SINAMICS G120

Frequency converter with the Control Units

CU240B-2

CU240B-2 DP CU240E CU240E

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

Operating Instructions · 04/2012



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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	Α

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

Operating Instructions

Edition 04/2012, firmware V4.5

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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	Power Module (Page 15)
PM230 Power Module in push through design	
PM240-2 Power Module with IP20 degree of protection	
PM240-2 Power Module in push through design	

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:	Functions (Page 141)		
Converter control			
Setpoint sources			
Setpoint processing			
Closed-loop motor control			
PID technology controller			
STO safety function			

Change history

Table of contents

	Change	history	3
1	Introduc	tion	11
	1.1	About this manual	11
	1.2	Guide through this manual	12
2	Descript	ion	13
	2.1	Modularity of the converter system	
	2.2	Overview of Control Units	
	2.3	Power Module	
	2.4	Line filter	
	2.5	Line reactor	
	2.6	Output reactor	
	2.7	Sine-wave filter	
	2.8	Braking resistor	
	2.9	Brake Relay	
	2.10	Accessories for commissioning and operation	25
3	Installing	g	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	
	3.3.2	Dimensions, hole drilling templates, minimum clearances, tightening torques	
	3.3.3	Dimension drawings PT	
	3.3.4	Connection overview for Power Module	
	3.3.5	Connecting the line supply and motor	
	3.3.6	EMC-compliant connection of the converter	
	3.3.7	Avoiding electromagnetic interference (EMI)	
	3.4	Installing Control Unit	
	3.4.1	Snapping the Control Unit onto the Power Module	
	3.4.2	Interfaces, connectors, switches, terminal blocks and LEDs of the CU	
	3.4.3	Terminal strips on CU240B-2 Control Units	
	3.4.4	Terminal strips on CU240E-2 Control Units	
	3.4.5	Wiring terminal strips	
	3.4.6	Select interface assignments	
	3.4.6.1	Pre-assignments and wiring of the inverter with CU240B-2 Control Units	
	3.4.6.2	Pre-assignments and wiring of the inverter with CU240E-2 Control Units	
4	Typical	commissioning scenarios	55

5	Basic co	mmissioning	57
	5.1 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6	Preparing for basic commissioning Collecting motor data Does the motor match the converter? Wiring examples for the factory settings Factory setting of the inverter control U/f control or speed control? Defining additional requirements for the application	57 58 59 61 62
	5.2	Restoring the factory setting	64
	5.3	Using the factory settings	65
	5.4 5.4.1 5.4.2 5.4.3	Basic commissioning with the BOP-2 Changing settings using BOP-2 Basic commissioning. Additional settings	67 68
	5.55.5.15.5.1.15.5.25.5.25.5.35.5.45.5.55.5.6	Basic commissioning with STARTER Adapting interfaces Adapting the USB interface. Accessing the converter via PROFINET Generating a STARTER project. Go online and start wizard for basic commissioning. Switch on the motor via the control panel. Making additional settings. Trace function for optimizing the drive	70 70 72 73 74 76 77
6	Adapt te	rminal 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	Configur	ing the fieldbus	93
	7.1 7.1.1 7.1.2 7.1.3 7.1.4 7.1.5	Communication via PROFINET What do you need for communication via PROFINET? Connect the converter to PROFINET Configuring communication to the control Select telegram Activating diagnostics via the control	95 95 96 96
	7.2 7.2.1 7.2.2 7.2.3 7.2.4 7.2.5	Communication via PROFIBUS What do you need for communication via PROFIBUS? Connect the frequency inverter to PROFIBUS Configuring communication to the control Setting the address Select telegram	98 98 99 99
	7.3 7.3.1 7.3.1.1	PROFIdrive profile for PROFIBUS and PROFINET Cyclic communication Control and status word 1	101

	7.3.1.2	Control and status word 3	
	7.3.1.3	Extend telegrams and change signal interconnection	
	7.3.1.4	Data structure of the parameter channel	
	7.3.1.5	Slave-to-slave communication	
	7.3.2	Acyclic communication	
	7.3.2.1	Reading and changing parameters via data set 47	115
	7.4	Communication via RS485	
	7.4.1	Integrating inverters into a bus system via the RS485 interface	
	7.4.2	Communication via USS	
	7.4.2.1	Basic settings for communication	
	7.4.2.2	Telegram structure	
	7.4.2.3	User data range of the USS telegram	
	7.4.2.4	USS parameter channel	
	7.4.2.5	USS process data channel (PZD)	
	7.4.2.6	Time-out and other errors	
	7.4.3	Communication over Modbus RTU	
	7.4.3.1	Basic settings for communication	
	7.4.3.2	Modbus RTU telegram	
	7.4.3.3	Baud rates and mapping tables	
	7.4.3.4	Write and read access via FC 3 and FC 6	
	7.4.3.5	Communication procedure	139
8	Function	ns	141
	8.1	Overview of the inverter functions	141
	8.2	Inverter control	
	8.2.1	Switching the motor on and off	
	8.2.2	Inverter control using digital inputs	
	8.2.3	Two-wire control: method 1	
	8.2.4	Two-wire control, method 2	
	8.2.5	Two-wire control, method 3	
	8.2.6	Three-wire control, method 1	
	8.2.7	Three-wire control, method 2	150
	8.2.8	Running the motor in jog mode (JOG function)	
	8.2.9	Switching over the inverter control (command data set)	153
	8.3	Command sources	
	8.4	Setpoint sources	
	8.4.1	Overview	
	8.4.2	Analog input as setpoint source	
	8.4.3	Specifying the motor speed via the fieldbus	
	8.4.4	Motorized potentiometer as setpoint source	
	8.4.5	Fixed speed as setpoint source	161
	8.5	Setpoint calculation	
	8.5.1	Overview of setpoint processing	
	8.5.2	Invert setpoint	
	8.5.3	Inhibit direction of rotation	
	8.5.4	Minimum speed	
	8.5.5	Maximum speed	
	8.5.6	Ramp-function generator	
	8.6	Motor control	

8.6.1 8.6.1.1	V/f control Characteristics of U/f control	
8.6.1.2	Selecting the U/f characteristic	
8.6.1.3	Optimizing with a high break loose torque and brief overload	
8.6.2	Closed-loop speed control	
8.6.2.1	Properties of the sensorless vector control.	
8.6.2.2	Select motor control	
8.6.2.3	Re-optimize the speed controller	
8.6.2.4	Torque control	
0.7		
8.7	Protection functions.	
8.7.1	Inverter temperature monitoring.	
8.7.2 8.7.3	Motor temperature monitoring using a temperature sensor Protecting the motor by calculating the motor temperature	
8.7.4	Overcurrent protection	
8.7.4 8.7.5	Limiting the maximum DC link voltage	
0.7.5		
8.8	Status messages	
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	
8.9.1.1	Changing over the motor standard	
8.9.1.2	Changing over the unit system	
8.9.1.3	Changing over process variables for the technology controller	
8.9.1.4	Changing of the units with STARTER.	
8.9.2	Braking functions of the inverter	
8.9.2.1	Comparison of electrical braking methods	
8.9.2.2	DC braking	
8.9.2.3	Compound braking	
8.9.2.4	Dynamic braking	
8.9.2.5	Braking with regenerative feedback to the line	
8.9.2.6	Motor holding brake	
8.9.3	Automatic restart and flying restart	
8.9.3.1	Flying restart – switching on while the motor is running	
8.9.3.2	Automatic switch-on	
8.9.4	PID technology controller	
8.9.4.1	Overview	
8.9.4.2	Setting the controller	
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	
8.10.2	Prerequisite for STO use	
8.10.2	Commissioning STO	
	Commissioning tool	
	Password	
	Resetting the safety function parameters to the factory setting	
	Changing settings	
	Interconnecting the "STO active" signal	

	8.10.3.6	Setting the signal filter	232
		Setting forced dormant error detection	
		Activate settings	
	8.10.3.9	Checking the assignment of the digital inputs D Acceptance - completion of commissioning	
	8.11	Switchover between different settings	
9		kup and series commissioning	
9		-	
	9.1 9.1.1	Backing up and transferring settings using a memory card Saving setting on memory card	
	9.1.1 9.1.2	Transferring the setting from the memory card	
	9.1.3	Safely remove the memory card	
	9.2	Backing up and transferring settings using STARTER	
	9.3	Saving settings and transferring them using an operator panel	
	9.4	Other ways to back up settings	
	9.5	Write and know-how protection	259
	9.5.1	Write protection	
	9.5.2	Know-how protection	
	9.5.2.1	Settings for the know-how protection	
	9.5.2.2	Creating an exception list for the know-how protection	
	9.5.2.3	Replacing devices with active know-how protection	
10		and maintenance	
	10.1	Overview of replacing converter components	
	10.2	Replacing the Control Unit	
	10.3	Replacing the Power Module	
11	Alarms, 1	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	Technica	al 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	
	12.3.1	Technical data, PM230 IP20	
		General data, PM230 - IP20 Power-dependent data, PM230, IP20	
	12.3.1.2	Technical data, PM240	
	-	General data, PM240	
		Power-dependent data, PM240	310
	12.3.3	Technical data, PM240-2	
		General data, PM240-2	
	12.J.J.Z	Power-dependent data PM240-2	

12.3.4	Technical data, PM250	318
12.3.4.	1 Power-dependent data, PM250	319
12.3.5		
12.3.5.	1 Power-dependent data, PM260	322
Appen	dix	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	
A.3.2	BICO technology: example	328
A.4	Application Examples	330
A.4.1	Configuring PROFIBUS communication in STEP 7	
A.4.1.1	Creating a STEP 7 project	330
A.4.1.2	2 Configuring communications to a SIMATIC control	331
A.4.1.3	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	2 Configuring the system in HW Config	334
A.4.2.3	3 Inserting the converter into the SIMATIC Manager	337
A.4.2.4	Activate diagnostic messages via STEP 7	337
A.4.2.5		
A.4.3	STEP 7 program examples	339
A.4.3.1	I STEP 7 program example for cyclic communication	340
A.4.3.2	2 STEP 7 program example for acyclic communication	
A.4.4	Configuring slave-to-slave communication in STEP 7	346
A.4.5	Connecting fail-safe digital inputs	
A.5	Documentation for accepting the safety functions	
A.5.1	Machine documentation	
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		

Introduction

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.

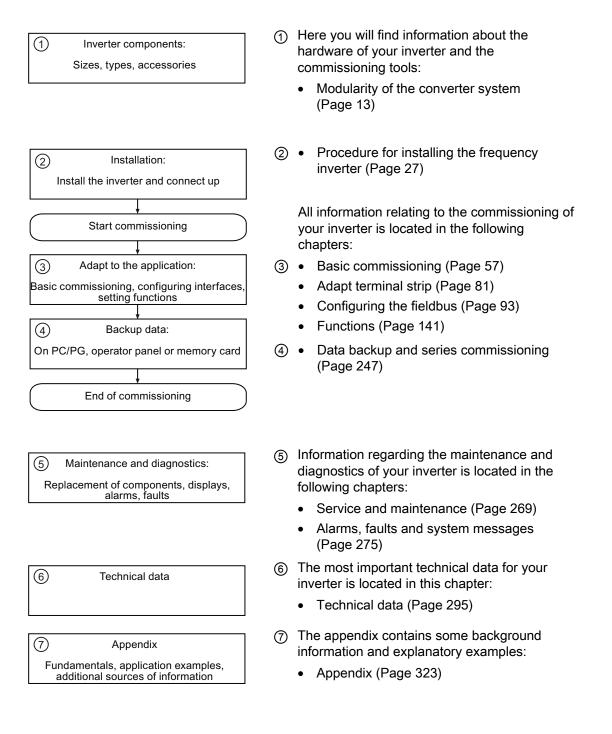
The information provided in the operating instructions has been compiled in such a way that it is sufficient for all standard applications and enables drives to be commissioned as efficiently as possible. Where it appears useful, additional information for entry level personnel has been added.

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

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:



Description

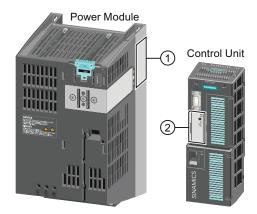
2.1 Modularity of the converter system

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:

Order no.:

- Technical data: \
 - Voltage, current and power e.g. 6SL3224-0BE13-7UA0

e.g. Power Module 240

• 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

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 D P	PROFIBUS DP mit PROFIsafe	PROFINET IO	PROFINET I mit PROFIsa	-
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 (**P**ush 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...

Description

2.3 Power Module

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

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	s 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.

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 2-8	Line reactors for PM240

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

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.

Modules PM240 FSA and FSB



Footprint output reactors for Power Output reactor for Power Module PM240 FSGX

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

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- 10 Output reactors for PM240 Power Module

Description 2.6 Output reactor

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

Table 2-11	Output reactors for PM250 Power Module
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2.7 Sine-wave filter

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.



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.

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 2-12 Sine-wave filter for PM240 Power Module

2.7 Sine-wave filter

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

Table 2-13 Sine-wave filter for PM250 Power Module	Table 2-13	Sine-wave filter for PM250 Power Module
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2.8 Braking resistor

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:





Module PM240-2 FSA

Braking resistor for Power 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

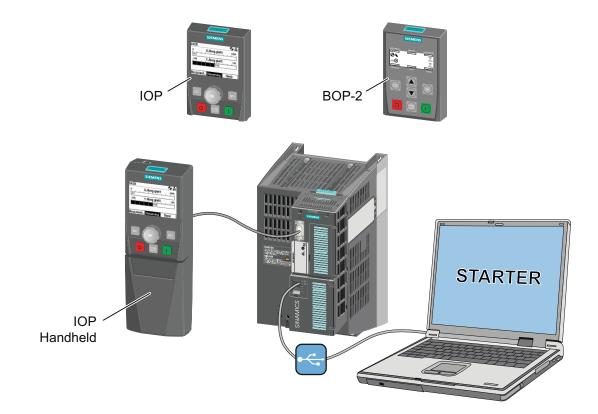
 Table 2- 16
 Accessories for commissioning and controlling the converter as well as for data backup

Component o	r tool	Order number
Operator Pan	els for commissioning, diagnostics and controlling converters	
	BOP-2 - for snapping onto the frequency converter	6SL3255-0AA00-4CA1
	Copies drive parameters	
	Two-line display	
	Guided commissioning	
	IOP - to snap onto the frequency converter or with the handheld	6SL3255-0AA00-4JA0
	Copies drive parameters	IOP Handheld:
	Plain text display	6SL3255-0AA00-4HA0
	Menu-based operation and application wizards	
	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	STARTER on DVD: 6SL3072-0AA00-0AG0
	Downloading: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/13 0000)	3
	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

Description

2.10 Accessories for commissioning and operation

Component or tool		Order number	
Memory cards: to save and transfer the converter settings			
T.	MMC card	6SL3254-0AM00-0AA0	
	SIEMENS SINAMICS WIRE INSTRUMENT WIRE IN TO WIRE IN T	SD card	6ES7954-8LB00-0AA0



Installing

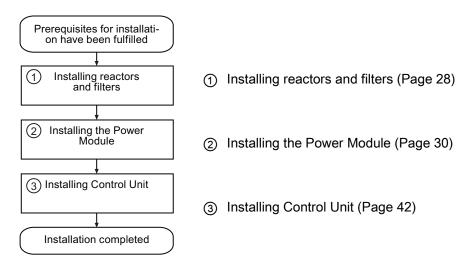
3.1 Procedure for installing the frequency inverter

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



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

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

3.2 Installing reactors and filters

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		х	
Braking resistor		х	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

Installing

3.2 Installing reactors and filters

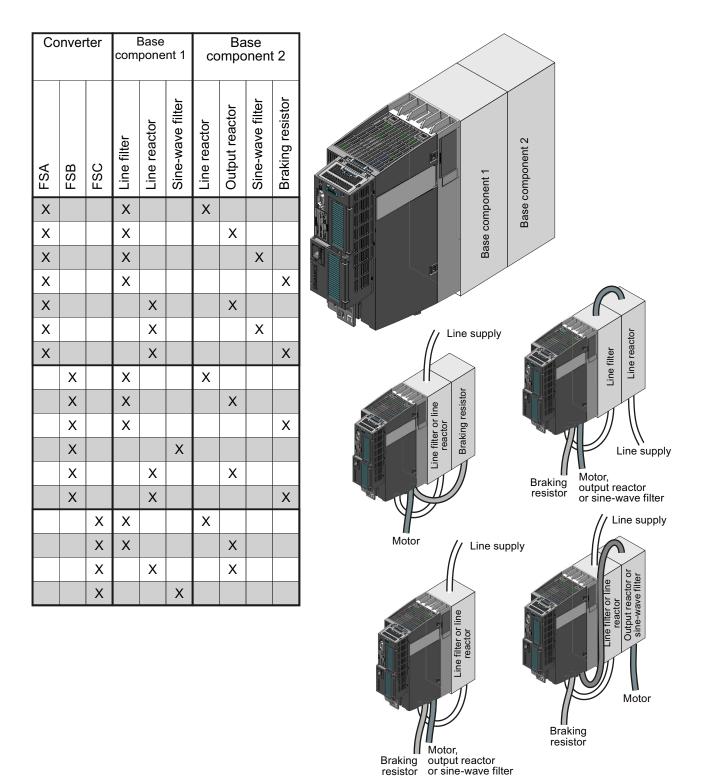


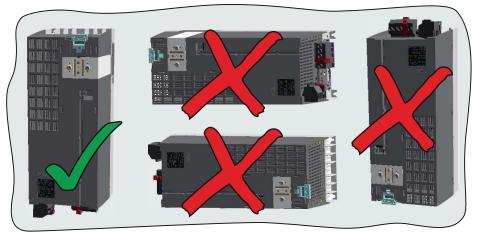
Figure 3-1 Base components and wiring options

3.3 Installing the Power Module

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).

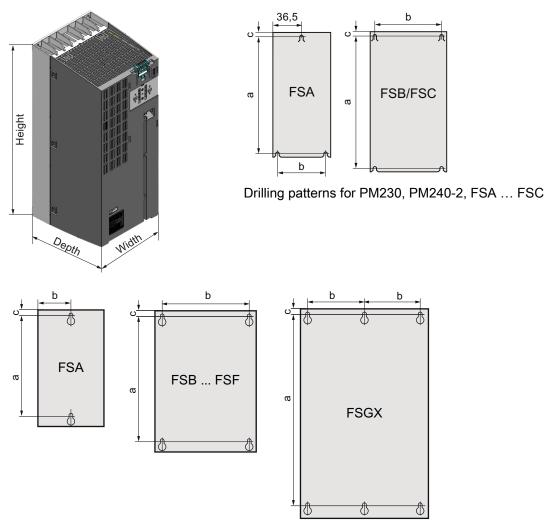
Please observe the mounting and installation instructions supplied with these components.

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 FSD ... FSF and for PM240, PM250 and PM260

Installing

3.3 Installing the Power Module

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

Frame size	Dimensions (mm)							Clearances (mm)			
	Height ¹⁾	Width	Depth	а	b	С	Тор	Bottom	Lateral		
FSA	196	73	165	186	62.3	6	80	100	02)		
FSB	292	100	165	281	80	6	80	100	02)		
FSC	355	140	165	343	120	6	80	100	02)		
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 \dots FSC

Frame size	Dimensions (mm)							Clearances (mm)			
	Height ¹⁾	Width	Depth	а	b	с	Тор	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.

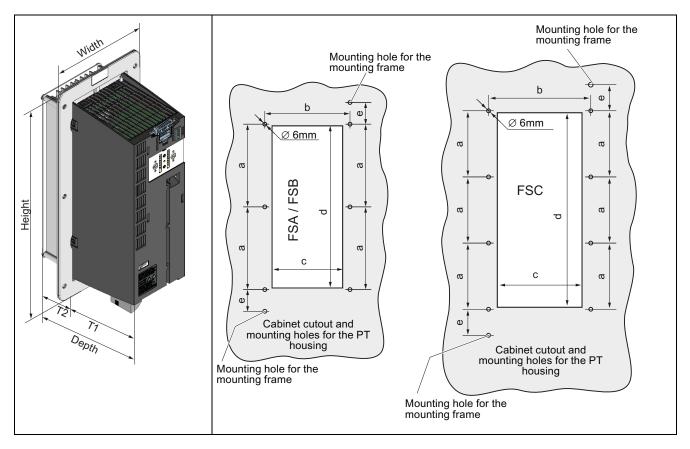
Dimensions and clearances for PM230, PM240, PM250 and PM260 - IP20 degree of protection, frame sizes FSD \ldots FSGX

Frame size	Dimensions	s (mm)					Clearanc	es (mm)	
	Height ¹⁾ Width Depth		а	b	с	Тор	Bottom	Lateral	
FSD without filter	419	275	204	325	235	11	300	300	02)
FSD with filter	512	275	204	419	235	11	300	300	02)
FSE without filter	499	275	204	405	235	11	300	300	02)
FSE with filter	635	275	204	541	235	11	300	300	02)
FSF without filter	634	350	316	598	300	11	350	350	02)
FSF with filter	934	350	316	899	300	11	350	350	02)
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 \ldots FSC

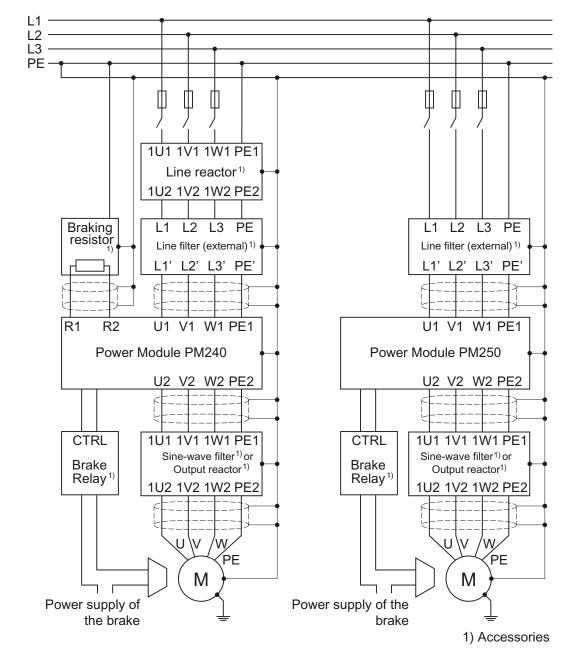
Frame size		Dimensions (mm)									
		Height ¹⁾	Width	Depth	T1	T2	а	b	с	d	е
FSA		238	125,9	171	117,7	53,1	103	106	88	198	27
FSB		345	153,9	171	117,7	53,1	147,5	134	116	304	34,5
FSC		410,5	200	171	117,7	53,1	123	174	156	365	30,5
Fixing:	FSA/F	SA/FSB/FSC: M5 screws, 3 Nm									

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 Installing the Power Module



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.



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 nongrounded (IT) line supply systems. The converters with integrated line filter are suitable only for connection to TN line supply systems. 3.3 Installing the Power Module

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 $(\underline{\bot})$ 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.

