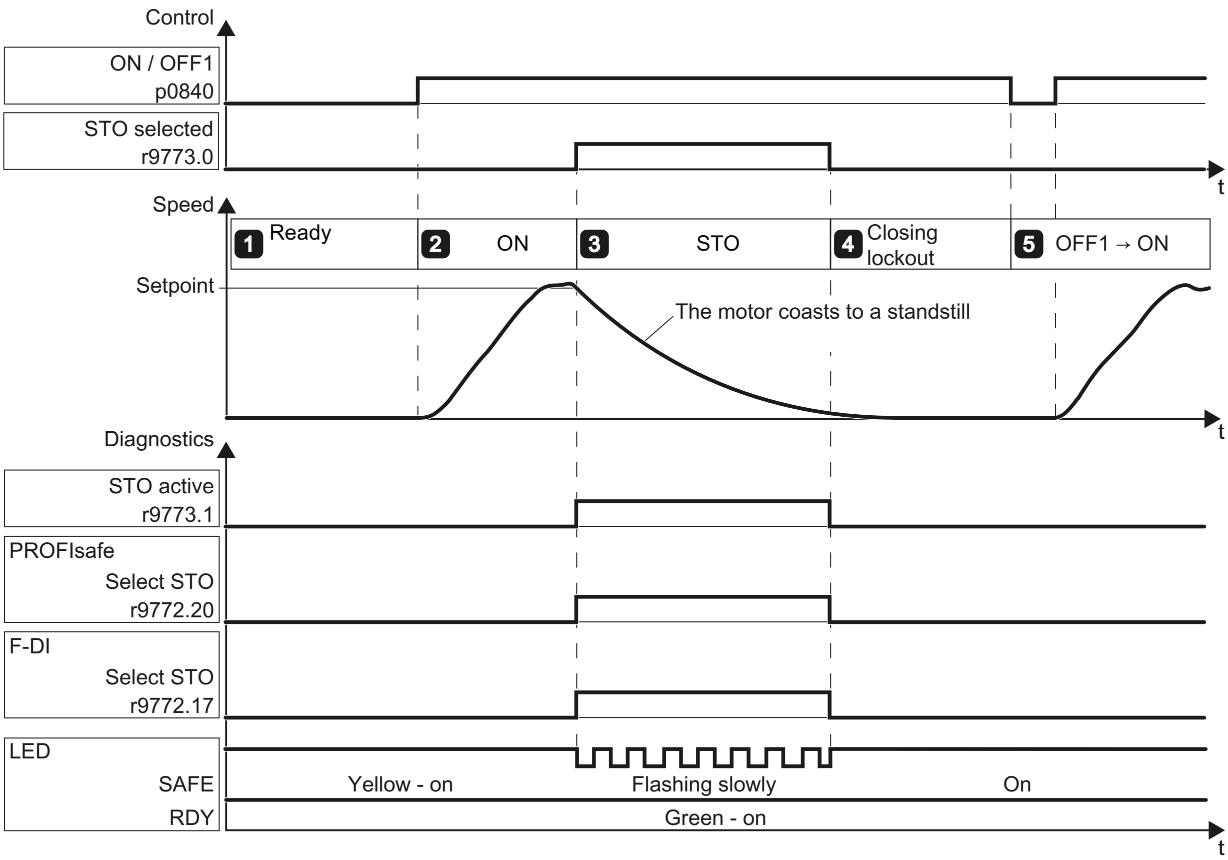


Figure 8-41 STO acceptance test for basic functions

Table 8- 72 Function "Safe Torque Off" (STO)

No.	Description		Status
1.	**Initial state**		
	• The converter is "ready" (p0010 = 0).		
	• The converter signals neither faults nor alarms for the safety functions (r0945[0…7], r2122[0…7]).		
	• STO is not active (r9773.1 = 0).		
2.	**Switch on the motor**		
	• Enter a speed setpoint ≠ 0, and switch on the motor (ON command).		
	• Ensure that the correct motor is running.		
3.	**STO select**		
	• Select STO while the motor is running **Note:** Test each configured control, e.g. via digital inputs and via PROFIsafe.		
	• Check the following:		
	For control via PROFIsafe	For control via terminal	
	• The converter signals the following: "STO Selection via PROFIsafe" (r9772.20 = 1)	• The converter 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 converter signals neither faults nor alarms for the safety functions (r0945[0…7], r2122[0…7]).		
	• The converter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).		
4.	**STO deselect**		
	• Deselect STO .		
	• Check the following:		
	• The converter signals neither faults nor alarms for the safety functions (r0945[0…7], r2122[0…7]).		
	• The converter signals the following: "STO is not selected " (r9773.0 = 0). "STO is not active" (r9773.1 = 0).		
	• The converter is in the "switching on inhibited" state (r0046.0 = 1).		
5.	**Switch on the motor**		
	• Switch the motor off (OFF1 command) and then on again (ON command).		
	• Ensure that the correct motor is running.		

8.11 Switchover between different settings

In several applications, the inverter must be able to be operated with different settings.

Example:

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

Drive data sets (DDS)

Your can parameterize several inverter functions differently and then switch over between the different settings.

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

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

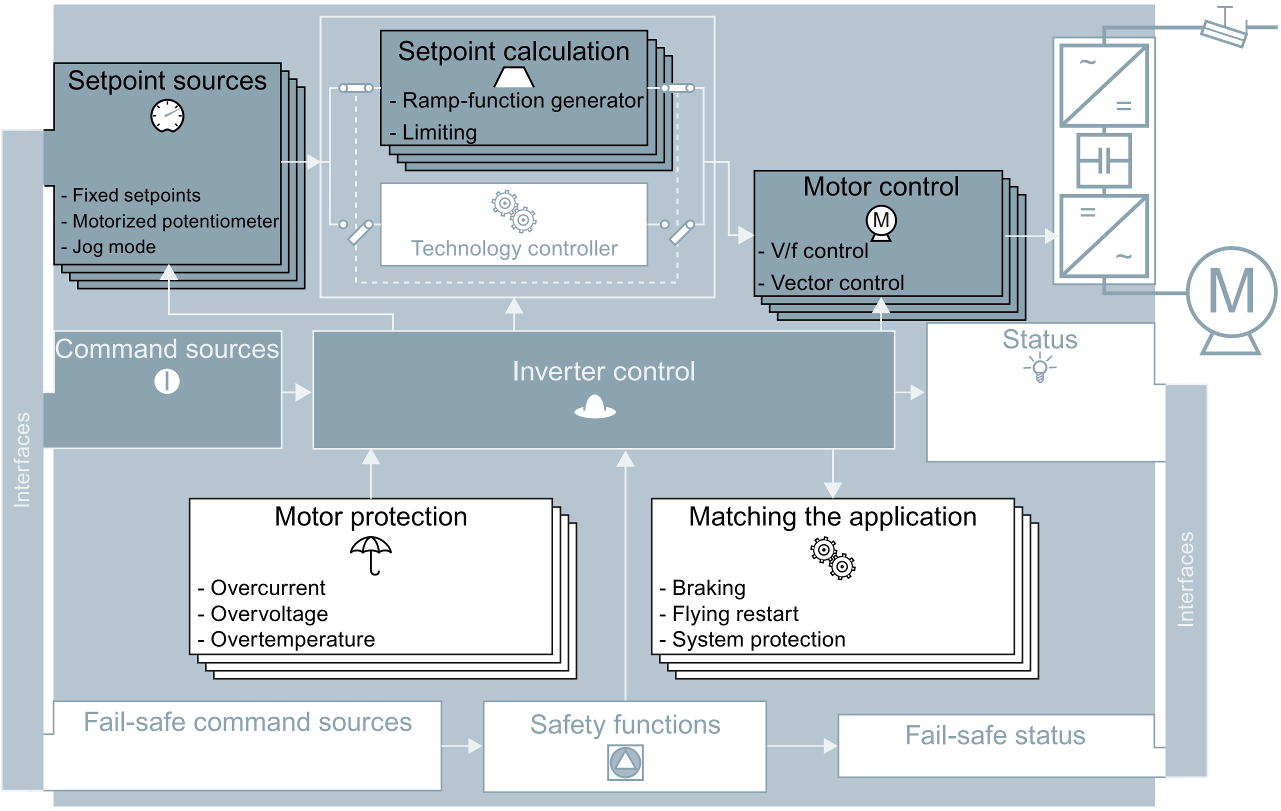


Figure 8-42 DDS switchover in the inverter

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

Table 8- 73 Selecting the number of command 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- 74 Parameters for switching the drive data sets:

Parameter	Description
p0820	**Drive data set selection DDS bit 0**
p0821	**Drive data set selection DDS bit 1**
p0826	**Motor changeover, motor number**
r0051	**Displaying the number of the DDS that is currently effective**

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

Note

You can only switch over the motor data of the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.

If you do not switch over the motor data together with the drive data sets (i.e. same motor number in p0826), then the drive data sets can also be switched over in operation.

Table 8- 75 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 Data backup 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 parameter 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 (Page 271)).

The following storage media are available for your settings:

1. Memory card
2. PC/PG
3. Operator Panel

Series commissioning

Series commissioning is the commissioning of several identical drives. After commissioning of the first drive, you must do the following:

1. Back up the settings of the first converter to an external storage medium.
2. Transfer the settings of the first converter to another converter via the storage medium.

Note

The control unit to which the parameters are transferred must have the same order number and the same or a higher firmware version as the source control unit.

9.1 Backing up and transferring settings using a memory card

What memory cards do we recommend?

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

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

Using memory cards from other manufacturers

If you use other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

⚠ CAUTION
You use memory cards from other manufacturers at your own risk. Depending on the card manufacturer, not all functions are supported (e.g. download).

9.1.1 Saving setting on memory card

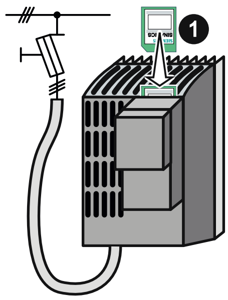
We recommend that you insert the memory card before switching on the converter. The converter always also backs up its settings on an inserted card.

If you wish to backup the converter settings on a memory card, you have two options:

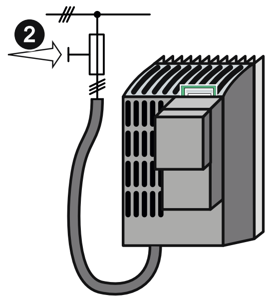
Procedure: Automatic backup

- The converter power supply has been switched off.

1. Insert an empty memory card into the converter.



2. Then switch-on the converter power supply.

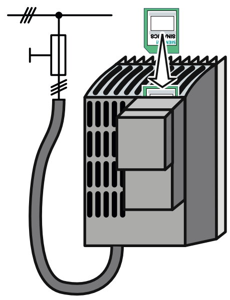


- After it has been switched on, the frequency converter copies its settings to the memory card.

NOTICE
If the memory card is not empty, then the converter accepts the data from the memory card. The previous setting in the converter will be deleted and will not be able to be restored.

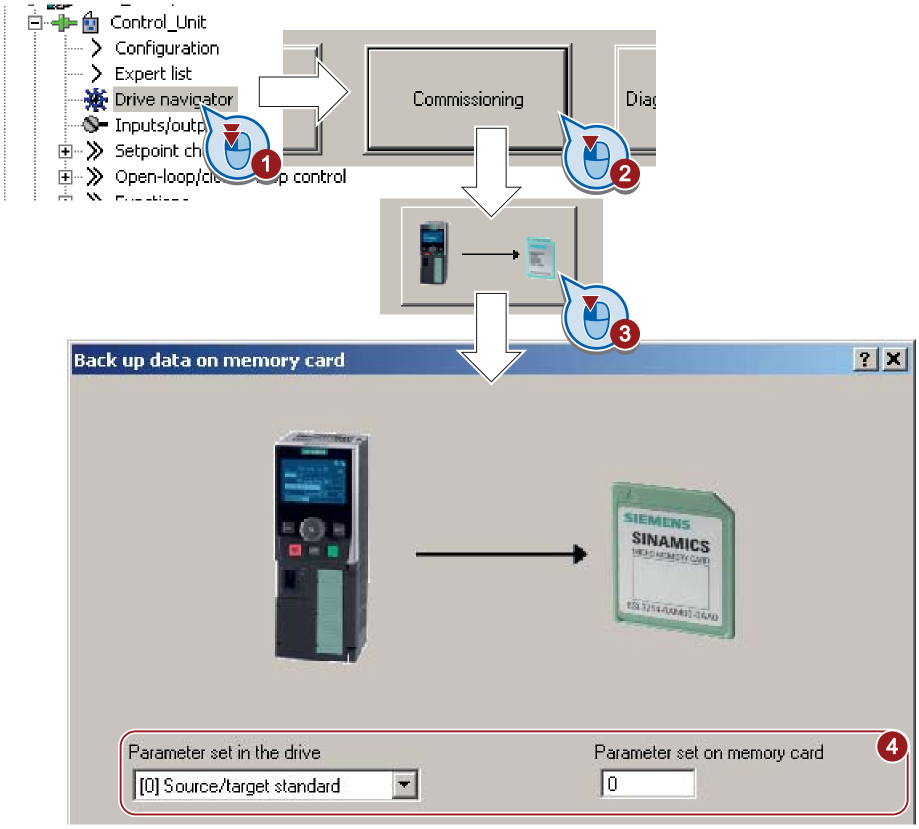
Procedure: Overwrite data on a memory card

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



Procedure using STARTER

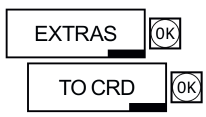
- Go online with STARTER.



- ① 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.
- Close the screen forms.

Procedure with the BOP-2

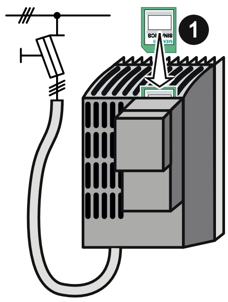
- Start data transfer in the menu "EXTRAS" - "TO CRD".



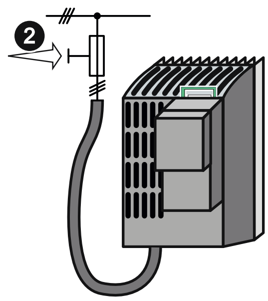
9.1.2 Transferring the setting from the memory card

Procedure

- The converter power supply has been switched off.
  1. Insert the memory card into the converter.



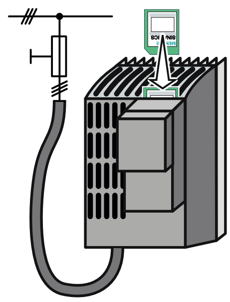
  2. Then switch-on the converter power supply.



- If there is valid parameter data on the memory card, then the converter accepts the data from the memory card.

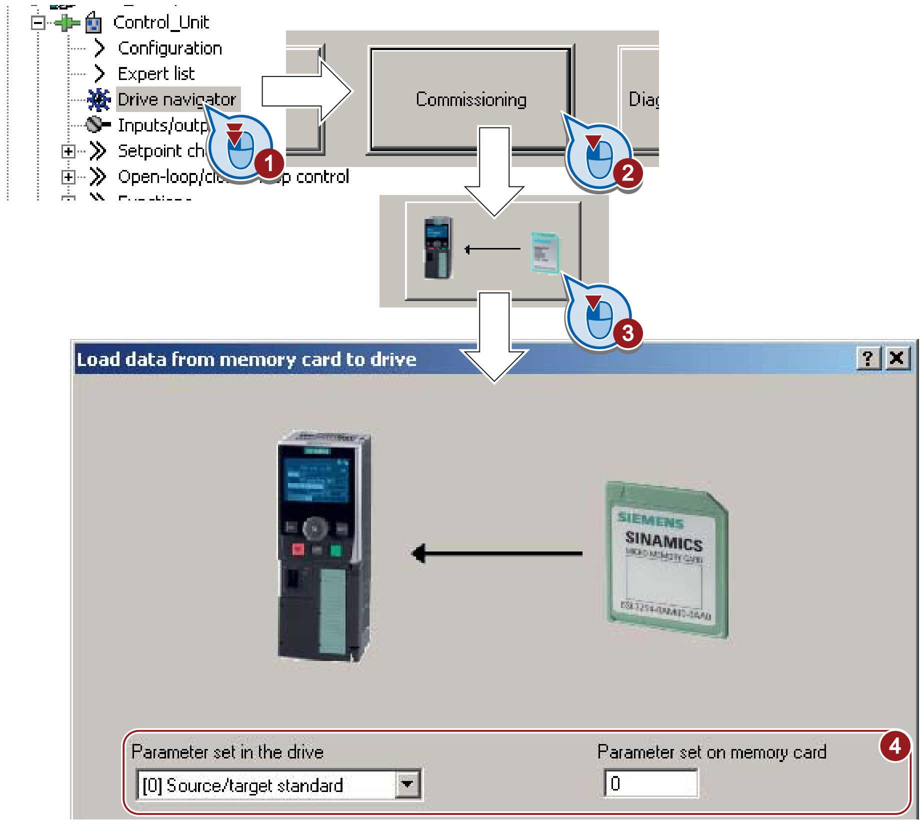
Procedure: Manual data transfer from a memory card

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



Procedure using STARTER

- Go online with STARTER.



- ① In your drive, select "Drive Navigator".
- ② Select the "Commissioning" button.
- ③ Select the button to transfer the data from the memory card to the converter.
- ④ Select the settings as shown in the diagram and start the data backup.
- Close the screen forms.
- Go offline with STARTER.
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

Procedure with the BOP-2

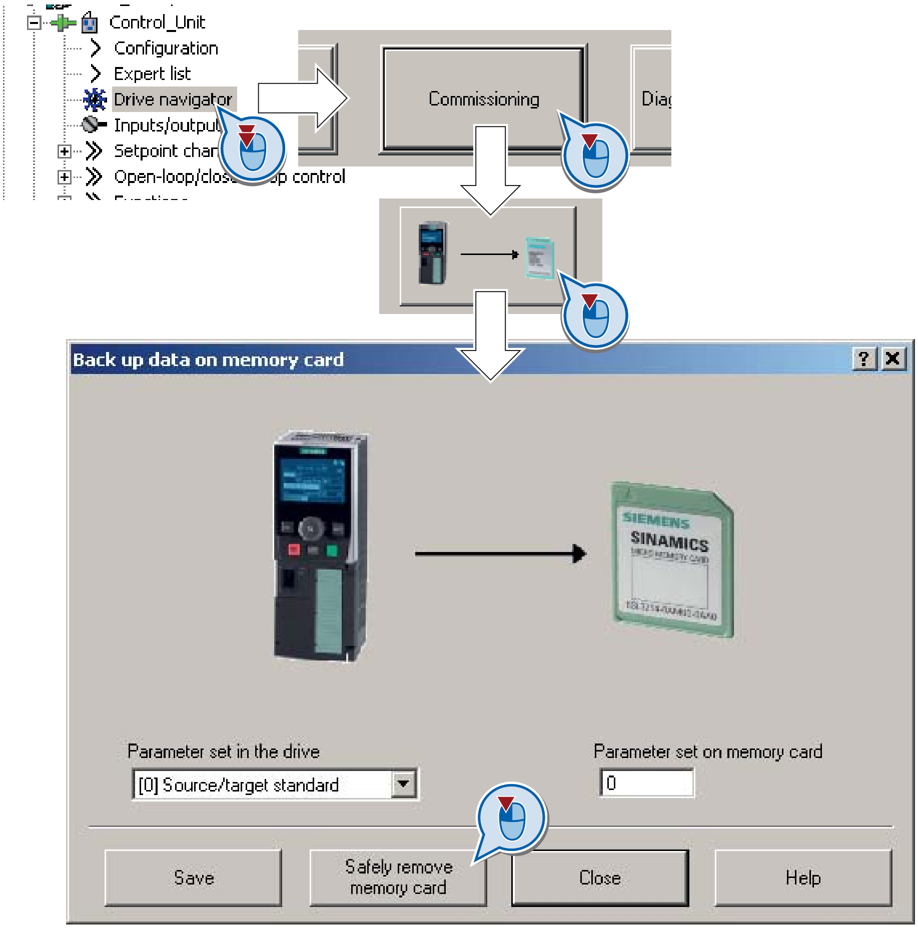
- Start data transfer in the menu "EXTRAS" - "FROM CRD".
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

9.1.3 Safely remove the memory card

CAUTION
The file system on the memory card can be destroyed if the memory card is removed while the converter is switched on without first requesting and confirming this using the "safe removal" function. The memory card will then no longer function.

