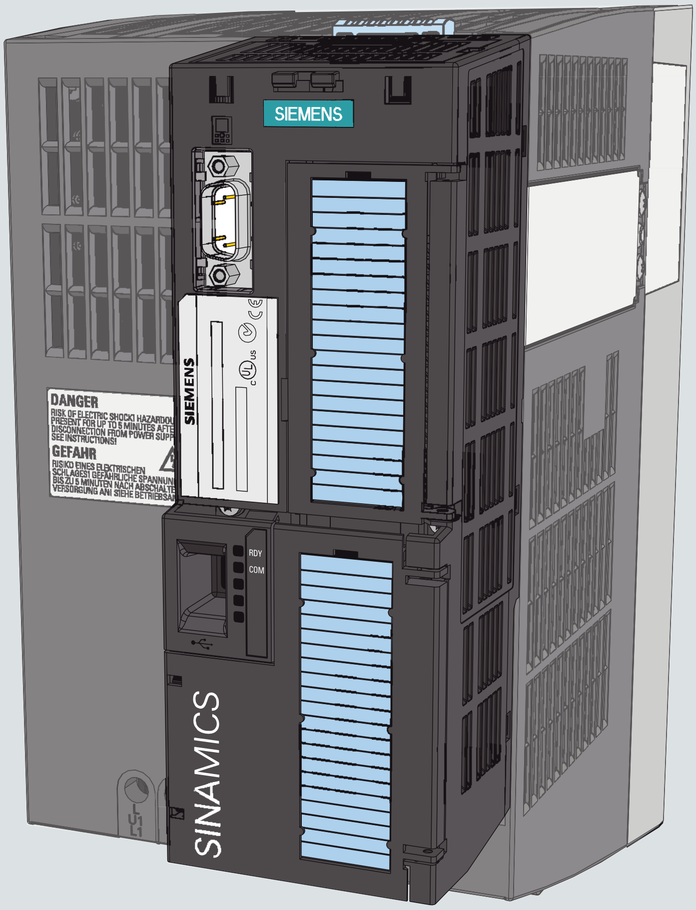
SINAMICS G120

Control Units CU230P-2 HVAC
CU230P-2 DP
CU230P-2 CAN

Operating Instructions · 02/2010 · FW 4.3



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G120
Control Units CU230P-2, FW 4.3

Operating Instructions

Edition 02/2010, FW 4.3

02/2010
A5E02430659B AB

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A5E02430659B AB
Ⓟ 01/2010

Table of contents

1 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.

Mistakes, questions and improvements

If you encounter mistakes when reading this manual or if you have any suggestions for how it can be improved, please contact us as follows:

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1.2 Overview of documentation

Manuals and software are available for every inverter application:

Table 1- 1 Documentation for SINAMICS G120

<table>
<tr><th>Planning and configuring</th><th>Installation and connection</th><th>Commissioning</th><th>Operation</th><th>Service and maintenance</th></tr>
<tr><td>SIZER
engineering tool</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Configuration Manual
Selecting geared motors, motors and inverters using calculation examples</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td colspan="2">Hardware Installation Manual, Power Modules
Comprehensive information on every Power Module. Available for:
• PM230
• PM240
• PM250
• PM260</td><td>---</td><td>---</td><td>Hardware Installation Manual, Power Modules
(refer to the lefthand column)</td></tr>
<tr><td colspan="5">Function Manual, Safety Integrated
Comprehensive information about the integrated safety functions of the CU240E-2 Control Unit</td></tr>
<tr><td>---</td><td colspan="4">Operating instructions
Contains extensive information for most applications. Available for the following Control Units:
• CU230P-2
• CU240B-2 and CU240E-2
• CU240E and CU240S</td></tr>
<tr><td>---</td><td>---</td><td>STARTER
Commissioning tool</td><td>---</td><td>STARTER
(refer to the lefthand column)</td></tr>
<tr><td>---</td><td>---</td><td>Getting Started
For entry level personnel to switch on the motor for the first time.
Available for Control Units:
• CU230P-2
• CU240B-2 and CU240E-2
• CU240E
• CU240S</td><td>---</td><td>---</td></tr>
<tr><td>---</td><td>---</td><td colspan="3">Parameter Manual
Contains detailed lists of all parameters, alarms and faults as well as graphic function block diagrams. Available for the following Control Units:
• CU230P-2
• CU240B-2 and CU240E-2
• CU240E and CU240S</td></tr>
</table>

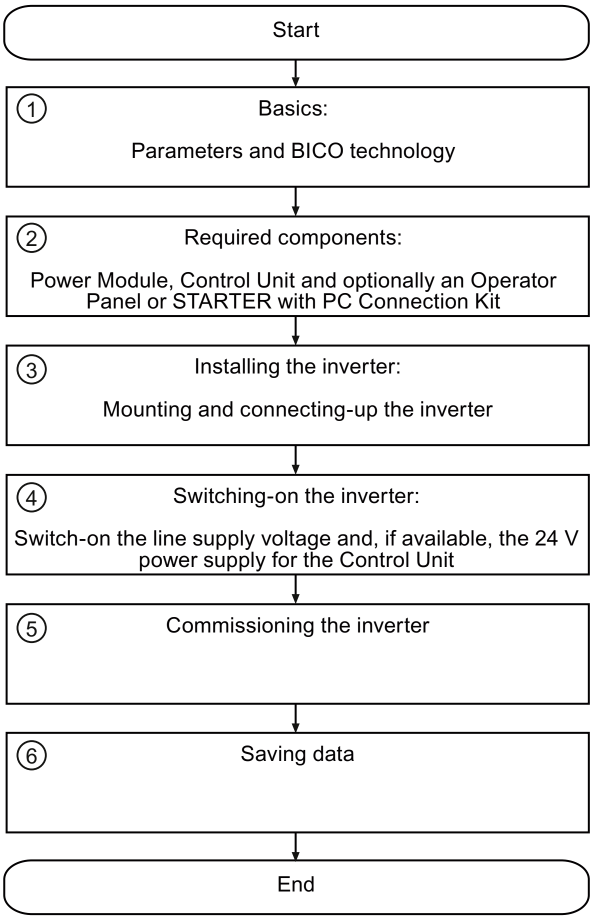
This is how you find the software and the manuals

SIZER	You obtain SIZER on a DVD (Order number: 6SL3070-0AA00-0AG0) and can be downloaded from the Internet: SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)
Configuration Manual	You can obtain the Configuration Manual from your local sales office
STARTER	You obtain STARTER on a DVD (Order number: 6SL3072-0AA00-0AG0) and can be downloaded from the Internet: STARTER (http://support.automation.siemens.com/WW/view/en/10804985/130000)
Getting Started	A paper copy of "Getting Started" is provided with each Control Unit
Operating instructions and manuals	All manuals can be downloaded from the Internet: Documentation (http://support.automation.siemens.com/WW/view/en/22339653/133300) and are additionally available on DVD: SD Manual Collection - all of the manuals on low-voltage motors, geared motors and low-voltage inverters, 5 languages • Order number: 6SL3298-0CA00-0MG0 (supplied once) • Order number: 6SL3298-0CA10-0MG0 (update service for 1 year; supplied 4 times)

1.3 Fast track commissioning

Procedure when commissioning

You can find the information you require to completely commission the inverter in this manual as follows:



① Adapting inverter to application (Page 15)
Frequently required parameters (Page 19)
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② Modularity of the converter system (Page 27)

③ Procedure for installing the frequency inverter (Page 33)

⑤ Commissioning (Page 59)

⑥ Saving and transferring data using the memory card (Page 86)

1.4 Adapting inverter to application

1.4.1 General basics

Adapting the inverter to the drive task

By means of commissioning with prompting, the inverter is adapted to the motor and the drive task so that the motor can be optimally operated and protected.

Functions extending beyond commissioning are activated and adapted by changing parameters directly.

Both commissioning and the parameterization of functions may be undertaken with one of the following operating units:

- Keyboard and display unit (Operator Panel) that is snapped onto the inverter.
  - BOP-2 Basic Operator Panel-2
  - IOP Intelligent Operator Panel
- Software (STARTER commissioning tool) that allows the inverter to be parameterized and controlled from a PC.

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

Many standard applications can function with the default parameters set in the factory

Although inverters can be parameterized for very specific applications, many standard applications can be configured by means of just a few parameters.

Use the factory settings (where possible)

For basic applications, commissioning can be carried out using just the factory settings (see Commissioning with factory settings (Page 65)).

Use quick commissioning (for simple, standard applications)

In the majority of standard applications, commissioning can be carried out by entering or changing just a few parameters during quick commissioning.

1.4.2 Parameter

There are two types of parameters, adjustable and display parameters.

Adjustable parameters

Adjustable parameters are represented with four digits preceded by the letter "P". You can change the value of these parameters within a defined range.

Example:
P0305 is the parameter for the rated motor current in Amps. This parameter is set during commissioning. You can enter values between 0.01 and 10000.

Display parameters

Display parameters are represented with four digits preceded by the letter "r". You cannot change the value of these parameters.

Example:
r0027 is the parameter for the inverter output current. The inverter measures the current and writes the current value to the parameter. You can display the parameter value, e.g. using an analog output of the inverter.

Change protection for setting parameters

The process of changing parameter values is subject to certain conditions. If an attempt to change a parameter is rejected by the inverter, this can have a number of causes:

1. The inverter operating state does not allow you to change parameters.
   For example, certain parameters can only be changed when the inverter is in commissioning mode.
2. In some cases, you may not be able to change certain parameters due to automatic follow-on parameterization.
   Example: Use P0922 to define the PROFIdrive telegram that the inverter uses to communicate with the higher-level control. As follow-on parameterization, P0840 (source of the ON/OFF1 command), for example, is assigned a permanent protected value depending on the value of P0922.

For each parameter, the List Manual specifies whether and which conditions apply for changing the values.

1.4.3 Parameters with follow-on parameterization

When you change certain parameters, the system may automatically change other parameters accordingly. This makes it much easier to parameterize complex functions.

Example: Parameter P0700 (command source)

Parameter P0700 can be used to switch the command source from the fieldbus to digital inputs. When the value of P0700 is changed from 6 (command source "fieldbus") to 2 (command source "digital inputs"), other parameter values are changed automatically:

- New functions are assigned to the digital inputs (P0701 ... P0713)
- New functions are assigned to the digital outputs (P0731 ... P0733)
- Inverter control is interconnected with the signals from the digital inputs (P0800, P0801, P0840, etc.)

You will find more information about follow-on parameterization for P0700 in the List Manual.

1.4.4 Parameter changes, which subsequently result in internal calculations

When changing the following parameters, the inverter is busy with internal calculations for several seconds. During this time, no entries are possible.

- p0014 Buffer mode
- p0340 Calculation of control parameters
- p0970 DO/reset drive
- p0971 DO/save drive
- p1082 Maximum speed
- p3235 Phase failure monitoring time
- p3900 Completion quick commissioning
- p1030 Motorized potentiometer config
- p2230 Tech motorized potentiometer config
- p0918 PROFIBUS address
- p2020 Fieldbus baud rate
- p2021 Fieldbus address
- p2030 Fieldbus selection
- p2042 PROFIBUS ident
- p8620 CAN address
- p0804 Data copy, MMC - flash
- p1900 MotID

This state "busy with internal calculations" is displayed as follows:

- at the BOP-2: "Busy"
- at the IOP: Progress bars

Further, the state can also be read-out using p3996:

- r3996 = 0 Inputs possible
- r3996 > 0 Inverter busy, inputs not possible

1.5 Frequently required parameters

Parameters that in many cases help

Table 1- 2 How to switch to commissioning mode or restore the factory setting

Parameter	Description
P0010 =	Commissioning parameters 0: Ready (factory setting) 1: Perform quick 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- 3 How to determine the firmware version of the Control Unit

Parameter	Description
r0018	The firmware version is displayed:

Table 1- 4 This is how you select the command source of the control signals (ON/OFF, reversing) of the inverter

Parameter	Description
P0700 =	2: Digital inputs (P0701 … P0709); factory setting for inverters without PROFIBUS interface 6: Fieldbus (P2050 … P02091), factory setting for inverters with PROFIBUS interface

Table 1- 5 This is how you select the setpoint source for the speed

Parameters	Description
P1000 =	0: No main setpoint 1: Motorized potentiometer 2: Analog setpoint; factory setting for inverters without PROFIBUS interface 3: Fixed speed setpoint 6: Fieldbus; factory setting for inverters with PROFIBUS interface 7: Analog setpoint 2

Table 1- 6 This is how you parameterize the up and down ramps

Parameters	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- 7 **This is how you set the closed-loop type**

Parameters	Description
P1300 = ...	0: V/f control with linear characteristic (factory setting) 1: V/f control with FCC 2: V/f control with parabolic characteristic 3: V/f control with programmable characteristic 4: V/f control with linear characteristic and ECO 20: Sensorless vector control 22: Sensorless torque control

Table 1- 8 **This is how you optimize the starting behavior of the V/f control for a high break loose torque and overload**

Parameters	Description
P1310 = …	**Voltage boost to compensate resistive losses** The voltage boost is effective from standstill up to the rated speed. The voltage boost continually decreases with increasing speed. The maximum voltage boost is effective at speed zero and is in V: 1.732 × rated motor current (P0305) × stator resistance (r0395) × P1310 / 100%.
P1311 = …	**Voltage when accelerating** The voltage boost is effective from standstill up to the rated speed. The voltage boost is independent of the speed. The voltage boost in V is: 1.732 × rated motor current (P305) × stator resistance (P350) × P1311 / 100%

1.6 Extended scope for adaptation

1.6.1 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.

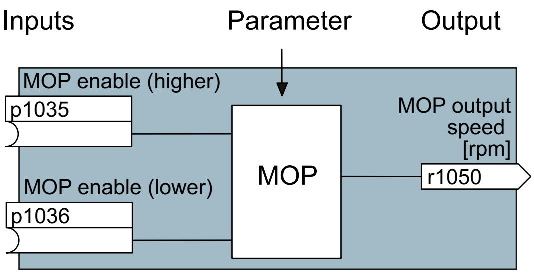


Figure 1-1 Example of a BICO block: Motorized potentiometer (MOP)

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.

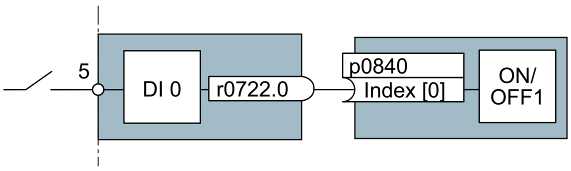


Figure 1-2 Example: Signal interconnection of two BICO blocks for digital input 0

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:

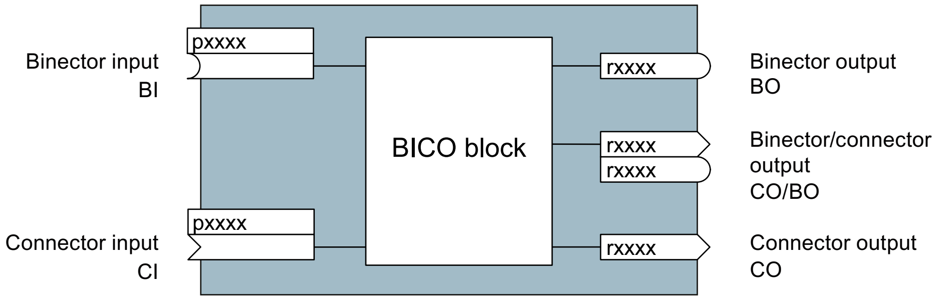


Figure 1-3 BICO symbols

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.

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.

1.6.2 BICO technology: example

Example: Shifting a basic PLC functionality into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 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.

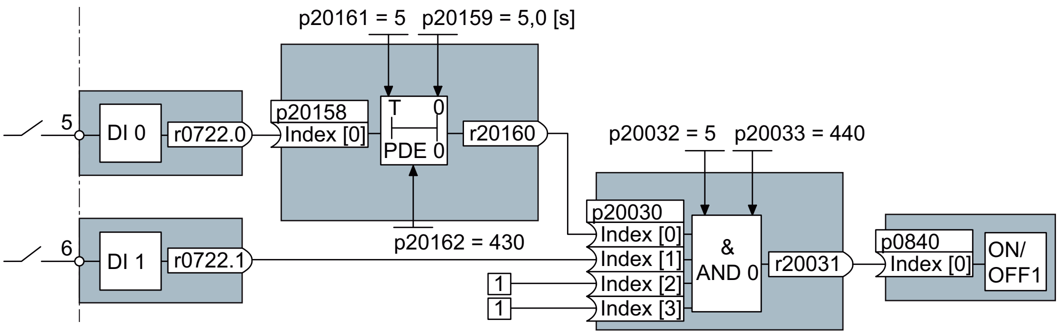


Figure 1-4 Example: Signal interconnection for interlock

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- 9 Parameterizing an interlock

Parameter	Description
P0700 = 2	Selecting the command source: Digital inputs
P0701 = 0	Enable ("open") digital input 0 (DI 0) for BICO parameterization
P0702 = 0	Enable ("open") digital input 1 (DI 1) for BICO parameterization
P20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
P20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
P20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
P20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
P20159 = 5.0	Setting the delay time of the time block: 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

Open the default signal interconnection for BICO parameterization

After selecting the digital inputs as command source (P0700 = 2), digital input 0 is automatically interconnected to the ON/OFF1 command. Parameter P0840[0] has the value 722.0.

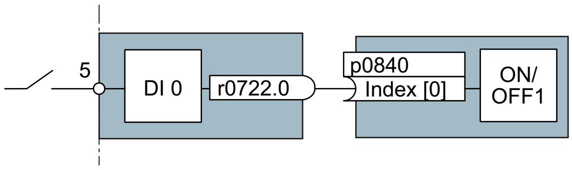


Figure 1-5 Interconnect the BICO block DI 0 and ON/OFF1 command

The setting P0701 = 0 means that this interconnection is disconnected.

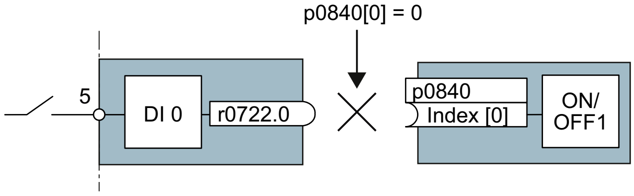


Figure 1-6 Disconnect the default interconnection: p0840[0] = 0

The "ON/OFF1 command" can now be interconnected again using BICO parameterization. The binector input of the BICO block ON/OFF1 is interconnected with the output of the AND logic block (P0840 = 20031).

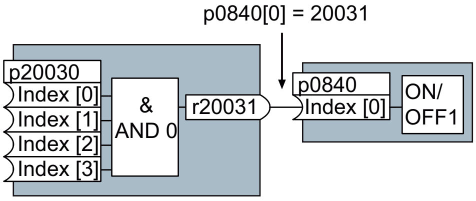


Figure 1-7 Interconnecting two BICO blocks by setting p0840[0] = 20031

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?

Description 2

2.1 Modularity of the converter system

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

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

Main components of the inverter

Each SINAMICS G120 inverter 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 inverter locally or centrally.
- The Power Modules are available for motors with a power range of between 0.37 kW and 250 kW.

Power Module Control Unit

Components for commissioning, diagnostics and controlling inverters

	Intelligent Operator Panel (IOP) • Operator panel for convenient commissioning, diagnostics and controlling of inverters • As handheld device or on the inverter itself • Properties: – Copies drive parameters – Plain text display – Menu-based operation and application wizards.
	Basic Operator Panel-2 (BOP-2) (available soon) • Operator panel for commissioning, diagnostics and controlling of inverters. • is plugged onto the inverter • Properties: – Copies drive parameters – Two-line display – Guided commissioning
	Memory card (MMC or SD) for carrying out standard commissioning of more than one inverter and for external data backup.
	PC Connection Kit, comprising STARTER DVD and USB cable for connecting an inverter to a computer

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 • Adapter for DIN rail mounting • Shield connection kit

2.2 Control Units

The CU230P 2 Control Units have integrated technology functions for pumps, fans and compressor applications. The I/O interfaces, the fieldbus interface and the specific software functions optimally support these applications. The integration of technological functions is a significant differentiating feature to the other Control Units of the SINAMICS G120 drive family.

CU230P-2-specific functions

- Emergency operation
- Multi-zone controller
- Motor staging
- Hibernation
- Bypass

The CU230P-2 is available with the following communications interfaces:

- As **CU230P-2 HVAC** with RS485 interface for:
  - USS
  - Modbus RTU
  - BACnet MS/TP
- As **CU230P-2 DP** for PROFIBUS DP
- As **CU230P-2 CAN** for CANopen

2.3 Power Module

A number of Power Module versions are available for different degrees of protection and line supply voltages in a power range from between 0.37 kW and 250 kW. Different braking methods are available depending on the type of Power Module. Details see Section Braking functions of the converter (Page 221)

Overview of the available Power Modules

Depending on the output, Power Modules are available with different frame sizes The range of frame sizes extends from FSA to FSGX.

Figure 2-1 Power Module versions with IP20 degree of protection

Table 2- 1 Power Modules available with IP20 degree of protection

Size	FSA	FSB	FSC	FSD	FSE	FSF	FSGX
PM240, 3AC 400V - with integrated braking chopper[2]							
Power range (LO)	0.37 kW … 1.5 kW	2.2 kW … 4 kW	7.5 kW … 15 kW	18.5 kW … 30 kW	37 kW … 45 kW	55 kW … 132 kW	160 kW … 250 kW
With integr. Line filter, Class A	○	●	●	●	●	◑[1]	◑[1]
PM250, 3AC 400V - capable of energy recovery							
Power range	-	-	7.5 kW … 15 kW	18.5 kW … 30 kW	37 kW … 45 kW	55 kW … 90 kW	-
With integr. Line filter, class A			●	●	●	●	

● = Feature available; ○ = Feature not available; ◑ = Feature available, modified

1) PM240 Power Modules, 110 kW and higher, are only available without an integrated class A filter. Instead, an optional class A line filter for side mounting is available.

2) An optional braking chopper can be fitted in the PM240 Power Module.

Figure 2-2 PM230 Power Module versions, IP55 degree of protection / UL type 12

Table 2- 2 Power Modules available with IP55 degree of protection

Size	FSA	FSB	FSC	FSD	FSE	FSF
PM230, 3-ph. 400V AC with integrated filter, Class A or Class B						
Power range	0.37 kW … 3 kW	4 kW … 7.5 kW	11 kW … 18.5 kW	22 kW … 30 kW	37 kW … 45 kW	55 kW … 90 kW
With integr. line filter, Class A	●	●	●	●	●	●
With integr. line filter, class B	●	●	●	●	●	●

Note

The power data refer to a duty cycle for low overload (LO)

2.4 Reactors and filters

Overview

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

Power Module	Line-side components			Load-side components	
	Line reactor	Line filters class B	Braking resistor	Sine-wave filter	Output reactor
PM230	-	-	-	-	-
PM240	●	●	●	●	●
PM250	-	●	-	●	●

For further details, refer to the connection example in section Procedure for installing the frequency inverter (Page 33).

3 Connecting

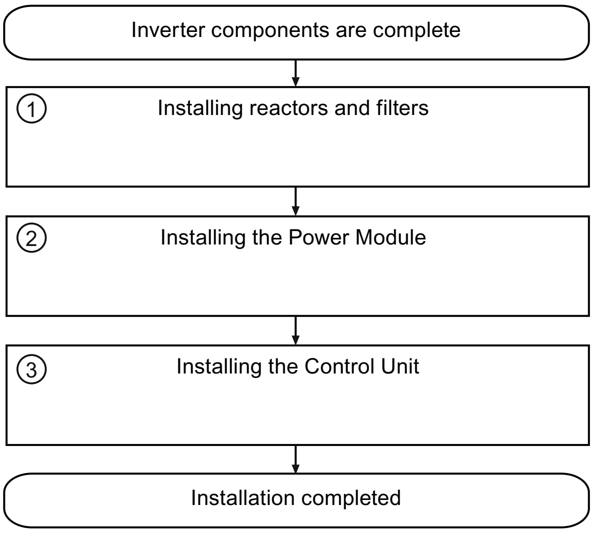
3.1 Procedure for installing the frequency inverter

Prerequisites for installing the inverter

Check that the following prerequisites are fulfilled before you install the inverter:

- Are the components, tools and small parts required for installation available?
- Are the ambient conditions permissible? See Technical data (Page 297).
- Have the cables and wires been routed in accordance with the applicable regulations? See EMC compliant installation for devices with degree of protection IP20 (Page 48).
- Are the minimum distances from other equipment complied with? (Cooling sufficient?) See Dimensions, hole drilling templates, minimum clearances, tightening torques (Page 37).

Installation sequence



① Mounting reactors and filters (Page 34)
② Installing Power Module (Page 36)
③ Installing Control Unit (Page 54)

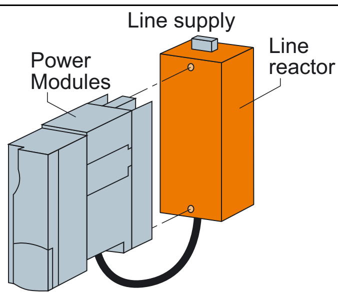
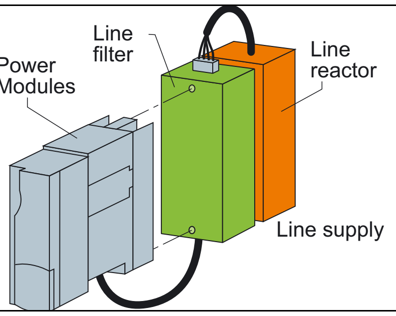
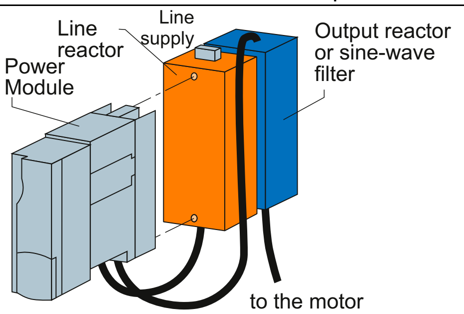
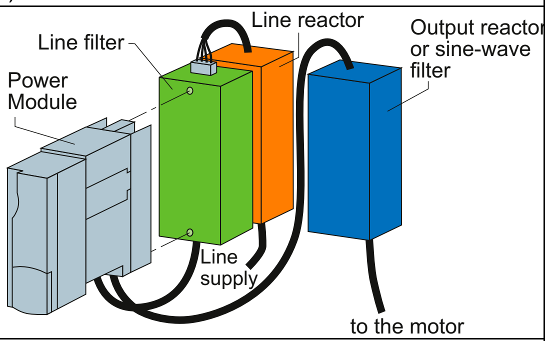
You will find details on how to install the inverter in the Hardware Installation Manual of the Power Module (http://support.automation.siemens.com/WW/view/en/30563173/133300).

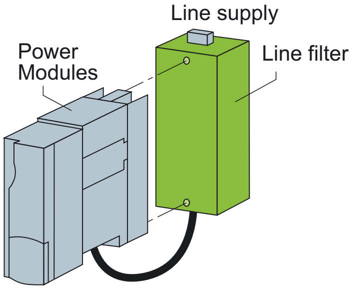
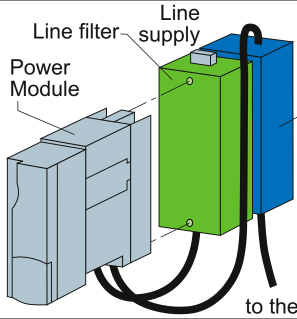
You can start to commission the inverter once installation has been completed.

3.2 Mounting 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.

<table>
<tr><td colspan="2">PM240</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Basic layout of a PM240 Power Module with line reactor as base component</td><td>PM240 Power Module frame size FSA with line reactor and class A line filter</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>PM240: frame size FSA with line reactor and output reactor or sine-wave filter</td><td>PM240 Power Module frame size FSA with line reactor, line filter and output reactor or sine-wave filter</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">PM250</td></tr>
</table>

	
Basic layout of a PM250 Power Module with class B line filter as a base component	Basic layout of a PM250 Power Module with a class B line filter as a base component and output reactor or sine-wave filter

3.3 Installing Power Module

3.3.1 Installing Power Modules

Options for installing Power Modules with degree of protection IP20

Depending on the format, various options are available for installing inverters. This manual describes how to install inverters directly on the cabinet wall.

