SINAMICS G120

Frequency converter with the Control Units

CU240B-2

CU240E-2

CU240B-2 DP CU240E-2 DP

CU240E-2 F

CU240E-2 DP-F

Operating instructions · 01 2011



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SINAMICS G120 Inverter with CU240B-2 and CU240E-2 Control Units

Operating Instructions

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Change history

Edition 01/2011, Firmware V4.4

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

Change history

Important changes with respect to the manual, edition 07/2010

New functions in firmware V4.4	In Chapter
Predefined settings for the interfaces of the converter	Installing Control Unit (Page 42)
Two- and three-wire control via terminal block	Inverter control (Page 149)
Unit changeover	Application-specific functions (Page 182)
Expanded options for controlling DC braking	Braking functions of the inverter (Page 187)
Expansion of the automatic restart with the addition of a new mode	Automatic restart and flying restart (Page 204)
Trace via STARTER	Commissioning with STARTER (Page 71)

Revised descriptions	In Chapter	
The description of the Power Module PM240-2 and PM250-2 has been removed. The release of this Power Module is scheduled to be with firmware V4.5.	 Installing the Power Module (Page 30) Technical data, Power Modules (Page 266) 	
Wiring the terminal strip	Installing Control Unit (Page 42)Adapt terminal strip (Page 89)	
Settings of the USB interface for commissioning with STARTER.	Commissioning with STARTER (Page 71)	
Slave-to-slave communications via PROFIBUS DP	Communication via PROFIBUS (Page 102) Application Examples (Page 279)	
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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

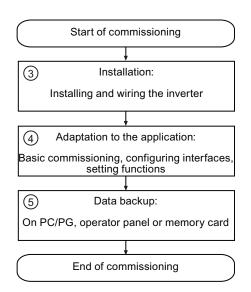
In this manual, you will find background information on your inverter, as well as a full description of the commissioning procedure:

- Basics:
 The parameters for the inverter
- Should you be unfamiliar with assigning parameters to the inverter, background information can be found here:
 - Adapting the inverter in line with the application (Page 13)
 - Frequently required parameters (Page 14)
 - Extended scope for adaptation (Page 16)
- ② Information on the inverter hardware can be found here:
 - Modularity of the converter system (Page 21)

② Components of the inverter:
e.g. reactors, filters, operator panel

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

- Procedure for installing the frequency inverter (Page 27)
- (4) Commissioning (Page 55)
 - Adapt terminal strip (Page 89)
 - Configuring the fieldbus (Page 101)
 - Data backup and standard commissioning (Page 81)



- Maintenance and diagnostics:
 Replacing components; displays; alarms; faults
- 7 Technical data
- ⑥ Information regarding the maintenance and diagnostics of your inverter is located in the following chapters:
 - Service and maintenance (Page 241)
 - Alarms, faults and system messages (Page 245)
- The most important technical data for your inverter is located in this chapter:
 - Technical data (Page 263)

1.3 Adapting the inverter in line with the application

1.3.1 General basics

Inverters are used to improve and extend the starting and speed response of motors.

Adapting the inverter to the drive task

The inverter must match the motor that it is controlling and the drive task to be able to optimally operate and protect the motor.

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

Use the factory settings (where possible)

In simple applications, the inverter already functions with its factory settings.

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

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

1.3.2 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.

1.4 Frequently required parameters

1.4 Frequently required parameters

Parameters that in many cases help

Table 1-1 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 1-2 How to determine the firmware version of the Control Unit

Parameter	Description
r0018	The firmware version is displayed:

Table 1-3 How to select the command and setpoint sources for the inverter

Parameter	Description
p0015	Additional information is available in the section Select interface assignments (Page 46).

Table 1-4 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 1-5 This is how you set the closed-loop type

Parameter	Description
p1300	0: V/f control with linear characteristic 1: V/f control with linear characteristic and FCC 2: V/f control with parabolic characteristic 3: V/f control with parameterizable characteristic 4: V/f control with linear characteristic and ECO 5: V/f control for drives requiring a precise frequency (textile area) 6: V/f control for drive requiring a precise frequency and FCC 7: V/f control with parabolic characteristic and ECO
	19: V/f control with independent voltage setpoint
	20: Speed control (without encoder) 22: Torque control (without encoder)

Table 1-6 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.

1.5 Extended scope for adaptation

1.5.1 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.

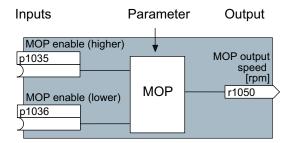


Figure 1-1 Example of a BICO block: Motorized potentiometer (MOP)

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.

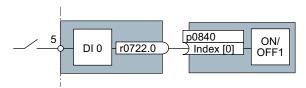


Figure 1-2 Example: Signal interconnection of two BICO blocks for digital input 0

Binectors and connectors

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

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

Definition of BICO technology

BICO technology represents a type of parameterization that can be used to disconnect all internal signal interconnections between BICO blocks or establish new connections. This is realized using **Bi**nectors and **Co**nnectors. Hence the name **BICO** technology. (Binector Connector Technology)

BICO parameters

You can use the BICO parameters to define the sources of the input signals of a block. Using BICO parameters you define from which connectors and binectors a block reads-in its input signals. This is how you "interconnect" the blocks stored in the devices according to your particular application requirements. The five different BICO parameter types are shown in the following diagram:

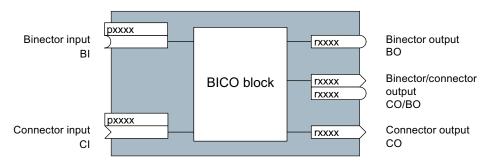


Figure 1-3 BICO symbols

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

BICO outputs (CO, BO, or CO/BO) can be used more than once.

When do you need to use BICO technology?

BICO technology allows you to adapt the inverter to a wide range of different requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

What precautions should you take when using BICO technology?

Always apply caution when handling internal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers various screens that make it much easier for you to use BICO technology. The signals that you can interconnect are displayed in plain text, which means that you do not need any prior knowledge of BICO technology.

1.5 Extended scope for adaptation

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.

1.5.2 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.

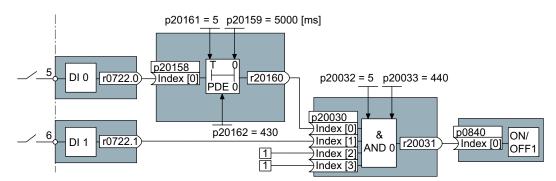


Figure 1-4 Example: Signal interconnection for interlock

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

Table 1-7 Parameterizing an interlock

Parameter	Description
P20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
P20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)

Parameter	Description
P20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
P20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
P20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
P20158 = 722.0	Connect the status of DI 0 to the input of the time block
	r0722.0 = Parameter that displays the status of digital input 0.
P20030 [0] = 20160	Interconnecting the time block to the 1st input of the AND
P20030 [1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input
	r0722.1 = Parameter that displays the status of digital input 1.
P0840 = 20031	Interconnecting the AND output to the control command ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter P0840[0] is the input of the "ON/OFF1 command" block of the converter. Parameter r20031 is the output of the AND block. To interconnect the ON/OFF1 command with the output of the AND block, set P0840 to 20031.

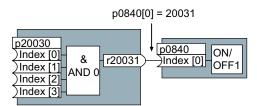


Figure 1-5 Interconnecting two BICO blocks by setting p0840[0] = 20031

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?

1.5 Extended scope for adaptation

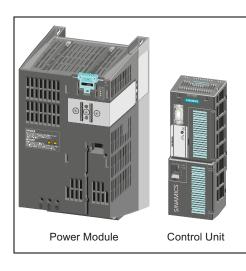
Description

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.

The following overview describes the converter components, which you require for your application.

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 in various control modes (which can be selected as required). 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.

2.1 Modularity of the converter system

Tools to commission the inverter

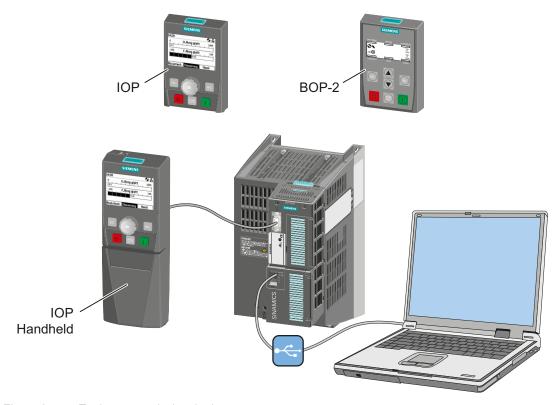


Figure 2-1 Tools to commission the inverter

Table 2- 1 Components and tools for commissioning and data backup

Component or tool		Order number
Operator panel for commissioning, diagnostics and controlling frequency	BOP-2 - for snapping onto the frequency converter Copies drive parameters Two-line display Guided commissioning	6SL3255-0AA00-4CA1
converters	IOP - to snap onto the frequency converter or with the handheld Copies drive parameters Plain text display Menu-based operation and application wizards	6SL3255-0AA00-4JA0 IOP Handheld: 6SL3255-0AA00-4HA0
	IOP/BOP-2 Mounting Kit IP54/UL Type 12	6SL3256-0AP00-0JA0
Tools for the PC	STARTER commissioning tool (PC software) connected to the frequency converter via USB cable	STARTER on DVD: 6SL3072-0AA00-0AG0 Downloading: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)
	PC Connection Kit The kit contains a STARTER DVD and USB cable	6SL3255-0AA00-2CA0

Component or tool			Order number
	Drive ES Basic To commission the frequency converter via interface. Includes STARTER	a the PROFIBUS	6SW1700-5JA00-4AA0
3	Memory card to save and transfer the	MMC card	6SL3254-0AM00-0AA0
SINAMICS SINSMICS SIN	frequency converter settings	SD card	6ES7954-8LB00-0AA0

Components, which you require depending on your particular application

Filters and reactors

- Line filters, Classes A and B
- Line reactors
- Braking resistors
- Output reactors
- Sine-wave filter

Further options

- Brake Relay
- Adapter for DIN rail mounting (only PM240, FSA)
- Shield connection kit (for Control Unit and Power Module)

2.2 Overview of Control Units

The Control Units differ in relation to the integrated safety functions, the type of fieldbuses, and the number of inputs and outputs.

	CU240B-2	CU240B-2 DP	CU240E-2	CU240E-2 F	CU240E-2 DP	CU240E-2 DP-F	
Fieldbus			USS or Modbus RTU	USS or Modbus RTU	PROFIBUS DP	PROFIBUS DP with PROFIsafe	
Integrated safety functions	-		STO STO, SS1, SLS		STO	STO, SS1, SLS	
Digital inputs	4		6				
Fail-safe digital inputs *)	-		1	3	1	3	
Analog inputs	1		2				
Digital outputs	1		3				
Analog outputs		1	2				

^{*)} A fail-safe digital input is created by combining two "standard" digital inputs

2.3 Power Module

Power Modules are available in various degrees of protection with a different topology in the power range from between 0.37 kW up to 250 kW. The Power Modules are sub-divided into various frame sizes (FS).

Power Modules with degree of protection IP20: PM240, PM250, PM260



Frame size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX			
PM240, 3AC 400V - power units with integrated braking chopper ¹⁾										
Power range (LO) in kW 0.37 1.5 2.2 4 7.5 15 18.5 30 37 45 55 132 160 250										
line filter, Class A	0	•	•	•	•	0	•			
PM250, 3AC 400V - power uni	PM250, 3AC 400V - power units capable of energy recovery									
Power range (LO) in kW			7.5 15	18.5 30	37 45	55 90				
line filter, Class A			•	•	•	•				
PM260, 3AC 690V - power uni	ts capable of	energy recov	/ery							
Power range (LO) in kW	Power range (LO) in kW 11 18.5 30 55									
line filter, Class A				○/●		○/●				
Sine-wave filter				•		•				

^{○ =} without; • = integrated; • = from 110 kW for external mounting

2.4 Reactors and filters

Overview

Depending on the Power Module, the following combinations with filters and reactors are permitted:

Power Module	ı	_ine-side component	Load-side components		
	Line reactor	Line filters class B	Braking resistor	Sine-wave filter	Output reactor
PM240	•	•	•	•	•
PM250	-	•	-	•	•
PM260	-	•	-	integrated	-

For further details, refer to the connection example in section Procedure for installing the frequency inverter (Page 27).

¹⁾ The Power Module PM240 FSGX is supplied without braking chopper, but is prepared for installation of an optional braking chopper

2.4 Reactors and filters

Installing

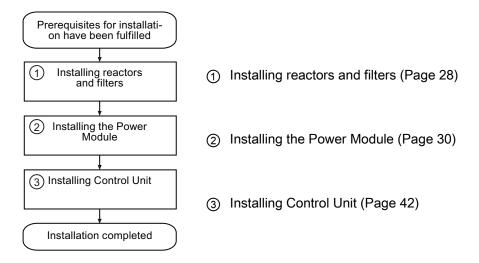
3.1 Procedure for installing the frequency inverter

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 263).

Installation sequence



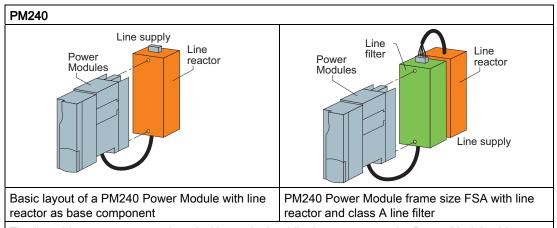
You will find details on the installation in the Internet: Hardware Installation Manual (http://support.automation.siemens.com/WW/view/en/30563173/133300).

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

3.2 Installing reactors and filters

Fitting inverter system components in space-saving manner

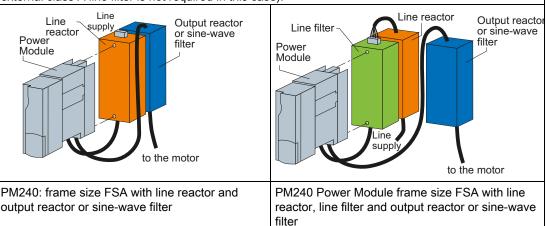
Many inverter system components are designed as base components, that is, the component is mounted on the baseplate and the inverter mounted above it to save space. Up to two base components can be mounted above one another.



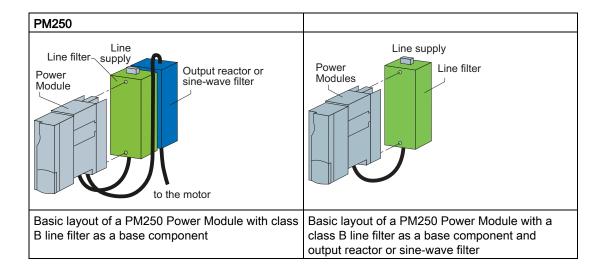
The line-side reactors are equipped with terminals while the reactors on the Power Module side are equipped with a prefabricated cable. In the final installation position, the mains terminals are at the top on frame sizes FSA to FSC, and at the bottom on frame sizes FSD to FSE.

For frame size FSA, in addition to the line reactor, a class A line filter can be used. In this case, the mains connection is at the bottom.

Power Modules of frame size FSB and higher are available with integrated class A line filters (an external class A line filter is not required in this case).



In installations containing more than two base-type system components (e.g. line filter + line reactor + output reactor), the components must be installed to the side of the Power Module whereby the line reactor and line filter are installed under the Power Module and the output reactor to the side.

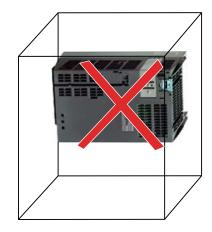


3.3 Installing the Power Module

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 relays etc., may also be used.

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

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

Note

With the exception of inverters in the 160 kW ... 250 kW power range, the CU240B-2 und CU240E-2 increase the inverter's total depth by 40 mm and by a further 30 mm if using an IOP.

Dimensions and drilling patterns for the PM240 Power Modules

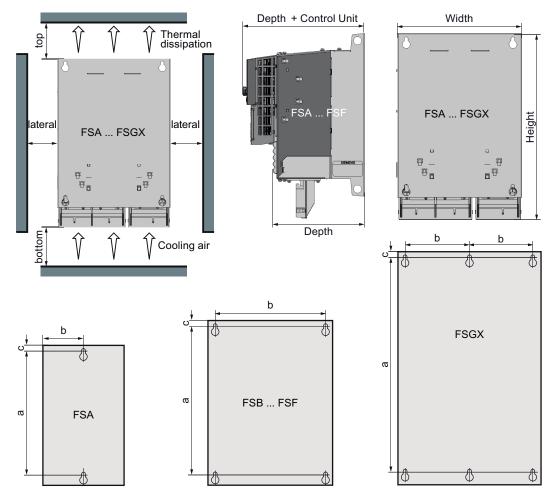


Figure 3-1 PM240 drilling pattern

Table 3-1 PM240, IP20 dimensions

Frame size		Dimensions (mm)						Clearances (mm)		
		Height	Width	Depth	а	b	С	top	bottom	lateral
FSA		173	73	145	160	36.5		100	100	30*
FSB		270	153	165	258	133		100	100	40*
FSC		334	189	185	323	167		125	125	50*
FSD without filter		419	275	204	325	235	11	300	300	0
FSD with filter, Class A		512	275	204	419	235	11	300	300	0
FSE without filter 4		499	275	204	405	235	11	300	300	0
FSE with filter, Clas	s A	635	275	204	541	235	11	300	300	0
FSF without filter		634	350	316	598	300	11	350	350	0
FSF with filter, Class A 93		934	350	316	899	300	11	350	350	0
FSGX		1533	326	547	1506	125	14.5	250	150	50
Fixing:		SA/FSB: M4 screws, 2.5 Nm / 22 lbf .in					GX: M8			

^{*)} up to 40 °C without any lateral clearance

3.3 Installing the Power Module

Dimensions and drilling patterns for the PM250 Power Modules

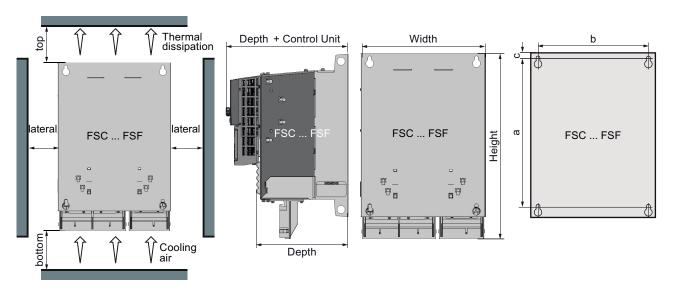


Figure 3-2 PM250 drilling pattern

Table 3- 2 PM250, IP20 dimensions

Frame size	Dimens	Dimensions (mm)				Clearances (mm)				
	Heigh	t Width	Depth	а	b	С	top	bottom	lateral	
FSC	334	189	185	323	167		125	125	50*	
FSD without filter	419	275	204	325	235	11	300	300	0	
FSD with filter, Class	A 512	275	204	419	235	11	300	300	0	
FSE without filter	499	275	204	405	235	11	300	300	0	
FSE with filter, Class	A 635	275	204	541	235	11	300	300	0	
FSF without filter	634	350	316	598	300	11	350	350	0	
FSF with filter, Class A	A 934	350	316	899	300	11	350	350	0	
•	FSB: M4 screws, 2.5 Nm / 22 lbf .in FSD/FSE: FSC: M5 screws, 2.5 Nm / 22 lbf .in FSF/: M8 screws, 13 Nm / 115 lbf .in						18			

^{*)} up to 40 °C without any lateral clearance

Dimensions and drilling patterns for the PM260 Power Modules

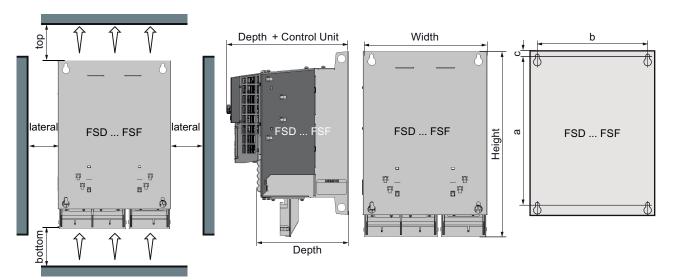


Figure 3-3 PM260 drilling pattern

Table 3-3 PM260, IP20 dimensions

Frame size	Dimensions (mm)				Clearances (mm)				
	Height	Width	Depth	а	b	С	top	bottom	lateral
FSD without / with filter	419	275	204	419	235	11	300	300	30*
FSF without / with filter	634	350	316	598	300	11	350	350	0
Fixing:	FSD: M6 screws, 6 Nm/53 lbf.in				FSF: M8 screws, 13 Nm / 115 lbf.in				

^{*)} up to 40 °C without any lateral clearance

3.3.3 Connection overview for Power Module

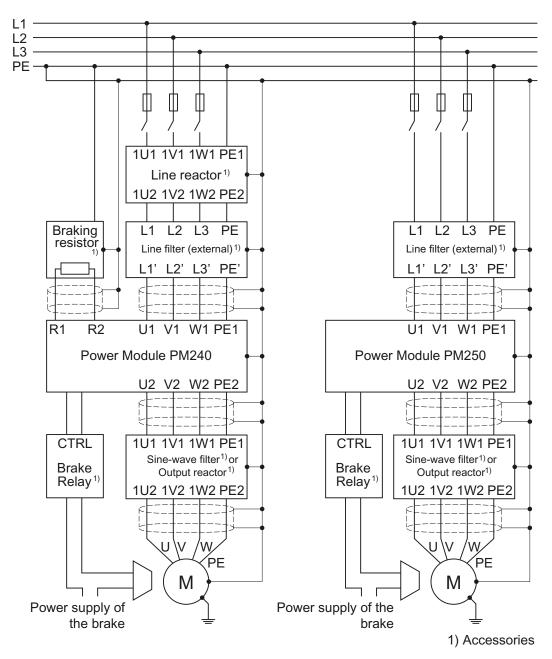


Figure 3-4 Connections for PM240 and PM250 Power Modules

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).

3.3.4 Connecting the line supply and motor

Preconditions

Once the inverter has been properly installed, the line and motor connections can now be established. The following warning information must be observed here.



/ WARNING

Line and motor connections

The inverter must be grounded on the line supply and motor side. If the inverter 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 inverter terminals be at hazardous voltages even after the inverter 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 inverter to the line supply, ensure that the motor terminal box is closed.

Even if the LED or other indicators do not light up or remain inactive when a function is switched from ON to OFF, this does not necessarily mean that the unit has been switched off or is de-energized.

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

Make sure that the inverter is configured for the correct supply voltage (the inverter must not be connected to a higher supply voltage).

If a residual-current circuit breaker is installed on the supply side of the electronic devices to protect against direct or indirect contact, only type B is permissible. In all other cases, other protective measures must be implemented, such as creating a barrier between the electronic devices and the environment by means of double or reinforced insulation or isolating them from the supply 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.

3.3 Installing the Power Module

Note

Electrical protective equipment

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

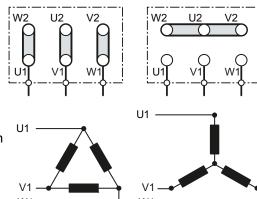
Delta connection

Connecting the motor: Star connection and delta connection

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)

The motor rating plate provides information about the correct connection data.



Star connection

Examples for operating the inverter and motor on a 400 V line supply

Assumption: The motor rating plate states 230/400 V Δ/Y.

Example 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.

Example 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.

Connecting the inverter

Motor connection

- If available, open the terminal covers of the inverter.
- Connect the motor to terminals U2, V2 and W2.
 Carefully observe the regulations for EMC-compliant wiring:
 EMC-compliant connection (Page 38)
- Connect the protective conductor of the motor to the terminal ① of the inverter. The following cable lengths are permissible:
 - Unshielded 100 m
 - Shielded:

50 m for inverters without filter

25 m for inverters with filter

You will wind additional information in Catalog D11.1 for longer cable lengths

Line supply connection

- 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 inverter.
- If available, close the terminal covers of the inverter.

Note

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

The permissible cable cross sections for the individual devices and power ratings are provided in Section Technical data (Page 263).

3.3.5 EMC-compliant connection

The inverters are designed for operation in industrial environments where high values of electromagnetic interference are 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 enclosed control cabinet.

Control cabinet design

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

Cable routing and shielding

- All inverter power cables (line supply cables, connecting cables between the braking chopper and the associated braking resistance as well as the motor cables) must be separately routed away from signal and data cables. The minimum clearance should be approx. 25 cm. As an alternative, the decoupling can be realized in the control cabinet using metal partitions (separating elements) connected to the mounting plate through a good electrical connection
- The cables from the line supply to the line filter must be routed separately away from non-filtered power cables with a high noise level (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.

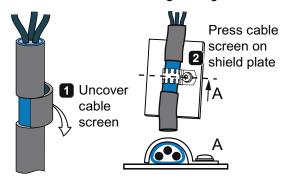
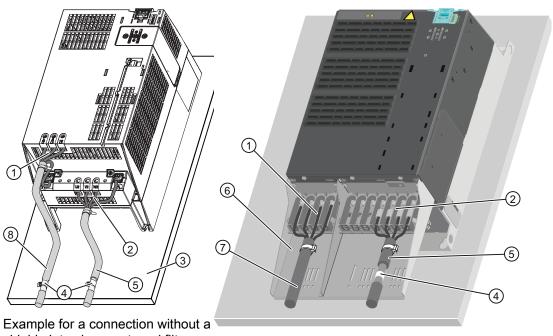


Figure 3-5 Shield support

EMC-compliant installation of Power Modules in degree of protection IP20

The EMC-compliant installation of power modules is shown in the following diagram using two examples.



- shield plate via an external filter
- Example for a connection with a shield plate, directly to the line supply
- 1 Line supply connection
- (2) Motor connection
- (3) Metal mounting plate (unpainted and with a good electrical conductivity)
- (4) Cable clamps for a good conductive electrical connection through a large surface area between the shield and mounting plate or shield plate.
- Shielded cable for the motor connection
- 6 Shield plate
- (7) Unshielded cable for connection directly to the line supply
- (8) Shielded cable for connection to the line supply via an external filter.

Note

An unshielded cable for the line connection should be used for Power Modules with integrated filter. Power Modules, which are connected to the line supply via an external filter, require a shielded cable between the line filter and 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 an optional shield plate. In this case, you must ensure that the cable shields are connected to the ground potential through the largest possible

surface area.

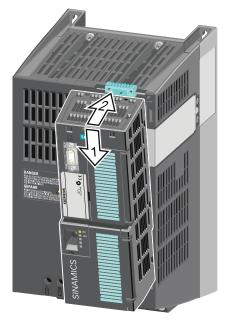
Braking resistor connection: The braking resistor is connected using a shielded

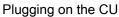
cable. Using a clamp, the shield should be connected to the mounting plate or to the shield plate through a good electrical connection and through the largest possible surface area.

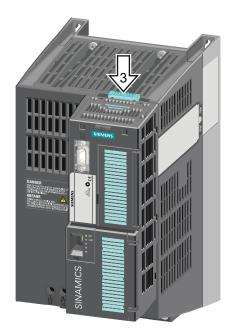
3.4 Installing Control Unit

3.4.1 Snapping the Control Unit onto the Power Module

Installing the Control Unit on an IP20 Power Module



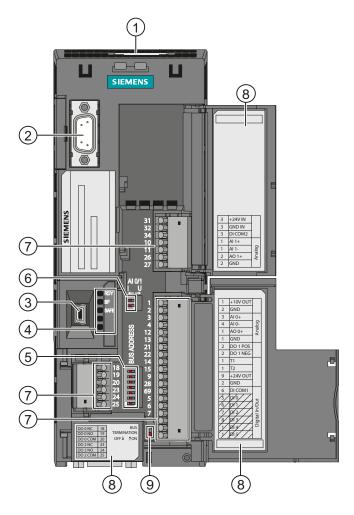




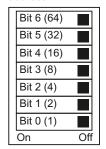
Removing the CU

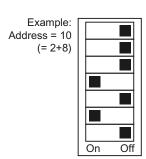
To gain access to the terminal strips, open the top and bottom front doors to the right. The terminal strips use spring-loaded terminals.

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

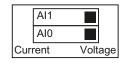


- 1) Slot for memory card (MMC or SD card)
- 2) Interface for operator panel (IOP or BOP-2)
- 3 USB interface for STARTER
- 4 Status LED RDY
 BF
 SAFE
- 5 DIP switch for fieldbus address





6 DIP switch for AI0 and AI1 (terminals 3/4 and 10/11)



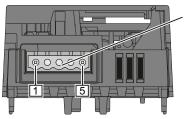
- 7 Terminal strip
- (8) Terminal designation
- 9 Depending on the fieldbus:

CU240B-2, CU240E-2, CU240E-2 F Bus termination



CU240B-2 DP, CU240E-2 DP, CU240E-2 DP-F No function

CU240B-2, CU240E-2, CU240E-2 F

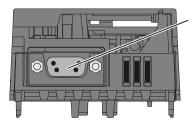


RS485 connector for communicating via fieldbus systems

Contact Designation

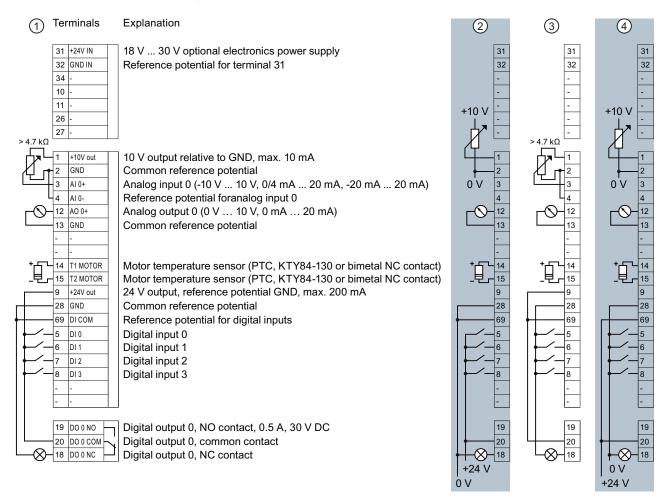
- 1 0 V, reference potential
- 2 RS485P, receiving and sending (+)
- 3 RS485N, receiving and sending (+)
- 4 Cable shield
- 5 Not connected

CU240B-2 DP, CU240E-2 DP, CU240E-2 DP-F



SUB D socket for communicating via PROFIBUS DP

3.4.3 Terminal strips on CU240B-2 Control Units



If you require more than four digital inputs, use terminals 3 and 4 (Al 0) as additional digital input DI 11.

- ① Wiring when using the internal power supplies.
- 2 Wiring when using external power supplies.
- Wiring when using the internal power supplies.
- Wiring when using external power supplies.

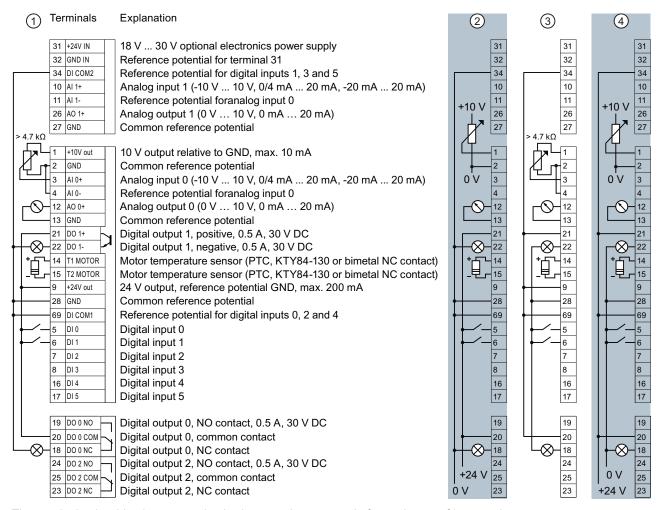
- DI = high, if the switch is closed.
- DI = high, if the switch is closed.
- DI = low, if the switch is closed.
- DI = low, if the switch is closed.