3.3 Installing the Power Module

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 nonfiltered 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

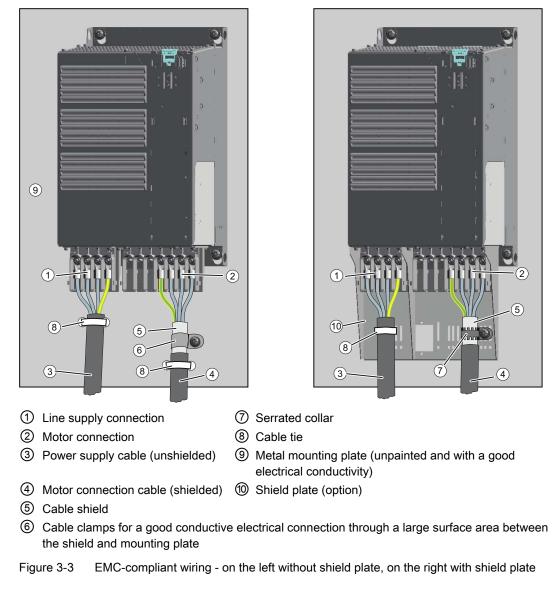
For an EMC-compliant installation, you must use the shield plate.

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.

3.3 Installing the Power Module



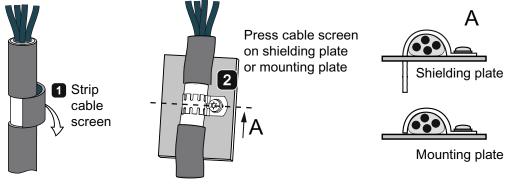


Figure 3-4 Shield connection - detail

3.3 Installing the Power Module

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.

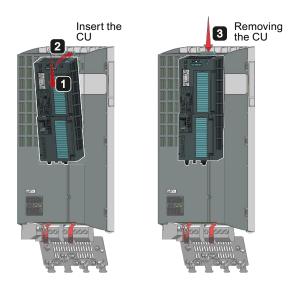
Shielding with shield plate:	Shield connection kits are available for all Power Module frame sizes (you will find more information in Catalog D11.1). The cable shields must be connected to the shield plate through the greatest possible surface area using shield clamps.
Shielding without shield plate:	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.

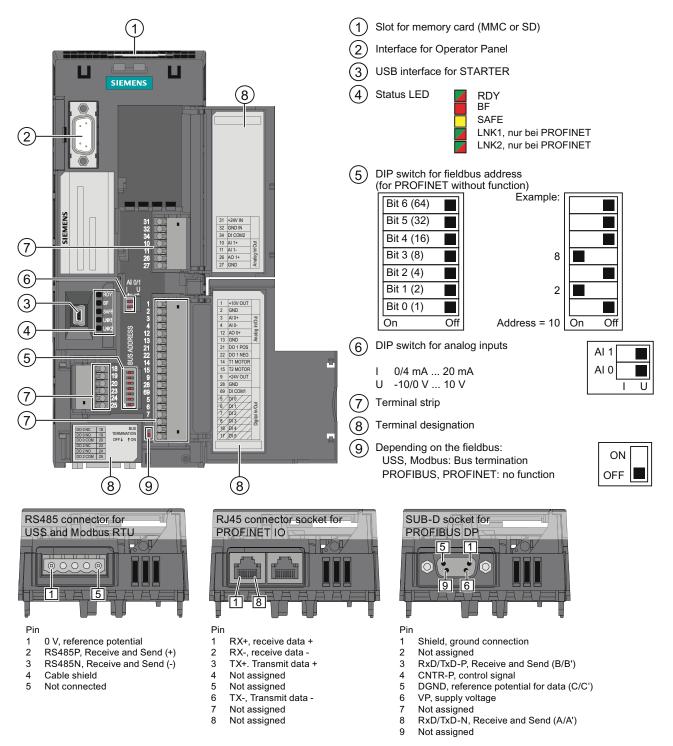
3.4 Installing Control Unit

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





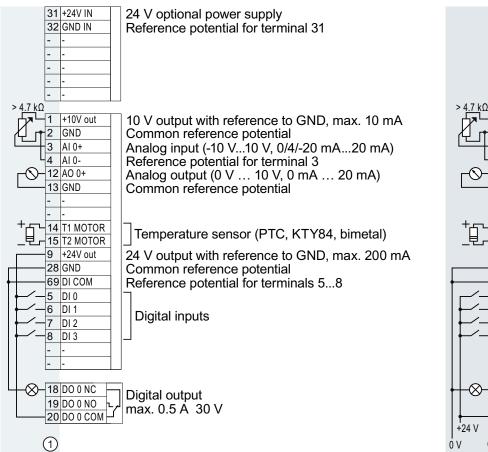
3.4.2 Interfaces, connectors, switches, terminal blocks and LEDs of the CU

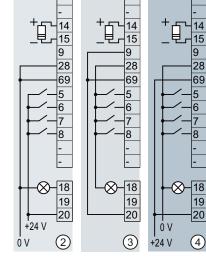
Figure 3-5 Design of the Control Unit using the example of the CU240E-2

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

3.4 Installing Control Unit

3.4.3 Terminal strips on CU240B-2 Control Units





+10 V-

31

32

12

13

DI = high, if the switch is closed.

DI = high, if the switch is closed.

DI = low, if the switch is closed.

DI = low, if the switch is closed.

31

32

3

4

12

13

+10 V

31

32

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.
- ② Wiring when using external power supplies.
- ③ Wiring when using the internal power supplies.
- ④ Wiring when using external power supplies.

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).

+10 V J.

Δ

(4)

∞−18

 \otimes

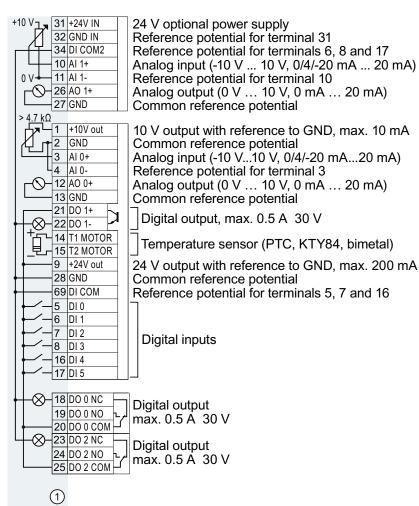
οv

+24 V

 \otimes

₽

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.

- Wiring when using the internal power supplies.
- ② Wiring when using external power supplies.
- ③ Wiring when using the internal power supplies.
- ④ Wiring when using external power supplies.

DI = high, if the switch is closed.

+10 V J.m

0 V

(2)

 \propto

∞-23

. +24 V

0 V

Ū.

+10 V_L 31

0 V

(3)

⊗–18

∞-23

₽

- DI = high, if the switch is closed.
- DI = low, if the switch is closed.
- 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.

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 3.4 Installing Control Unit

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 1mm^2 (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

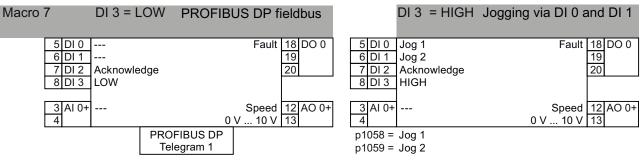
- In the basic commissioning, select the default settings of the interfaces that best match your particular wiring.
- If necessary, after the basic commissioning, adjust the function of the inputs or outputs and the fieldbus interface.

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.



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

Motorized potentiometer

Macro 9	Motorized potentiometer (MOP)	6 DI 1 7 DI 2	ON/OFF1 MOP up MOP down Acknowledge		18 DO 0 19 20
		3 AI 0+		Speed 0 V 10 V	12 AO 0+ 13

3.4 Installing Control Unit

Two- or three-wire control

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

		Macro 17 Method 2	Macro Meth		5 DI 0 6 DI 1 7 DI 2 8 DI 3	Control command 1 Control command 2 Acknowledge 	Fault 18 DO (19 20
Control command 1 ON Control command 2 Rev		ON/OFF1 rig ON/OFF1 lef	′ I	F1 right F1 left	3 AI 0- 4	+ Setpoint I ⊡∎U -10 V 10 V	Speed 12 AO (0 V 10 V 13
Three-wire control	Macro 1 Method		Macro 20 Method 2		5 DI 0 6 DI 1 7 DI 2 8 DI 3	Control command 1 Control command 2 Control command 3 Acknowledge	Fault 18 DO 0 19 20
Control command 1 Control command 2 Control command 3	Enable/O ON right		Enable/OFF1 DN Peversing		3 AI 0+	Setpoint I■U -10 V 10 V	Speed <u>12</u> AO 0- 0 V 10 V 13

Reversing

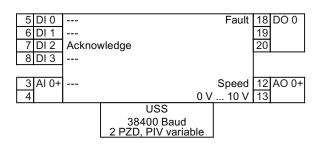
Communication with higher-level control via USS

ON left

Macro 21 Fieldbus USS

Control command 3

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	5 DI 0 ON/OFF1 right Fault 18 DO 0
	speeds	6 DI 1 ON/OFF1 left 19
	speeds	7 DI 2 Acknowledge 20
	p1003 = Fixed speed 3	8 DI 3 Alarm 21 DO 1
	p1004 = Fixed speed 4	16 DI 4 Fixed speed 3 22
		17 DI 5 Fixed speed 4
	DI 4 and DI 5 = HIGH:	
	Frequency converter added	3 AI 0 Speed 12 AO 0
	fixed speed 3 + fixed speed 4	4 0 V 10 V 13
		10 AI 1 Current 26 AO 1
		11 0 V 10 V 27
M 0		5 DI 0 ON/OFF1 + fixed speed 1 Fault 18 DO 0
Macro 2	Two fixed speeds with safety	
	function	6 DI 1 Fixed speed 2 19
	1001 England	7 DI 2 Acknowledge 20
	p1001 = Fixed speed 1	8 DI 3 Alarm 21 DO 1
	p1002 = Fixed speed 2	16 DI 4 Reserved for safety 22
	DI 0 and DI 1 = HIGH:	17 DI 5 function
	Motor rotates with	
		3 AI 0 Speed 12 AO 0
	fixed speed 1 + fixed speed 2	4 0 V 10 V 13
		10 AI 1 Current 26 AO 1
		11 0 V 10 V 27

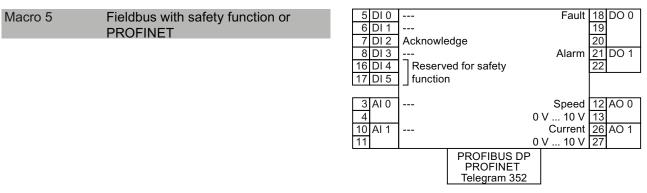
Refer also to section: Safe Torque Off (STO) safety function (Page 227).

Macro 3	Four fixed speeds	5 DI 0 ON/OFF1 + fixed speed 1 Fault 18 DO 0
		6 DI 1 Fixed speed 2 19
	p1001 = Fixed speed 1	7 DI 2 Acknowledge 20
	p1002 = Fixed speed 2	8 DI 3 Alarm 21 DO 1
	p1003 = Fixed speed 3	16 DI 4 Fixed speed 3 22
	p1004 = Fixed speed 4	17 DI 5 Fixed speed 4
	Several DI = HIGH:	3 AI 0 Speed 12 AO 0
	Frequency converter adds corresponding fixed	4 0 V 10 V 13
	speeds	10 AI 1 Current 26 AO 1
		11 0 V 10 V 27
N.4		5DI0 Fault 18DO0
Macro 4	PROFIBUS DP or PROFINET	6 DI 1 19
	fieldbus	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).

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

3.4 Installing Control Unit



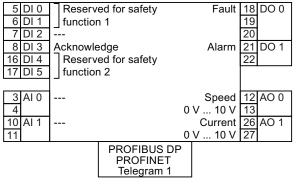
See also the following sections:

- 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	5	DI (
	with two safety functions	6	DI
	with two salety functions	7	DI 2
		8	DI :
		 40	DI

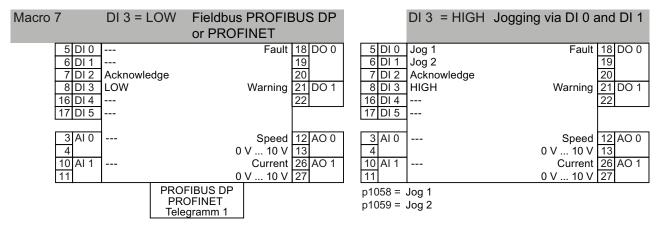


See also the following sections:

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

Automatic/local - Changeover between fieldbus and jog mode





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

Motorized potentiometer

Macro 8	Motorized potentiometer (MOP) with safety function	5 DI 0ON/OFF16 DI 1MOP up7 DI 2MOP down8 DI 3Acknowledge16 DI 4Reserved for sa17 DI 5function	Fault 18 DO 0 19 20 Alarm 21 DO 1 22
		3 AI 0 4 10 AI 1 11	Speed 12 AO 0 0 V 10 V 13 Current 26 AO 1 0 V 10 V 27

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

Macro 9

3.4 Installing Control Unit

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			
·	1		
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

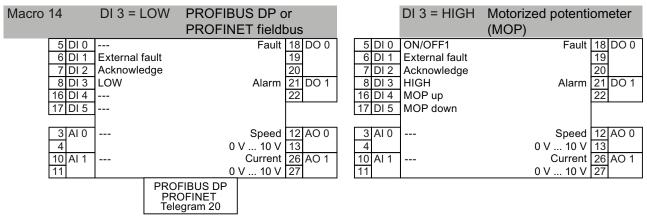
Applications with analog setpoint

Motorized potentiometer (MOP)

Macro 13	Setpoint via analog input and safety function	5 DI 0ON/OFF16 DI 1Reversing7 DI 2Acknowledge8 DI 316 DI 4Reserved for safety17 DI 5function	Fault 18 DO 0 19 20 Alarm 21 DO 1 22
		3 AI 0 4 I⊡U -10 V 10 V 10 AI 1 11	Speed 12 AO 0 0 V 10 V 13 13 Current 26 AO 1 0 V 10 V 27

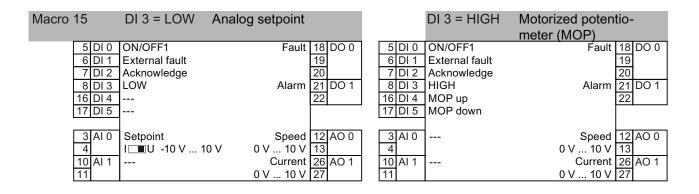
Refer also to section: Safe Torque Off (STO) safety function (Page 227).

Process industry



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

3.4 Installing Control Unit



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 Method 1	Macro 17 Method 2	Macro 18 Method 3	5 DI 0 6 DI 1 7 DI 2 8 DI 3	Control command 1 Control command 2 Acknowledge 	Fault 18 DO 0 19 20 Alarm 21 DO 1
Control command 1 Control command 2		ON/OFF1 right ON/OFF1 left	ON/OFF1 right ON/OFF1 left	16 DI 4 17 DI 5	 	22
				3 AI 0 4 10 AI 1 11	Setpoint I∎U -10 V 10 V 	Speed 12 AO 0 0 V 10 V 13 Image: Current 26 AO 1 0 V 10 V 27 Image: Current 26 Image: Current 27
	Macro	19 Mac	ro 20	5 DI 0	Control command 1	Fault 18 DO 0
Three-wire conti	ol Methoo	I 1 Metl	nod 2	6 DI 1 7 DI 2 8 DI 3	Control command 2 Control command 3 Acknowledge	19 20 Alarm 21 DO 1
Control command 1 Control command 2	Enable/C ON right	ON	le/OFF1	16 DI 4 17 DI 5		22
Control command 3	ON left	Reve	rsing	3 AI 0 4 10 AI 1 11	Setpoint I _■U -10 V 10 V 	Speed 12 AO 0 0 V 10 V 13 Current 26 AO 1 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 Bauc	1	
	2 PZD, PIV vari	able	
4 10 AI 1	38400 Bauc	0 V 10 V Current 0 V 10 V	13 26 AO 1

3.4 Installing Control Unit

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.

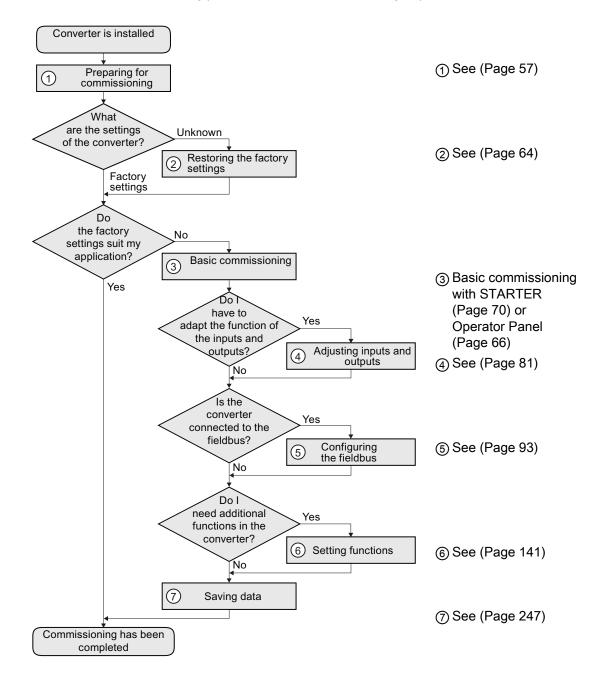
If, when making this check, you identify that you must adapt the factory settings, then you must commission the converter.

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:



Basic commissioning

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?

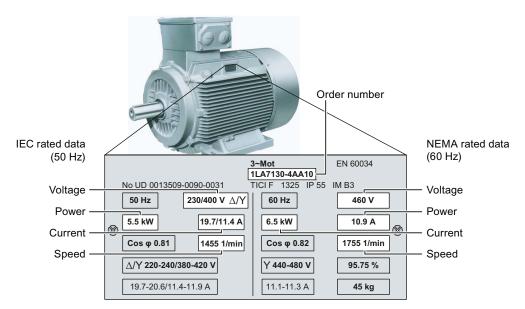
5.1.1 Collecting motor data

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.



Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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.

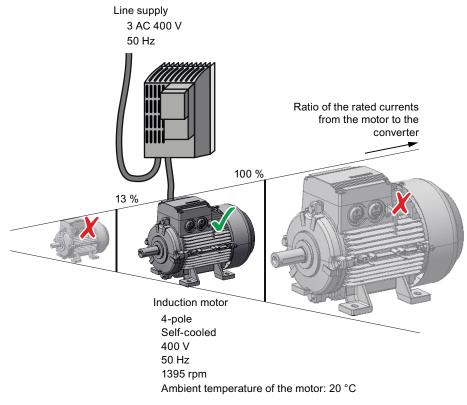


Figure 5-1 Motor data factory settings

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.

Basic commissioning

5.1 Preparing for basic commissioning

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

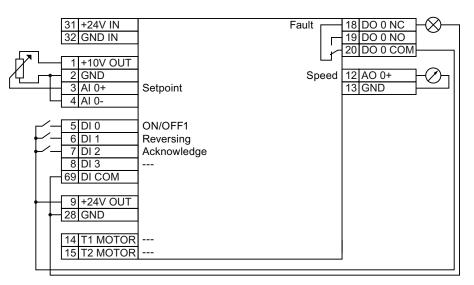


Figure 5-2 Wiring example to use the factory settings

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

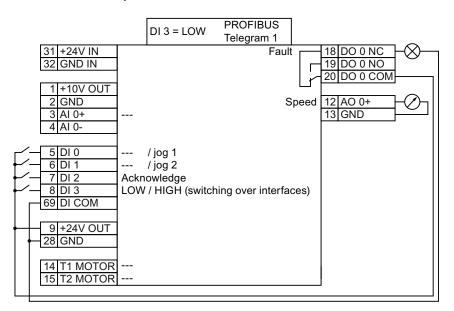
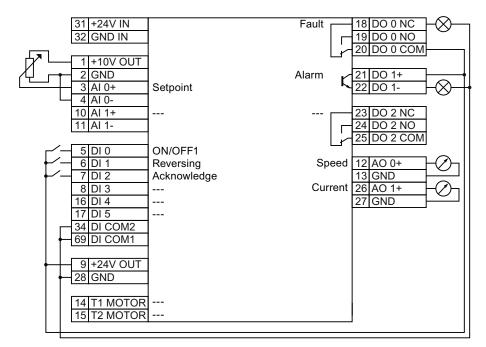


Figure 5-3 Wiring example to use the factory settings

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC Basic commissioning

5.1 Preparing for basic commissioning



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

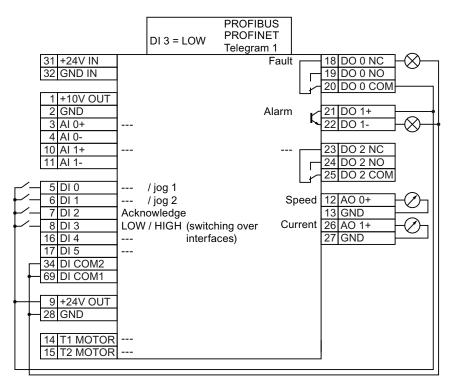


Figure 5-5 Wiring example to use the factory settings

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.

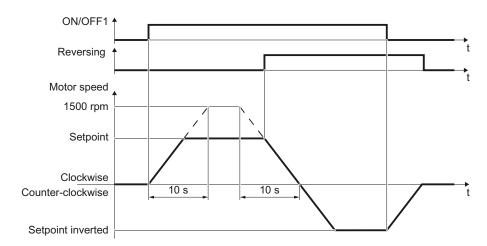


Figure 5-6 Switching on and switching off the motor and reversing in the factory setting

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.

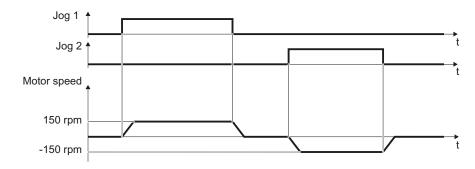


Figure 5-7 Jogging the motor in the factory setting

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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

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 F	Procedure
-------------	-----------

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

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.

edure

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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.