Installation options	Frame size						
	A	B	C	D	E	F	GX
Installation on standard rails	X	X	X	---	---	---	---
Mounting on a cabinet panel with shield connection kit	X	X	X	X	X	X	---
Installation directly on the cabinet wall	X	X	X	X	X	X	X

Installing Power Modules

Choose the best installation option for your application and install the Power Module in accordance with the instructions provided in this section.

NOTICE

Notes for installing Power Modules

The Power Module must not be installed horizontally.


Correct


Incorrect

Devices that could impede the flow of cooling air must not be installed in this area. Make sure that the ventilation openings for the cooling air for the inverter are not covered and that the flow of cooling air is not obstructed.

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

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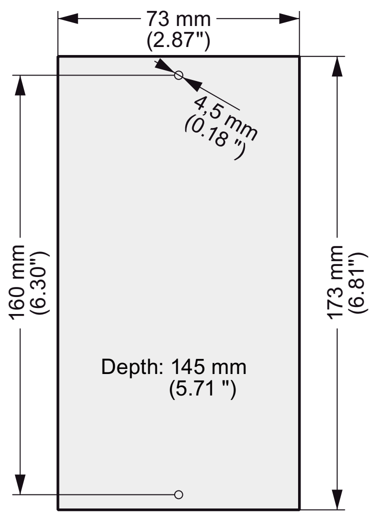
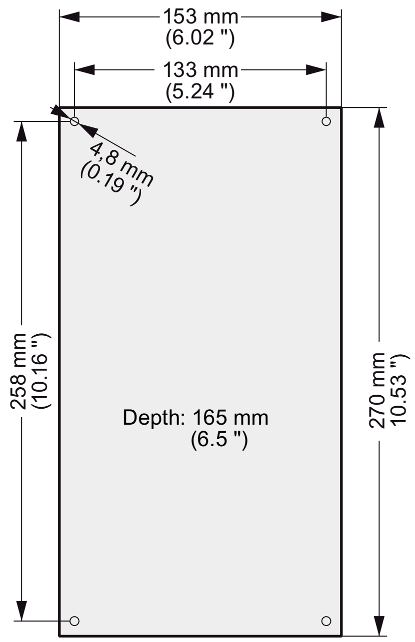
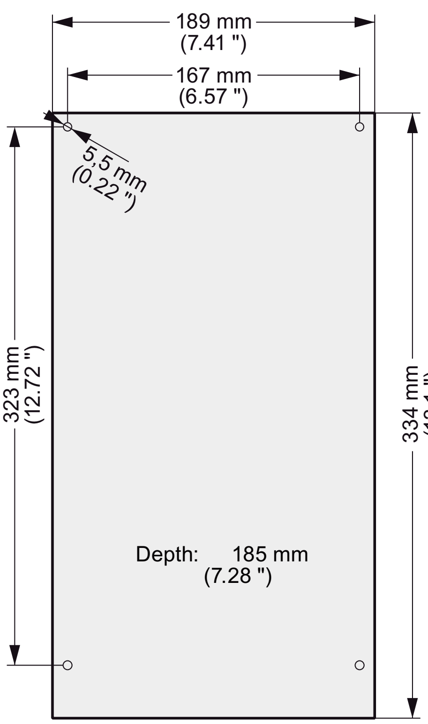
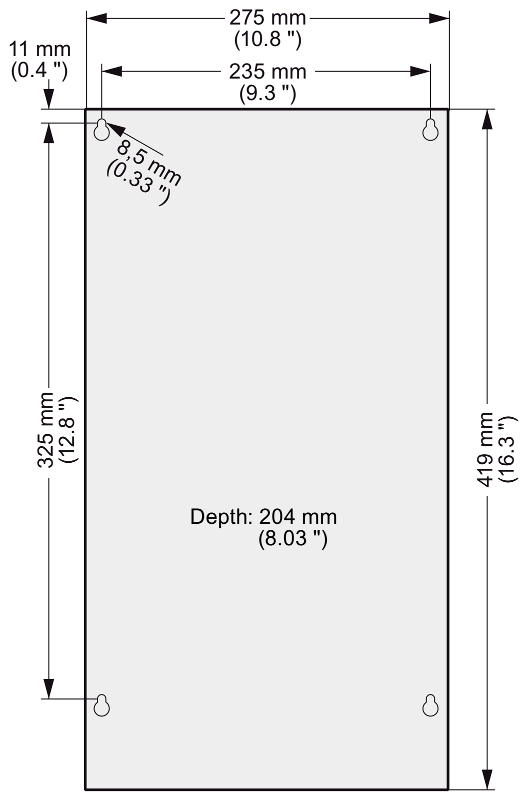
Note

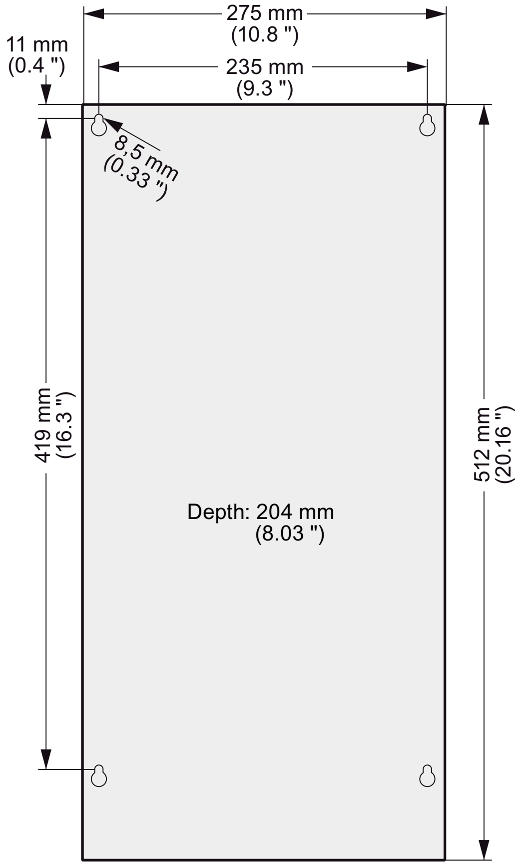
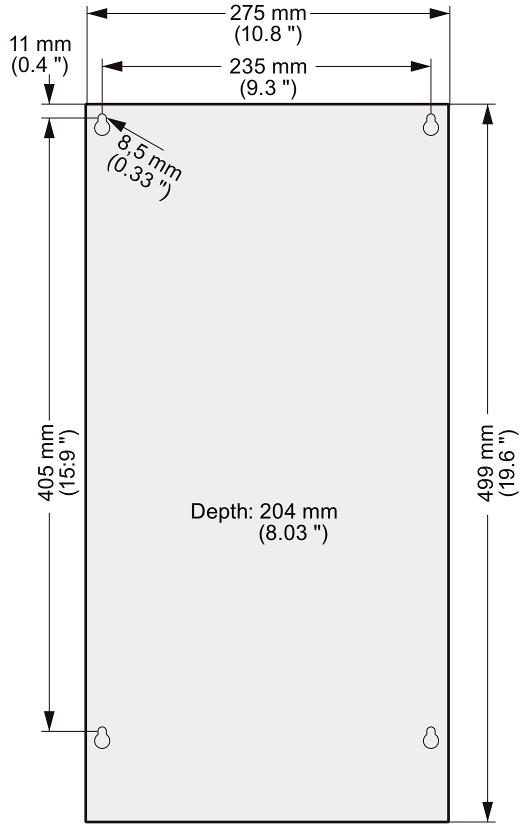
For Power Modules up to 132 kW, degree of protection IP20, the CU230P-2 increases the total inverter depth by 50 mm - and an additional 30 mm if you use an IOP.

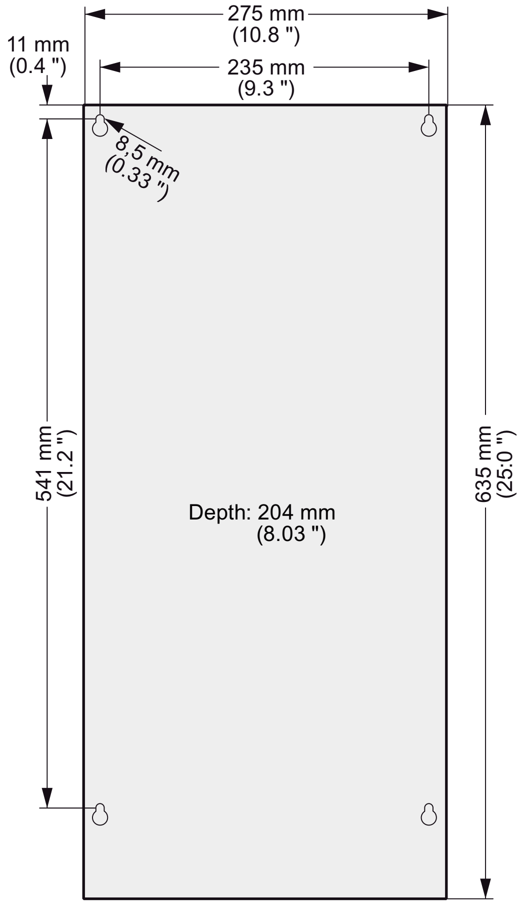
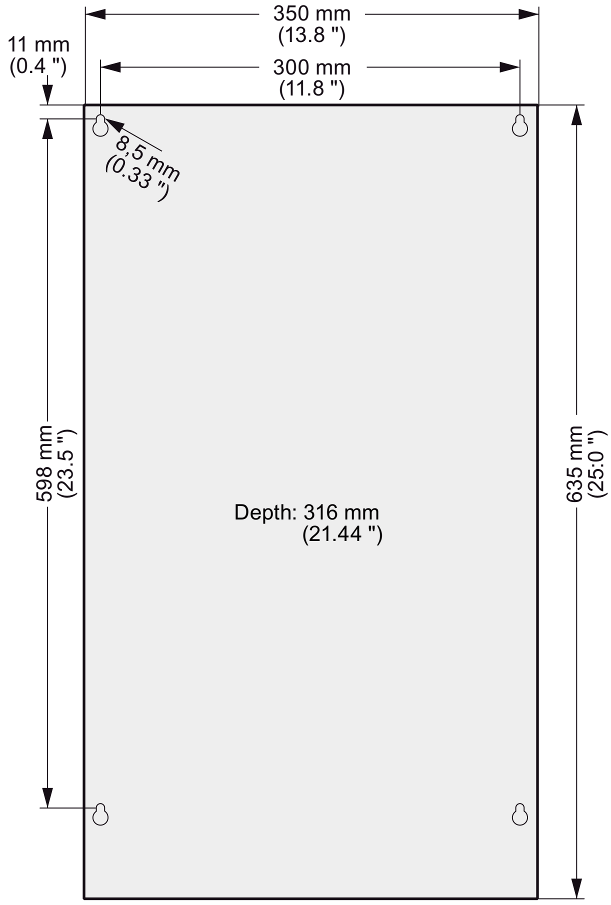
Overview of dimensions and drilling patterns of the PM240 and PM250 Power Modules

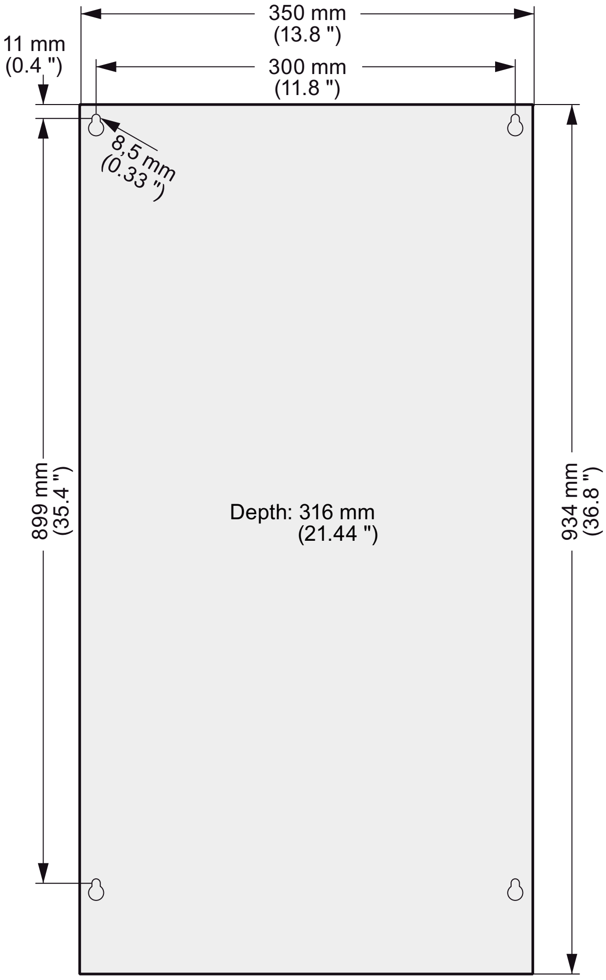
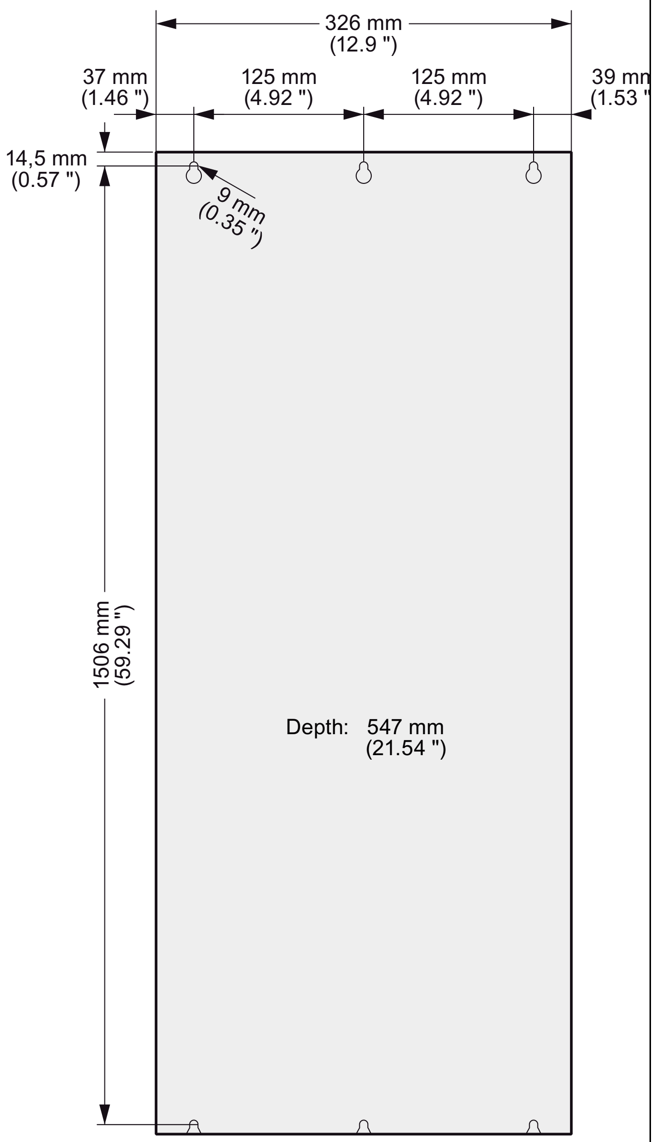
FSA, IP20 • 0.37 kW … 1.5 kW	FSB, IP20 • 2.2 kW … 4 kW
	
• Mounting element: – 2 x M4 bolts – 2 x M4 nuts – 2 x M4 washers • Tightening torques – 2.5 Nm (22.1 lbf.in) • Clearances to other devices – Lateral: up to 40°C: 0 mm (0 inch) from 40°C and higher: 30 mm (1.18 inch) Top/bottom: 100 mm (3.93 inch)	• Mounting element: – 4 x M4 bolts – 4 x M4 nuts – 4 x M4 washers • Tightening torques – 2.5 Nm (22.1 lbf.in) • Clearances to other devices – Lateral up to 40°C: 0 mm (0 inch) from 40°C and higher: 40 mm (1.57 inch) – Top/bottom: 100 mm (3.93 inch)

<table>
<tr><td>FSC, IP20
7.5 kW … 15 kW</td><td>FSD, IP20
18.5 kW … 30 kW without filter</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Mounting element:
– 4 x M5 bolts
– 4 x M5 nuts
– 4 x M5 washers
Tightening torques
– 2.5 Nm (22.1 lbf.in)
Clearances to other devices
– Lateral:
up to 40°C: 0 mm (0 inch)
from 40°C and higher: 50 mm (1.96 inch)

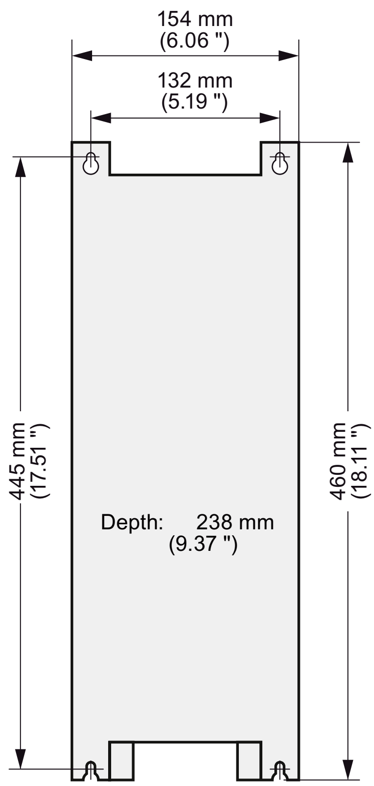
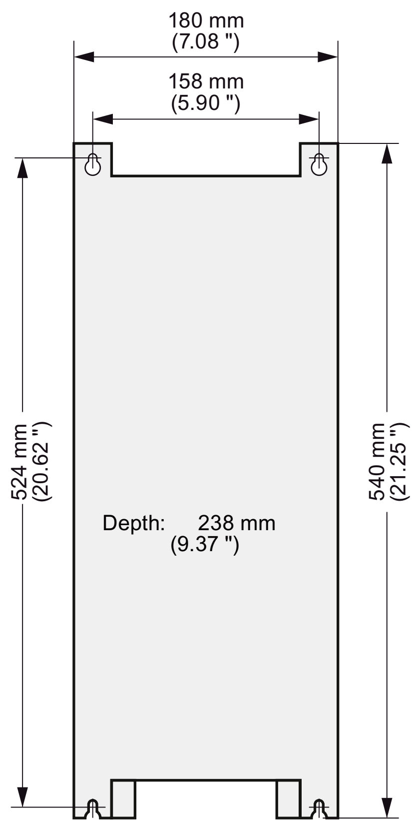
Top/bottom:
125 mm (4.92 inch)</td><td>Mounting elements
– 4 x M6 bolts
– 4 x M6 nuts
– 4 x M6 washers
Tightening torques
– 6 Nm (53 lbf.in)
Clearances to other devices
– Lateral: 0 mm (0 inch)
– Top/bottom: 300 mm (11.81 inch)</td></tr>
</table>

FSD, IP20 • 18.5 kW … 30 kW with filter	FSE, IP20 • 37 kW … 45 kW without filter
	
• Mounting elements – 4 x M6 bolts – 4 x M6 nuts – 4 x M6 washers • Tightening torques – 6 Nm (53 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 300 mm (11.81 inch)	• Mounting elements – 4 x M6 bolts – 4 x M6 nuts – 4 x M6 washers • Tightening torques – 6 Nm (53 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 300 mm (11.81 inch)

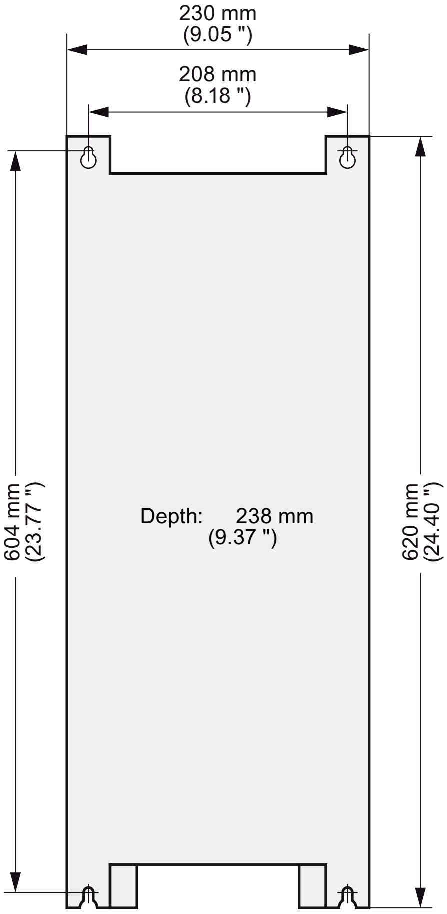
<table>
<tr><td>FSE, IP20
• 37 kW … 45 kW with filter</td><td>FSF, IP20
• 55 kW … 132 kW without filter</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>• Mounting elements
– 4 x M6 bolts
– 4 x M6 nuts
– 4 x M6 washers
• Tightening torques
– 6 Nm (53 lbf.in)
• Clearances to other devices
– Lateral: 0 mm (0 inch)
– Top/bottom: 300 mm (11.81 inch)</td><td>• Mounting elements
– 4 x M8 bolts
– 4 x M8 nuts
– 4 x M8 washers
• Tightening torques
– 13 Nm (115 lbf.in)
• Clearances to other devices
– Lateral: 0 mm (0 inch)
– Top/bottom: 350 mm (13.77 inch)</td></tr>
</table>

FSF, IP20 • 55 kW … 90 kW with filter	FSGX, IP20 • 160 kW … 250 kW for PM240
 Hole drilling template for FSF with filter	
• Mounting elements – 4 x M8 bolts – 4 x M8 nuts – 4 x M8 washers • Tightening torques – 13 Nm (115 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 350 mm (13.77 inch)	• Mounting elements – 6 x M8 bolts – 6 x M8 nuts – 6 x M8 washers • Tightening torques – 13 Nm (115 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top: 250 mm (9.84inch) – Bottom: 150 mm (5.91 inch)

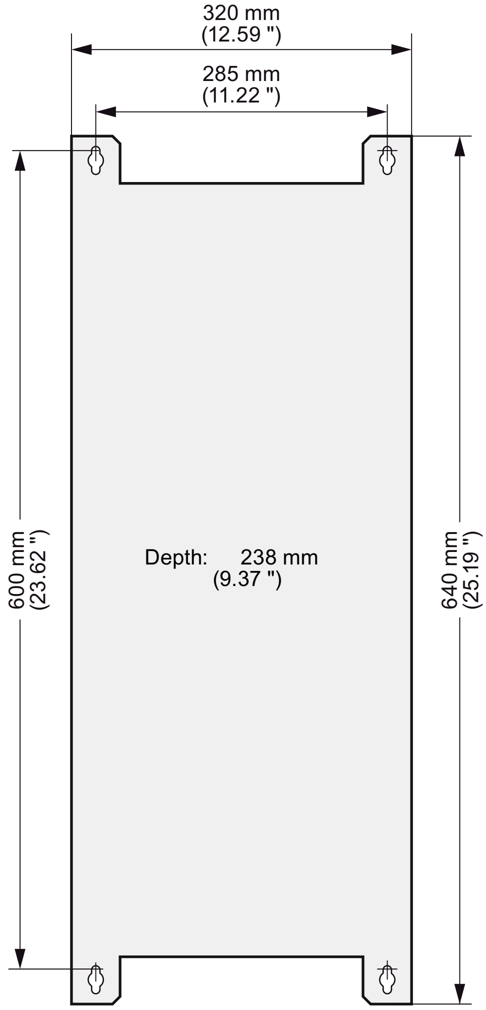
Overview of dimensions and drilling patterns for the PM230 Power Module, degree of protection IP 55 / UL type 12

FSA, IP55 • 0.37 kW … 3 kW	FSB, IP55 • 4 kW … 7.5 kW
	
• Mounting element: – 4 x M4 bolts – 4 x M4 nuts – 4 x M4 washers • Tightening torques – 2.5 Nm (22.1 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 100 mm (3.93 inch)	• Mounting element: – 4 x M4 bolts – 4 x M4 nuts – 4 x M4 washers • Tightening torques – 2.5 Nm (22.1 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 100 mm (3.93 inch)

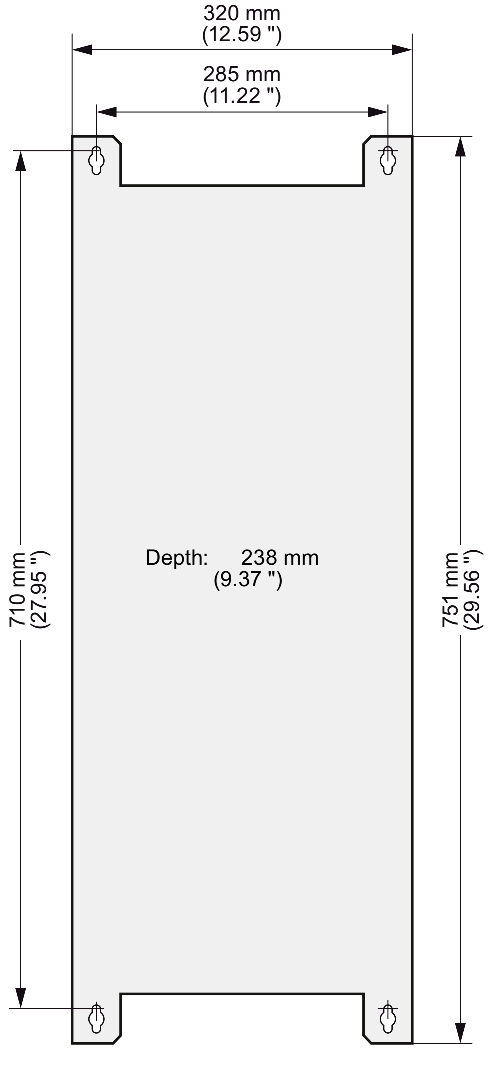
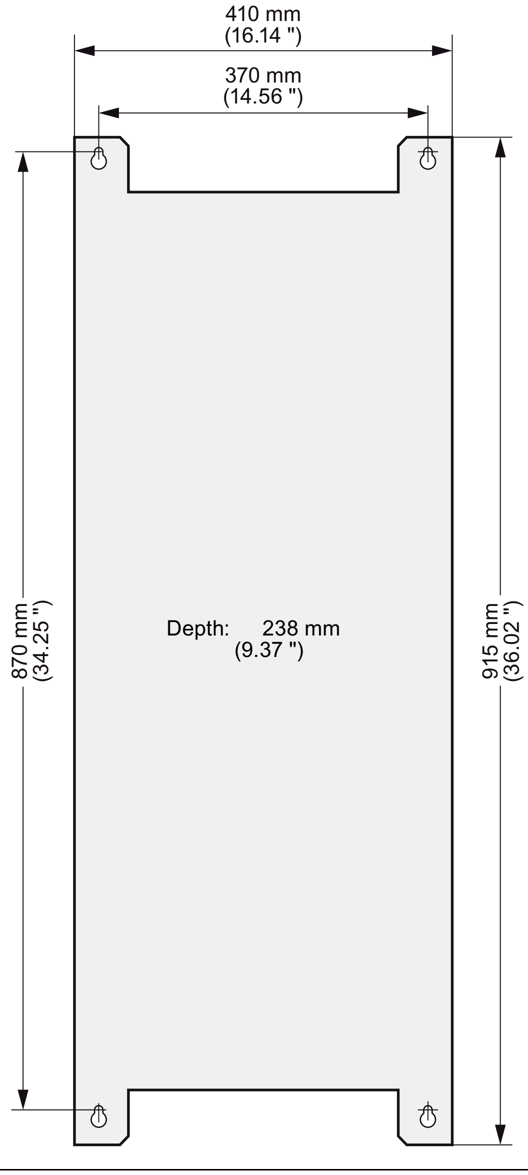
<table>
<tr><td>FSC, IP55
• 11 kW … 18.5 kW</td><td>FSD, IP55
• 22 kW … 30 kW</td></tr>
<tr><td>



</td><td>



</td></tr>
<tr><td>• Mounting element:
– 4 x M5 bolts
– 4 x M5 nuts
– 4 x M5 washers
• Tightening torques
– 2.5 Nm (22.1 lbf.in)
• Clearances to other devices
– Lateral: 0 mm (0 inch)
– Top/bottom: 125 mm (4.92 inch)</td><td>• Mounting elements
– 4 x M8 bolts
– 4 x M8 nuts
– 4 x M8 washers
• Tightening torques
– 13 Nm (115 lbf.in)
• Clearances to other devices
– Lateral: 0 mm (0 inch)
– Top/bottom: 300 mm (11.81 inch)</td></tr>
</table>