/ CAUTION

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240B-2 Control Unit (Page 263).

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

3.4.4 Terminal strips on CU240E-2 Control Units



The terminal strip wiring is not completely shown, only as example for each type of input and output.

If you require more than six digital inputs, use terminals 3 and 4 (Al 0) or terminals 10 and 11 (Al 1) as additional digital inputs DI 11 or DI 12.

① Wiring when using the internal power supplies.

Wiring when using external power supplies.

Wiring when using the internal power supplies.

4 Wiring when using external power supplies.

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.

CAUTION

If your application requires UL certification, please observe the note regarding the digital output in Section Technical data, CU240E-2 Control Unit (Page 264).

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

3.4 Installing Control Unit

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

Terminals	Designation	Fail-safe digital input with Basic Safety
16	DI4	F-DI0
17	DI5	

If you wish to use several fail-safe digital inputs of the converter, this is described in the Safety Integrated Function Manual. You will find the link to the Safety Integrated Function Manual in Section Additional information on the inverter (Page 292).

Additional information on fail-safe digital inputs is available in Chapter Permitted sensors (Page 220).

3.4.5 Select interface assignments

The inverter offers multiple predefined settings for its interfaces.

One of these predefined settings matches your particular application

Proceed as follows:

- 1. Wire the inverter corresponding to your application.
- 2. Carry-out the basic commissioning, see Section Commissioning (Page 55). In the basic commissioning, select the macro (the predefined settings of the interfaces) that matches your particular wiring.
- 3. When required, configure communication via fieldbus, see Adapt terminal strip (Page 89).

What do you do if none of the predefined settings matches your particular application 100%?

If none of the predefined settings matches your particular application, then proceed as follows:

- 1. Wire the inverter corresponding to your application.
- 2. Carry-out the basic commissioning, see Section Commissioning (Page 55). In the basic commissioning, select the macro (the predefined settings of the interfaces) that comes the closest to matching your particular application.
- 3. Adapt the inputs and outputs to your application, see Section Commissioning (Page 55).
- 4. When required, configure communication via fieldbus, see Configuring the fieldbus (Page 101).

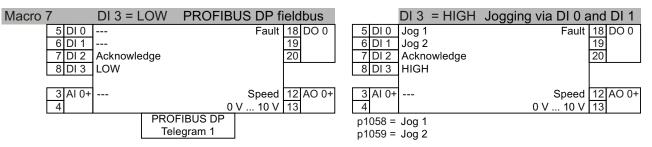
3.4.5.1 Inverter with CU240B-2 Control Units

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

Macro 12 Macro 17 Macro 18

Factory setting for converter with CU240B-2 DP Control Unit.



Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

Motorized potentiometer

Macro 9	Motorized potentiometer (MOP)	5 DI 0 ON/OFF1 6 DI 1 MOP up 7 DI 2 MOP down 8 DI 3 Acknowledge	Fault 18 DO 0 19 20
		3 AI 0+	Speed 12 AO 0+ 0 V 10 V 13

Two- or three-wire control

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

5 DI 0 Control command 1

Two-wire Met control	hod 1 Method 2	2 Method 3	6 DI 1 Control command 2 7 DI 2 Acknowledge 8 DI 3	20
Control command 1 ON/0 Control command 2 Reve			3 Al 0+ Setpoint I U -10 V 10 V	Speed 12 AO 0+ 0 V 10 V 13
Three-wire control	Macro 19 Method 1	Macro 20 Method 2	5 DI 0 Control command 1 6 DI 1 Control command 2 7 DI 2 Control command 3 8 DI 3 Acknowledge	Fault 18 DO 0 19 20
Control command 1 Control command 2 Control command 3	Enable/OFF1 ON right ON left	Enable/OFF1 ON Reversing	3 Al 0+ Setpoint 4 I U -10 V 10 V	Speed 12 AO 0+ 0 V 10 V 13

Fault 18 DO 0

3.4 Installing Control Unit

Communication with higher-level control via USS

Macro 21	Fieldbus USS	5 DI 0	Fault 18 DO 0
		6 DI 1	19
	p2020 = Baud rate	7 DI 2 Acknowledge	20
	p2022 = PZD number	8 DI 3	
	p2023 = PKW number	<u></u>	
	·	3 AI 0+	Speed 12 AO 0+
		4	0 V 10 V 13
			USS
		3	38400 Baud
			D. PIV variable

3.4.5.2 Inverter with CU240E-2 Control Units

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

Fixed speeds

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

You must enable the safety function, see Section: Safe Torque Off (STO) safety function (Page 220).

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 A 0 Speed 12 AO 0
	Frequency converter adds corresponding fixed	0 V 10 V 13
	speeds	10 Al 1 Current 26 AO 1
		11 0 V 10 V 27
Macro 4	PROFIBUS DP fieldbus	5 DI 0 Fault 18 DO 0
		6 DI 1 19
		7 DI 2 Acknowledge 20
		8 DI 3 Alarm 21 DO 1
		16 DI 4 22
		17 DI 5
		3 Al 0 Speed 12 AO 0
		0 V 10 V 13
		10 Al 1 Current 26 AO 1
		11 0 V 10 V 27
		PROFIBUS DP
		Telegram 352

Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

3.4 Installing Control Unit

Macro 5	Fieldbus with safety function	5 DI 0)		Fault	18 DO 0
	, , , , , , , , , , , , , , , , , , ,	6 DI 1	□			19
		7 DI 2	Acknowl	edge		20
		8 DI 3	3		Alarm	21 DO 1
		16 DI 4	Reserv	ed for safety		22
		17 DI 5	functio	n		
			7-			
		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)	
				Telegram 352		

You must enable the safety function, see Section: Safe Torque Off (STO) safety function (Page 220). Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

Two safety functions

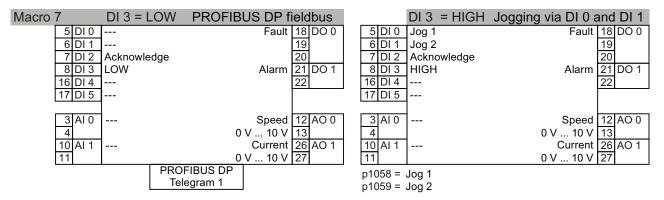
This default setting can only be used for CU240E-2 F and CU240E-2 DP F Control Units.

Macro 6	PROFIBUS DP fieldbus with two safety functions	6 DI 1	vledge rved for safety	Fault 18 DO 0 19 20 Alarm 21 DO 1 22
		3 Al 0 4 10 Al 1		Speed 12 AO 0 V 10 V 13 Current 26 AO 1 V 10 V 27

You must enable the safety function, see Section: Safe Torque Off (STO) safety function (Page 220). Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

Automatic/local - Changeover between fieldbus and jog mode

Factory setting for converters with PROFIBUS interface:



Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

Motorized potentiometer

Macro 8	Motorized potentiometer (MOP) with safety function	5 DI 0 ON/OFF1 6 DI 1 MOP up 7 DI 2 MOP down 8 DI 3 Acknowledge 16 DI 4 Reserved for safety function	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

You must enable the safety function, see Section: Safe Torque Off (STO) safety function (Page 220).

3.4 Installing Control Unit

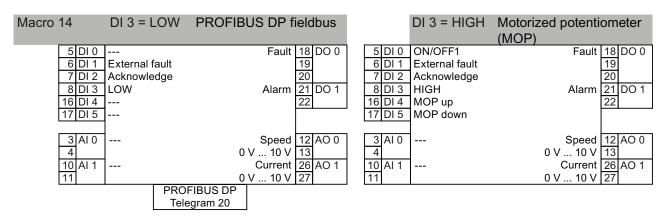
Macro 9	Motorized potentiometer (MOP)	5 DI 0 6 DI 1	ON/OFF1 MOP up	Fault 18 DO 0
		7 DI 2 8 DI 3	MOP down Acknowledge	20 Alarm 21 DO 1
		16 DI 4		22
		17 DI 5]	
		3 AI 0	1	Speed 12 AO 0 0 V 10 V 13
		10 AI 1	1	Current 26 AO 1
		11		0 V 10 V 27

Applications with analog setpoint

Macro 13	Setpoint via analog input and safety function	5 DI 0 6 DI 1 7 DI 2 8 DI 3 16 DI 4 17 DI 5	ON/OFF1 Reversing Acknowledge Reserved for safety function	Fault 18 DO 0 19 20 Alarm 21 DO 1
		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

You must enable the safety function, see Section: Safe Torque Off (STO) safety function (Page 220).

Process industry



Refer to the following Section on how you can obtain the GSD file: Configuring communication to the control (Page 102).

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

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

Two- or three-wire control

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

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

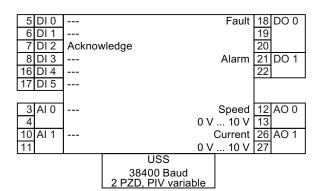
5	DI 0	Control command 1	Fault	18	DO 0
6	DI 1	Control command 2		19	
7	DI 2	Acknowledge		20	
8	DI 3		Alarm	21	DO 1
16	DI 4			22	
17	DI 5				-
3	AI 0	Setpoint	Speed	12	AO 0
4		I <u>■</u> U -10 V 10 V	0 V 10 V	13	
10	Al 1		Current	26	AO 1
11			0 V 10 V	27	

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

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

Communication with a higher-level control via USS

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



3.4 Installing Control Unit

3.4.6 Wiring terminal strips

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

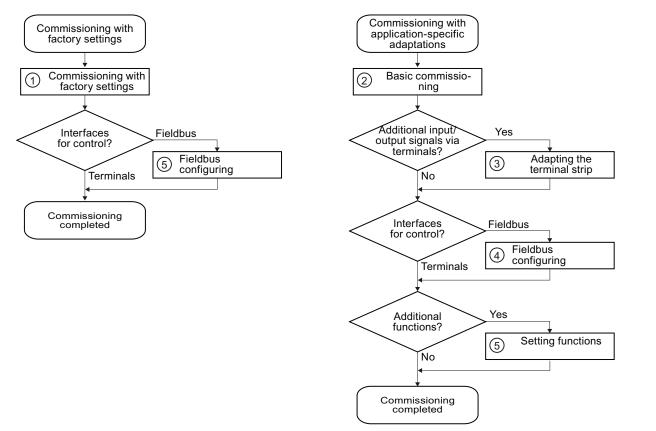
The permissible cable cross-section ranges between 0.5 mm² (21 AWG) and 1.5 mm² (16 AWG). When completely connecting-up the unit, we recommend cables with a cross-section of 1mm² (18 AWG).

Route the signal lines so that you can again completely close the front doors after connecting-up the terminal strip. If you use shielded cables, then you must connect the shield to the mounting plate of the control cabinet or with the shield support of the inverter through a good electrical connection and a large surface area.

Commissioning

You must commission the inverter after installation has been completed.

To do this, using Section "Collecting motor data (Page 59)" you must clarify whether the motor can be operated with the inverter factory settings or an additional adaptation of the inverter is required. The two commissioning options are shown in the following diagram.



① Commissioning with factory settings (Page 63)

- 4 Configuring the fieldbus (Page 101)
- ② Set basic commissioning with STARTER (Page 71) or BOP-2 (Page 66)
- 5 Functions (Page 147)

3 Adapt terminal strip (Page 89)

Figure 4-1 Commissioning procedure

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.

4.1 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.

Deactivating safety functions

The parameters of the safety functions can only be reset if you first deactivate the safety functions.

Table 4-1 Procedure

STARTER	BOP-2	
1. Go online with STARTER	Set the following parameters:	
2. Call the safety functions screen form	p9761 =	Password for the safety functions
3. Deactivate the safety functions	p0010 = 95	Changing the safety functions
	p9601 = 0	Deactivate safety functions
	p9700 = 208	Copy parameter
	p9701 = 220	Confirm setting
	p0010 = 0	Exit change

Final steps:

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

4.1 Restoring the factory setting

Restoring the factory setting with STARTER or BOP-2

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

Note

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

Table 4- 2 Procedure

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	

4.2 Preparing for commissioning

Prerequisites: before you start

Before starting commissioning, you must answer the following questions:

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

4.2.1 Collecting motor data

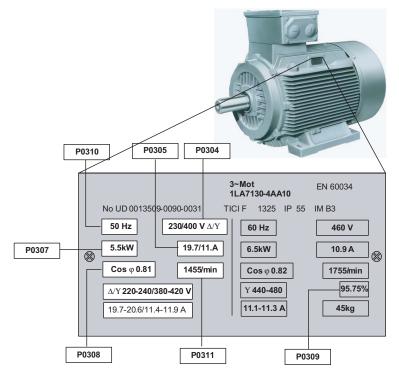
Which motor are you using? [P0300]

A synchronous or induction motor?

The inverters are preset in the factory for applications using 4-pole three-phase induction motors that correspond to the performance data of the inverter.

Motor data / data on the motor rating plate

If you use the STARTER commissioning tool and a SIEMENS motor, you only have to specify the motor Order No. In all other cases, you must read-off the data from the motor rating plate and enter into the appropriate parameters.



4.2 Preparing for commissioning

NOTICE

Information about installation

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

In which region of the world is the motor used? - Motor standard [P0100]

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

What is the prevailing temperature where the motor is operated? [P0625]

• Motor ambient temperature [P0625], if it differs from the factory setting = 20° C.

4.2.2 Inverter factory setting

Factory settings of additional important parameters

Parameter	Factory setting	Meaning of the factory setting	Name of the parameter and comments	
p0010	0	Ready to be entered	Drive, commissioning parameter filter	
p0100	0	Europe [50 Hz]	IEC/NEMA motor standard	
			IEC, Europe	
			NEMA, North America	
			Note: This parameter cannot cannot be changed in FW4.3.	
p0300	1	Induction motor	Motor type selection (induction motors / synchronous motor)	
p0304	400	[V]	Rated motor voltage (in accordance with the rating plate in V)	
p0305	depends on the Power Module	[A]	Rated motor current (in accordance with the rating plate in A)	
p0307	depends on the Power Module	[kW/hp]	Rated motor power (in accordance with the rating plate in kW/hp)	
p0308	0	[cos phi]	Rated motor power factor (in accordance with the rating plate in cos 'phi'). If p0100 = 1, 2, then p0308 has no significance.	
p0310	50	[Hz]	Rated motor frequency (in accordance with the rating plain Hz)	
p0311	1395	[rpm]	Rated motor speed (in accordance with the rating plate in rpm)	
p0335	0	Non-ventilated: Shaft- mounted fan in the motor	Motor cooling type (specify the motor cooling system)	
p0625	20	[°C]	Motor ambient temperature	
p0640	200	[A]	Current limit (of the motor)	
p0970	0	Locked	Reset drive parameters (restore to the factory settings)	
P1080	0	[rpm]	Minimum speed	
P1082	1500	[rpm]	Maximum speed	
P1120	10	[s]	Ramp-function generator, ramp-up time	
P1121	10	[s]	Ramp-function generator, ramp-down time	
P1300	0	V/f control with linear characteristic	Open-loop/closed-loop control operating mode	

4.2.3 Defining requirements for the application

What type of control is needed for the application? [P1300]

A distinction is made between V/f open-loop control and vector closed-loop control.

- The V/f open-loop control is the simplest operating mode for an inverter. For example, it is used for applications involving pumps, fans or motors with belt drives.
- For closed-loop vector control, the speed deviations between the setpoint and actual
 value are less than for V/f open-loop control; further, it is possible to specify a torque. It is
 suitable for applications such as winders, hoisting equipment or special conveyor drives.

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

The minimum and maximum speed with which the motor operates or is limited regardless of the speed setpoint.

- Minimum speed [P1080] factory setting 0 [rpm]
- Maximum speed [P1082] factory setting 1500 [rpm]

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 [P1120] factory setting 10 s
- Ramp-down time [P1121] factory setting 10 s

4.3 Commissioning with factory settings

Prerequisites for using the factory settings

In simple applications, commissioning can be carried out just using the factory settings. Check which factory settings can be used and which functions need to be changed. During this check you will probably find that the factory settings only require slight adjustment:

- 1. The inverter and motor must match one another; compare the data on the motor rating plate with the technical data of the Power Module.
 - The rated inverter current must, as a minimum, be the same as the motor.
 - The motor power should match that of the inverter; motors can be operated in the power range from 25 % ... 100 % of the inverter power rating.
- 2. If you are controlling the drive using the digital and analog inputs, the inverter must be connected as shown in the wiring example. (see Wiring examples for the factory settings (Page 64))
- If you connect the drive to a fieldbus, you must set the bus address using the DIP switches on the front of the Control Unit.

4.3 Commissioning with factory settings

4.3.1 Wiring examples for the factory settings

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

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

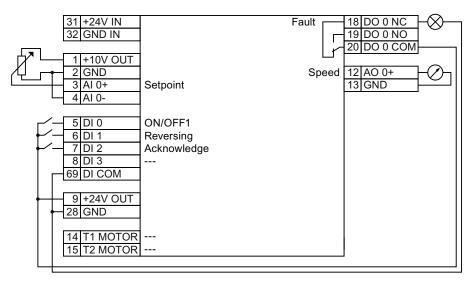


Figure 4-2 Wiring example to use the factory settings

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

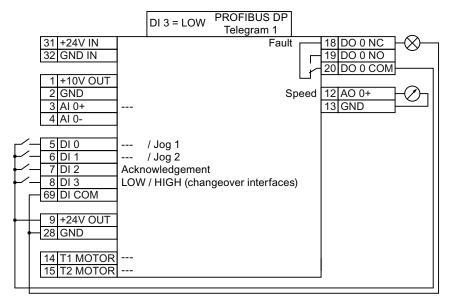


Figure 4-3 Wiring example to use the factory settings

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

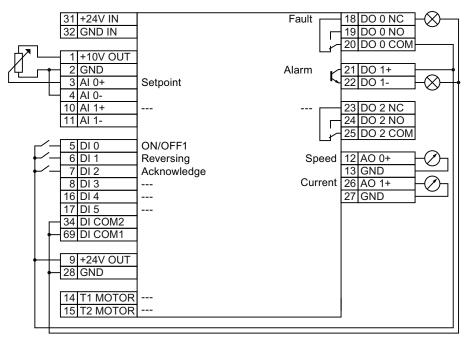


Figure 4-4 Wiring example to use the factory settings

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

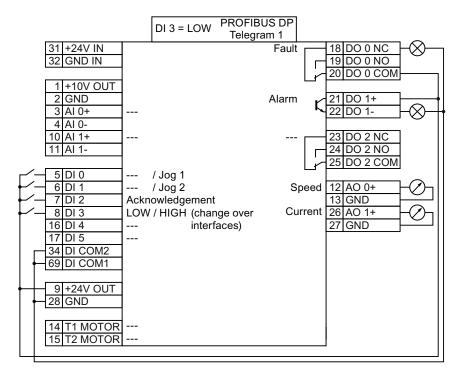
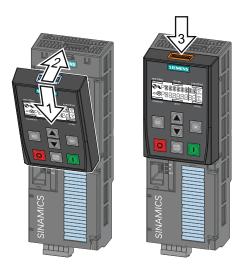


Figure 4-5 Wiring example to use the factory settings

4.4 Commissioning with 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.

Plugging on the BOP- Removing the BOP-2

4.4.1 Display of the BOP-2

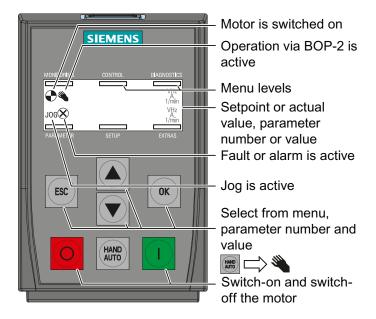
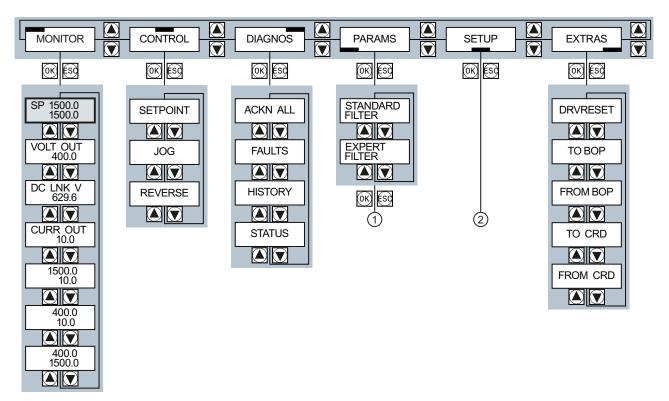


Figure 4-6 Operator control and display elements of the BOP-2

4.4.2 Menu structure

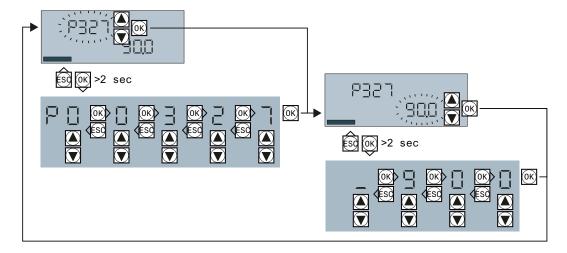


Changing parameter values:

- 1 Parameter number freely selectable
- ② Basic commissioning

4.4.3 Freely selecting and changing parameters

Use BOP-2 to change your inverter settings, by selecting the appropriate parameter number and changing the parameter value. Parameter values can be changed in the "PARAMS" menu and the "SETUP" menu.



Select the parameter nu	mber	Changing a parameter va	alue
If the parameter number flashes in the display, you have two options for changing the number:		If the parameter value flashes in the display, you have two options of changing the value:	
1. option: 2. option:		1. option:	2. option:
Increase or decrease the parameter number using the arrow keys until the number you want is displayed. Press and hold the OK key for more than two seconds and change the required parameter number digit by digit.		the parameter value using the arrow keys key for more than two seconds and enter the	
Confirm the parameter number using the OK key.		Confirm the parameter va	alue using the OK key.

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

4.4.4 Basic commissioning

Menu		Remark			
SETUP		Set all of the parameters of the menu "SETUP". In the BOP-2, select the menu "SETUP".			
ESC	RESET	Select reset if you wish to reset all parameters to the factory setting before the basic commissioning. NO → YES → OK			
	CTRL MODI	Select the motor	or control mode. The	he most important control modes are:	
	p1300	VF LIN	V/f control with lin	near characteristic	
		VF QUAD	V/f control with so	quare law characteristic	
		SPD N EN	Closed-loop spee	ed control (vector control)	
		TRQ N EN	Closed-loop torqu	ue control	
	EUR USA OK	② Standard: II	EC or NEMA	SIEMENS () () () () () () () () () (
	MOT VOLT OK	① Voltage		IEC/EN 60034 100L IMB3 IP55	
	MOT CURR OK	③ Current		NE 6206-2ZC3 11g	
	MOT POW OK	Power IEC power NEN	standard (kW) IA standard (HP)	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 6	
	MOT RPM OK	We recommend the setting STIL RC rotating).		Motor data on the rating plate	
	MOT ID P1900			ROT (Identify motor data at standstill and with the motor e.g. where travel is mechanically limited, select the setting idstill).	
	MAC PAR OK	Select the configuration for the inputs and outputs, as well as the correct fieldbus for your application. The predefined configurations can be found in the section titled Select interface assignments (Page 46).			
	MIN RPM DIVIDING DIVI	Minimum motor speed.			
	RAMP UP OK	Motor ramp-up time.			
	RAMP DWN p1121	Motor ramp-down time.			
	FINISH	Confirm that the basic commissioning has been completed (Parameter p3900): $NO \rightarrow YES \rightarrow OK$			

4.4 Commissioning with the BOP-2

Identifying motor data

If you select the MOT ID (p1900) during basic commissioning, alarm A07991 will be issued once basic commissioning has been completed. To enable the converter to identify the data for the connected motor, you must switch on the motor (e.g. via the BOP-2). The converter switches off the motor after the motor data identification has been completed.



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.

4.4.5 Additional settings

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

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, which is connected to the converter via the USB cable and on which STARTER V4.2 or higher has been installed.

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

Commissioning steps

Commissioning with STARTER is subdivided into the following steps:

- 1. Adapting the USB interface (Page 72)
- 2. Generating a STARTER project (Page 73)
- 3. Go online and perform the basic commissioning (Page 73)
- 4. Making additional settings (Page 77)

STARTER features a project Wizard that guides you step-by-step through the commissioning process.

Note

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

4.5.1 Adapting the USB interface

Switch on the converter supply voltage and 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 [10] (accessible participants). Case 1 shows the procedure if no settings are required. In case 2, a description is provided on how you can adapt the interface.

Case 1: USB interface OK - no setting is required

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

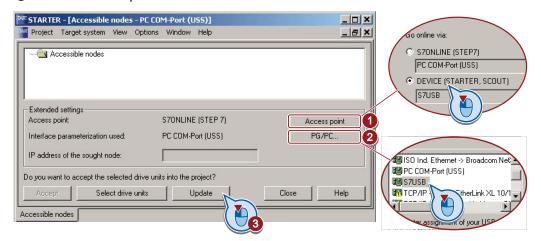


Close this screen form, without selecting the converter(s) that has/have been found. Now create your STARTER project.

Case 2: USB interface must be set

In this case, the message box "no other nodes found" is displayed. Close the window, and make the following settings in the "Accessible nodes" screen:

- ① Under "Access point activate "DEVICE (STARTER, Scout)"
- ② Under " PG/PC" select "S7USB"
- ③ Then click on "Update"

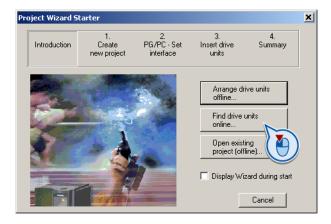


Close this screen form, without selecting the converter(s) that has/have been found. Now create your STARTER project.

4.5.2 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.



4.5.3 Go online and perform the basic commissioning

Going online

- ① Select your project and go online: -
- In the next screen form, select the device or the devices with which you want to go online.
 If you want to go online via the USB interface, then set the access point to "DEVICE".
- In the next screen form, download the hardware configuration that you found online into your project (PG or PC).

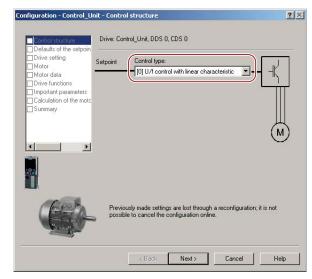


- STARTER shows you which converters it is accessing online and which are offline:
 - ② The converter is offline
 - 3 The converter is online
- 4 If you are online, open the screen form of the Control Unit.
- Start the wizard for the basic commissioning.

Wizard for basic commissioning

The wizard guides you step-by-step through the basic commissioning.

 In the first step of the wizard, select the control mode.
 If you are not certain which control mode you require for your particular application, then select U/f control for the time being.
 Help on how to select the control mode is provided in Chapter Motor control (Page 168).

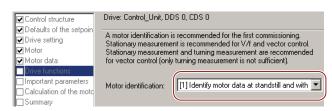


 In the next step, select the assignment of the converter interfaces (see also Section: Select interface assignments (Page 46)). Remark: The possible settings of your Control Unit can deviate from those in the diagram.



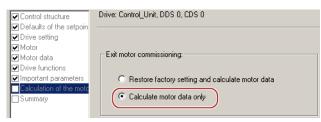
- In the next step, select the application for the converter:
 Low overload for applications that only require a low dynamic performance, e.g.: Pumps or fans.
 High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
- In the next step, enter the motor data according to the rating plate of your motor.
 The motor data for SIEMENS standard motors can be called in STARTER based on their order number.
- recommend the setting
 "Identify motor data at
 standstill and with the motor
 rotating".
 If the motor cannot freely
 rotate, e.g. due to a
 mechanically limited travel
 section, then select the
 "Identify motor data at
 standstill" setting.

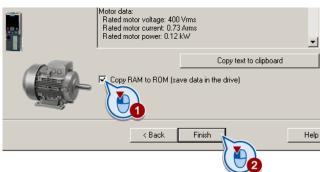
In the next step, we



• In the next step, set the most important parameters that match your application, e.g. the ramp-up and ramp-down time of the motor.

- In the next step, we recommend the setting "Calculate motor data only".
- ① In the next step, set the check mark for "RAM to ROM (save data in drive)" in order to save your data in the converter so that it is not lost when the power fails.
- ② If you exit the wizard, the converter outputs alarm A07791. You must now switch-on the motor to start motor data identification.





Switch on motor for motor data identification

/ CAUTION

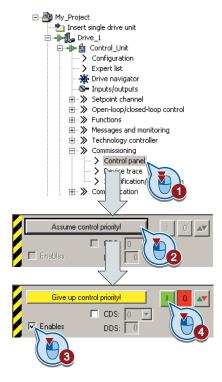
Motor data identification for dangerous loads

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

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

The converter now starts to identify the motor data. This measurement can take several minutes. After the measurement the converter switches off the motor.

• Relinquish the master control after the motor data identification.



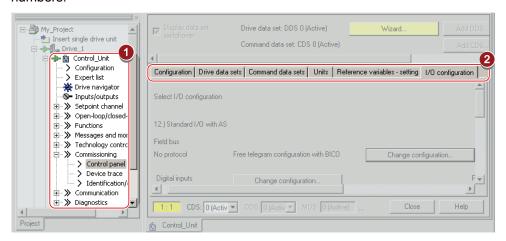
4.5.4 Making additional settings

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

STARTER offers two options:

- 1. Change the settings using the appropriate screen forms our recommendation.
 - ① Navigation bar: For each inverter function, select the corresponding screen form.
 - 2 tabs: Switch between screen forms.

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



2. You change the settings using the parameters in the expert list. If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.

Saving settings so that they are not lost when the power fails

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

Go offline

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

4.5.5 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 $\underline{\ }$ you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration by ____. Alternatively, you can also specify the measurement period and then you can calculate the trace clock cycle of STARTER using ____.

Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ().

Mathematical function

Using the mathematical function (P) 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.

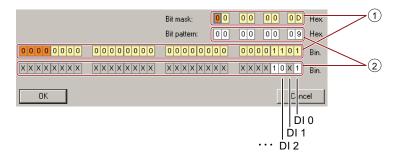
Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using <u>■</u>, select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using bin..., open the screen form in which you set the bits and their values for the start condition



- ① Select the bits for the trace trigger, upper line hex format, lower row binary format
- ② Define the bits for the trace trigger, upper line hex format, lower row binary format

Figure 4-7 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

Display options

In this area, you can set how the measurement results are displayed.

Repeat measurement:

This means that you place the measurements, which you wish to perform at different times, one above one another

Arrange curves in tracks

This means that you define as to whether all measured values are to be displayed with a common zero line – or whether each measured value is displayed with its own zero line.

Measuring cursor on:

This allows you to analyze the measuring intervals in detail

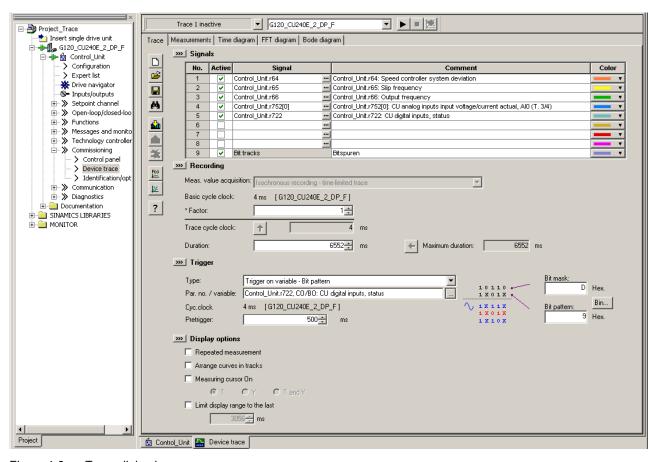


Figure 4-8 Trace dialog box

4.6 Data backup and standard commissioning

External data backup

After commissioning, your settings are saved in the inverter so that they are protected against power failure.