Procedure with STARTER

- In the Drive Navigatorselect the following screen form:

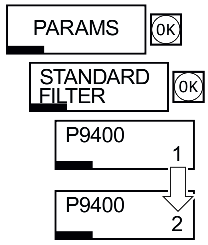


- Click on the button to safely remove the memory card.
- You may remove the memory card from the converter after the appropriate message has been output.

Procedure with the BOP-2

- Go to parameter p9400. If a memory card is correctly inserted, then p9400 = 1.
- Set p9400 = 2 The BOP-2 displays "BUSY" for several seconds and then jumps to either p9400 = 3 or p9400 = 100.
- For Bei p9400 = 3 you may remove the memory card.

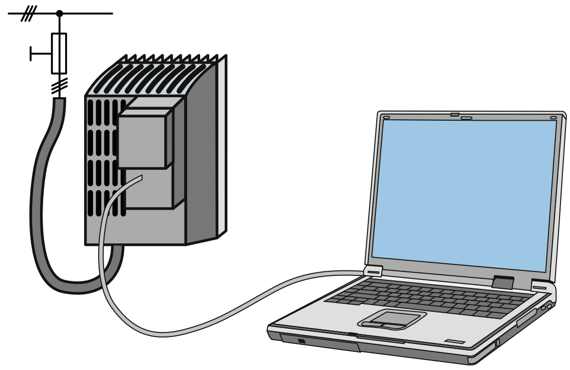
For p9400 = 100, you may not remove the memory card at the moment. In this case, try again by setting p9400 = 2.



9.2 Backing up and transferring settings using STARTER

With the supply voltage switched on, you can transfer the converter settings from the converter to a PG/PC, or the data from a PG/PC to the converter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.



You will find additional information about STARTER in the section: Accessories for commissioning and operation (Page 25).

Procedure converter → PC/PG

- Go online with STARTER : .
- Select the button "Download project to PG": .
- To save the data in the PG, select the button: .
- Go offline with STARTER : .

Procedure PC/PG → Converter

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

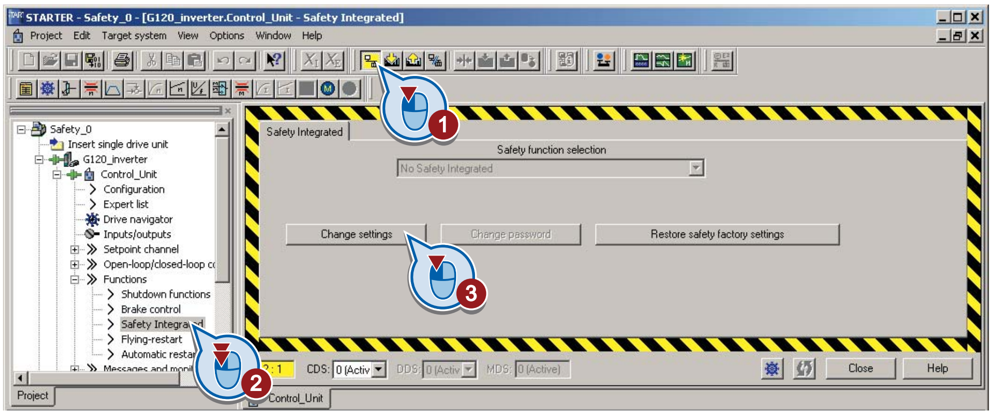
Converter without safety functions:

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

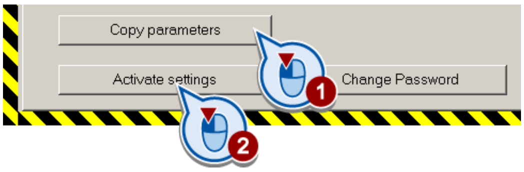
Converter with safety functions:

- ① Go online with STARTER : .
- ② Select the button "Download project to target system": .

- ③ Open the STARTER screen for the safety functions.



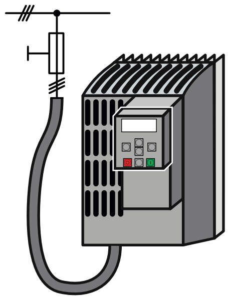
- ① Copy the safety function parameters.
- ② Activate the settings.



- To save the data in the converter, select the "Copy RAM to ROM" button: .
- Go offline with STARTER : .
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

9.3 Saving settings and transferring them using an operator panel

When the power supply is switched on, you can transfer the settings of the converter to the BOP-2 or, vice versa, transfer the data from the BOP-2 to the converter.



Procedure converter → BOP-2

- Start data transfer in the menu "EXTRAS" - "TO BOP".

Procedure BOP-2 → converter

- Start data transfer in the menu "EXTRAS" - "FROM BOP".
- Switch off the converter power supply.
- Wait until all LED on the converter go dark. Now switch on the converter power supply again. Your settings only become effective after this power-on reset.

9.4 Other ways to back up settings

Description

In addition to the default setting, the converter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

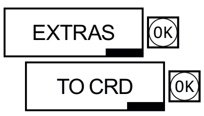
Table 9- 1 Backing up settings in the converter

Parameter	Description
p0970	**Reset drive parameters** Load backed-up setting (number 10, 11 or 12). You overwrite your actual parameter setting when loading.
p0971	**Save parameters** Back up the setting (10, 11 or 12).

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

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

Table 9- 3 Operation on the BOP-2

	Description	
		The converter writes its setting 0, 10, 11 or 12 to the memory card in accordance with p0802. The file on the memory card is assigned the number according to p0802.
		The converter loads the setting with the number according to p0802 from the memory card and thus overwrites its setting 0, 10, 11 or 12.

9.5 Write and know-how protection

The converter offers the option to protect configured settings from being changed or copied.

Write protection and know how protection are available for this purpose.

Write protection - overview

Write protection is primarily used to prevent converter settings from being inadvertently changed. No password is required for write protection, there is no encryption.

The following functions are excluded from the write protection:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Access to service parameters (p3950) - only for service personnel, a password is required
- Restoring the factory setting
- Upload
- Acknowledging alarms and faults
- Switching over to the control panel
- Trace
- Function generator
- Measuring functions
- Reading out diagnostic buffer

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Know-how protection - overview

The know-how protection is used, for example, so that a machine manufacturer can encrypt his configuration know-how and protect it against changes or copying.

The know-how protection is available in the following versions:

- **Know-how protection without copy protection** (possible with or without memory card)
- **Know-how protection with copy protection** (possible only with Siemens memory card)

A password is required for the know-how protection.

In case of active know-how protection, the STARTER dialog screens are locked. You can, however, read the values of the display parameters from the expert list. The values of the adjustment parameters are not displayed and cannot be changed.

Actions that are also possible during active know-how protection

Actions listed below can also be executed during active know-how protection:

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Displaying the alarm history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters, which are accessible even though know-how protection is active)

Actions that are not possible during active know-how protection

Actions listed below cannot be executed during active know-how protection:

- Download
- Export/import
- Trace
- Function generator
- Measuring functions
- Automatic controller setting
- Stationary/rotating measurement
- Deleting the alarm history

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

9.5.1 Write protection

Set write protection

In order that you can set write protection, your converter must be connected online with STARTER.

Activate and deactivate write protection

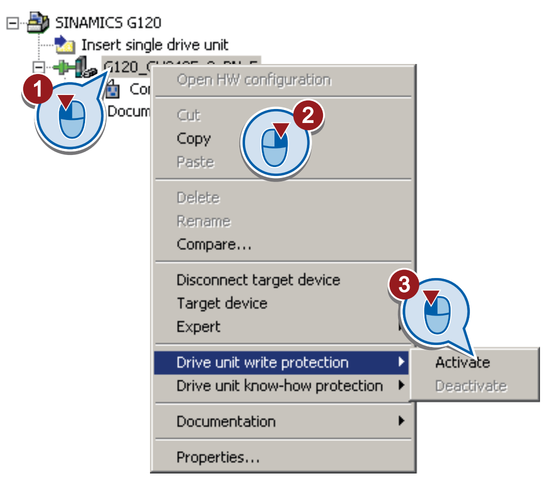
Select the converter in your STARTER project with the left mouse button ①.

Open the shortcut menu by right-clicking ②

Activate write protection ③

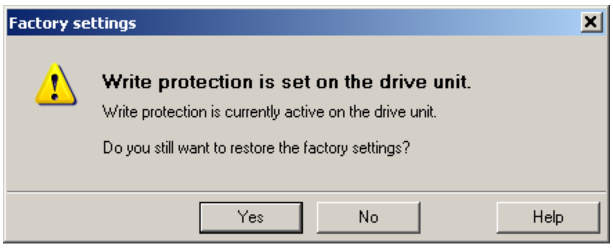
Deactivation is executed in analog.

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



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.



If you initiate reset using other methods such as the expert list, there is no prompt.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

9.5.2 Know-how protection

When the converter is operated with know-how protection, please take note of the following information:

Note

Support provided by technical support for active know-how protection

In the case of active know-how protection, support by the technical support is only possible with the consent of the machine manufacturer.

Know-how protection can only be activated online.

If you have created a project offline on your computer, you must download it to the converter and go online. Only then can you activate the know-how protection.

You cannot activate know-how protection in the project on the computer.

Know-how protection with copy protection is only possible with a Siemens memory card.

For "know-how protection with copy protection", a Siemens memory card must be plugged in!

If you try to activate the "know-how protection with copy protection" without a memory card, or with a different memory card, the error message "know-how protection for the drive unit could not be activated" is displayed.

Password check for know-how protection and Windows language settings

Please note that if the Windows language settings are changed, after activating know-how protection, errors can occur when subsequently checking the password. Therefore, only use characters from the ASCII character set for your password.

Commissioning the converter with know-how protection

Recommended procedure for commissioning with know-how protection.

1. Commission the converter.
2. Create the exception list (Page 264)
3. Activate the know-how protection (Page 263).
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.

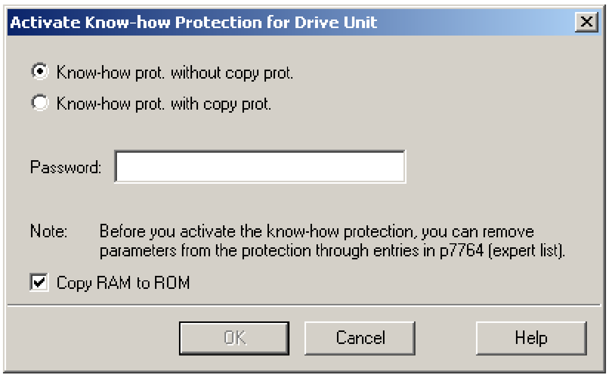
9.5.2.1 Settings for the know-how protection

Activating know-how protection

Select the converter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 261))..

The adjacent screen form then opens:

Enter your password in this screen and confirm with OK. The password must consist of at least one character and can be no longer than 30 characters. All characters are permissible.



In this screen form "Copy RAM to ROM" has been selected in the factory. This will ensure that your settings are permanently stored.

If "Copy RAM to ROM" is not selected, then your know-how protection settings are only saved in the volatile memory, and will no longer be available the next time the system is switched on.

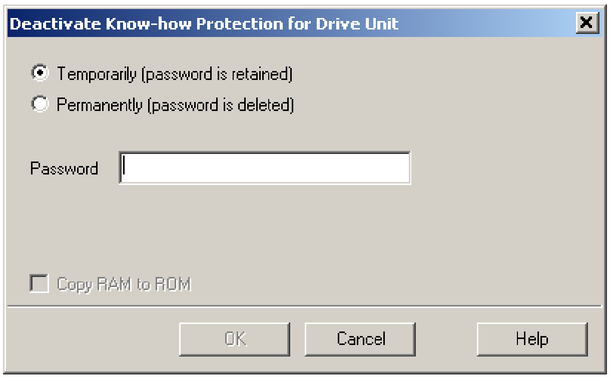
Backing up parameter settings on the memory card

When the know-how protection is activated, you may save the parameter 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

1. Select the converter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
3. Enter the password and exit the screen form with OK.



Note

Permanently or temporarily deactivating know-how protection

Temporarily deactivating know-how protection means that know-how protection is active again after switching off and switching on. Permanently deactivating means that know-how protection is no longer active after switching off and switching on again.

It goes without saying that you can always reactivate know-how protection, even if you have permanently canceled it, by following the procedure described above in this section.

Deactivating know-how protection temporarily

To temporarily deactivate the know-how protection means that you can change the settings in the converter until you switch the converter off and on again, or until you reactivate the know-how protection.

Finally deactivating know-how protection (delete password)

To finally deactivating the know-how protection means that you delete the password

- Immediately and finally, if you select "Copy RAM to ROM"
- Until the next OFF/ON if you do not select "Copy RAM to ROM"

Changing the password

Select the converter 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 indices to the parameter numbers of the selection list in p7764.

NOTICE

Procedure to change p7763 (number of parameters for the selection list)

1. Save the converter settings via an upload () on the computer/PG and go offline ()
2. In the project on the computer, set p7763 to the desired value. Save the project.
3. Go online and load the project into the converter ().
4. Now make the additional settings in p7764.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

⚠ CAUTION
Take special care when creating the exception list!
If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer deactivate know-how protection. The only possibility to be able to access the converter again is to reset the converter to the factory settings.

9.5.2.3 Replacing devices with active know-how protection

Replacing devices during know-how protection without copy protection

During know-how protection without copy protection, you can save the configuration settings of the converter with the automatic upload (see Saving setting on memory card (Page 249)) on an empty memory card, and with the automatic download (see Transferring the setting from the memory card (Page 251)) you can transfer these to another converter – and thus replace devices or commission other converters.

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the converter 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 converter cannot be replaced as described in "Replacing the Control Unit (Page 271)".

However, to allow the converter to be replaced, it must be operated with 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:

Case 1: The machine manufacturer only knows the serial number of the new converter

Procedure:

1. The end customer provides the machine manufacturer with the following information:
   – For which machine must the converter be replaced?
   – What is the serial number (r7758) of the new converter?
2. The machine manufacturer goes online on the sample machine.
   – deactivates the know-how protection, see Settings for the know-how protection (Page 263)
   – enters the serial number of the new converter 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 263)
   – writes the configuration with p0971 = 1 to the memory card
   – sends the memory card to the end customer

3. The end customer inserts the memory card and switches on the converter.

When powering up, the converter checks the serial numbers of the card and when there is a match, the converter goes into the "ready to start" state.

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

Case 2: The machine manufacturer knows the serial number of the new converter and the serial number of the MMC

Procedure

1. The end customer provides the machine manufacturer with the following information:
   – For which machine must the converter be replaced?
   – What is the serial number (r7758) of the new converter?
   – What is the serial number of the memory card?
2. The machine manufacturer goes online on the sample machine.
   – deactivates the know-how protection, see Settings for the know-how protection (Page 263)
   – enters the serial number of the new converter 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 263)
   – 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
3. The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the converter and switches on the converter.

When powering up, the converter checks the serial numbers of the card and when there is a match, the converter goes into the "ready to start" state.

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

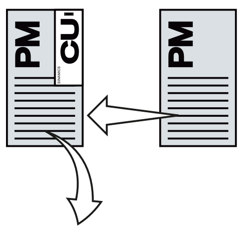
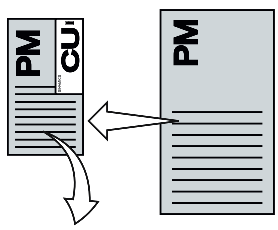
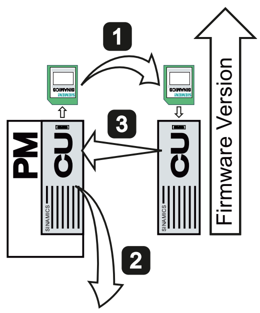
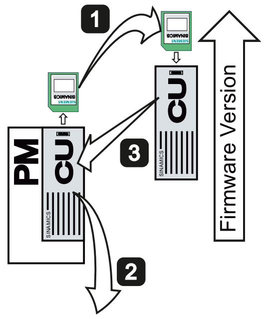
10 Service and maintenance

10.1 Overview of replacing converter components

In the event of a permanent function fault, you can replace the converter's Power Module or Control Unit independently of one another. In the following cases, you may immediately switch on the motor again after the replacement.

⚠ WARNING
In all other cases, you must recommission the drive.

Component replacement, general

Replacing the Power Module		Replacing the Control Unit with external backup of the settings, e.g. on a memory card	
Replacement: • Same type • Same power rating	Replacement: • Same type • *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)	The converter automatically loads the settings on the memory card into the new CU. If you have saved the settings of your converter on another medium, e.g. on an operator panel or on a PC, then after the replacement, the settings must be loaded into the converter.	

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, using the environment detection, you can replace a defective converter by a new device of the same type and with the identical software release without having to recommission the system.

You can either load the converter settings into the converter using the memory card, or – if you are using a SIMATIC S7 control with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

10.2 Replacing the Control Unit

After commissioning has been completed, we recommend that you back up your settings on an external storage medium, e.g.: on a memory card or the operator panel.

If you do not back up your data, you have to recommission the drive when you replace the Control Unit.

Procedure for replacing a Control Unit with a memory card

- 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.
- Remove the signal cables from the Control Unit.
- Remove the defective CU.
- Mount the new CU onto the Power Module. The new CU must have the same order number and the same or a higher firmware version as the CU that was replaced.
- Remove the memory card from the old Control Unit and insert it in the new Control Unit.
- Reconnect the signal cables of the Control Unit.
- Connect up the line voltage again.
- The converter adopts the settings from the memory card, saves them (protected against power failure) in its internal parameter memory, and switches to "ready to start" state.
- Switch on the motor and check the function of the drive.

Procedure for replacing a Control Unit without a memory card

- 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.
- Remove the signal cables of the Control Unit.
- Remove the defective CU.
- Mount the new CU onto the Power Module.
- Reconnect the signal cables of the Control Unit.
- Connect up the line voltage again.
- The converter goes into the "ready-to-switch-on" state.
- If you have backed up your settings:
  - Load the settings from the operator panel or via STARTER into the converter.
  - For converters of the same type and the same firmware version, you can now switch-on the motor. Check the function of the drive.
  - For a different type of converter, the converter outputs alarm A01028. The alarm indicates that the settings that have been loaded are not compatible with the converter. In this case, clear the alarm with p0971 = 1 and recommission the drive.
- If you have not backed up your settings, then you must recommission the drive.

Inverter with enabled safety functions

If you replace an inverter with enabled safety functions, then you also need to confirm the safety function settings on the new inverter. You will find the procedure in Section: Data backup and series commissioning (Page 247).

Acceptance test

If you activated the safety functions in the inverter, after replacing the inverter you must perform an acceptance test for the safety functions.

- Switch off the inverter supply voltage.
- Wait until all LEDs on the inverter go dark. Now switch on the inverter power supply again (power on reset).
- If you commissioned the inverter for the first time, carry out a **complete** acceptance test, see Full acceptance tests (Page 239).
- In all other cases, after downloading the parameters into the inverter, carry-out a **reduced** acceptance test. The reduced acceptance test is described in Section Reduced acceptance (Page 240).

10.3 Replacing the Power Module

Procedure for replacing a Power Module

- Disconnect the Power Module from the line supply.
- If being used, switch off the 24 V supply of the Control Unit.

> ⚠ DANGER
>
> **Risk of electrical shock!**
>
> Hazardous voltage is still present for up to 5 minutes after the power supply has been switched off.
>
> It is not permissible to carry out any installation work before this time has expired!