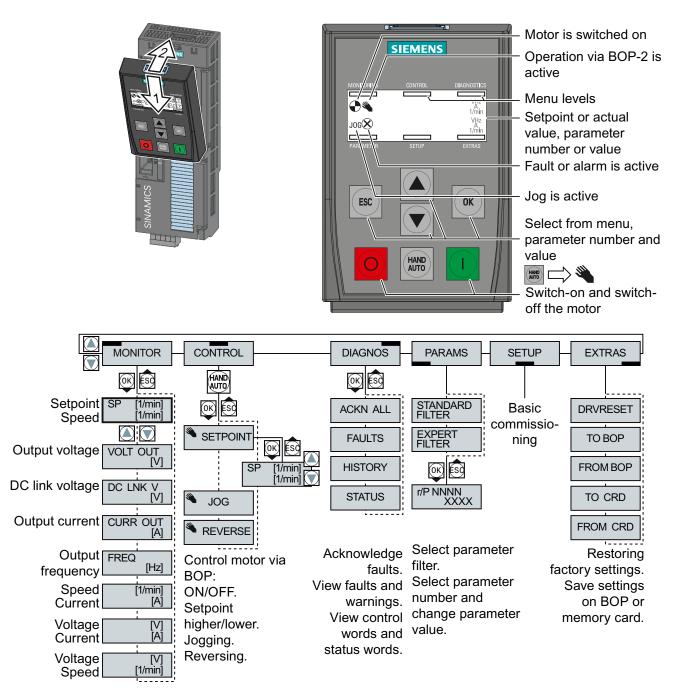
- 1. Connect the converter in accordance with the wiring example. See Section: Wiring examples for the factory settings (Page 59)
- 2. If you operate the drive on a fieldbus, you have to do the following:
 - Configure your central controller according to the settings of the converter.
 - If required 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

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.





Basic commissioning

5.4 Basic commissioning with the BOP-2

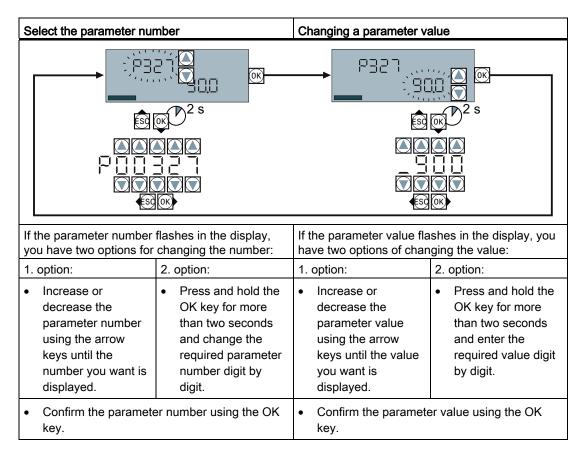
5.4.1 Changing settings using BOP-2

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



5.4 Basic commissioning with the BOP-2

5.4.2 Basic commissioning

Menu	Remark				
SETUP		of the parameters of the menu "SETUP". BOP-2, select the menu "SETUP".			
RESET	Select reset if you wish to reset all parameters to the factory setting before the basic commissioning. nO \rightarrow YES \rightarrow OK				
CTRL MOD P1300	Select the moto	ect the motor control mode. The most important control modes are: IN V/f control with linear characteristic			
P130 <u>0</u>	VF LIN				
	VF QUAD	V/f control with so	quare law characteristic		
	SPD N EN	Closed-loop spee	ed control (sensorless vector control)		
	TRQ N EN	Closed-loop torqu	ie control		
EUR/USA P100	② Standard: I	EC or NEMA	SIEMENS D-91056 Erlangen 3~Mot. 1LE10011AC434AA0 E0807/0496382_02 003		
MOT VOLT P304	① Voltage		IEC/EN 60034 100L IMB3 IP55 25 kg Th.Cl. 155(F) -20°C Tamb 40°C Bearing UNIREX-N3 DF C0°C 3722 455 4000 hzp		
MOT CURR P305	③ Current		DE 6206-2ZC3 15g Intervall: 4000hrs NE 6206-2ZC3 11g Operation 60Hz: SF 1.15 CONT NEMA MG1-12 TEFC Design A 2.0 HP V Hz A kW PF NOM.EFF rpm V A CL		
MOT POW P307	④ Power IEC⑤ Power NEN	standard (kW) IA standard (HP)	400 Δ 50 3.5 1.5 0.73 84.5% 970 380 - 420 3.55-3.55 690 Y 50 2.05 1.5 0.73 84.5% 970 660 - 725 2.05-2.05 460 Δ 60 3.15 1.5 0.69 86.5% 1175 K		
MOT RPM P311	6 Rated spee	d	Motor data on the rating plate		
MOT ID P1900	rotating).	Ve recommend the setting STIL ROT (identify motor data at standstill and with the motor otating). otating). f one of the following cases applies, select the setting STILL (identify motor data at standstill):			
			I control" control mode, but the motor cannot rotate freely, e.g.		
	for mechani	ically limited traver	sing sections.		
	You have se	et "V/f control" as c	control mode.		
MAc PAr P15		e predefined config	outs and outputs, as well as the correct fieldbus for your gurations can be found in the section titled Select interface		
MIN RPM P1080	Minimum motor	r speed.			
RAMP UP P1120	Motor ramp-up	time.			
RAMP DWN P1121	Motor ramp-dov	wn time.			
FINISH	Confirm that the	e basic commissio	ning has been completed (Parameter p3900): nO \rightarrow YES \rightarrow OK		

5.4 Basic commissioning with the BOP-2

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.

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				
8	The converter issues alarm A07991.				
HAND AUTO \Rightarrow \Rightarrow \Rightarrow	 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.				
8	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.				
HAND AUTO	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

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 (<u>http://support.automation.siemens.com/WW/view/en/10804985/133100</u>)

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:

- 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 题 ("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.

itar g	🕅 STARTER - [Accessible nodes - S7USB]						_ 🗆 🗙
TAR	Project	Target system	View	Options	Window	Help	_ 8 ×
F	Ac	cessible nodes 🎝 G120_CU24	0E_2_()P_F (Ser	ial number	= X4X730-002391, type = SINAMICS CU240E-2 DF	P F ∀4.4)

- 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"

^{TMR} STARTER - [Accessible nodes - PC Project Target system View Optic		×	do online via:
Accessible nodes Extended settings Access point:	S70NLINE (STEP 7)	Access point	© S70NLINE (STEP7) PC COM-Port (USS) © DEVICE (STARTER, SCOUT) S7USB
Interface parameterization used: IP address of the sought node: Do you want to accept the selected drive Accept Select drive units Accessible nodes	PC CDM-Port (USS)	PG/PC 2	ISO Ind. Ethernet -> Broadcom Net PC COM-Port (USS) S7USB TCP/IP therLink XL 10/1

- 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.

🚣 Local Area Connection Properties 🏾 🔋 🗙
General Authentication Advanced
Connect using:
Intel(R) 82578DM Gigabit Network Cc Configure
This connection uses the following items:
SIMATIC Industrial Ethernet (ISO)
PROFINET IO RT-Protocol (LLDP)
Internet Protocol (TCP/IP)
Install Install
Description
Transmission Control Protocol/Internet Protocol. The
wide area network protocol that provides communication
across diverse interconnected networks.
Show icon in notification area when connected
Notify me when this connection has limited or no connectivity
OK Cancel

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.

Basic commissioning

5.5 Basic commissioning with STARTER

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".

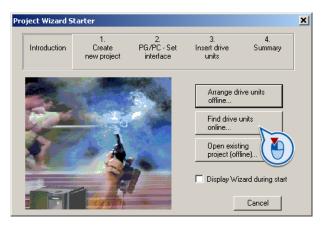
In the next step, create a new project, e.g. Profinet_G120_001.

Set PG/PC Interface	×				
Access Path LLDP / DCP					
Access Point of the Application: S70NLINE (STEP 7) -> TCP/IP -> Intel(R) 82578DM Gigab 💌 (Standard for STEP 7)					
Interface Parameter Assignment Used:	Properties				
TCP/IP -> Intel(R) 82578DM Gigab <act< td=""><td></td></act<>					
TCP/IP -> ASIX AX88178 USB2.0 I TCP/IP -> Intel(R) 83 78DM Gigab TCP/IP -> NdisWanl) TCP/IP(Auto) -> ASIP US (Assigning Parameters to Your NDIS CPs	Diagnostics Copy Delete				
with TCP/IP Protocol (RFC-1006))					
Add/Remove:	Select				
ОК	Cancel Help				

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.



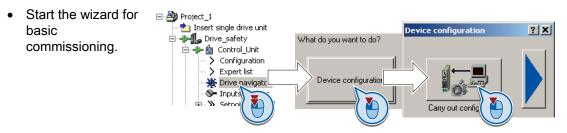
5.5.3 Go online and start wizard for basic commissioning

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.



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.

✓ Drive functions	If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".
	 [0] Inhibited [1] Identify motor data at standstill and with motor rotating [2] Identify motor data at standstill [3] Identify motor data 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.
✓ Important parameters	Set the most important parameters to suit your application.
Calculation of the moto	We recommend the setting "Calculate motor data only".
	- Exit motor commissioning:
	C Restore factory setting and calculate motor data
	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.

Copy RAM to RC	אוי (גפי	ve data in the f	2
< Bac	k	Finish	

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

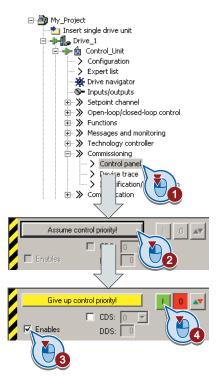
Motor data identification for dangerous loads

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.

Basic commissioning

5.5 Basic commissioning with STARTER

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.
 - Navigation bar: For each inverter function, select the corresponding screen form.
 tabs: Switch between screen forms.

If you change the settings using screen forms you do not need to know the parameter numbers.

My_Project	Display data set switchover	Drive data set: DDS 0 (Active) Command data set: CDS 0 (Active)	Wizard	Add DDS Add CDS
Configuration	Configuration Drive dat	a sets 🛛 Command data sets 🗍 Units 🗍 Refe	rence variables - setting	/O configuration
Drive navigator 	Select I/O configuration			
 ⊕ → >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	12.) Standard I/O with AS Field bus	3		
Technology contro ⊡> Commissioning Control panel	No protocol	Free telegram configuration with BICO	Change config	guration
Device trace Jervice trace Jervice trace Communication/	Digital inputs	Change configuration		Fy
Diagnostics	Control_Unit	DDS: 0 (Activ V MDS: 0 (Active)	Close	Help

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 subtron (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 $\underline{\mbox{ }}$ 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 \leftarrow . Alternatively, you can also specify the measurement period and then you can calculate the trace clock cycle of STARTER using \blacklozenge .

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.

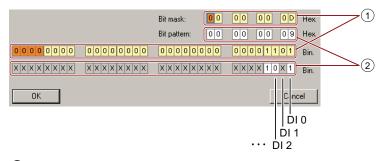
Example of a bit pattern as trigger:

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 <u>bin.</u>, 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

Project_Trace	Trace 1 inactive				
Insert single drive unit Trace Measurements Time diagram FFT diagram Bode diagram Trace Measurements Time diagram FFT diagram					
> Expert list	No. Active Signal Comment Color 1 V Control_Unit.r64 ···· Control_Unit.r64: Speed controller system deviation ····· ··· ··· ··· ··· ··· ··· ··· ···				
Drive navigator S Inputs/outputs	2 V Control_Unit.r65 Control_Unit.r65 Control_Unit.r65				
	3 Control_Unit.r66 Control_Unit.r66: Output frequency 4 Control_Unit.r752[0] Control_Unit.r752[0]: CU analog inputs input voltage/current actual, Al0 (T. 3/4)				
⊕ ≫ Open-loop/closed-loo	5 V Control Unit.r722 ···· Control Unit.r722: CU digital inputs, status				
E → >> Commissioning	8 9 V Bit tracks Bitspuren				
Control panel	W Becording				
Device trace Jentification/opt	F(0)				
⊡ → >> Communication	E Schronous recording - time-limited trace				
⊡ ≫ Diagnostics	Basic cycle clock: 4 ms [G120_L0240E_2_DP_F]				
Documentation SINAMICS LIBRARIES MONITOR MONITOR Trace cycle clock: 1 ms					
	Duration: 6552 ms				
	<u>»»</u> Trigger				
	Type: Trigger on variable - Bit pattern				
	Par. no. / variable: Control_Unit.r722, CO/BO: CU digital inputs, status 1 x 0 1 x . D Hex.				
	Cyc.clock 4 ms [G120_CU240E_2_DP_F]				
	Pretrigger: 500 ms 1 x 1 0 x 9 Hex.				
	»» Display options				
	Repeated measurement				
	Arrange curves in tracks				
	Measuring cursor On				
	Limit display range to the last				
	3056				
Project	🙆 Control_Unit 🌇 Device trace				

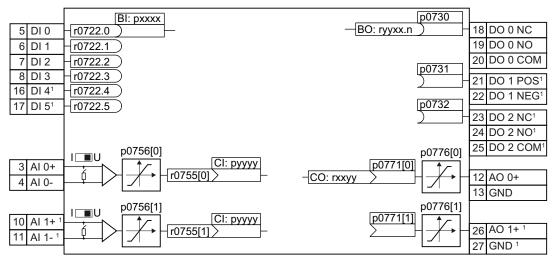
Figure 5-10 Trace dialog box

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).



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

6.1 Digital inputs

Digital input terminals	Changing the function of the digital input
5 DI 0 r0722.0 6 DI 1 r0722.1 7 DI 2 r0722.2 8 DI 3 r0722.3 16 DI 4 ¹ r0722.4 17 DI 5 ¹ r0722.5	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.

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:
i abic	0 2	Examples.

	With Operator Panel	In STARTER
Acknowledge fault with digital input 1: p2103 6 DI 1 r0722.1 722.1	Set p2103 = 722.1	Go online with STARTER and select "inputs/outputs". Change the input function via the corresponding
Switch-on motor with digital input 2:	Set p0840 = 722.2	screen form.
p0840 7 DI 2 r0722.2 722.2 ON/OFF1		

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.

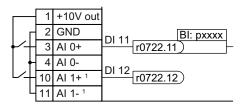


Figure 6-2 Additional digital inputs ¹Not available with CU240B-2 and CU240B-2 DP Control Units

6.2 Fail-safe input

6.2 Fail-safe input

This manual describes the STO safety function with control via a fail-safe input. All other safety functions, further fail-safe digital inputs of the 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).

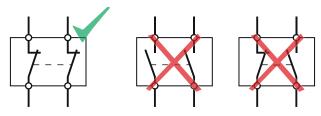
Connect devices

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

6.3 Digital outputs

Digital output terminals	Changing the function of the digital output
p0730 BO: ryyxx.n 18 DO 0 NC 19 DO 0 NO 20 DO 0 COM 21 DO 1 POS ¹ 22 DO 1 NEG ¹ 23 DO 2 NC ¹ 24 DO 2 NO ¹ 25 DO 2 COM ¹	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.

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:

	With Operator Panel	In STARTER
Signal fault via digital output 1.	Set p0731 = 52.3	Go online with STARTER and select "inputs/outputs". Change the output function via the corresponding screen form.

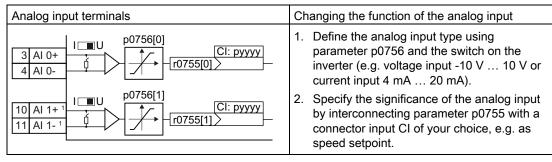
Advanced settings

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

6.4 Analog inputs



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

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

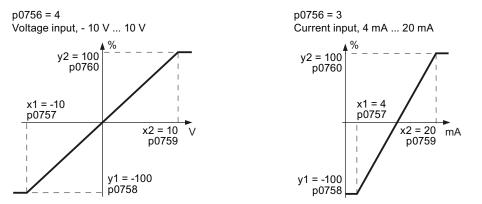


Figure 6-3 Examples for scaling characteristics

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 \dots 12 mA signal into the value range -100 % \dots 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"):	10 ^{10 −}

Parameter	Description	
following values:	56 to the value 3, the inverter sets the scaling c	haracteristic parameters to the
Adapt the character	'58[0] = 0,0; p0759[0] = 20; p0760[0] = 100 ristic:	
p0761[0] = 6.0	Analog inputs wire break monitoring, response threshold	Current input, 6 mA 12 mA
p0757[0] = 6.0	Analog inputs, characteristic (x1, y1)	y2 = 100 p0760
p0758[0] = -100.0	6 mA corresponds to -100 %	
p0759[0] = 12.0	Analog inputs, characteristic (x2, y2)	x1 = 6 p0757
p0760[0] = 100.0	12 mA corresponds to 100 %	y1 = -100 p0758

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.

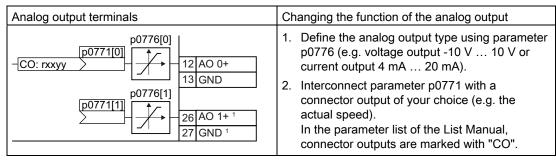
Advanced settings

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

6.5 Analog outputs



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

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).

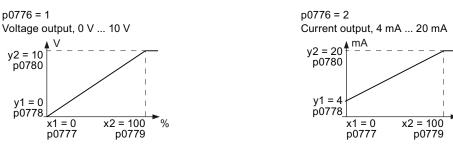


Figure 6-4 Examples for scaling characteristics

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

%

6.5 Analog outputs

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.

Parameter	Description		
p0776[0] = 2	Analog output, type		
	Define analog output 0 as current output.		
After changing p07 following values:	76 to the value 2, the converter sets the scaling	characteristic parameters to the	
p0777[0] = 0.0; p07	78[0] = 4.0; p0779[0] = 100.0; p0780[0] = 20.0		
Adapt the character	ristic:		
p0777[0] = 0.0	Analog output, characteristic (x1, y1)	Current output, 6 mA 12 mA	
p0778[0] = 6.0	0.0 % corresponds to 6 mA	y2 = 12 mA	
p0779[0] = 100.0	Analog output, characteristic (x2, y2)	p0780	
p0780[0] = 12.0	100 % corresponds to 12 mA		
		y1 = 6	
		p0778 x1 = 0 x2 = 100 p0777 p0779	

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)
-----------	---

со	Significance	со	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.

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 6.5 Analog outputs

Γ	able	6-	10	Example:

	With Operator Panel	In STARTER
Output the converter output current via analog output 0. i - <u>r0027 27</u> 12 AO 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.

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	RS485 connector
Modbus RTU (Page 131)	-	CU240E-2 CU240E-2 F	
	¹ Information on PROFIsafe can only be found in the Safety Integrated Functi 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 (<u>http://www.automation.siemens.com/mcms/automation/en/industrial-</u>communications/profinet/Pages/Default.aspx) manual.

7.1.1 What do you need for communication via PROFINET?

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

Questions	Answer/description	Example
Is the converter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 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)

Table 7-1 Checklist for communication via PROFINET

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

Parameter	Description	
p0015	Macro drive unit Configure the interface in basic commissioning, and select a telegram. See also the section: Select interface assignments (Page 46).	
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)	
	 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) 	

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 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)
- 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

7.2 Communication via PROFIBUS

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

7.2 Communication via PROFIBUS

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	Desci	iption		
p0015	Config	o drive unit gure the interface in basic commissioning, and select a telegram. See also the n: Basic commissioning with the BOP-2 (Page 66).		
p0922	PROF	Fldrive Telegram selection (factory setting for converters with PROFIBUS- or FINETinterface: Standard telegram 1, PZD-2/2)		
	Set th	e send and receive telegram, see Cyclic communication (Page 101)		
	1: Standard telegram 1, PZD-2/2			
	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:

FZD01 FZD02 FZD03 FZD04 FZD03 FZD00 FZD07 FZD00 FZD09 FZD10 FZD11 FZD12	PZD01 PZD02 PZD03 PZD04 PZD05 PZD06 PZD07 PZD08 P	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 da	ata for PCS	7	
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 da	ata for PCS	7	
ZSW1	NIST_A_ GLATT	IAIST_ GLATT		WARN_ CODE	

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

STW1 Configurable telegram length for the receive data											
	9	Ŭ	l Ű								
ZSW1	W1 Configurable telegram length for the transmit data										
	Ŭ	Ŭ	l u				1	1	1	1	

Figure 7-1 Telegrams for cyclic communication

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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-
IAIST_GLATT	smoothed actual current value		NAMUR definition

Table 7-5 Explanation of the abbreviations

Interconnection of the process data

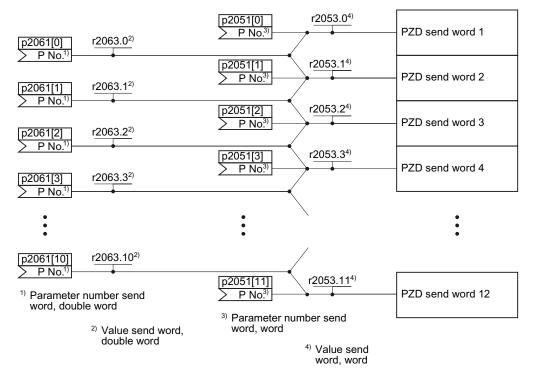


Figure 7-2 Interconnection of the send words

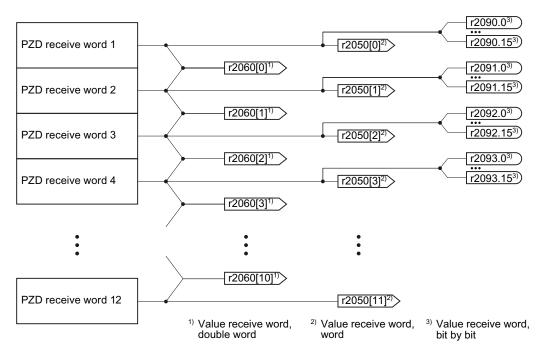


Figure 7-3 Interconnection of the receive words

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 C	Control word 1	and interconnection	in the converter

Bit	Meaning		Explanation	Signal	
	Telegram 20	All other telegrams		interconnection in the converter	
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 (OFF3) Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.		
	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] =	
	1 = Enable operation		Switch-on motor (pulses can be enabled).	r2090.3	
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] =	
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	r2090.5	
6	0 = Inhibit setpoint 1 = Enable setpoint		= Inhibit setpoint The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.		
			etpoint Motor accelerates with the ramp-up time p1120 to the setpoint.		
7	$0 \rightarrow 1$ = 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					
10	0 = No control via PLC		Converter ignores the process data from the fieldbus.	p0854[0] =	
	1 = Control from PLC		Control via fieldbus, converter accepts the process data from the fieldbus.	r2090.10	
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).

Bit	Meaning		Comments	Signal interconnection in the converter	
	Telegram 20	All other telegrams			
0	1 = Ready to star	t	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 ena	abled	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	9	Coast down to standstill is not active.	p2080[4] = r0899.4	
5	1 = OFF3 inactive	9	Quick stop is not active.	p2080[5] = r0899.5	
6	1 = Closing locko	ut 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] =	
	0 = Motor rotates	counterclockwise	Internal converter actual value < 0	r2197.3	
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	Explanation	Signal interconnection in the converter ¹⁾			
		Telegram 350					
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	p0820 = r2093.4			
5	1	DDS selection, bit 1	different motors (drive data sets).	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	p1501[0] = r2093.12			
	0	Speed control active	control.				
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			

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.

Bit	Value	Significance	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						

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

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:

Parameter	Description								
p0922 = 999	PROFIdrive telegram selection								
	999: Free telegram configuration with BICO								
p2079		Idrive PZD telegram selection extended e 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.									