Further, we recommend that you externally save the parameter settings so that in the case of a defect, you can simply replace the Power Module or Control Unit (see also Replacing the Control Unit (Page 242)).

You have three different options for externally backing up data (upload):

- 1. Memory card
- 2. PC/PG with STARTER
- 3. Operator Panel

Series commissioning

Series commissioning means the commissioning of several identical drives in the following steps:

- 1. Commission the first inverter.
- 2. Upload the parameters of the first inverter to an external memory.
- 3. Download the parameters from the external memory to a second or additional inverter.

Note

The control unit to which the parameters are transferred must be of the same type and have the same or a higher firmware version as the source control unit (the same 'type' means the same MLFB).

For further information, refer to the following sections.

4.6.1 Backing up and transferring settings using a memory card

What memory cards do we recommend?

The memory card is a removable flash memory, that offers you the following options

- Automatically or manually write parameter settings from the card into the inverter (automatic or manual download)
- Automatically or manually write parameter settings from the inverter onto the card (automatic or manual upload)

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

- MMC (order number 6SL3254-0AM00-0AA0)
- SD (order number 6ES7954-8LB00-0AA0)

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).

4.6.1.1 Saving setting on memory card

We recommend that you insert the memory card before switching on the inverter for the first time. The inverter then automatically ensures that the actual parameter setting is saved both in the inverter as well as on the card.

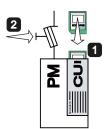
The following describes how you can save the inverter parameter setting on the memory card subsequently.

If you wish to transfer the parameter setting from the inverter on to a memory card (Upload), you have two options:

Automatic upload

The inverter power supply has been switched off.

- 1. Insert an empty memory card into the inverter.
- 2. Then switch-on the inverter power supply again. After it has been switched-on, the inverter copies the modified parameters to the memory card



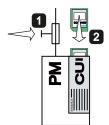
Transfer the setting to the empty memory card

NOTICE

If the memory card is not empty and already contains a parameter setting, the inverter will take on the parameter setting from the memory card. The previous setting in the inverter will be deleted.

Manual upload

If you do not wish to switch off the inverter power supply or you do not have an empty memory card available, you will need to transfer the parameter setting to the memory card as follows:



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

STARTER	BOP-2	
 Start the data transfer with p0971 = 1. Check the value of parameter p0971. 	Start data transfer in the menu "OPTIONS" - "TO CRD".	
If data transfer has been completed, then the inverter sets p0971 to 0.	Wait until the BOP-2 signals that data transfer has been completed.	

4.6 Data backup and standard commissioning

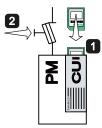
4.6.1.2 Transferring the setting from the memory card

If you wish to transfer the parameter setting from a memory card into the inverter (download), you have two options:

Automatic download

The inverter power supply has been switched off.

- 1. Insert the memory card into the inverter.
- 2. Then switch-on the inverter power supply.



If there is valid parameter data on the memory card, then the inverter accepts this automatically.

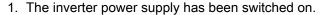
Note

Inverter with enabled safety functions

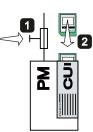
After the automatic download, the inverter also accepts all of the settings of the safety functions.

Manual download

If you do not want to switch off the power supply, then you must transfer the parameter setting into the inverter in the following way:



2. Insert the memory card into the inverter.



STARTER	BOP-2
 Go online with STARTER In the expert list, set p0804 = 1. Check the value of parameter p0804. Once data transfer has been completed, then p0804 = 0 is automatically set. 	 Start data transfer in the menu "EXTRAS" - "FROM CRD". Wait until the BOP-2 signals that data transfer has been completed.

Inverter with enabled safety functions

You must confirm the settings of the safety functions.

Table 4-3 Procedure

ST	ARTER	BOP-2	
1.	Go online with STARTER	Set the following parameters:	
2.	Call the safety functions screen form	p9761 = Password for the safety function	
3.	Click on the "Change settings" button	p0010 = 95	Changing the safety functions
4.	Enter the password for the safety functions	p9701 = 220	Confirm the settings of the safety
5.	Click on the "Activate settings" button.		functions
		p0010 = 0	Exit change

Final steps:

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

4.6.1.3 Safely remove the memory card

CAUTION

The file system on the memory card can be destroyed if the memory card is removed while the inverter 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 or BOP-2:

- 1. Set p9400 to 2.
- 2. Check the value of parameter p9400.

 If it is permissible to remove the memory card, p9400 is set to 3.
- 3. Remove the memory card.

4.6 Data backup and standard commissioning

4.6.2 Backing up and transferring settings using STARTER

Backing up the inverter settings on PC/PG (upload)

- 1. Go online with STARTER: \(\frac{\mathbb{H}}{\mathbb{L}}\).
- 2. Click on the button "Load project to PG": ...
- 3. To save data in the PG (computer), click on ...

Transferring settings from the PC/PG into the inverter (download)

- 1. Go online with STARTER.
- 2. Click on the button "Load project to target system": 🚵.
- 3. To save data in the converter, click on "Copy RAM to ROM" ...

Inverter with enabled safety functions

You must confirm the settings of the safety functions. Procedure:

- 1. In STARTER call-up the safety functions screen form
- 2. Click on the "Change settings" button
- 3. Click on the "Activate settings" button
- 4. Save your settings (copy RAM to ROM)
- 5. Switch off the inverter supply voltage
- 6. Wait until all LEDs on the inverter go dark. Now switch on the inverter supply voltage again. Your settings only become effective after this power-on reset.

4.6.3 Saving settings and transferring them using an operator panel

You start the download or upload in the "TOOLS" menu.

Download for inverters with enabled safety functions

You must confirm the settings of the safety functions.

Table 4-4 Procedure

Set the following parameters		
p9761 =	Password for the safety functions	
p0010 = 95	Changing the safety functions	
p9701 = 220	p9701 = 220 Confirm the settings of the safety functions	
p0010 = 0	Exit change	

Final steps:

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

4.6.4 Other ways to back up settings

You can backup three additional settings of the parameters in memory areas of the inverter reserved for this purpose. You will find additional information in the List Manual under the following parameters:

Parameter	Description
p0970	Resetting drive parameters
	Load the back-up setting (number 10, 11 or 12). You overwrite your actual parameter setting when loading.
p0971	Saving parameters
	Backing up the setting (10, 11 or 12).

You can back-up up to 99 additional parameter settings on the memory card. You will find additional information in the List Manual under the following parameters:

Parameter	Description
p0802	Data transfer with memory card as source/target
p0803	Data transfer with device memory as source/target
p0804	Start data transfer

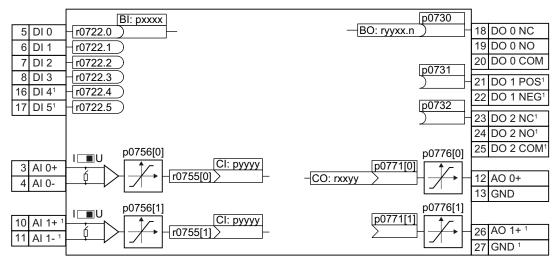
4.6 Data backup and standard commissioning

Adapt terminal strip

Before you adapt the inputs and outputs of the inverter, you should have completed the basic commissioning, see Chapter Commissioning (Page 55).

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.



Not available with Control Units CU240B-2 and CU240B-2 DP

Figure 5-1 Internal interconnection of the inputs and outputs

5.1 Digital inputs

Digital input terminals	Changing the function of the digital input
BI: pxxxx 5 DI 0	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 5- 1 Binector inputs (BI) of the inverter (selection)

ВІ	Significance	ВІ	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	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 5- 2 Examples:

p2103 6 DI 1	Acknowledge fault with digital input 1
p0840 7 DI 2 r0722.2 722.2 ON/OFF1	Switch-on motor with digital input 2

Advanced settings

You can debounce the digital input signal using parameter p0724.

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

Analog inputs as digital inputs

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

Terminals of the additional digital inputs	Changing the function of the digital input
DI 11 BI: pxxxx 4 AI 0- 10 AI 1+ 1 11 AI 1- 1	If you use an analog input as digital input, interconnect the status parameter of the digital input with a binector input of your choice.

Not available with CU240B-2 and CU240B-2 DP Control Units

5.2 Fail-safe digital input

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

Defining a fail-safe digital input

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

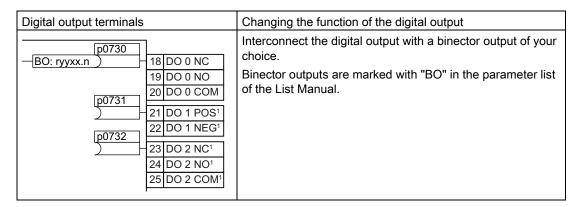
The inverter combines digital inputs DI 4 and DI 5 to form a fail-safe digital input.

Terminals of the fail-safe digital input	Function
16 DI 4 & FDI 0	You must enable STO to select the STO safety function (Basic Safety) via FDI 0.
17 DI 5	Further information can be found in section Safe Torque Off (STO) safety function (Page 220).

Note

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

5.3 Digital outputs



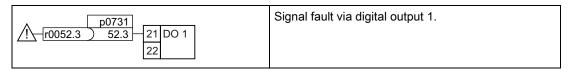
Not available with CU240B-2 and CU240B-2 DP Control Units

Table 5-3 Binector outputs of the inverter (selection)

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

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

Table 5-4 Example:

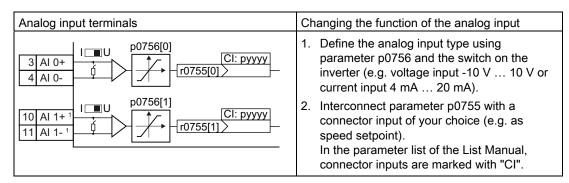


Advanced settings

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

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

5.4 Analog inputs



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:

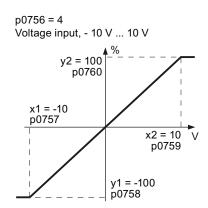
AI 0	Unipolar voltage input Unipolar voltage input monitored	0 V +10 V +2 V +10 V	p0756[0] =	0
	Unipolar current input	0 mA +20 mA		2
	Unipolar current input monitored	+4 mA +20 mA		3
	Bipolar voltage input	-10 V +10 V		4
	No sensor connected			8
Al 1	Unipolar voltage input	0 V +10 V	p0756[1] =	0
	Unipolar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

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



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

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



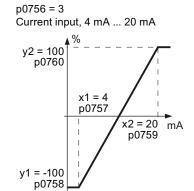


Figure 5-2 Examples for scaling characteristics

Table 5-5 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"):	→ () _ ()		
After changing p07s following values:	After changing p0756 to the value 3, the inverter sets the scaling characteristic parameters to the following values:				
p0757[0] = 4,0; p07	[58[0] = 0.0; p0759[0] = 20; p0760[0] = 100]	0			
Adapt the character	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 (x ₁ , y ₁)	y2 = 100	- 		
p0758[0] = -100.0	6 mA corresponds to -100 %	p0760			
p0759[0] = 12.0	Analog inputs, characteristic (x2, y2)	x1 = 6 p0757			
p0760[0] = 100.0	12 mA corresponds to 100 %	x2	= 12 mA 0759		

Define the significance of the analog input

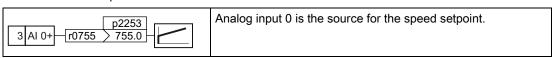
You define the analog input function by interconnecting a connector input of your choice with parameter p0755. Parameter p0755 is assigned to the particular analog input via its index, e.g. parameter p0755[0] is assigned to analog input 0.

Table 5-6 Connector inputs (CI) of the inverter (selection)

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

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

Table 5-7 Example:

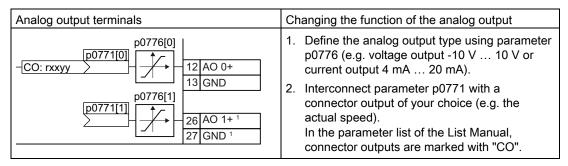


Advanced settings

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.

5.5 Analog outputs



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

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

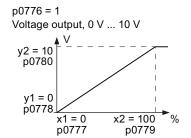
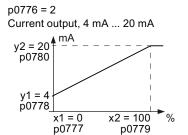


Figure 5-3 Examples for scaling characteristics



5.5 Analog outputs

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

Table 5-8 Parameters for the scaling characteristic

Parameter	Description
p0777	X coordinate of the 1st characteristic point [% of P200x]
	P200x are the parameters of the reference variables, e.g. P2000 is the reference speed.
p0778	Y coordinate of the 1st characteristic point [V or mA]
p0779	X coordinate of the 2nd characteristic point [% of P200x]
p0780	Y coordinate of the 2nd characteristic point [V or mA]

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

Example:

The inverter 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:	After changing p0776 to the value 2, the inverter sets the scaling characteristic parameters to the following values:				
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 (x ₁ , y ₁)	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

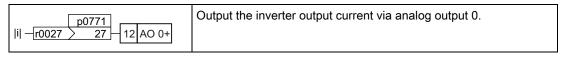
You define the analog output function by interconnecting parameter p0771 with a connector output of your choice. Parameter p0771 is assigned to the particular analog input via its index, e.g. parameter p0771[0] is assigned to analog output 0.

Table 5-9 Connector outputs (CO) of the inverter (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.

Table 5- 10 Example:



For more information, see the parameter list and the function block diagrams 9572 ff 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.

5.5 Analog outputs

Configuring the fieldbus

Before you connect the inverter to the field bus, you should have completed the basic commissioning, see Chapter Commissioning (Page 55)

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 DP (Page 102)	PROFIdrive	CU240B-2 DP	Sub D socket
	PROFIsafe	CU240E-2 DP	
		CU240E-2 DP-F	
USS (Page 123)	-	CU240B-2	RS485 connector
Modbus RTU (Page 137)	-	CU240E-2 CU240E-2 F	

Data exchange via the fieldbus

Analog signals

The converter always scales signals, which are transferred via the fieldbus, to a value of 4000 hex. The significance of this numerical value depends on the category of the signal that you are transferring.

Signal category	4000 hex corresponds to the value of the following parameters
Speeds, frequencies	p2000
Voltage	p2001
Current	p2002
Torque	p2003
Power	p2004
Angle	p2005
Temperature	p2006
Acceleration	p2007

Control and status words

Control and status words always comprise two bytes. Depending on the control type, the two bytes are differently interpreted as higher or lower significance. An example for transferring control and status words with a SIMATIC control is provided in Chapter STEP 7 program example for cyclic communication (Page 284).

6.1 Communication via PROFIBUS

Permissible cable lengths, routing and shielding the PROFIBUS cable

Information can be found in the Internet (http://support.automation.siemens.com/WW/view/en/1971286).

Recommended PROFIBUS connectors

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

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

Both connectors are suitable for all SINAMICS G120 inverters with respect to the angle of the outgoing cable.

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 V DC on terminals 31 and 32 if you require communication to take place with the controller when the line voltage is switched off.

6.1.1 Configuring communication to the control

The GSD is a description file for a PROFIBUS slave. You must import the GSD of the converter into the PROFIBUS master - i.e. into your control system - in order to configure communication between the control system and converter.

You have two options for obtaining the GSD of your converter:

- You can find the SINAMICS converter GSD on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
- 2. The GSD is saved in the converter. The GSD is written to the memory card if you insert the memory card in the converter and set p0804 to 12. Using the memory card, you can then transfer the GSD to your PG/your PC.

In Section Application Examples (Page 279) you will find an example showing how you can connect the converter with its GSD to a SIMATIC control via PROFIBUS.

6.1.2 Setting the address

You can set the inverter's PROFIBUS address using either DIP switches on the Control Unit or parameter p0918.

Valid PROFIBUS addresses: 1 ... 125 Invalid PROFIBUS addresses: 0, 126, 127

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

If you set all DIP switches to "OFF" (0) or "ON" (1), then p0918 defines the address.

The positions and settings of the DIP switches are described in Section: Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

CAUTION

A bus address that has been changed is only effective after the inverter has been switched off and back on again.

6.1.3 Basic settings for communication

Table 6- 1 The most important parameters

Parameter	Description			
p0015	Macro drive device Select the I/O configuration via PROFIBUS DP (e.g. p0015 = 7)			
p0922	PROFIdrive telegram selection (factory setting for converters with PROFIBUS interface: standard telegram 1, PZD-2/2)			
	Set th	et the send and receive telegram, see Cyclic communication (Page 105)		
	1:	Standard telegram 1, PZD-2/2		
	20:	0: 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:	354: SIEMENS telegram 354, PZD-6/6, PKW-4/4		
	999:	Free telegram configuring with BICO		

Using parameter p0922, you automatically interconnect the corresponding signals of the converter to the telegram.

This BICO interconnection can only be changed, if you set p0922 to 999. In this case, select your required telegram using p2079 and then adapt the BICO interconnection of the signals.

Table 6- 2 Advanced settings

Parameter	Description
p2079	PROFIdrive PZD telegram selection extended
	Contrary to p0922, using p2079, a telegram can be set and subsequently extended. For p0922 < 999, the following applies: p2079 has the same value and is locked. All of the interconnections and extensions contained in the telegram are locked. For p0922 = 999, the following applies: p2079 can be freely set. If p2079 is also set to 999, then all interconnections can be set. For p0922 = 999 and p2079 < 999, the following applies: The interconnections contained in the telegram are locked. However, the telegram can be extended.

For further information, please refer to the Parameter Manual.

6.1.4 Cyclic communication

The PROFIdrive profile defines different telegram types. Telegrams contain the data for cyclic communication with a defined meaning and sequence. The inverter has the telegram types listed in the table below.

Table 6-3 Inverter telegram types

Telegram type (p0922)	Process data (PZD) - control and status words, setpoints and actual values							
	PZD01 STW1 ZSW1	PZD02 HSW HIW	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08
Telegram 1 Speed control PZD 2/2	STW1	NSOLL_A	← The inverter receives this data from the control					
	ZSW1	NIST_A	⇒ The inverter sends this data to the control					
Telegram 20 Speed control, VIK/NAMUR PZD 2/6	STW1	NSOLL_A						
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	PIST_ GLATT	MELD_ NAMUR		
Telegram 350 Speed control PZD 4/4	STW1	NSOLL_A	M_LIM	STW3				
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	ZSW3				
Telegram 352 Speed control, PCS7 PZD 6/6	STW1	NSOLL_A	PCS7 process data					
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE		
Telegram 353 Speed control, PKW 4/4 and PZD 2/2	STW1	NSOLL_A						
	ZSW1	NIST_A_ GLATT						
Telegram 354 Speed control, PKW 4/4 and PZD 6/6	STW1	NSOLL_A	PCS7 process data					
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE		
Telegram 999 Free interconnection via BICO PZD n/m (n,m = 1 8)	STW1	Telegram length on receipt can be configured up to max. 8 words						
	ZSW1	Telegram length on transmission can be configured up to max. 8 words						

Table 6-4 Explanation of the abbreviations

Abbreviation	Significance	Abbreviation	Significance
STW1/2	Control word 1/2	PIST_GLATT	Actual active power
ZSW1/2	Status word 1/2	MELD_NAMUR	Control word according to the VIK-NAMUR definition
NSOLL_A	Speed setpoint	M_LIM	Torque limit value
NIST_A_GLATT	Smoothed speed actual value	FAULT_CODE	Fault number
IAIST_GLATT	Smoothed actual current value	WARN_CODE	Alarm number
MIST_GLATT	Actual torque		

6.1 Communication via PROFIBUS

Table 6-5 Telegram status in the inverter

Process data	Control ⇒ inverter		Inverter ⇒ control		
item	Status of the received word	Bits 015 in the received word	Defining the word to be sent	Status of the sent word	
PZD01	r2050[0]	r2090.0 r2090.15	p2051[0]	r2053[0]	
PZD02	r2050[1]	r2091.0 r2091.15	p2051[1]	r2053[1]	
PZD03	r2050[2]	r2092.0 r2092.15	p2051[2]	r2053[2]	
PZD04	r2050[3]	r2093.0 r2093.15	p2051[3]	r2053[3]	
PZD05	r2050[4]	-	p2051[4]	r2053[4]	
PZD06	r2050[5]	-	p2051[5]	r2053[5]	
PZD07	r2050[6]	-	p2051[6]	r2053[6]	
PZD08	r2050[7]	-	p2051[7]	r2053[7]	

Select telegram

Select the communication telegram using parameters p0922 and p2079. The following dependencies apply:

• P0922 < 999:

For p0922 < 999, the inverter sets p2079 to the same value as p0922. With this setting, the inverter defines the length and the content of the telegram. The inverter does not permit any changes to the telegram.

• p0922 = 999, p2079 < 999:

For p0922 = 999, select a telegram via p2079.

Also with this setting, the inverter defines the length and the content of the telegram. The inverter does not permit any changes to the telegram content. However, you can extend the telegram.

• p0922 = p2079 = 999:

For p0922 = p2079 = 999, enter the length and the content of the telegram. With this setting, you can define the telegram length via the central PROFIdrive configuration in the master. You define the telegram contents via the signal interconnections of the BICO technology. Using p2038, you can define the assignment of the control word according to SINAMICS or VIK/NAMUR.

You will find more details on the interconnection of command and setpoint sources, depending on the selected protocol, in the List Manual in function block diagrams 2420 to 2472.

6.1.4.1 Control and status word 1

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

Control word 1 (STW1)

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

Table 6-6 Control word 1 and interconnection with parameters in the inverter

Bit	Value	Significance		Comments	P No.	
		Telegram 20	All other telegrams			
0	0	OFF1		Motor brakes with the ramp-down time p1121 at standstill ($f < f_{min}$) the motor is switched off.	p0840[0] = r2090.0	
	1	ON	ON With a positive edge, the inverter goes into the "ready" state, with additionally bit 3 = 1, the inverter switches on the motor.			
1	0	OFF2		Switch off motor immediately, motor coasts to a standstill.	p0844[0] = r2090.1	
	1	No OFF2				
2	0	Quick stop (OF	FF3)	Quick stop: Motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2	
	1	No quick stop	(OFF3)			
3	0	Disable operat	ion	Immediately switch-off motor (cancel pulses).	p0852[0] =	
	1	Enable operati	on	Switch-on motor (pulses can be enabled).	r2090.3	
4	0	Lock ramp-fun	ction generator	The ramp-function generator output is set to 0 (quickest possible deceleration).	p1140[0] = r2090.4	
	1	Operating cond	dition	Ramp-function generator can be enabled		
5	0	Stop ramp-fun	ction generator	The output of the ramp-function generator is "frozen".	p1141[0] =	
	1	Ramp-function	generator enable		r2090.5	
6	0	Inhibit setpoint		Motor brakes with the ramp-down time p1121.	p1142[0] =	
	1	Enable setpoir	nt	Motor accelerates with the ramp-up time p1120 to the setpoint.	r2090.6	
7	1	Acknowledging	g faults	Fault is acknowledged with a positive edge. If the ON command is still active, the inverter switches to "closing lockout" state.	p2103[0] = r2090.7	
8		Not used				
9		Not used				
10	0	PLC has no ma	aster control	Process data invalid, "sign of life" expected.	p0854[0] =	
	1	Master control	by PLC	Control via fieldbus, process data valid.	r2090.10	
11	1	1)	Direction reversal	Setpoint is inverted in the inverter.	p1113[0] = r2090.11	
12		Not used			_	
13	1	1)	MOP up	The setpoint stored in the motorized potentiometer is increased.	p1035[0] = r2090.13	
14	1	1)	MOP down	The setpoint stored in the motorized potentiometer is decreased.	p1036[0] = r2090.14	
15	1	CDS bit 0	Not used	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.

6.1 Communication via PROFIBUS

Status word 1 (ZSW1)

Status word 1 (bits 0 to 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 to 15 for SINAMICS G120 only).

Table 6-7 Status word 1 and interconnection with parameters in the inverter

Bit	Value	Significance		Comments	P No.
		Telegram 20	All other telegrams		
0	1	Ready for switch	ching on	Power supply switched on; electronics initialized; pulses locked.	p2080[0] = r0899.0
1	1	Ready for oper	ation	Motor is switched on (ON1 command present), no active fault, motor can start as soon as "enable operation" command is issued. See control word 1, bit 0.	p2080[1] = r0899.1
2	1	Operation enal	oled	Motor follows setpoint. See control word 1, bit 3.	p2080[2] = r0899.2
3	1	Fault present		The inverter has a fault.	p2080[3] = r2139.3
4	1	OFF2 inactive		Coast to standstill not activated (no OFF2)	p2080[4] = r0899.4
5	1	OFF3 inactive		No fast stop active	p2080[5] = r0899.5
6	1	Closing lockout	t active	The motor is only switched on after a further ON1 command	p2080[6] = r0899.6
7	1	Alarm active		Motor remains switched on; acknowledgement is not required; see r2110.	p2080[7] = r2139.7
8	1	Speed deviatio	n within tolerance range	Setpoint/actual value deviation within tolerance range.	p2080[8] = r2197.7
9	1	Control reques	ted	The automation system is requested to assume control.	p2080[9] = r0899.9
10	1	Comparison sp exceeded	eed reached or	Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	0	I, M or P limit re	eached	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 ov	vertemperature		p2080[13] = r2135.14
14	1	Motor rotates forwards		Internal inverter actual value > 0	p2080[14] =
	0	Motor rotates b	ackwards	Internal inverter actual value < 0	r2197.3
15	1	CDS display	No alarm, thermal power unit 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.

6.1.4.2 Control and status word 3

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

Control word 3 (STW3)

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

Table 6-8 Control word 3 and interconnection with parameters in the converter

Bit	Value	Meaning	Comments	BICO interconnection 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	bit 1 different motors (drive data sets).			
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		

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

6.1 Communication via PROFIBUS

Status word 3 (ZSW3)

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

Table 6-9 Status word 3 and interconnection with parameters in the converter

Bit	Value	Meaning	Description	P No.
0	1	DC braking active		p2051[3] =
1	1	n_act > p1226 Absolute current speed > stationary state detection		r0053
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		_

6.1.4.3 Data structure of the parameter channel

Parameter channel

You can write and read parameter values via the parameter channel, e.g. in order to monitor process data. The parameter channel always comprises four words.

	Р	aramete	er channel	Abbreviations:	PKE : Parameter identifier
	PKE	IND	PWE		IND: Index PWE: Parameter value
	1 st	2 nd	3 rd and 4 th	ī 	FWE. Farameter value
1	word	word	word	! !	

Figure 6-1 Structure of the parameter channel

Parameter identifier (PKE), 1st word

The parameter identifier (PKE) contains 16 bits.

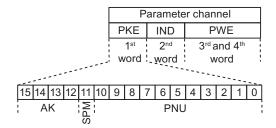


Figure 6-2 PKE - 1st word in parameter channel

- Bits 12 to 15 (AK) contain the request or response identifier.
- Bit 11 (SPM) is reserved and is always 0.
- Bits 0 to 10 (PNU) contain parameter numbers 1 ... 1999. For parameter numbers ≥ 2000
 an offset must be added that is defined in the 2nd word of the parameter channel (IND).

6.1 Communication via PROFIBUS

The meaning of the request identifier for request telegrams (control → inverter) is explained in the following table.

Table 6- 10 Request identifier (control → inverter)

Request identifier	Description	Response identifier		
		positive	negative	
0	No request	0	7/8	
1	Request parameter value	1/2	1	
2	Change parameter value (word)	1	1	
3	Change parameter value (double word)	2	1	
4	Request descriptive element 1)	3	1	
6	Request parameter value (field) 1)	4/5	1	
7	Change parameter value (field, word) 1)	4	1	
8	Change parameter value (field, double word) 1)	5	1	
9	Request number of field elements	6		
11	Change parameter value (field, double word) and save in EEPROM 2)	5	I	
12	Change parameter value (field, word) and save in EEPROM 2)	4	1	
13	Change parameter value (double word) and save in EEPROM	2	↓	
14	Change parameter value (word) and save in EEPROM	1	7/8	
1) The red	quired element of the parameter description is specified in IND (2nd wo	rd).		

The meaning of the response identifier for response telegrams (inverter → control) is explained in the following table. The request identifier determines which response identifiers are possible.

Table 6- 11 Response identifier (inverter → control)

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element 1)
4	Transfer parameter value (field, word) 2)
5	Transfer parameter value (field, double word) 2)
6	Transfer number of field elements
7	Request cannot be processed, task cannot be executed (with error number)
8	No master controller status / no authorization to change parameters of the parameter channel interface
1) The requ	ired element of the parameter description is specified in IND (2nd word).
2) The requ	ired element of the indexed parameter is specified in IND (2nd word).

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

If the response identifier is 7 (request cannot be processed), one of the error numbers listed in the following table will be saved in parameter value 2 (PWE2).

No.	Description	Comments
0	Impermissible parameter number (PNU)	Parameter does not exist
1	Parameter value cannot be changed	The parameter can only be read
2	Minimum/maximum not achieved or exceeded	-
3	Wrong subindex	_
4	No field	An individual parameter was addressed with a field request and subindex > 0
5	Wrong parameter type / wrong data type	Confusion of word and double word
6	Setting is not permitted (only resetting)	_
7	The descriptive element cannot be changed	Description cannot be changed
11	Not in the "master control" mode	Change request without "master control" mode (see P0927)
12	Keyword missing	_
17	Request cannot be processed on account of the operating state	The current inverter status is not compatible with the received request
20	Illegal value	Modification access with a value which is within the value limits but which is illegal for other permanent reasons (parameter with defined individual values)
101	Parameter number is currently deactivated	Dependent on the operating state of the inverter
102	Channel width is insufficient	Communication channel is too small for response
104	Illegal parameter value	The parameter can only assume certain values.
106	Request not included / task is not supported	After request ID 5, 10, 15
107	No write access with enabled controller	The operating state of the inverter prevents a parameter change
200/201	Changed minimum/maximum not achieved or exceeded	The maximum or minimum can be limited further during operation.
204	The available access authorization does not cover parameter changes.	-

Parameter index (IND)

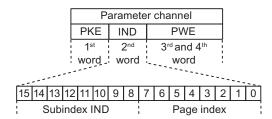


Figure 6-3 Structure of the parameter index (IND)

- For indexed parameters, select the index of the parameter by transferring the appropriate value between 0 and 254 to the subindex within a job.
- The page index is used to switch over the parameter numbers. Use this byte to add an
 offset to the parameter number that is transferred in the 1st word of the parameter
 channel (PKE).

Page index: Offset of parameter number

The parameter numbers are assigned to several parameter ranges. The following table shows which value you must transfer to the page index to achieve a particular parameter number.

Table 6-13 Page index setting dependent on parameter range

Parameter range	arameter range Page index				Hex value				
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0000 1999	0	0	0	0	0	0	0	0	0x00
2000 3999	1	0	0	0	0	0	0	0	0x80
6000 7999	1	0	0	1	0	0	0	0	0x90
8000 9999	0	0	1	0	0	0	0	0	0x20
10000 11999	1	0	1	0	0	0	0	0	0xA0
20000 21999	0	1	0	1	0	0	0	0	0x50
30000 31999	1	1	1	1	0	0	0	0	0xF0

Parameter value (PWE)

The parameter value (PWE) is transferred as a double word (32 bits). Only one parameter value may be transferred per telegram.