- Remove the connecting cables of the Power Module.
- Remove the Control Unit from the Power Module.
- Replace the old Power Module with the new Power Module.
- Mount the Control Unit onto the new Power Module.
- Connect up the new Power Module using the connecting cables.
- Switch on the line supply and, if being used, the 24 V supply for the Control Unit.
- If necessary, recommission the drive (also see Overview of replacing converter components (Page 269)).

Acceptance test of the safety functions

If you have activated the safety functions in the inverter, after replacing the Power Module, the following steps are required:

- Acknowledge the fault code issued by the inverter.
- Perform a reduced acceptance test. The necessary measures are described in the Chapter Reduced acceptance (Page 240).

11 Alarms, faults and system messages

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 right at the converter.
- Alarms and faults

  The converter signals alarms and faults via the fieldbus, the terminal strip (when appropriately set), on a connected operator panel or STARTER.
  Alarms and faults have a unique number.

If the converter no longer responds

Due to faulty parameter settings, e.g. by loading a defective file from the memory card, the converter can adopt the following condition:

Case 1

- The motor is switched off.
- You cannot communicate with the converter, either via the Operator Panel or other interfaces.
- The LEDs flicker and after 3 minutes the converter has still not powered up.

In this case, proceed as follows:

- Remove the memory card if one is inserted in the converter.
- Perform a power-on reset. Procedure for power on reset:
  - Switch off the converter power supply.
  - Wait until all LEDs on the converter go dark. Now switch on the converter power supply again
- Repeat the power on reset as often as required until the converter outputs fault F01018:
- Now set p0971 = 1 and perform an additional power-on reset. The converter now powers up with the factory settings.
- Recommission the converter.

Case 2

- The motor is switched off.
- You cannot communicate with the converter, either via the Operator Panel or other interfaces.
- The LEDs flash and are dark - this process is continually repeated.

In this case, proceed as follows:

- Remove the memory card if one is inserted in the converter.
- Perform a power-on reset. Procedure for power on reset:
  - Switch off the converter power supply.
  - Wait until all LEDs on the converter go dark. Now switch on the converter power supply again
- Repeat the power on reset until the converter outputs fault F01018, whereby you must switch off the converter if the LED flashes orange.
- Now set p0971 = 1 and perform an additional power-on reset. The converter now powers up with the factory settings.
- Recommission the converter.

11.1 Operating states indicated on LEDs

The LED RDY (Ready) is temporarily orange after the power supply voltage is switched-on. As soon as the color of the LED RDY changes to either red or green, the LEDs signal the inverter state.

Signal states of the LED

In addition to the signal states "on" and "off" there are two different flashing frequencies:

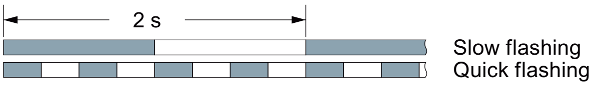


Table 11- 1 Inverter diagnostics

LED		Explanation
RDY	BF	
GREEN - on	---	There is presently no fault
GREEN - slow	---	Commissioning or reset to factory settings
RED - fast	---	There is presently a fault
RED - fast	RED - fast	Incorrect memory card

Table 11- 2 Inverter diagnostics

LNK LED	Explanation
GREEN - on	The communication via PROFINET is in order.
GREEN - slow	Device naming is active.
Off	No communication via PROFINET.

Table 11- 3 Communication diagnostics via RS485

LED BF	Explanation
On	Receive process data
RED - slow	Bus active - no process data
RED - fast	No bus activity

Table 11- 4 Communication diagnostics via PROFIBUS DP

LED BF	Explanation
off	Cyclic data exchange (or PROFIBUS not used, p2030 = 0)
RED - slow	Bus fault - configuration fault
RED - fast	Bus fault - no data exchange - baud rate search - no connection

Table 11- 5 Diagnostics of the safety functions

SAFE LED	Meaning
YELLOW - on	One or more safety functions are enabled, but not active.
YELLOW - slow	One or more safety functions are active; no safety function faults have occurred.
YELLOW - rapid	The converter has detected a safety function fault and initiated a STOP response.

11.2 Alarms

Alarms have the following properties:

- They do not have a direct effect in the inverter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - at the Operator Panel with a Axxxxx
  - via STARTER, 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 inverter 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 inverter 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 184).

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

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

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

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

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

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

Figure 11-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the inverter 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.

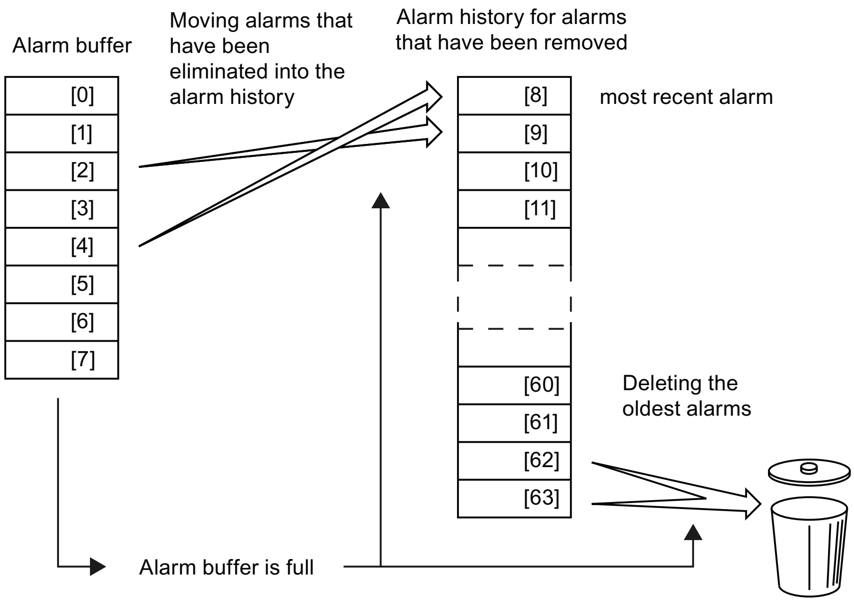


Figure 11-4 Shifting alarms that have been removed into the alarm history

The alarms that have still not been removed remain in the alarm buffer and are resorted so that gaps between the alarms are filled.

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

Parameters of the alarm buffer and the alarm history

Table 11- 6 Important parameters for alarms

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

Table 11- 7 Extended settings for alarms

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

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

11.3 Faults

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

The inverter signals a fault as follows:

- at the Operator Panel with Fxxxxx
- on the converter using the red LED RDY
- in bit 3 of the status word 1 (r0052)
- via STARTER

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

Every fault has a clear fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

For each fault received, the inverter saves the fault code, fault value and the time of the fault.

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

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

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

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written into parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter System runtime (Page 184).

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

Fault acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch-off the inverter power supply and switch-on again.
- Press the acknowledgement button on the operator panel
- Acknowledgement signal at digital input 2
- Acknowledgement signal in bit 7 of control word 1 (r0054) for Control Units with fieldbus interface

Faults that are triggered by internal converter hardware and firmware monitoring functions can only be acknowledged by switching off and on again. You will find a note about this restricted option to acknowledge faults in the fault list of the List Manual.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The fault acknowledgement has no effect as long as none of the fault causes of the fault buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indices 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.

3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

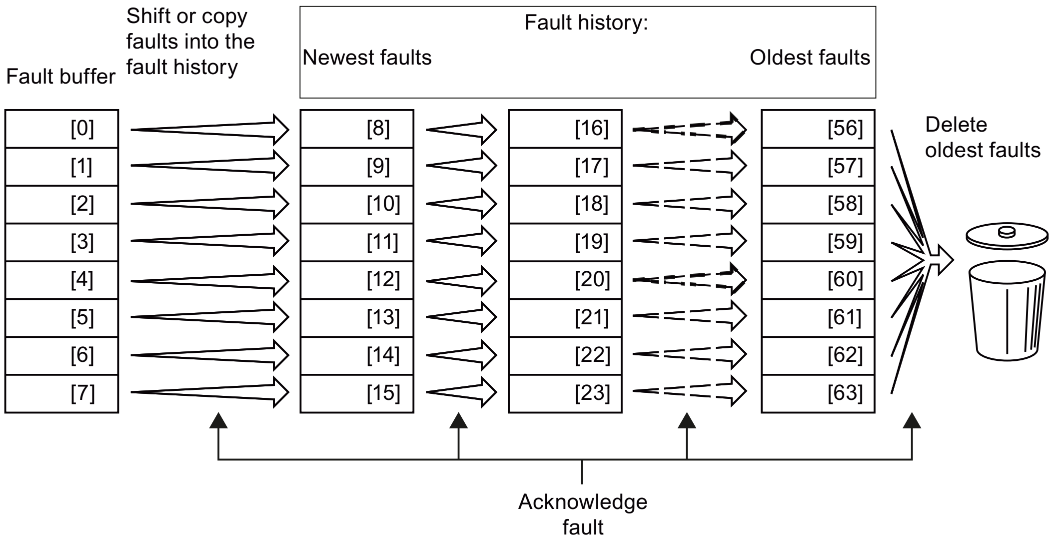


Figure 11-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history. 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 indices remain empty.

The inverters shifts the values previously saved in the fault history each by eight indices. Faults, which were saved in indices 56 … 63 before the acknowledgement, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Table 11- 8 Important parameters for faults

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 acknowledgement 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
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

The motor cannot be switched-on

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

- Is a fault present?
  If yes, then remove the fault cause and acknowledge the fault.
- Does p0010 = 0?
  If not, the inverter is e.g. still in a commissioning state.
- Is the inverter reporting the "ready to start" status (r0052.0 = 1)?
- Is the inverter missing enabling (r0046)?
- Are the interfaces of the converter (p0015) correctly parameterized?
  In other words, how is the converter receiving its setpoint and its commands?

Extended settings for faults

Table 11- 9 Advanced settings

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

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

11.4 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 11- 10 The most important alarms and faults of the safety functions

<table>
<tr><th>Number</th><th>Cause</th><th colspan="2">Remedy</th></tr>
<tr><td>F01600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
<tr><td>F01650</td><td>Acceptance test required</td><td colspan="2">Carry out acceptance test and create test certificate.
Switch the Control Unit off and then on again.</td></tr>
<tr><td rowspan="5">F01659</td><td rowspan="5">Write task for parameter rejected</td><td colspan="2">Cause: The converter should be reset to the factory setting. The resetting of the safety functions is, however, not allowed, because the safety functions are currently enabled.
Remedy with operator panel:</td></tr>
<tr><td>p0010 = 30</td><td>Parameter reset</td></tr>
<tr><td>p9761 = …</td><td>Enter password for the safety functions.</td></tr>
<tr><td>p0970 = 5</td><td>Reset Start Safety Parameter.
The converter sets p0970 = 5 if it has reset the parameters.</td></tr>
<tr><td colspan="2">Then reset the converter to the factory setting again.</td></tr>
<tr><td>A01666</td><td>Static 1 signal atF-DI for safe acknowledgment</td><td colspan="2">F-DI to a logical 0 signal.</td></tr>
<tr><td>A01698</td><td>Commissioning mode active for safety functions</td><td colspan="2">This message is withdrawn after the Safety commissioning has ended.</td></tr>
<tr><td>A01699</td><td>Shutdown path test required</td><td colspan="2">After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.</td></tr>
<tr><td>F30600</td><td>STOP A Triggered</td><td colspan="2">STO Select and then deselect again.</td></tr>
</table>

Table 11- 11 Faults, which can only be acknowledged by switching the inverter 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 has been output, the module is booted with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the inverter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.

Number	Cause	Remedy
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 11- 12 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 converter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB) Check the module parameters and recommission if necessary.
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Unit switchover: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
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.

Number	Cause	Remedy
F03505	Analog input, wire break	Check the connection to the signal source for interrupts. Check the level of the signal supplied. The input current measured by the analog input can be read out in r0752.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly parameterized	Check the parameterized supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check 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 temperature sensor fault (p0607 = 0).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	V_{DC_max} controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the up ramp for the setpoint speed.

Number	Cause	Remedy
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).
F07801	Motor overcurrent	Check current limits (p0640). 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 motor for star-delta connection and rating plate parameterization. Check power unit / motor combination. Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
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 converter 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 precontrol of the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.

Number	Cause	Remedy
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
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor data identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller into the RUN mode. • If the error occurs repeatedly, check the monitoring time set (p2044).
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.
F08700	Communications error	A CAN communications error has occurred. Check the following: • Bus cable • Baud rate (p8622) • Bit timing (p8623) • Master Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. • Insert a suitable memory card and switch the converter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).

Number	Cause	Remedy
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Converter overtemperature	Check whether the converter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the converter's input fuses. Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	• Check whether the fan is running.

Number	Cause	Remedy
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 a faulty configuration telegram. Check to see whether "Shared Device" is activated (p8929 = 2).
A50010	PROFINET name of station invalid	Correct name of station (p8920) and activate (p8925 = 2).
A50020	PROFINET: Second controller missing	"Shared Device" is activated (p8929 = 2). However, only the connection to a PROFINET controller is present.

For further information, please refer to the List Manual.

Technical data 12

12.1 Technical data, CU240B-2 Control Unit

Table 12- 1

Feature	Data	
Order numbers	6SL3244-0BB00-1BA1	With RS485 interface for the following protocols: • USS • Modbus RTU
	6SL3244-0BB00-1PA1	With PROFIBUSinterface.
Operating voltage	• Supply from the Power Module • or externally via terminals 31 and 32 with 24 V DC, a maximum of 200 VA Use a power supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1): The 0 V of the power supply must be connected with low resistance to the PE of the system. Example: SITOP Power power supply unit 5 A.	
	The power supply is electrically isolated from the control terminals.	
Power loss	5.0 W	Plus power loss of the output voltages.
Output voltages	+24 V out (terminal 9),18 V … 28.8 V, max. 100 mA	
	+10 V out (terminals 1 and 35), 9.5 V … 10.5 V, max. 10 mA	
Setpoint resolution	0.01 Hz	
Digital inputs	4 (DI 0 … DI 3)	• Low < 5 V, high > 11 V • Electrically isolated • 30 V maximum input voltage • 5.5 mA current consumption • SIMATIC-compatible • PNP/NPN switchable • 10 ms response time for debounce time p0724 = 0.
Analog input	1 (AI 0)	• Differential input • Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V • 12-bit resolution • 13 ms ± 1 ms response time • If AI 0 has been configured as additional digital input: Low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.

Feature	Data	
Digital output / relay output	1 (DO 0)	• 30 V DC / max. 0.5 A with resistive load • Update time 2 ms
	For applications which require UL certification, the voltage at DO 0 must not exceed 30 VDC referred to ground potential and must be supplied via a grounded class 2 power supply.	
Analog output	1 (AO 0)	• 0 V … 10 V or 0 mA … 20 mA • Reference potential: "GND" • 16-bit resolution • 4 ms update time
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.	
USB interface	Mini-B	
Dimensions (WxHxD)	73 mm × 199 mm × 39 mm	The depth specification is valid when mounting on the Power Module.
Weight	0.49 kg	
Memory cards	MMC	Recommendation: 6SL3254-0AM00-0AA0
	SD	Recommendation: 6ES7954-8LB00-0AA0 SDHC cards are not possible (SD High Capacity).
Operating temperature	0° C … 55° C	For operation without inserted Operator Panel.
	0° C … 50° C	For operation with inserted Operator Panel.
	Observe any possible restrictions regarding the operating temperature as a result of the Power Module.	
Storage temperature	- 40° C … 70° C	
Relative humidity	< 95%	Condensation is not permissible.

12.2 Technical data, CU240E-2 Control Unit

Table 12- 2

Feature	Data	
Order numbers	6SL3244-0BB12-1BA1 6SL3244-0BB13-1BA1	With RS485 interface for the following protocols: • USS • Modbus RTU
	6SL3244-0BB12-1PA1 6SL3244-0BB13-1PA1	With PROFIBUSinterface.
	6SL3244-0BB12-1FA0 6SL3244-0BB13-1FA0	With PROFINETinterface.
Operating voltage	• Supply from the Power Module • or externally via terminals 31 and 32 with 24 V DC, a maximum of 200 VA Use a power supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1): The 0 V of the power supply must be connected with low resistance to the PE of the system. Example: SITOP Power power supply unit 5 A.	
	The power supply is electrically isolated from the control terminals.	
Power loss	5.0 W	Plus power loss of the output voltages.
Output voltages	+24 V out (terminal 9),18 V … 28.8 V, max. 100 mA	
	+10 V out (terminals 1 and 35), 9.5 V … 10.5 V, max. 10 mA	
Setpoint resolution	0.01 Hz	
Digital inputs	6 (DI 0 … DI 5)	• Low < 5 V, high > 11 V • Electrically isolated • 30 V maximum input voltage • 5.5 mA current consumption • SIMATIC-compatible • PNP/NPN switchable • 10 ms response time for debounce time p0724 = 0.
Pulse input	1 (DI 3)	Maximum frequency 32 kHz
Analog inputs	2 (AI 0, AI 1)	• Differential input • Switchable: 0 V … 10 V, 0 mA … 20 mA or -10 V … +10 V • 12-bit resolution • 13 ms ± 1 ms response time • If AI 0 has been configured as additional digital input: Low < 1.6 V, high > 4.0 V, 13 ms ± 1 ms response time for a debounce time p0724 = 0.

Feature	Data	
Digital outputs	3 (DO 0 … DO 2)	• DO 0: Relay output, 30 V DC / max. 0.5 A with resistive load • DO 1: Transistor output, 30 V DC / max. 0.5 A with resistive load, protection against incorrect voltage polarity. • DO 2: Relay output, 30 V DC / max. 0.5 A with resistive load. • 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
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 functions of the 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 Additional information on the inverter (Page 352).	
PFH	5 × 10E-8	Probability of failure of the safety functions (Probability of Failure per Hour)
USB interface	Mini-B	
Dimensions (WxHxD)	73 mm × 199 mm × 39 mm	The depth specification is valid when mounting on the Power Module.
Weight	0.49 kg	
Memory cards	MMC	Recommendation: 6SL3254-0AM00-0AA0
	SD	Recommendation: 6ES7954-8LB00-0AA0 SDHC cards are not possible (SD High Capacity).

Feature	Data	
Operating temperature	0° C … 55° C	For operation without inserted Operator Panel.
	0° C … 53° C	Only applies to Control Units with PROFINET interface without inserted operator panel when both of the following conditions are satisfied: • There is no lateral spacing between one Control Unit and the other. For instance, this is the case if several Power Modules with Frame Size A are mounted directly side by side. • The input voltage of the associated Power Module is greater than 480 V.
	0° C … 50° C	For operation with inserted Operator Panel.
	Observe any possible restrictions regarding the operating temperature as a result of the Power Module.	
Storage temperature	- 40° C … 70° C	
Relative humidity	< 95 %	Condensation is not permissible.

12.3 Technical data, Power Modules

Permissible converter overload

There are two different power data specifications for the Power Modules: "**Low Overload**" (LO) and "**High Overload**" (HO), depending on the expected load.