FSE, IP55 • 37 kW … 45 kW	FSF, IP55 • 55 kW … 90 kW
	
• Mounting elements – 4 x M6 bolts – 4 x M6 nuts – 4 x M6 washers • Tightening torques – 13 Nm (115 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 300 mm (11.81 inch)	• Mounting elements – 4 x M8 bolts – 4 x M8 nuts – 4 x M8 washers • Tightening torques – 13 Nm (13.77 lbf.in) • Clearances to other devices – Lateral: 0 mm (0 inch) – Top/bottom: 350 mm (13.77 inch)

3.3.3 Connection overview for Power Modules

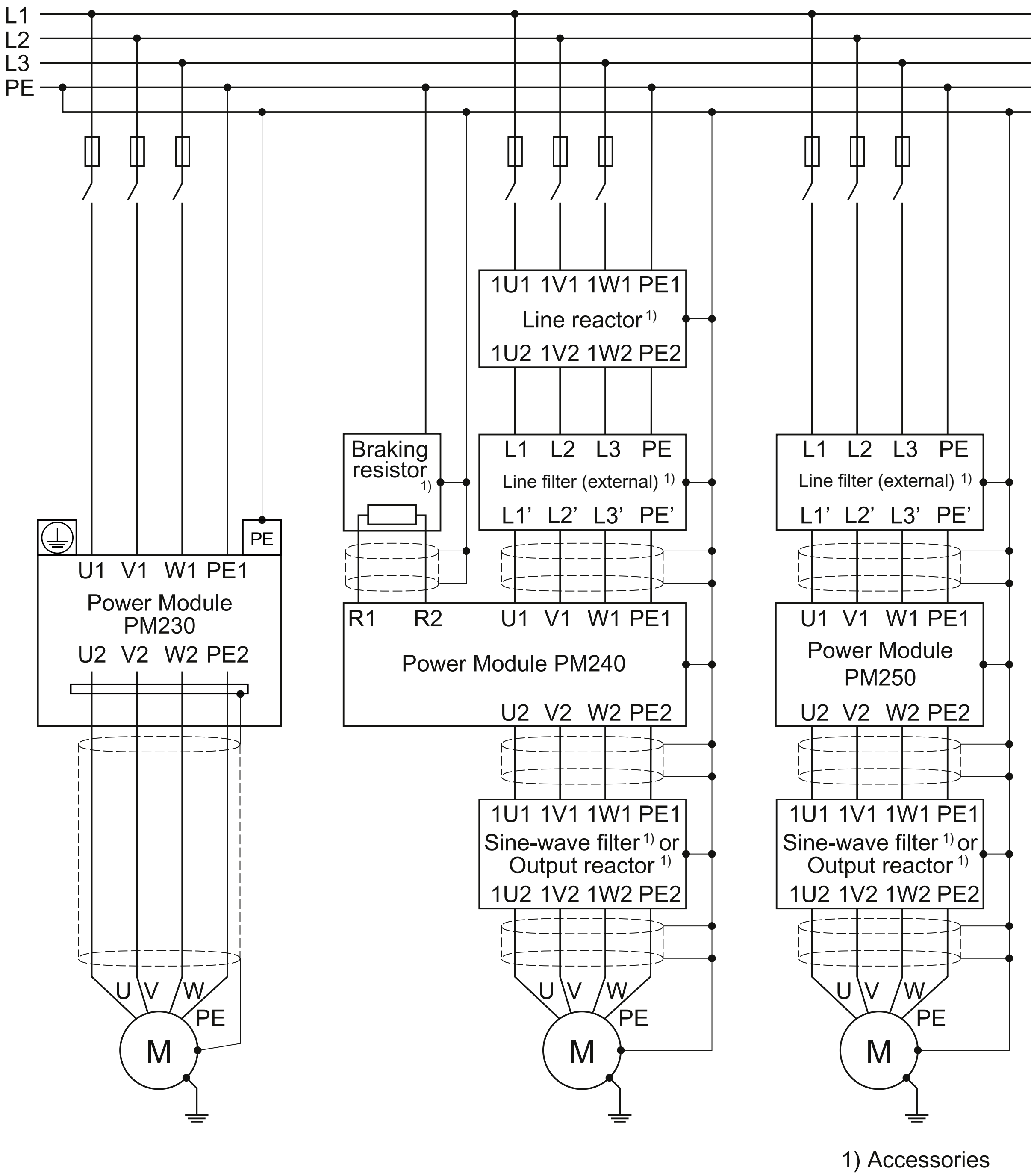


Figure 3-1 Connections for PM230, PM240 and PM250 Power Modules

PM240 and PM250 Power Modules are available with and without integrated class A line filters. Either a Class A or a Class B filter is integrated in the PM230 Power Module.

An external filter has to be installed in PM240 and PM250 Power Modules to satisfy more stringent EMC requirements (Class B).

3.3.4 Wiring Power Modules

Preconditions

Once the Power Module 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 drive unit 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 LEDs 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.

Note

Electrical protective equipment

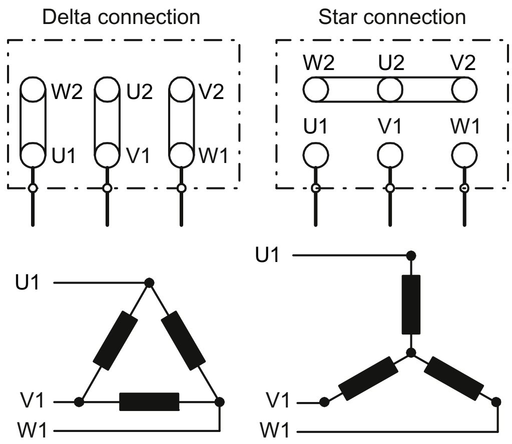
Ensure that the appropriate circuit breakers / fuses for the inverter's rated current are fitted between the line and inverter (see catalog D11.1).

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.



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-up Power Modules

Motor connection

1. If available, open the terminal covers of the Power Module
2. Connect the motor to terminals U2, V2 and W2.
   Carefully observe the regulations for EMC-compliant wiring:
   EMC compliant installation for devices with degree of protection IP20 (Page 48)
   EMC-compliant installation for devices with degree of protection IP55 / UL type 12 (Page 51)
3. Connect the protective conductor of the motor to the terminal ⏚ 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

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

---

Note

Power Modules without an integrated line filter can be connected to grounded (TN, TT) and non-grounded (IT) line supply systems. The Power Modules 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 297).

3.3.5 EMC compliant installation for devices with degree of protection IP20

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 (Power Module PM240 and PM250) must be installed and operated in an enclosed control cabinet.

Control cabinet design

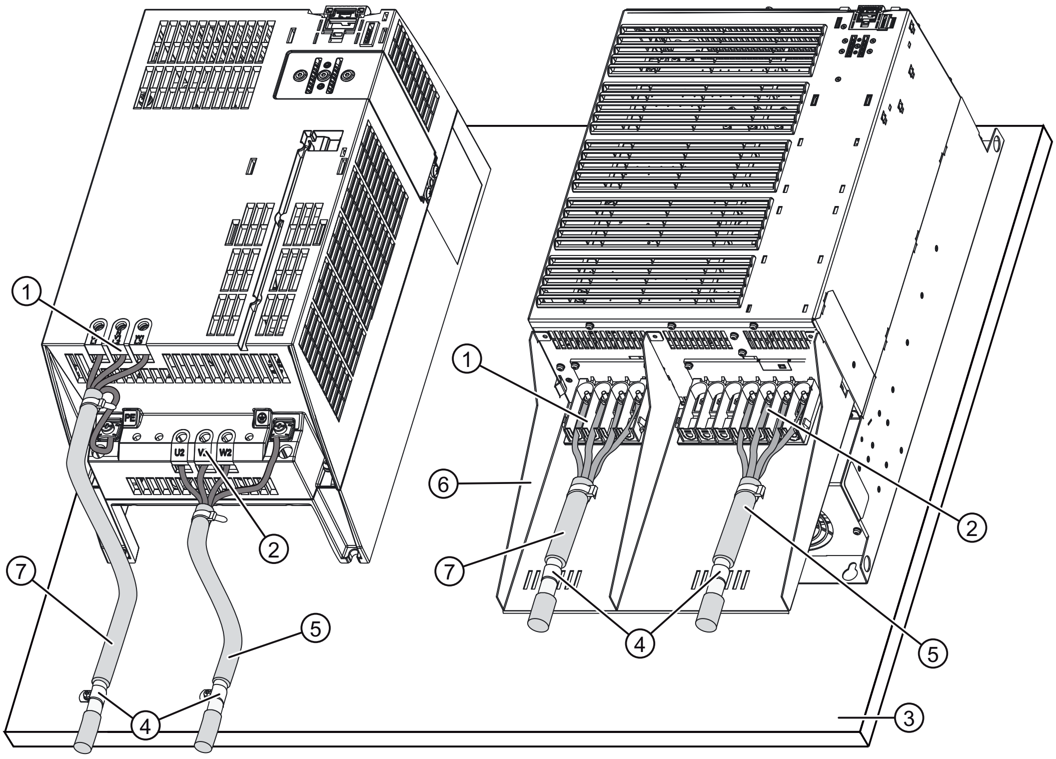
- All metal parts and components of the control cabinet (side panels, rear panels, roof and base plates) must be connected to the control cabinet frame through a good electrical connection – this is best achieved using the highest possible surface area or a high number of individual screw connections
- 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 connection 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 connection 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 connection element for control cables through a low inductive connection through a large surface area.
- Only metallic or metallized connector enclosures must be used for plug connectors for shielded data cables (e.g. PROFIBUS cables)

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

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



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 connection kit.

⑤ Shielded motor cable

⑥ Shield connection kit

⑦ Unshielded cable for Power Modules with integrated line filter.
Shielded cable to connect a Power Module to an external line filter

Figure 3-2 Power Module shielding

Shielding with shield connection kit:	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 connection kit through the greatest possible surface area using shield clamps.
Shielding without shield connection kit:	EMC-compliant shielding can also be implemented without an optional shield connection kit. 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 connection kit through a good electrical connection and through the largest possible surface area.

3.3.6 EMC-compliant installation for devices with degree of protection IP55 / UL type 12

Inverters with degree of protection IP55 (Power Module PM230) can be installed and operated in an enclosed control cabinet as well as without a control cabinet.

Cable routing and shielding

- Line supply cable and motor cable of the inverter should be routed separately away from signal and data cables. The minimum clearance should be approx. 25 cm
- 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 connection 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
- 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 shield support of the inverter through the largest possible surface area and through a low inductive connection
- Only metallic or metallized connector enclosures must be used for plug connectors for shielded data cables (e.g. PROFIBUS cables)

EMC-compliant installation of the inverter

The EMC-compliant installation of the PM230 Power Module and Control Unit is shown in the following diagrams.

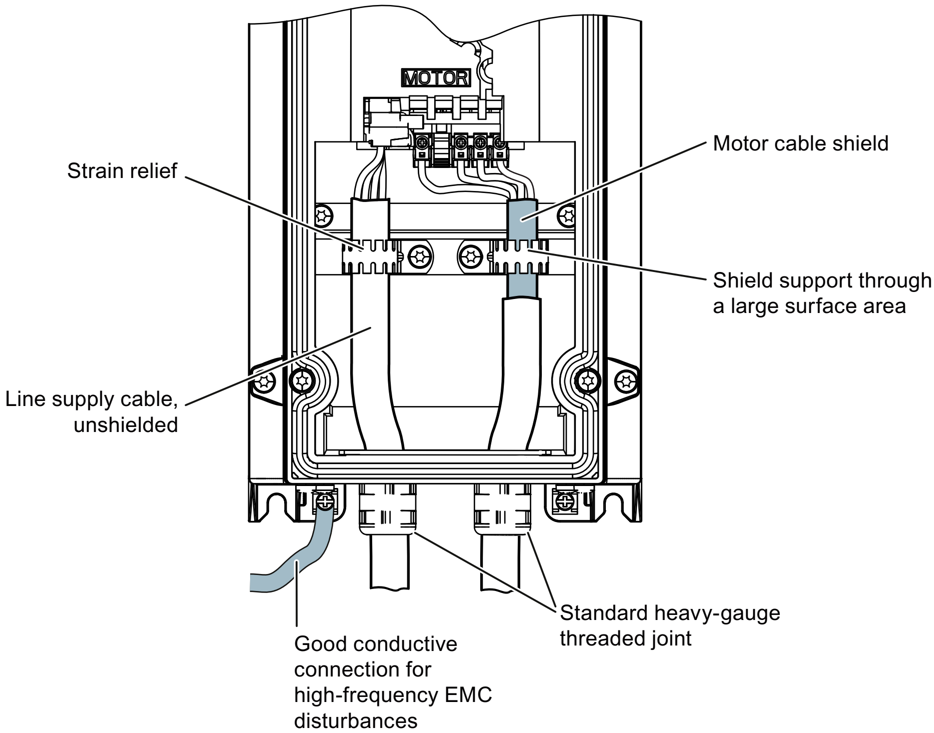


Figure 3-3 Shielding of the Power Module PM230, degree of protection IP55 / UL type 12

You must use a shielded cable if you utilize the inputs and outputs of the Control Unit. The cable shield must be connected to the gland plate through a good electrical connection using an EMC gland.

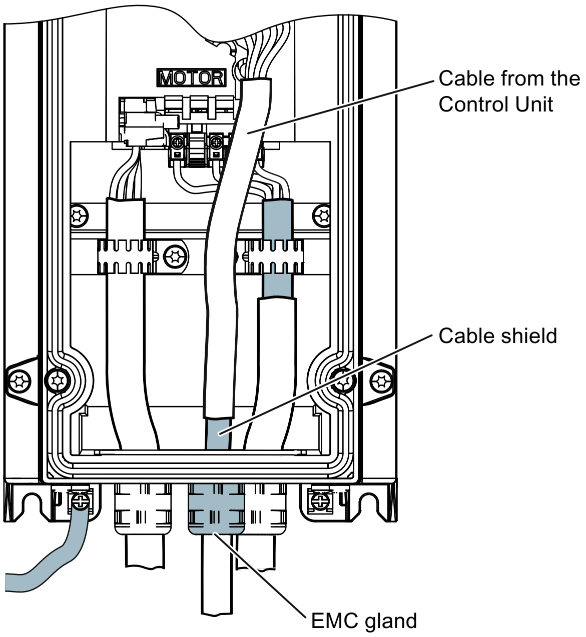
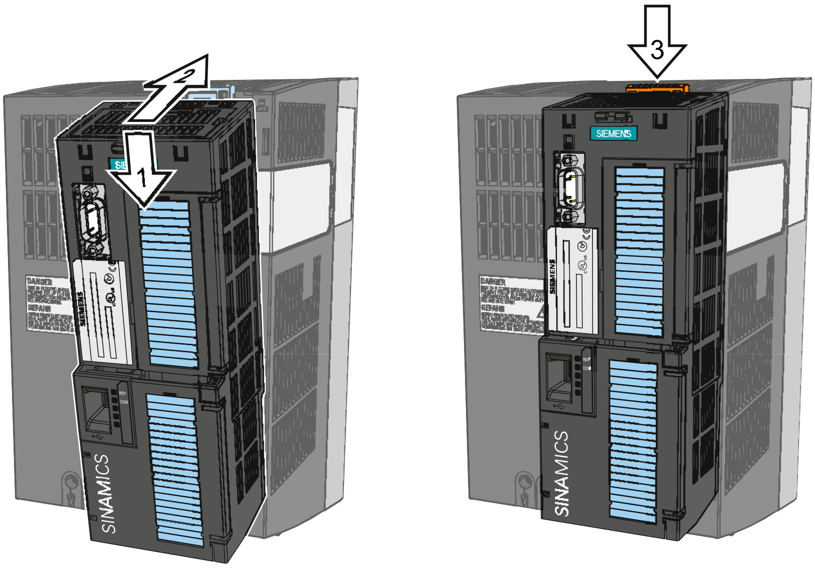


Figure 3-4 Shielding of the cable to the Control Unit

Additional information is available in the installation instructions for the Power Module PM230 (http://support.automation.siemens.com/WW/view/en/30563173/133300).

3.4 Installing Control Unit

IP20 Power Modules



Insert CU Remove CU

Figure 3-5 Insert the Control Unit on the Power Module and then remove

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

IP55 Power Modules

1 and 2	Insert CU
3	Remove CU for FSA to FSC for FSD to FSD the release knob is accessible from the top

Figure 3-6 Locate the CU on the PM

You will find a detailed description in the associated Hardware Installation Manual.

3.4.1 Interfaces, connectors, switches, control terminals, LEDs on the CU

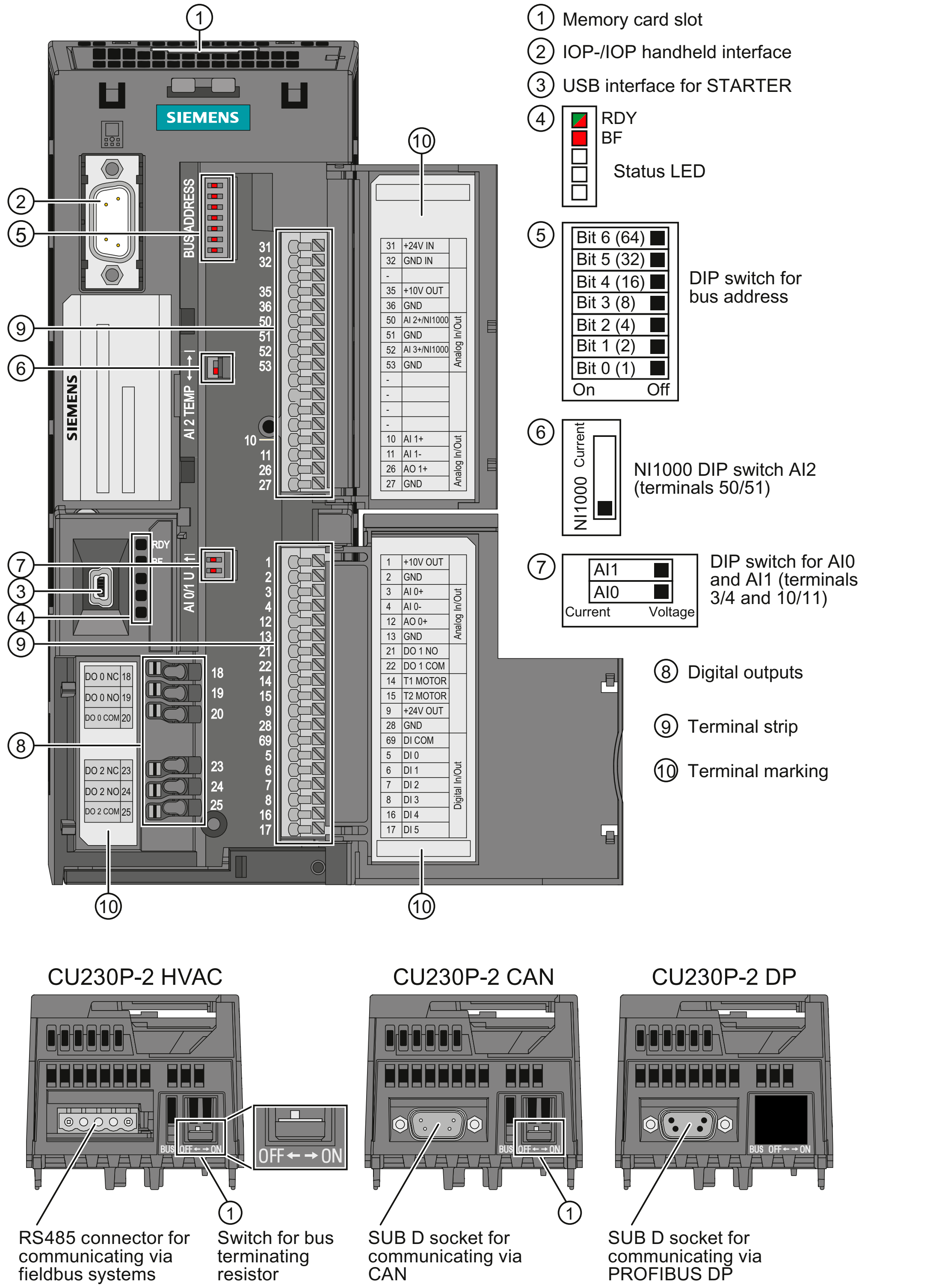


Figure 3-7 User interfaces of the CU230P-2

3.4.2 Terminal strips of the CU

Arrangement and function of the terminals on the CU230P-2 Control Unit

All Control Units are equipped with the same control terminals. The factory presettings for certain terminals differ, however, depending on the CU variant.

Color coding of the terminals

- Gray: Analog inputs and outputs
- Light gray: Digital inputs and outputs
- White: Other inputs and outputs

Terminals	Terminal designations		Explanations	
31	+24V IN		External 24 V	
32	GND		Reference potential for terminal 31	
-	-		---	
35	+10V OUT		10V voltage output	
36	GND		Reference potential for terminal 35	
50	NI1000/AI2+		Input for NI1000 or AI2+ temperature sensor	
51	GND		Reference potential for terminal 50	
52	NI1000/AI3+		Input for NI1000 or AI3+ temperature sensor	
53	GND		Reference potential for terminal 52	
-	-		---	
-	-		---	
-	-		---	
-	-		---	
10	AI1+	Analogue In/Out	Analog input 1, positive*	
11	AI1-	Analogue In/Out	Analog input 1, negative*	
26	AO1+	Analogue In/Out	Analog output 1, positive (0 V … 10 V, 0 mA … 20 mA, max. 500 Ω)	
27	AO GND	Analogue In/Out	Reference potential for terminal 26	
1	+10V OUT		10 V output without electrical isolation, max. 10 mA	
2	GND		Reference potential for terminal 1	
3	AI 0+	Analogue In/Out	Analog input 0, positive*	
4	AI 0-	Analogue In/Out	Analog input 0, negative*	
12	AO 0+	Analogue In/Out	Analog output 0, positive (0 V … 10 V, 0 mA … 20 mA, max. 500 Ω)	
13	AO GND	Analogue In/Out	Reference potential for terminal 12	
21	DO 1 NO		Digital output 1, NO contact, 0.5 A, 30 V DC	
22	DO 1 COM		Digital output 1, common contact, 0.5 A, 30 V DC	
14	PTC+		Motor temperature sensor (PTC, KTY84-130 or bimetal NC contact)	
15	PTC-		Motor temperature sensor (PTC, KTY84-130 or bimetal NC contact)	
9	+24V OUT		Isolated 24 V output, max. 100 mA	
28	GND		Reference potential for terminal 9	
69	DI COM	Digital In/Out	DI COM	
5	DI 0	Digital In/Out	Digital input 0, isolated	
6	DI 1	Digital In/Out	Digital input 1, isolated	
7	DI 2	Digital In/Out	Digital input 2, isolated	
8	DI 3	Digital In/Out	Digital input 3, isolated, FF setpoint 0	
16	DI 4	Digital In/Out	Digital input 4, isolated, FF setpoint 1	
17	DI 5	Digital In/Out	Digital input 5, isolated, FF setpoint 2	
18	DO 0 NC		Digital output 0, NC contact	
19	DO 0 NO		Digital output 0, NO contact	5 A, 30 V DC / 2 A, 230 V AC
20	DO 0 COM		Digital output 0, common contact	
23	DO 2 NC		Digital output 2, NC contact	
24	DO 2 NO		Digital output 2, NO contact	5 A, 30 V DC / 2 A, 230 V AC
25	DO 2 COM		Digital output 2, common contact	

* The analog inputs AI0 and AI1 can be used as additional digital inputs.

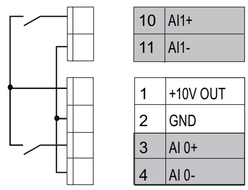


Figure 3-8 Terminal overview

3.4.3 Connecting-up the control unit

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 4

4.1 Commissioning guidelines

After installation, you need to commission the inverter to set the inverter functions such that the inverter/motor combination is best adapted to the drive task.

The inverter's functions and parameters are accessed either via the Operator Panel (BOP-2 or IOP) or the STARTER commissioning tool from a PC.

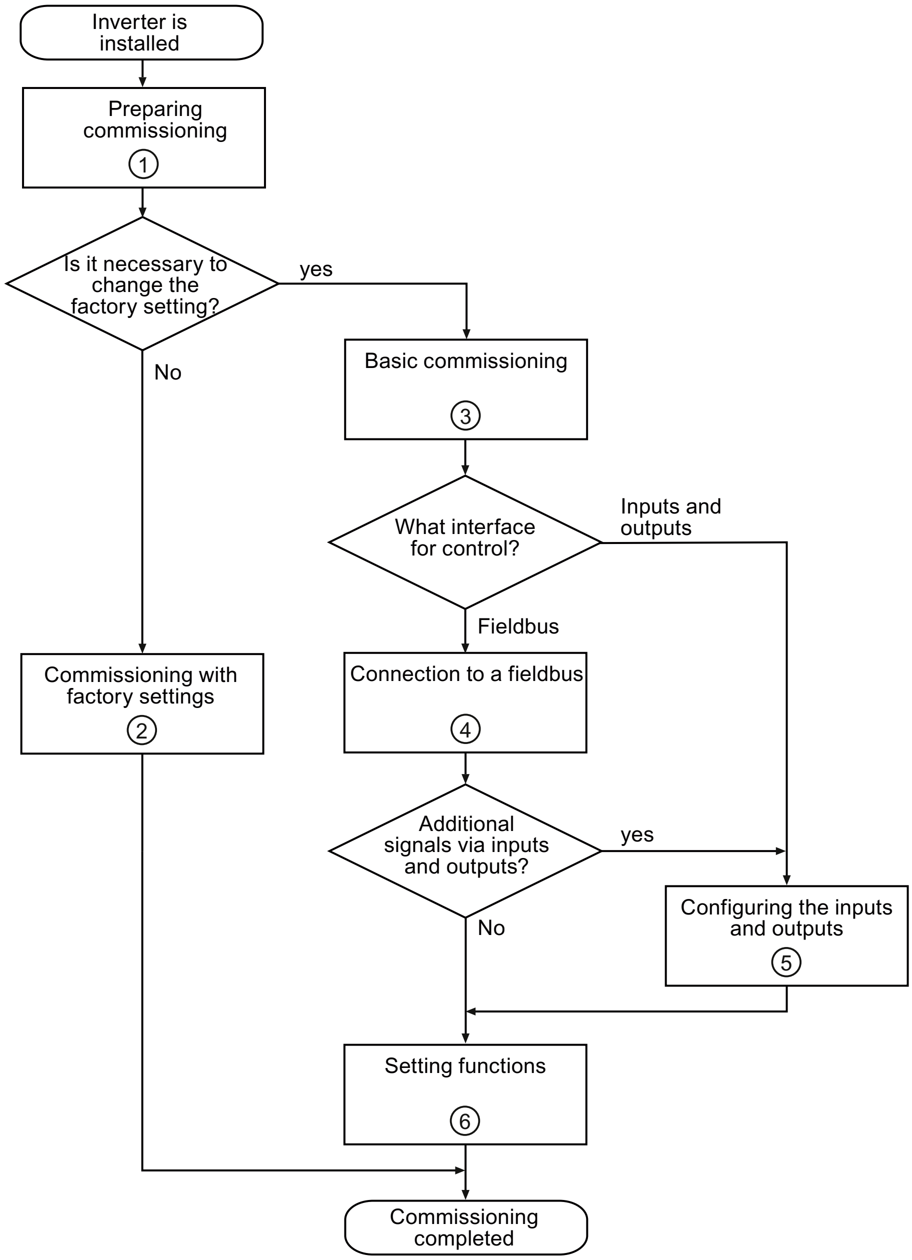
An inverter can also be commissioned by saving the settings of an inverter (which has been fully commissioned) onto a memory card (see External data backup and series commissioning (Page 84)) or the Operator Panel or using STARTER in the PC and then transferring (upload and download) them to another inverter used for the same drive task. This method is also suited to replacing a defective CU.

Note

Should anything go wrong during commissioning …

If you are not able to complete commissioning for any reason, be it due to line voltage failure, because you went wrong when setting the parameters and can no longer understand the individual settings or don't know whether the Control Unit has been used before, you can restore the inverter to the factory settings. See Restoring the factory setting (Page 87).