A 32 bit parameter value includes PWE1 (H word, 3rd word) and PWE2 (L word, 4th word).

A 16 bit parameter value is transferred in PWE2 (L word, 4th word). In this case, PWE1 (H word, 3rd word) must be set to 0.

Example of read request for parameter P7841[2]

To obtain the value of the indexed parameter P7841, you must fill the telegram of the parameter channel with the following data:

- Request parameter value (field): Bits 15 ... 12 in the PKE word: Request identifier = 6
- Parameter number without offset: Bits 10 ... 0 in the PKE word:
 Because you can only code parameter numbers from 1 ... 1999 in the PKE, you must
 deduct as large an offset as possible, a number divisible by 2000, from the parameter
 number, and transfer the result of this calculation to the PKE word.
 In our example, this means: 7841 6000 = 1841
- Coding the offset of the parameter number in the page index byte of the IND word: In this example: When offset = 6000, this corresponds to a page index value of 0x90.
- Index of parameter in the subindex byte of the IND word:
 In this example: Index = 2
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

Table 6- 14 Request to read parameter P7841[2]

		PKE (1st word)	IND (2n	d word)	PWE (3rd and 4th words)	
AK		PNU (10 bits)	Subindex (H byte)	Page index (L byte)	PWE1 (H word)	PWE2 (L word)
0x6	0	0x731 (decimal: 1841)	0x02	0x90	0x0000	0x0000

Rules for editing requests and responses

- You can only request one parameter per transmitted telegram
- Each received telegram contains only one response
- The request must be repeated until the right response is received
- The response is assigned to a request by means of the following identifiers:
 - Suitable response identifier
 - Suitable parameter number
 - Suitable parameter index IND, if required
 - Suitable parameter value PWE, if necessary
- The complete request must be sent in a telegram. Request telegrams cannot be subdivided. The same applies to responses.

6.1.4.4 Slave-to-slave communication

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

For slave-to-slave communication, in the control system you must define which inverter 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 inverters that operate as subscriber, you must define how the data transferred using slave-to-slave communication is processed. Using parameter r2077, in the inverter, you can read-out the PROFIBUS addresses of the inverters 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 8 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 inverters in STEP 7 is provided in Section: Configuring slave-to-slave communication in STEP 7 (Page 290).

6.1.5 Acyclic communication

As from performance level DP-V1, PROFIBUS communications offer acyclic data communications apart from cyclic communications. You can parameterize and troubleshoot (diagnostics) the inverter via acyclic data transfer. Acyclic data is transferred in parallel with cyclic data transfer but with a lower priority.

The inverter supports the following data transfer types:

- 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 286).

6.1.5.1 Reading and changing parameters via data set 47

Reading parameter values

Table 6- 15 Request to read parameters

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

6.1 Communication via PROFIBUS

Table 6- 16 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: 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		4			
	Value of the 1st index or - for a negative response - error value 1 You can find the error values in a table at the end of this section.				
Values, parameter 2					
Values, parameter m					

Changing parameter values

Table 6- 17 Request to change parameters

Data block	Byte n	Bytes n + 1	n			
Header	Reference 01 hex FF hex	02 hex: Change request	0			
	01 hex	Number of parameters (m) 01 hex 27 hex				
Address, parameter 1	10 hex: Parameter value	Number of indices 00 hex EA hex (00 hex and 01 hex have the same significance)	4			
	Parameter number 0001 hex FF	FF 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	···					
Values, parameter m						

Table 6- 18 Response, if the converter has executed the change request

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

6.1 Communication via PROFIBUS

Table 6- 19 Response, if the converter was not able to completely execute the change request

Data block	Byte n Bytes n + 1					
Header	Reference (identical to a change request)	82 hex				
	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 block not executed)					
	Only for "Error"- error value 1 You can find the error values in the table at	the end of this section.	6			
	Only if "number of error values" = 02 hex: Error value 2 Error value 1 defines whether the converter sends error value 2 and what it means.					
Values, parameter 2						
Values, parameter m						

Diagnostics

Table 6- 20 Error value in the parameter response

Error value 1	Meaning				
00 hex	Illegal parameter number (access to a parameter that does not exist)				
01 hex	Parameter value cannot be changed (change request for a parameter value that cannot be changed. Additional diagnostics in error value 2)				
02 hex	Lower or upper value limit exceeded (change request with a value outside the value limits. Additional diagnostics in error value 2)				
03 hex	Incorrect subindex (access to a subindex that does not exist. Additional diagnostics in error value 2)				
04 hex	No array (access with a subindex to non-indexed parameters)				
05 hex	Incorrect data type (change request with a value that does not match the data type of the parameter)				
06 hex	Setting not permitted, only resetting (change request with a value not equal to 0 without permission. Additional diagnostics in error value 2)				
07 hex	Descriptive element cannot be changed (change request to a descriptive element that cannot be changed. Additional diagnostics in error value 2)				
09 hex	Description data not available (access to a description that does not exist, parameter value is available)				
0B hex	No master control (change request but with no master control)				
0F hex	Text array does not exist (although the parameter value is available, the access is made to a text array that does not exist)				
11 hex	Request cannot be executed due to the operating state (access is not possible for temporary reasons that are not specified)				
14 hex	Inadmissible value (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values. Additional diagnostics in error value 2)				
15 hex	Response too long (the length of the actual response exceeds the maximum transfer length)				

Error	Meaning
value 1	
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 is only possible when Safety Integrated is being commissioned (p0010 = 95).
74 hex	Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).
75 hex	Change request is only possible in a commissioning state (p0010 ≠ 0).
76 hex	Change request is not possible for internal reasons (p0010 = 29).
77 hex	Change request is not possible at download.
81 hex	Change request is not possible at download.
82 hex	Transfer of the control authority (master) is inhibited by BI: p0806.
83 hex	Requested BICO interconnection is not possible (BICO output does not supply a float value, however the BICO input requires a float value)
84 hex	Converter does not accept a change request (converter is busy with internal calculations, see r3996)
85 hex	No access methods defined.
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)

6.2 Communication via RS485

6.2.1 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.

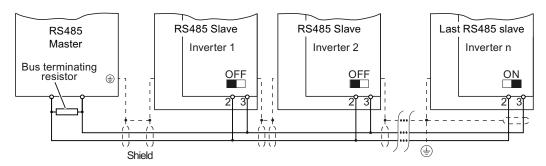


Figure 6-4 Communication network via RS485

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 V DC on terminals 31 and 32 if you require communication to take place with the controller when the line voltage is switched off.

6.2.2 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 122).

6.2.2.1 Setting the address

You can set the inverter's USS address using either DIP switches on the Control Unit or parameter p2021.

Valid USS addresses: 1 ... 30 Invalid USS addresses: 0, 31 ... 127

If you have specified a valid address using DIP switches, this address will always be the one that takes effect and p2021 cannot be changed.

If you set all DIP switches to "OFF" (0) or "ON" (1), then p2021 defines the address.

The positions and settings of the DIP switches are described in Section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

CAUTION

A bus address that has been changed is only effective after the inverter has been switched off and back on again.

6.2.2.2 Basic settings for communication

Parameter	Description						
P0015 = 21	Macro drive unit						
	Selecting the I/O configuration						
p2020	Value	Baud rate					
	4	2400					
	5	4800					
	6						
	7	19200					
	8						
	9	57600					
	10 11	76800 93750					
	1	115200					
	13	187500					
p2022		interface, USS PZD count					
PZUZZ		ne number of 16-bit words in the PZD part of the USS telegram					
p2023		interface, USS PKW count					
		ne number of 16-bit words in the PKW part of the USS telegram:					
		PKW count					
	0	PKW 0 words					
	3 PKW 3 words						
	4	PKW 4 words					
	127	PKW variable					
p2040	Fieldbus interface, monitoring time [ms]						
	Setting the monitoring time to monitor the received process data via fieldbus. If no						
	process data are received within this time, an appropriate message is output						

Additional information and parameters are provided on the following pages.

6.2.2.3 Structure of a USS telegram

A USS telegram comprises a sequence of characters, which are sent in a defined sequence. Every character within the telegram comprises 11 bits. The sequence of characters of a USS telegram is shown in the following diagram.

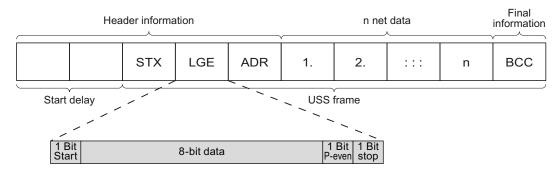


Figure 6-5 Structure of a USS telegram

Description

Telegrams with both a variable and fixed length can be used. This can be selected using parameters p2022 and p2023 to define the length of the PZD and the PKW within the net data.

STX	1 byte	
LGE	1 byte	
ADR	1 byte	
Net data	PKW	8 bytes (4 words: PKE + IND + PWE1 + PWE2)
(example)	PZD	4 bytes (2 words: PZD1 + PZD2)
BCC	1 byte	

Start delay

The start delay must be maintained before a new master telegram is started.

STX

The STX block is an ASCII character (0x02) and indicates the beginning of a message.

LGE

LGE specifies the number of bytes that following in the telegram. It is defined as the sum of the following bytes

- Net data
- ADR
- BCC

The actual overall telegram length is two bytes longer because STX and LGE are not counted in LGE.

ADR

The ADR range contains the address of the slave node (e.g. of the inverter). The individual bits in the address byte are addressed as follows:



- Bit 5 broadcast bit
 - Bit 5 = 0: normal data exchange. Bit 5 = 1: Address (bits 0 ... 4) is not evaluated (is not supported in SINAMICS G120!).
- Bit 6 mirror telegram
 Bit 6 = 0: normal data exchange. Bit 6 = 1: The slave returns the telegram unchanged to the master. Is used to test the bus connection.
- Bit 7 special telegram
 Bit 7 = 0: normal data exchange. Bit 7 = 1 to transfer telegrams that require a net data structure different from the device profile.

BCC

BCC (Block Check Character). It is an exclusive OR checksum (XOR) over all telegram bytes with the exception of the BCC itself.

6.2.2.4 User data range of the USS telegram

The user data range of the USS protocol is used to transmit application data. This comprises the parameter channel data and the process data (PZD).

The user data occupy the bytes within the USS frame (STX, LGE, ADR, BCC). The size of the user data can be configured using parameters p2023 and p2022. The structure and sequence of the parameter channel and process data (PZD) are shown in the figure below.

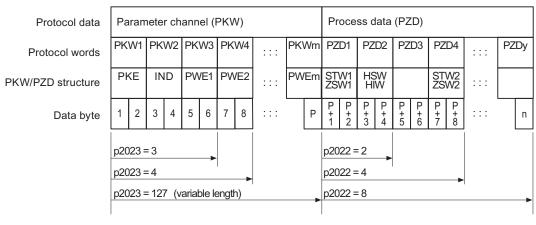


Figure 6-6 USS user data structure

The length for the parameter channel is determined by parameter p2023 and the length for the process data is specified by parameter p2022. If the parameter channel or the PZD is not required, the appropriate parameters can be set to zero ("PKW only" or "PZD only").

It is not possible to transfer "PKW only" and "PZD only" alternatively. If both channels are required, they must be transferred together.

6.2.2.5 Data structure of the USS parameter channel

The USS protocol defines for inverters the user data structure via which a master accesses the slave inverter. The parameter channel is used to read and write parameters in the inverter.

Parameter channel

You can use the parameter channel with a fixed length of 3 or 4 data words or with a variable length.

The first data word always contains the parameter identifier (PKE) and the second contains the parameter index.

The third, fourth and subsequent data words contain parameter values, texts and descriptions.

Parameter identifier (PKE), 1st word

The parameter identifier (PKE) is always a 16-bit value.

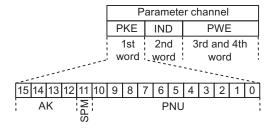


Figure 6-7 PKE structure

- Bits 12 to 15 (AK) contain the request or response identifier.
- Bit 11 (SPM) is reserved and always = 0.
- Bits 0 to 10 (PNU) contain parameter numbers 1 ... 1999. For parameter numbers
 ≥ 2000, you must add an offset in the 2nd word of the parameter channel (IND).

The following table includes the request ID for telegrams between the master → inverter.

Table 6- 21 Request identifier (master → inverter)

Request	Description	Response identifier		
identifier		Positive	Negative	
0	No request	0	7	
1	Request parameter value	1/2	7	
2	Change parameter value (word)		7	
3	Change parameter value (double word)		7	
4	Request descriptive element 1)	3	7	
6	Request parameter value 1) 2)	4/5	7	
7	Change parameter value (word) 1) 2)	4	7	
8	Change parameter value (double word) 1) 2)	5	7	

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

The following table includes the response ID for telegrams between the inverter \rightarrow master. The response ID depends on the request ID.

Table 6- 22 Response identifier (inverter → master)

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

²⁾ Identifier 1 is identical to identifier 6, ID 2 is identical to 7, and 3 is identical to 8. We recommend that you use identifiers 6, 7, and 8.

If the response ID = 7, then the inverter sends one of the error numbers listed in the following table in parameter value 2 (PWE2).

Table 6-23 Error numbers for the response "Request cannot be processed"

No.	Description	Comments				
0	Impermissible parameter number (PNU)	Parameter does not exist				
1	Parameter value cannot be changed	The parameter can only be read				
2	Minimum/maximum not achieved or exceeded	-				
3	Wrong subindex	_				
4	No field	An individual parameter was addressed with a field request and subindex > 0				
5	Wrong parameter type / wrong data type	Confusion of word and double word				
6	Setting is not permitted (only resetting)	Index is outside the parameter field[]				
7	The descriptive element cannot be changed	Description cannot be changed				
11	Not in the "master control" mode	Change request without "master control" state				
12	Keyword missing	-				
17	Request cannot be processed on account of the operating state	The actual inverter operating state is not compatible with the received request				
20	Illegal value	Modification access with a value which is within the value limits but which is illegal for other permanent reasons (parameter with defined individual values)				
101	Parameter number is currently deactivated	Dependent on the operating state of the inverter				
102	Channel width is insufficient	Communication channel is too small for response				
104	Illegal parameter value	The parameter can only assume certain values.				
106	Request not included / task is not supported	After request identifier 5,11,12,13,14,15				
107	No write access with enabled controller	The operating state of the inverter prevents a parameter change				
200/201	Changed minimum/maximum not achieved or exceeded	The maximum or minimum can be limited further during operation.				
204	The available access authorization does not cover parameter changes.	_				

Parameter index (IND)

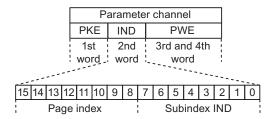


Figure 6-8 Structure of the parameter index (IND)

- For indexed parameters, select the index of the parameter by transferring the appropriate value between 0 and 254 to the subindex within a job.
- The page index is used to switch over the parameter numbers. Use this byte to add an
 offset to the parameter number that is transferred in the 1st word of the parameter
 channel (PKE).

Page index: Offset of parameter number

The parameter numbers are assigned to several parameter ranges. The following table shows which value you must transfer to the page index to achieve a particular parameter number.

Table 6-24 Page index setting dependent on parameter range

Parameter range	Page index						Hex value		
	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	
0000 1999	0	0	0	0	0	0	0	0	0x00
2000 3999	1	0	0	0	0	0	0	0	0x80
6000 7999	1	0	0	1	0	0	0	0	0x90
8000 9999	0	0	1	0	0	0	0	0	0x20
10000 11999	1	0	1	0	0	0	0	0	0xA0
20000 21999	0	1	0	1	0	0	0	0	0x50
30000 31999	1	1	1	1	0	0	0	0	0xF0

Parameter value (PWE)

You can vary the number of PWEs using parameter p2023.

Parameter channel with fixed length	Parameter channel with variable length			
P2023 = 4	P2023 = 127			
A parameter channel with fixed length should contain 4 words as this setting is sufficient for all parameters (including double words).	For a variable length of parameter channel, the master will only send the number of PWEs necessary for the task in the parameter channel.			
P2023 = 3	The response telegram is also no longer than			
You can select this setting if you only want to read or write 16-bit data or alarm signals.	necessary.			
16-bit data: e.g. p0210 supply voltage				
32-bit data: Indexed parameter, e.g. p0640[0n] Bit parameter, e.g. 722.012				
The master must always transmit the permanently set number of words in the parameter channel. Otherwise the slave will not respond to the telegram.				
When the slave responds it must always respond with the defined number of words.				

Note

8-bit values are transmitted as 16-bit values; the higher-order byte is zero. The fields of 8-bit values require one PWE per index.

Rules for editing requests/responses

- You can only request one parameter for each telegram sent.
- Each received telegram contains only one response.
- The master must repeat a request until it receives a suitable response.
- Request and response are assigned to one another using the following identifiers:
 - Suitable response identifier
 - Suitable parameter number
 - Suitable parameter index IND, if required
 - Suitable parameter value PWE, if necessary
- The master must send the complete request in one telegram. Request telegrams cannot be split up. The same applies to responses.

6.2.2.6 USS read request

Example: Reading out alarm messages from the inverter.

The parameter channel comprises four words (p2023 = 4). In order to obtain the values of the indexed parameter r2122, you must fill the telegram of the parameter channel with the following data:

- Request parameter value (field): Bits 15 ... 12 in the PKE word: Request identifier = 6
- Parameter number without offset: Bits 10 ... 0 in the PKE word:
 Because you can only code parameter numbers from 1 ... 1999 in the PKE, you must
 deduct as large an offset as possible, a number divisible by 2000, from the parameter
 number, and transfer the result of this calculation to the PKE word.
 In our example, this means: 2122 2000 = 122 = 7AH
- Offset of the parameter number in the byte page index of the word IND: for this example: When offset = 2000, this corresponds to a page index value of 0x80
- Index of the parameter in the byte subindex of the word IND:
 If you wish to read-out the last alarm, then you must enter index 0, for the third from last, index 2 (example). You can find a detailed description on the history of the alarm messages in the Section Alarms (Page 248).
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

Table 6-25 Request to read parameter r2122[2]

PKE (1st word)			IND (2nd word)		PWE (3rd and 4th words)			
AK		PNU	Page index	Subindex	PWE1(H word)	PWE2(L word)		
			(H byte)	(L byte)		Drive Object		
15 12	11	10 0	15 8	7 0	15 0	15 10	9 0	
0x6	0	0x7A (dec: 122)	0x80	0x02	0x0000	0x0000	0x0000	

6.2.2.7 USS write job

Example: Define digital input 2 as source for ON/OFF in CDS1

In this case, parameter p0840[1] (source, ON/OFF) must be assigned the value 722.2 (digital input 2).

The parameter channel comprises four words (p2023 = 4). To change the value of the indexed parameter P0840, you must fill the telegram of the parameter channel with the following data:

- Change parameter value (field): Enter bit 15 ... 12 in PKE (1st word): Request identifier = 7
- Parameter number without offset: Enter bit 10 ... 0 in PKE (1st word):
 As the parameter is < 1999, it can be directly entered without an offset converted into hex in the example 840 = 348H.</p>
- Enter the offset of the parameter number in byte page index of word IND (2nd word): in this example = 0.
- Enter the index of parameter in the byte subindex of word IND (2nd word): for this example = 1 (CDS1)
- Enter a new parameter value in PWE1 (Word3): in the example 722 = 2D2H.
- Drive Object: Enter bit 10 ... 15 in PWE2 (4th word): for SINAMICS G120, always 63 = 3FH
- Index of the parameter: Enter bit 0 ... 9 in PWE2 (word4): in example 2.

Table 6- 26 Request to change p0840[1]

PKE (1st word)			IND (2nd word)		PWE (3rd and 4th words)			
AK		PNU	Page index	Subindex	PWE1(H word)	PW	/E2(L word)	
			(H byte)	(L byte)		Drive Object		
15 12	11	10 0	15 8	7 0	15 0	15 10	9 0	
0x7	0	0x348 (dec: 840)	0x0000	0x01	0x2D2 (dec: 722)	3F (fixed) (dec: 63)	0x0002	

6.2.2.8 USS process data channel (PZD)

Description

Process data (PZD) is exchanged between the master and slave in this telegram range. Depending on the direction of transfer, the process data channel contains request data for the slave or response data to the master. The request contains control words and setpoints for the slaves, while the response contains status words and actual values for the master.

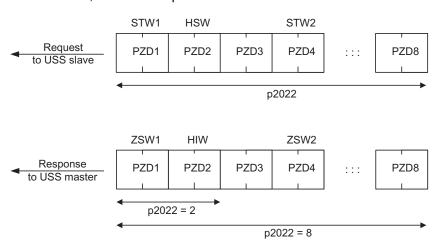


Figure 6-9 Process data channel

The number of PZD words in a USS telegram is defined by parameter p2022. The first two words are:

- Control 1 (STW1, r0054) and main setpoint (HSW)
- Status word 1 (ZSW1, r0052) and main actual value (HIW)

If P2022 is greater than or the same as 4, the additional control word (STW2, r0055) is transferred as the fourth PZD word (default setting).

You define the sources of the PZD using parameter p2051.

For further information, please refer to the Parameter Manual.

6.2.2.9 Time-out and other errors

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

Table 6- 27 Character runtime

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

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

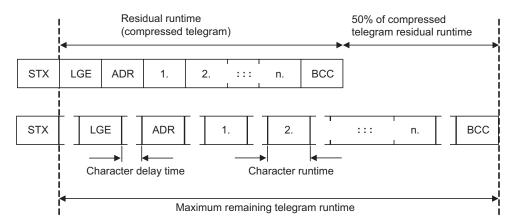


Figure 6-10 Telegram runtime as the sum of the residual runtime and character delay times

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

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

The slave only responds after the response delay has expired.

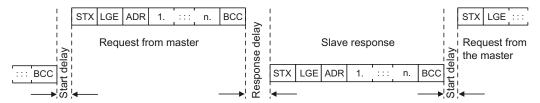


Figure 6-11 Start delay and response delay

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 6- 28 Duration of the start delay

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

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

6.2 Communication via RS485

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 \pm 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.

6.2.3 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		1 Bit stop

Communication settings

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



It is not permitted to change over the units!

The "Unit changeover (Page 182)" function is not permissible with this bus system!

6.2.3.1 Setting the address

You can set the inverter's Modbus RTU address using either DIP switches on the Control Unit or parameter p2021.

Valid Modbus RTU addresses: 1 ... 247

Invalid Modbus RTU addresses: 0

If you have specified a valid address using DIP switches, this address will always be the one that takes effect and p2021 cannot be changed.

If you set all DIP switches to "OFF" (0) or "ON" (1), then p2021 defines the address.

The positions and settings of the DIP switches are described in Section Interfaces, connectors, switches, terminal blocks and LEDs of the CU (Page 43).

CAUTION

A bus address that has been changed is only effective after the inverter has been switched off and back on again.

6.2.3.2 Basic settings for communication

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 140)")
	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).

6.2.3.3 Modbus RTU telegram

Description

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

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

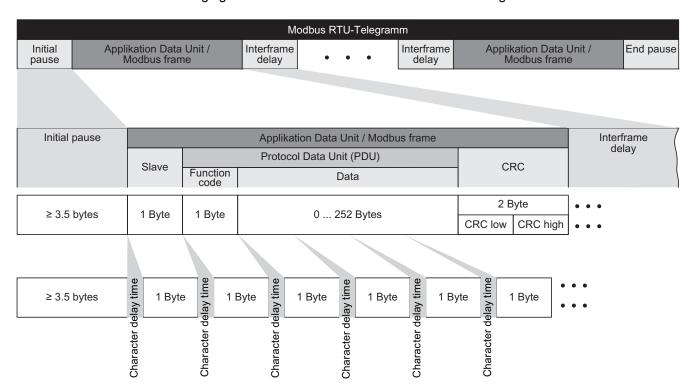


Figure 6-12 Modbus with delay times

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

6.2.3.4 Baud rates and mapping tables

Permissible baud rates and telegram delay

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

- Start detection
- · Between the individual frames
- End detection

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

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

Table 6-29 Baud rates, transmission times, and delays

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

Note

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

Modbus register and Control Unit parameters

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

The converter supports the following addressing ranges:

Addressing range	Remark				
40001 40065	Compatible with Micromaster MM436				
40100 40522					

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

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

Note

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

Table 6-30 Assigning the Modbus register to the parameters of the Control Unit

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Process	data						
Control d	ata						
40100	Control word	R/W		1			Process data 1
40101	Main setpoint	R/W		1			Process data 2
Status da	ta						
40110	Status word	R		1			Process data 1
40111	Main actual value	R		1			Process data 2
Paramete	er data						
Digital ou	tputs						
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 inp	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	Al 2	R	%	100	-300.0 300.0		r0755 [2]
40263	AI 3	R	%	100	-300.0 300.0 r0755 [r0755 [3]
Converte	r identification						

6.2 Communication via RS485

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
40300	Powerstack number	R		1	0	32767	r0200
40301	Converter firmware	R		0.0001	0.00	. 327.67	r0018
Converte	r data						
40320	Rated power of the power unit	R	kW	100	0	327.67	r0206
40321	Current Limit	R/W	%	10	10.0 .	400.0	p0640
40322	Rampup time	R/W	s	100	0.00 .	650.0	p1120
40323	Ramp-down time	R/W	s	100	0.00 .	650.0	p1121
40324	Reference speed	R/W	RPM	1	6.000 .	32767	p2000
Converte	r diagnostics						
40340	Speed setpoint	R	RPM	1		250 3250	r0020
40341	Speed actual value	R	RPM	1	1	250 3250	r0022
40342	Output frequency	R	Hz	100	- 327.68 327.67		r0024
40343	Output voltage	R	V	1	0	32767	r0025
40344	DC link voltage	R	V	1	0	32767	r0026
40345	Actual value of current	R	Α	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	HAN D	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

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range	Data / parameter
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 diag	nostics					
40520	Effective setpoint acc. to internal technology controller MOP rampfunction 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

6.2.3.5 Write and read access via FC 3 and FC 6

Function codes used

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

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

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

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

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

Number of registers

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

Table 6- 31 Structure of a read request for slave number 17

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

The response returns the corresponding data set:

Table 6- 32 Slave response to the read request

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"			

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

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

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

Table 6- 33 Structure of a write request for slave number 17

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"				

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

Table 6- 34 Slave response to the write request

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"			

6.2.3.6 Communication procedure

Procedure for communication in a normal case

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

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

Communication errors

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

Logical error

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

Table 6-35 Overview of exception codes

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

Maximum processing time, p2024[0]

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

Process data monitoring time (setpoint timeout), p2040

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

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

Note

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

Functions

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

- Commissioning (Page 55)
- If necessary: Adapt terminal strip (Page 89)
- If necessary: Configuring the fieldbus (Page 101)

7.1 Overview of the inverter functions

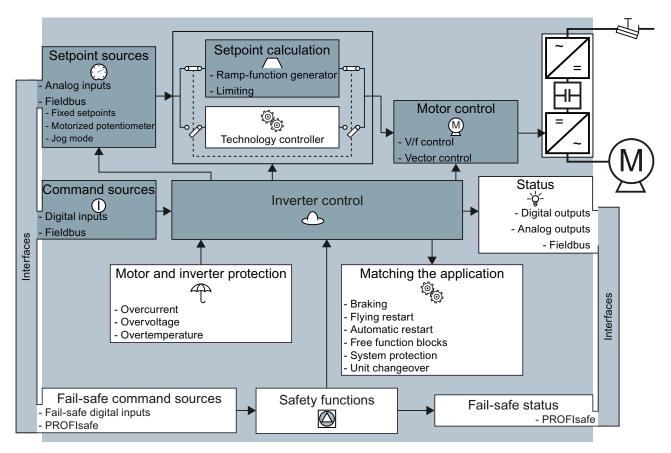


Figure 7-1 Overview of inverter functions

7.1 Overview of the inverter functions

Functions relevant to all applications		Functions required in special applications only		
The functions that you require in each application are shown in a dark color in the function overview above. You set these functions during the basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.		The functions whose parameters you only need to adapt when actually required are shown in white in the function overview above.		
\triangle	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 149)		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. Command sources (Page 158)	
(1)	The command source defines where the control signals are received from to switch on the motor, e.g. via digital inputs or a fieldbus. Protection functions (Page 175)	-\documents	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 181)	
	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 159)	(O)	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 182)	
The setpoint calculation uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value. Setpoint calculation (Page 166)			The safety functions are used in applications that must fulfill special requirements in terms of functional safety. Safe Torque Off (STO) safety function (Page 220)	
	The motor closed-loop control ensures that the motor follows the speed setpoint. Motor control (Page 168)			

7.2 Inverter control



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

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

Table 7-1 Two-wire control and three-wire control

	T	
Behavior of the motor Clockwise Stop Counter- Stop clockwise rotation	Control commands	Typical application
Motor on/off	Two-wire control, method 1 1. Switch the motor on and off (ON/OFF1). 2. Reverse the motor direction of rotation.	Local control in conveyor systems.
Motor on/off, a clockwise rotation Motor on/off, a 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 / motor off Motor on, clockwise rotation Motor on, counter-clockwise rotation	 Three-wire control, method 1 Issue enable for switching on motor and switch off motor (OFF1). Switch on motor (ON), clockwise rotation. Switch on motor (ON), counter-clockwise rotation. 	Traction drives with control via joystick
Enable / motor off Motor on the service of the ser	 Three-wire control, method 2 Issue enable for switching on motor and switch off motor (OFF1). Switch on motor (ON). Reverse the motor direction of rotation. 	-

7.2.1 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.

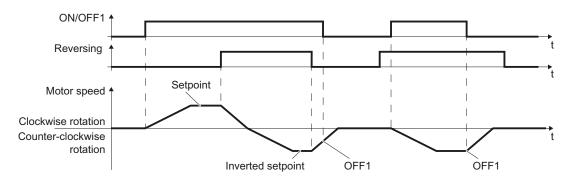


Figure 7-2 Two-wire control, method 1

Table 7-2 Function table

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

Table 7-3 Parameter

Parameter	Description				
p0015 = 12 Macro drive unit (factory setting for inverters without PROFIBUS interface			JS 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 (DI	x).			
p0840[0 n] = 722.x	BI: ON/OFF1 (ON/OFF1)				
p1113[0 n] = 722.x	0 n] = 722.x BI: Setpoint inversion (reversing)				
Example	Example				
p0840 = 722.3 DI 3: ON/OFF1. Also see Section Digital inputs (Page 90).					

7.2.2 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.

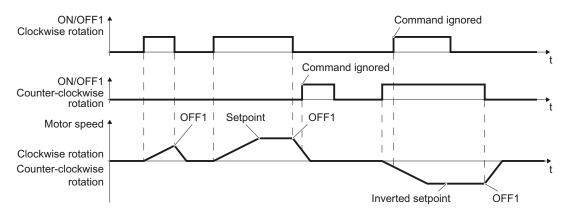


Figure 7-3 Two-wire control, method 2

Table 7-4 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 7- 5 Parameter

Parameter	Description				
p0015 = 17	5 = 17 Macro drive unit				
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1		
		ON/OFF1 clockwise rotation	ON/OFF1 , counter- clockwise rotation		
Advanced setting Interconnecting control of	commands with digital inputs of y	our choice (DI x).			
p3330[0 n] = 722.x	BI: 2-3-WIRE Control Command	1 (ON/OFF1 clockwis	e rotation)		
p3331[0 n] = 722.x	22.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 90).				