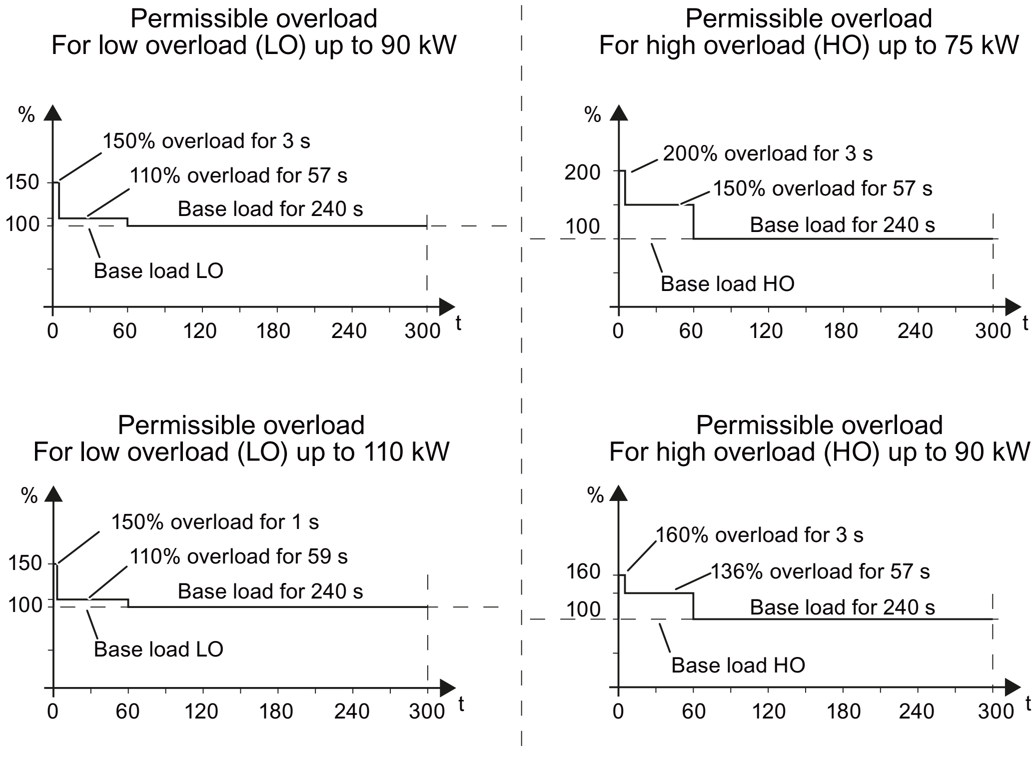


Figure 12-1 Duty cycles, "High Overload" and "Low Overload"

Note

The base load (100% power or current) of "Low Overload" is greater than the base load of "High Overload".

We recommend the "SIZER" engineering software to select the inverter based on duty cycles. See Additional information on the inverter (Page 352).

Definitions

- **LO input current** 100 % of the permissible input current for a load cycle according to Low Overload (LO base load input current).
- **LO output current** 100 % of the permissible output current for a load cycle according to Low Overload (LO base load output current).
- **LO power** Power of the inverter for LO output current.
- **HO input current** 100 % of the permissible input current for a load cycle according to High Overload (HO base load input current).
- **HO output current** 100 % of the permissible output current for a load cycle according to High Overload (HO base load output current).
- **HO power** Power of the inverter for HO output current.

If the power data comprise rated values without any further specifications they always refer to an overload capability corresponding to Low Overload.

12.3.1 Technical data, PM230 IP20

12.3.1.1 General data, PM230 - IP20

Feature	Version		
Line voltage	380 V ... 480 V 3-ph. AC ± 10%		
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)		
Input frequency	50 Hz … 60 Hz, ± 3 Hz		
Output frequency	0 … 650 Hz, depending on the control mode		
Power factor λ	0.9		
Line impedance	Uk ≤ 1%, no line reactor permitted		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps up to 16 kHz (up to 8 kHz for 55 kW and 75 kW). An increase in the pulse frequency results in a lower output current.		
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. For details, see the Hardware Installation Manual, Appendix A2.		
Braking methods	DC braking		
Degree of protection	IP20 built-in units PT devices	IP20 when mounted in a control cabinet IP54 on the control cabinet wall	
Operating temperature	LO without power reduction: HO without power reduction: LO/HO with power reduction:	0° C … +40° C 0° C … +50° C to 60° C	For details, see the Hardware Installation Manual.
Storage temperature	-40° C … +70° C		
Relative humidity	< 95% - condensation not permissible		
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007		
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995		
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • 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 the Hardware Installation Manual
Permissible short-circuit current	Frame size D ... F: 65 kA [1)]		
Overvoltage category	Supply circuits: Non-supply circuits:	Overvoltage category III Overvoltage category II	
Standards	UL [1),2)], CE, C-tick The drive only satisfies the UL requirements when UL-certified fuses are used.		

1) If fuse-protected with a listed Class J or 3NE1 fuse, rated voltage 600 VAC with the rated current of the specific converter.

2) UL available soon for frame sizes D … F

12.3.1.2 Power-dependent data, PM230, IP20

Note

For the Power Modules PM230, IP20, the low overload values (LO) are identical to the rated values.

Table 12- 3 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE11-3UL0 …1NE11-3AL0	…1NE11-7UL0 …1NE11-7AL0	…1NE12-2UL0 …1NE12-2AL0
LO power LO input current LO Output current		0.37 kW 1.3 A 1.3 A	0.55 kW 1.8 A 1.7 A	0.75 kW 2.3 A 2.2 A
HO power HO input current HO output current		0.25 kW 0.9 A 0.9 A	0.37 kW 1.3 A 1.3 A	0.55 kW 1.8 A 1.7 A
Fuse according to IEC Fuse according to UL		3NE1 813-0 AJT2 / 3NE1 813-0	3NE1 813-0 AJT4 / 3NE1 813-0	3NE1 813-0 AJT4 / 3NE1 813-0
Power losses, unfiltered Power losses, filtered		0.04 kW 0.04 kW	0.04 kW 0.04 kW	0.05 kW 0.05 kW
Required cooling air flow		1.5 l/s	1.5 l/s	4.5 l/s
Cross section of line and motor cable		1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered Weight, filtered		1.4 kg 1.6 kg	1.4 kg 1.6 kg	1.4 kg 1.6 kg

Table 12- 4 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE13-1UL0 …1NE13-1AL0	…1NE14-1UL0 …1NE14-1AL0	…-1NE15-8UL0 …-1NE15-8AL0
LO power LO input current LO Output current		1.1 kW 3.2 A 3.1 A	1.5 kW 4.2 A 4.1 A	2.2 kW 6.1 A 5.9 A
HO power HO input current HO output current		0.75 kW 2.3 A 2.2 A	1.1 kW 3.2 A 3.1 A	1.5 kW 4.2 A 4.1 A
Fuse according to IEC Fuse according to UL		3NE1 813-0 AJT6 / 3NE1 813-0	3NE1 813-0 AJT6 / 3NE1 813-0	3NE1 813-0 AJT10 / 3NE1 813-0
Power losses, unfiltered Power losses, filtered		0.06 kW 0.06 kW	0.07 kW 0.07 kW	0.08 kW 0.08 kW
Required cooling air flow		4.5 l/s	4.5 l/s	4.5 l/s
Cross section of line and motor cable		1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1.5 … 2.5 mm² 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered Weight, filtered		1.4 kg 1.6 kg	1.4 kg 1.6 kg	1.4 kg 1.6 kg

Table 12- 5 PM230, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3210…**	**…1NE17-7UL0**
Order No. - Filtered	**6SL3210…**	**…1NE17-7AL0**
LO power		3 kW
LO input current		8.0 A
LO Output current		7.7 A
HO power		2.2 kW
HO input current		6.1 A
HO output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power losses, unfiltered		0.11 kW
Power losses, filtered		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cable		1.5 … 2.5 mm^2 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg
Weight, filtered		1.6 kg

Table 12- 6 PM230, PT, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3211…**	**…1NE17-7UL0**
Order No. - Filtered	**6SL3211…**	**…1NE17-7AL0**
LO power		3 kW
LO input current		8.0 A
LO Output current		7.7 A
HO power		2.2 kW
HO input current		6.1 A
HO output current		5.9 A
Fuse according to IEC		3NE1 813-0
Fuse according to UL		AJT10 / 3NE1 813-0
Power losses, unfiltered		0.11 kW
Power losses, filtered		0.11 kW
Required cooling air flow		4.5 l/s
Cross section of line and motor cable		1.5 … 2.5 mm^2 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in
Weight, unfiltered		1.7 kg
Weight, filtered		1.9 kg

Table 12- 7 PM230, IP20, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE21-0UL0 …1NE21-0AL0	…1NE21-3UL0 …1NE21-3AL0	…1NE21-8UL0 …1NE21-8AL0
LO power		4 kW	5.5 kW	7.5 kW
LO input current		10.5 A	13.6 A	18.6 A
LO Output current		10.2 A	13.2 A	18 A
HO power		3 kW	4 kW	5.5 kW
HO input current		8.0 A	10.5 A	13.6 A
HO output current		7.7 A	10.2 A	13.2 A
Fuse according to IEC		3NE1 813-0	3NE1 814-0	3NE1 815-0
Fuse according to UL		AJT15 / 3NE1 813-0	AJT20 / 3NE1 814-0	AJT25 / 3NE1 815-0
Power losses, unfiltered		0.12 kW	0.15 kW	0.22 kW
Power losses, filtered		0.12 kW	0.15 KW	0.24 KW
Required cooling air flow		9.2 l/s	9.2 l/s	9.2 l/s
Cross section of line and motor cable		1.5 … 6 mm² 16 … 10 AWG	1.5 … 6 mm² 16 … 10 AWG	1.5 … 6 mm² 16 … 10 AWG
Tightening torque for line and motor cable		0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in	0.6 Nm / 5 lbf in
Weight, unfiltered		2.8 kg	2.8 kg	2.8 kg
Weight, filtered		3 kg	3 kg	3 kg

Table 12- 8 PM230, PT, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3211… 6SL3211…	…1NE21-8UL0 …1NE21-8AL0
LO power		7.5 kW
LO input current		18.6 A
LO Output current		18 A
HO power		5.5 kW
HO input current		13.6 A
HO output current		13.2 A
Fuse according to IEC		3NE1 815-0
Fuse according to UL		AJT25 / 3NE1 815-0
Power losses, unfiltered		0.22 kW
Power losses, filtered		0.24 KW
Required cooling air flow		9.2 l/s
Cross section of line and motor cable		1.5 … 6 mm² 16 … 10 AWG
Tightening torque for line and motor cable		0.6 Nm / 5 lbf in
Weight, unfiltered		3.4 kg
Weight, filtered		3.6 kg

Table 12- 9 PM230, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE22-6UL0 …1NE22-6AL0	…1NE23-2UL0 …1NE23-2AL0	…1NE23-8UL0 …1NE23-8AL0
LO power LO input current LO Output current		11 kW 26.9 A 26 A	15 kW 33.1 A 32 A	18.5 kW 39.2 A 38 A
HO power HO input current HO output current		7.5 kW 18.6 A 18 A	11 kW 26.9 A 26 A	15 kW 33.1 A 32 A
Fuse according to IEC Fuse according to UL		3NE1 803-0 AJT35 / 3NE1 803-0	3NE1 817-0 AJT45 / 3NE1 817-0	3NE1 817-0 AJT50 / 3NE1 817-0
Power losses, unfiltered Power losses, filtered		0.3 kW 0.3 kW	0.35 kW 0.35 KW	0.45 kW 0.45 KW
Required cooling air flow		18.5 l/s	18.5 l/s	18.5 l/s
Cross section of line and motor cable		6 …16 mm² 10 … 6 AWG	6 …16 mm² 10 … 6 AWG	6 …16 mm² 10 … 6 AWG
Tightening torque for line and motor cable		1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in
Weight, unfiltered Weight, filtered		4.5 kg 5.1 kg	4.5 kg 5.1 kg	4.5 kg 5.1 kg

Table 12- 10 PM230, PT, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3211… 6SL3211…	…1NE23-8UL0 …1NE23-8AL0
LO power LO input current LO Output current		18.5 kW 39.2 A 38 A
HO power HO input current HO output current		15 kW 33.1 A 32 A
Fuse according to IEC Fuse according to UL		3NE1 817-0 AJT50 / 3NE1 817-0
Power losses, unfiltered Power losses, filtered		0.45 kW 0.45 KW
Required cooling air flow		18.5 l/s
Cross section of line and motor cable		6 …16 mm² 10 … 6 AWG
Tightening torque for line and motor cable		1.3 Nm / 12 lbf in
Weight, unfiltered Weight, filtered		5.4 kg 6 kg

Table 12- 11 PM230, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE24-5UL0 …1NE24-5AL0	…1NE26-0UL0 …1NE26-0AL0
LO power		22 kW	30 kW
LO input current		42 A	56 A
LO output current		45 A	60 A
HO power		18.5 kW	22 kW
HO input current		36 A	42 A
HO output current		38 A	45 A
Fuse according to IEC		3NE1818-0	3NE1820-0
Fuse according to UL		3NE1818-0	3NE1820-0
Power losses, unfiltered		0.52 kW	0.68 kW
Power losses, filtered		0.52 kW	0.68 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cable		16 … 35 mm² 5 … 2 AWG	16 … 35 mm² 5 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		11 kg	11 kg
Weight, filtered		14 kg	14 kg

Table 12- 12 PM230, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1NE27-5UL0 …1NE27-5AL0	…1NE28-8UL0 …1NE28-8AL0
LO power		37 kW	45 kW
LO input current		70 A	84 A
LO output current		75 A	90 A
HO power		30 kW	37 kW
HO input current		56 A	70 A
HO output current		60 A	75 A
Fuse according to IEC		3NE1021-0	3NE1022-0
Fuse according to UL		3NE1021-0	3NE1022-0
Power losses, unfiltered		0.99 kW	1.2 kW
Power losses, filtered		0.99 kW	1.2 kW
Required cooling air flow		80 l/s	80 l/s
Cross section of line and motor cable		25 … 50 mm² 3 … 1-1/0 AWG	25 … 50 mm² 3 … 1-1/0 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		15 kg	15 kg
Weight, filtered		22 kg	22 kg

Table 12- 13 PM230, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3210…**	**…1NE31-1UL0**	**…1NE31-5UL0**
Order No. - Filtered	**6SL3210…**	**…1NE31-1AL0**	**…1NE31-5AL0**
LO power		55 kW	75 kW
LO input current		102 A	135 A
LO output current		110 A	145 A
HO power		45 kW	55 kW
HO input current		84 A	102 A
HO output current		90 A	110 A
Fuse according to IEC		3NE1224-0	3NE1225-0
Fuse according to UL		3NE1224-0	3NE1225-0
Power losses, unfiltered		1.4 kW	2.0 kW
Power losses, filtered		1.4 kW	2.0 kW
Required cooling air flow		150 l/s	150 l/s
Cross section of line and motor cable		35 … 120 mm^2 2 … 4/0 AWG	35 … 120 mm^2 2 … 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight, unfiltered		15 kg	34 kg
Weight, filtered		22 kg	46 kg

12.3.2 Technical data, PM240

12.3.2.1 General data, PM240

Feature	Version
Line voltage	380 V ... 480 V 3-ph. AC ± 10%
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)
Input frequency	50 Hz … 60 Hz, ± 3 Hz
Output frequency	0 … 650 Hz, depending on the control mode
Power factor λ	0.7 ... 0.85
Starting current	Less than the input current
Pulse frequency (factory setting)	4 kHz for 0.37 kW ... 90 kW 2 kHz for 110 kW ... 250 kW The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper
Degree of protection	IP20 chassis units
Operating temperature	LO without power reduction: all power ratings 0° C … +40° C HO without power reduction: 0.37 ... 110 kW 0° C … +50° C HO without power reduction: 132 … 200 kW 0° C … +40° C LO/HO with power reduction: all power ratings up to 60° C For details, see the Hardware Installation Manual.
Storage temperature	-40° C … +70° C
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007
Relative humidity	< 95% - condensation not permissible
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995
Shock and vibration	• 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: 0.37 kW ... 132 kW up to 1000 m above sea level 160 kW ... 250 kW up to 2000 m above sea level with power reduction: all power ratings up to 4000 m above sea level For details, see the Hardware Installation Manual
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.

12.3.2.2 Power-dependent data, PM240

Note

The given input currents are valid for operation without a line reactor for a line voltage of 400 V with Vk = 1 % referred to the rated power of the inverter. If a line reactor is used, the specified values are reduced by a few percent.

Table 12- 14 PM240, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered	6SL3224-…	…0BE13-7UA0	…0BE15-5UA0	…0BE17-5UA0
Rated / LO power Rated / LO input current Rated / LO Output current		0.37 kW 1.6 A 1.3 A	0.55 kW 2.0 A 1.7 A	0.75 kW 2.5 A 2.2 A
HO power HO input current HO output current		0.37 kW 1.6 A 1.3 A	0.55 kW 2.0 A 1.7 A	0.75 kW 2.5 A 2.2 A
Fuse		10 A, class J	10 A, class J	10 A, class J
Power losses		0.097 kW	0.099 kW	0.102 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 … 2.5 mm^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 cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.2 kg	1.2 kg	1.2 kg

Table 12- 15 PM240, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered	6SL3224-…	…0BE21-1UA0	…0BE21-5UA0
Rated / LO power Rated / LO input current Rated / LO Output current		1.1 kW 3.9 A 3.1 A	1.5 kW 4.9 A 4.1 A
HO power HO input current HO output current		1,1 kW 3.8 A 3.1 A	1,5kW 4.8 A 4.1 A
Fuse		10 A, class J	10 A, class J
Power losses		0.108 kW	0.114 kW
Required cooling air flow		4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		1.1 kg	1.1 kg

Table 12- 16 PM240, IP20, Frame Sizes B, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3224-… 6SL3224-…	…0BE22-2UA0 …0BE22-2AA0	…0BE23-0UA0 …0BE23-0AA0	…0BE24-0UA0 …0BE24-0AA0
Rated / LO power Rated / LO input current Rated / LO Output current		2.2 kW 7.6 A 5.9 A	3 kW 10.2 A 7.7 A	4 kW 13.4 A 10.2 A
HO power HO input current HO output current		2.2 kW 7.6 A 5.9 A	3 KW 10.2 A 7.7 A	4 kW 13.4 A 10.2 A
Fuse		16 A, Class J	16 A, Class J	20 A, Class J
Power losses		0.139 kW	0.158 kW	0.183 kW
Required cooling air flow		24 l/s	24 l/s	24 l/s
Cross section of line and motor cable		1.5 … 6 mm^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 cable		1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in
Weight		4.3 kg	4.3 kg	4.3 kg

Table 12- 17 PM240, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3224-… 6SL3224-…	…0BE25-5UA0 …0BE25-5AA0	…0BE27-5UA0 …0BE27-5AA0	…0BE31-1UA0 …0BE31-1AA0
Rated / LO power Rated / LO input current Rated / LO Output current		7.5 kW 21.9 A 18 A	11 kW 31.5 A 25 A	15 kW 39.4 A 32 A
HO power HO input current HO output current		5.5 kW 16.7 A 13.2 A	7.5 kW 23.7 A 19 A	11 kW 32.7 A 26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power losses		0.240 kW	0.297 kW	0.396 kW
Required cooling air flow		55 l/s	55 l/s	55 l/s
Cross section of line and motor cable		4 … 10 mm^2 12 … 8 AWG	4 … 10 mm^2 12 … 8 AWG	4 … 10 mm^2 12 … 8 AWG
Tightening torque for line and motor cable		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight, unfiltered Weight, filtered		6.5 kg 7 kg	6.5 kg 7 kg	6.5 kg 7 kg

Table 12- 18 PM240, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3224-…**	**…0BE31-5UA0**	**…0BE31-8UA0**	**…0BE32-2UA0**
Order No. - Filtered	**6SL3224-…**	**…0BE31-5AA0**	**…0BE31-8AA0**	**…0BE32-2AA0**
Rated / LO power		18.5 kW	22 kW	30 kW
Rated / LO input current		46 A	53 A	72 A
Rated / LO Output current		38 A	45 A	60 A
HO power		15 kW	18.5 kW	22 kW
HO input current		40 A	46 A	56 A
HO output current		32 A	38 A	45 A
Fuse according to IEC		3NA3820	3NA3822	3NA3824
Fuse according to UL		50 A, Class J	63 A, Class J	80 A, Class J
Power losses		0.44 kW 0.42 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 cable		10 … 35 mm² 7 … 2 AWG	10 … 35 mm² 7 … 2 AWG	16 … 35 mm² 5 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		13 kg	13 kg	13 kg
Weight, filtered		16 kg	16 kg	16 kg