Commissioning guidelines



① Preparing commissioning (Page 62)
② Commissioning with factory settings (Page 65)
③ Commissioning with STARTER (Page 71)

④ Connection to a fieldbus (Page 97)
⑤ Configuring the terminal strip (Page 89)
⑥ Functions (Page 187)

Figure 4-1 Commissioning procedure

Users can access the inverter parameters via the following interfaces

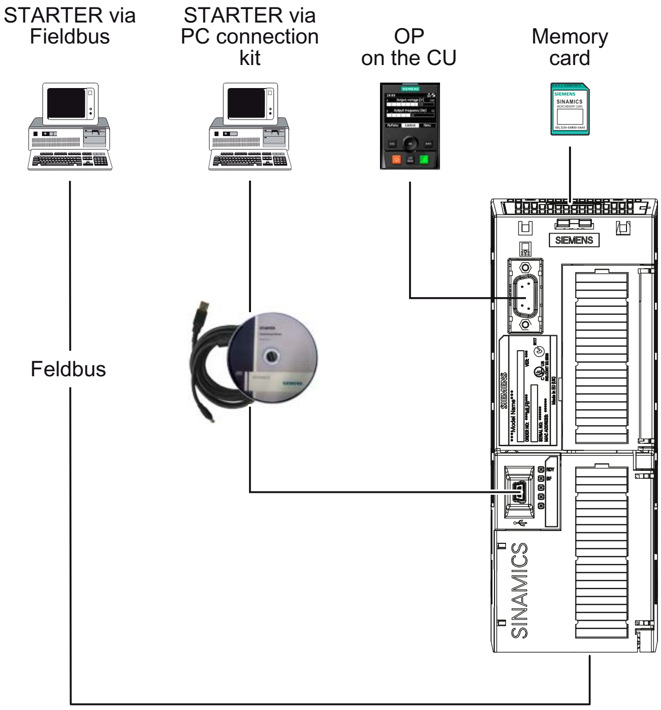


Figure 4-2 Inverter's parameterization interfaces

4.2 Preparing commissioning

Prerequisites: before you start

Before starting the commissioning, you should clarify the following.

Are the factory settings sufficient for your application?

Check which factory settings can be used and which functions need to be changed (see section Commissioning with factory settings (Page 65)). During this check you will probably find that the factory settings only require slight adjustment.

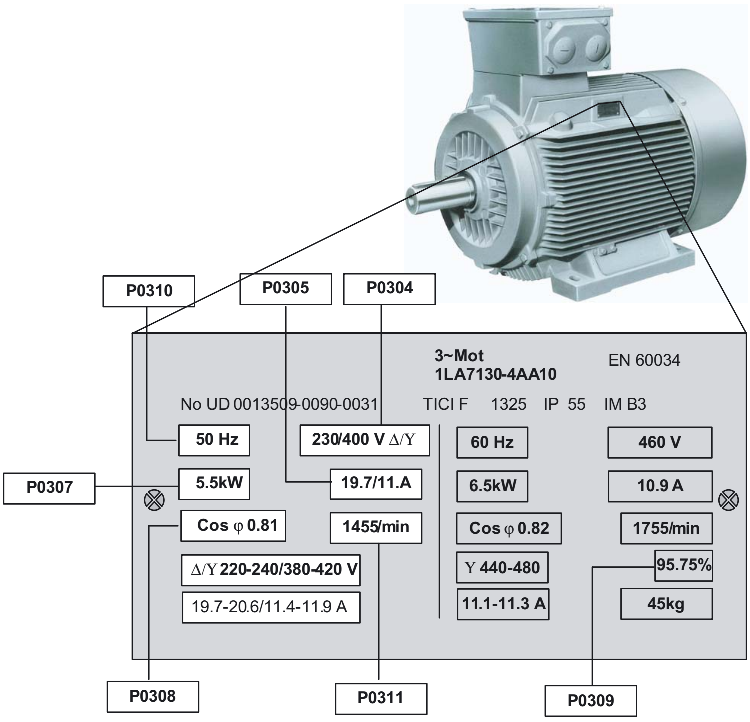
Which motor are you using? [P0300]

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.



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 [Δ]), 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.

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.

Which command and setpoint sources are used to control the motor?

The command and setpoint sources available are specified by the inverter's Control Unit.

On Control Units with a PROFIBUS interface the specified commands and setpoints are preset by the control. For all other Control Units the digital inputs and analog inputs are preset.

- Possible command sources
  - Fieldbus (when commands are specified by a control) - can be selected using P0700
  - Digital inputs - can be selected using P0700
  - Operator Panel
  - STARTER PC tool (in the commissioning phase with the "operator panel")
- Possible setpoint sources
  - Motorized potentiometer - can be selected using P1000
  - Analog setpoint - can be selected using P1000
  - Fixed frequency - can be selected using P1000
  - Fieldbus - can be selected using P1000
  - STARTER PC tool (in the commissioning phase with the "operator panel")

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

4.3.1 Prerequisites for using the factory settings

Prerequisites for using the factory settings

In simple applications, commissioning can be carried out just using the factory settings. This section explains what prerequisites must be fulfilled for this purpose and how they are fulfilled.

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. Commands and setpoints must be specified using the Control Unit sources set in the factory.
3. When connecting to a fieldbus, the bus address must be set using the DIP switch on the front of the Control Unit and the inverter must be connected to the control via the bus interface.
4. If controlling 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 69))

4.3.2 Inverter factory setting

Default command and setpoint sources

The inverters with PROFIBUS DP interface are preset in the factory so that the control and status signals can be exchanged via the fieldbus interface.

The other inverters are preset in the factory so that the control and status signals can be exchanged via the terminals.

Please refer to the following description or List Manual for details.

Table 4- 1 **Command and setpoint sources**

Parameter	Description
P0700 = 2 or 6	**Select the command source** 2: Digital inputs (P0701 … P0709) (factory setting for CUs without PROFIBUS interface) 6: Fieldbus (P2050 … P2091), (factory setting for CUs with PROFIBUS DP interface)
P1000 = 2 or 6	**Select the setpoint source** 2: Analog setpoint (factory setting for CUs without PROFIBUS DP interface) 6: Fieldbus (factory setting for CUs with PROFIBUS DP interface)

Table 4- 2 Factory settings of additional important parameters

Parameter	Factory setting	Meaning of the factory setting	Function
P0010	0	Ready to be entered	Commissioning parameter
P0100	0	Europe [50 Hz]	Frequency of the regional supply network • IEC, Europe • NEMA, North America **Note**: This parameter cannot cannot be changed in FW4.3.
P0300	1	Induction motor	Select the motor type (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 output (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 is irrelevant
P0309	0	[%]	Rated motor efficiency (in accordance with the rating plate in %) if P0100 = 0, then P0309 is irrelevant
P0310	50	[Hz]	Rated motor frequency (in accordance with the rating plate in 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 (specify the motor cooling system)
P0625	20	[°C]	Ambient temperature of motor
P0640	200	[A]	Motor current limit
P0970	0	Locked	Restore factory settings
P1080	0	[rpm]	Minimum speed
P1082	50	[rpm]	Maximum speed
P1120	10	[s]	Ramp-up time
P1121	10	[s]	Ramp-down time
P1300	0	V/f control with linear characteristic	Control mode

4.3.3 Default terminal settings

Factory settings of the process interfaces

The table below shows the assignment of digital inputs to the respective parameters and the factory settings for the individual Control Units

Digital inputs				
Abbreviation	Terminal	Parameter	Control Unit	Meaning of the factory setting
DI 0	5	P0701 = 0	CU230P-2 DP	Locked
		P0701 = 1	CU230P-2 HVAC / CU230P-2 CAN	ON/OFF1
DI 1	6	P0702 = 0	CU230P-2 DP	Locked
		P0702 = 12	CU230P-2 HVAC / CU230P-2 CAN	Direction reversal
DI 2	7	P0703 = 9	All Control Units	Fault acknowledgment
DI 3	8	P0704 = 15	All Control Units	Fixed speed setpoint selection bit 0
DI 4	16	P0705 = 16	All Control Units	Fixed speed setpoint selection bit 1
DI 5	17	P0706 = 17	All Control Units	Fixed speed setpoint selection bit 2
DI 11	3	P0712 = 0	All Control Units	Locked
DI 12	10	P0713 = 0	All Control Units	Locked

Digital outputs (relay outputs)					
Terminal	Abbreviation		Parameter	Factory setting	Meaning of the factory setting
18	NC	DO 0	P0730	52.3	Drive fault active
19	NO				
20	COM				
21	NO	DO 1	P0731	52.7	Drive alarm active
22	COM				
23	NC	DO 2	P0732	52.2	Operation enabled
24	NO				
25	COM				

Analog inputs					
Terminal	Abbreviation		Parameter	Factory setting	Meaning of the factory setting
3	AI 0+	AI0	P0756 [0]	4	Set bipolar voltage input: -10 V … +10 V DC in addition to parameterizing DIP switch on CU housing. The analog input 0 in the factory setting supplies the speed setpoint (with the exception of PROFIBUS Control Units).
4	AI 0-				
10	AI 1+	AI 1	P0756 [1]	4	Set bipolar voltage input: -10 V … +10 V DC in addition to parameterizing DIP switch on CU housing. **Not active in factory setting!**
11	AI 1-				
50	NI1000/ AI 2+	AI 2	P0756 [2]	6	Temperature sensor Ni1000. **Not active in factory setting!**
51	GND				
52	NI1000/ AI 3+	AI 3	P0756 [3]	7	Temperature sensor Ni1000. **Not active in factory setting!**
53	GND				

Analog outputs					
Terminal	Abbreviation		Parameter	Factory setting	Meaning of the factory setting
12	AO 0+	AO 0	P0771[0]	0	Can be switched from current output to voltage output by means of P0776 . **Not active in factory setting!**
13	AO 0-				
26	AO 1+	AO 1	P0771[1]	0	Can be switched from current output to voltage output by means of P0776 **Not active in factory setting!**
27	AO 1-				

PTC/KTY84 interface				
Terminal	Abbreviation	Parameters	Factory setting	Meaning of the factory setting
14	PTC+	P0601	0	Motor temperature sensor **Not active in factory setting!**
15	PTC-			

4.3.4 Wiring examples for the factory settings

Many applications function using the factory settings

The following wiring can be used for Control Units which receive their commands and setpoints via control terminals (CU230P-2 HVAC and CU230P-2 CAN) to use the factory setting.

Pre-assignment of control terminals in the factory for CU230P-2 HVAC and CU230P-2 CAN

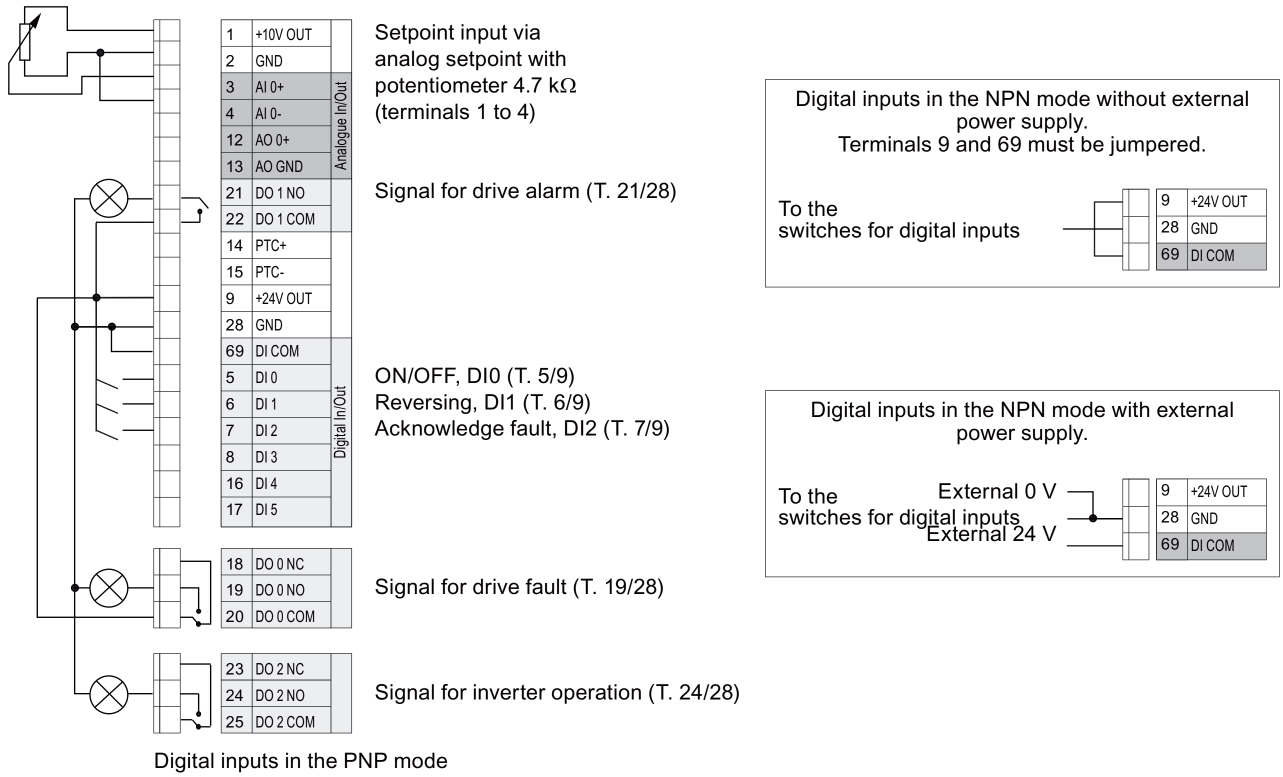


Figure 4-3 Wiring a CU230P-2 HVAC or CU230P-2 CAN to use the factory settings

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Note

In the NPN mode, a ground fault between the customer contact and digital input may undesirably control the drive input.

Pre-assignment of control terminals in the factory for CU230P-2 DP

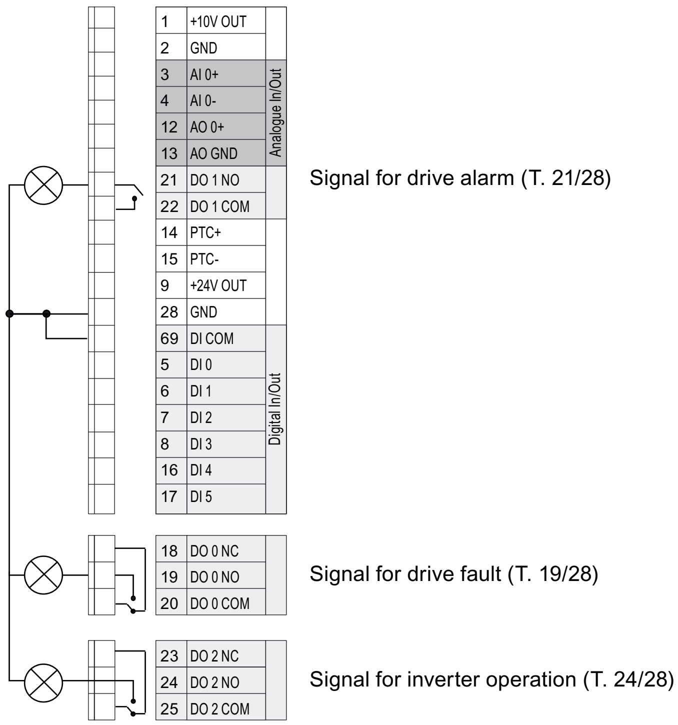


Figure 4-4 Wiring a CU230P-2 DP to use the factory settings

4.4 Commissioning with STARTER

4.4.1 Overview

Commissioning with STARTER comprises the following steps:

1. Install the USB interface
2. Create a new STARTER project, or open an existing project.
3. Set-up the online connection from your PC or PG to the inverter
4. Perform the basic commissioning
5. If required, configure the inverter inputs and outputs
6. Connect the inverter to the fieldbus if you are operating the inverter on a fieldbus

4.4.2 Requirements

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

The following is required to commission the inverter via the PC:

- A PC connection kit for connecting the inverter to a PC. This comprises:
  - USB cable for connecting inverter to PC
  - Installation DVD for STARTER
- A PC with installed STARTER software V4.1.5 or higher.
  Information on the actual STARTER version and a possibility of downloading it from the Internet under (http://support.automation.siemens.com/WW/view/en/10804985/133100).
- The motor must be connected to the inverter.

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.

4.4.3 Installing USB drivers

Description

You must install and set the USB driver if you are connecting your converter for the first time to your PC via the USB interface.

To start the installation:

- Connect the inverter to the PC using the USB cable supplied
- Switch on the inverter supply voltage

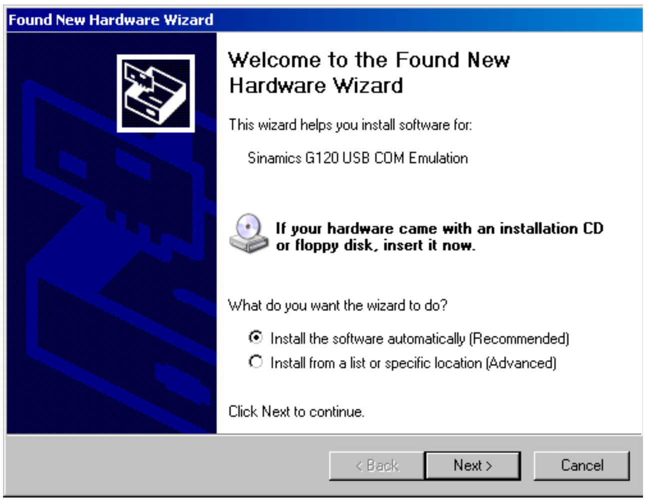
If you have still not installed the driver, then the following screen is displayed:

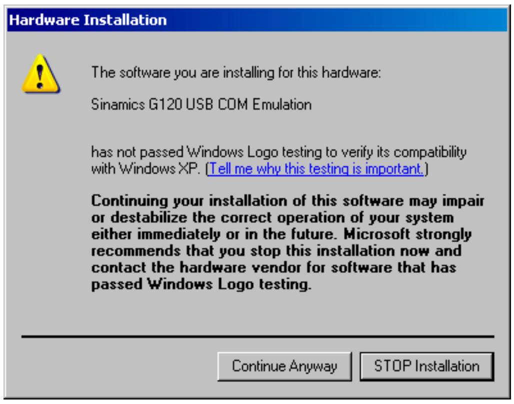
Without making any changes, click on "Next" and in the following screen select "Continue installation".

Installing the driver does not have any negative impact on your computer.

This completes the installation of the driver.

You must still set the interface address before you can start generating a STARTER project.

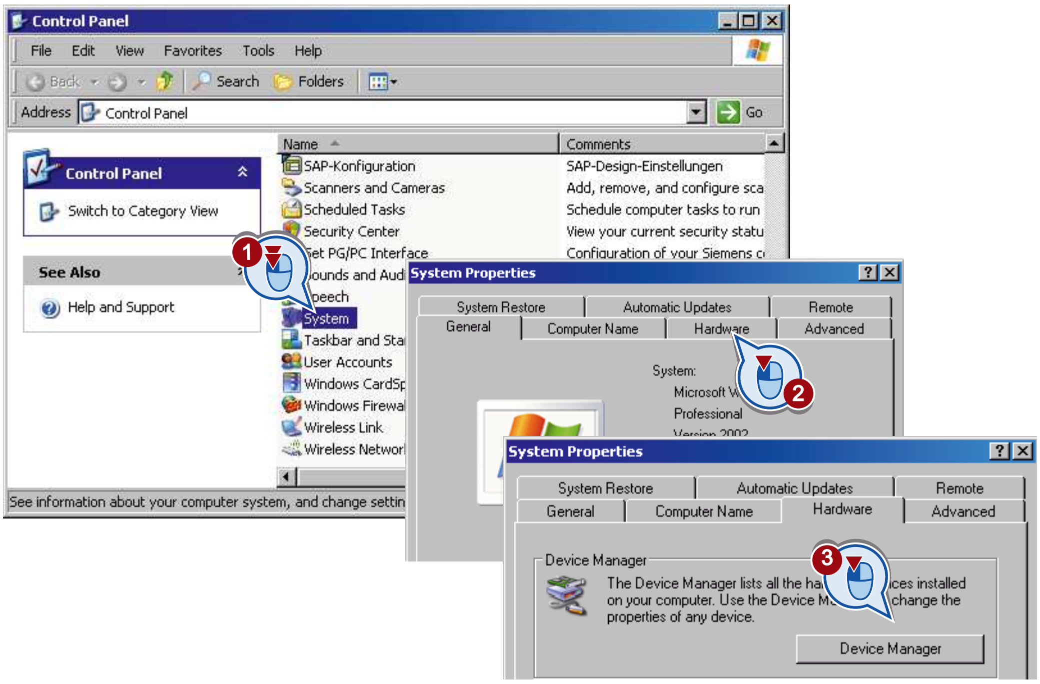




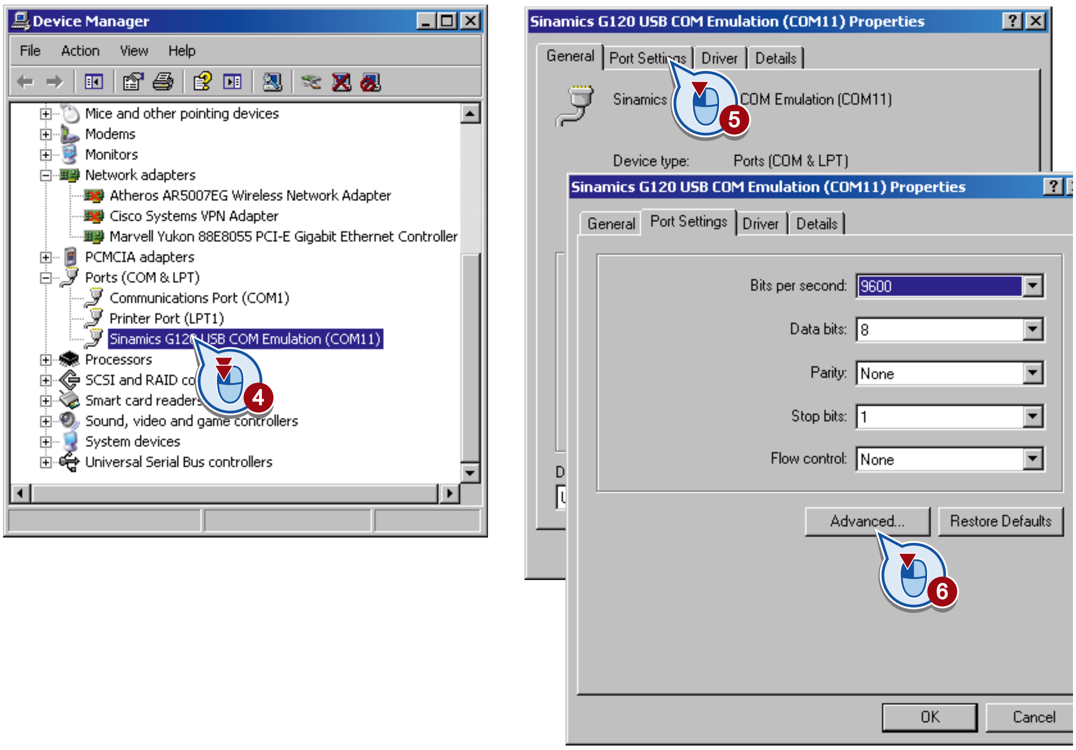
Additional settings for the USB interface

Before you can commission the inverter using the computer, you must assign the USB interface to a COM interface in the range COM1 … COM7 using the control panel. The procedure is explained in the following paragraphs.

Using the subsequently performed actions, you can identify which COM interface is assigned to the USB-COM emulation for the SINAMICS inverter.

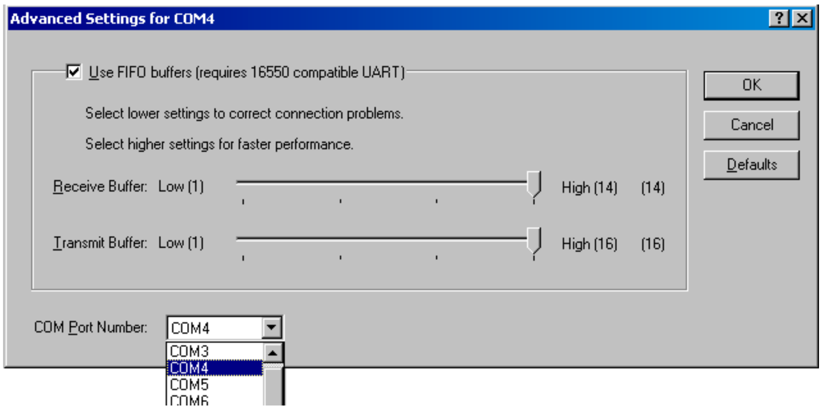


If the assignment lies in the range COM1 … COM7, then you do not have to make any changes and you can close the control panel again. However, you should note the number of the COM interface as you will require it in a later installation step.



If the USB-COM emulation is assigned to an address higher than COM7, open the properties window by double-clicking on the interface. There you will find the "Advanced" button under the "Port settings" tab.

A click on this button opens the extended properties in which you can assign the COM connection number an address < 8 via a selection box. If all of the COM1 … COM8 addresses are assigned, then select one of these addresses anyway and confirm the following message with "Yes". Please note the COM interface that you have assigned as you will require it in a subsequent installation step.



4.4.4 Using the project wizards

Description

The project wizard guides you in a user-friendly fashion through commissioning using the steps

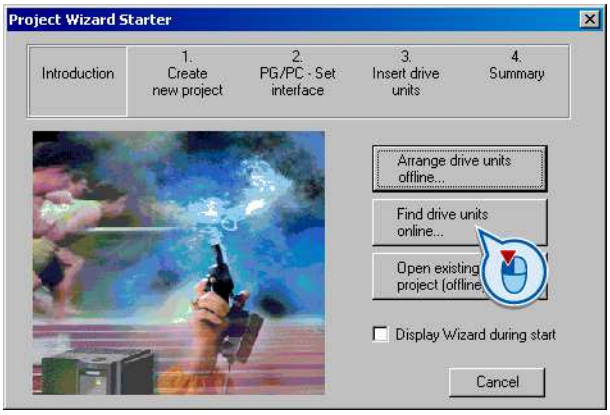
- Introduction
- 1. Create new project
- 2. Set PG/PC interface
- 3. Insert drive units
- 4. Summary

The step, in which you are presently, is highlighted in the upper navigation bar.

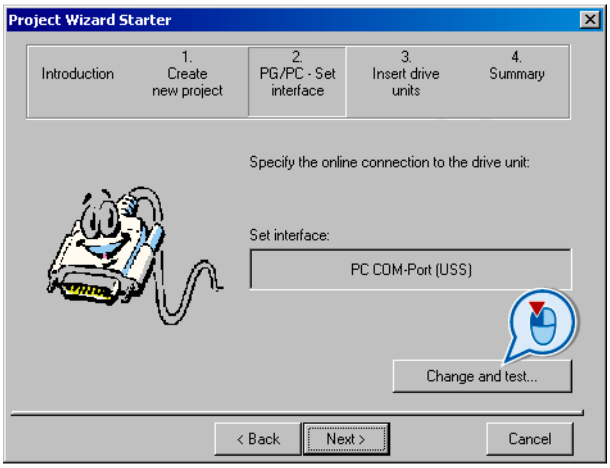
To start commissioning:

- Switch on the inverter supply voltage
- Launch the STARTER commissioning tool.
- Start a new project via "Project / New with Wizard"

- Click on "Find drive units online ..."



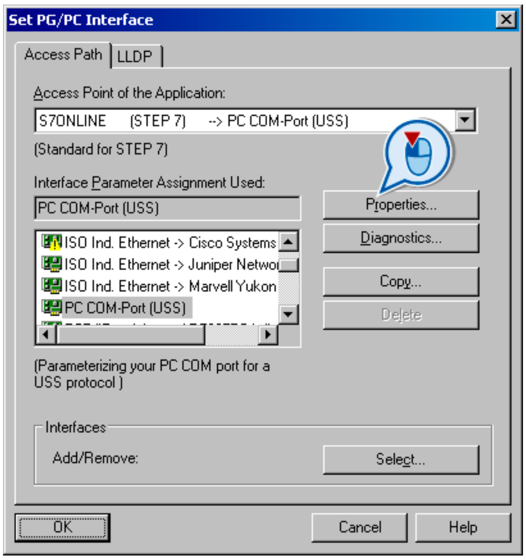
- In the window that follows (not shown here), specify a meaningful name for your project, e.g. "Commissioning G120" and click on "Continue". The following dialog box is displayed.