Table 7- 10 Procedure

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	Descr	Description						
p0922 = 999	PROFIdrive telegram selection							
	999:	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 (1:	st word)	IND (2n	id word)	PWE (3rd and 4th word)					
15 12 11	10 0	15 8	7 0	15 0	15 0				
AKS	PNU	Subindex	Page index	PWE 1	PWE 2				
M									

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 \rightarrow converter

Request	Description	Response	Response identifier			
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			
72)	Change parameter value (field, word) 1)	4	7/8			
82)	Change parameter value (field, double word) ¹⁾	5	7/8			
9	Request number of field elements	6	7/8			

Table 7- 12 Request identifiers control → converter

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

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

Overview of the response identifiers converter \rightarrow control

The response identifier depends on the request identifier.

Response identifier	Description							
0	No response							
1	Transfer parameter value (word)							
2	Transfer parameter value (double word)							
3	Transfer descriptive element 1)							
4	Transfer parameter value (field, word) ²⁾							
5	Transfer parameter value (field, double word) ²⁾							
6	Transfer number of field elements							
7	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							

Table 7-13 Response identifiers converter \rightarrow control

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 proc	essed"
---	--------

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).

Parameter number Offs		Page inc	lex							
		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

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

Indexed parameters

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

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.

	Parameter channel						
PKE, 1st word IND, 2nd word PWE1 - high, 3rd word PWE2 - low, 4th v				- 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
0110	0	1 1 1 0 0 1 1 0 0 0 1	0000010	1001000	000000000000000000	000000	00000000000

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					
	Ρ	PKE, 1st word	IND, 2r	nd 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	10010101010	00000000	00000000	00000000000000000	0000000000011010

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		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
A	Κ		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	0000001	00000000	000000101011010010	1 1 1 1 1 1	0000000010

2 with	1 ON/OFF	1
	Z WIU	2 with ON/OFF

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 (Human Machine Interface)

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

7.3.2.1 Reading and changing parameters via data set 47

Reading parameter values

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 <i>00 hex EA hex</i> (for parameters without index: 00 hex)	4
	Parameter number 0001 hex FFFF he	X	6
	Number of the 1st index 0000 hex FFI (for parameters without index: 0000 hex)	FF hex	8
Address, parameter 2			
Address, parameter m			

Table 7-16 Request to read parameters

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 You can find the error values in a table at		6
Values, parameter 2			
Values, parameter m			

Changing parameter values

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 <i>00 hex EA hex</i> (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 Value of the 1st index	Number of index values 00 hex EA hex	
Values, parameter 2			\vdash
			\square
Values, parameter m	····		

Table 7-18 Request to change parameters

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

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

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: Enternor value 1 defines whether the converter		8
Values, parameter 2			
Values, parameter m			

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

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)

Configuring the fieldbus

7.3 PROFIdrive profile for PROFIBUS and PROFINET

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 \neq 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)

7.4.1 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.

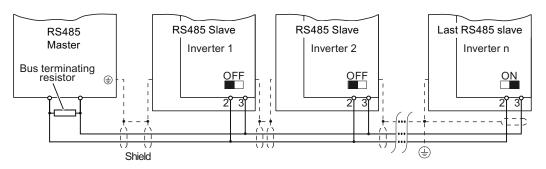


Figure 7-7 Communication network via RS485

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	Descript	Description								
P0015 = 21	Macro drive device Select the I/O configuration									
p2020	Setting t	Setting the baud rate								
	Value	Baud rate	Value	Baud rate						
	4 2400 9 57600 5 4800 10 76800									
	6 9600 11 93750 7 19200 12 115200 8 38400 13 187500									
p2022	Fieldbus interface USS PZD number 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	Sets the	interface monitoring time [ms] monitoring time to monitor the process of data are received within this time, an app								

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.

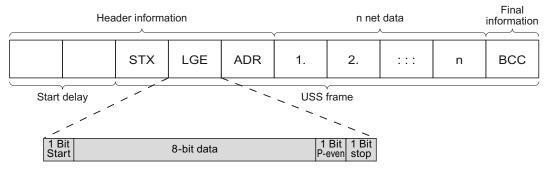


Figure 7-8 Structure of a USS telegram

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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 6 5 4 3 2 1 0 Special Mirror Broadcast bit 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.

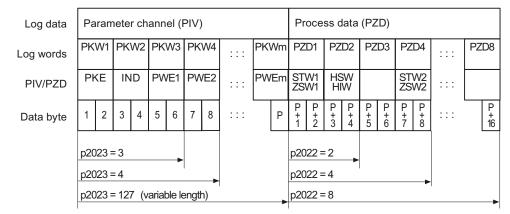


Figure 7-9 USS telegram - user data structure

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 = $0 \dots 8$). 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 S	PNU	Page index	Subindex	PWE 1, high word	PWE 2, low word					
P M										

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 \rightarrow converter

Request	Description	Response identifier			
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		
72)	Change parameter value (field, word) ¹⁾	4	7/8		
82)	Change parameter value (field, double word) ¹⁾	5	7/8		
9	Request number of field elements	6	7/8		

Table 7- 22 Request identifiers control → converter

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

²⁾ The following request IDs are identical: $1 \equiv 6, 2 \equiv 7, 3 \equiv 8$.

We recommend that you use identifiers 6, 7, and 8.

Overview of the response identifiers converter \rightarrow control

The response identifier depends on the request identifier.

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element ¹⁾
4	Transfer parameter value (field, word) ²⁾
5	Transfer parameter value (field, double word) 2)
6	Transfer number of field elements
7	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

Table 7-23 Response identifiers converter → control

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.

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 \rightarrow 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)

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

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	Offset	Page index								
number		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 \dots 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:
- 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

High word

Telegram examples, length of the parameter channel = 4

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

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

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

	Parameter channel								
	Ρ	PKE (1st word)	IND, 2r	nd word	PWE1 - high, 3rd word	PWE2	- low, 4th word		
15 12	2 11	10 0	15 8	7 0	15 0	15 10	9 0		
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index		
0110	011100111100111000110001000000000000000								

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)

Parameter channel								
	F	PKE, 1st word	IND, 2r	nd word	PWE1 - high, 3rd word	PWE2 - low, 4th word		
15 121	11	10 0	15 8	7 0	15 0	15 0		
AK		Parameter number	Page index	Subindex	Parameter value (bit 16 31)	Parameter value (bit 0 15)		
01110	0	10010101010	00000000	00000000	0000000000000000000	0000000000011010		

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, 2r	nd 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	00000000	0000001	0000001011010010	1 1 1 1 1 1	000000010	

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.

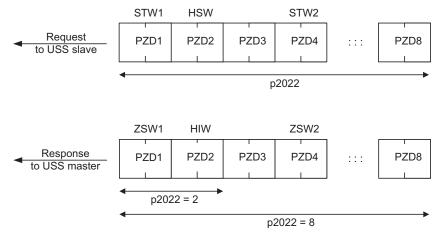


Figure 7-13 Process data channel

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.

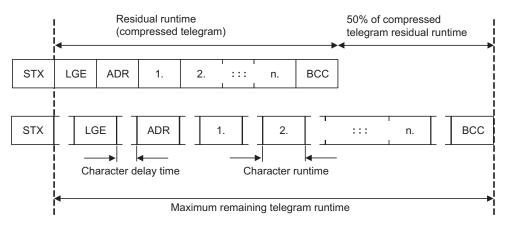
7.4.2.6 Time-out and other errors

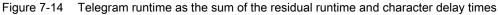
You require the telegram runtimes in order to set the telegram monitoring. The character runtime is the basis of the telegram runtime:

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

Table 7-26 Character runtime

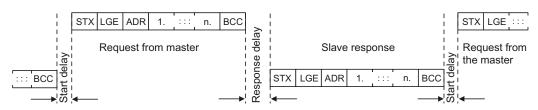
The telegram runtime is longer than just purely adding all of the character runtimes (=residual runtime). You must also take into consideration the character delay time between the individual characters of the telegram.





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

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



The slave only responds after the response delay has expired.

Figure 7-15 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	ay
--	----

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 \neq 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 1 Bit P-even 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.

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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.

							Modbus	RTU	-Telegra	mm									
Initial pause	Арр	plikation Data Unit / Modbus frame				interframe delay	•	•	•	interfra dela		Applikation Data Unit Modbus frame			nit /		End paus		
Initial p	ause					Applik	ation Data	a Uni	it / Modb	us fram	ne							frame elay	(
			Slave			Protoc	ol Data U	Jnit (PDU)				CRO	`			ue	siay	
			Slave	Funct cod									URU	,					
≥ 3.5 b	oytes	1 Byte			1 Byte 0 252 Bytes						CRC lo	2 Byt	te CRC h	igh	••	•			
															_				
≥ 3.5 b	oytes	ay time	1 Byte	-	1 E	ay time	1 Byte	ay time	1 Byte	-	1 By	ay time	1 6	Byte	•	••			
		Character delay time		Character delay		Character delay		Character delay		Character delay		Character delay time							

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]).

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

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

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.

Configuring the fieldbus

7.4 Communication via RS485

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/O or value	ff text e range	Data / parameter
Process	data						
Control d	ata						
40100	Control word	R/W		1			Process data 1
40101	Main setpoint	R/W		1			Process data 2
Status da	Ita						
40110	Status word	R		1			Process data 1
40111	Main actual value	R		1			Process data 2
Paramete	er data						
Digital ou	itputs			-			
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 o	utputs						
40220	AO 0	R	%	100	-100.0 .	100.0	r0774.0
40221	AO 1	R	%	100	-100.0 .	100.0	r0774.1
Digital in	outs						
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 in	puts						
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]
Converte	r identification			_	•		1
40300	Powerstack number	R		1	0 3	32767	r0200
40301	Converter firmware	R		0.0001	0.00	327.67	r0018
Converte	r data	1	1		1		1
40320	Rated power of the power unit	R	kW	100	0 3	27.67	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
Converte	r diagnostics	1			1		1
40340	Speed setpoint	R	RPM	1	-16250.	16250	r0020
40341	Speed actual value	R	RPM	1	-16250.	16250	r0022

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

Configuring the fieldbus

7.4 Communication via RS485

Modbus	Description	Modbus	Unit	Scaling	On/Off text	Data / parameter
Reg.		access		factor	or value range	
No.					-	
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	А	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 diag	gnostics					
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	032767	r2110 [0]
40499	PRM ERROR code	R		1	099	
Technolo	gy 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
Technolo	gy 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 diagr	nostics					
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.

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"		

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

The response returns the corresponding data set:

Example	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"			

Table 7-31 Slave response to the read request

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.

Example	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"			

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

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

Example	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"			

Table 7-33 Slave response to the write request

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).

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.

Table 7-34 Overview of exception codes

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

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

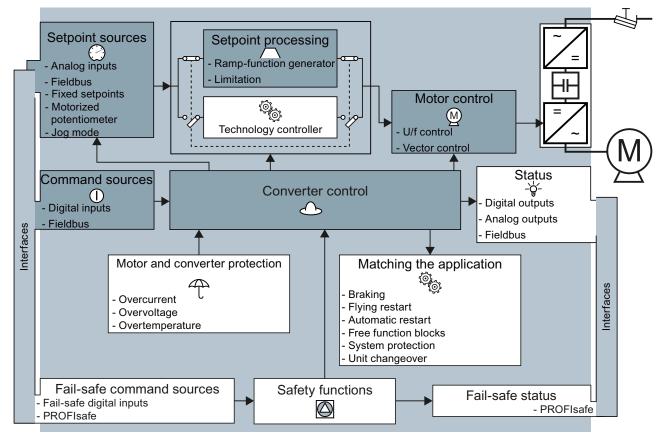


Figure 8-1 Overview of inverter functions

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 8.1 Overview of the inverter functions

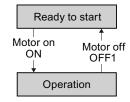
Functions	relevant to all applications	Functions required in special applications only			
in a dark c You set the that in mai	ons that you require in each application are shown olor in the function overview above. ese functions during the basic commissioning, so ny cases, the motor can be operated without 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)	Ą	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)		
0	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)	--\overline{	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.		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)		
M	Setpoint calculation (Page 163) The motor closed-loop control ensures that the motor follows the speed setpoint. Motor control (Page 167)		(Faye 221)		
П					

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".



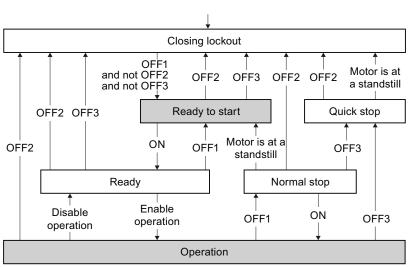
Converter states and commands for switching the motor on and off

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.



Switch on the inverter power supply

Figure 8-2 State overview of the converter

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

8.2 Inverter control

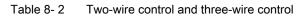
State	Explanation		
Closing lockout	In this state, the converter does not respond to the ON command. The converter goes into this state under the following conditions:		
	• The ON command was active when switching on the converter. Exception: When the automatic start function is active, the ON command 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.		

Table 8-1 Explanation of the converter states

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).



Behavior of the motor		
Clockwise Stop Counter- rotation Stop Stop	Control commands	Typical application
Motor on/off	 Two-wire control, method 1 Switch the motor on and off (ON/OFF1). Reverse the motor direction of rotation. 	Local control in conveyor systems.
Motor on/off, clockwise rotation Motor on/off, counter- clockwise rotation	 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
Enable / I I I I I I I I I I I I I I I I I I	 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
Enable / I I I I I I I I I I I I I I I I I I	 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. 	-

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

8.2 Inverter control

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.

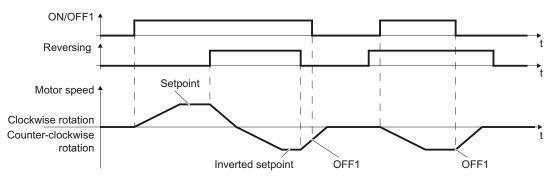


Figure 8-3 Two-wire control, method 1

Table 8- 3Function 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

Parameter	Description		
p0015 = 12	Macro drive unit (factory setting for inverters without PROFIBUS interface)		
	Controlling the motor using the digital inputs	DI 0	DI 1
	of the inverter:	ON/OFF1	Reversing
¥	commands with digital inputs of your choice (D	x).	
p0840[0 n] = 722.x	BI: ON/OFF1 (ON/OFF1)		
p1113[0 n] = 722.x	BI: Setpoint inversion (reversing)		
Example			
p0840 = 722.3	DI 3: ON/OFF1. Also see Section Digital inputs (Page 82).		

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.

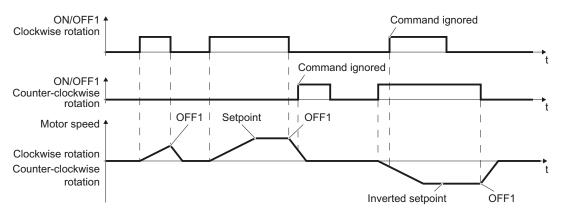


Figure 8-4 Two-wire control, method 2

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

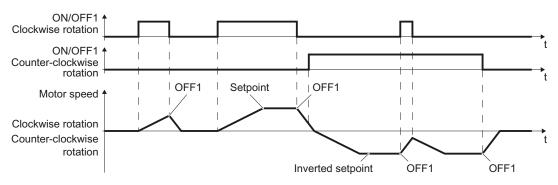
Parameter	Description		
p0015 = 17	Macro drive unit		
	Controlling the motor using the	DI 0	DI 1
	digital inputs of the inverter:	ON/OFF1 clockwise rotation	ON/OFF1 , counter- clockwise rotation
Advanced setting Interconnecting control commands with digital inputs of your choice (DI x).			
p3330[0 n] = 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).		

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 8.2 Inverter control

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.





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.

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

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).

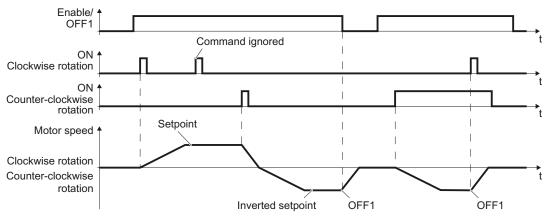


Figure 8-6 Three-wire control, method 1

Table 8- 9	Function table
1 aute 0- 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

Parameter	Description			
p0015 = 19	Macro drive unit			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable/OFF1	ON clockwise rotation	ON , counter- clockwise rotation
Advanced setting Interconnecting control	commands with digital inp	uts of your choic	e (DI x).	
p3330[0 n] = 722.x	BI: 2-3-WIRE Control Command 1 (enable/OFF1)			
p3331[0 n] = 722.x	BI: 2-3-WIRE Control Command 2 (ON clockwise rotation)			
p3332[0 n] = 722.x	BI: 2-3-WIRE Control Command 3 (ON, counter-clockwise rotation)			
Example				
p3332 = 722.0	DI 0: ON Counter-clockwise rotation. Also see Section Digital inputs (Page 82).			

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 8.2 Inverter control

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).

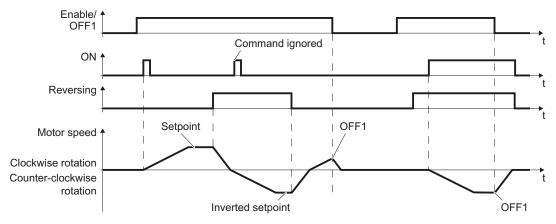


Figure 8-7 Three-wire control, method 2

Table 8- 11	Function table
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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
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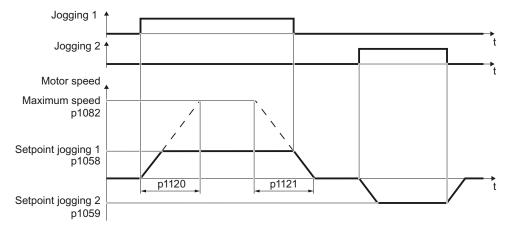
Parameter	Description			
p0015 = 20	Macro drive unit			
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1	DI 2
		Enable/OFF1	ON	Reversing
	commands with digital inputs of you	. ,		
$p3330[0 \dots n] = 722.x$	BI: 2-3-WIRE Control Command 1 (enable/OFF1)			
p3331[0 n] = 722.x p3332[0 n] = 722.x	BI: 2-3-WIRE Control Command 2 (ON) BI: 2-3-WIRE Control Command 3 (reversing)			
Example				
p3331 = 722.0	DI 0: ON. Also see Section Digital inputs (Pa	00)		

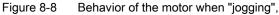
8.2.8 Running the motor in jog mode (JOG function)

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.





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.



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Functions
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8.2 Inverter control

Setting jogging

Table 8- 13 Setti	ngs
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	1			
Parameter	Description			
p1058	Jog	Jogging 1 speed setpoint (factory setting, 150 rpm)		
p1059	Jog	ging 2 speed setpoint (factory setting, -150 rpm)		
p1082	Max	kimum speed (factory setting 1500 rpm)		
p1110	Inhi	bit 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

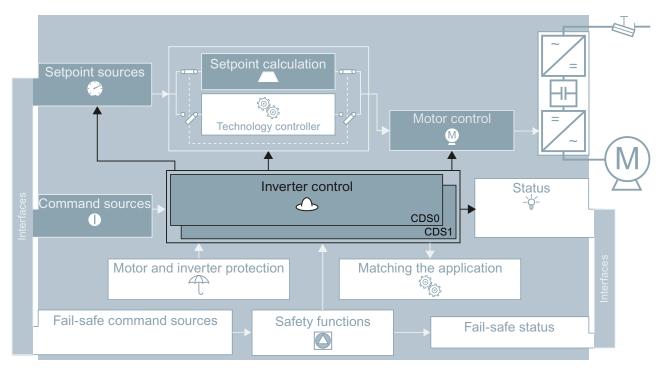
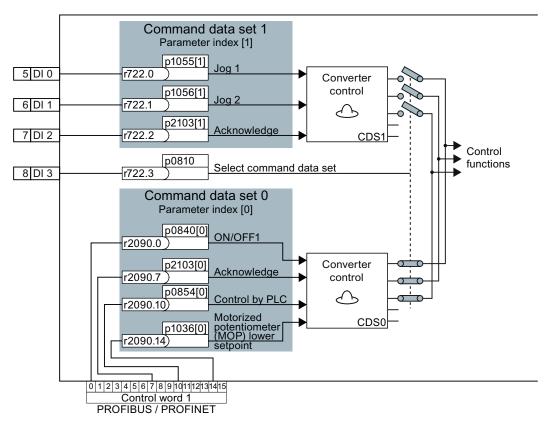


Figure 8-9 Command data sets (CDS): Different setting of the inverter control

8.2 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.

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

Table 8-14 Defining the number of command data sets

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.

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.

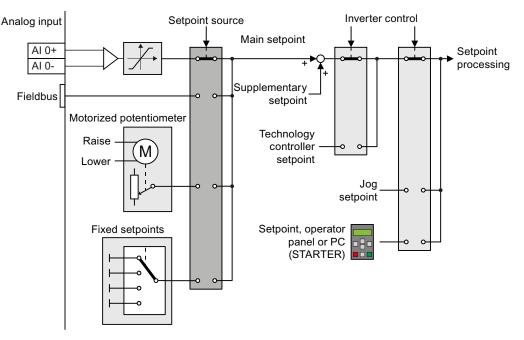


Figure 8-11 Setpoint sources for the inverter

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.

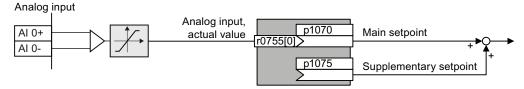


Figure 8-12 Example: Analog input 0 as setpoint source

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).

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 8.4 Setpoint sources

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

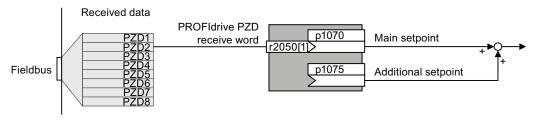


Figure 8-13 Fieldbus as setpoint source

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

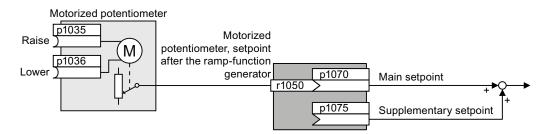


Figure 8-14 Motorized potentiometer as setpoint source

Table 8- 19	Setting the MOP as setpoint source
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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

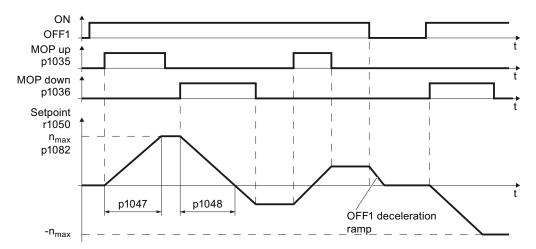


Figure 8-15 Function chart of motorized potentiometer

Table 8- 20 Basic setup of motorized po	otentiometer
---	--------------

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.

8.4 Setpoint sources

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 active0: Setpoint is only calculated with enabled pulses1: 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.

Table 8-21 Extended setup of motorized potentiometer

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

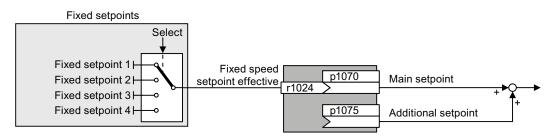


Figure 8-16 Fixed speeds as setpoint source

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.