7.2.3 Two-wire control, method 3

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

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

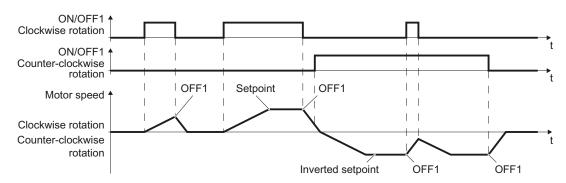


Figure 7-4 Two-wire control, method 3

Table 7-6 Function table

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

Table 7- 7 Parameter

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 of	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 Also see Section Digital inputs (Pa			

7.2.4 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).

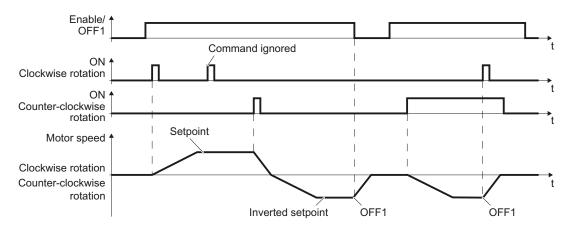


Figure 7-5 Three-wire control, method 1

Table 7-8 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 7-9 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 of	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 90).			

7.2.5 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).

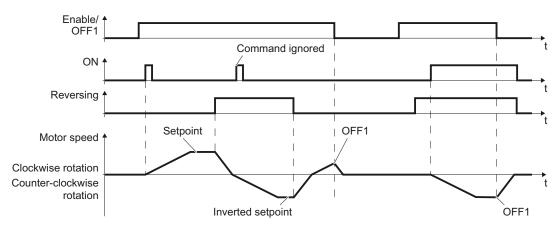


Figure 7-6 Three-wire control, method 2

Table 7- 10 Function table

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

Table 7- 11 Parameter

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

7.2.6 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

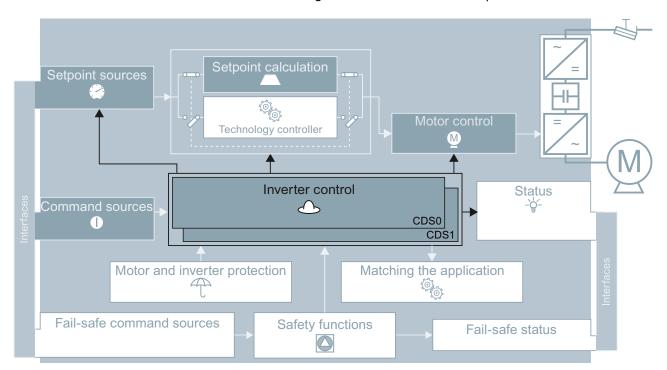


Figure 7-7 Command data sets (CDS): Different setting of the inverter control

7.2 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.

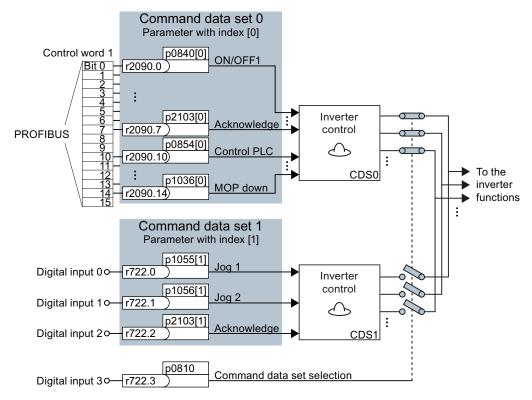


Figure 7-8 Example for the various command data sets

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

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

Note

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

Advanced settings

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

Table 7- 12 Defining the number of command data sets

Parameter	Description
p0010 = 15	Drive commissioning: Data sets
p0170	Number of command data sets (factory setting: 2) P0170 = 2, 3 or 4
p0010 = 0	Drive commissioning: Ready
r0050	Displaying the number of the CDS that is currently active

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

Table 7- 13 Selecting a command data set

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

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

Table 7- 14 Parameters for copying the command data sets

Parameter	Description
P0809[0]	Number of the command data set to be copied (source)
P0809[1]	Number of the command data set to which the data is to be copied (target)
P0809[2] = 1	Copying is started Once copying has been completed, the inverter sets p0809[2] to 0.

7.3 Command sources

7.3 Command sources



The command source is the interface via which the inverter receives its control commands. When commissioning, you define this using macro 15 (p0015).

Note

The "Get master control" or "Manual/Auto changeover" function can also be used to specify commands and setpoints via STARTER or the Operator Panel.

Change command source

If you subsequently change the command source using macro 15, then you must carry out commissioning again.

You also have the option to adapt the pre-assignment - which you selected using macro 15 - to the requirements of your particular system. You can obtain detailed information about this in the Sections Adapt terminal strip (Page 89) and Configuring the fieldbus (Page 101).

7.4 Setpoint sources



The setpoint source is the interface via which the inverter receives its setpoint. The following options are available:

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

Depending on the parameterization, the setpoint in the inverter has one of the following meanings:

- Speed setpoint for the motor.
- Torque setpoint for the motor.
- Setpoint for a process variable.
 The inverter receives a setpoint for a process variable, e.g. the level of liquid in a container, and calculates its speed setpoint using the internal technology controller.

7.4.1 Analog input as setpoint source

If you use an analog input as setpoint source, then you must adapt this analog input to the type of connected signal (± 10 V, 4 ... 20 mA, ...). Additional information is available in Section Analog inputs (Page 94).

Procedure

You have two options for interconnecting the setpoint source with an analog input:

- Using p0015, select a configuration that is suitable for your application.
 Please refer to the section titled Select interface assignments (Page 46) to find out which configurations are available for your inverter.
- 2. Interconnect main setpoint p1070 with an analog input of your choice.

Table 7- 15 Analog inputs as setpoint source

Parameter	Setpoint source
r0755[0]	Analog input 0
r0755[1]	Analog input 1

Example: You interconnect analog input 0 as the setpoint source with p1070 = 755[0].

7.4 Setpoint sources

7.4.2 Motorized potentiometer as setpoint source

The 'motorized potentiometer' (MOP) function simulates an electromechanical potentiometer for entering setpoints. You can continuously adjust the motorized potentiometer (MOP) using the control signals "raise" and "lower". The control signals are received via the digital inputs of the inverter or from the operator panel that has been inserted.

Typical applications

- Entering the speed setpoint during the commissioning phase.
- Manual operation of the motor should the higher-level control fail.
- Entering the speed setpoint after changeover from automatic operation to manual operation.
- Applications with largely constant setpoint and without higher-level control.

Principle of operation

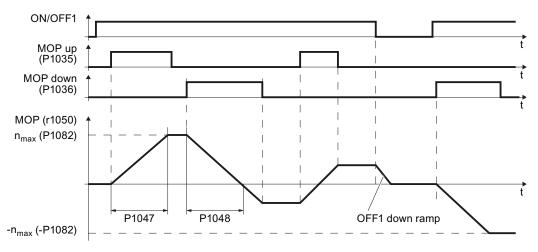


Figure 7-9 Function chart of motorized potentiometer

Motorized potentiometer parameters

Table 7- 16 Basic setup of motorized potentiometer

Parameter	Description
p1047	MOP ramp-up time (factory setting 10 s)
p1048	MOP ramp-down time (factory setting 10 s)
p1040	Start value of MOP (factory setting 0 rpm) Determines the start value [rpm] that becomes effective when the motor is switched on

Table 7- 17 Extended setup of motorized potentiometer

Parameter	Description
p1030	Configuration of the MOP, parameter value with four independently adjustable bits 00 to 03 (factory setting 00110 bin)
	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. The initial rounding is a sensitive way of specifying small setpoint changes (progressive reaction when keys are pressed).
	Bit 03: Store setpoint in power-independent manner 0: No power-independent saving 1: Setpoint is saved in the event of a power failure (bit 00 = 1)
	Bit 04: Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: Setpoint is calculated independent of the pulse enable (this setting is required if the energy-saving mode has been selected).
p1035	Signal source to increase setpoint (factory setting 0) Automatically pre-assigned during commissioning, e.g. with the button on the Operator Panel
p1036	Signal source to reduce setpoint (factory setting 0) Automatically pre-assigned during commissioning, e.g. with the button on the operator panel
p1037	Maximum setpoint (factory setting 0 rpm) Automatically pre-assigned during commissioning
p1038	Minimum setpoint (factory setting 0 rpm) Automatically pre-assigned during commissioning
p1039	Signal source to invert minimum and maximum setpoints (factory setting 0)
p1044	Signal source for set value (factory setting 0)

For more information about the motorized potentiometer, see the List Manual (function diagram 3020 and the parameter list).

Interconnecting the motorized potentiometer with the setpoint source

You have two options for interconnecting the motorized potentiometer with the setpoint source:

- 1. Using p0015, select a configuration that is suitable for your application.

 Please refer to the section titled Select interface assignments (Page 46) to find out which configurations are available for your inverter.
- 2. Interconnect the main setpoint with the motorized potentiometer by setting p1070 to 1050.

7.4 Setpoint sources

Example of parameterization of the motorized potentiometer

Table 7- 18 Implementing a motorized potentiometer using digital inputs

Parameter	Description
p0015 = 9	Macro drive unit: Configure inverter on MOP as the setpoint source
	The motor is switched on and off via digital input 0.
	The MOP setpoint is increased via digital input 1.
	The MOP setpoint is decreased via digital input 2.
p1040 = 1 0	MOP start value Each time the motor is switched on a setpoint corresponding to 10 rpm is specified
p1047 = 5	MOP ramp-up time: The MOP setpoint is increased from zero to maximum (p1082) in 5 seconds
p1048 = 5	MOP ramp-down time: The MOP setpoint is reduced from maximum (p1082) to zero in 5 seconds

7.4.3 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 of this simplified specification of speed setpoint are:

- Conveyor belt with two different speeds.
- Grinding machine with different speeds corresponding to the diameter of the grinding wheel.

If you use the technology controller in the inverter, then you can enter process variables that remain constant over time using a fixed setpoint, e.g.:

- Closed-loop control of a constant flow with a pump.
- Closed-loop control of a constant temperature using a fan.

Procedure

You can set up to 16 various fixed setpoints and select these either via digital inputs or the fieldbus. The fixed setpoints are defined using parameters p1001 to p1004 and can be assigned to the corresponding command sources (e.g. the digital inputs) using parameters p1020 to p1023.

The various fixed setpoints can be selected in two ways:

1. Direct selection:

Precisely one fixed speed setpoint is assigned to each selection signal (e.g. a digital input). As several selection signals are selected, the associated fixed speed setpoints are added together to from a total setpoint.

Direct selection is particularly well suited to controlling the motor using the inverter's digital inputs.

2. Binary selection:

Precisely one fixed speed setpoint is assigned to each possible combination of selection signals.

Binary selection should preferably be used with a central control and when linking the inverter to a fieldbus.

Table 7- 19 Parameters for direct selection of fixed setpoints

Parameter	Description
p1016 = 1	Direct selection of fixed setpoints (factory setting)
p1001	Fixed setpoint 1Factory setting: 0 rpm)
p1002	Fixed setpoint 2Factory setting: 0 rpm)
p1003	Fixed setpoint 3Factory setting: 0 rpm)
p1004	Fixed setpoint 4Factory setting: 0 rpm)
p1020	Signal source for selection of fixed setpoint 1 (factory setting: 722.3, i.e. selection via digital input 3)
p1021	Signal source for selection of fixed setpoint 2 (factory setting: 722.4, i.e. selection via digital input 4)
p1022	Signal source for selection of fixed setpoint 3 (factory setting: 722.5, i.e. selection via digital input 5)
p1023	Signal source for selection of fixed setpoint 4 (factory setting: 0, i e. selection is locked)

Table 7-20 Function diagram of direct selection of fixed setpoints

Fixed setpoint selected by	BICO interconnection of selection signals (example)	The resultant fixed setpoint corresponds to the parameter values of
Digital input 3 (DI 3)	p1020 = 722.3	p1001
Digital input 4 (DI 4)	p1021 = 722.4	p1002
Digital input 5 (DI 5)	p1022 = 722.5	p1003
Digital input 6 (DI 6)	p1023 = 722.6	p1004
DI 3 and DI 4		p1001 + p1002
DI 3 and DI 5		p1001 + p1003
DI 3, DI 4 and DI 5		p1001 + p1002 + p1003
DI 3, DI 4, DI 5 and DI 6		p1001 + p1002 + p1003 + p1004

You will find further information about the fixed setpoints and *binary* selection in function block diagrams 3010 and 3011 in the List Manual.

7.4 Setpoint sources

Example: Selecting two fixed speed setpoints using digital input 2 and digital input 3

The motor is to run at two different speeds:

- The motor is switched on with digital input 0
- When digital input 2 is selected, the motor is to run at a speed of 300 rpm.
- When digital input 3 is selected, the motor is to accelerate to a speed of 2000 rpm.
- When digital input 1 is selected, the motor should go into reverse

Table 7-21 Parameter settings for the example

Parameter	Description
p0015 = 12	Macro drive unit: Configure inverter with terminal strip as the command and setpoint source.
	The motor is switched on and off via digital input 0.
	The setpoint source is analog input 0.
p1001 = 300.000	Defines the fixed setpoint 1 in [rpm]
p1002 = 2000.000	Defines the fixed setpoint 2 in [rpm]
p1016 = 1	Direct selection of fixed setpoints
p1020 = 722.2	Interconnection of fixed setpoint 2 with DI 2. r0722.2 = parameter that displays the status of digital input 2.
p1021 = 722.3	Interconnection of fixed setpoint 3 with status of DI 3. r0722.3 = parameter that displays the status of digital input 3.
p1070 = 1024	Interconnect main setpoint with fixed speed setpoint

7.4.4 Running the motor in jog mode (JOG function)

Using the "jog" function (JOG function), you can switch the motor on and off using a control command or the operator panel. The speed to which the motor accelerates for "Jog" can be set.

The motor must be switched-off before you issue the "jog" control command. "Jog" has no effect when the motor is switched on.

The "Jog" function is typically used to manually switch-on a motor after switching over from automatic to manual operation.

Setting jogging

The "Jog" function has two different speed setpoints, e.g. for motor counter-clockwise rotation and clockwise rotation.

With an operator panel, you can always select the "Jog" function. If you wish to use additional digital inputs as control commands, you must interconnect the particular signal source with a digital input.

Table 7- 22 Parameters for the "Jog" function

Parameter	Description	
p1055	Signal source for jogging 1 - jog bit 0 (factory setting: 0)	
	If you wish to jog via a digital input, then set p1055 = 722.x	
p1056	Signal source for jogging 2 - jog bit 1 (factory setting: 0)	
	If you wish to jog via a digital input, then set p1056 = 722.x	
p1058	Jogging 1 speed setpoint (factory setting, 150 rpm)	
p1059	Jogging 2 speed setpoint (factory setting, 150 rpm)	

7.4.5 Specifying the motor speed via the fieldbus

If you enter the setpoint via a fieldbus, you must connect the inverter to a higher-level control. For additional information, see chapter Configuring the fieldbus (Page 101).

Interconnecting the fieldbus with the setpoint source

You have two options for using the fieldbus as the setpoint source:

- Using p0015, select a configuration that is suitable for your application.
 Please refer to the section titled Select interface assignments (Page 46) to find out which configurations are available for your inverter.
- 2. Interconnect main setpoint p1070 with the fieldbus.

Table 7-23 Fieldbus as setpoint source

Parameter	Setpoint source
r2050[x]	Receive word no. x from RS485 interface
r2090[x]	Receive word no. x from PROFIBUS interface

7.5 Setpoint calculation

7.5 Setpoint calculation



The setpoint processing modifies the speed setpoint, e.g. it limits the setpoint to a maximum and minimum value and using the ramp-function generator prevents the motor from executing speed steps.

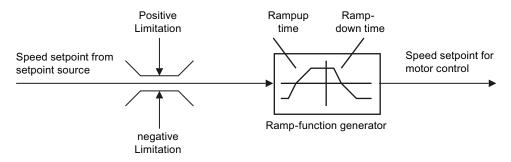


Figure 7-10 Setpoint processing in the inverter

7.5.1 Minimum speed and maximum speed

The speed setpoint is limited by both the minimum and maximum speed.

When the motor is switched on, it accelerates to the minimum speed regardless of the speed setpoint. The set parameter value applies to both directions of rotation. Beyond its limiting function, the minimum speed serves as a reference value for a series of monitoring functions.

The speed setpoint is limited to the maximum speed in both directions of rotation. The inverter generates a message (fault or alarm) when the maximum speed is exceeded.

The maximum speed also acts as an important reference value for various functions (e.g. the ramp-function generator).

Table 7-24 Parameters for minimum and maximum speed

Parameter	Description
P1080	Minimum speed
P1082	Maximum speed

7.5.2 Ramp-function generator

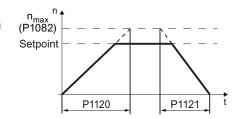
The ramp-function generator in the setpoint channel limits the speed of changes to the speed setpoint. The ramp-function generator does the following:

- 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.

Ramp-up/down time

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



Ramp-up time (p1120)

Duration of acceleration (in seconds) from zero speed to the maximum speed P1082

Ramp-down time (P1121)

Duration of deceleration (in seconds) from the maximum speed P1082 to standstill The quick-stop function (OFF3) has a separate ramp-down time, which is set with P1135.

Note

If the ramp-up/down times are too short, the motor accelerates/decelerates with the maximum possible torque and the set times will be exceeded.

For more information about this function, see the List Manual (function diagram 3060 and the parameter list).

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).

For more information, see the List Manual (the parameter list and function diagram 3070).

7.6 Motor control

7.6 Motor control



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

- Open-loop control with V/f-characteristic (V/f control)
- Field-oriented control (vector control)

Criteria for selecting either V/f control or vector control

V/f control is perfectly suitable for almost any application in which the speed of induction motors is to be changed. Examples of typical applications for V/f control include:

- Pumps
- Fans
- Compressors
- Horizontal conveyors

Commissioning vector control takes more time than when commissioning V/f control. When compared to V/f control, vector control offers the following advantages:

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

Examples of typical applications in which vector control is used:

- Hoisting gear and vertical conveyors
- Winders
- Extruders

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

- If the motor is too small in comparison to the 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

7.6.1 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.

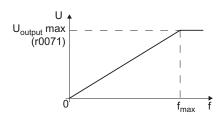
V/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load. If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint 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.

7.6.1.1 V/f control with linear and square-law characteristic

V/f control with linear characteristic (p1300 = 0):

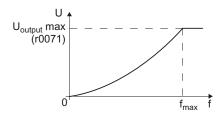
Mainly used in applications in which the motor torque must be independent of the motor speed. Examples of such applications include horizontal conveyors or compressors.



V/f control with parabolic characteristic (p1300 = 2)

Used in applications in which the motor torque increases with the motor speed Examples of such applications include pumps and fans.

V/f control with square-law characteristic reduces the losses in the motor and inverter due to lower currents than when a linear characteristic is used.



Note

V/f control with a square-law characteristic must not be used in applications in which a high torque is required at low speeds.

7.6 Motor control

7.6.1.2 Additional characteristics for the V/f control

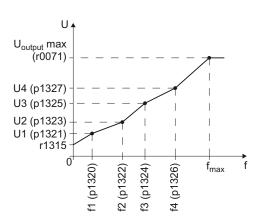
In addition to linear and square-law characteristics, there are the following additional versions of the V/f control that are suitable for special applications.

Linear V/f characteristic with Flux Current Control (FCC) (P1300 = 1)

Voltage losses across the stator resistance are automatically compensated. This is particularly useful for small motors since they have a relatively high stator resistance. The prerequisite is that the value of the stator resistance in P350 is parameterized as accurately as possible.

V/f control with parameterizable characteristic (p1300 = 3)

Variable V/f characteristic that supports the torque response of synchronous motors (SIEMOSYN motors).



Linear V/f characteristic with ECO (p1300 = 4), quadratic V/f characteristic with ECO (p1300 = 7)

ECO mode is suitable for applications with a low dynamic response and constant speed setpoint, and allows energy savings of up to 40%.

When the setpoint is reached and remains unchanged for 5 s, the inverter automatically reduces its output voltage to optimize the motor's operating point. ECO mode is deactivated in the event of setpoint changes or if the inverter's DC-link voltage is too high or too low.

In ECO mode set the slip compensation (P1335) to 100 %. In the event of minor fluctuations in the setpoint, you have to raise the ramp-function generator tolerance using p1148.

Note: Sudden load variations can cause the motor to stall.

V/f control for drives requiring a precise frequency (textile industry) (p1300 = 5), V/f control for drives requiring a precise frequency and FCC (p1300 = 6)

These characteristics require the motor speed to remain constant under all circumstances. This setting has the following effects:

- When the maximum current limit is reached, the stator voltage is reduced but not the speed.
- Slip compensation is locked.

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

V/f control with independent voltage setpoint

The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user. With BICO technology, P1330 defines the interface via which the voltage setpoint is entered (e.g. analog input → P1330 = 755).

7.6.1.3 Optimizing with a high break loose torque and brief overload

The ohmic losses in the motor stator resistance and the motor cable play a more significant role the smaller the motor and the lower the motor speed. You can compensate for these losses by raising the V/f characteristic.

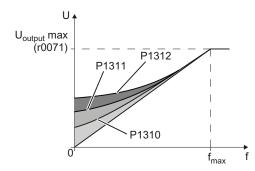
There are also applications where the motor temporarily needs more than its rated current in the lower speed range or during acceleration in order to adhere to the speed setpoint. Examples of such applications are:

- Driven machines with a high break loose torque
- Utilizing the brief overload capability of the motor when accelerating

Voltage increase in V/f control (boost)

Voltage losses resulting from long motor cables and the ohmic losses in the motor are compensated for using parameter p1310. An increased break loose torque when starting and accelerating is compensated using parameter p1312 and/or p1311.

The voltage boost is active for every characteristic type of the V/f control. The figure opposite shows the voltage boost using the example of a linear V/f characteristic.



7.6 Motor control

Note

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

Table 7-25 Optimizing the starting characteristics for a linear characteristic

Parameter	Description		
P1310	Permanent voltage boost (factory setting 50 %)		
	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 voltage boost at zero speed in V: 1.732 × rated motor current (p0305) × stator resistance (r0395) × p1310 / 100 %.		
P1311	Voltage boost on acceleration		
	The voltage boost on acceleration is independent of speed and occurs when the setpoint is increased. It disappears as soon as the setpoint is reached. Value in V: 1.732 × rated motor current (p0305) × stator resistance (r0395) x p1311 / 100 %		
P1312	Voltage boost at start up		
	The voltage boost at start-up results in an additional voltage boost when accelerating, but only the first time the motor accelerates after it has been switched on. The voltage boost in V is: $1.732 \times 1.732 \times 1.73$		

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

7.6.2 Vector control

7.6.2.1 Properties of vector control

Using a motor model, the vector 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.

Vector control is possible without directly measuring the motor speed. This closed-loop control is also known as sensorless vector control.

7.6.2.2 Commissioning vector control

Vector control only functions error-free if, during the basic commissioning, the motor data were correctly parameterized and a motor data identification was performed with the motor in the cold state.

You can find the basic commissioning in the following sections:

- Commissioning with the BOP-2 (Page 66)
- Commissioning with STARTER (Page 71)

Optimizing vector control

• Carry out the automatic speed controller optimization using (p1960 = 1)

Table 7-26 The most important vector control parameters

Parameter	Description
P1300 = 20	Control type: Vector control without speed encoder
p0300 p0360	Motor data is transferred from the rating plate during basic commissioning and calculated with the motor data identification
p1452 p1496	Speed controller parameters
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.

You will find more information On the Internet: (http://support.automation.siemens.com/WW/view/en/7494205):

7.6 Motor control

7.6.2.3 Torque control

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

Typical applications for torque control

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

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

Commissioning the torque control

The torque control only functions error-free if, during the basic commissioning, you correctly 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:

- Commissioning with the BOP-2 (Page 66)
- Commissioning with STARTER (Page 71)

Table 7-27 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.

7.7 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.

7.7.1 Inverter temperature monitoring

The inverter temperature is essentially determined by the resistive losses of the output current and the switching losses which occur when pulsing the Power Module. The inverter temperature falls when either the output current or the pulse frequency of the Power Module is reduced.

12t monitoring (A07805 - F30005)

The Power Module's I2t monitoring controls the inverter utilization by means of a current reference value. The utilization is specified in r0036 [%].

Monitoring the chip temperature of the power unit (A05006 - F30024)

The temperature difference between the power chip (IGBT) and heat sink is monitored using A05006 and F30024. The measured values are specified in r0037[1] [°C].

Heat sink monitoring (A05000 - F30004)

The power unit heat sink temperature is monitored using A05000 and F30004. The values are specified in r0037[0] [°C].

Inverter response

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.

7.7 Protection functions

7.7.2 Motor temperature monitoring using a temperature sensor

You can use one of the following sensors to protect the motor against overtemperature:

- PTC sensor
- KTY 84 sensor
- ThermoClick sensor

The motor's temperature sensor is connected to the Control Unit.

Temperature measurement via PTC

The PTC sensor is connected to terminals 14 and 15.

- Overtemperature: The threshold value to switch over to an alarm or fault is 1650 Ω. After the PTC responds, alarm A07910 or shutdown with fault F07011 is initiated corresponding to the setting in p0610.
- Short-circuit monitoring: Resistance values < 20 Ω indicate a temperature sensor short-circuit

Temperature measurement using KTY 84

The device is connected to terminals 14 (anode) and 15 (cathode) in the forward direction of the diode. The measured temperature is limited to between -48 °C and +248°C and is made available for further evaluation.

- When the alarm threshold is reached (set via p0604; factory setting: 130 °C), alarm A7910 is triggered. Response -> p0610)
- Fault F07011 is output (depending on the setting in p0610) if
 - the fault threshold temperature (settable in p0605) is reached
 - the alarm threshold temperature (settable in p0604) is reached and is still present after the delay time as expired.

Wire-break and short-circuit monitoring via KTY 84

- Wire break: Resistance value > 2120 Ω
- Short circuit: Resistance value < 50 Ω

As soon as a resistance outside this range is measured, A07015 "Alarm temperature sensor fault" is activated and after the delay time expires, F07016 "Motor temperature sensor fault" is output.

Temperature monitoring via ThermoClick sensor

The ThermoClick sensor responds at values $\geq 100 \Omega$. After the ThermoClick sensors has responded, either alarm A07910 or shutdown with fault F07011 is initiated corresponding to the setting in p0610.

Parameters to set the motor temperature monitoring with sensor

Table 7-28 Parameters for detecting the motor temperature via a temperature sensor

Parameter	Description			
P0335	Specify the motor cooling 0: Self-ventilated - with fan on the motor shaft (IC410* or IC411*) - (factory setting) 1: Forced ventilation - with a separately driven fan (IC416*) 2: Self-ventilated and inner cooling* (open-circuit air cooled) 3: Forced ventilated and inner cooling* (open-circuit air cooled)			
P0601	Motor temperature sensor type 0: No sensor (factory setting) 1: PTC thermistor (→ P0604) 2: KTY84 (→ P0604) 4: ThermoClick sensor	Terminal no.		
		14	PTC+ KTY anode ThermoClick	
		15	PTC- KTY cathode ThermoClick	
P0604	Motor temperature alarm threshold (factory setting 130 °C) The alarm threshold is the value at which the inverter is either shut down or I _{max} is reduced (P0610)			
P0605	Motor temperature fault threshold (Factory setting: 145 °C)			
P0610	Motor overtemperature response Determines the response when the motor temperature reaches the alarm threshold.			
	0: No motor response, only an alarm 1: Alarm and reduction of I _{max} (factory setting) reduces the output speed 2: Fault message and shutdown (F07011)			
P0640	Current limit (input in A)			

^{*}According to EN 60034-6

7.7 Protection functions

7.7.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode (P1300 \geq 20) and functions by calculating a thermal motor model.

Table 7-29 Parameter to sense the temperature without using a temperature sensor

Parameters	Description	
P0621 = 1	Motor temperature measurement after restarting	
	0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on	
P0622	Magnetization time of the motor for temperature measurement after starting (set automatically as the result of motor data identification)	
P0625 = 20	Ambient motor temperature Enter the ambient motor temperature in °C at the instant that the motor data is acquired (factory setting: 20°C).	
	The difference between the motor temperature and motor environment (P0625) must lie within a tolerance range of approx. \pm 5 °C.	

7.7.4 Overcurrent protection

During vector control, the motor current remains within the torque limits set there.

During U/f control, the maximum current controller (I_{max} controller) protects the motor and inverter against overload by limiting the output current.

Method of operation of I_{max} controller

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, i.e. it is being driven by the connected machine, the I_{max} controller increases the speed and stator voltage of the motor to reduce the current.

Note

The inverter load is only reduced if the motor torque decreases at lower speeds (e.g. for fans).

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

Settings

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

Table 7- 30 I_{max} controller parameters

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

For more information about this function, see function diagram 1690 in the List Manual.

7.7.5 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 inverter and causes V_{DC} in the inverter to increase.

Above a critical DC link voltage both the inverter as well as the motor will be damaged. Before the voltage can reach critical levels, however, the inverter switches the motor off with the fault message "DC link overvoltage".

Protecting the motor and inverter 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 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 inverter braking methods can be found in Section Braking functions of the inverter (Page 187).

7.7 Protection functions

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

Table 7- 31 V_{DCmax} controller parameters

Parameter for vector control	Description
p1240 = 1	V _{DC} controller or V _{DC} monitoring configuration(factory setting: 1)1: Enable V _{DCmax} controller
r1242	V _{DCmax} controller switch-on level Shows the value of the DC-link voltage above which the V _{DCmax} controller is active
p1243	V _{DCmax} controller dynamic factor (factory setting: 100 %) scaling of the control parameters P1290, P1291 and P1292
p1250	V _{DCmax} controller proportional gain (factory setting: 1)
p1251	V _{DCmax} controller reset time (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1252	V _{DCmax} controller rate time (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
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	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.
	p1240 = 1 r1242 p1243 p1250 p1251 p1252

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

7.8 Status messages

7.8.1 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 89).

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 101).

7.8.2 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 245).

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

You cannot reset the system runtime.

7.9 Application-specific functions



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

- Unit changeover
- Braking functions
- Automatic restart and flying restart
- · Basic process control functions
- Logical and arithmetic functions using function blocks that can be freely interconnected

Please refer to the following sections for detailed descriptions.

7.9.1 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 183) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 184)
- Changing over process variables for the technology controller (Page 185)

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 185).

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

7.9.1.1 Changing over the motor standard

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

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

The parameters listed below are affected by the changeover.

Table 7- 32 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm²	lb ft ²	kgm²
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm²	Ib ft ²	kgm²

^{*)} Factory setting

7.9.1.2 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".

7.9.1.3 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.

7.9.1.4 Changing of the units with STARTER

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

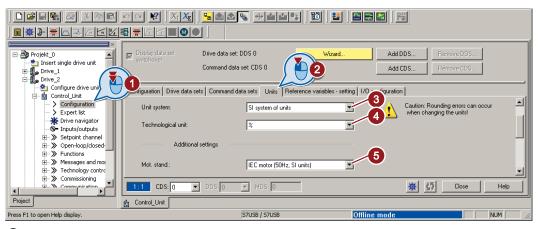
STARTER shows whether you change settings online in the converter or change offline in the PC (Online mode / Offline mode).

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



Procedure

Go to the "Units" tab in the configuration screen form to change over the units.

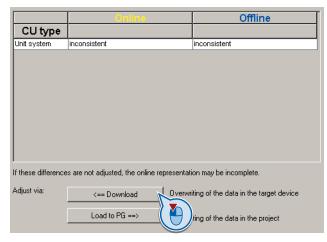


- 3 Changing over the unit system
- 4 Selecting process variables of the technology controller
- 5 adapting to the line supply

Figure 7-11 Unit changeover

- Save your settings
- · 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.