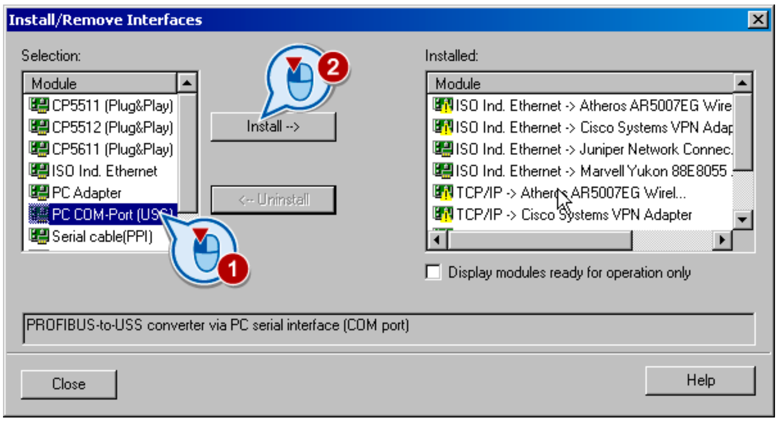
- Click "Change and test..." to set up the PG/PC interface.

PG/PC - Set interface

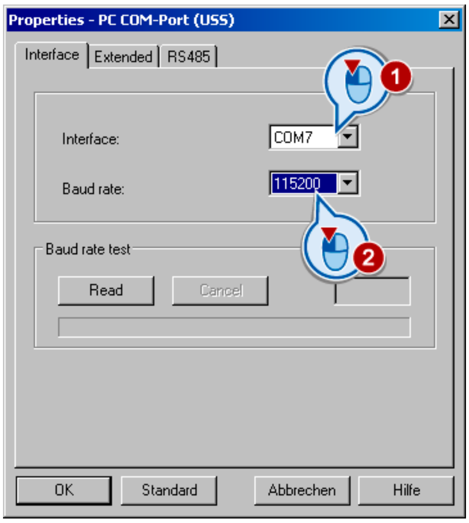
- Select "PC COM-Port (USS)" from the list and click on "Properties …"



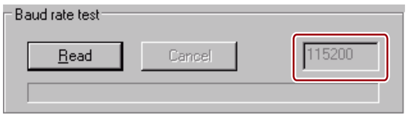
- If "PC COM-Port (USS)" is not available, click on "Select …" to install the "PC COM-Port (USS)" interface as shown in the "Install/Remove Interfaces" dialog box.



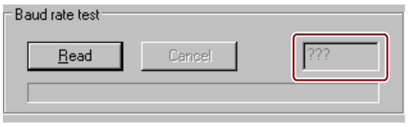
- If you have installed the "PC COM-Port (USS)" interface, close the dialog box and now call up "Properties - PC COM-Port (USS)".



- In this dialog box, select the COM address that you defined when setting the USB interface. Select 115200 as baud rate.
- You can check the correctness of the settings using the "Read" button in the "Baud rate test" field. If your interface has been correctly set, then you obtain the following display:

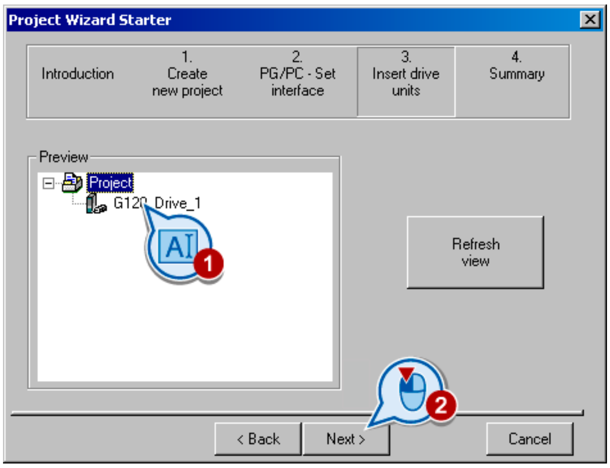


- If the interface is incorrect, then instead, the following is displayed:



- Under the "RS 485" tab, in addition, select the "Automatic mode".
- When you click "OK", the "Set PG/PC Interface" dialog box is displayed again.
- When you choose "OK" again, this takes you back to the Project Wizard.
- By clicking on "Continue", you start a search for devices that are available online and you then come to the step "Insert drives".

Insert drives



- In this dialog box, enter a name for your inverter, e.g. "G120_Drive_1" (no blanks or special characters).
- Click on "Continue" and close the following dialog box by clicking on "Complete".

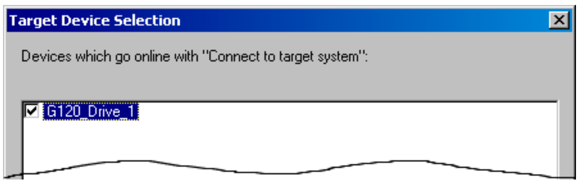
This means that you have generated the STARTER project and the inverter is inserted in the STARTER project tree. The next section explains how you establish an online connection to the inverter.

4.4.5 Establishing an online connection between the PC and converter (going "online")

Description

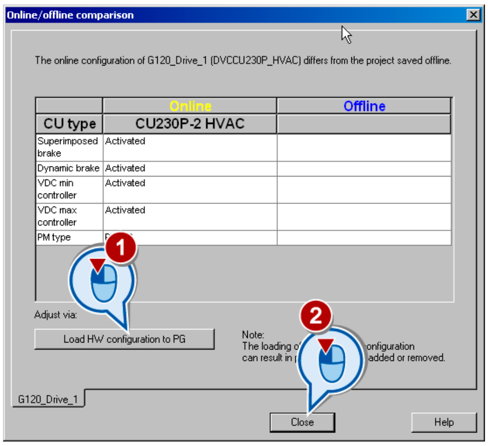
With the procedure described above, the project has been created and your inverter is integrated into the project tree. However, there is no online connection.

- In the STARTER, click on the ("Connect to target system") button. In the next dialog box, select the inverter (✓) and confirm with OK.



- The following dialog screen lists the inverter settings in the "Online" column. The "Offline" column will be empty for a new project.

- Click on "Load hardware configuration to PG" to save the online setup to your PC and create an online link between the inverter and PC.



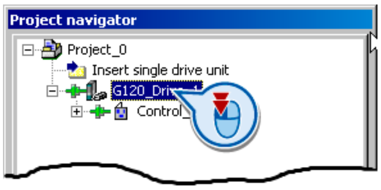
- To conclude your entry, choose "Close".
- The status display changes from the "Offline mode" with blue background into the "Online mode" with yellow background.

Note

If you click on "Close" without having first run "Load hardware configuration to PG", the data is not saved and the inverter remains offline.

4.4.6 Starting basic commissioning

- In the online state, open the STARTER screen of the Control Unit with a double click and there click on the "Wizard" button.



Carry-out basic commissioning

The configuration wizard guides you step by step through the commissioning procedure. After the basic commissioning, you can change all of the settings and make detailed changes.

- In the start dialog box of the basic commissioning, select the control mode of the motor. If you are not certain which control mode you require for your application, then initially select V/f control. Help on how to select the control mode is provided in Chapter Motor control (Page 203).

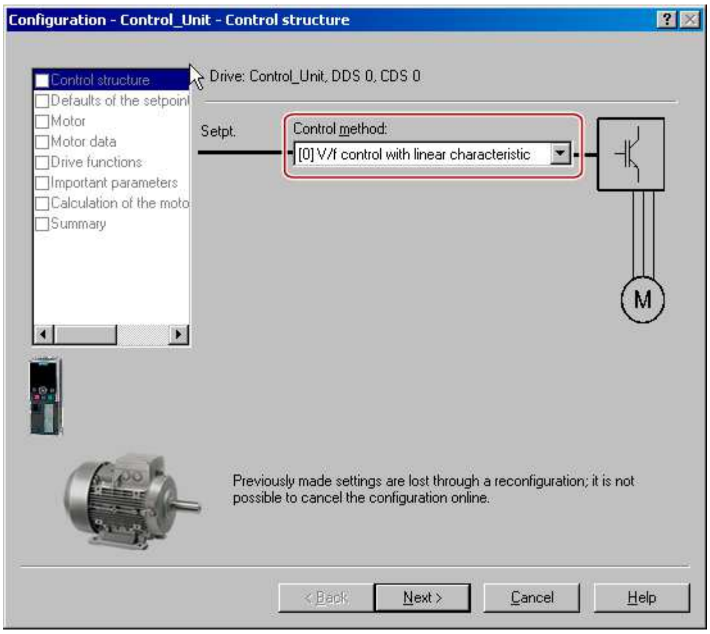
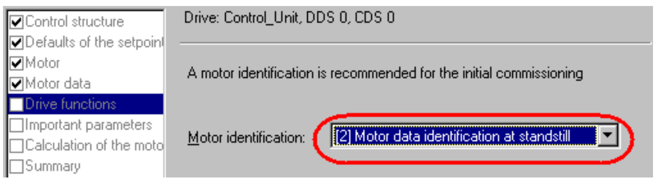
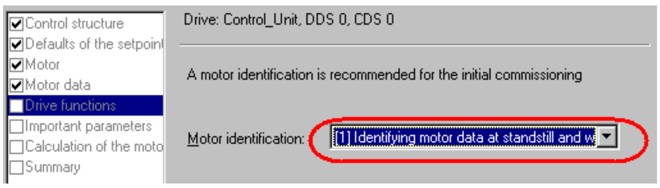


Figure 4-5 Basic commissioning with V/f control

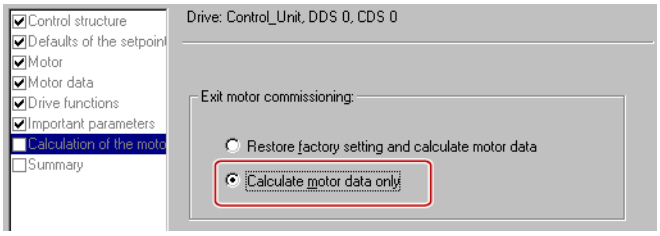
- With "Continue" you can go to the next dialog boxes where you must make the appropriate settings for your particular application.
- In the dialog box "Drive functions", in the case of the V/f control, "Motor data identification at standstill" must be selected; for vector control, we recommend "Identifying motor data at standstill and with motor rotating".
  - Setting for V/f control:



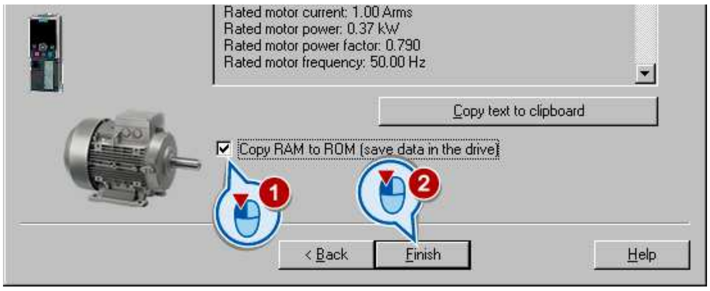
  - Recommended setting for vector control:



- We recommend the following setting in the dialog box "Calculate motor data":



- The configuration wizard closes with the following summary:



Note

Set the check mark for "RAM to ROM (save data in the drive)" in order to save your data in the inverter so that it is not lost when the power fails.

Identifying motor data

If the inverter has still not identified the motor data, alarm A07791 is output. You must switch-on the motor to identify its data.

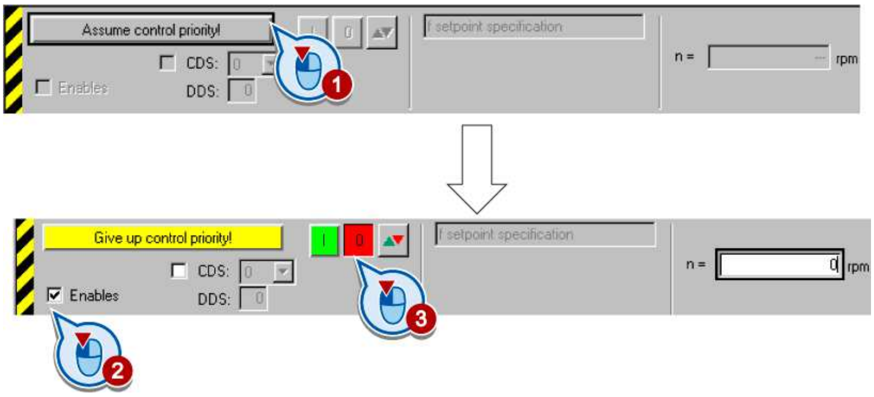
⚠ CAUTION

Motor data identification for dangerous loads

Before starting the motor data identification routine, dangerous plant and system parts must be carefully secured, e.g. by fencing off the dangerous location or lowering a suspended load to the floor.

- In STARTER, select the control panel with a double click.

- In the control panel, click on the "Assume control priority" button.
  Then set the check mark for "Enables" signals and switch-on the motor.



The inverter identifies the motor data after it has been switched-on. The measurement can take several minutes. After the measurement has been completed, the inverter automatically switches off the motor and alarm A07791 is cancelled.

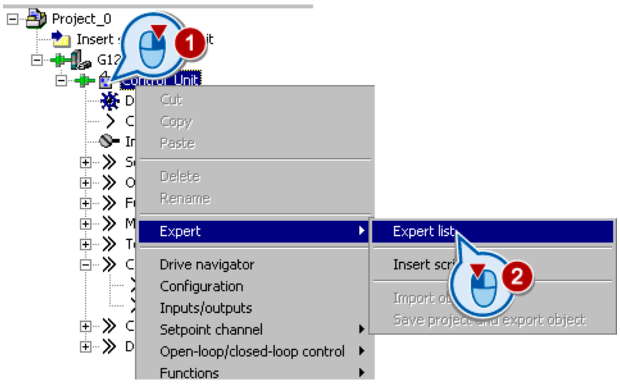
- In the control panel, click on the "Give up control priority" button.

4.4.7 Additional commissioning steps

After the basic commissioning, you should check the following settings and if required, change:

- Inverter inputs and outputs
  see Chapter Configuring the terminal strip (Page 89).
- Operating the inverter on a fieldbus
  See Chapter Connection to a fieldbus (Page 97).
- You can make additional settings either using the Drive Navigator or via the functions in the Project Navigator.

NOTICE
Line supply voltage not equal to 400 V If you connect the inverter to a line supply with a voltage ≠ 400 V, however, in the tolerance range of 3-ph. 380 V AC… 480 V ± 10 %, then you must adapt the voltage value in p0210. In this case, as shown below, call the expert list, there, scroll to parameter p0210 and enter the appropriate voltage value. You close the expert list by double clicking on an entry in the STARTER project tree.



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 that it is switched off. In order that your changes are permanently saved, you must permanently save the changes e.g. using the button (RAM to ROM). Select the drive involved 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 External data backup and series commissioning

Commissioning is completed and the parameters are saved in the inverter so that they are not lost when the power fails.

In addition, you can also save the parameters on a storage medium outside the inverter:

1. Memory card inserted in the inverter
2. PC/PG with STARTER
3. Operator Panel

By backing up data on an external storage medium you can transfer parameters to another inverter without having to perform the complete commissioning procedure.

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 the storage medium outside the inverter.
3. Download the parameters from the storage medium 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).

See also the following sections "Saving and transferring data using STARTER (Page 85)" and "Saving and transferring data using the memory card (Page 86)".

4.6 Saving and transferring data using STARTER

You can save parameters on your PC/PG and transfer them to other inverters, e.g. to identically parameterize several devices or to transfer the settings after a device has been replaced.

Transferring data from the inverter to the PC/PG (upload)

- Go online with STARTER.
- Click on the button "Load project to PG": .

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

- Go online with STARTER.
- Click on the button "Load project to target system": .

4.7 Saving and transferring data using the memory card

You can save parameters of an inverter on a memory card and transfer them to other inverters, e.g. to identically parameterize several devices or to transfer the settings after a device has been replaced.

Data backup

The memory card is a removable, non-volatile flash memory for all inverter parameters and does not require a power supply.

Upload: Transferring parameters from the inverter to the memory card

There are two upload options available:

1. Automatic upload:
   When the memory card is inserted, the inverter parameters are automatically backed up on the memory card if you activate the "RAM to ROM" function in starter.
2. Manual upload
   You can also manually start the data backup if you proceed as follows:
   – Start the data backup with p0971 = 1.
   – Check the value of parameter p0971.
     If data transfer has been completed, p0971 is automatically set to 0.

Note

Time it takes to save the data

Data transfer can can take several minutes.

   – "Safely remove" the memory card:
     Set p9400 to 2.
   – Check the value of parameter p9400.
     If it is permissible to remove the memory card, p9400 is set to 3.
   – Removing the memory card.

CAUTION
The file system on the memory card can be destroyed if the memory card is removed without first requesting and confirming this using the "safe removal" function. The memory card will then no longer function.

Downloading: Transferring parameters from the memory card to the inverter

There are two download options available:

1. Automatic download:
   – Insert the memory card into the Control Unit.
   – Then switch on the Control Unit power supply.
   If valid parameter data are on the memory card, then these are automatically transferred into the inverter.
2. Manual download:
   – Insert the memory card into the Control Unit to be written to.
   – Set p0804 to 1.

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

4.8 Restoring the factory setting

The inverter is reset to the delivery condition by restoring the parameters to the factory setting, with the exception of the following parameters.

Note

The reset operation is not applied to parameters p0014, p0100, p0201, p0205 or the communication parameters. Motor parameters p0300 ... p0311 are suitably preassigned for the power unit.

Restoring the factory settings using STARTER

In order to restore the factory setting of the inverter with STARTER, the STARTER tool must be connected with the inverter online, see Establishing an online connection between the PC and converter (going "online") (Page 78). To restore the factory setting, in STARTER, click on the button .

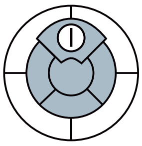
Configuring the terminal strip 5

5.1 Preconditions

Before you configure the inputs and outputs of the inverter, you should have completed the basic commissioning, see Chapter Commissioning (Page 59) .

The assignment of the inputs and outputs in the factory setting and after the basic commissioning are listed in Chapter Wiring examples for the factory settings (Page 69).

5.2 Assigning functions to digital inputs



The digital inputs are pre-assigned with certain control commands in the factory. However, these digital inputs can be freely assigned to a control command. The Control Unit has eight digital outputs, of which, digital inputs DI11 and DI12 (terminals 3 and 10) can also be used as analog inputs.

Table 5- 1 Factory setting of the digital inputs

Digital input No., Terminal No.	Control command set in the factory		Factory setting can be changed via
Digital input 0 (DI 0), Terminal 5	Switch motor on and off (ON/OFF1) (p0701 = 1)	No control command for the CU230P-2 DP (p0701 = 0)	P0701
Digital input 1 (DI 1), Terminal 6	Direction reversal (p0702 = 12)	No control command for the CU230P-2 DP (p0702 = 0)	P0702
Digital input 2 (DI 2), Terminal 7	Acknowledge faults (p0703 = 9)		P0703
Digital input 3 (DI 3), Terminal 8	Fixed speed setpoint selection Bit 0 (p0704 = 15)		P0704
Digital input 4 (DI 4), Terminal 16	Fixed speed setpoint selection Bit 1 (p0705 = 16)		P0705
Digital input 5 (DI 5), Terminal 17	Fixed speed setpoint selection Bit 2 (p0705 = 17)		P0706

Table 5- 2 Terminals, that can be used as either digital or analog inputs

Terminal no.	Setting options
• Terminal 3 as analog input 0 (AI 0) • Terminal 3 as digital input 11 (DI 11)	• **p0712 = 0**: Terminal 3 together with terminal 4 can be used as AI0, the type can be set using p0756[0] • **p0712 > 0**: Terminal 3 can be used as DI11 corresponding to the value from p0712
• Terminal 10 as analog input 1 (AI 1) • Terminal 10 as digital input 12 (DI 12)	• **p0713 = 0:** Terminal 10 together with terminal 11 can be used as AI1, the type can be selected using p0756[1] • **p0713 > 0:** Terminal 10 can be used as DI12 corresponding to the value from p0713

The following control commands are available for the digital inputs.

p0701 … p0706, p0712, p0713	= 0	No control command
	= 1	ON/OFF1
	= 3	2. OFF2
	= 4	2. OFF3
	= 9	2. Acknowledge faults
	= 10	Jogging bit 0
	= 11	Jogging bit 1
	= 12	Direction reversal
	= 13	Motorized potentiometer setpoint raise
	= 14	Motorized potentiometer setpoint lower
	= 15	Fixed speed setpoint selection, bit 0
	= 16	Fixed speed setpoint selection, bit 1
	= 17	Fixed speed setpoint selection, bit 2
	= 18	Fixed speed setpoint selection, bit 3
	= 25	Activate DC braking
	= 26	Activate emergency operation
	= 27	Enable technology controller
	= 29	External fault 1
	= 35	Command data set selection CDS, bit 0
	= 50	Load monitoring failure detection

5.3 Assigning specific functions to digital outputs

The inverter has three digital outputs that can be used to display different inverter states, e.g. faults, alarms, current limit value violations etc.

Table 5- 3 Factory setting of the digital outputs

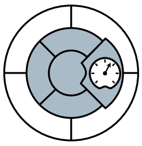
Terminal No., significance			Function
18	NC	Digital output 0 (DO0)	Inverter fault active
19	NO		
20	COM		
21	NO	Digital output 1 (DO1)	Inverter alarm active
22	COM		
23	NC	Digital output 2 (DO2)	Digital output deactivated
24	NO		
25	COM		

Table 5- 4 Changing the functions of the digital outputs

Terminal No., significance			Parameter	Description
18	NC	DO0	P0731	Possible values and functions for P0731, P0732 and P0732: Value Function 0 Deactivate digital output 52.0 Drive ready 52.1 Drive ready 52.2 Drive running 52.3 Drive fault active 52.4 OFF2 active 52.5 OFF3 active 52.6 Closing lockout active 52.7 Drive alarm active 52.8 Setpoint/actual value deviation 52.9 Process data control 52.10 f_act >= P1082 (f_max) 52.11 Alarm: Motor current/torque limitation 52.12 Brake active 52.13 Motor overload 52.14 Motor CW rotation 52.15 Inverter overload 53.0 DC brake active 53.1 f_act < P2167 (f_off) 53.2. f_act > P1080 (f_min) 53.3 Current actual value r0027 ≥ P2170 53.6 f_act ≥ setpoint (f_set)
19	NO			
20	COM			
21	NO	DO1	P0732	
22	COM			
23	NC	DO2	P0733	
24	NO			
25	COM			
			P0748	Inverting digital outputs Bit 0:Digital output 0 Bit 1:Digital output 1 Bit 2:Digital output 2

Further, the digital outputs can be interconnected with all binector outputs. A list of the binector outputs is provided in the List Manual.

5.4 Assigning analog inputs to specific functions



The inverter has four analog inputs, AI0 … AI3.

- AI0 and AI1 can be set as either voltage input or current input.
- AI2 can be set as either current input or as temperature sensor.
- AI3 is configured as temperature sensor.

The analog inputs can be connected further using the CO parameters r0752[0 … 3] (V/mA/°C) or r0755[0 … 3] (%). You can change the analog input type using P0756.

Note

In the factory setting (with the exception of the PROFIBUS Control Units) analog input 0 (r0755[0]) can be pre-set as percentage value as source for the main setpoint (p1070) and -10 V corresponds to the maximum negative (- 100 %) and 10 V to the maximum positive (100 %) speed.

Factory settings and setting options for the analog inputs

Table 5- 5 Analog inputs - type set in the factory

Analog input No. Terminal	Analog input type set in the factory	Factory setting can be changed via
Analog input 0 (AI0+) **Terminal 3**	Bipolar voltage input, -10 V … +10 V (P0756[0] = 4)	P0756[0]
Analog input 0 (AI0-) **Terminal 4**		
Analog input 1 (AI1+) **Terminal 10**	Bipolar voltage input, -10 V … +10 V (P0756[1] = 4)	P0756[1]
Analog input 1 (AI1-) **Terminal 11**		
Analog input 2 (AI2+) **Terminal 50**	Temperature sensor Ni1000, (P0756[2] = 6)	P0756[2]
Analog input 2 (AI2-) **Terminal 51**		
Analog input 3 (AI3+) **Terminal 52**	Temperature sensor PT1000, (P0756[1] = 7)	P0756[3]
Analog input 3 (AI3-) **Terminal 53**		

Setting options for analog inputs

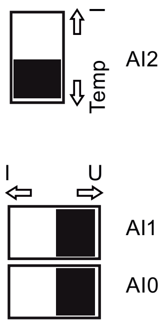
p0756[0], p0756[1], p0756[3], p0756[4]

= 0 Unipolar voltage input (0 V … +10 V) AI0/AI1
= 1 Unipolar voltage input monitored (+2 … +10 V) AI0/AI1
= 2 Unipolar current input (0 mA … +20 mA) AI0/AI1/AI
= 3 Unipolar current input monitored (+4 mA … +20 mA) 2
= 4 Bipolar voltage input (factory setting) (-10 V … +10 V) AI0/AI1/AI
= 6 Temperature sensor Ni1000 2
= 7 Temperature sensor PT1000 AI0/AI1
= 8 No sensor connected AI2/AI3
AI2/AI3
all

The adjacent DIP switches should be set corresponding to whether analog inputs AI0 and AI1 are used as voltage or current inputs.

You will find

- the DIP switch for AI0 and AI1 (current / voltage) on the Control Unit behind the lower terminal cover.
- the DIP switch for AI2 (temperature / current) on the Control Unit behind the upper terminal cover



Setting the normalization characteristic for analog inputs AI0, AI1 and AI2

The normalization characteristic of an analog input is defined by two points P1(x1|y1) and P2(x2|y2) in the coordinate system.

When changing p0756, then P1 and P2 are pre-assigned the value of p0756. The values only have to be adapted if you wish to use the analog input, e.g. in a range from 8 mA … 12 mA. This should only be done by an experienced commissioning engineer.

Table 5- 6 Parameter for setting the normalization characteristic

P0757[0…3]	**x-coordinate of 1st characteristic point [V or mA]**
P0758[0…3]	**y coordinate of the 1st characteristic point [% of P200x]** P200x are the parameters to which the normalization is referenced. p2000: Reference speed, p2001 reference voltage, p2002 reference current, p2003 reference torque, r2004 reference power
P0759[0…3]	**x-coordinate of 2nd characteristic point [V or mA]**
P0760[0…3]	**y-coordinate of 2nd characteristic point [% of P200x]**

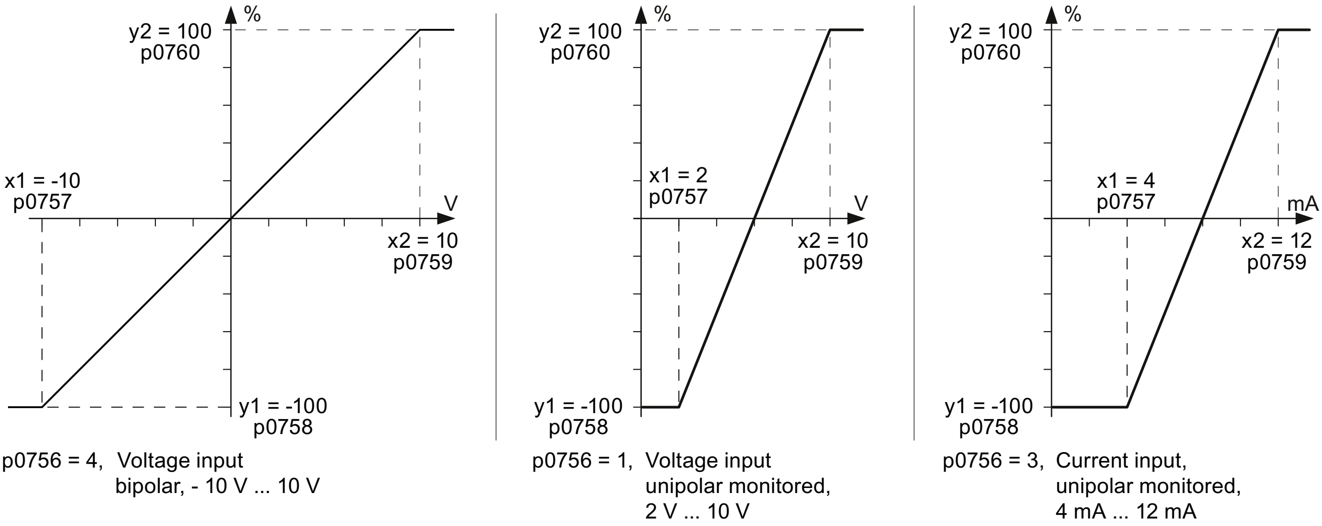


Figure 5-1 Examples for different normalization of an analog input

Example - setting analog input 0 as source for the speed setpoint

AI0 should be used as monitored unipolar voltage input for the speed setpoint in the range from -100 % (p1080) to 100 % (p1082).