8.4 Setpoint sources

Direct selection of fixed setpoints

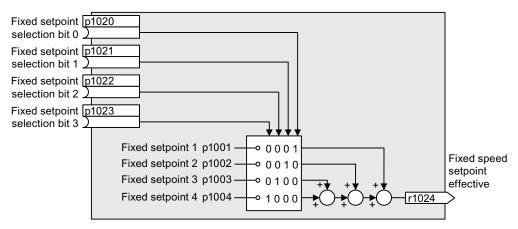


Figure 8-17 Simplified function diagram for directly selecting fixed setpoints

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

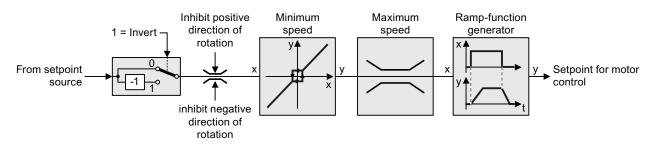
8.5 Setpoint calculation

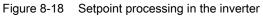
8.5.1

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.





8.5.2 Invert setpoint

Procedure

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

Tabla 0 25	Examples of settings to invert the setpoint
Table o- Zo	

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.

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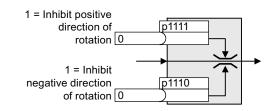
8.5 Setpoint calculation

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.



I able 8-26 Examples of settings to inhibit the direction of rotation	Table 8- 26	Examples of settings to inhibit the direction of rotation
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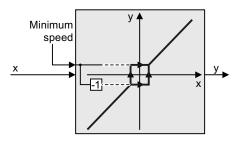
Parameter	Remark
p1110 = 1	Inhibit negative direction Negative direction is permanently inhibited.
p1110 = 722.3	Inhibit negative direction Digital input 3 = 0: Negative direction of rotation is enabled. Digital input 3 = 1: Negative direction of rotation is inhibited.

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.



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. Speed limit in positive direction of rotation

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.

8.5 Setpoint calculation

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.

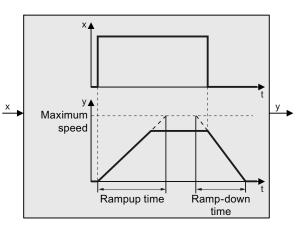


Table 8-29	Parameters for minimum	n and maximum speed

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.

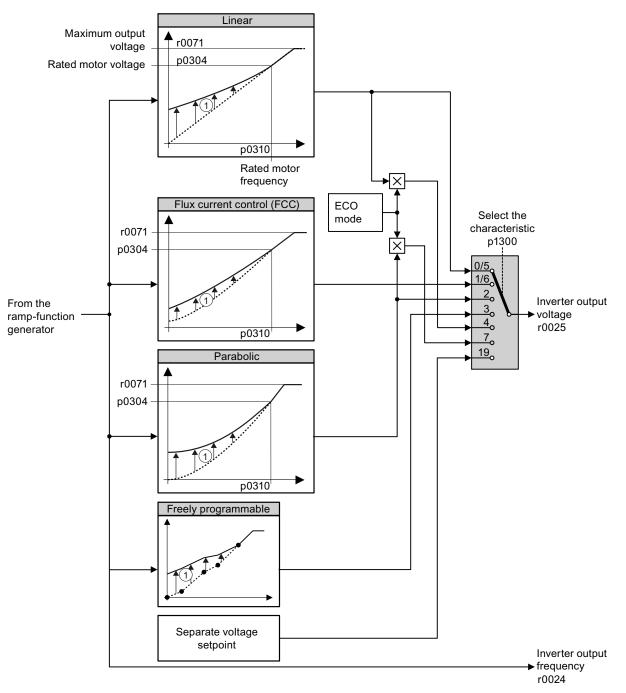
The characteristic is selected during commissioning, using p1300.

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Functions
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8.6 Motor control

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	Conveyor belts, roller	-	Linear	p1300 = 0
torque is independent of the speed	conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	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

8.6 Motor control

Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic.	ECO mode	p1300 = 4 or p1300 = 7
constant speed		If the speed setpoint is reached and remains unchanged for 5 seconds, then the inverter again reduces its output voltage.		
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

Table 8-31 Characteristics for special applications

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.

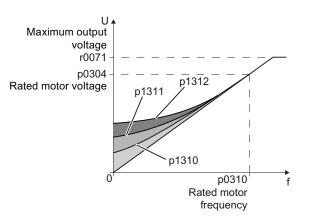


Table 8- 32	Parameters for the voltage boost
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Parameter	Description	
p1310	Permanent voltage boost (factory setting 50 %)	
	Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.	
p1311	Voltage boost when accelerating (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 Motor control

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".

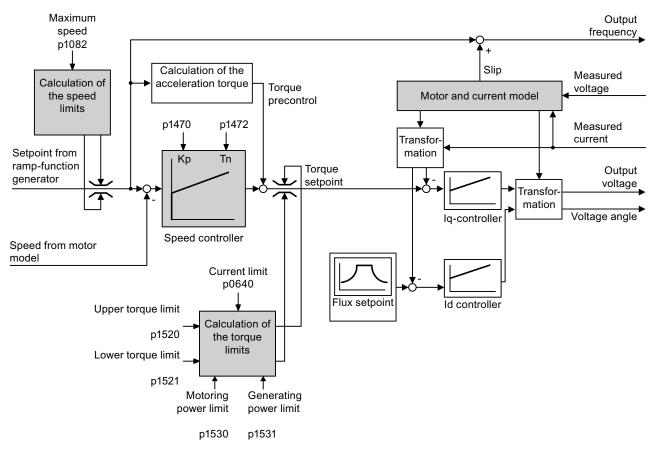


Figure 8-20 Simplified function diagram of sensorless vector control

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.

8.6 Motor control

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:

• Set p1496 = 0.

- Using STARTER:
- 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).

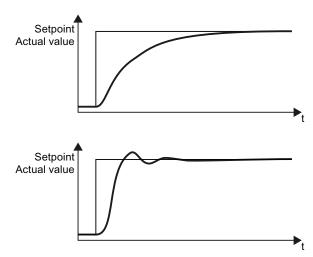
With an Operator Panel:

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 %.





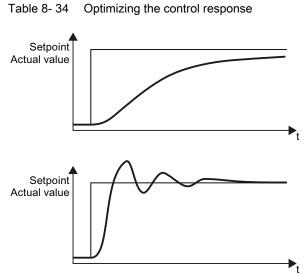
Optimum control response for applications that do not permit any overshoot.

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).

8.6 Motor control



Optimizing the control response

The actual value only slowly approaches the setpoint.

Increase the proportional component • $K_{\mbox{\scriptsize P}}$ 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 Motor control

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:

- I2t monitoring (alarm A07805, fault F30005) The I²t 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].
- 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 Protection functions

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.

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	⊞ ୳2≻େଳ	_년15 T2 MOTOR	
			1

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.

Functions

8.7 Protection functions

Parameters for the temperature 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)

Table 8-36 Setting the monitoring

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 \ge 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 time2: 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. \pm 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 Imax 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.

Functions

8.7 Protection functions

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.

Parameter	Description
P0305	Rated motor current
P0640	Motor current limit
P1340	Proportional gain of the Imax controller for speed reduction
P1341	Integral time of the Imax controller for speed reduction
r0056.13	Status: Imax controller active
r1343	Speed output of I _{max} controller Shows the amount to which the I-max controller reduces the speed.

Table 8-38 Imax controller parameters

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.

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.

Table 8- 39 V_{DCmax} controller parameters

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

8.8 Status messages

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.



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.

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

Table 8-40 Variables affected by changing over the motor standard

*) 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: $p0505 = 1 \triangleq p0505 = 2$ and $p0505 = 3 \triangleq p0505 = 4$.

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

Parameters affected by changeover

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

8.9.1.3 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.

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Drive_1	Visplay data set Drive data se witchover Command da		Add DD Add CD		ve DDS ve CDS	
Configure drive uni	figuration Drive data sets Command	data sets Units Reference variables - set				
Configuration Expert list	Unit system:	SI system of units		Caution: Rounding e when changing the	errors can occur units!	
Drive navigator Orive Inputs/outputs	Technological unit:	*				
	Additional settings					
Messages and moi Technology contro	Mot. stand.:	IEC motor (50Hz, SI units)				-
Commissioning	: 1 CDS: 0 💌 DDS: 0	MDS: 0		* 5	Close	Help
Project 🔂 C	iontrol_Unit					
Press F1 to open Help display.		S7USB / S7USB	Offline mode		N	

- 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.

	Online	Offline
CU type		
Unit system	inconsistent	inconsistent
If these difference	s are not adjusted, the online representat	on may be incompleté.
Adjust via:	<== Download Verwr	iting of the data in the target device
	Load to PG ==>	ting of the data in the project

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 wearfree. 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

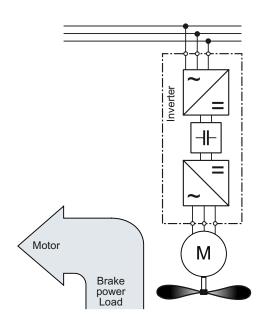
The motor converts the regenerative power into heat.

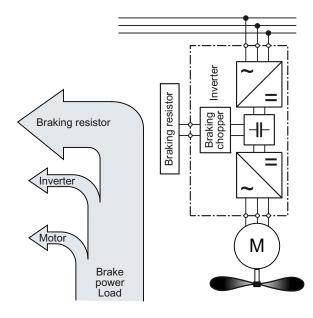
- *Advantage:* Defined braking characteristics, the motor brakes without the inverter having to convert any regenerative energy
- Disadvantages: significant motor temperature rise; no constant braking torque; regenerative power is dissipated as heat; does not function when the line supply fails

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



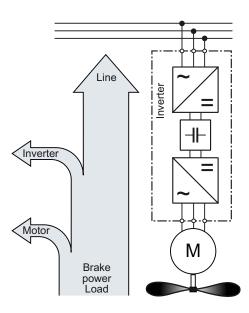


Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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?
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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,	Dynamic braking	PM240
hoisting gear, cranes, winders	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:

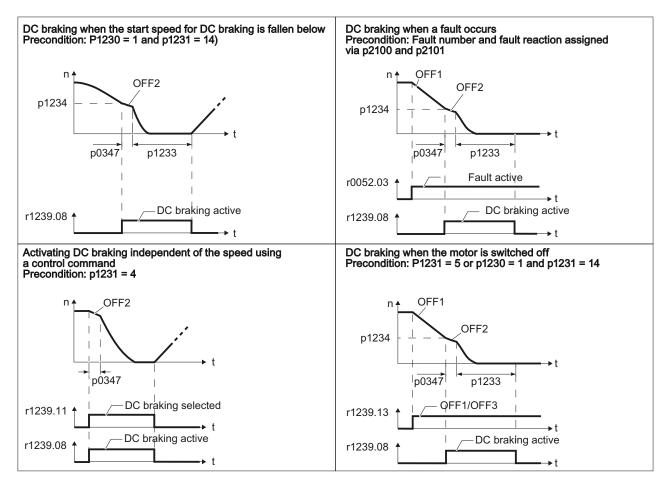
- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

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.



Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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.

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
	i alametere ier eeniganig	

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
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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 a index in p21	assigned an index of p2100. The associated fault response must be assigned the same 01.	
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.		

Functions

8.9 Application-specific functions

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

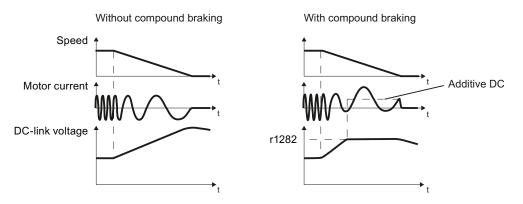


Figure 8-23 Motor brakes with and without active compound braking

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
	i alametere te chable and bet 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		

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 $V_{DC link, max}$.

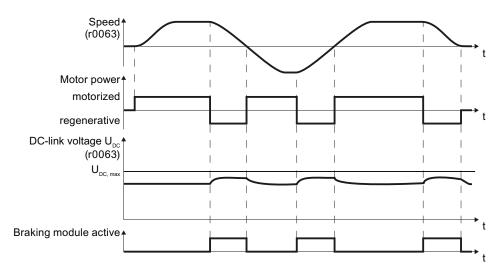


Figure 8-24 Simplified representation of dynamic braking with respect to time

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.

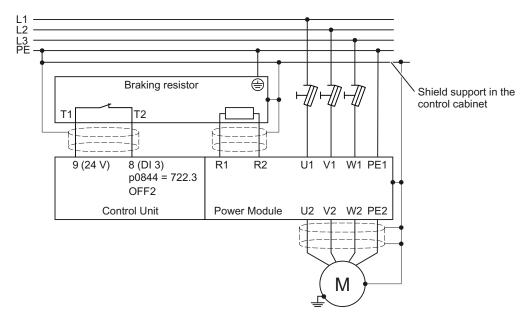


Figure 8-25 Braking resistor connection (example: Temperature monitoring via DI 3)

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).

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 hand application.		the braking resistor (factory setting: 0 kW) braking power that the braking resistor must handle in your particular	
	Under certain circumstances, for low braking power ratings, the converter extends th ramp-down time of the motor.		
Example : In your particular application, the motor brakes every 10 second the braking resistor must handle a braking power of 1 kW for 2 s. Use a br with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the n braking power to: $p0219 = 1$ (kW).		or must handle a braking power of 1 kW for 2 s. Use a braking resistor power rating of 1 kW \times 2 s / 10 s = 0.2 kW and set the maximum	
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

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 fee	dback with vector control (P1300 ≥ 20)		
P1531	Regenerative power limit		
	The maximum regenerative load is entered as negative value via p1531. (-0.01100000.00 kW).		
	Values higher than the rated value of the power unit (r0206) are not possible.		

Table 8-47 Settings for braking with regenerative feedback to the line

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).

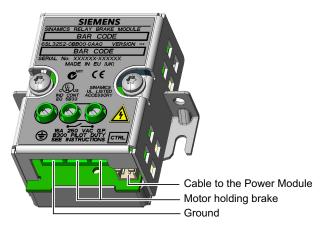
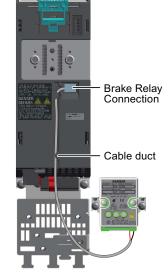
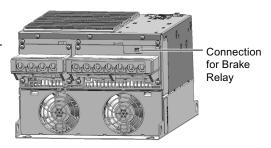


Figure 8-26 Brake Relay connections

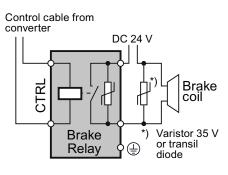
- Connect the Brake Relay to the Power Module using the cable form provided.
- Power Modules FSA ... FSC:
 - Connect the Brake Relay at the connector on the front of the Power Module.
 - Route the control cable in the guide on the Power Module.



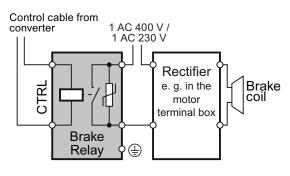
- Power Modules FSD ... FSF:
 - Connect the Brake Relay at the connector on the lower side of the Power Module.



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



24 V brake connection



440V brake connection



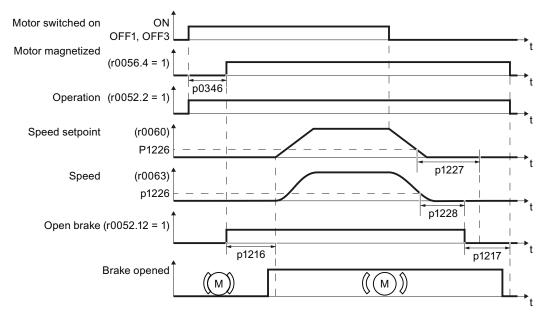


Figure 8-27 Controlling the motor holding brake when the motor is switched on and off

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.
- 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.

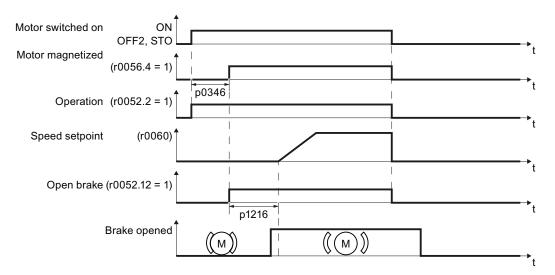


Figure 8-28 Controlling the motor holding brake after an OFF2 command or STO

Commissioning

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 torgue 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	
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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- 49Advanced 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.

Functions

8.9 Application-specific functions

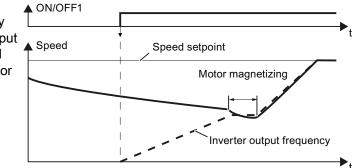
8.9.3 Automatic restart and flying restart

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).

Parameter	Description		
P1200	Flyi	Flying restart operating mode (factory setting: 0)	
	0 1 4	Flying restart is locked Flying restart is enabled, look for the motor in both directions, start in direction of setpoint Flying restart is enabled, only search in direction of setpoint	

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).

Table 8- 51 Advanced settings

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

Functions

8.9 Application-specific functions

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.

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.

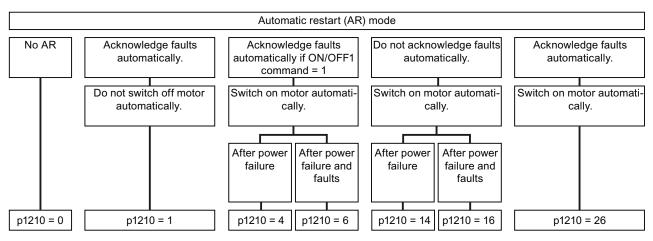


Figure 8-29 Selecting the automatic restart mode

- ▲ Fault Fault after power failure or in operation External fault Counter is decre-Start attempts Counter = p1211 If counter < 0, then fault mented by 1 counter F07320 1 Automatic acknowledgment 1 П П Г Automatic ON command² p1212 p1212 Motor speed Sum of the times for flying restart 1,0 s 1,0 s and magnetizing the motor 2nd start attempt 1st start attempt | successful 3 unsuccessful Monitoring time p1213[0] At least one start attempt must have been successful within this time. If not, fault F07320. Ţ Monitoring time p1213[1] After this time expires, the inverter resets the "attempted starts counter".
- 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

Parameter	Explanation	
p1210	Automatic restart mode (factory setting: 0)	
	 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 	
p1211	Automatic restart start attempts (factory setting: 3)	
	This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.	
	You define the maximum number of start attempts using p1211. After each successful 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.	
p1212	Automatic restart wait time start attempt (factory setting: 1.0 s)	
	This parameter is only effective for the settings p1210 = 4, 6, 26.	
	Examples for setting this parameter:	
	 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.	

Table 8- 52 Se	etting the automatic restart
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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 \Rightarrow No restart for fault F07331.

Suppressing the automatic restart only functions for the setting p1210 = 6, 16 or 26.

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).

Functions

8.9 Application-specific functions

8.9.4 PID technology controller

8.9.4.1 Overview

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

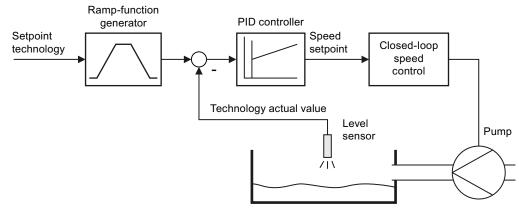


Figure 8-31 Example: technology controller as a level controller

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.

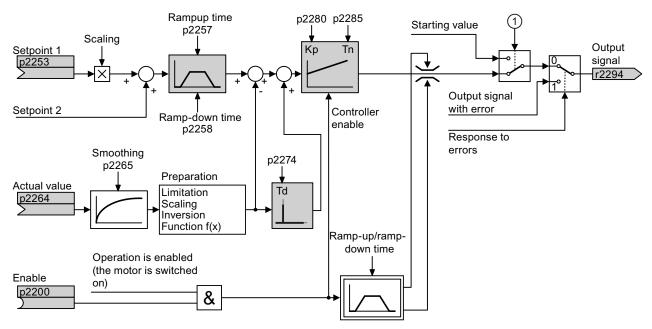


Figure 8-32 Simplified representation of the technology controller

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.		

Table 8-53 Setting the technology controller

Advanced settings

Parameter	Remark		
Limiting the outp	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	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		

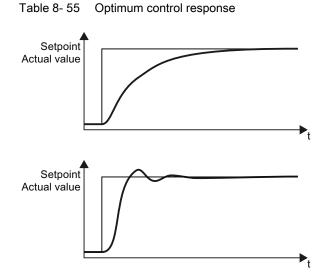
You can find additional information in function block diagram 7958 of the List Manual.

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.



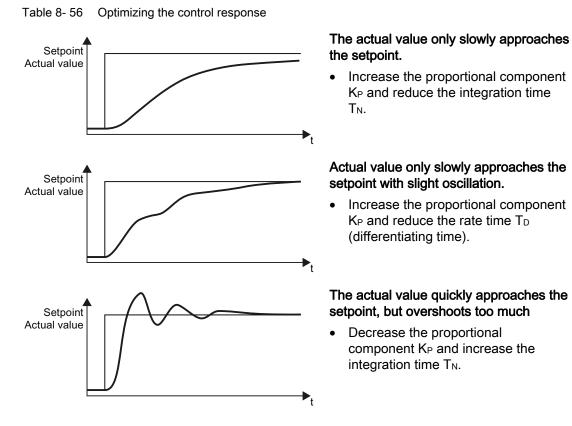
Optimum controller response for applications that do not permit any overshoot.

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).

Functions



• 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)

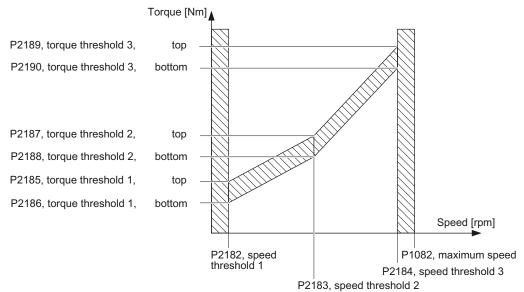
In many applications, it is advisable to monitor the motor torque:

- 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.
- Blocking protection: The converter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.
- Stall protection: The converter generates a message if the converter control has lost the orientation of the motor.
- Speed-dependent torque monitoring The converter measures the actual torque and compares it with a parameterized speed/torque characteristic.



Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

Parameter	Description			
No-load mo	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 pro	otection			
P2177	Delay time for the "motor locked" message			
Stall protec	lion			
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-dep	endent 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"			

Table 8- 57 Parameterizing the monitoring functions

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

8.9 Application-specific functions

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

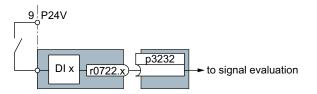


Figure 8-33 Load failure monitoring by means of a digital input

Table 8-58 Setting load failure monitoring

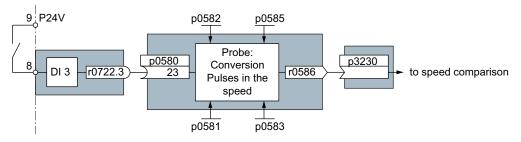
Parameter	Description
p2193 = 1 to 3	 Load monitoring configuration (factory setting: 1) 0: Monitoring is disabled 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring
p2192	Load monitoring delay time (factory setting 10 s) If, after the motor is switched 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.





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.

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.		

Table 8- 59 Setting speed deviation monitoring

8.9 Application-specific functions

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.

	Runtime	groups 1	6 with a	associated	l time slice	s
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	~	~	\checkmark	\checkmark	\checkmark	\checkmark
Arithmetic blocks ADD, SUB, MUL, DIV, AVA, NCM, PLI	-	-	-	-	~	1
Time modules MFP, PCL, PDE, PDF, PST	-	-	-	-	~	1
Memories RSR, DSR	~	1	1	\checkmark	1	~
Switches NSW	-	-	-	-	1	~
Switches BSW	1	1	1	1	1	~
Controllers LIM, PT1, INT, DIF	-	-	-	-	1	~
Limit value monitoring LVM	-	-	-	-	1	\checkmark

Table 8-60 Runtime groups and possible assignments of the free function blocks

 \checkmark : 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 ($0 \triangleq 0 \%$, $1 \triangleq 100 \%$).

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).

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	

Table 8- 61	Parameters for using the free function blocks
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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

8.10 Safe Torque Off (STO) safety function



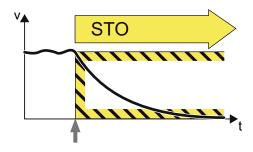
These operating instructions describe the commissioning of the STO safety function when it is controlled via a fail-safe digital input.

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

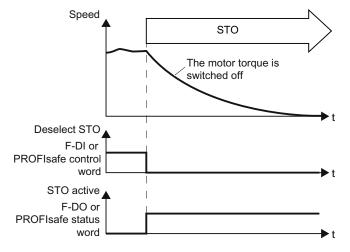
Example	Solution option		
When the Emergency Stop button is pressed, it is not permissible that a stationary motor undesirably starts.	 Wire the Emergency Stop button with a fail- safe input. Select STO via the fail-safe input. 		
A central Emergency Stop button ensures that several drives cannot unintentionally start.	 Evaluating an Emergency Stop pushbutton in a central control. Select STO via PROFIsafe. 		

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Functions
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How does STO function in detail?

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

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	6SL3255-0AA00-2CA0
(http://support.automation.siemens.com/WW/v	PC Connection Kit, includes STARTER DVD and
iew/en/10804985/130000)	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	Driv	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.	

Changing settings

Procedure

8.10.3.4

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

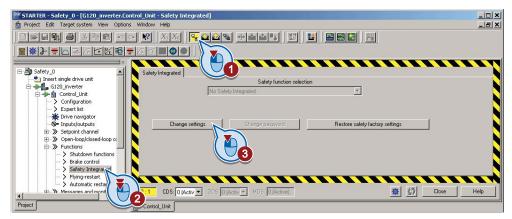


Table 8-65 Parameter

Parameter	Description	
p0010 = 95	Drive commissioning parameter filter Safety Integrated commissioning	

• Selecting "STO via terminal":

Safety Integ	rated Safety function selection	
	Basic functions via PROFIsafe	
Safe to	No safety function	
5010 (0)	No safetu function Basic functions via onboard terminals	
	Basic functions via PROFIsafe	
	Basic functions via PROFIsafe and onboard terminal 🛛 🖉 🏹	
	Extended functions via onboard terminals	
	Extended functions via PROFIsafe	/
	Extended functions via PROFIsafe and basic functions via onboard terminals	

8.10 Safe Torque Off (STO) safety function

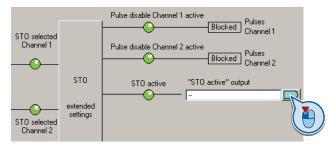
Parameter	Description	
p9601	Enable functions integrated in the drive (factory setting: 0000 bin)	
	p9601 = 0	Safety functions integrated in the drive inhibited
	p9601 = 1	Enable basic functions via onboard terminals

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.





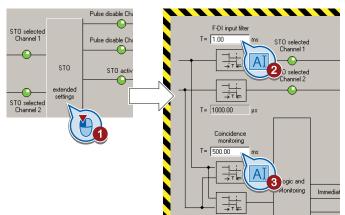
Parameter	Description
r9773.01	1 signal : STO active in drive

8.10 Safe Torque Off (STO) safety function

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:

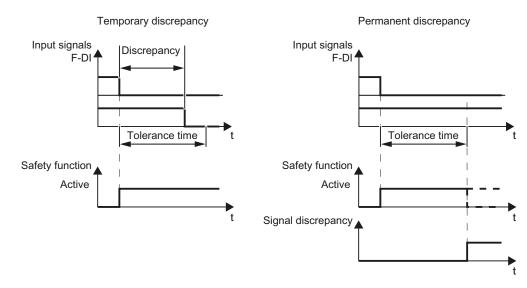
- A tolerance for the simultaneous monitoring.
- A filter to suppress short signals, e.g. test pulses.

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.

8.10 Safe Torque Off (STO) safety function



When appropriately set, the converter tolerates brief discrepancies.

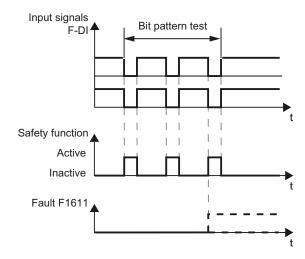
Figure 8-35 Tolerance regarding discrepancy

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.
- 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.

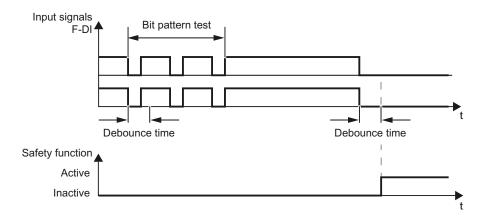


Figure 8-37 Filter for suppressing temporary signal changes

Note

The filter increases the converter response time. The converter only selects its safety function after the debounce time has elapsed.

8.10 Safe Torque Off (STO) safety function

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.

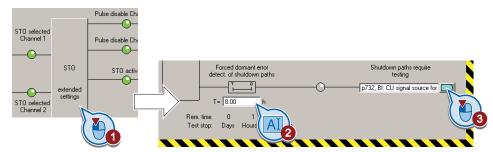
If you use an input as a standard input, set the debounce time using parameter p0724 .

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.

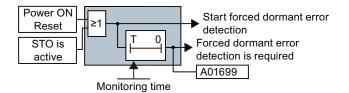


Figure 8-38 Triggering and monitoring the forced checking procedure

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.

Table 8- 69

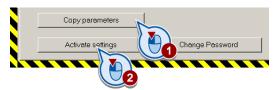
Select function STO or switch off the converter supply voltage temporarily and on again.

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 Safe Torque Off (STO) safety function

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:

	Safety function selection		
STO via terminal			
Safe torque off (STO)			
	STO selected Channel 1	STO extended settings	Pulse disable Channel 1 active Free Pulses Channel 1 Pulse disable Channel 2 active Pulses Channel 2 STO active "STO active" output
	Channel 2		· · · · · · · · · · · · · · · · · · ·

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

Digital inputs Relay outputs Analog inputs Analog outputs Measuring Input	
Current I/O configuration: 12	
5 DI 0 Terminal eval. Digital input 0 Digital input 0 Digital input 0 Digital input 1 Digital Digital input 1 Digital Dig	
3 Di 11 Terminal eval. Digital input 11 Digital input 11 10 Di 12 Terminal eval. Digital input 12 10 Terminal eval. Digital input 12	
9 0 28 0 	
211 DDS:0 (Activ - MDS:0 (Activ - MDS:0 (Active)	Help
	Durrent I/D configuration: 12 Image: Digital input 0 Digital input 0 Image: Digital input 0 Digital input 1 Image: Digital input 0 Digital input 1 Image: Digital input 1 Di

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 Safe Torque Off (STO) safety function

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 dataAdd configurationAdd 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 descriptionCheck firmware versionsCheck checksums	

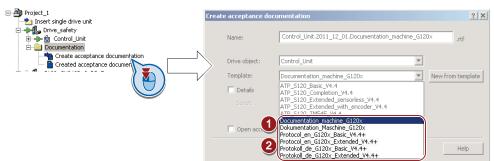
8.10 Safe Torque Off (STO) safety function

Documents for acceptance

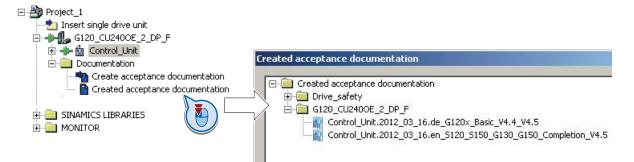
The STARTER provides you with a number of documents to be regarded as a recommendation for the acceptance tests of the safety functions.

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

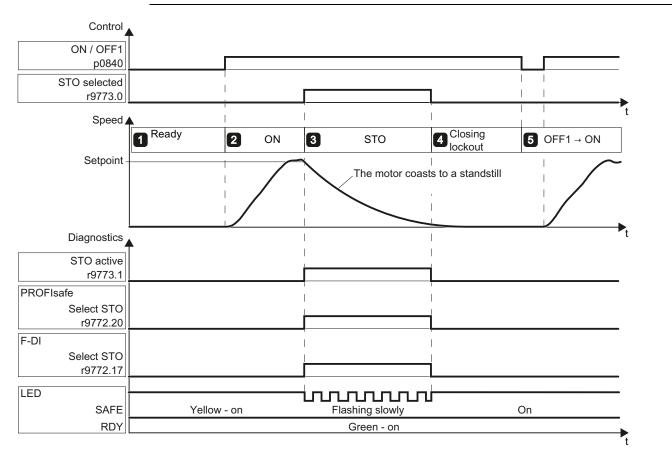
Perform the acceptance test with the maximum possible velocity and acceleration in order to test the expected maximum braking distances and braking times.

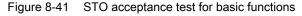
Note

Non-critical alarms

The following alarms occur each time the system boots, and are not critical for the acceptance:

- A01697
- A01796





Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

8.10 Safe Torque Off (STO) safety function

Table 8- 72	Function "Safe Torque Off" (STO)
-------------	----------------------------------

No.	Description		
1.	Initial state		
	• The converter is "ready" (p0010 = 0).		
	• The converter signals neither faults nor alarms for the safety functions (r0945[07], r2122[07]).		
	• 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) (r9772.17 = 1) (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[07], r2122[07]).		
	 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[07], r2122[07]).		
	 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

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.

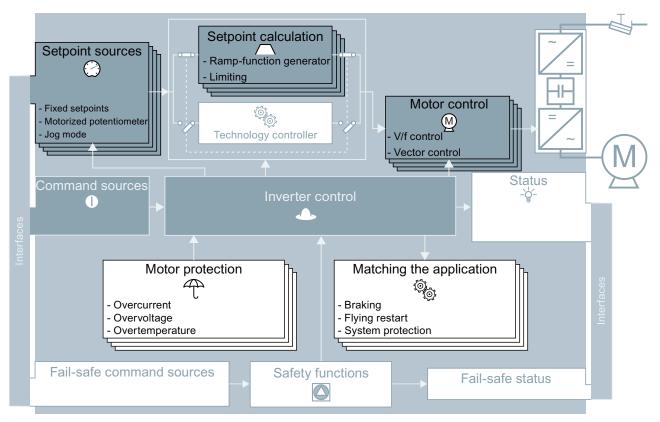


Figure 8-42 DDS switchover in the inverter

8.11 Switchover between different settings

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).

8.11 Switchover between different settings

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.

Data backup and series commissioning

9.1 Backing up and transferring settings using a memory card

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.)

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 Backing up and transferring settings using a memory card

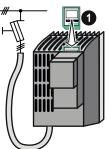
9.1.1 Saving setting on memory card

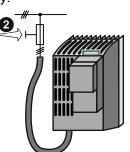
We recommend that you insert the memory card before switching on the converter. The converter always also backs up its settings on an inserted card.

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.





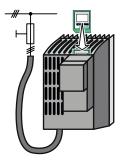
 After it has been switched on, the frequency converter copies its settings to the memory card.

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.



9.1 Backing up and transferring settings using a memory card

Procedure using STARTER

• Go online with STARTER. Control_Unit Configuration > Expert list 5 Commissioning 🔆 Drive navigator Diad 🛇 Inputs/outp 📎 Setpoint ch ÷ ÷ ≫ Open-loop/cl p control _ _ _ _ _ _ Back up data on memory card ? × SINAMICS 4 Parameter set in the drive Parameter set on memory card 0 [0] Source/target standard •

- 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

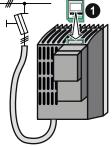
• Start data transfer in the menu "EXTRAS" - "TO CRD".

EXTRAS	ОK
TO CRD	ОК

9.1.2 Transferring the setting from the memory card

Procedure

- The converter power supply has been switched off.
 - Insert the memory card into the converter.



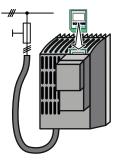
supply.

2. Then switch-on the converter power

• If there is valid parameter data on the memory card, then the converter accepts the data from the memory card.

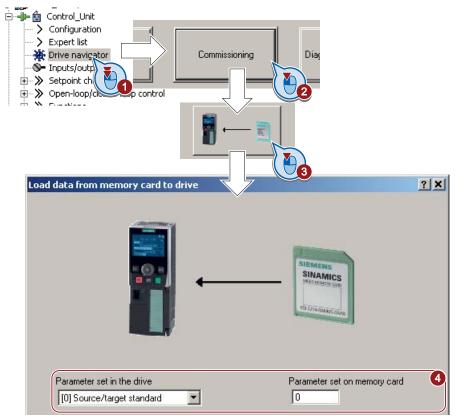
Procedure: Manual data transfer from a memory card

- 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:

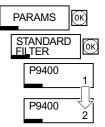
Control_Unit Configuration Expert list Drive navigator Inputs/output Setpoint char Open-loop/clossop co			
Back up data on memory	card		<u>? ×</u>
Parameter set in the driv [0] Source/target stan		Parameter set on me	mory card
Save	Safely remove memory card	Close	Help

- 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.

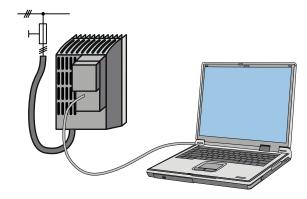


9.2 Backing up and transferring settings using STARTER

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).

$\label{eq:procedure} Procedure \quad converter \rightarrow PC/PG$

- Go online with STARTER : 🔚
- Select the button "Download project to PG": <u></u>
- To save the data in the PG, select the button: I.
- Go offline with STARTER : 强.

Procedure $PC/PG \rightarrow Converter$

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

Converter without safety functions:

- Go online with STARTER :
 ^B

- Select the button "Download project to target system": Main
- To save the data in the converter, select the "Copy RAM to ROM" button: <a>[]
- Go offline with STARTER : 强.

Converter with safety functions:

- 1 Go online with STARTER : 🔚.
- ② Select the button "Download project to target system": system

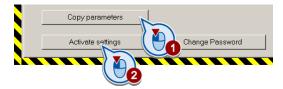
9.2 Backing up and transferring settings using STARTER

③ Open the STARTER screen for the safety functions.

 ^{™#}STARTER - Safety_0 - [Gi20_INVERTER. Safety Integrated]
 ☆ Project Edit Target system View Options Window Help



- 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 : S
- 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

9.3 Saving settings and transferring them using an operator panel

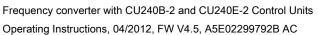
When the power supply is switched on, you can transfer the settings of the converter to the BOP-2 or, vice versa, transfer the data from the BOP-2 to the converter.

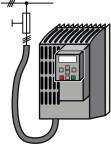


• Start data transfer in the menu "EXTRAS" - "TO BOP".

Procedure $BOP-2 \rightarrow converter$

- 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.





EXTRAS	ОК

FROM BOP

EXTRAS

TO BOP

OK

(OK)

(ок)

9.4 Other ways to back up settings

9.4 Other ways to back up settings

Description

In addition to the default setting, the converter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (<u>http://support.automation.siemens.com/WW/view/en/43512514</u>).

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	
EXTRAS OK TO CRD OK	The converter writes its setting 0, 10, 11 or 12 to the memory card in accordance with p0802. The file on the memory card is assigned the number according to p0802.
EXTRAS (K) FROM CRD (K)	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.

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".

Data backup and series commissioning 9.5 Write and know-how protection

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

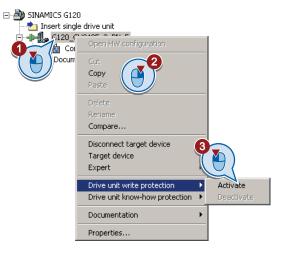
Select the converter in your STARTER project with the left mouse button ①.

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" <u>.</u> 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 \Rightarrow 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 \mathbf{s} or via p0971 = 1.
- 5. Save the project with an 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.

Activate Know-how Protection for Drive Unit	×
Know-how prot. without copy prot.	
C Know-how prot. with copy prot.	
Password:	
Note: Before you activate the know-how protection, you can remove parameters from the protection through entries in p7764 (expert lis	st).
Copy RAM to ROM	
OK. Cancel Help	

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

- 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.

Deactivate Know-how Protection for Drive Unit	×
 Temporarily (password is retained) Permanently (password is deleted) 	
Password	
Copy RAM to ROM	
OK Cancel Help	

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 (1) on the computer/PG and go offline (1)
- 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)

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).

Data backup and series commissioning

9.5 Write and know-how protection

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.

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:	Replacement:	Replacement:	Replacement:
Same type	Same type	Same type	Same type
Same power rating	• <i>Higher</i> power rating	Same firmware version	 <i>higher</i>firmware version (e.g. replace FW V4.2 by FW V4.3)
DM CCI	PM	E Firmware Version	E Firmware Version
	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.		

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 10.1 Overview of replacing converter components

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

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 switchon 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.

10.2 Replacing the Control Unit

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).

Service and maintenance

10.3 Replacing the Power Module

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.



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).

Service and maintenance

10.3 Replacing the Power Module

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:

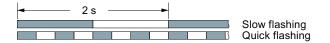


Table 11-1 Inverter diagnostics

L	ED	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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 11.1 Operating states indicated on LEDs

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.

Table 11-5 Diagnostics of the safety functions

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	e Alarm	value	Alarm rece			n time oved
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		132	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 rece		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.

11.2 Alarms

	Alarm code	Alarm	value	Alarm rece		Alarm remo		
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]	$\left(\right)$

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.

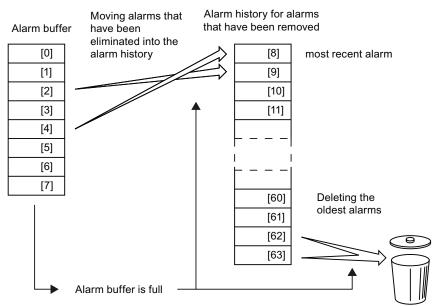


Figure 11-4 Shifting alarms that have been removed into the alarm history

The alarms that have still not been removed remain in the alarm buffer and are resorted so that gaps between the alarms are filled.

11.2 Alarms

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

Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	Alarm code
	Displays the numbers of alarms that have occurred
r2123	Alarm time received in milliseconds
	Displays the time in milliseconds when the alarm occurred
r2124	Alarm value
	Displays additional information about the alarm
r2125	Alarm time removed in milliseconds
	Displays the time in milliseconds when the alarm was removed
p2111	Alarm counter
	Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [07] are transferred into the alarm history [863]
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

Table 11-6 Important parameters for alarms

Extended settings for alarms

Table 11-7 Extended settings for alarms

Parameter	Description					
You can cha	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.

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		t time eived		time oved
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
Istiauit		132	Float	Days	ms	Days	ms

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

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

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

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

	Fault code	Fault	value	Fault rece		Fault remo	
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]

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.

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

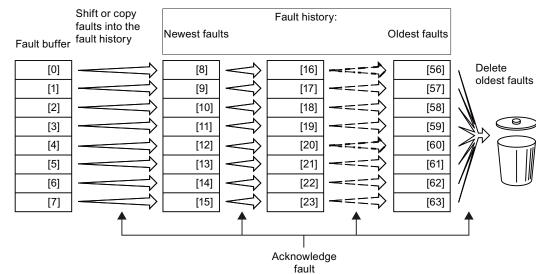
Faults that are triggered by internal converter hardware and firmware monitoring functions can only be acknowledged by switching off and on again. You will find a note about this restricted option to acknowledge faults in the fault list of the List Manual.

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

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

Table 11-8 Important parameters for faults

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
	, la la la loca cola ligo

Parameter	Description
You can ch	ange 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 ch	ange 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 ch	ange 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

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

Table 11- 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.

11.4 List of alarms and faults

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 UCE	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	 Switch the module off and on again. After this fault has been output, the module is booted with the factory settings. 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 $p2040 \neq 0$ 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.	

11.4 List of alarms and faults

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. 	

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

11.4 List of alarms and faults

Number	Cause	Remedy
F07426	Technology controller actual value	 Adapt the limits to the signal level (p2267, p2268).
	limited	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	External alarm 1 3	The signal for "external alarm 1" has been triggered.
A07851 A07852		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.

11.4 List of alarms and faults

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.
A07921	Torque/speed too high	Check the connection between the motor and the load.
A07922	Torque/speed out of tolerance	 Adapt the parameterization corresponding to the load.
F07923	Torque/speed too low	Check the connection between the motor and the load.
F07924	Torque/speed too high	Adapt the parameterization corresponding to the load.
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary	Acknowledge pending faults.
	measurement	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	Check the following:
	adjustable parameters	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).

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

11.4 List of alarms and faults

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.
500005		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.
1 30011		Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables.
1 000 10		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-	Check the supply voltage at the input terminals.
1 30027	charging	Check the line voltage setting (p0210).
	L	energine intertenage certing (per te).

11.4 List of alarms and faults

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.

11.4 List of alarms and faults

Technical data

12.1 Technical data, CU240B-2 Control Unit

Table 12-1

Feature	Data		
Order numbers	6SL3244-0BB00-	1BA1 With RS485 interface for the following protocols:USS	
		Modbus RTU	
	6SL3244-0BB00-		
Operating voltage			
Operating voltage		ne Power Module ria terminals 31 and 32 with 24 V DC, a maximum of 200 VA	
	Use a power s 0 V of the pow	supply with Protective Extra Low Voltage (PELV) according to EN 61800-5-1): The ver supply must be connected with low resistance to the PE of the system. OP 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 (termina	al 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 \pm 1 ms response time for a debounce time p0724 = 0.	