Table 12- 19 PM240, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3224-…**	**…0BE33-0UA0**	**…0BE33-7UA0**
Order No. - Filtered	**6SL3224-…**	**…0BE33-0AA0**	**…0BE33-7AA0**
Rated / LO power		37 kW	45 kW
Rated / LO input current		88 A	105 A
Rated / LO Output current		75 A	90 A
HO power		30 kW	37 kW
HO input current		73 A	90 A
HO output current		60 A	75 A
Fuse according to IEC		3NA3830	3NA3832
Fuse according to UL		100 A, Class J	125 A, Class J
Power losses, unfiltered		0.99 kW	1.2 kW
Power losses, filtered		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cable		25 … 35 mm² 3 … 2 AWG	25 … 35 mm² 3 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered		16 kg	16 kg
Weight, filtered		23 kg	23 kg

Table 12- 20 PM240, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3224-… 6SL3224-…	…0BE34-5UA0 …0BE34-5AA0	…0BE35-5UA0 …0BE35-5AA0	…0BE37-5UA0 …0BE37-5AA0
Rated / LO power Rated / LO input current Rated / LO Output current		55 kW 129 A 110 A A	75 kW 168 A 145 A	90 kW 204 A 178 A
HO power HO input current HO output current		45 kW 108 A 90 A	55 kW 132 A 110 A	75 kW 169 A 145 A
Fuse according to IEC Fuse according to UL		3NA3832 160 A, Class J	3NA3140 200 A, Class J	3NA3144 250 A, Class J
Power losses, unfiltered Power losses, filtered		1.4 kW 1.5 kW	1.9 kW 2.0 kW	2.3 kW 2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		35 … 120 mm² 2 … 4/0 AWG	70 … 120 mm² 2/0 … 4/0 AWG	95 … 120 mm² 3/0 … 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight, unfiltered Weight, filtered		36 kg 52 kg	36 kg 52 kg	36 kg 52 kg

Table 12- 21 PM240, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - Unfiltered	6SL3224-…	…0BE38-8UA0	…0BE41-1UA0
Rated / LO power Rated / LO input current Rated / LO Output current		110 kW 234 A 205 A	132 kW 284 A 250 A
HO power HO input current HO output current		90 kW 205 A 178 A	110 kW 235 A 205 A
Fuse according to IEC Fuse according to UL		--- 250 A, Class J	--- 315 A, Class J
Power losses		2.4 kW	2.5 kW
Required cooling air flow		117 l/s	117 l/s
Cross section of line and motor cable		95 … 120 mm² 3/0 … 4/0 AWG	95 … 120 mm² 3/0 … 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight,		39 kg	39 kg

Table 12- 22 PM240 Frame Sizes GX, 3 AC 380 V … 480 V

Order No. - Unfiltered	6SL3224-…	…0XE41-3UA0	…0XE41-6UA0	…0XE42-0UA0
Rated / Low Overlaod values				
Rated / LO power		160 kW	200 kW	240 kW
Rated / LO input current		297 A	354 A	442 A
Rated / LO Output current		302 A	370 A	477 A
High Overload values				
HO power		132 kW	160 kW	200 kW
HO input current		245 A	297 A	354 A
HO output current		250 A	302 A	370 A
Fuse according to IEC		3NA3254	3NA3260	3NA3372
Fuse according to UL		355 A, Class J	400 A, Class J	630 A, Class J
Power losses,		3.9 kW	4.4 kW	5.5 kW
Required cooling air flow		360 l/s	360 l/s	360 l/s
Cross section of line and motor cable		95 ... 2 x 240 mm^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 cable		14 Nm / 120 lbf in	14 Nm / 120 lbf in	14 Nm / 120 lbf in
Weight,		176 kg	176 kg	176 kg

12.3.3 Technical data, PM240-2

12.3.3.1 General data, PM240-2

Feature	Version
Line voltage	380 V ... 480 V 3-ph. AC ± 10%
Output voltage	0 V 3-ph. AC … input voltage x 0.95 (max.)
Input frequency	50 … 60 Hz, ± 3 Hz
Output frequency	0 … 650 Hz, depending on the control mode
Power factor λ	0.7 without line reactor; 0.85 with line reactor
Line impedance	Uk ≥ 1%, a line reactor is required for lower values
Starting current	Less than the input current
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency results in a lower output current.
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. For details, see the Hardware Installation Manual, Appendix A2.
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper
Degree of protection	IP20 built-in units: IP20 when mounted in a control cabinet PT devices: IP54 on the control cabinet wall
Operating temperature	LO without power reduction: 0° C … +40° C HO without power reduction: 0° C … +50° C LO/HO with power reduction: to 60° C For details, see the Hardware Installation Manual.
Storage temperature	-40° C … +70° C (-40° F … 158° F)
Relative humidity	< 95% - condensation not permissible
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • 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: up to 1000 m above sea level with power reduction: up to 4000 m above sea level For details, see the Hardware Installation Manual
Standards	UL, cUL, CE, C-tick, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.

12.3.3.2 Power-dependent data PM240-2

Table 12- 23 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1PE11-8UL0 …1PE11-8AL0	…1PE12-3UL0 …1PE12-3AL0	…1PE13-2UL0 …1PE13-2AL0
LO power LO input current LO 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 power HO input current HO output current		0.37 kW 2 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 801 (6 A) 10 A class J	3NA3 801 (6 A) 10 A class J	3NA3 801 (6 A) 10 A class J
Power losses, unfiltered Power losses, filtered		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 cable		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 cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered Weight, filtered		1.4 kg 1.5 kg	1.4 kg 1.5 kg	1.4 kg 1.5 kg

Table 12- 24 PM240-2, IP20, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered Order No. - Filtered	6SL3210… 6SL3210…	…1PE14-3UL0 …1PE14-3AL0	…1PE16-1UL0 …1PE16-1AL0	…1PE18-0UL0 ---
LO power LO input current LO output current		1.5 kW 5.5 A 4.1 A	2.2 kW 7.7 A 5.9 A	3 kW 10.1 A 7.7 A
HO power HO input current HO output current		1.1 kW 4.7 A 3.1 A	1.5 kW 6.1 A 4.1 A	2.2 kW 8.8 A 5.9 A
Fuse according to IEC Fuse according to UL		3NA3 803 (10 A) 10 A class J	3NA3 803 (10 A) 10 A class J	3NA3 805 (16 A) 15 A class J
Power losses, unfiltered Power losses, filtered		0.07 kW 0.07 kW	0.1 kW 0.1 kW	0.12 kW 0.12 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable		1 … 2.5 mm^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 cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered Weight, filtered		1.4 kg 1.5 kg	1.4 kg 1.5 kg	1.4 kg ---

Table 12- 25 PM240-2, PT, Frame Sizes A, 3 AC 380 V … 480 V

Order No. - Unfiltered	**6SL3211…**	**---**	**…1PE18-0UL0**
Order No. - Filtered	**6SL3211…**	**…1PE16-1AL0**	**__**
LO power LO input current LO Output current		2.2 kW 7.7 A 5.9 A	3 kW 10.1 A 7.7 A
HO power HO input current HO output current		1.5 kW 6.1 A 4.1 A	2.2 kW 8.8 A 5.9 A
Fuse according to IEC Fuse according to UL		3NA3 803 (10 A) 10 A class J	3NA3 805 (16 A) 15 A class J
Power losses, unfiltered Power losses, filtered		0.1 kW [1)] 0.1 kW [1)]	0.12 kW [2)] 0.12 kW [2)]
Required cooling air flow		7 l/s	7 l/s
Cross section of line and motor cable		1.5 … 2.5 mm² 16 … 14 AWG	1.5 … 2.5 mm² 16 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered Weight, filtered		--- 1.8 kg	1.7 kg ---

1) 0.08 kW via heat sink;

2) 0.1 kW via heat sink

12.3.4 Technical data, PM250

Feature	Version
Line voltage	380 V ... 480 V 3-ph. AC ± 10%
Output voltage	0 V 3-ph. AC … input voltage x 0.87 (max.)
Input frequency	47 Hz … 63 Hz
Power factor λ	0.9
Starting current	Less than the input current
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased up to 16 kHz in 2 kHz steps. An increase in the pulse frequency results in a lower output current.
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2
Braking methods	DC braking, energy recovery (up to 100% of the output power)
Degree of protection	IP20 chassis units
Operating temperature	LO without power reduction: 0° C … +40° C HO without power reduction: 0° C … +50° C LO/HO with power reduction: to 60° C For details, see the Hardware Installation Manual.
Storage temperature	-40° C … +70° C
Relative humidity	< 95% - condensation not permissible
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • 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: up to 1000 m above sea level with power reduction: up to 4000 m above sea level For details, see the Hardware Installation Manual
Standards	UL, CE, CE, SEMI F47 The drive only satisfies the UL requirements when UL-certified fuses are used.

12.3.4.1 Power-dependent data, PM250

Table 12- 26 PM250, IP20, Frame Sizes C, 3 AC 380 V … 480 V

Order No. - Filtered	6SL3225-…	0BE25-5AA0	0BE27-5AA0	0BE31-1AA0
Rated / LO power Rated / LO input current Rated / LO Output current		7.5 kW 18 A 18 A	11 kW 25 A 25 A	15 kW 32 A 32 A
HO power HO input current HO output current		5. 5 kW 13.2 A 13.2 A	7.5 kW 19 A 19 A	11 kW 26 A 26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power losses		0.24 kW	0.30 kW	0.31 kW
Required cooling air flow		38 l/s	38 l/s	38 l/s
Cross section of line and motor cable		2.5 … 10 mm² 14 … 8 AWG	4.0 … 10 mm² 12 … 8 AWG	4.0 … 10 mm² 12 … 8 AWG
Tightening torque for line and motor cable		2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in	2.3 Nm / 20 lbf in
Weight		7.5 kg	7.5 kg	7.5 kg

Table 12- 27 PM250, IP20, Frame Sizes D, 3 AC 380 V … 480 V

Order No. - Filtered	6SL3225-…	0BE31-5AA0	0BE31-8AA0	0BE32-2AA0
Rated / LO power Rated / LO input current Rated / LO Output current		18.5 kW 36 A 38 A	22 kW 42 A 45 A	30 kW 56 A 60 A
HO power HO input current HO output current		15 kW 30 A 32 A	18.5 kW 36 A 38 A	22 kW 42 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 losses		0.44 kW	0.55 kW	0.72 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		10 … 35 mm² 7 … 2 AWG	10 … 35 mm² 7 … 2 AWG	16 … 35 mm² 6 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		15 kg	15 kg	16 kg

Table 12- 28 PM250, IP20, Frame Sizes E, 3 AC 380 V … 480 V

Order No. - Filtered	**6SL3225-…**	**0BE33-0AA0**	**0BE33-7AA0**
Rated / LO power Rated / LO input current Rated / LO Output current		37 kW 70 A 75 A	45 kW 84 A 90 A
HO power HO input current HO output current		30 kW 56 A 60 A	37 kW 70 A 75 A
Fuse according to IEC Fuse according to UL		3NA3830 100 A, Class J	3NA3832 125 A, Class J
Power losses		1.04 kW	1.2 kW
Required cooling air flow		22 l/s	39 l/s
Cross section of line and motor cable		25 … 35 mm² 3 … 2 AWG	25 … 35 mm² 3 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		21 kg	21 kg

Table 12- 29 PM250, IP20, Frame Sizes F, 3 AC 380 V … 480 V

Order No. - Filtered	**6SL3225-…**	**0BE34-5AA0**	**0BE35-5AA0**	**0BE37-5AA0**
Rated / LO power Rated / LO input current Rated / LO Output current		55 kW 102 A 110 A	75 kW 135 A 145 A	90 kW 166 A 178 A
HO power HO input current HO output current		45 kW 84 A 90 A	55 kW 102 A 110 A	75 kW 135 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 losses		1.5 kW	2.0 kW	2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		35 … 120 mm² 2 … 4/0 AWG	35 … 120 mm² 2 … 4/0 AWG	35 … 120 mm² 2 … 4/0 AWG
Tightening torque for line and motor cable		13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight		51 kg	51 kg	51 kg

12.3.5 Technical data, PM260

Feature	Version
Line voltage	660 V ... 690 V 3-ph. AC ± 10% The power units can also be operated with a minimum voltage of 500 V –10 %. In this case, the power is linearly reduced.
Input frequency	50 Hz … 60 Hz, ± 3 Hz
Power factor λ	0.9
Starting current	Less than the input current
Pulse frequency	16 kHz
Electromagnetic compatibility	The devices in compliance with EN 61800-3: 2004 are suitable for Category C1 and C2 environments. For details, see the Hardware Installation Manual, Appendix A2
Braking methods	DC braking, energy recovery (up to 100% of the output power)
Degree of protection	IP20 chassis units
Operating temperature	LO without power reduction: 0° C … +40° C HO without power reduction: 0° C … +50° C LO/HO with power reduction: to 60° C For details, see the Hardware Installation Manual.
Storage temperature	-40° C … +70° C (-40° F … 158° F)
Relative humidity	< 95% - condensation not permissible
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995
Shock and vibration	• Long-term storage in the transport packaging according to Class 1M2 to EN 60721-3-1: 1997 • 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: up to 1000 m above sea level with power reduction: up to 4000 m above sea level For details, see the Hardware Installation Manual
Standards	CE, C-TICK

12.3.5.1 Power-dependent data, PM260

Table 12- 30 PM260, IP20, Frame Sizes D - 3 AC 660 V … 690 V

Order No. - Unfiltered **Order No. - Filtered**	**6SL3225-…** **6SL3225-…**	**0BH27-5UA1** **0BH27-5AA1**	**0BH31-1UA1** **0BH31-1AA1**	**0BH31-5UA1** **0BH31-5AA1**
Rated / LO power Rated / LO input current Rated / LO Output current		11 kW 13 A 14 A	15 kW 18 A 19 A	18.5 kW 22 A 23 A
HO power HO input current HO 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, unfiltered Power losses, filtered				
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		2,5 … 16 mm^2 14 … 6 AWG	4 … 16 mm^2 12 … 6 AWG	6 … 16 mm^2 10 … 6 AWG
Tightening torque for line and motor cable		1,5 Nm / 53 lbf in	1,5 Nm / 53 lbf in	1,5 Nm / 53 lbf in
Weight, unfiltered Weight, filtered		22 kg 23 kg	22 kg 23 kg	22 kg 23 kg
Noise pressure		< 64 dB(A)	< 64 dB(A)	< 64 dB(A)

Table 12- 31 PM260, IP20, Frame Sizes F - 3 AC 660 V … 690 V

Order No. - Unfiltered **Order No. - Filtered**	**6SL3225-…** **6SL3225-…**	0BH32-2UA1 0BH32-2AA1	0BH33-0UA1 0BH33-0AA1	0BH33-7UA1 0BH33-7AA1
Rated / LO power Rated / LO input current Rated / LO Output current		30 kW 34 A 35 A	37 kW 41 A 42 A	55 kW 60 A 62 A
HO power HO input current HO output current		22 kW 26 A 26 A	30 kW 34 A 35 A	37 kW 41 A 42 A
Fuse		50 A	50 A	80 A
Power losses, unfiltered Power losses, filtered				
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and motor cable		10 … 35 mm^2 8 … 2 AWG	16 … 35 mm^2 6 … 2 AWG	25 … 35 mm^2 4 … 2 AWG
Tightening torque for line and motor cable		6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight, unfiltered Weight, filtered		56 kg 58 kg	56 kg 58 kg	56 kg 58 kg
Noise pressure		< 70 dB(A)	< 70 dB(A)	< 70 dB(A)

Appendix A

A.1 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.

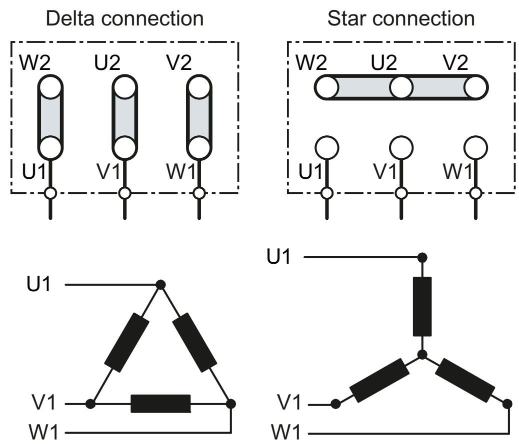
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

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.2 Parameter

Parameters are the interface between the firmware of the inverter and the commissioning tool, e.g. an operator panel.

Adjustable parameters

Adjustable parameters are the "adjusting screws" with which you adapt the inverter to its particular application. If you change the value of an adjustable parameter, then the inverter 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 inverter and the motor to be read.

Display parameters are shown with a "r" as prefix, e.g. p0027 is the parameter for the inverter output current.

Parameters that in many cases help

Table A- 1 **How to switch to commissioning mode or restore the factory setting**

Parameter	Description
p0010	**Commissioning parameters** 0: Ready (factory setting) 1: Carry out basic commissioning 3: Perform motor commissioning 5: Technological applications and units 15: Define number of data records 30: Factory setting - initiate restore factory settings

Table A- 2 **How to determine the firmware version of the Control Unit**

Parameter	Description
r0018	**The firmware version is displayed:**

Table A- 3 **How to select the command and setpoint sources for the inverter**

Parameter	Description
p0015	Additional information is available in the section Select interface assignments (Page 46).

Table A- 4 This is how you parameterize the up and down ramps

Parameter	Description
p1080	Minimum speed 0.00 [rpm] factory setting
p1082	Maximum speed 1500.000 [rpm] factory setting
p1120	Rampup time 10.00 [s]
p1121	Rampdown time 10.00 [s]

Table A- 5 This is how you set the closed-loop type

Parameter	Description
p1300	0: V/f control with linear characteristic 1: V/f control with linear characteristic and FCC 2: V/f control with parabolic characteristic 3: V/f control with parameterizable characteristic 4: V/f control with linear characteristic and ECO 5: V/f control for drives requiring a precise frequency (textile area) 6: V/f control for drive requiring a precise frequency and FCC 7: V/f control with parabolic characteristic and ECO 19: V/f control with independent voltage setpoint 20: Speed control (without encoder) 22: Torque control (without encoder)

Table A- 6 This is how you optimize the starting behavior of the V/f control for a high break loose torque and overload

Parameter	Description
p1310	Voltage boost to compensate ohmic losses The voltage boost is active from standstill up to the rated speed. It is at its highest at speed 0 and continually decreases as the speed increases. Value of the voltage boost at zero 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.

A.3 Interconnecting signals in the inverter

A.3.1 BICO technology: basic principles

Principle of operation of BICO technology

Open/closed-loop control functions, communication functions as well as diagnostic and operator functions are implemented in the inverter. Every function comprises one or several BICO blocks that are interconnected with one another.

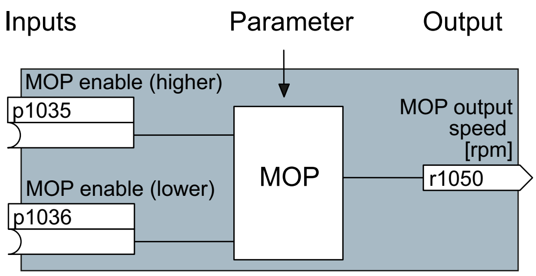


Figure A-1 Example of a BICO block: Motorized potentiometer (MOP)

Most of the BICO blocks can be parameterized. You can adapt the blocks to your application 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.