7.9.2 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 198).
- 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.

7.9.2.1 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 inverter offers the following options to convert the regenerative power of the motor into heat or to feed it back into the line:

- DC braking (Page 190) for Power Module PM240, PM250 and PM260
- Compound braking (Page 193) for Power Module PM240
- Dynamic braking (Page 195) for Power Module PM240
- Braking with regenerative feedback to the line (Page 197) for Power Module PM250 and 260

Main features of the braking functions

DC braking

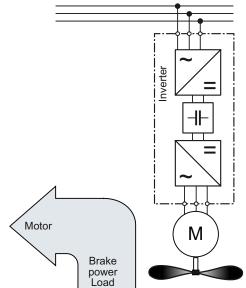
The motor converts the regenerative power into heat.

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

Compound braking

The motor converts the regenerative power into heat.

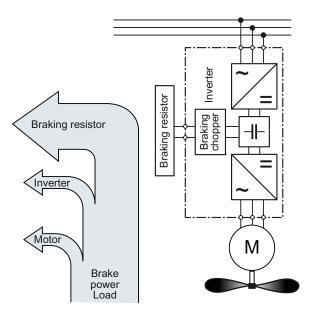
- Advantage: Defined braking characteristics, the motor brakes without the inverter having to convert any regenerative energy
- Disadvantages: significant motor temperature rise; no constant braking torque; regenerative power is dissipated as heat; does not function when the line supply fails



Dynamic braking

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

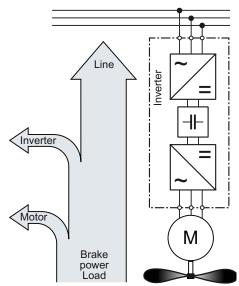
- Advantages: defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails
- Disadvantages: Braking resistor required; regenerative power is dissipated as heat



Braking with regenerative feedback into the line supply

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

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



Braking with regenerative feedback into the line supply

Braking method depending on the application

Table 7- 33 What braking method is suitable for what application?

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

7.9.2.2 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

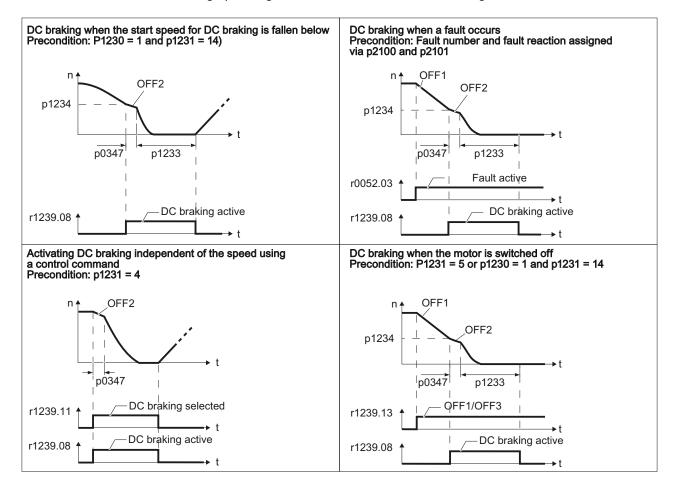
- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Whether DC braking or ramp-down with an OFF1 command is more effective depends on the motor properties.

Principle of operation

With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to demagnetize the motor - and then impresses the braking current for the duration of the DC braking.

The following operating modes are available for DC braking.



DC braking when the start speed for DC braking is fallen below

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 204)" must be activated:

- DC braking when the start speed for DC braking is fallen below
- · Activating DC braking independent of the speed using a control command
- DC braking when the motor is switched off

The DC braking function can only be set for induction motors.

CAUTION

DC braking converts some of the kinetic energy of the motor and load into heat in the motor (temperature rise). The motor will overheat if the braking operation lasts too long or the motor is braked too often.

DC braking parameters

Table 7-34 Parameters for configuring DC braking

Parameter	Description	
p1230	Activate DC braking (BICO parameter)	
	The value for this parameter (0 or 1) can be either entered directly or specified by means of an interconnection with a control command.	
p1231	Configure DC braking	
	• p1231 = 0, no DC braking	
	p1231 = 4, general enabling of DC braking	
	• p1231 = 5, DC braking for OFF1/3, independent of p1230	
	P1231 = 14, enables DC braking for the case that the motor speed falls below the start speed for DC braking.	

Table 7-35 Parameters for configuring DC braking in the event of faults

Parameter	Description	
p2100	Set fault number for fault reaction (factory setting: 0)	
	Enter the fault number for which DC braking should be activated, e.g.: p2100[3] = 7860 (external fault 1).	
p2101 = 6	Fault reaction setting (factory setting: 0)	
	Assigning the fault response: p2101[3] = 6.	
T1 6 11 1		

The fault is assigned an index of p2100. The associated fault response must be assigned the same index in p2101.

In the List Manual of the inverter - in the "Faults and alarms" list - possible fault responses are listed for every fault. The entry "DCBRAKE" means that for this particular fault, DC braking can be set as fault response.

Table 7-36 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.

7.9.2.3 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

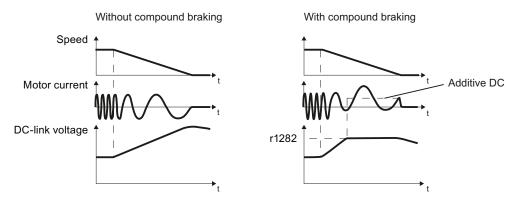


Figure 7-12 Motor brakes with and without active compound braking

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 7-37 Parameters to enable and set compound braking

Parameter	Description
P3856	Compound braking current (%)
	With the compound braking current, the magnitude of the DC current is defined, which is additionally generated when stopping the motor for operation with V/f control to increase the braking effect.
	P3856 = 0
	Compound braking locked
	P3856 = 1 250
	Current level of the DC braking current as a % of the rated motor current (P0305)
	Recommendation: p3856 < 100 % × (r0209 - r0331) / p0305 / 2
r3859.0	Status word, compound braking
	r3859.0 = 1: Compound braking is active

/ CAUTION

Compound braking converts part of the kinetic energy of the motor and load into motor heat (temperature rise). The motor can overheat if braking lasts too long or the drive is braked too frequently.

7.9.2.4 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 $V_{DC link, max}$.

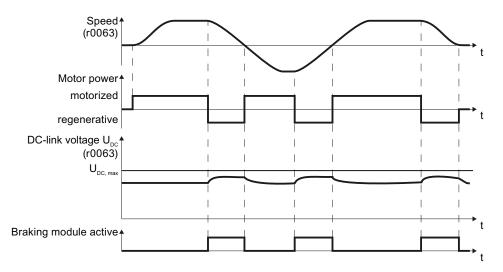


Figure 7-13 Simplified representation of dynamic braking with respect to time

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.

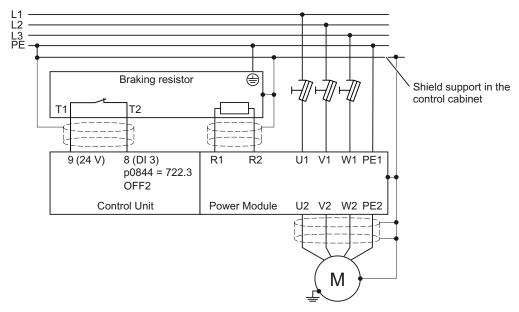


Figure 7-14 Braking resistor connection (example: Temperature monitoring via DI 3)

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

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

/ WARNING

If an unsuitable braking resistor is used, this could result in a fire and severely damage the converter.

The temperature of braking resistors increases during operation. For this reason, avoid coming into direct contact with braking resistors. Maintain sufficient clearances around the braking resistor and ensure that there is adequate ventilation.

Parameterizing the dynamic braking

Deactivate the V_{DCmax} controller. The V_{DCmax} controller is described in Section Limiting the maximum DC link voltage (Page 179).

The dynamic braking does not have to be parameterized any further.

7.9.2.5 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 266)).

Parameterization of braking with regenerative feedback to the line

Table 7-38 Settings for braking with regenerative feedback to the line

Parameter	Description		
Limiting the	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 feed	Limiting feedback 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.		

7.9.2.6 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The inverter has internal logic to control a motor holding brake.

The motor holding brake control inside the inverter is suitable for the following typical applications:

- Horizontal, inclined and vertical conveyors
- **Pumps**
- Fans

Connecting the motor holding brake

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

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

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

Brake Relay Power Module FSA ... FSC Power Module FSD ... FSF 0.37 kW ... 15 kW 18.5 kW ... 110 kW Flying lead to Power Module Connection to brake coil inside the motor Ground Earth The Brake Relay's control The Brake Relay's control The Brake Relay's control connection is marked "CTRL".

connection ① is on the front

panel of the Power Module.

The Power Module has a cable guide ② for the control

cable

Table 7-39 Connecting the Brake Relay to the Power Module

connection ① is on the lower

side of the Power Module.

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

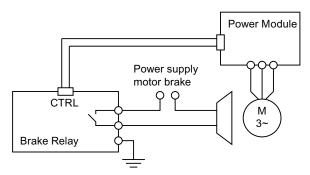


Figure 7-15 Connecting the motor holding brake

Further information can be found in the Hardware Installation Manual for your Power Module.

Principle of operation after OFF1 and OFF3 command

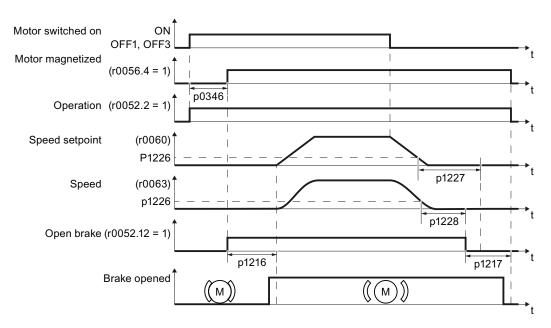


Figure 7-16 Controlling the motor holding brake when the motor is switched on and off

The motor brake is controlled as shown in the following diagram:

- 1. After the ON command (switch on motor), the inverter magnetizes the motor. At the end of the magnetizing time (p0346), the inverter issues the command to open the brake.
- 2. The motor remains at a standstill until the end of the brake opening time p1216. The motor holding brake must open within this time.
- 3. At the end of the brake opening time the motor accelerates to its speed setpoint.
- 4. After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
- 5. If the speed setpoint and the current speed fall below threshold p1226, the monitoring time p1227 or p1228 is started.
- 6. As soon as the first of the two monitoring times (p1227 or p1228) has elapsed, the inverter issues the command to close the brake. The motor comes to a standstill but remains switched on.
- 7. At the end of the brake closing time p1217, the motor is switched off. The motor holding brake must close within this time.

Principle of operation after OFF2 or STO command

For the following signals, the brake closing time is not taken into account:

- OFF2 command
- For fail-safe applications, in addition, after "Safe Torque Off" (STO)

After these control commands, the signal to close the motor holding brake is immediately output independent of the motor speed. The inverter does not monitor the motor speed until the brake closes.

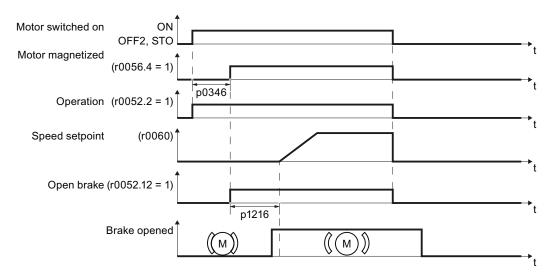


Figure 7-17 Controlling the motor holding brake after an OFF2 command or STO

Commissioning

/ WARNING

The following applications require special settings of the motor holding brake. In these cases, the motor holding brake control may only be commissioned by experienced personnel:

- All applications that involve moving and transporting people
- · Hoisting gear
- Elevators
- Cranes
- Before commissioning, secure any dangerous loads (e.g. loads on inclined conveyors)
- Suppress the motor holding brake control, e.g. by disconnecting the control cables
- When opening the motor holding brake, ensure that a torque is established that prevents the load from briefly dropping.
 - Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero
 - V/f control (p1300 = 0 to 3):
 Set the boost parameters p1310 and p1311.
 Define the motor torque when switching on using p1351 and p1352.
 - Vector control (p1300 ≥ 20):
 Define the motor torque when switching on using p1475.
- Assigning parameters for the opening and closing times of the motor holding brake.
 It is extremely important that electromechanical brakes are controlled with the correct timing in order to protect the brakes against long-term damage. The exact values can be found in the technical data of the connected brake. Typical values:
 - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
 - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
- Reestablish the control of the motor holding brake.
 r0052.12 ("Motor holding brake open") controls the brake.

Table 7-40 Control logic parameters of the motor holding brake

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

Table 7- 41 Advanced settings

Parameter	Description	
p0346	Magnetizing time (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.	
p0855	Open motor holding brake (imperative) (factory setting 0)	
p0858	Close motor holding brake (imperative) (factory setting 0)	
p1226	Stationary state detection speed threshold (factory setting 20 rpm) When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started	
p1227	Stationary state detection monitoring time (factory setting 300 s)	
p1228	Pulse deletion delay time (factory setting 0.01 s)	
p1351	Starting frequency of motor holding brake (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.	
p1352	Starting frequency for motor holding brake (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.	
p1475	Speed controller torque set value for motor holding brake (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.	

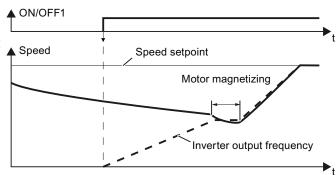
7.9.3 Automatic restart and flying restart

7.9.3.1 Flying restart – switching on while the motor is running

If you switch on the motor while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (overcurrent fault F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

- The motor rotates after a brief line interruption.
- A flow of air turns the fan impeller.
- A load with a high moment of inertia drives the motor.

After the ON command, the "flying restart" function initially synchronizes the inverter output frequency to the motor speed and then accelerates the motor up to the setpoint.



Principle of operation of the "flying restart" function

If the inverter simultaneously drives several motors, then you must only use the "flying restart" function if the speed of all of the motors is always the same (group drive with a mechanical coupling).

Table 7-42 Basic setting

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

Table 7-43 Advanced settings

Parameter	Description
P1201	Flying restart enable signal source (factory setting: 1)
	Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
P1202	Flying restart search current (factory setting 100 %)
	Defines the search current with respect to the motor magnetizing current (r0331), which flows in the motor while the flying restart function is being used.
P1203	Flying restart search speed factor (factory setting 100 %)
	The value influences the speed with which the output frequency is changed during the flying restart. A higher value results in a longer search time.
	If the inverter does not find the motor, reduce the search speed (increase p1203).

7.9.3.2 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 204).
- Using p1210, select the automatic restart mode that best suits your application.

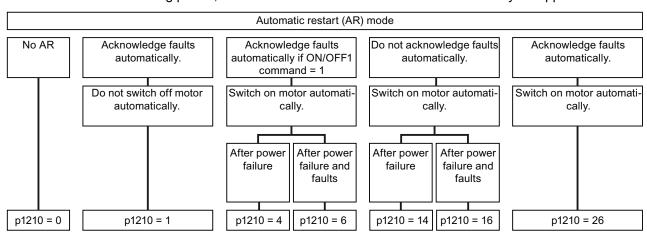
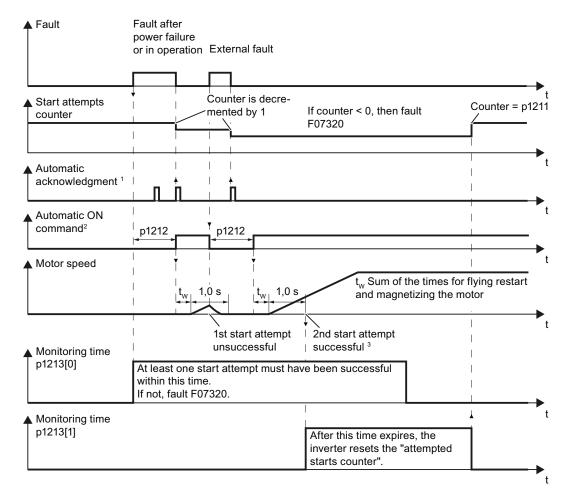


Figure 7-18 Selecting the automatic restart mode

Set the parameters of the automatic restart function.
 The method of operation of the parameters is explained in the following diagram and in the table.



- ¹ The inverter automatically acknowledges faults under the following conditions:
 - p1210 = 1 or 26: always.
 - p1210 = 4 or 6: If the command to switch on the motor is available at a digital input or via the fieldbus (ON/OFF1 command = HIGH).
 - p1210 = 14 or 16: never.
- ² The inverter attempts to automatically switch-on the motor under the following conditions:
 - p1210 = 1: never.
 - p1210 = 4, 6, 14, 16, or 26: If the command to switch on the motor is available at a digital input or via the fieldbus (ON/OFF1 command = HIGH).
- 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 7-19 Time response of the automatic restart

Table 7- 44 Setting 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.		

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 $p1206[0 \dots 9]$.

Example: P1206[0] = 07331 \Rightarrow No restart for fault F07331.

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

/!\warning

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).

7.9.4 PID technology controller

The technology controller permits all types of simple process controls to be implemented. You can use the technology controller for e.g. pressure controllers, level controls or flow controls.

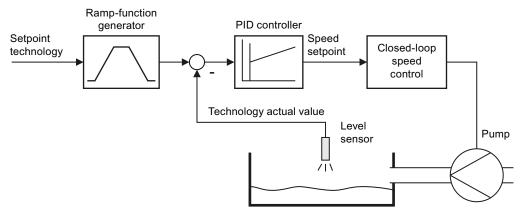


Figure 7-20 Example: technology controller as a level controller

Principle of operation

The technology controller specifies the speed setpoint of the motor in such a way that the process variable to be controlled corresponds to its setpoint. The technology controller is designed as a PID controller, which makes it highly flexible.

The technology controller setpoint is entered via an analog input or via the fieldbus.

Table 7-45 Technology controller parameters

Parameter	Description
P2200 =	Enable technology controller
P2201 r2225	Fixed speeds for the technology controller
P2231 P2248	Motorized potentiometer for the technology controller
P2251 r2294	General adjustment parameters of the technology controller
P2345 =	Changing the fault reaction for the technology controller

Additional information about this function is provided in the parameter list and in the function diagrams 7950 ... 7958 in the List Manual.

7.9.5 Load torque monitoring (system protection)

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

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

Load torque monitoring functions

The converter monitors the torque of the motor in different ways:

1. No-load monitoring:

The converter generates a message if the motor torque is too low.

2. Blocking protection:

The converter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.

3. Stall protection:

The converter generates a message if the converter control has lost the orientation of the motor.

4. Speed-dependent torque monitoring

The converter measures the actual torque and compares it with a parameterized speed/torque characteristic.

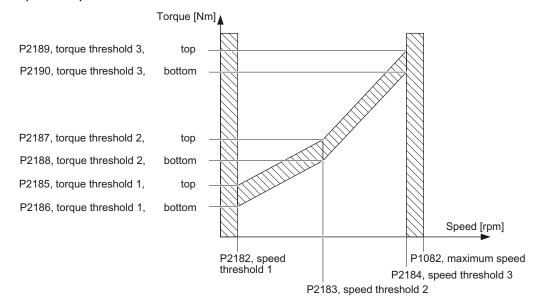


Table 7-46 Parameterizing the monitoring functions

Parameter	Description		
No-load monitoring			
P2179	Current limit for no-load detection		
	If the converter current is below this value, the message "no load" is output.		
P2180	Delay time for the "no load" message		
Blocking protection			
P2177	Delay time for the "motor locked" message		
Stall protection			
P2178	Delay time for the "motor stalled" message		
P1745	Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated This parameter is only evaluated as part of encoderless vector control.		
Speed-depe	Speed-dependent torque monitoring		
P2181	Load monitoring, response		
	Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled		
P2182	Load monitoring, speed threshold 1		
P2183	Load monitoring, speed threshold 2		
P2184	Load monitoring, speed threshold 3		
P2185	Load monitoring torque threshold 1, upper		
P2186	Load monitoring torque threshold 1, lower		
P2187	Load monitoring torque threshold 2, upper		
P2188	Load monitoring torque threshold 2, lower		
P2189	Load monitoring torque threshold 3, upper		
P2190	Load monitoring torque threshold 3, lower		
P2192	Load monitoring, delay time		
	Delay time for the message "Leave torque monitoring tolerance band"		

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

7.9.6 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

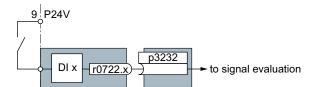


Figure 7-21 Load failure monitoring by means of a digital input

Table 7-47 Setting load failure monitoring

Parameter	Description
p2193 = 1 to 3	Load monitoring configuration (factory setting: 1) 0: Monitoring is disabled 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring
p2192	Load monitoring delay time (factory setting 10 s) If, after the motor is switched on, the "LOW" signal is present on the associated digital input for longer than this time, a load failure is assumed (F07936)
p3232 = 722.x	Load monitoring failure detection (factory setting: 1) Interconnect the load monitoring with a digital input of your choice.

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

Speed deviation monitoring

This function is only available for Control Units CU240E-2, CU240E-2 DP, CU240E-2 F and CU240E-2 DP-F. The monitoring sensor is connected to digital input 3.

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

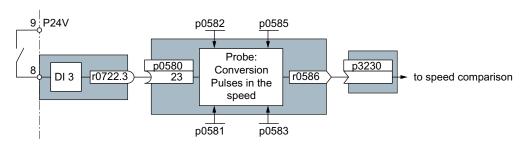


Figure 7-22 Speed deviation monitoring by means of digital input DI3

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

The calculated speed is compared with the actual speed value from the motor control and, if an (adjustable) deviation is detected, a response (also adjustable) is triggered.

Table 7-48 Setting speed deviation monitoring

Parameter	Description
P2193 = 2	Load monitoring configuration (factory setting: 1) 2: Speed and load failure monitoring.
P2192	Load monitoring delay time (factory setting 10 s) Setting of the delay time for evaluating load monitoring.
P2181	Load monitoring response (factory setting 0) Setting of the response for evaluating load monitoring.
P3231	Load monitoring speed deviation (factory setting 150 rpm) Permissible speed deviation of load monitoring.
P0580 = 23	Probe input terminal (factory setting 0) Interconnection of speed calculation with DI 3.
P0581	Probe edge (factory setting 0) Setting the edge for evaluation of the probe signal to measure actual speed value 0: 0/1 edge 1: 1/0 edge
P0582	Probe pulses per revolution (factory setting 1) Setting of the number of pulses per revolution.
P0583	Maximum probe measuring time (factory setting 10 s) Setting the maximum measuring time for the probe. If there is no new pulse before the maximum measuring time elapses, the actual speed value in r0586 is set to zero. With the next pulse, the time is restarted.
P0585	Probe gear factor (factory setting 1) The inverter multiplies the measured speed by the gear factor and then displays it in r0586.
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).

7.9.7 Logical and arithmetic functions using function blocks

Additional signal interconnections in the inverter 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 inverter 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 inverter.

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

Table 7-49 Runtime groups and possible assignments of the free function blocks

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 ($0 ext{ } ext{0} ext{ } ext{0} ext{ } ext{0} ext{0} ext{0}$).

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 %	

^{✓:} The block can be assigned to the runtime group

^{-:} The block cannot be assigned to this runtime group

7.9 Application-specific functions

Scaling examples

Speed:

Reference speed p2000 = 3000 rpm, actual speed 2100 rpm. As a consequence, the following applies to the scaled input quantity: 2,100 / 3,000 = 0.7.

• Temperature:

Reference quantity is 100 °C. For an actual temperature of 120 °C, the input value is obtained from 120 °C / 100 °C = 1.2.

Note

Limits within the function blocks should be entered as scaled values. The scaled value can be calculated as follows using the reference parameter: Scaled limit value = physical limit value / value of the reference parameter.

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

Example: Logic combination of two digital inputs

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

- 1. Activate a free OR block by assigning it to a runtime group, and define the run sequence.
- 2. Interconnect the status signals of the two digital inputs DI 0 and DI 1 via BICO to the two inputs of the OR block.
- 3. Finally, interconnect the OR block output with the internal ON command (P0840).

Table 7- 50 Parameters for using the free function blocks

Parameter	Description	
P20048 = 1	Assignment of block OR 0 to runtime group 1 (factory setting: 9999)	
	The block OR 0 is calculated in the time slice with 8 ms	
P20049 = 60	Definition of run sequence within runtime group 1 (factory setting: 60)	
	Within one runtime group, the block with the smallest value is calculated first.	
P20046 [0] = 722.0	Interconnection of first OR 0 input (factory setting: 0)	
	The first OR 0 input is linked to digital input 0 (r0722.0)	
P20046 [1] = 722.1	Interconnection of second OR 0 input (factory setting: 0)	
	The second OR 0 input is linked to digital input 1 (r0722.1)	
P0840 = 20047	Interconnection of OR 0 output (factory setting: 0)	
	The OR 0 output (r20047) is connected with the motor's ON command	

Example: AND operation

An example of an AND logic operation, explained in detail, including the use of a time block is provided in the BICO technology: example (Page 18)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)

7.10 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 292).

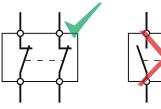
7.10.1 Prerequisite for STO use

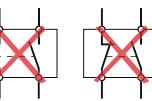
In order to use the STO safety function, your machine should have already performed a risk assessment (e.g. in compliance with EN ISO 1050, "Safety of machinery - Risk assessment - Part 1: Principles"). The risk assessment must confirm that the inverter is permitted for use in accordance with SIL 2 or PL d.

7.10.2 Permitted sensors

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

It is not possible to directly connect sensors with two NO contacts and antivalent contacts (1 NO contact and 1 NC contact).





The fail-safe digital inputs are configured for both directly connecting safety sensors, e.g. emergency stop control devices or light curtains, as well as for connecting pre-processing safety relays, e.g. fail-safe controls.

Permitted sensors

On the following pages, you will find examples of interconnecting the fail-safe digital input from "Basic safety", in accordance with PL d to EN 13849-1 and SIL2 to IEC 61508. You can find further examples and information in the Safety Integrated Function Manual.

7.10.3 Connecting fail-safe digital inputs

On the following pages, you will find examples of connecting the fail-safe digital input from "Basic safety", in accordance with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all of the components are installed in a control cabinet.

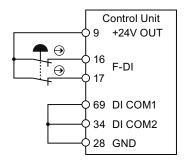


Figure 7-23 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch

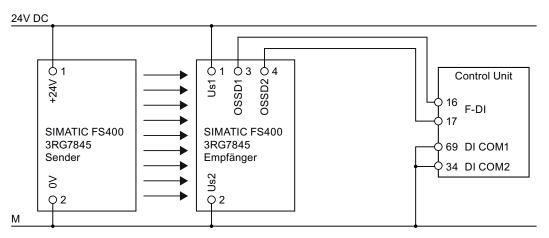


Figure 7-24 Connecting an electronic sensor, e.g. SIMATIC FS-400 light curtain

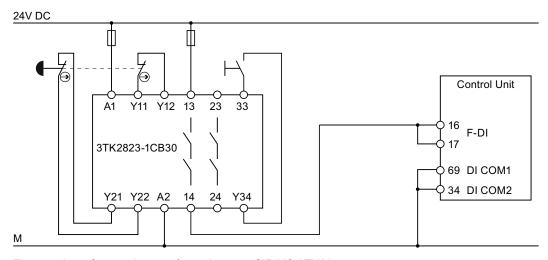


Figure 7-25 Connecting a safety relay, e.g. SIRIUS 3TK28

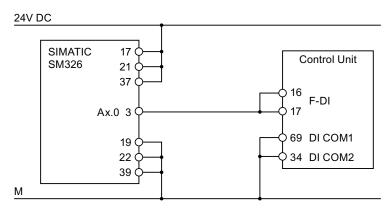


Figure 7-26 Connecting an F digital output module, e.g. SIMATIC F digital output module

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 292).

7.10.4 F-DI signal filtering

The inverter checks the signals of the fail-safe digital input for consistency. Consistent signals at both inputs always assume the same signal state (high or low).

Discrepancy

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 points toward a fault in the wiring of a fail-safe input, e.g. a wire break.

An adjustable filter in the inverter prevents faults caused by temporary discrepancy. Within the filter tolerance time (parameters p9650 and p9850), the inverter suppresses the discrepancy monitoring of the fail-safe inputs.

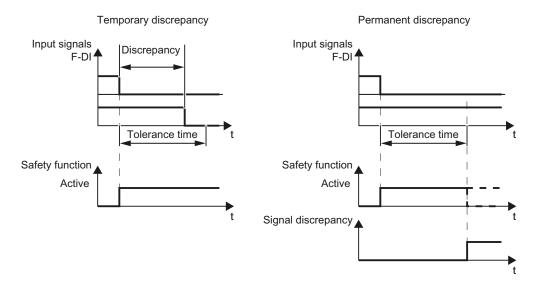


Figure 7-27 Filter for suppressing discrepancy monitoring

The filter does not increase the inverter response time. The inverter activates its safety functions as soon as one of the two F-DI signals changes its state from high to low.

Bit pattern test of fail-safe outputs and contact bounces of sensors

The inverter normally responds immediately to signal changes at its fail-safe input. This is not required in the following cases:

 When you interconnect the fail-safe input of the inverter with an electromechanical sensor, contact bounce may result in signal changes occurring, to which the inverter responds.

2. Several control modules test their fail-safe outputs using bit pattern tests (on/off tests), in order to identify faults due to either short or cross circuiting. When you interconnect the fail-safe input of the inverter with a fail-safe output of a control module, the inverter responds to these test signals.

A signal change during a bit pattern test usually lasts 1 ms.

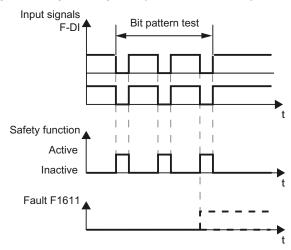


Figure 7-28 Inverter response to a bit pattern test

If the signal to control STO is not "stable", then the inverter responds with a fault. (Definition of a stable signal: Following a change to the F-DI input signals, the inverter triggers an internal monitoring time. Up until the end of the time interval 5 x p9650, both input signals must have a constant signal level. A constant signal level is a high or a low state, for a period of at least p9650).

An adjustable signal filter in the inverter suppresses temporary signal changes using bit pattern test or contact bounce.

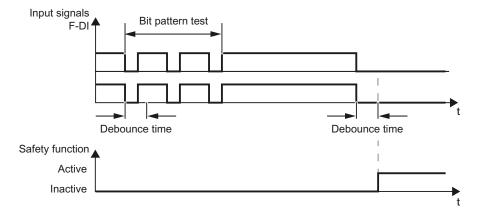


Figure 7-29 Filter for suppressing temporary signal changes

Note

The filter increases the inverter response time. The inverter only activates its safety function after the debounce time has elapsed (parameters p9651 and p9851).

Note

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence over the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not influence the signals of the "standard" inputs.

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

If you use an input as fail-safe input, set the debounce time as described above.

7.10.5 Forced dormant error detection

To fulfill the requirements of standards EN 954-1, ISO 13849-1 and IEC 61508 regarding timely error detection, the inverter must regularly test its safety-relevant circuits to ensure that they function correctly - this must be performed at least once every year.

After the power supply has been connected, the inverter checks its circuits to switch-off the torque each time the STO function is selected.

The inverter monitors the regular test of its safety-relevant circuits using a time module.

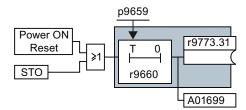


Figure 7-30 Forced dormant error detection monitoring

r9660 contains the remaining time until the monitoring responds. The inverter signals Alarm A01699 after the monitoring time expires.