Table 5- 7 Parameter settings for the example

Parameters / setting	Description
p1000 = 2	Select the analog setpoint as setpoint source
p0756[0] = 1	Define the analog input type
	Set AI0 as voltage input using the DIP switch
p0757[0] = 2, p0758[0] = -100, p0759[0] = 10, p0760[0] = 100	Set the normalization characteristic or check
P0761[0] = 2	Set the wire-break threshold to 2 V

5.5 Assigning certain functions to analog outputs

The inverter has two analog outputs which can be set via p0771 to display a number of variables, e.g.: Current speed, current output voltage or current output current.

Table 5- 8 Factory setting of the analog outputs

Terminal No., significance			Function	Constraint
12	AO0+	Analog output 0 (AO0) P0771[0]	Locked	These analog inputs can be used as additional digital inputs. In order that they operate as analog input, p0712 (AI0), or p0713 (AI1) must be set to 0. Only then are the adjustable values in the following table effective.
13	AO0-			
26	AO1+	Analog output 1 (AO1) P0771[1]	Locked	
27	AO1-			

Table 5- 9 Typical values that are displayed using the analog outputs

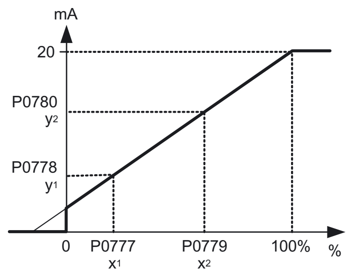
Parameter value	Displayed value
P0771[x] = 0	Display via analog outputs locked (factory setting)
P0771[x] = 21:	Actual speed (r0021) Scaling corresponding to p2000
P0771[x] = 24:	Output actual frequency (r0024) Scaling corresponding to p2000
P0771[x] = 25:	Output actual voltage (r0025) Scaling corresponding to p2001
P0771[x] = 26:	Actual value DC link voltage (r0026) Scaling corresponding to p2001
P0771[x] = 27:	Output (r0027) Scaling corresponding to p2002

The analog outputs can also be interconnected with all connector outputs. A list of the connector outputs is provided in the List Manual.

Table 5- 10 Other setting options for the analog outputs

Parameter	Description
P0775 = 0	**Permit absolute value** Specifies whether or not the absolute value of the analog output is used. If enabled, this parameter will use the absolute value of the value to be output. If the original value was negative, the corresponding bit is set in r0785.
P0776 = 0	**Analog output type** Scaling of r0774. 0: Current output (factory setting) 1: Voltage output **Note:** P0776 changes the scaling of r0774 (0 to 20 mA ⇔ 0 to 10 V). The scaling parameters P0778 and P0780 as well as the dead band are always entered with 0 to 20 mA. Analog output 0 can be switched as a voltage output between 0 and 10 V. Analog output 1 is a current output only. If it is to be used as a voltage output, it must be terminated with a 500 Ω resistor.

Parameter	Description
P0777 = 0.0	**Value x1 for analog output scaling** Defines output characteristic x1 (in %). This parameter is the minimum analog value expressed as a percentage of P200x (depending on how P0771 is set).
P0778 = 0	**Value y1 for analog output scaling** This parameter is the value of x1 (in mA).
P0779 = 100	**Value x2 for analog output scaling** This defines x2 of the output characteristic as a percentage. This parameter is the maximum analog value expressed as a percentage of P200x (depending on how P0771 is set).
P0780 = 20	**Value y2 for analog output scaling** This parameter is the value of x2 (in mA).



Connection to a fieldbus 6

Before you connect the inverter to the field bus, you should have completed the basic commissioning, see Chapter Commissioning (Page 59)

Fieldbus interfaces of the CU versions

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

- CU230P-2 HVAC for USS using RS485
  - Control via PZD (process data channel)
  - Parameterizing using PKW (parameter channel)
- CU230P-2 HVAC for Modbus RTU using RS485
  - Control and parameterization according to the Modbus register
- CU230P-2 HVAC for BACnet MS/TP using RS485
  - Control and parameterization using BACnet objects
- CU230P-2 DP for PROFIBUS DP
  - Control in cyclic operation using telegrams 1, 20, 350, 352 and 999
  - Control and parameterizing in cyclic operation using telegrams 353 and 354
  - Assigning parameters via the acyclic parameter channel (data block 47)
- CU230P-2 CAN for CANopen
  - Control by means of PDO
  - Parameterization by means of SDO

6.1 Data exchange via the fieldbus

Analog signals

The inverter always scales signals, which are transferred via the fieldbus, to the hexadecimal value of 4000. The significance of this numerical value depends on the category of the signal that you transfer:

Signal category	4000H corresponds to a parameter value of ...
Speeds, frequencies	p2000
Voltage	p2001
Current	p2002
Torque	p2003
Power	p2004
Angle	p2005
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 154).

6.2 Setting the bus address via DIP switch

The bus address can be set via DIP switch or via parameter. The address set via DIP switch has priority over the setting via parameter.

The setting via parameter is always accepted if all DIP switches for the bus address are at "OFF" (0) or "ON" (127) or if the address is invalid (e.g. 124 for USS).

Setting via parameter is described in the sections for the particular fieldbus interfaces.

You can find the arrangement of the DIP switches in Interfaces, connectors, switches, control terminals, LEDs on the CU (Page 56).

Set the DIP switch to address 10 (as shown in the following table).

Table 6- 1 Examples of setting the bus addresses

DIP switch		1	2	3	4	5	6	7
Address = added values of the DIP switches that are set to ON.		1	2	4	8	16	32	64
Example 1: Address = 10 = 2 + 8	ON OFF	OFF	ON	OFF	ON	OFF	OFF	OFF
Example 2: Address = 39 = 1 + 2 + 4 + 32	ON OFF	ON	ON	ON	OFF	OFF	ON	OFF

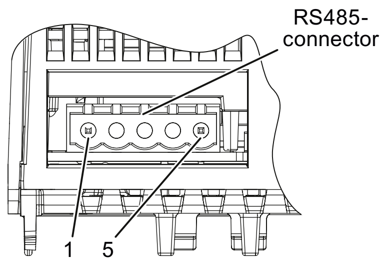
6.3 Communication via RS485

6.3.1 Integrating inverters into a bus system via the RS485 interface

Connecting to a network via RS485

The Control Unit has a two-section terminal strip on its lower side which allows the inverter to be integrated into a bus system via the RS485 interface. This connector has short-circuit proof, isolated pins. You will find the terminal assignments in the following table.

Table 6- 2 Assignments for the terminal strip of the RS485 interface

Contact	Designation	Description	
1	0 V	Reference potential	
2	RS485P	Receive and send signal (+)	
3	RS485N	Receive and send signal (-)	
4	Shield	Cable shield	
5	---	---	

General specifications and requirements for error-free communication

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.

You must switch-in the bus terminating resistor for the first and last participants. The bus terminating resistor is either located on the lower side next to the RS485 connector or on the front side of the Control Unit behind the front door, see Chapter .

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.

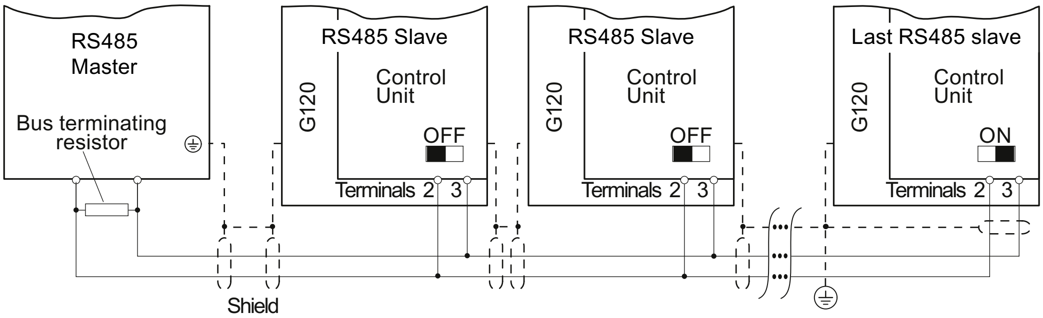


Figure 6-1 Communication network via RS485

6.3.2 Communication via USS

6.3.2.1 General information about communication with USS via RS485

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 100).

Setting the bus address of the inverter

The inverter's USS address can be set via DIP switches on the Control Unit or using p2021. Using p2021, the address can only be set if all DIP switches for the bus address are either set to "OFF" (0) or to "ON" (127).

If the address switches are set to a value = 1 … 30, then this address is always active and p2021 is read-only.

Valid USS address area: 1 … 30

The setting using DIP switches is described in Setting the bus address via DIP switch (Page 99).

CAUTION
A bus address that has been changed is only effective after switching-off and switching-on again. It is particularly important that any external 24 V supply is switched off.

Additional communication settings

Parameter	Description	
p0700 = 6	**Command source selection** Selecting the fieldbus as command source	You set the command and setpoint source during the basic commissioning, see Commissioning (Page 59)
p1000 = 6	**Speed setpoint selection** Selecting the fieldbus as setpoint source	
p2020	Value | Baud rate 4 | 2400 5 | 4800 6 | 9600 7 | 19200 8 | 38400 9 | 57600 10 | 76800 11 | 93750 12 | 115200 13 | 187500	
p2022	**Fieldbus interface, USS PZD count** Setting the number of 16-bit words in the PZD part of the USS telegram	
p2023	**Fieldbus interface, USS PKW count** Setting the number of 16-bit words in the PKW part of the USS telegram: Value | PKW count 0 | PKW 0 words 3 | PKW 3 words 4 | PKW 4 words 127 | PKW variable	
p2030 = 1	**Fieldbus interface protocol selection** 1: USS	
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.

6.3.2.2 Structure of a USS telegram

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

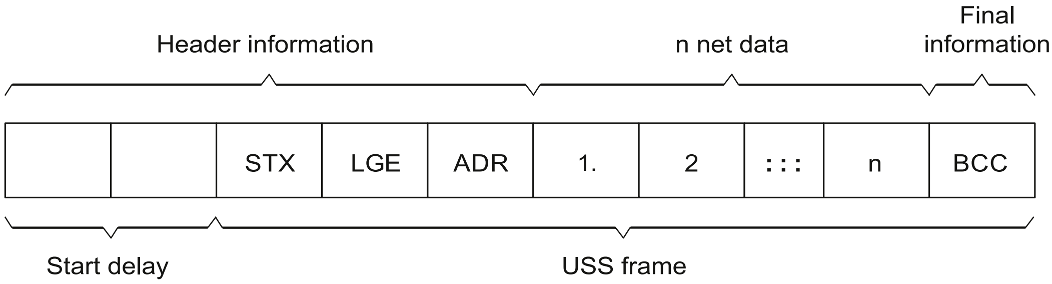


Figure 6-2 Structure of a USS telegram

Every character within the telegram comprises 11 bits.

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

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 (example)	PKW	8 bytes (4 words: PKE + IND + PWE1 + PWE2)
	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:

7	6	5	4	3	2	1	0
Special	Mirror	Send	5 address bits				

- Bit 5 is the broadcast bit.

Note

The Broadcast function is not supported in the current software version.

- Bit 6 = 1 indicates a mirror telegram.
  The node address is evaluated and the addressed slave returns the telegram to the master unchanged.

Bit 5 = 0, bit 6 = 0 and bit 7 = 0 indicate normal data communication for devices. The node address (bit 0 to bit 4) is evaluated.

BCC

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

6.3.2.3 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.

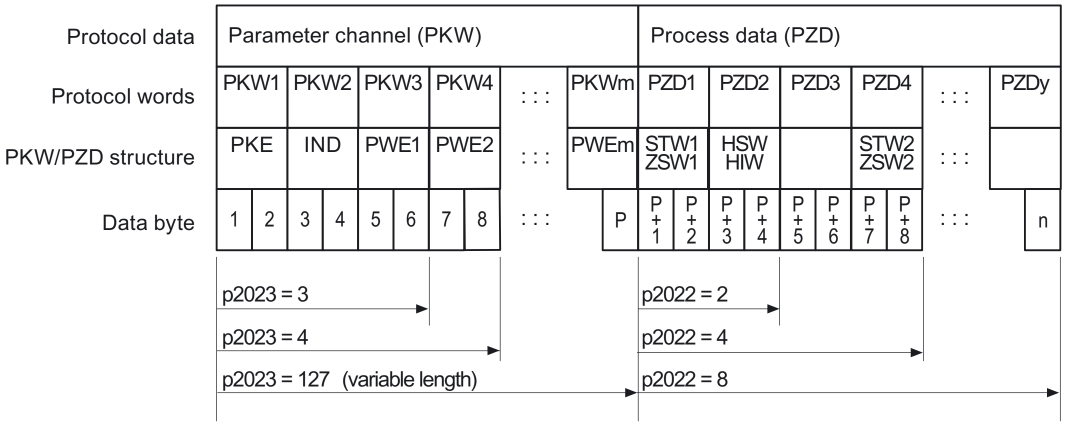


Figure 6-3 USS user data structure

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.

6.3.2.4 Data structure of the USS parameter channel

Description

The USS protocol defines for inverters the user data structure via which a master can access the slave inverter. The parameter channel can be used to monitor and change any parameters in the inverter.

Parameter channel

Process data can be edited and monitored (written/read) via the parameter channel, as described below. The parameter channel can be set to a fixed length of 3 or 4 data words or to 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.

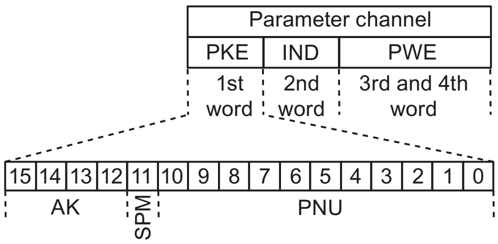


Figure 6-4 PKE structure

- 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 an offset must be added that is defined in the 2nd word of the parameter channel (IND).

The significance of the request identifier for request telegrams (master → inverter) is described in the following table.

Table 6- 3 Request identifier (master → inverter)

Request identifier	Description	Response identifier	
		Positive	Negative
0	No request	0	7
1	Request parameter value	1 / 2	7
2	Change parameter value (word)	1	7
3	Change parameter value (double word)	2	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 (second 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.

The significance of the response identifier for response telegrams (inverter → master) is described in the following table. The request identifier determines which response identifiers are possible.

Table 6- 4 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 (second word).

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

Table 6- 5 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" mode (see p0927)
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)

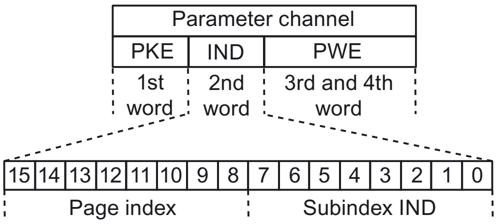


Figure 6-5 Structure of the parameter index (IND)

- 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- 6 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

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 A parameter channel with fixed length should contain 4 words as this setting is sufficient for all parameters (including double words).	P2023 = 127 For a variable length of parameter channel, the master will only send the number of PWEs necessary for the task in the parameter channel. The response telegram is also no longer than necessary.
P2023 = 3 You can select this setting if you only want to read or write 16-bit data or alarm signals.	
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.

Example of read request for parameter P7841[2]

In this example the parameter channel consists of four words.

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- 7 Request to read parameter P7841[2]

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

Rules for editing requests/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.

6.3.2.5 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.

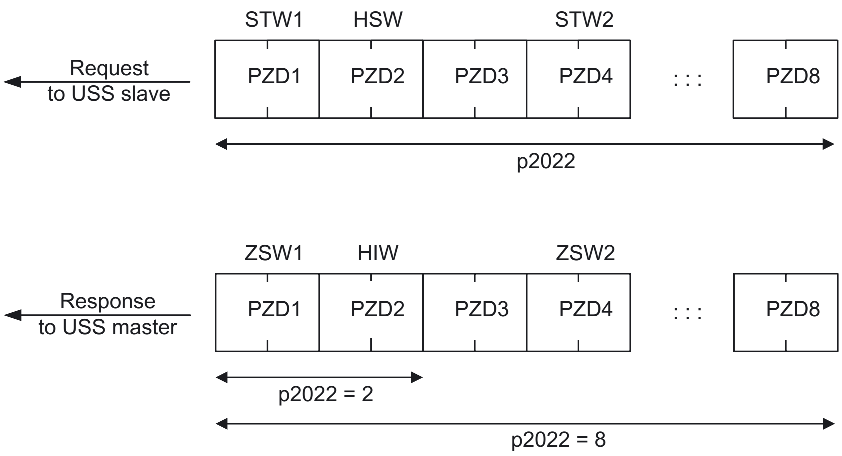


Figure 6-6 Process data channel

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.

6.3.2.6 Telegram monitoring

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

Table 6- 8 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). The character delay time between the individual characters of the telegram also has to be taken into account.

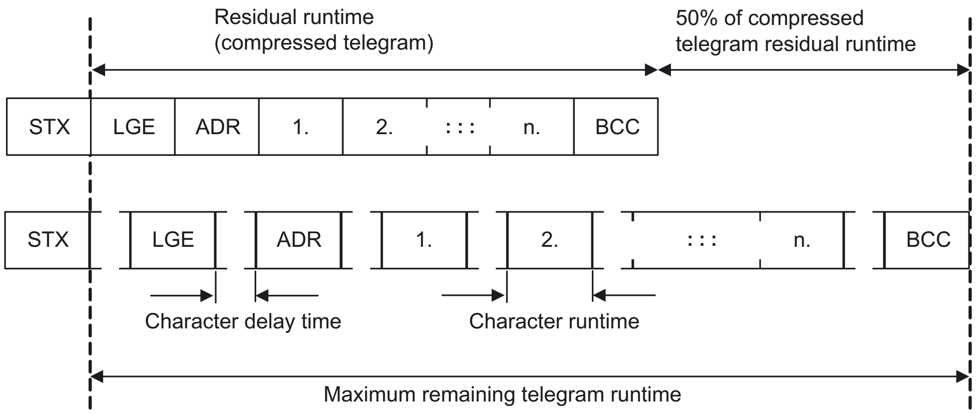


Figure 6-7 Telegram runtime as the sum of the residual runtime and character delay times

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

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

The slave only responds after the response delay has expired.

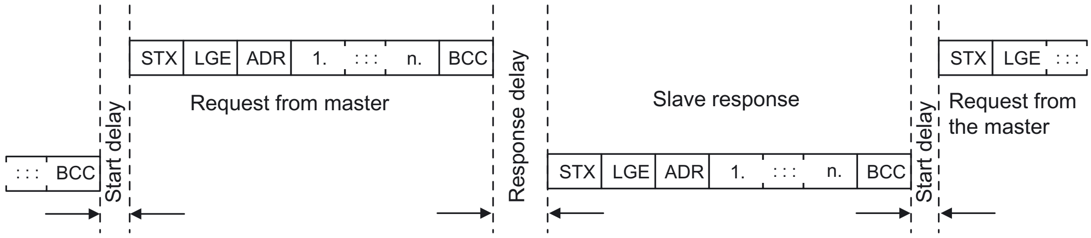


Figure 6-8 Start delay and response delay

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- 9 Duration of the start delay

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

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

Telegram monitoring of the master

The USS master must monitor the following times:

- 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 inverter

The inverter monitors the time between two requests of the master. Parameter p2040 defines the permissible time in ms. If this time is exceeded, it is interpreted as a telegram failure and results in fault message 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.

There is no monitoring for p2040 = 0.

If the USS is configured as a command source for the drive and p2040 is not zero, bit 10 of the received control word 1 is checked. If the bit is not set, then fault message F07220 is immediately output.

6.3.3 Communication over Modbus RTU

6.3.3.1 General information for communication with Modbus

Overview

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

Modbus offers three transmission modes:

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

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

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

Communication settings

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

6.3.3.2 Parameters for Modbus communication settings

Setting the bus address of the inverter

The Modbus address of the inverter can be set using DIP switches on the Control Unit or using p2021. Using p2021, the address can only be set if all DIP switches for the bus address are either set to "OFF" (0) or to "ON" (127).

If the address switches are set to a value = 1 … 127, then this address is always active and p2021 is read-only.

Valid Modbus addressing range: 1 … 247.

The setting using DIP switches is described in Setting the bus address via DIP switch (Page 99).

CAUTION
A bus address that has been changed is only effective after switching-off and switching-on again. It is particularly important that any external 24 V supply is switched off.

Additional communication settings

Table 6- 10 Parameters for setting communication via Modbus

Parameter	Description
p0700 = 6	**Select the command source** 6: Via fieldbus
p1000 = 6	**Select the setpoint source** 6: Via fieldbus
p2030 = 2	**Fieldbus telegram selection** 2: Modbus
p2020	**Fieldbus baud rate** Baud rates from 4800 bit/s to 19200 bit/s can be set for communication, factory setting = 19200 bit/s.
p2024	**Modbus timing** (see Section "Baud rates and mapping tables (Page 117)") • **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).

Possible causes of a timeout

Alarm No.	Parameter name	Note
A1910	**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 • Communication error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)	

6.3.3.3 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.

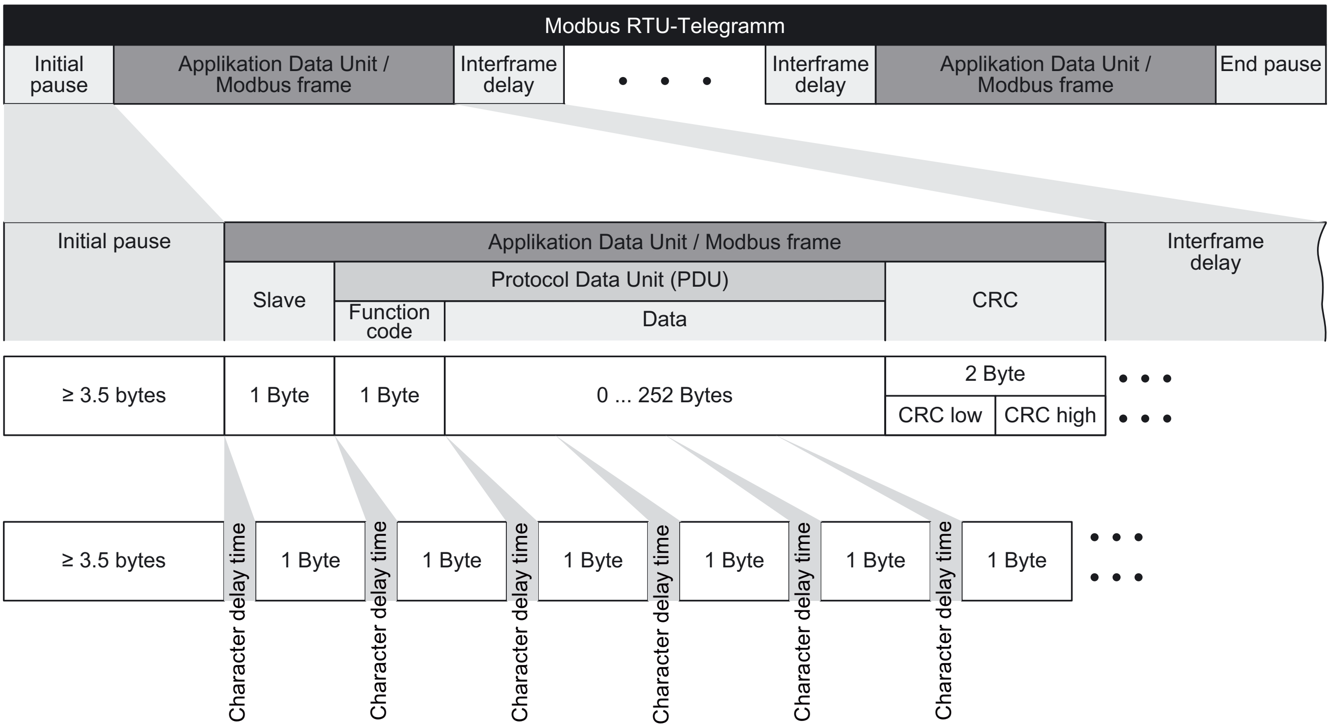


Figure 6-9 Modbus with delay times

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

6.3.3.4 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- 11 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	≥ 8.022 ms	≤ 3.4380 ms
9600	1.146 ms	≥4.011 ms	≤ 2.1900 ms
19200 (factory setting)	0.573 ms	≥ 2.0055 ms	≤ 0.8595 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.

To ensure compatibility with the Micromaster MM436, two address areas are supported.

- MM436 40001 … 40065
- SINAMICS G120 from 40100 to 40522

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

As a user, you can use both the register from the MM436 area and from the SINAMICS G120 area.

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- 12 Assigning the Modbus register to the parameters of the Control Unit

Modbus Reg. No.	Description	Mod-bus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Process data							
Control data							
40100	Control word	R/W	--	1			Process data 1
40101	Main setpoint	R/W	--	1			Process data 2
Status data							
40110	Status word	R	--	1			Process data 1
40111	Main actual value	R	--	1			Process data 2
Parameter data							
Digital outputs							
40200	DO 0	R/W	--	1	HIGH	LOW	p0730, r747.0, p748.0
40201	DO 1	R/W	--	1	HIGH	LOW	p0731, r747.1, p748.1
40202	DO 2	R/W	--	1	HIGH	LOW	p0732, r747.2, p748.2
Analog outputs							
40220	AO 0	R	%	100	-100.0 … 100.0		r0774.0
40221	AO 1	R	%	100	-100.0 … 100.0		r0774.1
Digital inputs							
40240	DI 0	R	--	1	HIGH	LOW	r0722.0
40241	DI 1	R	--	1	HIGH	LOW	r0722.1
40242	DI 2	R	--	1	HIGH	LOW	r0722.2
40243	DI 3	R	--	1	HIGH	LOW	r0722.3
40244	DI 4	R	--	1	HIGH	LOW	r0722.4
40245	DI 5	R	--	1	HIGH	LOW	r0722.5
Analog inputs							
40260	AI 0	R	%	100	-300.0 … 300.0		r0755 [0]
40261	AI 1	R	%	100	-300.0 … 300.0		r0755 [1]
40262	AI 2	R	%	100	-300.0 … 300.0		r0755 [2]
40263	AI 3	R	%	100	-300.0 … 300.0		r0755 [3]
Inverter identification							
40300	Powerstack number	R	--	1	0 … 32767		r0200
40301	CU firmware	R	--	0.0001	0.00 … 327.67		r0018
Inverter 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
Inverter diagnostics							
40340	Speed setpoint	R	RPM	1	-16250 … 16250		r0020
40341	Speed actual value	R	RPM	1	-16250 … 16250		r0022
40342	Output frequency	R	Hz	100	- 327.68 … 327.67		r0024

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

6.3.3.5 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- 13 Structure of a read request for slave number 17

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

The response returns the corresponding data set:

Table 6- 14 Slave response to the read request

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

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

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

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

Table 6- 15 Structure of a write request for slave number 17

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

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

Table 6- 16 Slave response to the write request

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

6.3.3.6 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- 17 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 inverter).

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).

6.3.4 Communication via BACnet MS/TP

6.3.4.1 BACnet properties

Description

In BACnet, components and systems are considered to be black boxes which contain a number of objects. BACnet objects only define behavior outside the device, internal functions are not determined by BACnet.

Each component is represented by a series of object types and their instances.

Each BACnet device has precisely one BACnet device object. A BACnet device is clearly identified by an NSAP (Network Service Access Point - comprising network number and MAC address; MAC: **M**edium **A**ccess **C**ontrol). This address is BACnet-specific and must not be confused with the Ethernet MAC address.

Data exchange with the client

The inverter receives control commands and setpoints via service instructions from the control and transmits its status back to the control. The inverter can also send telegrams automatically itself, respectively execute services, e.g. I-Am.

Communication settings

- The Control Unit supports BACnet via RS485 (BACnet MS/TP)
- The maximum cable length is 1200 m (3281 ft).

Protocol Implementation Conformance Statement

You will find the Protocol Implementation Conformance Statement (PICS) under the following link: http://support.automation.siemens.com/WW/view/de/38439094 (http://support.automation.siemens.com/WW/view/en/38439094)

6.3.4.2 Parameters for setting communication via BACnet

Setting the bus address of the inverter

The MAC ID of the inverter can be set using DIP switches on the Control Unit or using p2021. Using p2021, the address can only be set if all DIP switches for the bus address are to "OFF" (0).

If the address switches are set to a value = 1 … 127, then this address is always active and p2021 is read-only.

Valid BACnet addressing range: 1 … 127

The setting using DIP switches is described in Setting the bus address via DIP switch (Page 99).

CAUTION
A bus address that has been changed is only effective after switching-off and switching-on again. It is particularly important that any external 24 V supply is switched off.