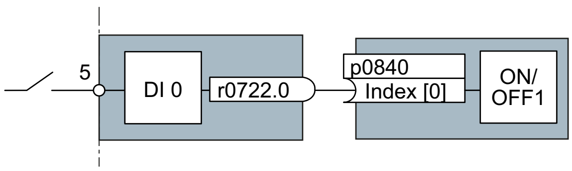


Figure A-2 Example: Signal interconnection of two BICO blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual BICO 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)

Definition of BICO technology

BICO technology represents a type of parameterization that can be used to disconnect all internal signal interconnections between BICO blocks or establish new connections. This is realized using **Bi**nectors and **Co**nnectors. Hence the name **BICO** technology. (Binector Connector Technology)

BICO parameters

You can use the BICO parameters to define the sources of the input signals of a block. Using BICO parameters you define from which connectors and binectors a block reads-in its input signals. This is how you "interconnect" the blocks stored in the devices according to your particular application requirements. The five different BICO parameter types are shown in the following diagram:

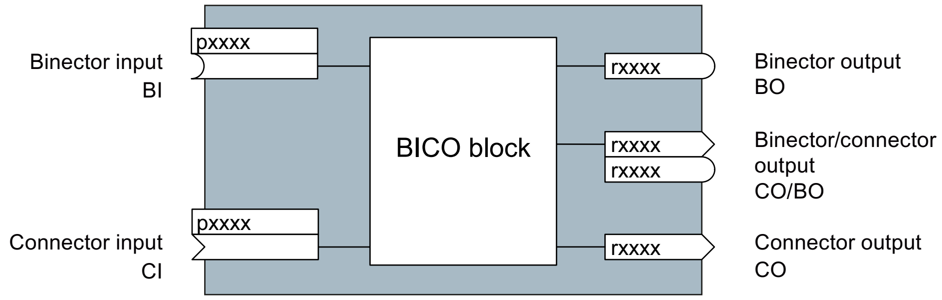


Figure A-3 BICO symbols

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.

BICO outputs (CO, BO, or CO/BO) can be used more than once.

When do you need to use BICO technology?

BICO technology allows you to adapt the inverter to a wide range of different 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.

What precautions should you take when using BICO technology?

Always apply caution when handling internal 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 various screens that make it much easier for you to use BICO technology. The signals that you can interconnect are displayed in plain text, which means that you do not need any prior knowledge of BICO technology.

What sources of information do you need to help you set parameters using BICO technology?

- This manual is sufficient for simple signal interconnections, e.g. assigning a different significance to the to digital inputs.
- The parameter list in the List Manual is sufficient for signal interconnections that go beyond just simple ones.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

A.3.2 BICO technology: example

Example: Shifting a basic PLC functionality into the converter

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 five seconds)
- The protective door is closed

The task is realized by inserting free blocks between the digital input 0 and the internal ON/OFF1 command and interconnecting them.

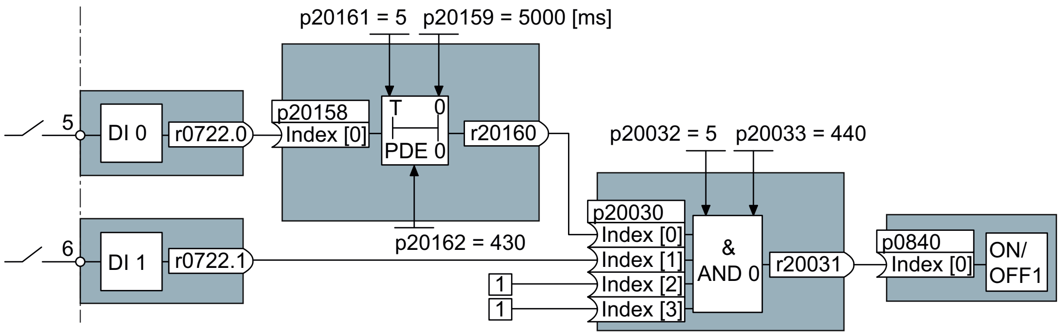


Figure A-4 Example: Signal interconnection for interlock

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.

Table A- 7 Parameterizing an interlock

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)

Parameter	Description
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	Interconnecting the AND output to the control command ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter P0840[0] is the input of the "ON/OFF1 command" block of the converter. Parameter r20031 is the output of the AND block. To interconnect the ON/OFF1 command with the output of the AND block, set P0840 to 20031.

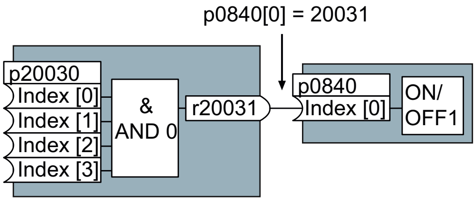


Figure A-5 Interconnecting two BICO blocks by setting p0840[0] = 20031

Principle when connecting BICO blocks using BICO technology

An interconnection between two BICO blocks comprises a connector or binector and a BICO parameter. The interconnection is always established from the perspective of the input of a particular BICO block. This means that the output of an upstream block must always be assigned to the input of a downstream block. The assignment is always made by entering the number of the connector/binector from which the required input signals are read in a BICO parameter.

This interconnection logic involves the question: **where does the signal come from?**

NOTICE
For the basic commissioning, you determine the function of the interfaces for your inverter via predefined settings (p0015). If you subsequently select a different predefined setting for the function of the interfaces, then all BICO interconnections that you changed will be lost.

A.4 Application Examples

A.4.1 Configuring PROFIBUS communication in STEP 7

Using a suitable example, the following section provides information on how you connect an inverter to a higher-level SIMATIC control via PROFIBUS.

What prior knowledge is required?

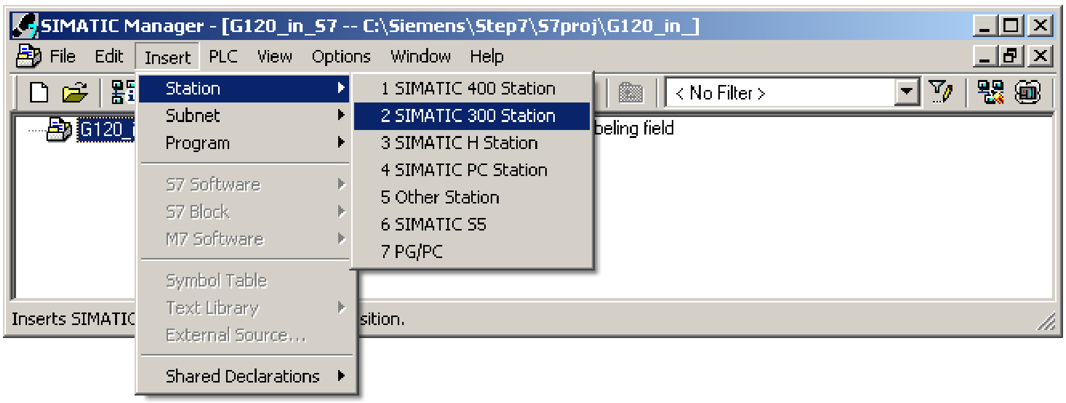
In this example, it is assumed that readers know now to basically use an S7 control and the STEP 7 engineering tool and is not part of this description.

A.4.1.1 Creating a STEP 7 project

PROFIBUS communication between the inverter and a SIMATIC control is configured using the SIMATIC STEP 7 and HW Config software tools.

Procedure

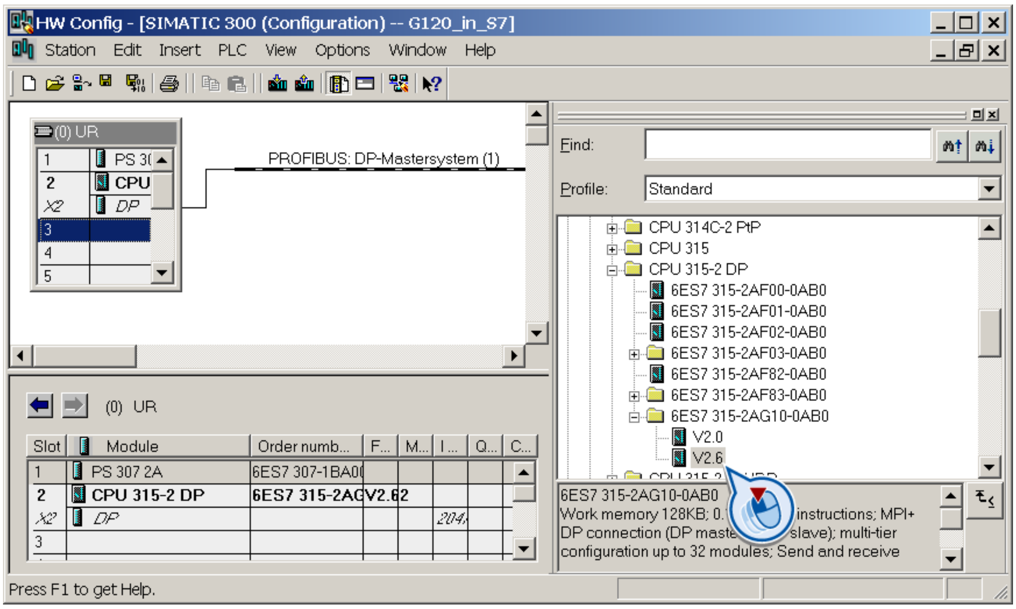
- Create a new STEP 7 project, e.g. "G120_in_S7 ". Add an S7 300 CPU.



- Select the SIMATIC 300 station in your project and open the hardware configuration (HW Config) by double clicking on "Hardware".
- Add an S7 300 mounting rail to your project by dragging and dropping it from the "SIMATIC 300" hardware catalog. Locate a power supply at slot 1 of the mounting rail and a CPU 315-2 DP at slot 2.

When you add the SIMATIC 300, a window is displayed in which you can define the network.

- Create a PROFIBUS DP network.



A.4.1.2 Configuring communications to a SIMATIC control

The inverter can be connected to a SIMATIC control in two ways:

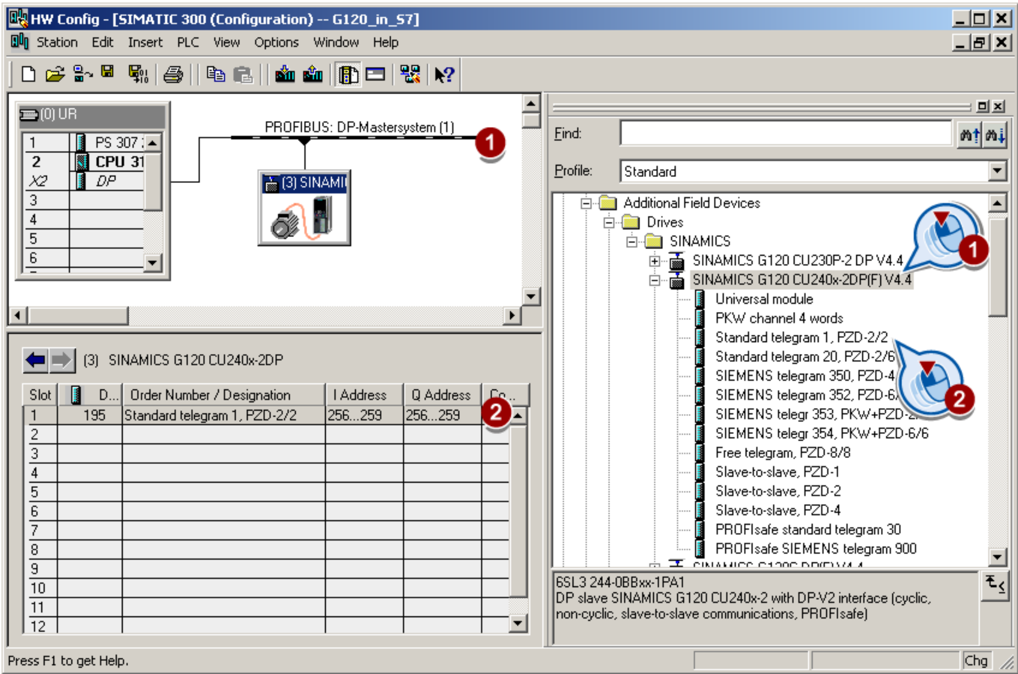
1. Using the inverter GSD
2. Using the STEP 7 object manager

   This somewhat more user-friendly method is only available for S7 controls and installed Drive ES Basic (see Section Accessories for commissioning and operation (Page 25)).

The following section describes how to configure the inverter using the GSD.

A.4.1.3 Insert the frequency converter into the STEP 7 project

- Install the GSD of the converter in STEP 7 via HW Config (Menu "Tools - Install GSD files").
  Once the GSD has been installed, the converter appears under "PROFIBUS DP - Additional field devices" in the hardware catalog of HW Config.



- Drag and drop the converter into the PROFIBUS network. Enter the PROFIBUS address set at the converter in HW Config.
- The telegram type defines which data is exchanged between the control and converter. Insert the required telegram type from the HW catalog by dragging and dropping into slot 1 of the converter.
  You can find more information on the telegram types in Chapter Cyclic communication (Page 101).

Sequence when assigning the slots

1. PROFIsafe module (if one is being used)
   Information on connecting the converter via PROFIsafe can be found in the "Safety Integrated Function Manual".
2. PKW channel (if one is used)
3. Standard, SIEMENS or free telegram (if one is used)
4. Slave-to-slave module

If you do not use one or several of the modules 1, 2 or 3, configure the remaining modules starting with the 1st slot.

Note regarding the universal module

It is not permissible to configure the universal module with the following properties:

- PZD length 4/4 words
- Consistent over the complete length

With these properties, the universal module has the same DP identifier (4AX) as the "PKW channel 4 words" and is therefore identified as such by the higher-level control. As a consequence, the control does not establish cyclic communication with the inverter.

Remedy: Change the length to 8/8 bytes in the properties of the DP slave. As an alternative, you can also change the consistency to "unit".

Final steps

- Save and compile the project in STEP 7.
- Establish an online connection between your PC and the S7 CPU and download the project data to the S7 CPU.
- In the inverter, select the telegram type, which you configured in STEP 7, using parameter P0922.

The inverter is now connected to the S7 CPU. This therefore defines the communication interface between the CPU and the inverter. An example of how you can supply this interface with data can be found in the next section.

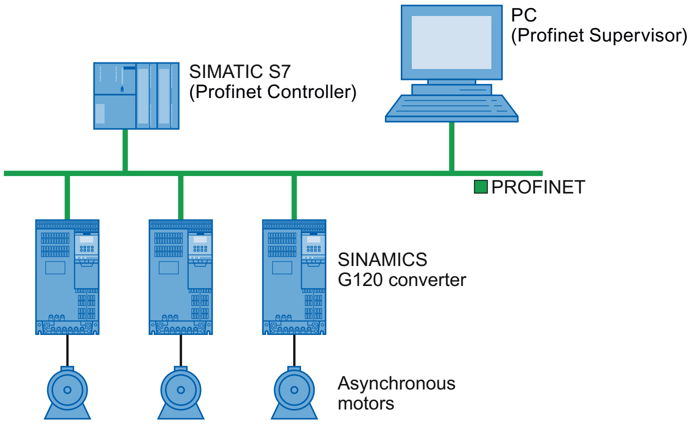
A.4.2 Configuring PROFINET communication in STEP 7

A.4.2.1 Communication via PROFINET - example

Profinet network in a line topology

The adjacent example shows the structure of a Profinet network in a line topology, with one controller (S7-300), three devices (G120 converters) and one supervisor (programming device).

Communication is established via "twisted-pair lines" with RJ45 connectors. 100 Mbit/s in the full duplex mode is required as transmission rate.



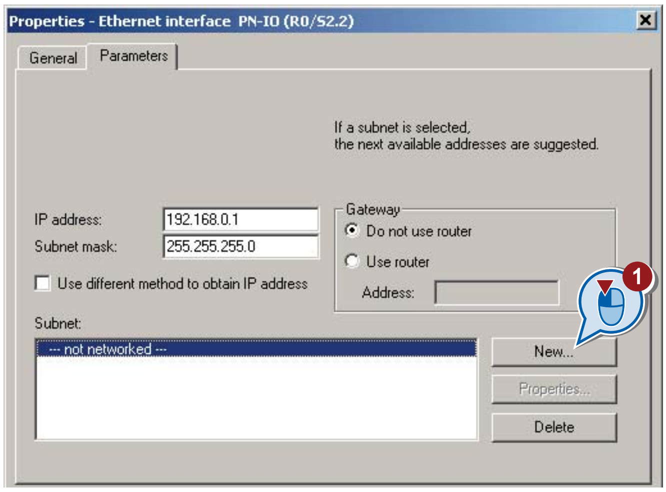
A.4.2.2 Configuring the system in HW Config

Open HW Config in STEP 7 via "Insert/[Station]", and create the components in accordance with your hardware structure. The following example is limited to the components that are absolutely required.

Insert the CPU if you have configured your station with a rack and power supply.

NOTICE
Device name for PROFINET Based on the device name, when booting, the PROFINET controller assigns the IP address; as a consequence, the device names within a subnet must be unique. In the SIMATIC Manager, only lower-case letters may be used for the device name. Spaces and special characters are replaced by "x".

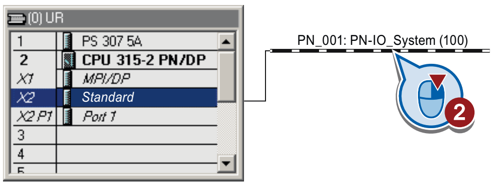
In the screen form that opens, HW Config proposes the next free IP address and a subnet mask. If you have configured a local area network, and are not working within a larger Ethernet network, you can use the proposed entries. Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. The subnet mask must have the same address that you assigned when addressing the supervisor.



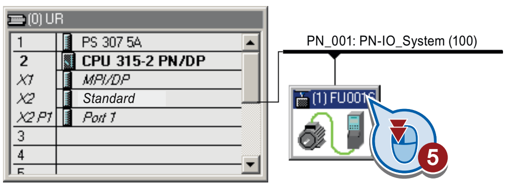
Use the "New" button (①) to either create a new PROFINET subnet or select an existing one.

Assign a name for your PROFINET network there. Additional modifications are not necessary. Exit this screen form and the next one with OK.

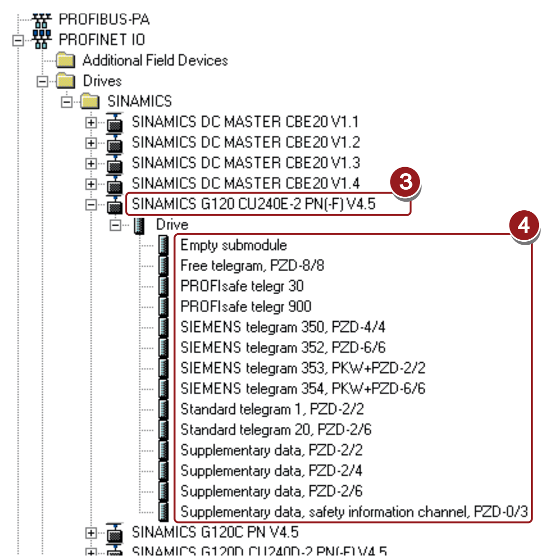
In the next step, select the bus (②), and via the hardware catalog using drag-and-drop, first insert the converter (③) and then the communication telegram (④).



Open the properties window of the converter (⑤) and enter a unique and descriptive device name for the converter. You will also find the proposed IP address in this screen form. If required, you can change the IP address via "Properties".



Hardware catalog



Then save your hardware configuration with "Save and compile" ( ). You have now completed configuring the device in STEP 7.

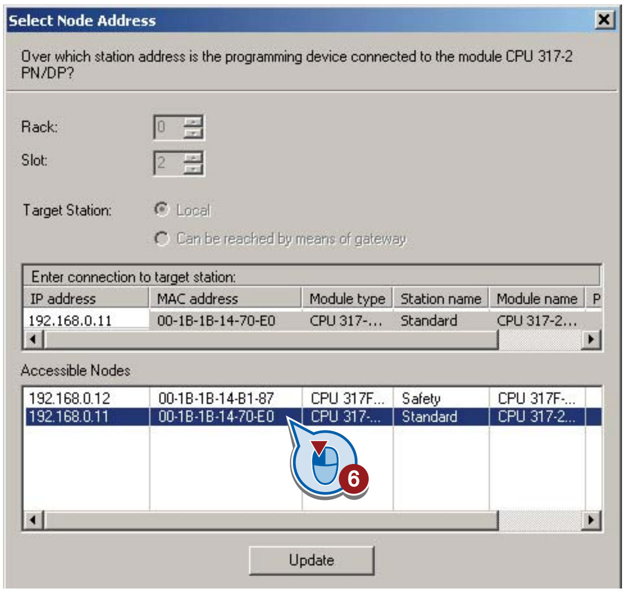
Note

STEP 7 with Drive ES Basic

If you have installed Drive ES Basic, you can now integrate the converter via the object manager and open STARTER in HW Config by double-clicking the converter. In this case, STARTER automatically accepts the device name and IP address. As a consequence, the procedure described in Section Inserting the converter into the SIMATIC Manager (Page 337) is superfluous.