You define the monitoring time while commissioning the system depending on your particular application.

Examples for the times when forced dormant error detection is performed:

- When the drives are at a standstill after the system has been switched on.
- When the protective door is opened.
- At defined intervals (e.g. every 8 hours).
- In automatic mode (time and event dependent).

If alarm A01699 signals that the monitoring time has expired, then you must initiate the forced dormant error detection at the next opportunity. These alarms do not affect the operation of your machine.

7.10.6 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.

The factory setting for the password is "0". During commissioning, choose your password from the permissible range 1 ... FFFF FFFF.

7.10.7 Commissioning the STO

7.10.7.1 Commissioning tool

We strongly recommend that you commission the safety functions using the STARTER PC tool.

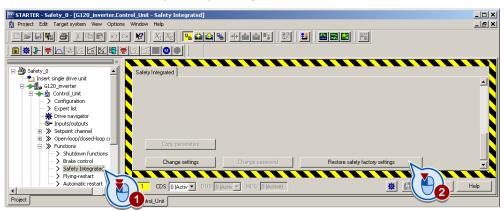
Table 7-51 STARTER commissioning tool (PC software)

Download	Order number
STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)	PC Connection Kit The kit contains a STARTER DVD and USB cable
	6SL3255-0AA00-2CA0

7.10.7.2 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.
- Open the screen form of the safety functions.
- Click on the "Restore Safety factory settings" button.



- Enter the password, for the safety functions.
- Confirm that the parameters have been saved (RAM to ROM).
- Go offline with STARTER.
- Switch off the converter supply voltage.
- Wait until all LEDs on the converter go dark. Now switch on the converter power supply again (power on reset).

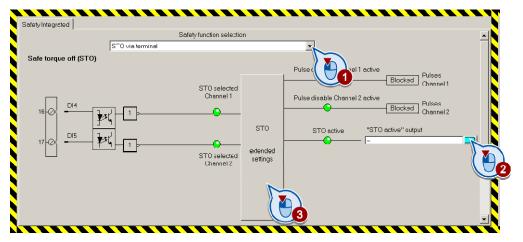
Procedure

- Go online with STARTER.
- In STARTER, call up the screens displaying the fail-safe functions and click on "Change settings":



7.10.7.3 Defining commissioning method

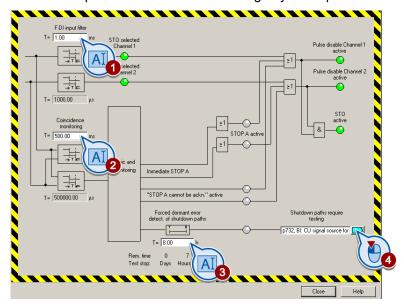
Select "STO via terminal".



- If you require the status signal "STO active" in your higher-level controller, interconnect it accordingly.
- Click the button to call up the advanced settings for STO.

7.10.7.4 Setting STO

• You can adapt the STO function according to your requirements in the following screen.



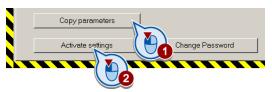
- Set the following in the above screen:
 - ① ② F-DI input filter (debounce time) and monitoring for simultaneous operation (discrepancy):

The method of functioning of the two filters is described in the section entitled F-DI signal filtering (Page 223).

- 3 4 Time interval for forced dormant error detection:
 Information regarding forced dormant error detection can be found in the Forced dormant error detection (Page 226) section.
- · Close the screen.

7.10.7.5 Activate settings

• Click "Copy parameters" and then click "Activate settings":



- You are prompted to allocate a password if the password = 0 (factory setting).
 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 226).
- Confirm the prompt for saving your settings (copy RAM to ROM).

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

7.10.7.6 Multiple assignment of the DI

 Check whether the digital inputs used as fail-safe input are also assigned a further function.

NOTICE

Both, the assignment of digital inputs with the selection of a safety function or with a "standard" function can lead to an unexpected behavior of the motor.

Remove multiple assignments of the digital inputs:

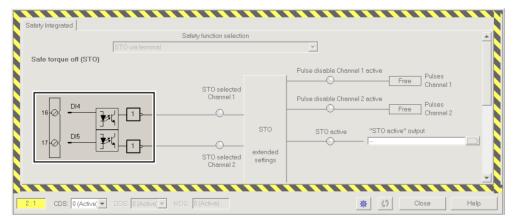


Figure 7-31 Example: automatic assignment of digital inputs DI 4 and DI 5 with STO

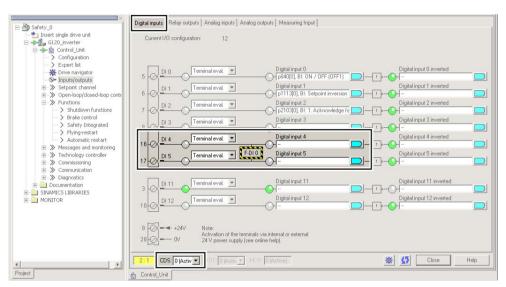


Figure 7-32 Remove pre-assignment of digital inputs DI 4 and DI 5

• When you use the data set changeover CDS, you must delete the multiple assignment of the digital inputs for all CDS.

7.10.8 Acceptance test - following completion of commissioning

7.10.8.1 Prerequisites and authorized persons

Requirements for acceptance tests are derived from the EC Machinery Directive and ISO 13849-1.

- Check the safety-related functions and machine parts following commissioning.
- Issue an "Acceptance certificate" which describes 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 must be complete. These include, for example:
 - Configuration of the setpoint channel.
 - Position control in the higher-level controller.
 - Drive 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.

7.10.8.2 Complete acceptance test

A complete acceptance test includes the following:

- 1. Documentation
 - Description of the machines and overview/block diagram
 - Safety functions of the drive
 - Description of safety equipment
- 2. Function test
 - Test of the shutdown paths
 - Test of safety functions used
- 3. Conclusion of the report
 - Inspection of safety function parameters
 - Recording of the checksums
 - Verify the data backup
 - Countersignatures

7.10.8.3 Reduced acceptance test (only STO)

A complete acceptance test is only necessary following first commissioning. An acceptance test with a reduced scope is sufficient for expansions of safety functions.

The reduced acceptance tests must be carried out separately for each individual drive, as far as the machine allows.

Reduced acceptance test for function extensions

Table 7- 52 Scope of the acceptance test depending on specific measures

Measure	Acceptance test			
	Documentation	Function test	Completion of the certificate	
Replacing the Control Unit or	Supplement:	Yes.	Supplement:	
the Power Modules.	Hardware data		New checksums and countersignature	
	Configuration		Countersignature	
	Firmware Versions			
Hardware replacement of	Supplement:	Yes.	No.	
safety-related distributed I/O devices (e.g. emergency off	Hardware data	Limitation to replaced		
switch).	Configuration	components.		
	Firmware Versions			
Firmware - upgrading the	Supplement:	Yes.	Supplement:	
Control Unit.	Version data		New checksums and	
	New safety functions		countersignature.	
Functional expansion of the	Supplementary safety functions	Yes.	Supplement:	
machine (additional drive).	for each drive and function table.	Testing the additional functions.	New checksums and countersignature.	
Functional expansion of a drive	Supplement to the safety	Yes.	Supplement.	
(e.g. enable STO).	functions for each drive and function table.	Testing the additional functions.	New checksums and countersignature.	
Transfer of converter parameters to other identical machines by means of series commissioning.	Supplement to the machine description (checking of the firmware versions).	Yes. Testing the interfaces FDI or PROFIsafe.	No, if data are identical (checking of checksums).	

7.10.8.4 Documentation

Machine overview

Enter your machine's data into the following table.

Designation	
Туре	
Serial number	
Manufacturer	•••
End customer	•••
Overview image of the machine	
	···
	•••
	•••
	···

Converter data

Document the hardware and firmware versions for each safety-related converter of your machine.

	MLFB and hardware version of the converter	Converter firmware version	Version of th	e safety funct	ions	
Designation of the 1st drive		r0018 =	r9770[0]	r9770[1]	r9770[2]	r9770[3]
			r9590[0]	r9590[1]	r9590[2]	r9590[3]
Designation of the 2nd drive				1	l	l

Function table

Fill in the following table for your machine.

Mode of operation	Safety device	Drive	Controlling the safety function	Status of the safety function
		•••		

Table 7- 53 Example:

Mode of operation	Safety device	Drive	Controlling the safety function	Status of the safety function
Production	Protective door closed and locked	1 2	-	not active not active
	Protective door unlocked	1 2	F-DI 0 PROFIsafe	STO active STO active
Setup	Protective door closed and locked	1 2	- PROFIsafe	not active STO active
	Protective door unlocked	1 2	F-DI 0 PROFIsafe	STO active STO active

7.10.8.5 Function test

The following is checked during the function test:

- The hardware is functioning properly.
- The digital inputs of the inverter are assigned correctly to the safety function.
- The PROFIsafe address of the inverter has been set correctly.
- The safety function has been parameterized correctly.
- Routine for the dormant error detection of the switch-off signal paths of the inverter.

Note

Perform the acceptance test with the maximum possible velocity and acceleration.

Table 7- 54 "Safe Torque Off" (STO) function

No.	Description	Status
1.	Initial state:	
	• The inverter is in "Ready" state (p0010 = 0).	
	• The inverter indicates neither faults nor alarms for safety functions (r0945, r2122, r2132).	
	STO is not active.	
2.	Switch on the motor (ON command).	
3.	Ensure that the correct motor is running.	
4.	Select STO while the motor is running	
	Note: Test each configured activation, e.g. via digital inputs and PROFIsafe.	
5.	Check the following:	
	 If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at a standstill. 	
	The inverter indicates neither faults nor alarms for safety functions.	
	 The inverter indicates: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1). 	
6.	Deselect STO.	
7.	Check the following:	
	The inverter indicates neither faults nor alarms for safety functions.	
	• The inverter indicates: "STO is not selected" (r9773.0 = 0). "STO is not active" (r9773.1 = 0).	
	• The inverter is in "Closing lockout" state (p0046.0 = 1).	
8.	Switch the motor off (OFF1 command) and then on again (ON command).	
9.	Ensure that the correct motor is running.	

7.10.8.6 Completion of the certificate

Document your machine's data for each drive based on the following specifications.

Parameters of the safety functions

The function test does not detect all faults in the parameter assignment of safety functions, e.g. forced dormant error detection time or filtering time of fail-safe inputs. Therefore, check all parameters once more.

	All parameter values checked
Designation of the 1st drive	
Designation of the 2nd drive	

Checksums of the safety functions

The converter calculates checksums across all parameters and safety functions.

When you change the safety function settings, the converter calculates new checksums. This means that subsequent changes in your machine can be tracked.

In addition to the individual checksums of the parameters, the converter calculates and saves the following values:

- 1. The "total" checksum across all checksums.
- 2. Time of the last parameter changed.

Labeling the drive	Checksums			
	Processor 1	Processor 2	Total	Time stamp
Designation of the 1st drive	p9798	p9898	r9781[0]	r9782[0]
	p9799	p9899		
		•	•	·

Data backup

	Storage medium		Holding area	
	Туре	Designation	Date	
Parameter				
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 parameters recorded above are correct.

Date	Name	Company/dept.	Signature

7.11 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.

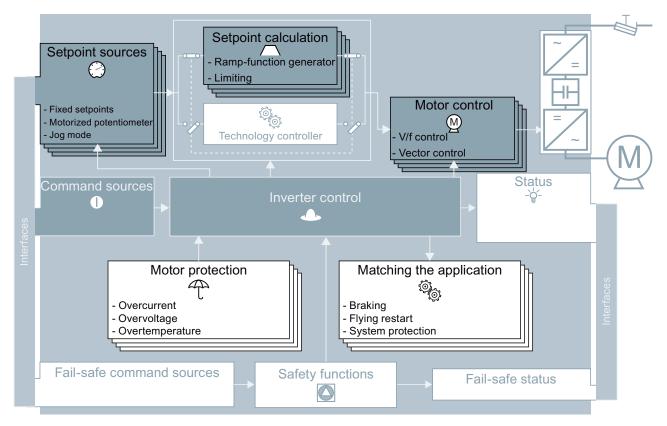


Figure 7-33 DDS switchover in the inverter

7.11 Switchover between different settings

Using parameter p0180 you can define the number of command data sets (2, 3 or 4).

Table 7- 55 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 7- 56 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 7-57 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).

Service and maintenance

8.1 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.

Replacing the Power Module		Replacing the Control Unit wit settings, e.g. on a memory car	•
Replacement:	Replacement:	Replacement:	Replacement:
Same type	Same type	Same type	Same type
Same power rating	Higher power rating	Same firmware version	higherfirmware version (e.g. replace FW V4.2 by FW V4.3)
PM GU PM		Firmware Version	Eirmware Version
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	The converter automatically lo memory card into the new CU If you have saved the settings medium, e.g. on an operator p the replacement, the settings converter.	of your converter on another panel or on a PC, then after



In all other cases, you must recommission the drive.

8.2 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 of the Power Module and (if installed) the external 24 V supply or the voltage for the relay outputs DO 0 and DO 2 of the Control Unit.
- · Remove the signal cables of the Control Unit.
- Remove the defective CU from the Power Module.
- Plug the new CU on to 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 of the Power Module and (if installed) the external 24 V supply or the voltage for the relay outputs DO 0 and DO 2 of the Control Unit.
- Remove the signal cables of the Control Unit.
- Remove the defective CU from the Power Module.
- Plug the new CU on to 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 different converter types, then the converter outputs alarm A01028. This alarm indicates that the settings that have been loaded are not compatible with the converter. In this case, clear the alarm with p0971 = 1 and recommission the drive.
- If you have not backed up your settings, then you must recommission the drive.

Inverter with enabled safety functions

If you replace an inverter with enabled safety functions, then you also need to confirm the safety function settings on the new inverter. You will find the procedure in Section: Data backup and standard commissioning (Page 81).

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 Complete acceptance test (Page 232).
- 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 test (only STO) (Page 233).

8.3 Replacing the Power Module

Procedure for replacing a Power Module

- Disconnect the Power Module from the line supply.
- If being used, switch off the 24 V supply of the Control Unit.



/!\DANGER

Risk of electrical shock!

Hazardous voltage is still present for up to 5 minutes after the power supply has been switched off.

It is not permissible to carry out any installation work before this time has expired!

- Remove the connecting cables of the Power Module.
- Remove the Control Unit from the Power Module.
- Replace the old Power Module with the new Power Module.
- Snap 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 241)).

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 test (only STO) (Page 233).

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:

- The motor is switched off.
- You cannot communicate with the converter, either via the Operator Panel or other interfaces.

In this event proceed as follows:

- Remove the memory card if one is inserted in the converter.
- Repeat the power on reset until the converter outputs fault F01018:
 - Switch off the converter supply voltage.
 - Wait until all LEDs on the converter go dark. Now switch on the converter supply voltage again.
- If the converter signals fault F01018, repeat the power on reset one more time.
- The converter must now have been restored to its factory settings.
- Recommission the converter.

9.1 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:

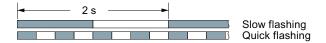


Table 9- 1 Inverter diagnostics

LE	D	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 9- 2 Communication diagnostics via RS485

LED BF	Explanation
On	Receive process data
RED - slow	Bus active - no process data
RED - fast	No bus activity

Table 9-3 Communication diagnostics via PROFIBUS DP

LED BF	Explanation
off	Cyclic data exchange (or PROFIBUS not used, p2030 = 0)
RED - slow	Bus fault - configuration fault
RED - fast	Bus fault - no data exchange - baud rate search - no connection

Table 9-4 Diagnostics of the safety functions

SAFE LED	Meaning
YELLOW - on	One or more safety functions are enabled, but not active.
YELLOW - slow	One or more safety functions are active; no safety function faults have occurred.
YELLOW - rapid	The converter has detected a safety function fault and initiated a STOP response.

9.2 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 mat the bottom left of the STARTER screen

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

Alarm buffer

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

	Alarm code	Alarm	value	Alarm rece		Alarm remo	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 9-1 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 181).

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 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]

Figure 9-2 Saving the second alarm in the alarm buffer

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

	Alarm code Alarm value		Alarm rece		Alarm time removed			
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0] r	2125[0]	
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]	
3. Alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]	
4. Alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]	
5. Alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]	
6. Alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]	
7. Alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]	
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]	

Figure 9-3 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.

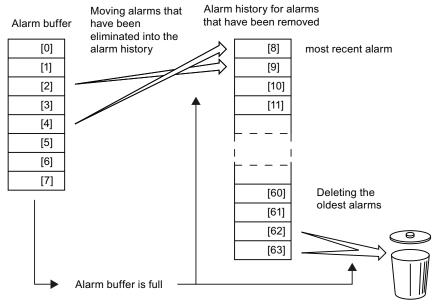


Figure 9-4 Shifting alarms that have been removed into the alarm history

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

9.2 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

Table 9-5 Important parameters for alarms

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

Extended settings for alarms

Table 9-6 Extended settings for alarms

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

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

9.3 Faults

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

The inverter signals a fault as follows:

- at the Operator Panel with Fxxxxx
- at the Control Unit 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

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]
		132	Float	Days	ms	Days	ms

Figure 9-5 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 181).

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 valu	ie	Fault recei		Fault remo	
1st fault	r0945[0]	r0949[0] r21	33[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 9-6 Saving the second fault in the fault buffer

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

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

Figure 9-7 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 monitoring of hardware and firmware inside the inverter 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).

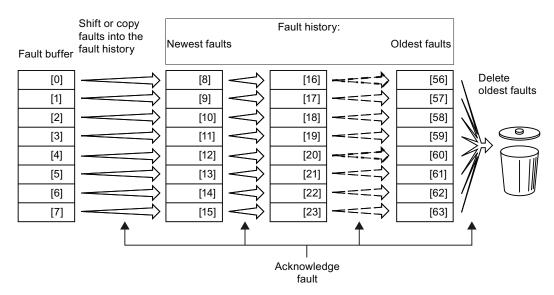


Figure 9-8 Fault history after acknowledging the faults

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

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

The inverters shifts the values previously saved in the fault history each by eight indices. Faults, which were saved in indices 56 ... 63 before the acknowledgement, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Table 9-7 Important parameters for faults

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

The motor cannot be switched-on

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

- Is a fault present?
 If yes, then remove the fault cause and acknowledge the fault
- Does p0010 = 0?
 If not, the inverter is e.g. still in a commissioning state.
- Is the inverter reporting the "ready to start" status (r0052.0 = 1)?
- Is the inverter missing enabling (r0046)?
- Are the command and setpoint sources for the inverter (p0015) correctly parameterized?
 In other words, where is the inverter getting its speed setpoint and commands from (fieldbus or analog input)?
- Do the motor and inverter match?
 Compare the data on the motor's nameplate with the corresponding parameters in the inverter (P0300 ff).

Extended settings for faults

Table 9-8 Advanced settings

Parameter	Description		
You can cha	nge 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 cha	nge 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 cha	nge 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.

Axxxxx Alarm Fyyyyy: Fault

Table 9-9 The most important alarms and faults of the safety functions

Number	Cause	Remedy
F01600	STOP A initiated	Select STO and then deselect again
F01650	Acceptance test required	Carry out acceptance test and create test certificate.
		Switch the Control Unit off and then on again.
F01659	Write task for parameter rejected	Cause: A parameter reset was selected. The fail-safe parameters have not yet been reset, as the safety functions are enabled
		Remedy: block safety functions or reset fail-safe parameters (p0970 = 5), then reset the drive parameters once again.
A01666	Static 1 signal on the F-DI for secure acknowledgement	Setting F-DI to logical 0 signal
A01698	Commissioning mode active for safety functions	This message is withdrawn after the safety functions have been commissioned
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 initiated	Select STO and then deselect again

Table 9- 10 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.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U _{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.

Number	Cause	Remedy
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 9- 11 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 ≠ 0 ms and one of the following causes is present:
		The bus connection is interrupted
		The MODBUS master is switched off
		Communications error (CRC, parity bit, logical error)
		An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
F03505	Analog input, wire break	Check the 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?

Number	Cause	Remedy
F06310	Supply voltage (p0210) incorrectly	Check the parameterized supply voltage and if required change (p0210).
	parameterized	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	The alarm automatically disappears after one of the following measures:
	controller active	Increase the current limit (p0640).
		Reduce the load.
		Slow down the up ramp for the setpoint speed.
F07426	Technology controller actual value	
101720	limited	Adapt the limits to the signal level (p2267, p2268). Observe the production and the page 1 in the page 2 in
		Check the actual value scaling (p2264).

Number	Cause	Remedy
F07801	Motor overcurrent	Check current limits (p0640).
		Vector control: Check current controller (p1715, p1717).
		U/f control: Check the current limiting controller (p1340 p1346).
		Increase acceleration ramp (p1120) or reduce load.
		Check motor and motor cables for short circuit and ground fault.
		Check 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 $1\dots 3$.
		Remedy: Rectify the cause of this alarm.
F07860 F07861 F07862	External fault 1 3	Remove the external causes for this fault.
F07900	Motor blocked	Check that the motor can run freely.
1 07 000	Wotor Brooked	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).
. 0.00.	oto: overepeed	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.
1.0.000		Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load.
		Check the motor's ambient temperature.
		Check the KTY84 sensor.
		Check the overtemperatures of the thermal model (p0626 p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve.
A07921	Torque/speed too high	, , , , , , , , , , , , , , , , , , , ,
	1 1 1	

Number	Cause	Remedy
A07922	Torque/speed out of tolerance	Check the connection between the motor and the load.
		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.
F30001	Overcurrent	Check the following:
		Motor data, if required, carry out commissioning
		Motor connection method (Y / Δ)
		U/f operation: Assignment of rated currents of motor and Power Module
		Line quality
		Make sure that the line commutating reactor is connected properly
		Power cable connections
		Power cables for short-circuit or ground fault
		Power cable length
		Line phases
		If this doesn't help:
		U/f operation: Increase the acceleration ramp
		Reduce the load
		Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121).
		Set the rounding times (p1130, p1136).
		Activate the DC link voltage controller (p1240, p1280).
		Check the line voltage (p0210).
		Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Converter overtemperature	Check whether the converter fan is running.
		Check whether the ambient temperature is in the permissible range.
		Check whether the motor is overloaded.
		Reduce the pulse frequency.
F30005	I2t converter overload	Check the rated currents of the motor and Power Module.
		Reduce current limit p0640.
		When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the converter's input fuses.
		Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables.
		Increase the ramp-up or ramp-down time (p1120).

Number	Cause	Remedy
F30021	Ground fault	Check the power cable connections.Check the motor.
		 Check the current transformer. Check the cables and contacts of the brake connection (a wire might
		be broken).
F30027	Time monitoring for DC link pre- charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	Check whether the fan is running.
F30036	Overtemperature, inside area	Check the fan filter elements.
		Check whether the ambient temperature is in the permissible range.
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.
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.
F30059	Internal fan defective	Check the internal fan and if required replace.

For further information, please refer to the List Manual.

Technical data 10

10.1 Technical data, CU240B-2 Control Unit

Feature	Data
Operating voltage	Supply from the Power Module or an external 24 V DC supply (20.4 V 28.8 V, 1 A) via control terminals 31 and 32
Heat loss	5.0 W plus power loss of output voltages
Output voltages	18 V to 30 V (max. 200 mA) 10 V ±0.5 V (max. 10 mA)
Setpoint resolution	0.01 Hz
Digital inputs	• 4 digital inputs, DI 0 DI 3, isolated;
	• Low < 5 V, high > 11 V, maximum input voltage 30 V, current consumption 5.5 mA
	Response time: 10 ms without debounce time (p0724)
Analog input	Al 0: 12-bit resolution, differential input, 0 V 10 V, 0 mA 20 mA and -10 V +10 V Reaction time: 13 ms ± 1 ms Can be configured as additional digital input: Low < 1.6 V, High > 4.0 V Reaction time: 13 ms ± 1 ms without debounce time (p0724)
Digital output	DO 0: Relay output 30 V DC / max. 0.5 A with resistive load, update time 2 ms
	For applications, which require UL certification, the voltage at DO 0 must not exceed 30 V DC referred to ground potential and must be supplied via a grounded class 2 power supply.
Analog output	AO 0: 0 V \dots 10 V or 0 mA \dots 20 mA, reference potential: "GND", resolution 16 bit, update time: 4 ms
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω , switching threshold 1650 Ω
	• KTY84
	ThermoClick sensor with dry contact
USB interface	Mini-B
Dimensions (WxHxD)	73 mm × 199 mm × 46 mm
Weight	0.49 kg
Memory cards	MMC (we recommend a card with Order No. 6SL3254-0AM00-0AA0).
	SD (Secure Digital Memory Card, we recommend the card with Order No. 6ES7954-8LB00-0AA0). SDHC (SD High Capacity) cannot be used.
Operating temperature	0 °C 55 °C (operation without inserted operator panel) 0 °C 50 °C (operation with inserted operator panel)
	Observe any possible restrictions as a result of the Power Module.

10.2 Technical data, CU240E-2 Control Unit

Feature	Data			
Operating voltage	Supply from the Power Module or an external 24 V DC supply (20.4 V 28.8 V, 0.5 A) via control terminals 31 and 32			
Heat loss	5.0 W plus power loss of output voltages			
Output voltages	18 V to 30 V (max. 200 mA) 10 V ±0.5 V (max. 10 mA)			
Setpoint resolution	0.01 Hz			
Digital inputs	6 digital inputs, DI 0 DI 5, isolated;			
	• Low < 5 V, high > 11 V, maximum input voltage 30 V, current consumption 5.5 mA			
	Response time: 10 ms without debounce time (p0724)			
Pulse input	Digital input 3, maximum pulse frequency 32 kHz			
Analog inputs (differential inputs, resolution 12 bits)	Al 0, Al 1: 12-bit resolution, differential inputs, 0 V 10 V, 0 mA 20 mA and -10 V +10 V, reaction time: 13 ms \pm 1 ms Can be configured as additional digital inputs: Low < 1.6 V, High > 4.0 V. Reaction time: 13 ms \pm 1 ms without debounce time (p0724).			
Digital outputs / relay	DO 0: Relay output, 30 V DC / max. 0.5 A with resistive load			
outputs	 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 			
	Update time of all DO: 2 ms			
	For applications, which require UL certification, the voltage at DO 0 and at DO 2 must not exceed 30 V DC referred to ground potential and must be supplied via a grounded class 2 power supply.			
Analog outputs	AO 0, AO 1: 0 V 10 V or 0 mA 20 mA, reference potential: "GND", resolution 16 bit, update time: 4 ms			
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω , switching threshold 1650 Ω			
	• KTY84			
	ThermoClick sensor with dry contact			
Fail-safe digital input	DI4 and DI5 form a fail-safe digital input			
(Basic Safety)	Maximum input voltage 30 V, 5.5 mA			
	Response time:			
	Typical: 5 ms + debounce time p9651 (6 ms, if p9651 = 0)			
	- Worst-case scenario: 15 ms + debounce time p9651 (16 ms, if p9651 = 0)			
	You will find the "Extended Safety" data in the Safety Integrated Function Manual, see section Additional information on the inverter (Page 292).			
PFH	5 × 10E-8			
USB interface	Mini-B			
Dimensions (WxHxD)	73 mm × 199 mm × 46 mm			
Weight	0.49 kg			

10.2 Technical data, CU240E-2 Control Unit

Feature	Data
Memory cards	MMC (we recommend a card with Order No. 6SL3254-0AM00-0AA0).
	SD (Secure Digital Memory Card, we recommend the card with Order No. 6ES7954-8LB00-0AA0). SDHC (SD High Capacity) cannot be used.
Operating temperature	0 °C 55 °C (operation without inserted operator panel) 0 °C 50 °C (operation with inserted operator panel)
	Observe any possible restrictions as a result of the Power Module.

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.

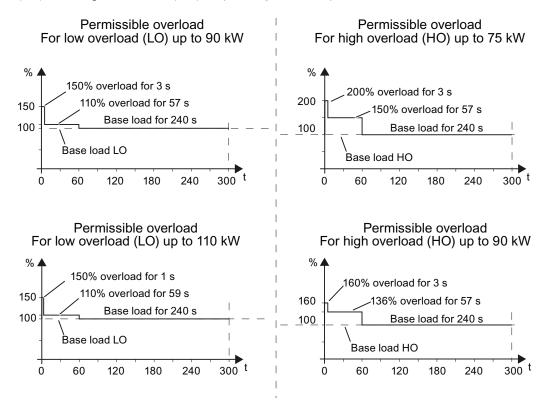


Figure 10-1 Duty cycles, "High Overload" and "Low Overload"

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 292).

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.

NOTICE

UL-certified fuses must be used

In order that the system is in compliance with UL, UL certified fuses, circuit breakers or self-protected combination motor controllers must be used.

10.3.1 Technical 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.

General data, PM240 - IP20

Feature	Version		
Line voltage	3-ph. 380 V 480 V AC ± 10 %		
	The actual permissible line voltage depends on the installation altitude.		
Input frequency	47 Hz 63 Hz		
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. A higher pulse frequency reduces the permissible output current.		
Electromagnetic compatibility	The devices are suitable for environmental classes C1 and C2 in conformance with IEC61800-3. 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		
Operating temperature • without power reduction	LO operation of all power 0 °C +40 °C (32 °F 104 °F) ratings 0 °C +50 °C (32 °F 122 °F) HO operation: 0 °C +40 °C (32 °F 104 °F)		
with power reduction	0.37 kW 110 kW up to 60 °C (140° F), for details, refer to the Hardware HO operation: 132 kW 200 Installation Manual kW all power ratings, HO/LO		
Storage temperature	-40 °C +70 °C (-40 °F 158 °F)		
Relative humidity	< 95 % RH - condensation not permissible		
Environmental requirements	Protected according to environmental class 3C2 to EN 60721-3-3 against damaging chemical substances		
Shock and vibration	Do not allow the inverter to fall and avoid it being subject to hard shocks. Do not install the inverter in an area where it could be continuously subject to vibration.		
Electromagnetic radiation	Do not install the inverter close to sources of electromagnetic radiation.		
Installation altitude • without power reduction • with power reduction	0.37 kW 132 kW up to 1000 m (3300 ft) above sea level up to 2000 m (6500 ft) above sea level all power ratings up to 4000 m (13000 ft) above sea level, for details refer to the		
Standards	Hardware Installation Manual. UL, cUL, CE, C-tick, SEMI F47 In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.		