12.1 Technical data, CU240B-2 Control Unit

Feature	Data	
Digital output / relay	1 (DO 0)	30 V DC / max. 0.5 A with resistive load
output		Update time 2 ms
		which require UL certification, the voltage at DO 0 must not exceed 30 VDC I 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 swite	ch 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	0° C 55° C	For operation without inserted Operator Panel.
temperature	0° C 50° C	For operation with inserted Operator Panel.
	Observe any poss Module.	sible restrictions regarding the operating temperature as a result of the Power
Storage temperature	- 40° C 70° C	
Relative humidity	< 95%	Condensation is not permissible.

12.2 Technical data, CU240E-2 Control Unit

12.2 Technical data, CU240E-2 Control Unit

Table 12-2

Feature	Data		
Order numbers	6SL3244-0BB12-1BA1 6SL3244-0BB13-1BA1 • USS • Modbus RTU		
	6SL3244-0BB12-1PA1 With PROFIBUSinterface. 6SL3244-0BB13-1PA1		
	6SL3244-0BB12-1FA0 With PROFINETinterface. 6SL3244-0BB13-1FA0		
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 \pm 1 ms response time for a debounce time p0724 = 0.		

12.2 Technical data, CU240E-2 Control Unit

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).

12.2 Technical data, CU240E-2 Control Unit

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 po Module.	ossible restrictions regarding the operating temperature as a result of the Power
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.

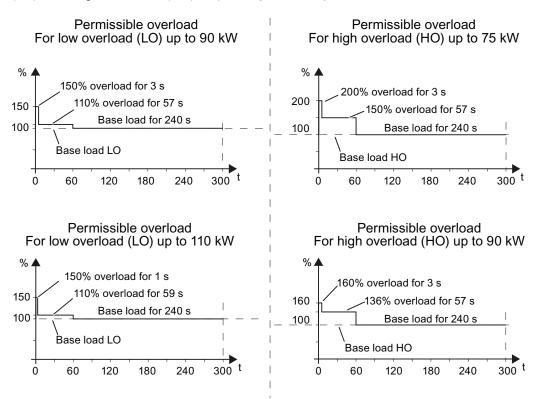


Figure 12-1 Duty cycles, "High Overload" and "Low Overload"

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).

Technical data

12.3 Technical data, Power Modules

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 unitsIP20 when mounted in a control cabinetPT devicesIP54 on the control cabinet wall				
Operating temperature	LO without power reduction:0° C +40° CFor details, see the HardwareHO without power reduction:0° C +50° CInstallation Manual.LO/HO with power reduction:to 60° C				
Storage temperature	-40° C +70° C				
Relative humidity	< 95% - condensation not permissible				
Dirt and contamination	Protected according to pollution degree 2 to EN 61800-5-1: 2007				
Environmental requirements	Protected against damaging chemical substances according to environmental class 3C2 to EN 60721-3-3; 1995				
Shock and vibration	 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 levelFor details, see the Hardwarewith power reduction:up to 4000 m above sea levelInstallation Manual				
Permissible short-circuit current	Frame size D F: 65 kA ¹⁾				
Overvoltage category	Supply circuits: Overvoltage category III Non-supply circuits: 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 \ldots F

Technical data

12.3 Technical data, Power Modules

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	6SL3210	1NE11-3UL0	1NE11-7UL0	1NE12-2UL0
Order No Filtered	6SL3210	1NE11-3AL0	1NE11-7AL0	1NE12-2AL0
LO power		0.37 kW	0.55 kW	0.75 kW
LO input current		1.3 A	1.8 A	2.3 A
LO Output current		1.3 A	1.7 A	2.2 A
HO power		0.25 kW	0.37 kW	0.55 kW
HO input current		0.9 A	1.3 A	1.8 A
HO output current		0.9 A	1.3 A	1.7 A
Fuse according to IEC		3NE1 813-0	3NE1 813-0	3NE1 813-0
Fuse according to UL		AJT2 / 3NE1 813-0	AJT4 / 3NE1 813-0	AJT4 / 3NE1 813-0
Power losses, unfiltered		0.04 kW	0.04 kW	0.05 kW
Power losses, filtered		0.04 kW	0.04 kW	0.05 kW
Required cooling air flow		1.5 l/s	1.5 l/s	4.5 l/s
Cross section of line and motor cal	ble	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 moto	or cable	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.6 kg	1.6 kg	1.6 kg

Table 12- 4 PM230, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No Unfiltered	6SL3210	1NE13-1UL0	1NE14-1UL0	1NE15-8UL0
Order No Filtered	6SL3210	1NE13-1AL0	1NE14-1AL0	1NE15-8AL0
LO power		1.1 kW	1.5 kW	2.2 kW
LO input current		3.2 A	4.2 A	6.1 A
LO Output current		3.1 A	4.1 A	5.9 A
HO power		0.75 kW	1.1 kW	1.5 kW
HO input current		2.3 A	3.2 A	4.2 A
HO output current		2.2 A	3.1 A	4.1 A
Fuse according to IEC		3NE1 813-0	3NE1 813-0	3NE1 813-0
Fuse according to UL		AJT6 / 3NE1 813-0	AJT6 / 3NE1 813-0	AJT10 / 3NE1 813-0
Power losses, unfiltered		0.06 kW	0.07 kW	0.08 kW
Power losses, filtered		0.06 kW	0.07 kW	0.08 kW
Required cooling air flow		4.5 l/s	4.5 l/s	4.5 l/s
Cross section of line and motor cabl	e	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		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.6 kg	1.6 kg	1.6 kg

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

Order No Unfiltered Order No Filtered	6SL32101NE17-7UL0 6SL32101NE17-7AL0	
LO power LO input current LO Output current	3 kW 8.0 A 7.7 A	
HO power HO input current HO output current	2.2 kW 6.1 A 5.9 A	
Fuse according to IEC Fuse according to UL	3NE1 813-0 AJT10 / 3NE1 813-0	
Power losses, unfiltered Power losses, filtered	0.11 kW 0.11 kW	
Required cooling air flow	4.5 l/s	
Cross section of line and motor cable	e 1.5 2.5 mm² 16 14 AWG	
Tightening torque for line and motor	cable 0.5 Nm / 4 lbf in	
Weight, unfiltered Weight, filtered	1.4 kg 1.6 kg	

Table 12- 5 $\,$ PM230, IP20, Frame Sizes A, 3 AC 380 V \ldots 480 V $\,$

Table 12- 6 PM230, PT, Frame Sizes A, 3 AC 380 V ... 480 V

	6SL32111NE17-7UL0 6SL32111NE17-7AL0	
LO power LO input current LO Output current	3 kW 8.0 A 7.7 A	
HO power HO input current HO output current	2.2 kW 6.1 A 5.9 A	
Fuse according to IEC Fuse according to UL	3NE1 813-0 AJT10 / 3NE1 813-0	
Power losses, unfiltered Power losses, filtered	0.11 kW 0.11 kW	
Required cooling air flow	4.5 l/s	
Cross section of line and motor cable	1.5 … 2.5 mm² 16 … 14 AWG	
Tightening torque for line and motor of	able 0.5 Nm / 4 lbf in	
Weight, unfiltered Weight, filtered	1.7 kg 1.9 kg	

Technical data

Order No Unfiltered	6SL3210	1NE21-0UL0	1NE21-3UL0	1NE21-8UL0
Order No Filtered	6SL3210	1NE21-0AL0	1NE21-3AL0	1NE21-8AL0
LO power		4 kW	5.5 kW	7.5 kW
LO input current		10.5 A	13.6 A	18.6 A
LO Output current		10.2 A	13.2 A	18 A
HO power		3 kW	4 kW	5.5 kW
HO input current		8.0 A	10.5 A	13.6 A
HO output current		7.7 A	10.2 A	13.2 A
Fuse according to IEC		3NE1 813-0	3NE1 814-0	3NE1 815-0
Fuse according to UL		AJT15 / 3NE1 813-0	AJT20 / 3NE1 814-0	AJT25 / 3NE1 815-0
Power 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 cab	le	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 moto	r 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 12-7 PM230, IP20, Frame Sizes B, 3 AC 380 V ... 480 V

Table 12- 8 PM230, PT, Frame Sizes B, 3 AC 380 V ... 480 V

	6SL32111NE21-8UL0 6SL32111NE21-8AL0	
LO power LO input current LO Output current	7.5 kW 18.6 A 18 A	
HO power HO input current HO output current	5.5 kW 13.6 A 13.2 A	
Fuse according to IEC Fuse according to UL	3NE1 815-0 AJT25 / 3NE1 815-0	
Power losses, unfiltered Power losses, filtered	0.22 kW 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 c	able 0.6 Nm / 5 lbf in	
Weight, unfiltered Weight, filtered	3.4 kg 3.6 kg	

Order No Unfiltered	6SL3210	1NE22-6UL0	1NE23-2UL0	1NE23-8UL0
Order No Filtered	6SL3210	1NE22-6AL0	1NE23-2AL0	1NE23-8AL0
LO power		11 kW	15 kW	18.5 kW
LO input current		26.9 A	33.1 A	39.2 A
LO Output current		26 A	32 A	38 A
HO power		7.5 kW	11 kW	15 kW
HO input current		18.6 A	26.9 A	33.1 A
HO output current		18 A	26 A	32 A
Fuse according to IEC		3NE1 803-0	3NE1 817-0	3NE1 817-0
Fuse according to UL		AJT35 / 3NE1 803-0	AJT45 / 3NE1 817-0	AJT50 / 3NE1 817-0
Power losses, unfiltered		0.3 kW	0.35 kW	0.45 kW
Power losses, filtered		0.3 kW	0.35 KW	0.45 KW
Required cooling air flow		18.5 l/s	18.5 l/s	18.5 l/s
Cross section of line and motor cab	le	616 mm² 10 6 AWG	616 mm² 10 6 AWG	616 mm² 10 6 AWG
Tightening torque for line and motor	r cable	1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in	1.3 Nm / 12 lbf in
Weight, unfiltered		4.5 kg	4.5 kg	4.5 kg
Weight, filtered		5.1 kg	5.1 kg	5.1 kg

Table 12- 9 PM230, IP20, Frame Sizes C, 3 AC 380 V ... 480 V

Table 12- 10 PM230, PT, Frame Sizes C, 3 AC 380 V ... 480 V

	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		616 mm² 10 6 AWG	
Tightening torque for line and motor of	able	1.3 Nm / 12 lbf in	
Weight, unfiltered Weight, filtered		5.4 kg 6 kg	

Order No Unfiltered Order No Filtered	6SL3210 6SL3210	1NE24-5UL0 1NE24-5AL0	1NE26-0UL0 1NE26-0AL0	
LO power LO input current LO output current		22 kW 42 A 45 A	30 kW 56 A 60 A	
HO power HO input current HO output current		18.5 kW 36 A 38 A	22 kW 42 A 45 A	
Fuse according to IEC Fuse according to UL		3NE1818-0 3NE1818-0	3NE1820-0 3NE1820-0	
Power losses, unfiltered Power losses, filtered		0.52 kW 0.52 kW	0.68 kW 0.68 kW	
Required cooling air flow		80 l/s	80 l/s	
Cross section of line and motor ca	ble	16 … 35 mm² 5 … 2 AWG	16 35 mm² 5 2 AWG	
Tightening torque for line and mote	or cable	6 Nm / 53 lbf in	6 Nm / 53 lbf in	
Weight, unfiltered Weight, filtered		11 kg 14 kg	11 kg 14 kg	

Table 12- 11 $\,$ PM230, IP20, Frame Sizes D, 3 AC 380 V \ldots 480 V $\,$

Table 12- 12 $\,$ PM230, IP20, Frame Sizes E, 3 AC 380 V \ldots 480 V

Order No Unfiltered Order No Filtered	6SL3210 6SL3210	1NE27-5UL0 1NE27-5AL0	1NE28-8UL0 1NE28-8AL0	
LO power LO input current 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		3NE1021-0 3NE1021-0	3NE1022-0 3NE1022-0	
Power losses, unfiltered Power losses, filtered		0.99 kW 0.99 kW	1.2 kW 1.2 kW	
Required cooling air flow		80 l/s	80 l/s	
Cross section of line and motor ca	ble	25 50 mm ² 3 1-1/0 AWG	25 50 mm ² 3 1-1/0 AWG	
Tightening torque for line and moto	or cable	6 Nm / 53 lbf in	6 Nm / 53 lbf in	
Weight, unfiltered Weight, filtered		15 kg 22 kg	15 kg 22 kg	

Technical data

12.3 Technical data, Power Modules

Order No Unfiltered Order No Filtered	6SL3210 6SL3210	1NE31-1UL0 1NE31-1AL0	1NE31-5UL0 1NE31-5AL0	
LO power LO input current LO output current		55 kW 102 A 110 A	75 kW 135 A 145 A	
HO power HO input current HO output current		45 kW 84 A 90 A	55 kW 102 A 110 A	
Fuse according to IEC Fuse according to UL		3NE1224-0 3NE1224-0	3NE1225-0 3NE1225-0	
Power losses, unfiltered Power losses, filtered		1.4 kW 1.4 kW	2.0 kW 2.0 kW	
Required cooling air flow		150 l/s	150 l/s	
Cross section of line and motor cable)	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	
Weight, unfiltered Weight, filtered		15 kg 22 kg	34 kg 46 kg	

Table 12- 13 $\,$ PM230, IP20, Frame Sizes F, 3 AC 380 V \ldots 480 V

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 ratings0° C +40° CFor details, seeHO without power reduction:0.37 110 kW0° C +50° Cthe HardwareHO without power reduction:132 200 kW0° C +40° CInstallationLO/HO with power reduction:all power ratingsup to 60° CManual.					
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 160 kW 250 kW all power ratingsup to 1000 m above sea level up to 2000 m above sea level up to 4000 m above sea level Installation ManualFor 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.					

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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	I0BE13-7UA0	0BE15-5UA0	0BE17-5UA0
Rated / LO power Rated / LO input current	0.37 kW 1.6 A	0.55 kW 2.0 A	0.75 kW 2.5 A
Rated / LO Output current	1.3 A	1.7 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 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	1.2 kg	1.2 kg	1.2 kg

Table 12- 15 PM240, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No Unfiltered 6SL3224-	0BE21-1UA0	0BE21-5UA0	
Rated / LO power	1.1 kW	1.5 kW	
Rated / LO input current	3.9 A	4.9 A	
Rated / LO Output current	3.1 A	4.1 A	
HO power	1,1 kW	1,5kW	
HO input current	3.8 A	4.8 A	
HO output current	3.1 A	4.1 A	
Fuse	10 A, class J	10 A, class J	
Power losses	0.108 kW	0.114 kW	
Required cooling air flow	4.8 l/s	4.8 l/s	
Cross section of line and motor cable	1 2.5 mm²	1 2.5 mm ²	
	18 14 AWG	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	

Technical data

	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 cal	ble	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 moto	r cable	1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf in	1.5 Nm / 13 lbf ir
Weight		4.3 kg	4.3 kg	4.3 kg

Table 12- 16 $\,$ PM240, IP20, Frame Sizes B, 3 AC 380 V \ldots 480 V

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 moto	r cable	4 10 mm² 12 8 AWG	4 10 mm² 12 8 AWG	4 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, unfiltered Weight, filtered		6.5 kg 7 kg	6.5 kg 7 kg	6.5 kg 7 kg

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 n	notor 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- 18 $\,$ PM240, IP20, Frame Sizes D, 3 AC 380 V \ldots 480 V

Table 12- 19 $\,$ PM240, IP20, Frame Sizes E, 3 AC 380 V \ldots 480 V

Order No Unfiltered Order No Filtered	6SL3224 6SL3224	0BE33-0UA0 0BE33-0AA0	0BE33-7UA0 0BE33-7AA0	
Rated / LO power Rated / LO input current Rated / LO Output current		37 kW 88 A 75 A	45 kW 105 A 90 A	
HO power HO input current HO output current		30 kW 73 A 60 A	37 kW 90 A 75 A	
Fuse according to IEC Fuse according to UL		3NA3830 100 A, Class J	3NA3832 125 A, Class J	
Power losses, unfiltered Power losses, filtered		0.99 kW 1.04 kW	1.2 kW 1.2 kW	
Required cooling air flow		22 l/s	39 l/s	
Cross section of line and motor c	able	25 35 mm² 3 2 AWG	25 35 mm ² 3 2 AWG	
Tightening torque for line and mo	tor cable	6 Nm / 53 lbf in	6 Nm / 53 lbf in	
Weight, unfiltered Weight, filtered		16 kg 23 kg	16 kg 23 kg	

Technical data

Order No Unfiltered	6SL3224	0BE34-5UA0	0BE35-5UA0	0BE37-5UA0
Order No Filtered	6SL3224	0BE34-5AA0	0BE35-5AA0	0BE37-5AA0
Rated / LO power		55 kW	75 kW	90 kW
Rated / LO input current		129 A	168 A	204 A
Rated / LO Output current		110 A A	145 A	178 A
HO power		45 kW	55 kW	75 kW
HO input current		108 A	132 A	169 A
HO output current		90 A	110 A	145 A
Fuse according to IEC		3NA3832	3NA3140	3NA3144
Fuse according to UL		160 A, Class J	200 A, Class J	250 A, Class J
Power losses, unfiltered		1.4 kW	1.9 kW	2.3 kW
Power losses, filtered		1.5 kW	2.0 kW	2.4 kW
Required cooling air flow		94 l/s	94 l/s	117 l/s
Cross section of line and moto	r 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 i	motor cable	13 Nm / 115 lbf in	13 Nm / 115 lbf in	13 Nm / 115 lbf in
Weight, unfiltered		36 kg	36 kg	36 kg
Weight, filtered		52 kg	52 kg	52 kg

Table 12- 20 PM240, IP20, Frame Sizes F, 3 AC 380 V ... 480 V

Table 12- 21 $\,$ PM240, IP20, Frame Sizes F, 3 AC 380 V \ldots 480 V

Order No Unfiltered 6SL3224	0BE38-8UA0	0BE41-1UA0	
Rated / LO power	110 kW	132 kW	
Rated / LO input current	234 A	284 A	
Rated / LO Output current	205 A	250 A	
HO power	90 kW	110 kW	
HO input current	205 A	235 A	
HO output current	178 A	205 A	
Fuse according to IEC			
Fuse according to UL	250 A, Class J	315 A, Class J	
Power losses	2.4 kW	2.5 kW	
Required cooling air flow	117 l/s	117 l/s	
Cross section of line and motor cable	95 120 mm ²	95 120 mm ²	
	3/0 4/0 AWG	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	

Order No Unfiltered 6	SL3224	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	е	95 2 x 240 mm ²	120 2 x 240 mm ²	185 2 x 240 mm ²
		3/0 2 x 600 AWG	4/0 2 x 600 AWG	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

Table 12- 22 $\,$ PM240 Frame Sizes GX, 3 AC 380 V \ldots 480 V

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	th line reactor					
Line impedance	Uk ≥ 1%, a line reactor is requir	ed for lower values					
Starting current	Less than the input current						
Pulse frequency (factory setting)	4 kHz The pulse frequency can be inc results in a lower output current	he pulse frequency can be increased in 2 kHz steps. An increase in the pulse frequency					
Electromagnetic compatibility	Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments. For details, see the Hardware Installation Manual, Appendix A2.						
Braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper						
Degree of protection	IP20 built-in units PT devices						
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 (-40° F 158	₿° F)					
Relative humidity	< 95% - condensation not perm	issible					
Dirt and contamination	Protected according to pollution	degree 2 to EN 61800-5-	1: 2007				
Environmental requirements	Protected against damaging che EN 60721-3-3; 1995	emical substances accord	ing to environmental class 3C2 to				
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 with power reduction: up to	1000 m above sea level 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 r	equirements when UL-ce	rtified fuses are used.				