In the next step, load the configuration into the control by clicking the button. In the next screen form, set the IP address of the control.

If you do not have the IP address readily available, you can display the participants that can be reached by clicking the "Display" button. Select the control from the list of accessible participants (⑥), and exit the screen form with OK.



The CPU must be stopped to complete the loading process.

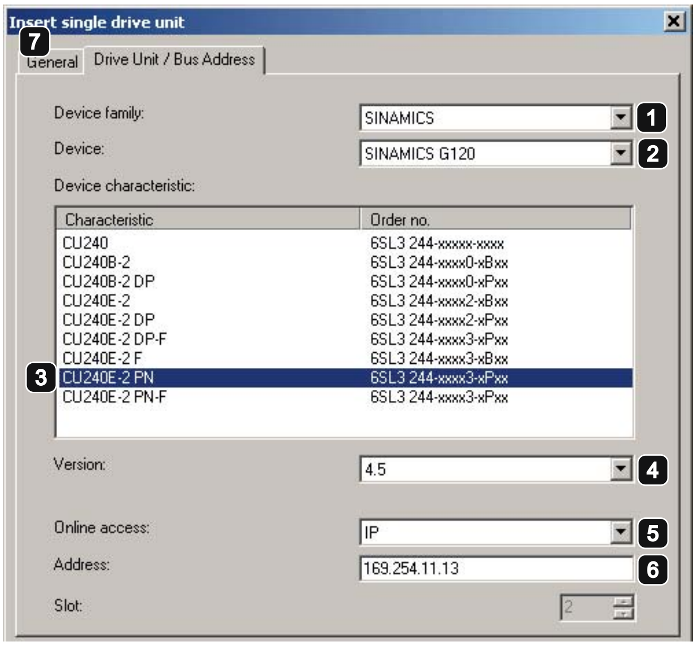
If you have installed Drive ES Basic, open STARTER by double-clicking the converter symbol in the Hardware Manager and configure the converter in STARTER.

If you are working with the GSDML, now close HW Config and insert the converter in the SIMATIC Manager as described in the following section.

A.4.2.3 Inserting the converter into the SIMATIC Manager

Select your project in the SIMATIC Manager and open the "Insert single drive unit" screen form by right clicking on "Insert New Object/SINAMICS".

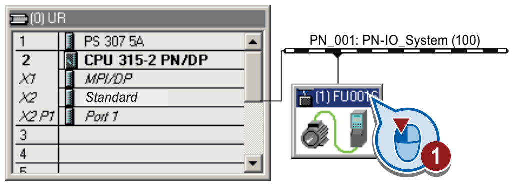
There, under the tab "Drive unit/bus address", as shown in the diagram, select your converter and under the tab "General" (⑦) enter the PROFINET device name. Exit the screen form with OK.



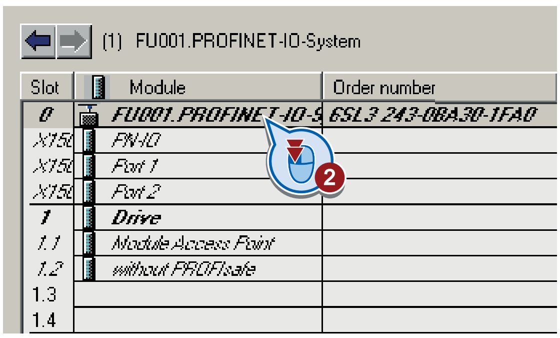
The converter is now displayed in your project in the SIMATIC Manager.

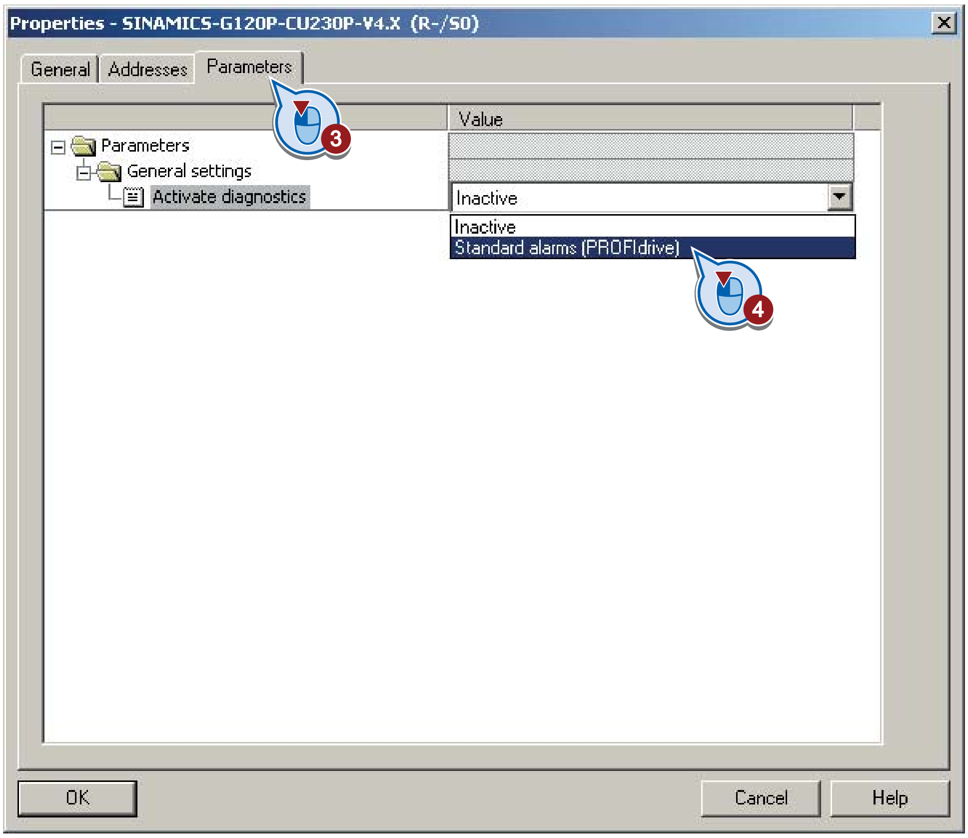
A.4.2.4 Activate diagnostic messages via STEP 7

In HW Config, select the converter ①



Open by double-clicking on slot 0 in the station window ② the properties window for the network settings of the converter and activate there in the parameter ③ tab as shown the standard alarms ④.



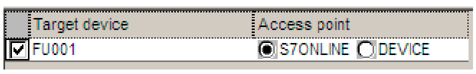


With the next ramp-up of the controller, the diagnostic messages of the converter are then transferred to the controller.

A.4.2.5 Go online with STARTER via PROFINET

Select the converter in SIMATIC Manager with the righthand mouse button and open STARTER via "Open object".

Configure the converter in STARTER and click on the Online button (). In the following window, select the converter and then the S7ONLINE as access point.



Exit the screen form with OK and the online connection will be established.

A.4.3 STEP 7 program examples

Data exchange via the fieldbus

Analog signals

The converter always scales signals, which are transferred via the fieldbus, to a value of 4000 hex.

Table A- 8 Signal category and the associated scaling parameters

Signal category	4000 hex ≙ …	Signal category	4000 hex ≙ …
Speeds, frequencies	p2000	Power	p2004
Voltage	p2001	Angle	p2005
Current	p2002	Temperature	p2006
Torque	p2003	Acceleration	p2007

Control and status words

Control and status words consist of a high byte and a low byte. A SIMATIC control interprets words differently than the converter: The higher and lower-order bytes are interchanged when they are transferred. See also the following program example.

A.4.3.1 STEP 7 program example for cyclic communication

Network 1: Control word 1 and setpoint

Control word 1: 047E hex Setpoint: 2500 hex

```
L   W#16#47E
T   MW    1
L   W#16#2500
T   MW    3
```

Network 2: Acknowledge fault

```
U   E     0.6
=   M     2.7
```

Network 3: Switch the motor on and off

```
U   E     0.0
=   M     2.0
```

Network 4: Write process data

```
L   MW    1
T   PAW   256
L   MW    3
T   PAW   258
```

Network 4: Read process data

Status word 1: MW 5 Actual value: MW 7

```
L   PEW   256
T   MW    5
L   PEW   258
T   MW    7
```

The control and inverter communicate via standard telegram 1. The control specifies control word 1 (STW1) and the speed setpoint, while the inverter responds with status word 1 (ZSW1) and its actual speed.

In this example, inputs E0.0 and E0.6 are linked to the -bit ON/OFF1 or to the "acknowledge fault" bit of STW 1.

Control word 1 contains the numerical value 047E hex. The bits of control word 1 are listed in the following table.

The hexadecimal numeric value 2500 specifies the setpoint frequency of the inverter. The maximum frequency is the hexadecimal value 4000 (also see STEP 7 program examples (Page 339)).

The control cyclically writes the process data to logical address 256 of the inverter. The inverter also writes its process data to logical address 256. You define the address area in HW Config, seeInsert the frequency converter into the STEP 7 project (Page 332).

Table A- 9 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
E	0	0	ON/OFF1	8		0	E0.0
	1	1	ON/OFF2	9		1	
	1	2	ON/OFF3	10		2	
	1	3	Operation enable	11		3	
7	1	4	Ramp-function generator enable	12		4	
	1	5	Start ramp-function generator	13		5	
	1	6	Setpoint enable	14		6	
	0	7	Acknowledge fault	15		7	E0.6
4	0	8	Jog 1	0	0		
	0	9	Jog 2	1	1		
	1	10	PLC control	2	2		
	0	11	Setpoint inversion	3	3		
0	0	12	Irrelevant	4	4		
	0	13	Motorized potentiometer ↑	5	5		
	0	14	Motorized potentiometer ↓	6	6		
	0	15	Data set changeover	7	7		

A.4.3.2 STEP 7 program example for acyclic communication

OB1: Cyclic control program

Network 1: Reading and writing parameters

```
     // read parameters
           O(
           U      M      9.2
           UN     M      9.1
           )
           O(
           U      M      9.0
           UN     M      9.1
           )
           R      M      9.3

           SPB    RD

     // write parameters
           O(
           U      M      9.3
           UN     M      9.0
           )
           O(
           U      M      9.1
           UN     M      9.0
           )
           R      M      9.2

           SPB    WR
           BEA

     RD:   NOP    0
           CALL   FC     1
           BEA
     WR:   NOP    0      9.1
           CALL   FC     3
```

M9.0 Starts reading parameters

M9.1 Starts writing parameters

M9.2 displays the read process

M9.3 displays the write process

The number of simultaneous requests for acyclic communication is limited. More detailed information can be found on Data set communication (http://support.automation.siemens.com/WW/view/en/15364459).

FC1: PAR_RD

Network 1: Parameters for reading

```
      L     MB      40
      T     DB1.DBB   0
      L     B#16#01
      T     DB1.DBB   1
      T     DB1.DBB   2
      L     MB      62
      T     DB1.DBB   3
// -----------------------------------------
      L     MW      50
      T     DB1.DBW   6
      L     MB      58
      T     DB1.DBB   5
      L     MW      63
      T     DB1.DBW   8
// -----------------------------------------
      L     MW      52
      T     DB1.DBW  12
      L     MB      59
      T     DB1.DBB  11
      L     MW      65
      T     DB1.DBW  14
// -----------------------------------------
      L     MW      54
      T     DB1.DBW  18
      L     MB      60
      T     DB1.DBB  17
      L     MW      67
      T     DB1.DBW  10
// -----------------------------------------
      L     MW      56
      T     DB1.DBW  24
      L     MB      61
      T     DB1.DBB  23
      L     MW      69
      T     DB1.DBW  26
```

Network 2: Read request, part 1

```
CALL   SFC    58
  REQ        :=M9.0
  IOID       :=B#16#54
  LADDR      :=W#16#170
  RECNUM     :=B#16#2F
  RECORD     :=P#DB1.DBX0.0 BYTE 28
  RET_VAL    :=MW10
  BUSY       :=M8.1

U     M      8.1
R     M      9.0
S     M      9.2
```

Network 3: Read delay after a read request

```
U     M      8.1
UN    M      9.1
L     S5T#1s
SS    T      1
U     M      8.3
R     T      1
U     T      1
=     M      8.2
```

Network 4: Read request, part 2

```
CALL   SFC    59
  REQ        :=M8.2
  IOID       :=B#16#54
  LADDR      :=W#16#170
  RECNUM     :=B#16#2F
  RET_VAL    :=MW12
  BUSY       :=M8.3
  RECORD     :=P#DB2.DBX0.0 BYTE 36

U     M      8.3
R     M      8.2
```

Figure A-6 Reading parameters

Note

With PROFINET standard function blocks (SFB) instead of system functions (SFC)

With acyclic communication via PROFINET, you must replace the system functions with standard function blocks as follows:

- SFC 58 -> SFB 53
- SFC 59 -> SFB 52

Explanation of FC 1

Table A- 10 Request to read parameters

Data block DB 1	Byte n	Bytes n + 1	n
Header	Reference *MB 40*	01 hex: Read request	0
	01 hex	Number of parameters (m) *MB 62*	2
Address, parameter 1	Attribute *10 hex: Parameter value*	Number of indices *MB 58*	4
	Parameter number *MW 50*		6
	Number of the 1st index *MW 63*		8
Address, parameter 2	Attribute *10 hex: Parameter value*	Number of indices *MB 59*	10
	Parameter number *MW 52*		12
	Number of the 1st index *MW 65*		14
Address, parameter 3	Attribute *10 hex: Parameter value*	Number of indices *MB 60*	16
	Parameter number *MW 54*		18
	Number of the 1st index *MW 67*		20
Address, parameter 4	Attribute *10 hex: Parameter value*	Number of indices *MB 61*	22
	Parameter number *MW 56*		24
	Number of the 1st index *MW 69*		26

SFC 58 copies the specifications for the parameters to be read from DB 1 and sends them to the converter as a read request. No other read requests are permitted while this one is being processed.

After the read request and a waiting time of one second, the control takes the parameter values from the converter via SFC 59 and saves them in DB 2.

FC3: PAR_WR

Network 1: Parameters for writing

```
      L    MB      42
      T    DB3.DBB  0
      L    B#16#02
      T    DB3.DBB  1
      L    B#16#01
      T    DB3.DBB  2
      L    MB      44
      T    DB1.DBB  3
  // -----------------------------------------
      L    MW      21
      T    DB3.DBW  6
      L    MW      23
      T    DB3.DBW  8
      L    MW      35
      T    DB3.DBW  12
      L    MB      25
      T    DB3.DBB  10
      L    MB      27
      T    DB3.DBB  11
```

Network 2: Write request:

```
CALL   SFC   58
   REQ       :=M9.1
   IOID      :=B#16#54
   LADDR     :=W#16#170
   RECNUM    :=B#16#2F
   RECORD    :=P#DB3.DBX0.0 BYTE 14
   RET_VAL   :=MW10
   BUSY      :=M8.1

U    M    8.1
R    M    9.1
S    M    9.3
```

Figure A-7 Writing parameters

Explanation of FC 3

Table A- 11 Request to change parameters

Data block DB 3	Byte n	Bytes n + 1	n
Header	Reference *MB 42*	02 hex: Change request	0
	01 hex	Number of parameters *MB 44*	2
Address, parameter 1	10 hex: Parameter value	Number of indices *00 hex*	4
	Parameter number *MW 21*		6
	Number of the 1st index *MW 23*		8
Values, parameter 1	Format *MB 25*	Number of index values *MB 27*	10
	Value of 1st index *MW35*		12

SFC 58 copies the specifications for the parameters to be written from DB 3 and sends them to the converter. No other write requests are permitted while this one is being processed.

A.4.4 Configuring slave-to-slave communication in STEP 7

Two drives communicate via standard telegram 1 with the higher-level control. In addition, drive 2 receives its speed setpoint directly from drive 1 (actual speed).

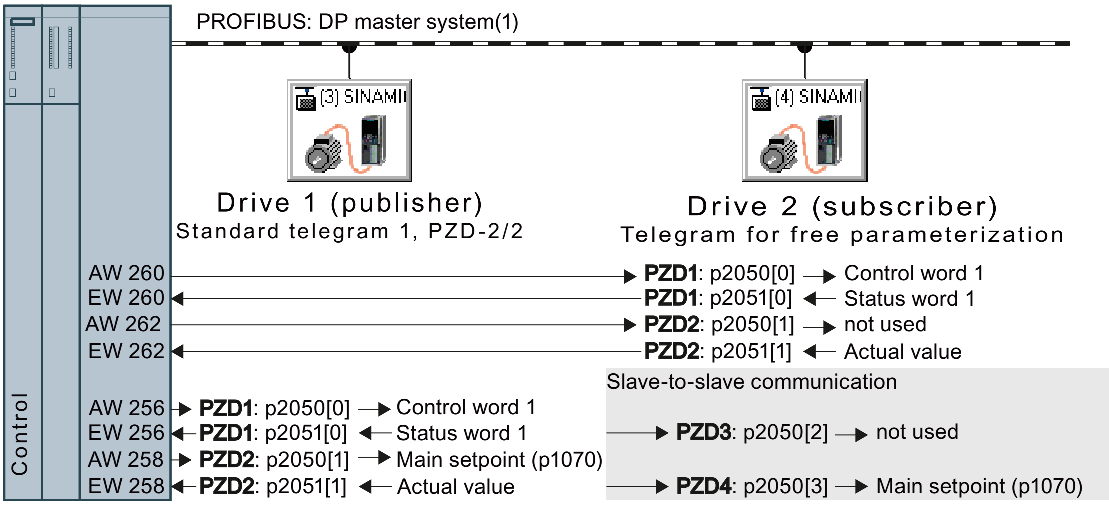
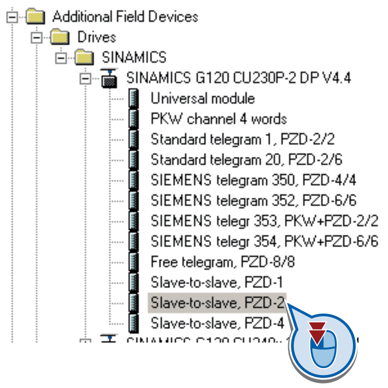


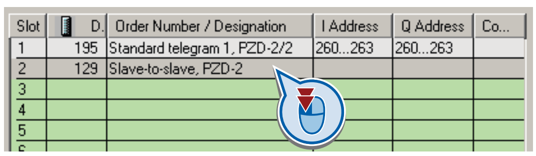
Figure A-8 Communication with the higher-level control and between the drives with slave-to-slave communication

Settings in the control

In HW Config in drive 2 (subscriber), insert a slave-to-slave communication object, e.g. "Slave-to-slave, PZD2".



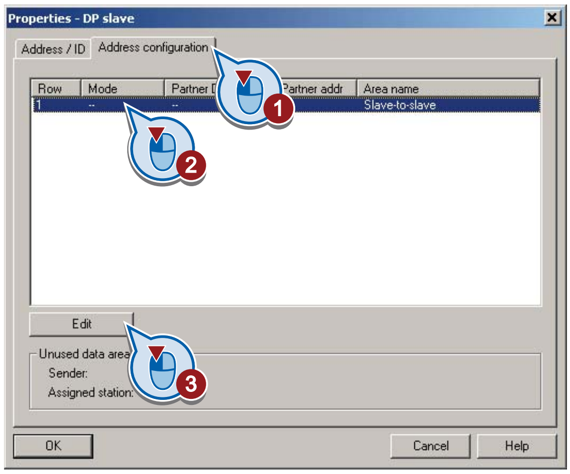
With a double-click, open the dialog box to make additional settings for the slave-to-slave communication.