Additional communication settings

Table 6- 18 Parameters for setting communication via BACnet MS/TP

P no.	Parameter name
p2030	**Fieldbus telegram selection** 0: No protocol 1: USS 2: Modbus **5: BACnet**
p0700	**Select the command source** 2: Via terminals 6: Via fieldbus
p1000	**Select the setpoint source** 0: No main setpoint 1: Via motorized potentiometer 2: Via analog setpoint 3: Via fixed speed setpoint 6: Via fieldbus 7: Via analog setpoint 2
p2020	**Baud rate** 6: 9600 (factory setting) 7: 19200 8: 38400 10: 76800
p2024[0 … 2]	**Processing times** P2024 [0]: 0 ms … 10000 ms, maximum processing time (APDU timeout), factory setting = 1000 ms, P2024 [1 … 2]: No significance for BACnet

P no.	Parameter name
p2025[0…3]	**BACnet communication parameter** • p2025 [0]: 0 … 4194303, Device object instance number, Factory setting = 1 • p2025 [1]: 1 … 10, Maximum Info Frames, factory setting = 1 • p2025 [2]: 0 … 99, Number of APDU Retries (repeated attempts after fault telegrams), factory setting = 3 • p2025 [3]: 1 … 127, maximum Master address, factory setting = 127
p2026	**Setting of the COV_Increment** (COV = Change of values) 0 … 4194303.000, factory setting = 0.100 COV_Increment: Value change of the "Present Value" of an object instance where an UnConfirmedCOVNotification or ConfirmedCOVNotification should be transferred from the server. • p2026 [0]: COV increment of object instance "Analog Input 0" • p2026 [1]: COV increment of object instance "Analog Input 1" • p2026 [2]: COV increment of object instance "Analog Input 10" • p2026 [3]: COV increment of object instance "Analog Input 11" You can use these parameters to set for which value changes an UnConfirmedCOVNotification or ConfirmedCOVNotificationresult is sent. Therefore, the factory setting 0.100 means that an UnConfirmedCOVNotification or ConfirmedCOVNotification is sent if the value being considered (e.g. for a control range from 0 … 10 V) changes by an absolute value of ≥ 0.1. Of course this only applies if previously a SubscribeCOV service was activated for the particular object instance. You can also set the COV increment using the object property "COVIncrement" of the particular analog input.
p2040	**Fieldbus monitoring time** 0 ms … 65535000 ms, factory setting = 100 ms **Note:** The factory setting for communication with BACnet is possibly too low and must be increased. Please adapt the value to the requirements and properties of your particular plant or system. The reason for the factory setting of 100 ms is that the communication protocols for USS and Modbus RTU should also be executed via the RS485 interface.

6.3.4.3 Supported services and objects

BIBBs used by the inverter

The BIBBs are a collection of one or several BACnet services The BACnet services are sub-divided into A and B devices. An A device operates as client and B device as server.

The inverter is a server and therefore operates as B device, as "BACnet Application Specific Controller" (B-ASC).

The CU230P-2 HVAC uses the BIBBs listed below:

Table 6- 19 Overview of the BIBB used by CU230P-2 HVAC and associated services

Short designation	BIBB	Service
DS-RP-B	Data Sharing-ReadProperty-B	ReadProperty
DS-WP-B	Data Sharing-WriteProperty-B	WriteProperty
DM-DDB-B	Device Management-Dynamic Device Binding-B	• Who-Is • I-Am
DM-DOB-B	Device Management-Dynamic Object Binding-B	• Who-Has • I-Have
DM-DCC-B	Device Management-DeviceCommunicationControl-B	DeviceCommunicationControl
DS-COV-B	Data Sharing-COV-B	• SubscribeCOV, • ConfirmedCOVNotification, • UnConfirmedCOVNotification

The inverter can simultaneously process up to 32 SubscribeCOV services. These can all refer to the same object instances - or different object instances.

SubscribeCOV is supported for binary value objects (BVxx) and for analog input objects (AI xx).

Note

SubscribeCOV services are not retentive, i.e. when switching-off, COVs, which have not been executed, are lost and must be re-initiated when the CU restarts.

Table 6- 20 Code numbers of the object types supported in BACnet

Object type	Code number for BACnet object type
Device	8
Digital input	3
Digital output	4
Digital value	5
Analog input	0
Analog output	1
Analog value	2

Table 6- 21 Object properties of the "Device" object type

• Object_Identifier	• Application_Software_Version	• APDU_Timeout
• Object_Name	• Protocol_Version	• Number_Of_APDU_Retries
• Object_Type	• Protocol_Revision	• Max Master
• System_Status	• Protocol_Services_Supported	• Max Info Frames
• Vendor_Name	• Protocol_Object_Types_Supported	• Device Address Binding
• Vendor_Identifier	• Object_List	• Database Revision
• Model_Name	• Max_APDU_Length_Accepted 1)	
• Firmware_Revision	• Segmentation_Supported 2)	

1) Maximum value = 480, 2) is not supported

Table 6- 22 Object properties of other object types

Object property	Object type				
	Binary input	Binary output	Binary value	Analog input	Analog value
Object_Identifier	X	X	X	X	X
Object_Name	X	X	X	X	X
Object_Type	X	X	X	X	X
Present_Value	X	X	X	X	X
Status_Flags	X	X	X	X	X
Event_State	X	X	X	X	X
Out_Of_Service	X	X	X	X	X
Units				X	X
Priority_Array		X	X*		X*
Relinquish_Default		X	X*		X*
Polarity	X	X			
Active_Text	X	X	X		
Inactive_Text	X	X	X		
COV_Increment				X	

* for command values only (access type C)

Note

Access types are available in the following versions

- C: commandable
- R: Readable
- W: Writable

Table 6- 23 Binary input objects

Instance ID	Object name	Description	Possible values	Text active / text inactive	Access type	Parameter
BI0	DI0 ACT	State of DI 0	ON/OFF	ON/OFF	R	r0722.0
BI1	DI1 ACT	State of DI 1	ON/OFF	ON/OFF	R	r0722.1
BI2	DI2 ACT	State of DI 2	ON/OFF	ON/OFF	R	r0722.2
BI3	DI3 ACT	State of DI 3	ON/OFF	ON/OFF	R	r0722.3
BI4	DI4 ACT	State of DI 4	ON/OFF	ON/OFF	R	r0722.4
BI5	DI5 ACT	State of DI 5	ON/OFF	ON/OFF	R	r0722.5
BI7	DI7 ACT	State of AI 1 - used as DI	ON/OFF	ON/OFF	R	r0722.11
BI8	DI8 ACT	State of AI 2 - used as DI	ON/OFF	ON/OFF	R	r0722.12
BI10	DO0 ACT	Controls DO 0 (relay 1)	ON/OFF	ON/OFF	R	read r747.0
BI11	DO1 ACT	Controls DO 1 (relay 2)	ON/OFF	ON/OFF	R	read r747.1
BI12	DO2 ACT	Status of DO2 (relay 3)	ON/OFF	ON/OFF	R	read r747.2

Table 6- 24 Binary output objects

Instance ID	Object name	Description	Possible values	Text active / text inactive	Access type	Parameter
BO0	DO0 CMD	Controls DO 0 (relay 1)	ON/OFF	ON/OFF	C	p0730
BO1	DO1 CMD	Controls DO 1 (relay 2)	ON/OFF	ON/OFF	C	p0731
BO2	DO2 CMD	Controls DO 2 (relay 3)	ON/OFF	ON/OFF	C	p0732

Table 6- 25 Binary value objects

Instance ID	Object name	Description	Possible values	Text active	Text inactive	Access type	Parameter
BV0	RUN/ STOP ACT	Inverter status regardless of command source	RUN/STOP	STOP	RUN	R	r0052.2
BV1	FWD/ REV	Direction of rotation regardless of command source	REV/ FWD	FWD	REV	R	r0052.14
BV2	FAULT ACT	Fault status of inverter	FAULT/OK	FAULT	OK	R	r0052.3
BV3	WARN ACT	Warning status of inverter	WARN/OK	WARN	OK	R	r0052.7
BV4	HAND/ AUTO ACT	Indicates the source of the hand/auto inverter control	AUTO / MANUAL	AUTO	LOCAL	R	r0052.9
BV7	CTL OVERRIDE ACT	ACT indicates if the inverter control has been transferred to BACnet override control via BV93. Note that the operator panel's "Manual" operating mode has a higher priority than the BACnet override control.	ON/OFF	0	1	R	r2032[10]
BV8	AT SET-POINT	Setpoint reached	YES/NO	YES	NO	R	r0052.8
BV9	AT MAX FREQ	Maximum speed reached	YES/NO	YES	NO	R	r0052.10

Instance ID	Object name	Description	Possible values	Text active	Text inactive	Access type	Parameter
BV10	DRIVE READY	Inverter ready	YES/NO	YES	NO	R	r0052.1
BV15	RUN COM ACT	ACT indicates the status of the ON command, regardless of the source	YES/NO	0	1	R	r2032[0]
BV16	HIB MOD ACT	ACT means that the inverter is operating in hibernation mode.	ON/OFF	0	1	R	r2399[1]
BV17	ESM MOD	ACT means that the inverter is operating in emergency mode.	ON/OFF	0	1	R	r3889[0]
BV20	RUN/ STOP CMD	ON command for the inverter (when controlling via BACnet)	RUN/STOP	0	1	C	r0054.0
BV21	FWD/ REV CMD	Reverse direction of rotation (when controlling via BACnet)	REV/ FWD	0	1	C	r0054.11
BV22	FAULT RESET	Acknowledge fault (when controlling via BACnet)	RESET/NO	0	1	C	r0054.7
BV24	CDS	Local/Remote	Local/Remote	YES	NO	C	r0054.15
BV26	RUN ENA CMD	Enable inverter operation		ENABLED	DISABLED	C	r0054.3
BV27	OFF2	OFF2 status	RUN/STOP	0	1	C	r0054.1
BV28	OFF3	OFF3 status Note: Bits r0054.4, r0054.5 and r0054.6 are also set or reset via BV28	RUN/STOP	0	1	C	r0054.2
BV50	ENABLE PID	Enable PID controller		ENABLED	DISABLED	C	p2200
BV90	LOCAL LOCK	Use HAND (operator panel) to lock inverter control		LOCK	UNLOCK	C	p0806
BV93	CTL OVERRIDE CMD	Inverter control using BACnet override control	ON/OFF	0	1	C	r0054.10

Table 6- 26 Analog input objects

Instance ID	Object name	Description	Unit	Area	Access type	Parameter
AI0	ANALOG INPUT 0	AI0 input signal	V/mA	-300.0 … 300.0	R	r0752[0]
AI1	ANALOG INPUT 1	AI1 input signal	V/mA	-300.0 … 300.0	R	r0752[1]
AI10	ANALOG INPUT 0 SCALED	Standardized AI 0 input signal	%	-100.0 … 100.0	R	r0755[0]
AI11	ANALOG INPUT 1 SCALED	Standardized AI 1 input signal	%	-100.0 … 100.0	R	r0755[1]

Table 6- 27 Analog value objects

Instance ID	Object name	Description	Unit	Area	Access type	Parameter
AV0	OUTPUT FREQ_Hz	Output frequency (Hz)	Hz	-327.68 … 327.67	R	r0024
AV1	OUTPUT FREQ_PCT	Output frequency (%)	%	-100.0 … 100.0	R	HIW
AV2	OUTPUT SPEED	Motor speed	RPM	-16250 … 16250	R	r0022
AV3	DC BUS VOLT	DC link voltage.	V	0 … 32767	R	r0026
AV4	OUTPUT VOLT	Output voltage	V	0 … 32767	R	r0025
AV5	CURRENT	Motor current	A	0 … 163.83	R	r0027
AV6	TORQUE	Motor torque	Nm	- 325.00 … 325.00	R	r0031
AV7	POWER	Motor power	kW	0 … 327.67	R	r0032
AV8	DRIVE TEMP	Heat-sink temperature	°C	0 … 327.67	R	r0037
AV9	MOTOR TEMP	Measured or calculated motor temperature	°C	0 … 327.67	R	r0035
AV10	KWH (NR)	Cumulative inverter energy consumption (cannot be reset!)	kWh	0 … 32767	R	r0039
AV12	INV RUN TIME (R)	Motor's operating hours (is reset by entering "0")	h	0 … 4294967295	W	p0650
AV13	INV Model	Code number of Power Module	---		R	r0200
AV14	INV FW VER	Firmware version	---		R	r0018
AV15	INV POWER	Rated power of the inverter	kW	0 … 327.67	R	r0206
AV16	RPM STPT 1	Inverter's reference speed	RPM	6.0 … 210000	W	p2000
AV17	FREQ STPT PCT	Setpoint 1 (when controlling via BACnet)	%	0.00 … 100.00	C	HSW
AV18	ACT FAULT	Fault number of fault due to be dealt with	---	0 … 32767	R	r0947[0]
AV19	PREV FAULT 1	Fault number of last fault	---	0 … 32767	R	r0947[1]
AV20	PREV FAULT 2	Fault number of last but one fault	---	0 … 32767	R	r0947[2]
AV21	PREV FAULT 3	Fault number of the third from last fault	---	0 … 32767	R	r0947[3]
AV22	PREV FAULT 4	Fault number of the fourth from last fault	---	0 … 32767	R	r0947[4]
AV25	Select Setpoint Source	Command to select the setpoint source	---	0 … 32767	W	p1000
AV28	AO1 ACT	Signal from AO 1	mA	-100.0 … 100.0	R	r0774.0
AV29	AO2 ACT	Signal from AO 1	mA	-100.0 … 100.0	R	r0774.1
AV30	MIN SPEED	Minimum speed	RPM	0.000 – 19500.000	W	p1080
AV31	MAX FREQ	Maximum speed	RPM	0.000 … 210000.000	W	p1082
AV32	ACCEL TIME	Rampup time	s	0.00 … 999999.0	W	p1120
AV33	DECEL TIME	Ramp-down time	s	0.00 … 999999.0	W	P1121
AV34	CUR LIM	Current limit	A	0.00 … 10000.00	R	p0640
AV39	ACT WARN	Indication of pending alarm	---	0 … 32767	R	r2110[0]
AV40	PREV WARN 1	Indication of the last alarm	---	0 … 32767	R	r2110[1]
AV41	PREV WARN 2	Indication of the last but one alarm	---	0 … 32767	R	r2110[2]

6.4 Communication via PROFIBUS

6.4.1 Connect the frequency inverter to PROFIBUS

Assignment of the SUB-D connector to connect to the PROFIBUS-DP network

Inverters with PROFIBUS DP interface have a nine-pin SUB-D socket on the lower side of the Control Unit to integrate the inverter into a PROFIBUS network.

The SUB D connection is suitable for the SIMATIC RS485 bus connector.

Recommended PROFIBUS connectors

We recommend one of the following connectors for the PROFIBUS cable:

1. 6GK1500-0FC00
2. 6GK1500-0EA02

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

Note

PROFIBUS communication when the 400 V supply for the inverter is switched off

If the inverter is only supplied via the 400 V line connection for the Power Module, the PROFIBUS connection for the Control Unit is interrupted as soon as the power supply is disconnected. To prevent this, the Control Unit must be connected to a separate 24 V power supply via terminals 31 (+24 V I_n) and 32 (0 V I_n).

Permissible cable lengths, routing and shielding the PROFIBUS cable

Information can be found in the Internet (http://www.automation.siemens.com/net/html_76/support/printkatalog.htm).

6.4.2 Configuring communication via PROFIBUS

6.4.2.1 Task

The inverter is to be controlled from a central SIMATIC controller via PROFIBUS. whereby the control signals and speed setpoint are to be transferred from an S7-300 CPU to the drive. In the other direction, the drive is to transfer its status messages and actual speed value to the central controller via PROFIBUS.

Using a suitable example, the following section provides instructions explaining how to connect an inverter to a higher-level SIMATIC controller via PROFIBUS. To extend the PROFIBUS network to include additional inverters, simply repeat the relevant steps.

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.

6.4.2.2 Required components

The examples given in this manual for configuring communication between the control and inverter are based on the hardware listed below:

Table 6- 28 Hardware components (example)

Component	Type	Order no.	Qty
Central controller			
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
Drive			
SINAMICS G120 Control Unit	CU230P-2 DP	6SL3243-0BB30-1PA1	1
SINAMICS G120 Power Module	Any	-	1
PROFIBUS connector	PROFIBUS connector	6GK1500-0FC00	1

In order to configure the communication you also require the following software packages:

Table 6- 29 Software components

Component	Type (or higher)	Order no.	Qty
SIMATIC STEP 7	V5.3 + SP3	6ES7810-4CC07-0YA5	1
STARTER	V4.1 SP5	6SL3072-0AA00-0AG0	1
Drive ES Basic	V5.4	6SW1700-5JA00-4AA0	1

Drive ES Basic is the basic software of the engineering system, which combines the drive technology and Siemens controllers. The STEP 7 Manager user interface acts as a basis with which Drive ES Basic is used to integrate drives in the automation environment with respect to communication, configuration, and data storage.

6.4.2.3 Setting the PROFIBUS address

Setting the PROFIBUS address of the inverter

The inverter's PROFIBUS address is set using DIP switches on the Control Unit or using p0918. Using p0918, the address can only be set if all DIP switches for the bus address are either set to "OFF" (0) or to "ON" (127).

If the address switches are set to a value ≠ 0 or 127, this address is always active and p0918 is read-only.

The setting using DIP switches is described in Setting the bus address via DIP switch (Page 99).

Valid PROFIBUS addresses:	1 … 125
Invalid PROFIBUS addresses:	126, 127

CAUTION
A bus address that has been changed is only effective after switching-off and switching-on again. It is particularly important that any external 24 V supply is switched off.

6.4.2.4 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.

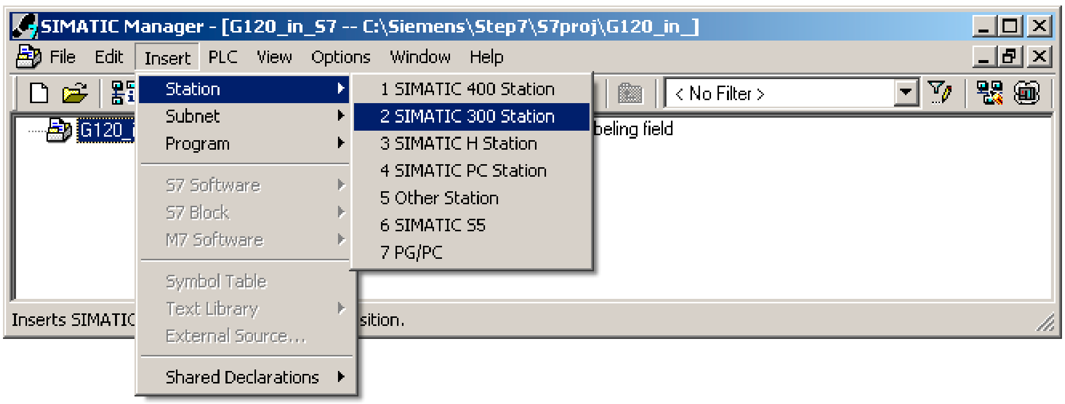


Figure 6-10 Inserting a SIMATIC 300 station into a STEP 7 project

- 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.

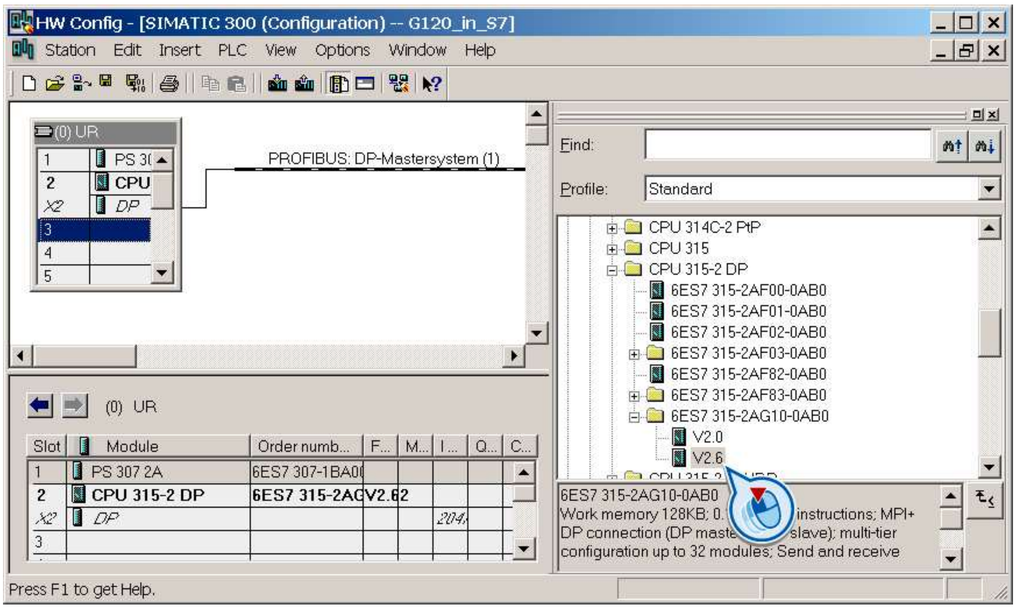


Figure 6-11 Inserting a SIMATIC 300 station with PROFIBUS DP network

In STEP 7, the inverter can be connected to an S7 control in two ways:

1. Using the inverter GSD

   The GSD is a standardized description file for a PROFIBUS slave. The GSD is used by all controls, which are the PROFIBUS master.
   You have two options to obtain the GSD for your inverter:

   – You can find the GSD SINAMICS inverters in the Internet under the URL Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).

   – The GSD is saved in the inverter. The GSD is written to the memory card if you insert the memory card in the Control Unit and set p0804 to 12. Using the memory card, you can then transfer the GSD to your PG/your PC.

2. Using the STEP 7 object manager

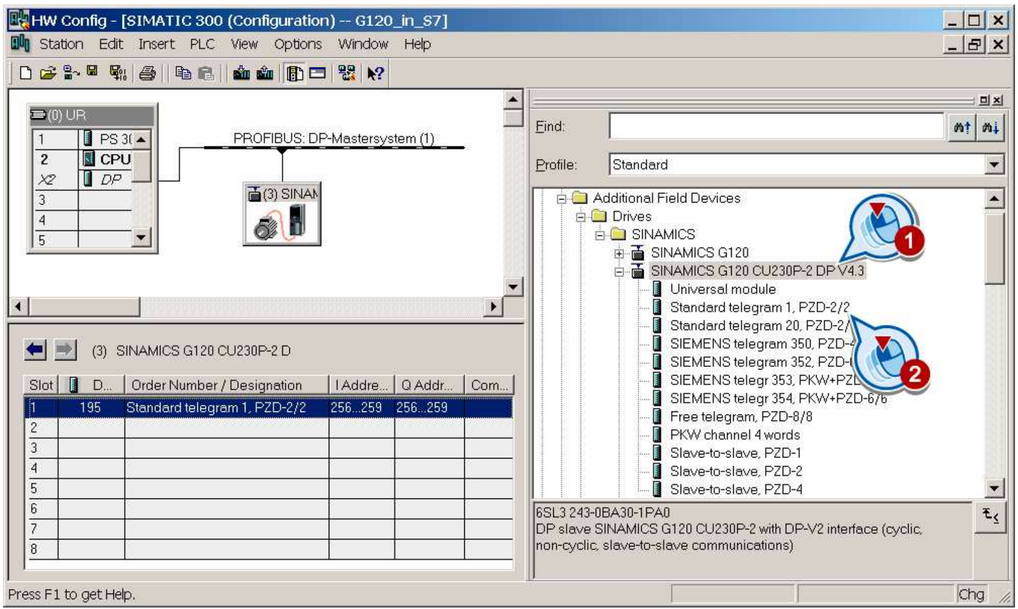
   This somewhat more user-friendly method is only available for S7 controls and installed Drive_ES_Basic.

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

6.4.2.5 Inserting the inverter into the STEP 7 project

- Install the GSD of the inverter in STEP 7 using HW Config (menu "Options - Install GSD files").

Once the GSD has been installed, the inverter appears as "SINAMICS G120 CU230P-2 DP V4.3" object under "PROFIBUS DP - additional field devices" in the hardware catalog of HW Config.



- Drag and drop the inverter into the PROFIBUS network. Enter the PROFIBUS address set at the inverter in HW Config.
- Insert the required telegram type from the HW Catalog to slot 1 of the inverter by 'dragging and dropping'.
  STEP 7 automatically allocates the address range in which the inverter process data are located.

The inverter object in the HW Config product catalog contains several telegram types. The telegram type defines which data is exchanged between the control and inverter. More information on the telegram types can be found in Chapter The PROFIdrive profile (Page 139).

Rules for the slot sequence

The following sequence must be maintained when assigning the slots:

1. PKW channel (if one is used)
2. Standard, SIEMENS or free telegram (if one is used)
3. Slave-to-slave module

If you do not use one or several of the modules 1 or 2, 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 section STEP 7 program examples (Page 154).

6.4.3 Communication parameters

Table 6- 30 The most important parameters

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td>p0700 = 6</td><td colspan="2">Command source selection
Selecting the fieldbus as command source</td><td rowspan="2">You set the command and setpoint source during the basic commissioning, see Commissioning (Page 59)</td></tr>
<tr><td>p1000 = 6</td><td colspan="2">Speed setpoint selection
Selecting the fieldbus as setpoint source</td></tr>
<tr><td rowspan="2">p0922</td><td colspan="3">PROFIdrive telegram selection
Set the send and receive telegram, see The PROFIdrive profile (Page 139)</td></tr>
<tr><td>1:
20:
350:
352
353:
354:
999:</td><td colspan="2">Standard telegram 1, PZD-2/2
Standard telegram 20, PZD-2/6
SIEMENS telegram 350, PZD-4/4
SIEMENS telegram 352, PZD-6/6
SIEMENS telegram 353, PZD-2/2, BW-PKW-4/4
SIEMENS telegram 354, PZD-6/6, BW-PKW-4/4
Free telegram configuring with BICO</td></tr>
</table>

Using parameter p0922, you automatically interconnect the corresponding signals of the inverter 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- 31 Extended setup

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.

6.4.4 The PROFIdrive profile

6.4.4.1 User data structure in the PROFIdrive profile

PROFIdrive as an inverter interface on PROFIBUS or PROFINET

The SINAMICS G120 inverters are controlled via the PROFIdrive profile, version 4.1. The PROFIdrive profile defines the user data structure with which a central control communicates with the inverter by means of cyclic or acyclic data transfer. The PROFIdrive profile is a cross-vendor standard.

6.4.4.2 Cyclic communication

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

Table 6- 32 Inverter telegram types

Telegram type	Process data (PZD) - control and status words, actual values							
	PZD01 STW1 ZSW1	**PZD02 HSW HIW**	**PZD03**	**PZD04**	**PZD05**	**PZD06**	**PZD 07**	**PZD 08**
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	STW2				
	ZSW1	NIST_A_ GLATT	IAIST_ GLATT	ZSW2				
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- 33 Explanation of the abbreviations

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

Select telegram

The communication telegram is selected via parameters p0922 and p2079. The following dependencies apply:

- P0922 < 999:
  When p0922 < 999, p2079 is always set internally to the same value as p0922 and cannot be changed. The interconnections defined in the telegram cannot be changed.
- p0922 = 999:
  When p0922 = 999 you can select a telegram via p2079. The interconnections defined in the telegram cannot be changed. However, the telegram can be added to by the user.
- p0922 = p2079 = 999:
  When p0922 = p2079 = 999, all interconnections can be set in any way. In this case you can preset the command and setpoint sources with p0700, p1000 and p1500 = 2 or 6. p2038 can be used to preset the assignment of the control word in accordance with the SINAMICS or VIK/NAMUR definitions.

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

Inverter behavior when switching over the communication telegram

Overview

When switching over the communication telegram via p0922, several parameters and terminals are assigned again.

The following table shows the dependency of the telegram selection and the associated pre-assignment.

The individual parameters can be subsequently set back to all of the values permissible in the particular parameters, if p0922 and p2079 are set to 999 beforehand.