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

12.3.3.2 Power-dependent data PM240-2

Table 12- 23 PM240-2, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No Unfiltered	6SL3210	1PE11-8UL0	1PE12-3UL0	1PE13-2UL0
Order No Filtered	6SL3210	1PE11-8AL0	1PE12-3AL0	1PE13-2AL0
LO power		0.55 kW	0.75 kW	1.1 kW
LO input current		2.3 A	2.9 A	4.1 A
LO output current		1.7 A	2.2 A	3.1 A
HO power		0.37 kW	0.55 kW	0.75 kW
HO input current		2 A	2.6 A	3.3 A
HO output current		1.3 A	1.7 A	2.2 A
Fuse according to IEC		3NA3 801 (6 A)	3NA3 801 (6 A)	3NA3 801 (6 A)
Fuse according to UL		10 A class J	10 A class J	10 A class J
Power losses, unfiltered		0.04 kW	0.04 kW	0.04 kW
Power losses, filtered		0.04 kW	0.04 kW	0.04 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cab	le	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		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.5 kg	1.5 kg	1.5 kg

Table 12- 24 PM240-2, IP20, Frame Sizes A, 3 AC 380 V ... 480 V

Order No Unfiltered	6SL3210	1PE14-3UL0	1PE16-1UL0	1PE18-0UL0
Order No Filtered	6SL3210	1PE14-3AL0	1PE16-1AL0	
LO power		1.5 kW	2.2 kW	3 kW
LO input current		5.5 A	7.7 A	10.1 A
LO output current		4.1 A	5.9 A	7.7 A
HO power		1.1 kW	1.5 kW	2.2 kW
HO input current		4.7 A	6.1 A	8.8 A
HO output current		3.1 A	4.1 A	5.9 A
Fuse according to IEC		3NA3 803 (10 A)	3NA3 803 (10 A)	3NA3 805 (16 A)
Fuse according to UL		10 A class J	10 A class J	15 A class J
Power losses, unfiltered		0.07 kW	0.1 kW	0.12 kW
Power losses, filtered		0.07 kW	0.1 kW	0.12 kW
Required cooling air flow		5 l/s	5 l/s	5 l/s
Cross section of line and motor cable	е	1 2.5 mm² 18 14 AWG	1.5 2.5 mm² 16 14 AWG	1.5 2.5 mm² 16 14 AWG
Tightening torque for line and motor	cable	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight, unfiltered		1.4 kg	1.4 kg	1.4 kg
Weight, filtered		1.5 kg	1.5 kg	

Order No Unfiltered Order No Filtered	6SL3211 6SL3211	 1PE16-1AL0	1PE18-0UL0	
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 cab	le	1.5 … 2.5 mm² 16 … 14 AWG	1.5 2.5 mm² 16 14 AWG	
Tightening torque for line and moto	r cable	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	
Weight, unfiltered Weight, filtered		 1.8 kg	1.7 kg 	

Table 12- 25 PM240-2, PT, Frame Sizes A, 3 AC 380 V ... 480 V

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 ir frequency results in a lower o	ncreased up to 16 kHz in 2 kHz s utput current.	teps. An increase in the pulse				
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	DC braking, energy recovery (up to 100% of the output power)					
Degree of protection	IP20 chassis units	IP20 chassis units					
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 per	missible					
Dirt and contamination	Protected according to pollution	on degree 2 to EN 61800-5-1: 20	07				
Environmental requirements	Protected against damaging o EN 60721-3-3; 1995	hemical substances according to	environmental class 3C2 to				
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 2M	13 to EN 60721-3-2: 1997				
	Vibration during operation	according to Class 3M2 to EN 60	0721-3-3: 1995				
Installation altitude	•	p to 1000 m above sea level p to 4000 m above sea level	For details, see the Hardware Installation Manual				
Standards	UL, CE, CE, SEMI F47 The drive only satisfies the UI	_ 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 6SL3	3225	0BE25-5AA0	0BE27-5AA0	0BE31-1AA0
Rated / LO power		7.5 kW	11 kW	15 kW
Rated / LO input current		18 A	25 A	32 A
Rated / LO Output current		18 A	25 A	32 A
HO power		5. 5 kW	7.5 kW	11 kW
HO input current		13.2 A	19 A	26 A
HO output current		13.2 A	19 A	26 A
Fuse		20 A, Class J	32 A, Class J	35 A, Class J
Power losses		0.24 kW	0.30 kW	0.31 kW
Required cooling air flow		38 l/s	38 l/s	38 l/s
Cross section of line and motor cable		2.5 10 mm ²	4.0 10 mm ²	4.0 10 mm ²
		14 8 AWG	12 8 AWG	12 8 AWG
Tightening torque for line and motor cab	le	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 \ldots 480 V

Order No Filtered 65	L3225	0BE31-5AA0	0BE31-8AA0	0BE32-2AA0
Rated / LO power		18.5 kW	22 kW	30 kW
Rated / LO input current		36 A	42 A	56 A
Rated / LO Output current		38 A	45 A	60 A
HO power		15 kW	18.5 kW	22 kW
HO input current		30 A	36 A	42 A
HO output current		32 A	38 A	45 A
Fuse according to IEC		3NA3820	3NA3822	3NA3824
Fuse according to UL		50 A, Class J	63 A, Class J	80 A, Class J
Power losses		0.44 kW	0.55 kW	0.72 kW
Required cooling air flow		22 l/s	22 l/s	39 l/s
Cross section of line and motor cable		10 35 mm²	10 35 mm²	16 35 mm²
		7 2 AWG	7 2 AWG	6 2 AWG
Tightening torque for line and motor o	able	6 Nm / 53 lbf in	6 Nm / 53 lbf in	6 Nm / 53 lbf in
Weight		15 kg	15 kg	16 kg

Technical data

12.3 Technical data, Power Modules

Order No Filtered 6S	L3225	0BE33-0AA0	0BE33-7AA0	
Rated / LO power		37 kW	45 kW	
Rated / LO input current		70 A	84 A	
Rated / LO Output current		75 A	90 A	
HO power		30 kW	37 kW	
HO input current		56 A	70 A	
HO output current		60 A	75 A	
Fuse according to IEC		3NA3830	3NA3832	
Fuse according to UL		100 A, Class J	125 A, Class J	
Power losses		1.04 kW	1.2 kW	
Required cooling air flow		22 l/s	39 l/s	
Cross section of line and motor cable		25 35 mm ²	25 35 mm ²	
		3 2 AWG	3 2 AWG	
Tightening torque for line and motor c	able	6 Nm / 53 lbf in	6 Nm / 53 lbf in	
Weight		21 kg	21 kg	

Table 12- 28 $\,$ PM250, IP20, Frame Sizes E, 3 AC 380 V \ldots 480 V

Table 12- 29 $\,$ PM250, IP20, Frame Sizes F, 3 AC 380 V \ldots 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

Technical data

12.3 Technical data, Power Modules

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° CFor details, see the HardwareHO without power reduction:0° C +50° CInstallation Manual.LO/HO with power reduction:to 60° CInstallation 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 levelFor details, see the Hardwarewith power reduction:up to 4000 m above sea levelInstallation Manual				
Standards	CE, C-TICK				

12.3.5 Technical data, PM260

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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 mm² 14 … 6 AWG	4 16 mm² 12 6 AWG	6 16 mm² 10 6 AWG
Tightening torque for line and m	otor 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 mm² 8 2 AWG	16 35 mm² 6 2 AWG	25 35 mm² 4 2 AWG
Tightening torque for line and n	notor 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)

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 .

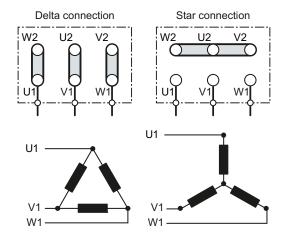
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

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

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).

A.2 Parameter

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 setpoint20: 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 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.

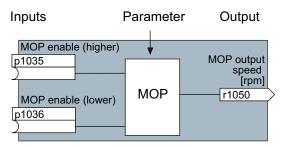


Figure A-1 Example of a BICO block: Motorized potentiometer (MOP)

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.

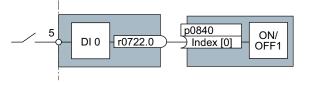


Figure A-2 Example: Signal interconnection of two BICO blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual BICO blocks:

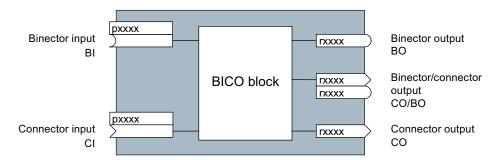
- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

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:





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.

A.3 Interconnecting signals in the inverter

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.

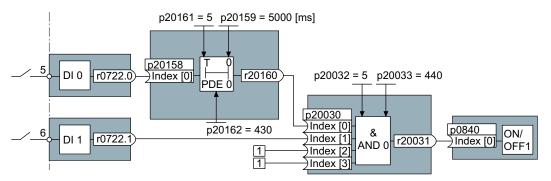


Figure A-4 Example: Signal interconnection for interlock

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.

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)

A.3 Interconnecting signals in the inverter

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.

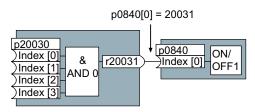


Figure A-5 Interconnecting two BICO blocks by setting p0840[0] = 20031

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 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.

			C:\Siemens\Step7\57pro	i∖G120_in_]	-DX
File Edit D 22 25 G120 32 32	Insert PLC View Op Station Subnet Program		ns Window Help 1 SIMATIC 400 Station 2 SIMATIC 300 Station 3 SIMATIC H Station	💼 < No Filter > beling field	× ■ ₩ ₩ •
	57 Software 57 Block M7 Software	+ + +	4 SIMATIC PC Station 5 Other Station 6 SIMATIC 55 7 PG/PC		
Inserts SIMATIC	Symbol Table Text Library External Source	•	sition.		
	Shared Declarations	۲			

- 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.

🔣 HW Config - [SIMATIC 30	0 (Configuration) G120_in_S7]		_ 🗆 🗙
🛄 Station Edit Insert PLC	View Options Window Help		_ & ×
D 🛩 ≌~ ¤ 🖏 ⊕ D 🖨	💼 🏜 📳 🗖 🚼 💦		
DP DP D	PROFIBUS: DP-Mastersystem (1)	Profile: Standard	×
4		CPU 315 CPU 315-2 DP GES7 315-2AF00-0AB0 GES7 315-2AF01-0AB0 GES7 315-2AF02-0AB0 GES7 315-2AF02-0AB0 GES7 315-2AF02-0AB0 GES7 315-2AF02-0AB0 GES7 315-2AF02-0AB0	
(0) UR		e- 🖨 6ES7 315-2AF83-0AB0 ⊡- 🚍 6ES7 315-2AG10-0AB0	
Slot 🚺 Module	Order numb F M I Q I	2	
1 I PS 307 2A	6ES7 307-1BA0		
2 CPU 315-2 DP	6ES7 315-2ACV2.62	6ES7 315-2AG10-0AB0	_ ₹ <u></u>
X2 DP 3	204,	Work memory 128KB; 0. instructions; MPI+ DP connection (DP master slave); multi-tier configuration up to 32 modules; Send and receive	
Press F1 to get Help.			

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)).

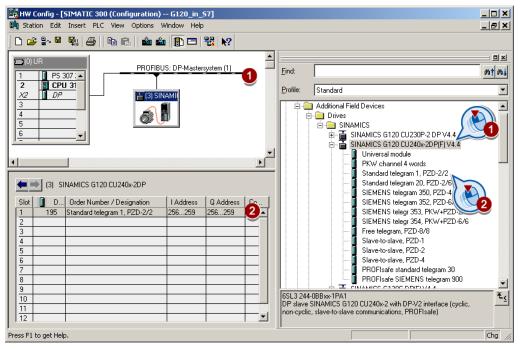
The following section describes how to configure the inverter using the GSD.

A.4 Application Examples

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

- 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.

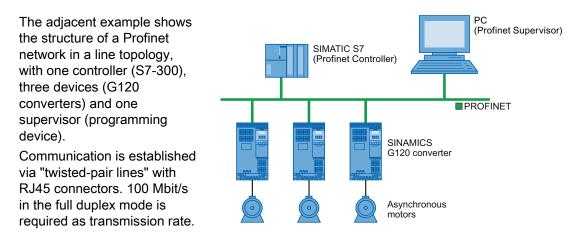
The inverter is now connected to the S7 CPU. This therefore defines the communication interface between the CPU and the inverter. An example of how you can supply this interface with data can be found in the next section.

A.4 Application Examples

A.4.2 Configuring PROFINET communication in STEP 7

A.4.2.1 Communication via PROFINET - example

Profinet network in a line topology



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".

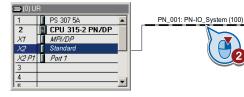
In the screen form that opens, HW Config proposes the next free IP address and a subnet mask. If you have configured a local area network, and are not working within a larger Ethernet network, you can use the proposed entries. Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. The subnet mask must have the same address that you assigned when addressing the supervisor.

General Paramet	ers	
		If a subnet is selected, the next available addresses are suggested.
IP address: Subnet mask: IP Use different m	192.168.0.1 255.255.255.0 ethod to obtain IP address	Gateway © Do not use router © Use router Address:
Subnet:		
not networked		New
		Properties
		Delete

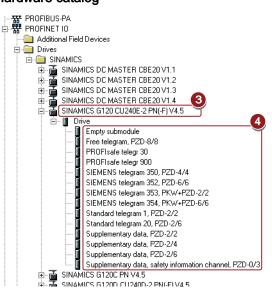
Use the "New" button (1) to either create a new PROFINET subnet or select an existing one.

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).



Hardware catalog



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".

🚍 (0) U	R	
1	PS 307 5A	PN_001: PN-IO_System (100)
2	CPU 315-2 PN/DP	
X7 -	MPI/DP	
X2	Standard	1) FU001
X2 P1	Port 1	
3		
4		
I E		

A.4 Application Examples

Then save your hardware configuration with "Save and compile" (4). 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.

Dver which station PN/DP?	n address is the programmir	ng device conne	cted to the modu	ule CPU 317-2	
Rack:	0 +				
Slot:	2 #				
Target Station:	C Local				
	C Can be reached by	means of gatew	ay		
					_
Enter connection	n to target station:				
Enter connection IP address	n to target station: MAC address	Module type	Station name	Module name	P
and an entering the second	the second se	Module type CPU 317	Station name Standard	Module name CPU 317-2	P
IP address 192.168.0.11 4	MAC address 00-1B-1B-14-70-E0				P
IP address 192.168.0.11	MAC address 00-1B-1B-14-70-E0				P
IP address	MAC address 00-1B-1B-14-70-E0	CPU 317	Standard	CPU 317-2	P
IP address 192.168.0.11	MAC address 00-1B-1B-14-70-E0 00-1B-1B-14-B1-87	CPU 317	Standard Safety	CPU 317-2	P

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.

Device family:	SINAMICS
Device:	SINAMICS G120
Device characteristic:	
Characteristic	Order no.
CU240	6SL3 244-xxxxx-xxxx
CU240B-2	6SL3 244-xxxx0-xBxx
CU240B-2 DP	6SL3 244-xxxx0-xPxx 6SL3 244-xxxx2-xBxx
CU240E-2 CU240E-2 DP	65L3 244-xxxx2-x8xx 65L3 244-xxxx2-x8xx
CU240E-2 DP-F	65L3 244-xxxx3-xPxx
CU240E-2 F	6SL3 244-xxxx3-xBxx
CU240E-2 PN	6SL3 244-xxxx3-xPxx
CU240E-2 PN-F	6SL3 244-xxxx3-xPxx
Version:	L.C.
rolon.	4.5
Online access:	IP
Address:	169.254.11.13

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.



	1) FU001.PROFINET-10-Sy	stem
Slot	🚺 Module	Order number
0	🚡 FUODI.PROFINET-ID-S	65L3 243-0BA30-1FA0
X750	FN-10	
X150	📕 Pavt 1	2
X150	🛽 Fort 2	9
1	Drive	
1.1	🚦 Module Access Point	
1.2	🚦 without FROFIsale	
1.3		
1.4		

A.4 Application Examples

eneral Addresses Parameters	Value	
🖃 🔄 Parameters		
General settings	Inactive	-
	Inactive	

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 (Pm). In the following window, select the converter and then the S7ONLINE as access point.

Target device	Access point
FU001	STONLINE DEVICE
	No.

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.

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

Table A- 8	Signal category and the associated scaling parameters
	eight bategory and the associated sealing paramete

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 Application Examples

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#			
Т	MW	•		
L	W#16#			
Т	MW	3		
Network 2:	Acknow	wledge fault		
	F	0.6		
U	E			
=	М	2.7		
Network 3:	Switch	Switch the motor on and off		
U	Е	0.0		
=	Μ	2.0		
Network 4:	Write process data			
	- The p			
L	MW	1		
Т	PAW	256		
L	MW	3		
Т	PAW	258		
Network 4:	Read p	process data		
Status word				
Actual value				
L	PEW	256		
		200 F		

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).

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
Е	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 \downarrow	6	6		
	0	15	Data set changeover	7	7		

Table A-9 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

A.4 Application Examples

A.4.3.2 STEP 7 program example for acyclic communication

OB1:	Cyclic	control	program				
Networ	Network 1: Reading and writing parameters						
// rea	d parar O(neters					
	U	М	9.2				
	UN)	Μ	9.1				
	O(U	М	9.0				
	UN		9.1				
) R	М	9.3				
	SPB	RD					
// writ		meters					
	O(U	М	9.3				
	UN)	Μ	9.0				
	O(U	М	9.1				
	UN	M	9.0				
) R	М	9.2				
	SPB BEA	WR					
RD:	NOP CALL		1				
WR:	BEA NOP CALL		9.1 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/vie

w/en/15364459).

A.4 Application Examples

C1: PAR	_RD			etwork 2:	Read r	equest, part 1
L	Parameters MB 40 DB1.DBB			R K L R R		:=M9.0 :=B#16#54 :=W#16#170 :=B#16#2F :=P#DB1.DBX0.0 BYTE 2
L T T	B#16#01 DB1.DBB DB1.DBB			В	USY	:=M8.1
L T	MB 62 DB1.DBB	3		U R S	M M M	8.1 9.0 9.2
L T	MW 50 DB1.DBW		Ν	etwork 3:	Read d	lelay after a read request
L T L	MB 58 DB1.DBB MW 63	5				
	DB1.DBW			U UN	M M	8.1 9.1
L T L	MW 52 DB1.DBW MB 59			L SS U	S5T#1 T	ls 1
T L T	DB1.DBB MW 65 DB1.DBW	14		R U =	T T M	1 1 8.2
// L T	MW 54 DB1.DBW		N			equest, part 2
L T	MB 60 DB1.DBB					
L T	MW 67 DB1.DBW			R		:=M8.2
"L T L T	MW 56 DB1.DBW MB 61 DB1.DBB	24		L R R	ET_VAL	:=B#16#2F :=MW12
L T	MW 69 DB1.DBW				USY ECORD	. 1110.0
				R	M	8.2
igure 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

A.4 Application Examples

Explanation of FC 1

Data block DB 1	Byte n	Bytes n + 1		
Header	Reference MB 40	01 hex: Read request		
	01 hex	Number of parameters (m) MB 62		
Address,	Attribute 10 hex: Parameter value	Number of indices MB 58		
parameter 1	Parameter number MW 50			
	Number of the 1st index MW 63			
Address,	Attribute 10 hex: Parameter value	Number of indices MB 59		
parameter 2	Parameter number MW 52			
	Number of the 1st index MW 65			
Address,	Attribute 10 hex: Parameter value	Number of indices MB 60		
parameter 3	Parameter number MW 54			
	Number of the 1st index MW 67			
Address,	Attribute 10 hex: Parameter value	Number of indices MB 61		
parameter 4	Parameter number MW 56			
	Number of the 1st index MW 69			

Table A- 10	Request to read	parameters
-------------	-----------------	------------

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.

A.4 Application Examples

C3: PAR	_WR		etwork 2:	Write re	equest:
Network 1:	Parameters	for writing			:=M9.1 :=B#16#54
L	MB 42				:=B#16#2F
Т	DB3.DBB	0			:=P#DB3.DBX0.0 BYTE 1
L	B#16#02			I_VAL	:=MW10 :=M8.1
Т		1	DC	51	100.1
L T	B#16#01 DB3.DBB	2	U	Μ	8.1
L	MB 44	2	R	М	9.1
T	DB1.DBB	3	S	М	9.3
// L	MW 21				
Т	DB3.DBW	6			
Ĺ	MW 23	0			
Т	DB3.DBW	8			
L	MW 35				
Т	DB3.DBW	12			
L	MB 25				
Т	DB3.DBB	10			
L	MB 27				
Т	DB3.DBB	11			

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,	10 hex: Parameter value	Number of indices 00 hex	4
parameter 1	Parameter number MW 21		6
	Number of the 1st index MW 23		8
Values,	Format MB 25	Number of index values MB 27	10
parameter 1	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 Application Examples

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).

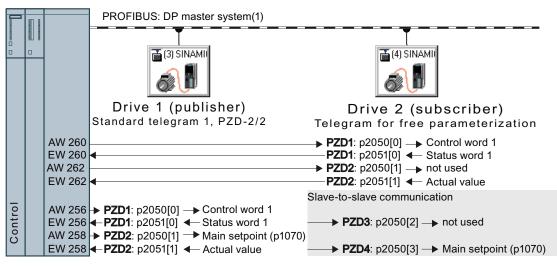
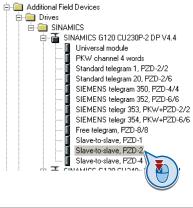


Figure A-8 Communication with the higher-level control and between the drives with slave-to-slave communication

Settings in the control

In HW Config in drive 2 (subscriber), insert a slave-toslave communication object, e.g. "Slave-to-slave, PZD2".



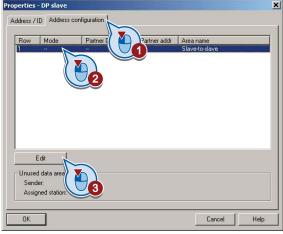
With a double-click, open the dialog box to make additional settings for the slave-to-slave communication.

Slot	D.	Order Number / Designation	I Address	Q Address	Co
1	195	Standard telegram 1, PZD-2/2	260263	260263	
2	129	Slave-to-slave, PZD-2			
3					
4		(<u>N</u>			
5					
10					

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.

Properties - DP slav	e - Address confi	guration - Row 1		×
Mode:	DX	(Direct data exchan	ge)	
DP partner: sender-		V data area		
DP address:	3 -		Slave-to-slave	
Name:	SINAMICS G			
Address type:	Input	2		
Address:	256			
Length:	4			
Unit:	Byte			
Consistency:	Total length			
0K	Apply		Cancel H	elp

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 Application Examples

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.

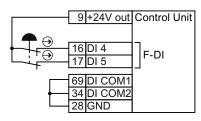


Figure A-9 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

24V DC

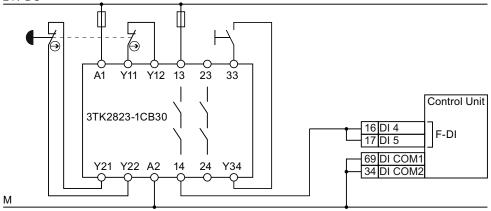


Figure A-10 Connecting a safety relay, e.g. SIRIUS 3TK28

24V DC

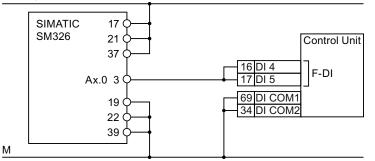


Figure A-11 Connecting an F digital output module, e.g. SIMATIC F digital output module

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 Documentation for accepting the safety functions

A.5.1 Machine documentation

Machine or plant description

Designation	
Туре	
Serial number	
Manufacturer	
End customer	
Block diagram of the machine a	nd/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	

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC A.5 Documentation for accepting the safety functions

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 Documentation for accepting the safety functions

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></r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v></r9770_v>

Table A- 15 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v></r9780_v>

Table A- 16 Checksums

Name	Number	Value
SI target checksum SI parameters	p9799	<p9799_v></p9799_v>

Table A- 17 Settings of the safety function

Name	Number	Value
SI enable, functions integrated in the drive	p9601	<p9601_v></p9601_v>
SI PROFIsafe address	p9610	<p9610_v></p9610_v>
SI F-DI changeover, tolerance time	p9650	<p9650_v></p9650_v>
SI STO debounce time	p9651	<p9651_v></p9651_v>
SI forced dormant error detection timer	p9659	<p9659_v></p9659_v>

Table A- 18 Safety logbook

Name		Value
SI checksum to check changes	r9781[0]	<r9781[0]_v></r9781[0]_v>
SI checksum to check changes	r9781[1]	<r9781[1]_v></r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v></r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v></r9782[1]_v>

A.6 Additional information on the inverter

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.automatio n.siemens.com/WW/vie w/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:	Installing the Power Module	English	
	PM240, PM250 and PM260PM240-2PM230			
+	Installation Instructions for reactors, filters and braking resistors	Installing components		
+++	Hardware Installation Manual for the following SINAMICS G120 Power Modules:	Installing power modules, reactors and filters. Maintaining power modules.	English, German	
	PM230 IP20 PM230 IP55			
	PM230 IP55PM240			
	 PM240-2 			
	 PM250 			
	• PM260			
+++	 Operating Instructions for the following Operator Panels: BOP-2 IOP 	Operation of Operator Panels, door mounting kit for mounting of IOP.		

A.6 Additional information on the inverter

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 (<u>www.siemens.en/sinamics-g120</u>)
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 (<u>http://support.automation.siemens.com/W</u> W/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/W W/view/en/37728795)

Table A- 20	Support when	configuring and	selecting the converter
-------------	--------------	-----------------	-------------------------

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

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

Α

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

В

Back up Parameter, 271 Back up parameters, 271 Basic commissioning, 46 Basic functions, 46, 84 BF (Bus Fault), 277

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 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

С

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

Е

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

Н

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC 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

Κ

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

Μ

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

Ν

No-load monitoring, 218, 219

0

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

Ρ

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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

Т

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

Frequency converter with CU240B-2 and CU240E-2 Control Units Operating Instructions, 04/2012, FW V4.5, A5E02299792B AC

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

Ζ

ZSW1 (status word 1), 105 ZSW3 (status word 3), 107

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