① Activate the tab "Address configuration".

② Select line 1.

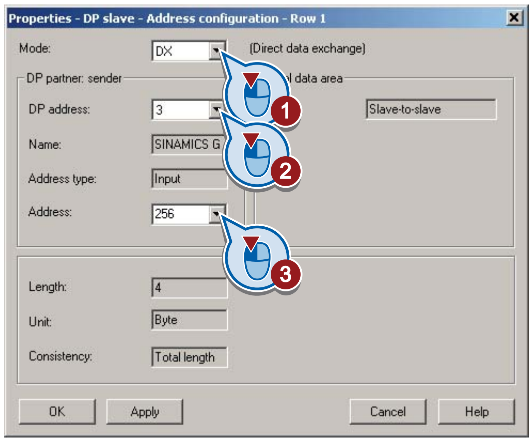
③ Open the dialog box in which you define the Publisher and the address area to be transferred.



① Select DX for direct data exchange

② Select the PROFIBUS address of drive 1 (publisher).

③ In the address field, select the start address specifying the data area to be received from drive 1. In the example, these are the status word 1 (PZD1) and the speed actual value with the start address 256.



Close both screen forms with OK. You have now defined the value range for slave-to-slave communication.

In the slave-to-slave communication, drive 2 receives the sent data and writes this into the next available words, in this case, PZD3 and PZD4.

Settings in drive 2 (subscriber)

Drive 2 is preset in such a way that it receives its setpoint from the higher-level control. In order that drive 2 accepts the actual value sent from drive 1 as setpoint, you must set the following:

- In drive 2 ,set the PROFIdrive telegram selection to "Free telegram configuration with BICO" (p0922 = 999).
- In drive 2, set the source of the main setpoint to p1070 = 2050.3.

A.4.5 Connecting fail-safe digital inputs

The following examples show the interconnection of a fail-safe digital input accordance with PL d to EN 13849-1 and SIL2 according to IEC61508. You can find further examples and information in the Safety Integrated Function Manual.

The examples comply with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all components are installed within one control cabinet.

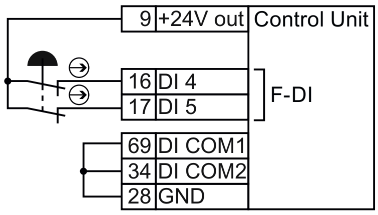


Figure A-9 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

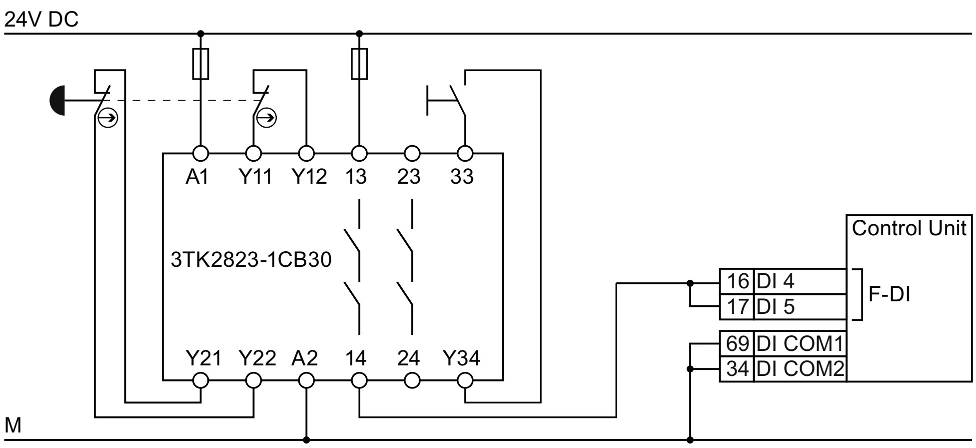


Figure A-10 Connecting a safety relay, e.g. SIRIUS 3TK28

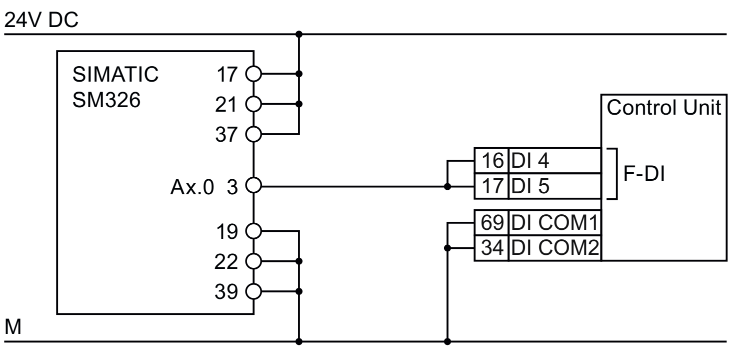


Figure A-11 Connecting an F digital output module, e.g. SIMATIC F digital output module

You can find additional connection options and connections in separate control cabinets in the Safety Integrated Function Manual, see Section: Additional information on the inverter (Page 352).

A.5 Documentation for accepting the safety functions

A.5.1 Machine documentation

Machine or plant description

Designation	…
Type	…
Serial number	…
Manufacturer	…
End customer	…
Block diagram of the machine and/or plant: … … … … … … …	

Inverter data

Table A- 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.5.2 Log of the settings for the basic functions, firmware V4.4 and V4.5

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 target checksum SI parameters	p9799	<p9799_v>

Table A- 17 Settings of the safety function

Name	Number	Value
SI enable, functions integrated in the drive	p9601	<p9601_v>
SI PROFIsafe address	p9610	<p9610_v>
SI F-DI changeover, tolerance time	p9650	<p9650_v>
SI STO debounce time	p9651	<p9651_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.6 Additional information on the inverter

Table A- 19 Manuals for your converter

Depth of the information	Manual	Contents	Available languages	Download or order number
++	**Getting Started Guide** for the SINAMICS G120 converter with the CU230P-2; CU240B-2 and CU240E-2 Control Units	Installing the converter and commissioning.	English, German, Italian, French, Spanish, Chinese	Download: (http://support.automation.siemens.com/WW/view/en/22339653/133300) **SINAMICS Manual Collection** Documentation on DVD, order number 6SL3097-4CA00-0YG0
+++	**Operating instructions**	(this manual)		
+++	**Safety Integrated Function Manual** for the SINAMICS G120 and G120C and G120D converters	Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the converter.	English, German	
+++	**List Manual** for the SINAMICS G120 converter with the CU240B-2; CU240E-2 Control Units	Graphic function block diagrams. Complete list of all parameters, alarms and faults.	English, German, Chinese	
+	**Getting Started Guide** for the following SINAMICS G120 Power Modules: • PM240, PM250 and PM260 • PM240-2 • PM230	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: • PM230 IP20 • PM230 IP55 • PM240 • PM240-2 • PM250 • PM260	Installing power modules, reactors and filters. Maintaining power modules.	English, German	
+++	**Operating Instructions** for the following Operator Panels: • BOP-2 • IOP	Operation of Operator Panels, door mounting kit for mounting of IOP.		

Table A- 20 Support when configuring and selecting the converter

Manual or tool	Contents	Languages	Download or order number
Catalog D 31	Ordering data and technical information for the standard SINAMICS G converters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (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)
Configuration Manual	Selecting geared motors, motors, converters and braking resistor based on calculation examples	English, German	Configuration Manual (http://support.automation.siemens.com/WW/view/en/37728795)

If you have further questions

You can find additional information on the product and more in the Internet under: Product support (http://support.automation.siemens.com/WW/view/en/4000024).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

A.7 Mistakes and improvements

If you come across any mistakes when reading this manual or if you have any suggestions for how it can be improved, then please send your suggestions to the following address or by E-mail:

Siemens AG
Drive Technologies
Motion Control Systems
Postfach 3180
91050 Erlangen, Germany

E-mail (mailto:documentation.standard.drives@siemens.com)

Index

8

87 Hz characteristic, 323

A

acceptance test
- Reduced scope of, 240

Acceptance test, 239
- Authorized person, 239
- Complete, 272
- Preconditions, 239
- reduced, 272, 273
- Requirements, 239
- STO, 243
- Test scope, 240

Acceptance test record, 239
Acyclic data transfer, 114
Adjustable parameters, 324
Alarm, 275, 279
Alarm buffer, 279
Alarm code, 279
Alarm history, 280
Alarm time, 279
Alarm value, 279
Ambient temperature, 58, 181
Analog input, 44, 45, 46
- Function, 81

Analog inputs, 59, 60
Analog output, 44, 45, 46
- Function, 81

Analog outputs, 59, 60
Analog setpoint, 52
Authorized person, 239
Automatic mode, 153
Automatic restart, 210

B

Back up
- Parameter, 271

Back up parameters, 271
Basic commissioning, 46
Basic functions, 46, 84
BF (Bus Fault), 277
BICO block, 326
BICO parameters, 327
BICO technology, 81, 327
Bimetallic switch, 178
Binectors, 326
Bit pattern test, 233
Block, 326
Blocking protection, 218, 219
BOP-2
- Display, 66
- Menu, 66

Brake Relay, 202
Braking
- Regenerative, 201

Braking chopper, 198
Braking method, 192
Braking module, 24
Braking resistor, 198
Break loose torque, 325
Bus fault, 277
Bus termination, 43

C

Catalog, 353
CDS, 153
CDS (Command Data Set), 238
Centrifuge, 190, 193, 196, 201
Changing parameters
- BOP-2, 67
- STARTER, 77

Characteristic
- Additional, 170
- Linear, 169
- parabolic, 169
- square-law, 169

Checklist
- PROFIBUS, 98
- PROFINET, 95

Circuit diagram, 350
Clockwise, 145
Closing lockout, 104, 144
Command Data Set, 153
Command source, 142
- Selecting, 156, 324

Commissioning
- Guidelines, 56

Commutation dips, 19

Compound braking, 196, 197
Compressor, 62
Configuring support, 353
Configuring the interfaces, 46
Connectors, 326
Consistency, 232
Consistent signals, 232
Contact bounce, 233
Control Data Set, CDS, 153
Control mode, 325
Control terminals, 59, 60
Control Unit
  Updating, 240
Control Units, 13
Control word, 103, 106
Control word 1, 104
Control word 3, 106
Controlling the motor, 145
Conveyor belt, 193
Conveyor systems, 74
Copy
  Series commissioning, 240
Copy parameters
  Series commissioning, 240
Correction manual, 354
Counterclockwise, 145
Countersignatures, 350
Crane, 190, 201, 206
Current input, 87
Customer support, 229

D

Data backup, 251, 255, 257, 350
Data exchange fieldbus, 339
Data set 47, 114, 115, 344
Data set changeover, 238
Data transfer, 251, 255, 257
DC braking, 106, 194, 195
DC link overvoltage, 182
DC link voltage, 182
Default settings, 58
Delta connection (Δ), 58, 323
DI (Digital Input), 84, 238
Digital input, 44, 45, 46
  Fail-safe, 46
  Function, 81
Digital inputs, 59, 60
  Multiple assignment, 238
Digital output, 44, 45, 46
  Function, 81
Digital outputs, 59, 60
  Functions of the, 86
DIP switch
  Analog input, 87
Direction reversal, 145
Discrepancy, 232
  Filter, 232
  Tolerance time, 232
Display parameters, 324
Down ramp, 325
Download, 26, 251, 255, 257
DP-V1 (PROFIBUS), 114
Drive Data Set, DDS, 244
Drive Data Sets, 244
Drive ES Basic, 331
DS 47, 115, 344

E

Electromechanical sensor, 84
Elevator, 206
Emergency Stop button, 227
EN 61800-5-2, 227
End customer, 349
Energy recovery option, 201
Error detection, 235
Extended functions, 84
Extruders, 62

F

Factory assignment, 59, 60
Factory pre-assignment, 59, 60
Factory setting
  Terminal strip, 47
Factory settings, 64, 229
  Restoring the, 64, 229
Fail-safe input, 84
Fan, 62, 74
Fans, 190, 202
Fault, 275, 282
  Acknowledge, 282, 283
Fault buffer, 282
Fault case, 282
Fault code, 282
Fault history, 283
Fault time, 282
  received, 282
  removed, 282
Fault value, 282
F-DI (Fail-safe Digital Input), 84
F-digital output module, 348

FFC (Flux Current Control), 169
Field weakening, 323
Fieldbus interfaces, 43
Filter
  Contact bounce, 233
  Discrepancy, 232
  On/off test, 233
Firmware, 13
  Updating, 240
Firmware version, 324, 349
Fixed speed, 49
Flow control, 214
Flying restart, 208, 209
Forced checking procedure, 235
  Basic functions, 235
Formatting, 248
Function blocks
  Free, 223, 226
Function table, 349
Functional expansions, 240
Functions
  BOP-2, 66
  Overview, 141
  Technological, 142

G

Getting Started, 352
Grinding machine, 190, 193, 196
GSD, 47, 49, 50, 51, 52, 331
GSD (Generic Station Description), 99
GSDML (Generic Station Description Markup Language), 96

H

Hardware configuration, 330
Hardware Installation Manual, 352
Harmonics, 19
Hoisting gear, 62, 190, 198, 201, 206
Holding brake, 190
Horizontal conveyor, 196
Horizontal conveyors, 62, 198, 202
Hotline, 353
HW Config, 330
HW Config (hardware configuration), 330

I

I2t monitoring, 177
Identifying motor data, 68, 76, 173, 176
Imax controller, 181
Inclined conveyors, 62, 190, 198, 202
IND, 111, 126
Industry Mall, 353
Inhibit direction of rotation, 163
Installation, 27, 30
Interfaces, 43
Interlock, 328
Inverter control, 142

J

JOG function, 151
Jogging, 47, 51

K

KTY84 sensor, 178

L

LED
  BF, 277
  LNK, 277
  RDY, 277
  SAFE, 278
LED (light emitting diode), 275
Level control, 214
Limit speed, 163
Line filter, 18
LNK (PROFINET Link), 277
Load failure, 220

M

Machine description, 349
Machine manufacturer, 239
Manual Collection, 352
Manual mode, 153
Manuals
  Converter accessories, 352
  Download, 352
  Function Manual for Safety Integrated, 352
  Overview, 352
Manufacturer, 349
Maximum current controller, 181
Maximum speed, 63, 163, 165, 325
Memory card
  Formatting, 248
  MMC, 248

SD, 248
Menu
BOP-2, 66
Operator panel, 66
Minimum speed, 63, 163, 164, 325
Mistakes manual, 354
MLFB (order number), 349
MMC (memory card), 248
MOP (motorized potentiometer), 47, 158
MotID (motor data identification), 68
Motor control, 142
Motor holding brake, 190, 204, 205, 206
Motor standard, 186
Motor temperature sensor, 44, 45, 59, 60, 180
Motorized potentiometer, 47, 51, 52, 158
Multiple assignment
Digital inputs, 238

N

No-load monitoring, 218, 219

O

OFF1 command, 145
ON command, 145
On/off test, 233
Open circuit, 232
Operating Instructions, 352
Operating mode, 349
Operation, 144
Operator panel
Display, 66
Menu, 66
Operator Panel
BOP-2, 25
Handheld, 25
IOP, 25
Mounting Kit IP54, 25
Order number, 13
Output reactor, 20
Overload, 181, 325
Overview
Manuals, 352
Overview of the functions, 141
Overvoltage, 182
Overvoltage protection, 19

P

p0015, configuring macro interfaces, 46
Page index, 111, 126
Parameter channel, 109, 123
IND, 111, 126
Parameter index, 111, 126
Parameter Manual, 352
Parameter types, 324
Password, 229
PC Connection Kit, 228
PELV, 295, 297
Permitted sensors, 84
PFH (Probability of failure per hour), 298
PID controller, 214
Plant description, 349
PLC functionality, 328
PLC program, 350
Power failure, 210
Power Module, 13
Power on reset, 64, 229, 237, 272
Pressure control, 214
Probe, 221
Process industry, 52
Process variables of the technology controller, 188
PROFIsafe, 93, 332
Protection functions, 142
PTC sensor, 178
Pulse cancelation, 104
Pulse enable, 104
Pump, 62, 74, 202

Q

Questions, 353
Quick stop, 143

R

Radio interference class, 18
Ramp-down time, 63, 166, 325
Ramp-function generator, 163
Rampup time,
RDY (Ready), 277
Ready, 144
Ready to start, 144
Regenerative power, 190
Reset
Parameter, 64, 229
Reverse direction of rotation, 163
Reversing, 163
Run sequence, 224
Runtime group, 224

S

SAFE, 278
Safety function, 49, 50, 51, 52, 142
Safety Integrated Function Manual, 348
Safety relay, 348
Saw, 193, 196
Scaling fieldbus, 339
Scaling, analog input, 88
Scaling, analog output, 90
SD (memory card), 248
Self-test (forced checking procedure), 235
Sensor
    Electromechanical, 348
Sequence control, 143
Serial number, 349
Series commissioning, 26, 240, 247
Setpoint calculation, 142
Setpoint processing, 163
Setpoint source, 142
    Selecting, 157, 158, 324
Short-circuit monitoring, 179
Signal interconnection, 326, 327
SIMATIC, 330, 331
SIZER, 353
Slave-to-slave communication, 114, 346
Speed monitoring, 220
    Deviation, 220
    Load failure, 220
Stall protection, 218, 219
Standard telegram 1, 47, 50, 51
Star connection (Y), 58, 323
STARTER, 228
    Download, 25
STARTER commissioning tool, 228
STARTER PC tool, 228
Starting characteristics
    Optimization, 170
State overview, 143
Status messages, 142
Status word, 103, 106
Status word 1, 105
Status word 3, 107
STEP 7 object manager, 331
STO
    Acceptance test, 243
    select, 228
STO (Safe Torque Off), 228
Storage medium, 247
STW1 (control word 1), 104
STW3 (control word 3), 106
Subindex, 111, 126
Suggestions for improvement manual, 354
Support, 353
Swap
    Control Unit, 240
    Hardware, 240
    Power Module, 240
Switch off
    Motor, 143
    OFF1 command, 143
    OFF2 command, 143
    OFF3 command, 143
Switch on
    Motor, 143
    ON command, 143
Switch-off signal paths (forced checking procedure), 235
System runtime, 184

T

Technical data
    Control Unit, 295, 297
Technology controller, 106, 214
Telegram 20, 52
Telegram 352, 49
Telegram types, 332
Temperature calculation, 181
Temperature monitoring, 177, 181
Temperature sensor, 44, 45, 46, 59, 60
Temperature switch, 178
Terminal assignment
    USS, 53
Terminal strip
    Assignment, 59, 60
    Overview, 45
    Pre-assignment, 59
Terminal strip CU240B-2, 59
Terminal strip CU240B-2 DP, 59
Terminal strip CU240B-2 PN, 60
Terminal strip CU240E-2, 60
Terminal strip CU240E-2 DP, 60
Test signals, 233
Test stop (forced checking procedure), 235
Three-wire control, 48, 53, 145
Time slices, 224
Torque monitoring
    Speed-dependent, 218, 219
Two-wire control, 48, 52, 53, 145
Type plate
    Control Unit, 13
    Power Module, 13

U

Unit changeover, 185
Unit system, 187
Unwinders, 201
Up ramp, 325
Updating
    Control Unit, 240
    Firmware, 240
Upload, 26, 249, 255, 257
User interfaces, 43
USS, 48, 53

V

V/f control, 167, 325
Vector control, 325
    Sensorless, 172
Vector control, 325
Vector control, 325
Version
    Control Unit, 13
    Firmware, 349
    Hardware, 349
    Power Module, 13
    Safety function, 349
Vertical conveyors, 62, 198, 202
Voltage boost, 170, 325
voltage input, 87

W

Winders, 62, 201
Wire-break monitoring, 88, 179

Z

ZSW1 (status word 1), 105
ZSW3 (status word 3), 107

Siemens AG
Industry Sector
Drive Technologies
Motion Control Systems
P.O. Box 3180
91050 ERLANGEN
GERMANY

www.siemens.com/sinamics-g120