Power-dependent data, PM240 - IP20

Table 10- 1 PM240 frame size A, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number Without filter	6SL3224-0BE13-7UA0	6SL3224-0BE15-5UA0	6SL3224-0BE17-5UA0
Values based on Low Overload			
 LO power 	0.37 kW	0.55 kW	0.75 kW
LO input current	1.6 A	2.0 A	2.5 A
LO output current	1.3 A	1.7 A	2.2 A
Values based on High Overload			
HO power	0.37 kW	0.55 kW	0.75 kW
HO input current	1.6 A	2.0 A	2.5 A
HO output current	1.3 A	1.7 A	2.2 A
General values			
 Power loss 	0.097 kW	0.099 kW	0.102 kW
• Fuse	10 A	10 A	10 A
 Cooling air requirement 	4.8 l/s	4.8 l/s	4.8 l/s
 Cable cross-section for line and 			
motor connection	1 2.5 mm²	1 2.5 mm ²	1 2.5 mm²
 Torque for line and motor and 			
motor connection	1.1 Nm	1.1 Nm	1.1 Nm
Weight	1.2 kg	1.2 kg	1.2 kg

Table 10- 2 PM240 frame size A, 3-ph. 380 V AC... 480 V, ± 10 %

Order number Without filter	6SL3224-0BE21-1UA0	6SL3224-0BE21-5UA0			
Values based on Low Overload	Values based on Low Overload				
 LO power 	1.1 kW	1.5 kW			
LO input current	3.8 A	4.8 A			
LO output current	3.1 A	4.1 A			
Values based on High Overload					
HO power	1.1 kW	1.5 kW			
HO input current	3.8 A	4.8 A			
HO output current	3.1 A	4.1 A			
General values					
 Power loss 	0.108 kW	0,114 kW			
• Fuse	10 A	10 A			
 Cooling air requirement 	4.8 l/s	4.8 l/s			
 Cable cross-section for line and 					
motor connection	1 2.5 mm²	1 2.5 mm²			
 Torque for line and motor and 					
motor connection	1.1 Nm	1.1 Nm			
Weight	1.2 kg	1.2 kg			

Table 10- 3 $\,$ PM240 frame size B, 3-ph. 380 V AC... 480 V, ± 10 %

Order number	with filter	6SL3224-0BE22-2AA0	6SL3224-0BE23-0AA0	6SL3224-0BE24-0AA0
	without filter	6SL3224-0BE22-2UA0	6SL3224-0BE23-0UA0	6SL3224-0BE24-0UA0
Values based on Low Overload				
 LO power 		2.2 kW	3 kW	4 kW
 LO input curre 	ent	7.6 A	10.2 A	13.4 A
 LO output cur 	rent	5.9 A	7.7 A	10.2 A
Values based or	n High Overload			
 HO power 	•	2.2 kW	3 kW	4 kW
 HO input curr 	ent	7.6 A	10.2 A	13.4 A
 HO output cu 	rrent	5.9 A	7.7 A	10.2 A
General values				
 Power loss 		0.139 kW	0.158 kW	0.183 kW
Fuse		16 A	16 A	16 A
 Cooling air re 	quirement	24 l/s	24 l/s	24 l/s
 Cable cross-s 	section for line and			
motor connection		1.5 6 mm ²	1.5 6 mm ²	1.5 6 mm ²
 Torque for lin 	e and motor and			
motor connec	tion	1.5 Nm	1.5 Nm	1.5 Nm
 Weight 		4.3 kg	4.3 kg	4.3 kg

Table 10- 4 PM240 frame size C, 3-ph. 380 V AC... 480 V, ± 10 %

Order number	with filter without filter	6SL3224-0BE25-5AA0 6SL3224-0BE25-5UA0	6SL3224-0BE27-5AA0 6SL3224-0BE27-5UA0	6SL3224-0BE31-1AA0 6SL3224-0BE31-1UA0
Values based or	n Low Overload			
 LO power 		7.5 kW	11 kW	15 kW
 LO input curre 	ent	21.9 A	31.5 A	39.4 A
LO output cur	rrent	18 A	25 A	32 A
Values based or	n High Overload			
 HO power 	•	5.5 kW	7.5 kW	11 kW
 HO input curr 	ent	16.7 A	23.7 A	32.7 A
HO output current		13.2 A	19 A	26 A
General values				
 Power loss 		0.240 kW	0.297 kW	0.396 kW
Fuse		20 A	32 A	35 A
• Cooling air re	quirement	55 l/s	55 l/s	55 l/s
• Cable cross-s	section for line and			
motor connec	tion	4 10 mm ²	4 10 mm²	4 10 mm²
• Torque for lin	e and motor and			
motor connec	tion	2.3 Nm	2.3 Nm	2.3 Nm
 Weight 		6.5 kg	6.5 kg	6.5 kg

Table 10- 5 $\,$ PM240 frame size D, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number	with filter without filter	6SL3224-0BE31-5AA0 6SL3224-0BE31-5UA0	6SL3224-0BE31-8AA0 6SL3224-0BE31-8UA0	6SL3224-0BE32-2AA0 6SL3224-0BE32-2UA0
Values based on	Low Overload			
 LO power 		18.5 kW	22 kW	30 kW
 LO input curre 	ent	46 A	53 A	72 A
LO output curi	rent	38 A	45 A	60 A
Values based on	High Overload			
 HO power 	•	15 kW	18.5 kW	22 kW
HO input curre	ent	40 A	46 A	56 A
 HO output cur 	rent	32 A	38 A	45 A
General values				
 Power loss 		0.44 kW	0.55 kW	0.72 kW
Fuse		50 A	63 A	80 A
 Cooling air red 	quirement	55 l/s	55 l/s	55 l/s
 Cable cross-se 	ection for line and			
motor connect	ion	10 35 mm²	10 35 mm²	10 35 mm²
 Torque for line 	and motor and			
motor connect	ion	6 Nm	6 Nm	6 Nm
 Weight with fil 	ter	16 kg	16 kg	16 kg
Weight without	t filter	13 kg	13 kg	13 kg

Table 10- 6 PM240 frame size E, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number	with filter without filter	6SL3224-0BE33-0AA0 6SL3224-0BE33-0UA0	6SL3224-0BE33-7AA0 6SL3224-0BE33-7UA0	
Values based on				
 LO power 		37 kW	45 kW	
 LO input curre 	nt	88 A	105 A	
LO output curr	ent	75 A	90 A	
Values based on	High Overload			
 HO power 	_	30 kW	37 kW	
HO input current		73 A	90 A	
HO output curr	rent	60 A	75 A	
General values				
Power loss		1.04 kW	1.2 kW	
• Fuse		100 A	125 A	
 Cooling air req 	luirement	110 l/s	110 l/s	
Cable cross-section for line and				
motor connection		25 35 mm ²	25 35 mm ²	
 Torque for line and motor and 				
motor connection		6 Nm	6 Nm	
Weight with filter		23 kg	23 kg	
 Weight without 	t filter	16 kg	16 kg	

Table 10- 7 $\,$ PM240 frame size F, 3-ph. 380 V AC... 480 V, ± 10 %

Order number	with filter without filter	6SL3224-0BE34-5AA0 6SL3224-0BE34-5UA0	6SL3224-0BE35-5AA0 6SL3224-0BE35-5UA0	6SL3224-0BE37-5AA0 6SL3224-0BE37-5UA0
Values based on				
 LO power 		55 kW	75 kW	90 kW
 LO input currer 	nt	129 A	168 A	204 A
LO output curre	ent	110 A	145 A	178 A
Values based on	High Overload			
 HO power 	•	45 kW	55 kW	75 kW
HO input currer	nt	108 A	132 A	169 A
HO output curre	ent	90 A	110 A	145 A
General values				
 Power loss 		1.5 kW	2.0 kW	2.4 kW
Fuse		160 A	200 A	250 A
 Cooling air requ 	uirement	150 l/s	150 l/s	150 l/s
 Cable cross-se 	ction for line and			
motor connection		35 120 mm ²	35 120 mm ²	35 120 mm ²
 Torque for line and motor and 				
motor connection		13 Nm	13 Nm	13 Nm
 Weight with filter 	er	52 kg	52 kg	52 kg
 Weight without 	filter	36 kg	36 kg	36 kg

Table 10- 8 PM240 frame size F, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number Without filter	6SL3224-0BE38-8UA0	6SL3224-0BE41-1UA0	
Values based on Low Overload			
 LO power 	110 kW	132 kW	
LO input current	234 A	284 A	
LO output current	205 A	250 A	
Values based on High Overload			
HO power	90 kW	110 kW	
HO input current	205 A	235 A	
 HO output current 	178 A	205 A	
General values			
 Power loss 	2.4 kW	2.5 kW	
• Fuse	250 A	315 A	
 Cooling air requirement 	150 l/s	150 l/s	
 Cable cross-section for line and 			
motor connection	35 120 mm ²	35 120 mm ²	
 Torque for line and motor and 			
motor connection	13 Nm	13 Nm	
Weight	39 kg	39 kg	

Table 10- 9 PM240 frame size GX, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number	Without filter	6SL3224-0BE41-3UA0	6SL3224-0BE41-6UA0	6SL3224-0BE42-0UA0
Values based on I	Low Overload			
 LO power 		160 kW	200 kW	250 kW
 LO input curren 	ıt	297 A	354 A	442 A
LO output curre	ent	302 A	370 A	477 A
Values based on I	High Overload			
 HO power 		132 kW	160 kW	200 kW
 HO input currer 	nt	245 A	297 A	354 A
HO output curre	ent	250 A	302 A	370 A
General values				
 Power loss 		3.9 kW	4.4 kW	5.5 kW
Fuse		355 A	400 A	630 A
 Cooling air requ 	uirement	360 l/s	360 l/s	360 l/s
 Cable cross-se 	ction for line and			
motor connection	on	95 240 mm ²	120 240 mm ²	185 240 mm²
 Torque for line 	and motor and			
motor connection	on	14 Nm	14 Nm	14 Nm
 Weight 		176 kg	176 kg	176 kg

10.3.2 Technical data, PM250

General data, PM250 - IP20

Feature	Version		
Line voltage	3-ph. 380 V 480 V AC ± 10 %		
	The actual permissible line voltage depends on the installation altitude		
Input frequency	47 Hz 63 Hz		
Modulation depth	93 % (the maximum output voltage is 93 % of the input voltage)		
Power factor λ	0.9		
Starting current	Less than the input current		
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased up to 16 kHz in 2 kHz steps. A higher pulse frequency reduces the permissible output current.		
Electromagnetic compatibility	The devices are suitable for environmental classes C1 and C2 in conformance with IEC61800-3. For details, see the Hardware Installation Manual, Appendix A2		
Braking method	DC braking, energy recovery (up to 100% of the output power)		
Degree of protection	IP20		
Operating temperature • without power reduction • with power reduction	LO operation: 0 °C +40 °C (32 °F 104 °F) HO operation: 0 °C +50 °C (32 °F 122 °F) HO/LO up to 60 °C (140° F), for details see the Hardware Installation		
Storage temperature	-40 °C +70 °C (-40 °F 158 °F)		
Relative humidity	< 95 % RH - condensation not permissible		
Environmental requirements	Protected according to environmental class 3C2 to EN 60721-3-3 against damaging chemical substances		
Shock and vibration	Do not allow the inverter to fall and avoid it being subject to hard shocks. Do not install the inverter in an area where it could be continuously subject to vibration.		
Electromagnetic radiation	Do not install the inverter close to sources of electromagnetic radiation.		
Installation altitude • without power reduction • with power reduction	Up to 1000 m (3300 ft) above sea level up to 4000 m (13000 ft) above sea level, for details see the Hardware Installation Manual.		
Standards	UL, CE, CE, SEMI F47 In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.		

Power-dependent data, PM250 - IP20

Table 10- 10 PM250 frame size C, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number	6SL3225-0BE25-5AA0	6SL3225-0BE27-5AA0	6SL3225-0BE31-1AA0
Values based on Low Overload			
 LO power 	7.5 kW	11.0 kW	15 kW
LO input current	18.0 A	25.0 A	32.0 A
LO output current	18.0 A	25.0 A	32.0 A
Values based on High Overload			
HO power	5.5 kW	7.5 kW	11.0 kW
HO input current	13.2 A	19.0 A	26.0 A
HO output current	13.2 A	19.0 A	26.0 A
General values			
 Power loss 	Available soon	Available soon	Available soon
• Fuse	20 A	32 A	35 A
 Cooling air requirement 	38 l/s	38 l/s	38 l/s
Cable cross-section for line and			
motor connection	2.5 10 mm ²	4 to 10 mm ²	6 to 10 mm ²
 Torque for line and motor and 			
motor connection	2.3 Nm	2.3 Nm	2.3 Nm
Weight	7.5 kg	7.5 kg	7.5 kg

Table 10- 11 PM250 frame size D, 3-ph. 380 V AC... 480 V, ± 10 %

Order number	6SL3225-0BE31-5AA0	6SL3225-0BE31-8AA0	6SL3225-0BE32-2AA0
Values based on Low Overload			
 LO power 	18.5 kW	22.0 kW	30 kW
LO input current	36.0 A	42.0 A	56.0 A
LO output current	38.0 A	45.0 A	60.0 A
Values based on High Overload			
HO power	15.0 kW	18.5 kW	22.0 kW
HO input current	30.0 A	36.0 A	42.0 A
HO output current	32.0 A	38.0 A	45.0 A
General values			
 Power loss 	0.44 kW	0.55 kW	0.72 kW
• Fuse	50 A	63 A	80 A
 Cooling air requirement 	22 l/s	22 l/s	39 l/s
Cable cross-section for line and			
motor connection	10 35 mm²	10 35 mm²	16 35 mm²
 Torque for line and motor and 			
motor connection	6 Nm	6 Nm	6 Nm
Weight	15 kg	15 kg	16 kg

Table 10- 12 PM250 frame size E, 3-ph. 380 V AC... 480 V, \pm 10 %

Order number	6SL3225-0BE33-0AA0	6SL3225-0BE33-7AA0	
Values based on Low Overload			
 LO power 	37 kW	45 kW	
LO input current	70 A	84 A	
LO output current	75 A	90 A	
Values based on High Overload			
HO power	30.0 kW	37.0 kW	
HO input current	56 A	70 A	
HO output current	60 A	75 A	
General values			
 Power loss 	1 kW	1.3 kW	
• Fuse	100 A	125 A	
 Cooling air requirement 	22 l/s	39 l/s	
 Cable cross-section for line and 			
motor connection	25 35	25 35	
 Torque for line and motor and 			
motor connection	6 Nm	6 Nm	
Weight	21 kg	21 kg	

Table 10- 13 $\,$ PM250 frame size F, 3-ph. 380 V AC... 480 V, ± 10 %

Order number	6SL3225-0BE34-5AA0	6SL3225-0BE35-5AA0	6SL3225-0BE37-5AA0
Values based on Low Overload			
 LO power 	55.0 kW	75 kW	90 kW
LO input current	102 A	190 A	223 A
LO output current	110 A	145 A	178 A
Values based on High Overload			
HO power	45.0 kW	55.0 kW	75 kW
HO input current	84 A	103 A	135 A
HO output current	90 A	110 A	145 A
General values			
 Power loss 	1.5 kW	2 kW	2.4 kW
• Fuse	160 A	200 A	250 A
 Cooling air requirement 	94 l/s	94 l/s	117 l/s
Cable cross-section for line and			
motor connection	35 150 mm ²	70 150 mm ²	95 150 mm ²
 Torque for line and motor and 			
motor connection	13 Nm	13 Nm	13 Nm
Weight	51.0 kg	51.0 kg	51.0 kg

10.3.3 Technical data, PM260

General data, PM260 - IP20

Feature	Version
Line voltage	3-ph. 660 V \dots 690 V AC \pm 10% The permissible line voltage depends on the installation altitude
	The power units can also be operated with a minimum voltage of 500 V -10 %. In this case, the power is linearly reduced as required.
Input frequency	47 Hz 63 Hz
Power factor λ	0.9
Starting current	Less than the input current
Pulse frequency	16 kHz
Electromagnetic compatibility	The devices are suitable for environmental classes C1 and C2 in conformance with IEC61800-3. For details, see the Hardware Installation Manual, Appendix A2
Braking method	DC braking, energy recovery (up to 100% of the output power)
Degree of protection	IP20
Operating temperature • without power reduction • with power reduction	LO operation: 0 °C +40 °C (32 °F 104 °F) HO operation: 0 °C +50 °C (32 °F 122 °F) HO/LO up to 60 °C (140° F), for details see the Hardware Installation Manual
Storage temperature	-40 °C +70 °C (-40 °F 158 °F)
Relative humidity	< 95% RH - condensation not permissible
Environmental requirements	Protected according to environmental class 3C2 to EN 60721-3-3 against damaging chemical substances
Shock and vibration	Do not allow the inverter to fall and avoid it being subject to hard shocks. Do not install the inverter in an area where it could be continuously subject to vibration.
Electromagnetic radiation	Do not install the inverter close to sources of electromagnetic radiation.
Installation altitude without power reduction with power reduction	Up to 1000 m (3300 ft) above sea level up to 4000 m (13000 ft) above sea level, for details see the Hardware Installation Manual.
Standards	CE, C-TICK

Power-dependent data, PM260 - IP20

Table 10- 14 PM260 frame size D, 3-ph. 660 V AC... 690 V, ± 10% (500 V - 10%)

Order number	with filter without filter	6SL3225- 0BH27-5AA1 6SL3225- 0BH27-5UA1	6SL3225- 0BH31-1AA1 6SL3225- 0BH31-1UA1	6SL3225- 0BH31-5AA1 6SL3225- 0BH31-5UA1
Values based or	n Low Overload			
 LO power 		11 kW	15 kW	18.5 kW
 LO input curre 	ent	13 A	18 A	22 A
 LO output cur 		14 A	19 A	23 A
Values based or	n High Overload			
 HO power 	J	7.5 kW	11 kW	15 kW
 HO input curr 	ent	10 A	13 A	18 A
HO output cu	rrent	10 A	14 A	19 A
General values				
 Power loss 		No data	No data	No data
Fuse		25 A	35 A	35 A
 Cooling air re 	quirement	44 l/s	44 l/s	44 l/s
 Cable cross-s 	section for line and			
motor connectio	n	2.5 16 mm ²	2.5 16 mm ²	2.5 16 mm ²
 Torque for line 	e and			
motor connec	tion	1.5 Nm	1.5 Nm	1.5 Nm
 Weight with fi 	lter	23 kg	23 kg	23 kg
 without filter 		22 kg	22 kg	22 kg

Table 10- 15 PM260 frame size F, 3-ph. 660 V AC... 690 V, ± 10% (500 V - 10%)

Order number	with filter without filter	6SL3225- 0BH32-2AA1 6SL3225- 0BH32-2UA1	6SL3225- 0BH33-0AA1 6SL3225- 0BH33-0UA1	6SL3225- 0BH33-7AA1 6SL3225- 0BH33-7UA1
Values based or	n Low Overload			
 LO power 		30 kW	37 kW	55 kW
 LO input curre 	ent	34 A	41 A	60 A
LO output cur	rent	35 A	42 A	62 A
Values based or	n High Overload			
 HO power 	•	22 kW	30 kW	37 kW
HO input curr	ent	26 A	34 A	41 A
HO output cu	rrent	26 A	35 A	42 A
General values				
 Power loss 		No data	No data	No data
Fuse		63 A	80 A	100 A
 Cooling air re 	quirement	130 l/s	130 l/s	130 l/s
• Cable cross-s	section for line and			
motor connectio	n	10 35 mm²	10 35 mm²	10 35 mm²
• Torque for line	e and			
motor connec	tion	6 Nm	6 Nm	6 Nm
 Weight with fi 	lter	58 kg	58 kg	58 kg
 without filter 		56 kg	56 kg	56 kg

Appendix

A.1 Application Examples

A.1.1 Configuring communication in STEP 7

A.1.1.1 Task

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.1.1.2 Required components

The example in this manual is based on the following hardware:

Table A- 1 Hardware components (example)

Component	Туре	Order no.	Qty
Control			
Power supply	PS307 2 A	6ES7307-1BA00-0AA0	1
S7 CPU	CPU 315-2DP	6ES7315-2AG10-0AB0	1
Memory card	MMC 2MB	6ES7953-8LL11-0AA0	1
DIN rail	DIN rail	6ES7390-1AE80-0AA0	1
PROFIBUS connector	PROFIBUS connector	6ES7972-0BB50-0XA0	1
PROFIBUS cable	PROFIBUS cable	6XV1830-3BH10	1
Converter			
SINAMICS G120 Control Unit	CU240E-2 DP	6SL3244-0BB12-1PA1	1
SINAMICS G120 Power Module	Any	-	1
PROFIBUS connector	PROFIBUS connector	6GK1500-0FC00	1

A.1 Application Examples

In order to configure communication you also require the following software packages:

Table A- 2 Software components

Component	Type (or higher)	Order no.	Qty
SIMATIC STEP 7	V5.3 + SP3	6ES7810-4CC07-0YA5	1
STARTER	V4.2	6SL3072-0AA00-0AG0	1

A.1.1.3 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 and assign a project name, e.g. "G120_in_S7". Add an S7 300 CPU.

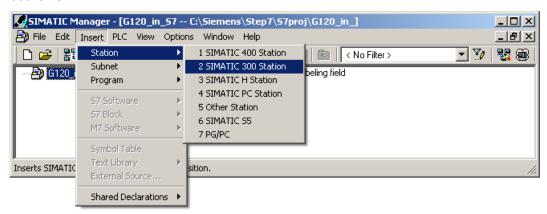


Figure A-1 Inserting a SIMATIC 300 station into a STEP 7 project

- 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.

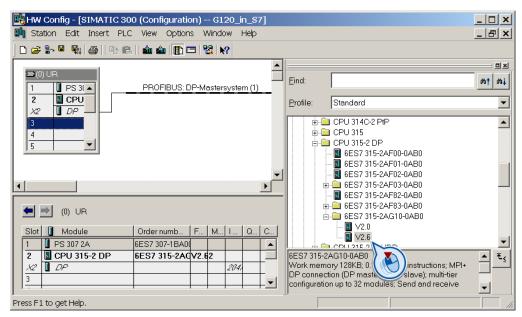


Figure A-2 Inserting a SIMATIC 300 station with PROFIBUS DP network

A.1.1.4 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

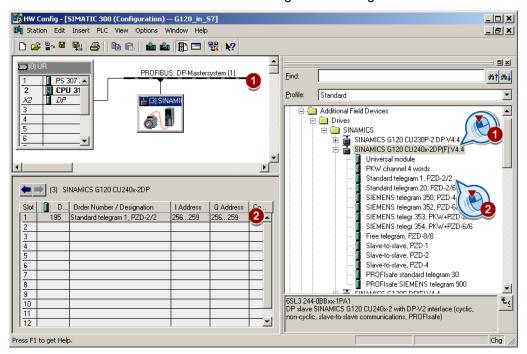
This somewhat more user-friendly method is only available for S7 controls and installed Drive ES Basic (see Section Modularity of the converter system (Page 21)).

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

A.1.1.5 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 105).

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.1.2 STEP 7 program examples

A.1.2.1 STEP 7 program example for cyclic communication

Network 1: Control word 1 and setpoint

Control word 1: 047E hex Setpoint: 2500 hex W#16#47E Τ MW W#16#2500 L Т MWNetwork 2: Acknowledge fault U Ε 0.6 2.7 Μ

Network 3: Switch the motor on and off

U Е 0.0 М 2.0

Network 4: Write process data

L MW 1 Т **PAW** 256 MW3 Т 258 PAW

Status word 1: MW 5

Network 4: Read process data

Actual value: MW 7 PEW 256 Τ MW PEW 258 MW

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 Configuring the fieldbus (Page 101)).

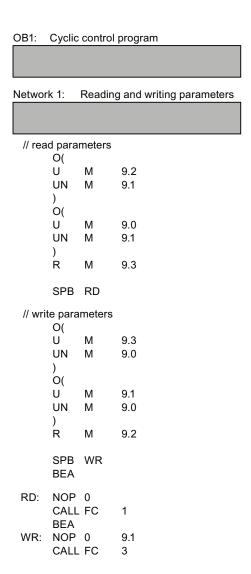
The control cyclically writes the process data to logical address 256 of the inverter. The inverter also writes its process data to logical address 256. You define the address area in HW Config, seeInsert the frequency converter into the STEP 7 project (Page 282).

Table A- 3 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
E	0	0	ON/OFF1	8		0	E0.0
	1	1	ON/OFF2	9		1	
	1	2	ON/OFF3	10		2	
	1	3	Operation enable	11		3	
7	1	4	Ramp-function generator enable	12		4	
	1	5	Start ramp-function generator	13		5	
	1	6	Setpoint enable	14		6	
	0	7	Acknowledge fault	15		7	E0.6
4	0	8	Jog 1	0	0		
	0	9	Jog 2	1	1		
	1	10	PLC control	2	2		
	0	11	Setpoint inversion	3	3		
0	0	12	Irrelevant	4	4		
	0	13	Motorized potentiometer ↑	5	5		
	0	14	Motorized potentiometer ↓	6	6		
	0	15	Data set changeover	7	7		

A.1 Application Examples

A.1.2.2 STEP 7 program example for acyclic communication



```
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 in the Data set communication

(http://support.automation.siemens.com/WW/view/en/15364459).

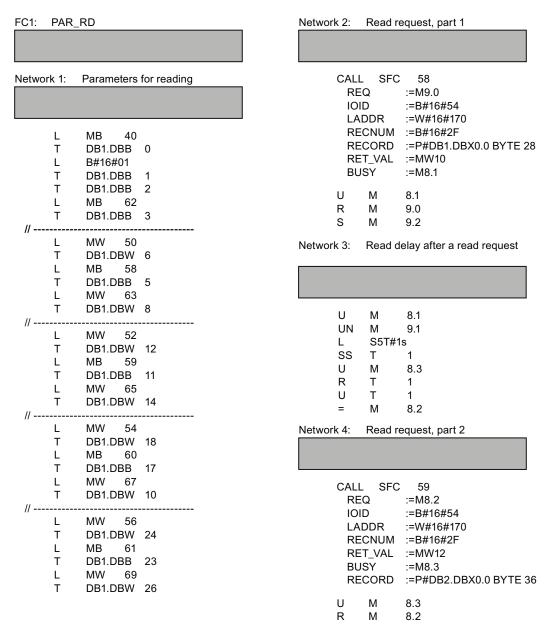


Figure A-3 Reading parameters

A.1 Application Examples

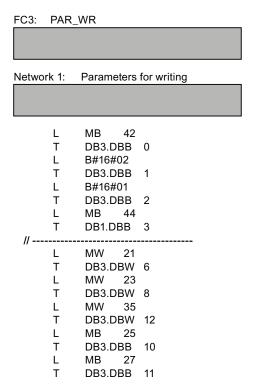
Explanation of FC 1

Table A- 4 Request to read parameters

Data block DB 1	Byte n	Bytes n + 1	n
Header	Reference MB 40	01 hex: Read request	0
	01 hex	Numberof parameters (m) MB 62	2
Address,	Attribute 10 hex: Parameter value	Number of indices MB 58	4
parameter 1	Parameter number MW 50		6
	Number of the 1st index MW 63		8
Address,	Attribute 10 hex: Parameter value	Number of indices MB 59	10
parameter 2	Parameter number MW 52		12
	Number of the 1st index MW 65		14
Address,	Attribute 10 hex: Parameter value	Number of indices MB 60	16
parameter 3	Parameter number MW 54		18
	Number of the 1st index MW 67		20
Address,	Attribute 10 hex: Parameter value	Number of indices MB 61	22
parameter 4	Parameter number MW 56		24
	Number of the 1st index MW 69		26

SFC 58 copies the specifications for the parameters to be read from DB 1 and sends them to the converter as a read request. No other read requests are permitted while this one is being processed.

After the read request and a waiting time of one second, the control takes the parameter values from the converter via SFC 59 and saves them in DB 2.



SFC CALL 58 REQ :=M9.1 IOID :=B#16#54 LADDR :=W#16#170 RECNUM :=B#16#2F RECORD :=P#DB3.DBX0.0 BYTE 14 RET_VAL :=MW10 BUSY :=M8.1

8.1

9.1

9.3

Μ

M

Μ

R

S

Write request:

Network 2:

Figure A-4 Writing parameters

Explanation of FC 3

Table A- 5 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.1.3 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).

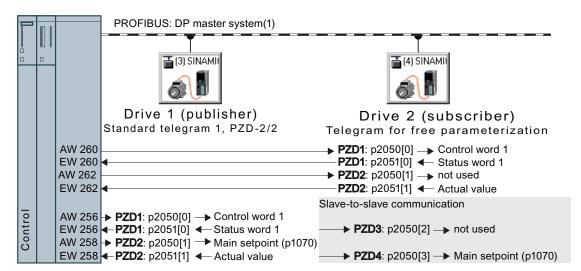
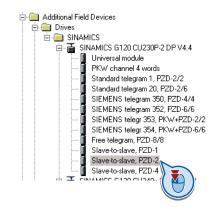


Figure A-5 Communication with the higher-level control and between the drives with slave-to-slave communication

Settings in the control

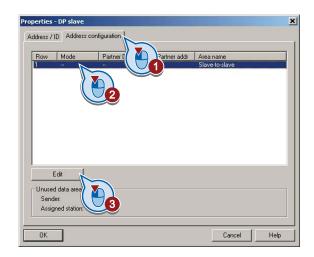
In HW Config in drive 2 (Subscriber), insert a slave-to-slave communication object, e.g. "Slave-to-slave, PZD2".



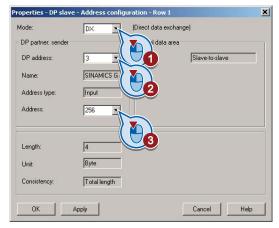
With a double-click, open the dialog box to make additional settings for the slave-to-slave communication.

Slo	: D.	Order Number / Designation	LAddress	Q Address	Co
1	195	Standard telegram 1, PZD-2/2	260263	260263	
2	129	Slave-to-slave, PZD-2			
3					
4					
5					

- 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.



- Select DX for direct data exchange
- ② Select the PROFIBUS address of drive 1 (publisher).
- ③ In the address field, select the start address specifying the data area to be received from drive 1. In the example, these are the status word 1 (PZD1) and the speed actual value with the start address 256.



Close both screen forms with OK. You have now defined the value range for slave-to-slave communication.

In the slave-to-slave communication, drive 2 receives the sent data and writes this into the next available words, in this case, PZD3 and PZD4.

Settings in drive 2 (subscriber)

Drive 2 is preset in such a way that it receives its setpoint from the higher-level control. In order that drive 2 accepts the actual value sent from drive 1 as setpoint, you must set the following:

- In drive 2, set the PROFIdrive telegram selection to "Free telegram configuration with BICO" (p0922 = 999).
- In drive 2, set the source of the main setpoint to p1070 = 2050.3.

A.2 Additional information on the inverter

Table A- 6 Manuals for your inverter

Depth of the information	Manual	Contents	Available languages	Download or order number
+	Getting Started Control Units CU230P-2; CU240B-2; CU240E-2	Installing and commissioning the inverter.	English, German, Italian, French, Spanish	Download manuals (http://support.automation.siemens.com/WW/view/en/2233
+	Getting Started SINAMICS G120 Power Module	Installing the Power Module		9653/133300) Order numbers:
++	Operating instructions	(this manual)		SD Manual Collection (DVD)
+++	Function Manual for Safety Integrated	Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter.	English, German	• 6SL3298-0CA00-0MG0
+++	List Manual Control Units CU240B-2; CU240E-2	Graphic function block diagrams. Complete list of all parameters, alarms and faults.		
+++	Hardware Installation Manual	Installing power modules, reactors and filters.		
	PM240 Power Module	Maintaining power modules.		
	PM250 Power Module			
	PM260 Power Module			
+++	Operation and installation instructions	For inverter accessories, e.g. operator panel, reactors or filters.		

Table A- 7	Support when	configuring and	selecting the	converter

Manual or tool	Contents	Languages	Download or order number
Catalog D 11.1	Ordering data and technical information for the standard SINAMICS G converters	English, German, Italian, French, Spanish	Everything about SINAMICS G120 (www.siemens.en/sinamics-g120)
Online catalog (Industry Mall)	Ordering data and technical information for all SIEMENS products	English, German	
SIZER	The overall configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controls and SIMATIC technology	English, German, Italian, French	You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and in the Internet: Download SIZER (http://support.automation.siemens.com/W W/view/en/10804987/130000)
Configuration Manual	Selecting geared motors, motors and converters using calculation examples	English, German	You can obtain the Configuration Manual from your local sales office.

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, we offer our complete knowledge base on the Internet at: Here, you will 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.3 Mistakes and improvements

A.3 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)

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