Table 6- 34 Assignment of the digital inputs dependent on the telegram

Parameter		Pre-assignment when switching over to p0922 =	
		1 / 20 / 352 / 353 / 354	350
p0701[0]	Digital input 0	0	0
p0702[0]	Digital input 1	0	0
p0703[0]	Digital input 2	9	9
p0704[0]	Digital input 3	15	0
p0705[0]	Digital input 4	16	0
p0706[0]	Digital input 5	17	0
p0712[0]	Digital input 6	0	0
p0713[0]	Digital input 7	0	0

Table 6- 35 Assignment of the parameters for data set selection dependent on the telegram

Parameter		Pre-assignment when switching over to p0922 =		
		1 / 352 / 353 / 354	20	350
p0810	BI: Command data set selection, bit 0	0 1)	r2090.15 1)	0 1)
P0811	BI: Command data set selection, bit 1	--- 1)	--- 1)	p2093.15
P0820[0]	BI: Drive data set selection DDS, bit 0	--- 1)	--- 1)	p2093.4
P0821[0]	BI: Drive data set selection DDS, bit 1	--- 1)	--- 1)	p2093.5

"---" no change to the selected value
1): These parameters can be changed without p0922 being set to 99.

Table 6- 36 Assignment of the parameter for the control word dependent on the telegram

Parameter		Pre-assignment when switching over to p0922 =	
		1 / 350 / 352 / 353 / 354	20
p0840[0]	BI: ON/OFF1	r2090.0	r2090.0
p0844[0]	BI: 1. OFF2	r2090.1	r2090.1
p0848[0]	BI: 1. OFF3	r2090.2	r2090.2
p0852[0]	BI: Enable operation	r2090.3	r2090.3
p0854[0]	BI: Master control by PLC	r2090.10	r2090.10
p1035[0]	BI: Motorized potentiometer, setpoint, raise	r2090.13	---
p1036[0]	BI: Motorized potentiometer, setpoint, lower	r2090.14	---
p1113[0]	BI: Setpoint inversion	r2090.11	---
p1140[0]	BI: Ramp-function generator	r2090.4	r2090.4
p1141[0]	BI: Start ramp-function generator	r2090.5	r2090.5
p1142[0]	BI: Enable speed setpoint	r2090.6	r2090.6
p2103[0]	BI: 1. Acknowledge faults	r2090.7	r2090.7

"---" no change to the set value

Table 6- 37 Assignment of the parameter for the status word dependent on the telegram

Parameter		Pre-assignment when switching over to p0922 =	
		1 / 350 / 352 / 353 / 354	20
p2080.0	BI: Binector-connector converter, status word 1	p0899.0	p0899.0
p2080.1	BI: Binector-connector converter, status word 1	p0899.1	p0899.1
p2080.2	BI: Binector-connector converter, status word 1	p0899.2	p0899.2
p2080.3	BI: Binector-connector converter, status word 1	p2139.3	p2139.3
p2080.4	BI: Motorized potentiometer, setpoint, lower	p0899.4	p0899.4
p2080.5	BI: Binector-connector converter, status word 1	p0899.5	p0899.5
p2080.6	BI: Binector-connector converter, status word 1	p0899.6	p0899.6
p2080.7	BI: Binector-connector converter, status word 1	p2139.7	p2139.7
p2080.8	BI: Binector-connector converter, status word 1	p2197.7	p2197.7
p2080.9	BI: Binector-connector converter, status word 1	p0899.9	p0899.9
p2080.10	BI: Motorized potentiometer, setpoint, lower	p2199.1	p2199.1
p2080.11	BI: Binector-connector converter, status word 1	p1407.7	p1407.7
p2080.12	BI: Binector-connector converter, status word 1	p0899.12	---
p2080.13	BI: Binector-connector converter, status word 1	p2135.14	p2135.14
p2080.14	BI: Binector-connector converter, status word 1	p2197.3	p2197.3
p2080.15	BI: Binector-connector converter, status word 1	p2135.15	---

"---" no change to the set value

Table 6- 38 Parameter assignment to select the fixed speed setpoint dependent on the telegram

Parameter		Pre-assignment when switching over to p0922 =	
		1 / 20 / 352 / 353 / 354	350
p1020[0]	BI: Fixed speed setpoint selection bit 0	r0722.3	r2093.0
p1021[0]	BI: Fixed speed setpoint selection bit 1	r0722.4	r2093.1
p1022[0]	BI: Fixed speed setpoint selection bit 2	r0722.5	r2093.2
p1023[0]	BI: Fixed speed setpoint selection bit 3	r0722.6	r2093.3
p2220[0]	BI: Technology controller fixed value selection bit 0	r0722.3	0
p2221[0]	BI: Technology controller fixed value selection bit 1	r0722.4	0
p2222[0]	BI: Technology controller fixed value selection bit 2	r0722.5	0
p2223[0]	BI: Technology controller fixed value selection bit 3	r0722.5	0

Table 6- 39 Additional parameters with telegram-dependent pre-assignment

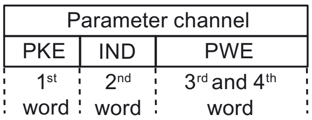
Parameter		Pre-assignment when switching over to p0922 =		
		1 / 352 / 353 / 354	20	350
P1230[0]	BI: DC braking activation	---	---	p2093.9
P1492[0]	BI: Droop feedback enable	---	---	p2093.11
P1501[0]	BI: Change over between closed-loop speed/torque control	---	---	p2093.12
p2051.0	CI: PROFIdrive PZD send word	p2089.0	p2089.0	p2089.0
p2088	Binector-connector converter, invert status word	43008	43008	43008
p2038	PROFIdrive STW/ZSW interface node	0	2	0
p2106[0]	BI: External fault 1	---	---	p2093.13
P2200[0]	BI: Technology controller enable	---	---	p2093.8

"---" no change to the set value

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.



Abbreviations: PKE : Parameter identifier
IND : Index
PWE: Parameter value

Figure 6-12 Structure of the parameter channel

Parameter identifier (PKE), 1st word

The parameter identifier (PKE) contains 16 bits.

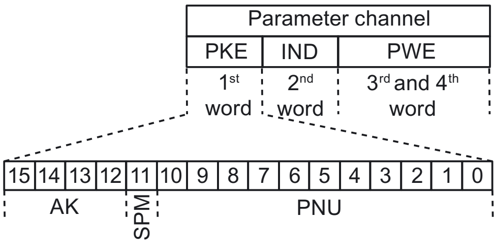


Figure 6-13 PKE - 1st word in parameter channel

- 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).

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

Table 6- 40 Request identifier (control → inverter)

Request identifier	Description	Response identifier	
		positive	negative
0	No request	0	7 / 8
1	Request parameter value	1 / 2	↑
2	Change parameter value (word)	1	|
3	Change parameter value (double word)	2	|
4	Request descriptive element 1)	3	|
6	Request parameter value (field) 1)	4 / 5	|
7	Change parameter value (field, word) 1)	4	|
8	Change parameter value (field, double word) 1)	5	|
9	Request number of field elements	6	|
11	Change parameter value (field, double word) and save in EEPROM 2)	5	|
12	Change parameter value (field, word) and save in EEPROM 2)	4	|
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 required element of the parameter description is specified in IND (second word). 2) The required element of the indexed parameter is specified in IND (second word).			

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- 41 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 required element of the parameter description is specified in IND (second word). 2) The required element of the indexed parameter is specified in IND (second 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).

Table 6- 42 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)	–
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)

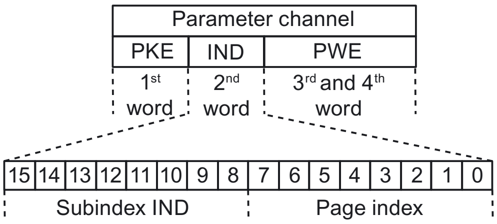


Figure 6-14 Structure of the parameter index (IND)

- 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- 43 Page index setting dependent on parameter range

Parameter 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

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 (high-order word, third word) and PWE2 (low-order word, fourth word).

A 16 bit parameter value is transferred in PWE2 (low-order word, fourth word). In this case, PWE1 (high-order 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- 44 Request to read parameter P7841[2]

PKE (1st word)			IND (2nd word)		PWE (3rd and 4th words)	
AK		PNU (10 bits)	Subindex (H byte)	Page index (L byte)	PWE1 (high-order word)	PWE2 (low-order 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.

Control and status words

Description

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- 45 Assignment of control word 1

Bit	Value	Significance	Comments
0	0	OFF1	Motor brakes on the ramp down of the ramp-function generator; at standstill ($f < f_{min}$) the motor is switched off.
	1	ON	Switches the inverter to "ready" mode. The direction of rotation must be specified via bit 11.
1	0	Coast to standstill (OFF2)	Switch off motor immediately, motor coasts to a standstill.
	1	No coast to standstill (OFF2)	--
2	0	Quick stop (OFF3)	Quick stop: Motor brakes to a standstill on the ramp down of the additionally adjustable ramp-function generator.
	1	No quick stop (OFF3)	--
3	0	Disable operation	Switch off the motor
	1	Enable operation	Switch on the motor
4	0	Reset ramp-function generator (RFG)	RFG output is set to 0 (quickest possible deceleration), motor remains switched on
	1	Enable ramp-function generator (RFG)	
5	0	Inhibit ramp-function generator (RFG)	The setpoint currently provided by the ramp-function generator is "frozen".
	1	Enable ramp-function generator (RFG)	
6	0	Inhibit setpoint	Motor brakes on the ramp down of the ramp-function generator, motor remains switched on
	1	Enable setpoint	Motor accelerates to the setpoint on the ramp up of the ramp-function generator.
7	1	Fault acknowledgment	Fault is acknowledged with a positive edge. If the ON command is still active, the inverter switches to"closing lockout" state.
8	0	Jog 1 OFF	Motor brakes to standstill.
	1	Jog 1 ON	The motor accelerates to the jog setpoint 1
9	0	Jog 2 OFF	Motor brakes to standstill.
	1	Jog 2 ON	The motor accelerates to the jog setpoint 2
10	0	No PLC control	Process data invalid, "sign of life" expected.
	1	PLC control	Control via fieldbus interface; process data valid
11	0	No setpoint inversion	--
	1	Setpoint inversion	Setpoint is inverted in the inverter

Bit	Value	Significance	Comments
12		Not used	
13	1	Motorized potentiometer, raise	The setpoint stored in the motorized potentiometer is increased.
14	1	Motorized potentiometer, lower	The setpoint stored in the motorized potentiometer is decreased.
15	1	Data set changeover	Switching over the command data sets (CDS) 0

Default assignment of control word 2 (STW2)

The settings for control word 2 are defaulted as follows. You can change the assignment with BICO technology.

Table 6- 46 Default setting for control word 2 (not defined for VIK/NAMUR)

Bit	Value	Significance
0	1	Bit 0 to select a fixed speed setpoint
1	1	Bit 1 to select a fixed speed setpoint
2	1	Bit 2 to select a fixed speed setpoint
3	1	Bit 3 to select a fixed speed setpoint
4	–	Bit 0 to select the drive data set (DDS)
5	–	Bit 1 to select the drive data set (DDS)
6	–	Not used
7	–	Not used
8	1	Enable technology controller
9	1	Enable DC brake
10	–	Not used
11	1	Enable droop speed controller
12	1	Torque control
	0	Speed control
13	0	External fault 1
14	–	Not used
15	–	Command data set selection CDS bit 1

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- 47 Bit assignments for status word 1 (for all PROFIdrive and VIK/NAMUR telegram)

Bit	Value	Significance	Comments
0	1	Ready for switching on	Power supply switched on; electronics initialized; pulses locked.
	0	Not ready for switching on	--
1	1	Ready for operation	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.
	0	Not ready for operation	--
2	1	Operation enabled	Motor follows setpoint. See control word 1, bit 3.
	0	Operation locked	--
3	1	Fault present	Inverter faulty. There is a fault in the inverter, the motor is switched off. Once the fault has been rectified and acknowledged, the inverter switches to "closing lockout" state.
	0	No fault	--
4	1	Coast to standstill not activated (no OFF2)	--
	0	"Coast to standstill" activated (OFF2)	"Coast to standstill" (OFF 2) command present.
5	1	Quick stop not activated	--
	0	Quick stop activated	Quick stop (OFF 3) command present.
6	1	Closing lockout	The motor is only switched on after a further ON1 command
	0	Switch-on not locked	--
7	1	Alarm present	Motor remains switched on; alarm in service/maintenance parameter; no acknowledgement necessary; see alarm parameter r2110.
	0	No alarm	No alarm is active.
8	1	Speed deviation within tolerance range	Setpoint/actual value deviation within tolerance range.
	0	Speed deviation outside of tolerance range	--
9	1	Master control requested	The automation system is requested to assume control.
	0	No control requested	--
10	1	Maximum speed reached or exceeded	Inverter output frequency is greater than or equal to the corresponding maximum speed.
	0	Maximum speed not reached	--
11	1	--	--
	0	Alarm: Motor current/torque limit reached	--
12	1	Motor holding brake active	Signal can be used to control a holding brake.
	0	--	--
13	1	--	Motor data displays overload status.
	0	Motor overload	--

Bit	Value	Significance	Comments
14	1	Clockwise rotation	--
	0	Counter-clockwise rotation	--
15	1	--	--
	0	Inverter overload	E.g. current or temperature

Status word 2 (ZSW2)

Status word 2 has the following standard assignment. You can change the assignment with BICO technology.

Table 6- 48 Default setting for status word 2 (not defined for VIK/NAMUR)

Bit	Value	Significance	Description
0	1	DC brake active	--
1	1	$\lvert n\_act \rvert$ > P1226	Absolute current speed > stationary state detection
2	1	$\lvert n\_act \rvert$ > P1080	Absolute actual speed > minimum speed
3	1	i_act ≧ P2170	Actual current ≥ current threshold value
4	1	$\lvert n\_act \rvert$ > P2155	Absolute actual speed > speed threshold value 2
5	1	$\lvert n\_act \rvert$ ≦ P2155	Absolute actual speed < speed threshold value 2
6	1	$\lvert n\_act \rvert$ ≧ 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 ≦ P2292	Technology controller output at lower limit value
11	1	Technology controller output > P2291	Technology controller output at upper limit value (controller saturated)
12	1	Reserved	--
13	1	Reserved	--
14	1	Reserved	--
15	1	Reserved	--

6.4.4.3 Acyclic communication

Overview

The contents of the transferred data set corresponds to the structure of the acyclic parameter channel according to the PROFIdrive profile, Version 4.1.

The acyclic data transfer mode generally allows:

- The transfer of large volumes of user data (up to 240 bytes). A parameter request/response must fit into a data set (max. 240 bytes). The requests/responses are not distributed over several data sets.
- Transfer of complete fields or field parts or the complete parameter description.
- Transfer of different parameters in one access (multiple request).
- Reading of profile-specific parameters over an acyclic channel
- Acyclic data transfer in parallel with cyclic data transfer.

Only one parameter request is processed at a time (no pipelining). No spontaneous messages are transferred.

Description

The PROFIBUS DP expansions DPV1 comprise the definition of acyclic data exchange.

It supports concurrent access by other PROFIBUS masters (Class 2 master, e.g. commissioning tool).

Suitable channels are provided in the inverters of the SINAMICS G120 series for the different masters/different data transfer types:

- Acyclic data exchange with the same Class 1 master using the DPV1 functions READ and WRITE (with data set 47 (DS47)).
- Acyclic data exchange with the help of a SIEMENS startup tool (Class 2 master, e.g. STARTER). The startup tool can acyclically access parameters and process data in the inverter.
- Acyclic data exchange with a SIMATIC HMI (Human Machine Interface) (second Class 2 master). The SIMATIC HMI can acyclically access parameters in the inverter.
- Instead of a SIEMENS startup tool or a SIMATIC HMI, it is also possible for an external master (Class 2 master) as defined in the acyclic parameter channel according to the PROFIdrive profile, Version 4.1 (with DS47), to access the inverter.

6.4.5 STEP 7 program examples

6.4.5.1 STEP 7 program example for cyclic communication

S7 program for controlling the inverter

In the example provided below, communication between the control and inverter is handled 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 value.

```
Network 1 : Create control word 1 and speed setpoint

STW1: 0x47E
Freq: 0x2500

          L     W#16#47E
          T     MW     1
          L     W#16#2500
          T     MW     3


Network 2 : Acknowledge fault

Comment:

          U     E      0.6
          =     M      2.7


Network 3 : Start and stop

Comment:

          U     E      0.0
          =     M      2.0


Network 4 : Write process data

Comment:

          L     MW     1
          T     PAW  256
          L     MW     3
          T     PAW  258
```

Figure 6-15 Controlling the G120 via PROFIBUS or PROFINET

```
Network 5 : Read process data

Comment:

          L     PEW  256
          T     MW     5
          L     PEW  258
          T     MW     7
```

Figure 6-16 Evaluating the status of G120 via PROFIBUS or PROFINET

Information about the S7 program

The hexadecimal numeric value 047E is written to control word 1. The bits of control word 1 are listed in the following table.

Table 6- 49 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		

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.

The hexadecimal numeric value 2500 specifies the setpoint frequency of the inverter. The maximum frequency is the hexadecimal value 4000.

The process data is written to logical address 256 of the inverter in the cyclic time slice of S7 (e.g. OB1) and read from logical address 256 of the inverter. The logical addresses for field bus communication were defined in HW Config.

6.4.5.2 STEP 7 program example for acyclic communication

Simple S7 program for parameterizing the inverter

The number of simultaneous requests for acyclic communication is limited. More detailed information can be found in the Internet (http://support.automation.siemens.com/WW/view/en/15364459).

```
OB1 :   "Main Program Sweep (Cycle)"

Kommentar:

Netzwerk 1 : Define Read or write

Kommentar:

    // Read parameter
          O(
          U      M      9.2
          UN     M      9.1
          )
          O(
          U      M      9.0
          UN     M      9.1
          )
          R      M      9.3

          SPB    RD

    // write parameter
          O(
          U      M      9.3
          UN     M      9.0
          )
          O(
          U      M      9.1
          UN     M      9.0
          )
          R      M      9.2

          SPB    WR
          BEA

    RD:   NOP    0
          CALL   FC     1
          BEA
    WR:   NOP    0
          CALL   FC     3
```

M9.0	Starts reading parameters	M9.2	displays the read process
M9.1	Starts writing parameters	M9.3	displays the write process

Figure 6-17 STEP 7 program example for acyclic communication - OB1

FC1 to read parameters from the inverter

Inverter parameters are read via SFC 58 and SFC 59.

```
FC1 : PAR_RD

Kommentar:

Netzwerk 1 : Parameters for reading

Kommentar:

      L     MB    62
      T     DB1.DBB    3
//---------------------------------------------
      L     MW    50
      T     DB1.DBW    6
      L     MB    58
      T     DB1.DBB    5
      L     MW    63
      T     DB1.DBW    8
//---------------------------------------------
      L     MW    52
      T     DB1.DBW   12
      L     MB    59
      T     DB1.DBB   11
      L     MW    65
      T     DB1.DBW   14
//---------------------------------------------
      L     MW    54
      T     DB1.DBW   18
      L     MB    60
      T     DB1.DBB   17
      L     MW    67
      T     DB1.DBW   20
//---------------------------------------------
      L     MW    56
      T     DB1.DBW   24
      L     MB    61
      T     DB1.DBB   23
      L     MW    69
      T     DB1.DBW   26
```

Netzwerk 2 : Read request

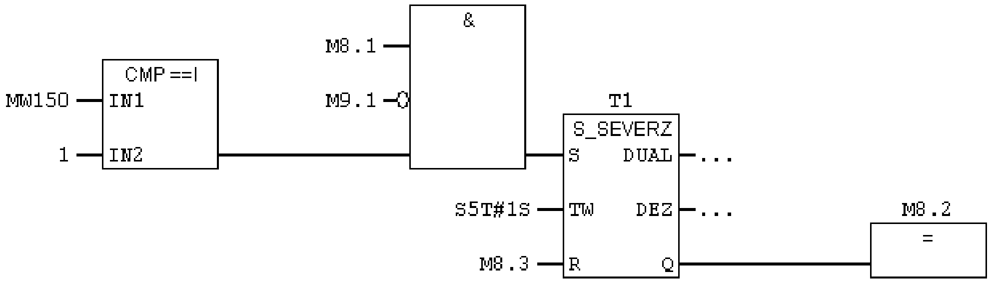
Kommentar:

```
CALL  SFC   58
 REQ    :=M9.0
 IOID   :=B#16#54
 LADDR  :=W#16#170
 RECNUM :=B#16#2F
 RECORD :=P#DB1.DBX0.0 BYTE 28
 RET_VAL:=MW10
 BUSY   :=M8.1

U     M      8.1
R     M      9.0
S     M      9.2
```

Netzwerk 3 : Read delay after sending the read request

Kommentar:



Netzwerk 4 : Read request

Kommentar:

```
CALL  SFC   59
 REQ    :=M8.2
 IOID   :=B#16#54
 LADDR  :=W#16#170
 RECNUM :=B#16#2F
 RET_VAL:=MW12
 BUSY   :=M8.3
 RECORD :=P#DB2.DBX0.0 BYTE 36

U     M      8.3
R     M      8.2
```

Figure 6-18 Function block for reading parameters

You first have to define how many parameters (MB62), which parameter numbers (MW50, MW52, etc.), and how many parameter indices (MW58, MB59, etc.) are read for each parameter number. The specifications are saved in DB1.

SFC 58 copies the specifications for the parameters to be read from DB1 and sends them to the inverter as a read request. No other read requests are permitted while this one is being processed.

Once the read request has been issued and a waiting time of one second has elapsed, the parameter values are copied from the inverter via SFC 59 and saved in DB2.

FC3 to write parameters to the inverter

```
FC3 : PAR_WR

Kommentar:

Netzwerk 1 : Parameter for writing

Kommentar:

        L     MW    21
        T     DB3.DBW    6
        L     MW    23
        T     DB3.DBW    8
        L     MW    35
        T     DB3.DBW   12

Netzwerk 2 : Write request

Kommentar:

        CALL  SFC   58
         REQ    :=M9.1
         IOID   :=B#16#54
         LADDR  :=W#16#170
         RECNUM :=B#16#2F
         RECORD :=P#DB3.DBX0.0 BYTE 14
         RET_VAL:=MW10
         BUSY   :=M8.1

        U     M      8.1
        R     M      9.1
        S     M      9.3
```

Figure 6-19 Function block for writing parameters

You first have to define which value (MW35) is written to which parameter index (MW23) of which parameter (MW21). The specifications are saved in DB3.

SFC 58 copies the specifications for the parameters to be written from DB3 and sends them to the inverter. No other write requests are permitted while this one is being processed.

For more information about SFC 58 and SFC 59, consult the STEP 7 online help.

6.5 Communication over CANopen

Integrating the inverter into CANopen

Inverters are integrated into CANopen using Electronic Data Sheets (EDS files).

You can find this manual in the Internet under:
http://support.automation.siemens.com/WW/view/de/35209032
(http://support.automation.siemens.com/WW/view/en/35209032)

Additional information ...

- can be found on the CAN Internet pages (http://www.can-cia.org)
- the CANdictionary under CAN downloads (http://www.can-cia.org/index.php?id=6) provides an explanation of CAN terminology.

6.5.1 Connecting inverter to CAN bus

Description

Inverters with CANopen interface have a 9-pin, SUB-D pin connector on the lower side of the Control Unit in order to integrate the inverter into the CANopen fieldbus system. The connections of this pin connector are short-circuit proof and isolated.

CANopen cable connector

For setting up a CANopen network, you can use cables for serial 9-pin connections with SUB-D connectors.

This is subsequently described:

Table 6- 50 Pin assignment of the connector

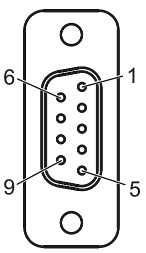
	1	---	Not assigned
	2	CAN_L	CAN signal (dominant low)
	3	CAN_GND	CAN ground
	4	---	Not assigned
	5	(CAN _SHLD)	Optional shield
	6	(GND)	Optional CAN ground
	7	CAN_H	CAN signal (dominant high)
	8	---	Not assigned
	9	---	Not assigned

Table 6- 51 Permissible cable lengths, depending on the baud rate

Baud rate (kbit/s)	Maximum cable lengths	
1000	18 m	59 ft
800	39 m	128 ft
500	100 m	328 ft
250	270 m	886 ft
125	610 m	2000 ft
50	1600 m	5300 ft
20	4150 m	13700 ft
10	8400 m	27600 ft

General specifications for CANopen and requirements for fault-free communication

You can integrate up to 126 stations into a CANopen network. These must be subdivided into segments of up to 32 stations. For the first and last station of each segment, you have to activate the bus terminating resistor via the DIP switch on the right next to the SUB-D socket.

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 line voltage 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.

Setting the CANopen address

The CANopen address of the inverter can be set using DIP switches on the Control Unit or using p8620. Using p8620, the address can only be set if all DIP switches for the bus address are either set to "OFF" (0) or to "ON" (127).

If the address switches are set to a value ≠ 0 or 127, this address is always active and p8620 is read-only.

The setting using DIP switches is described in Setting the bus address via DIP switch (Page 99).

CAUTION

A bus address that has been changed is only effective after switching-off and switching-on again. It is particularly important that any external 24 V supply is switched off.

6.5.2 Interconnecting the CAN control word

The CAN control word is automatically connected up via parameter p8790. The following setting options are available:

P8790 = 0	No interconnection	
P8790 = 1:	BI: p0840.0 (BI: ON/OFF1)	= r209x.0
	BI: p0844.0 (BI: 1. OFF2)	= r209x.1
	BI: p0848.0 (BI: 1. OFF3)	= r209x.2
	BI: p0852.0 (BI: Enable operation)	= r209x.3
	BI: p2103.0 (BI: 1. Acknowledge faults)	= r209x.7

The specified BICO interconnections are automatically established if the CANopen control word is mapped to one of the positions x = 0 ... 3 in the receive process data buffer.

Write access is rejected if a CANopen control word is not mapped at one of these positions.

This causes the commissioning software to interrupt the project download.

6.5.3 Objects to access SINAMICS parameters

Description

All inverter parameters can be addressed via the SDO parameter channel in the 2000 hex to 470F hex range of the object directory.

The parameter numbers of the inverter must be converted to hex values and an offset of 2000 hex must also be applied. This figure is the object number contained in the SDO request for the parameter number of the inverter.

There is no need to distinguish between write and display parameters (p and r parameters).

Table 6- 52 Examples of conversions of inverter parameters to manufacturer-specific CANopen objects

Inverter parameter	CANopen object number	Name of inverter parameter
P0010	200A hex	Commissioning parameter filter
r0062	203E hex	Speed setpoint
r0947	23B3 hex	Fault number

Setting accessing options

The access settings are entered in parameter p8630[0…2]

p8630[0]: Access to virtual CANopen objects

- p8630[0] = 0: No access to virtual CANopen objects
- p8630[0] = 1: Access to virtual CANopen objects
- p8630[0] = 2: Not relevant for G120 inverters

p8630[1]: Selection of index range of inverter parameters

A maximum total of 255 indices can be transferred in a CANopen object. Should it be necessary to transfer parameters with more indices, an additional CANopen object must be set up. It is possible to transfer a maximum of 1024 indices.

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

P8630[2] Parameter range selection

- P8630[2] = 0: 1 ... 9999

Note

Since all parameter numbers of the G120 inverter are in the < 10000 range, it is only necessary to set P8630[2] = 0.

If the inverter were to use parameter numbers ≥ 10000, it would be possible to set ranges from 10000 ... 39999 using indices 1 ... 3.

6.5.4 CANopen functionality of the CU230P-2 CAN

Introduction

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

The communication objects can be subdivided as follows:

- Service data objects (SDO) for reading and changing parameters
- Process data objects (PDO) for transferring process data
- Network management objects (NMT) for controlling CANopen communication and for monitoring the individual nodes on the basis of a master-slave relationship.
- Additional objects such as synchronize (SYNC), time stamp and error messages (EMCY).

The CU230P-2 CAN supports the following communication objects:

- NMT
- PDO
- SDO
- SYNC
- EMCY

The CU230P-2 CAN works with communication objects from the following profiles:

- CANopen communication profile DS 301 version 4.0
- Device profile DSP 402 (drives and motion control) version 2.0
- Indicator profile DR303-3 version 1.0.

The communication monitoring can be used via both node guarding and heartbeat protocol (heartbeat producer).

Note

Communication status after CAN controller state "Bus off" (inverter fault F8700, fault value 1)

If this fault is acknowledged by an OFF/ON, the bus off state is also canceled and communication is re-established after the next boot.

If the fault is acknowledged by means of DI2, or directly with p3981, the inverter remains in the bus off state. To initialize the communication links, p8608 = 1 must be set in this case.

⚠ WARNING

If a bus fault has occurred, the CAN communication links are not restored if the fault is acknowledged by means of digital input DI2 (p3981 = 1).

If p8641 = 0 is set (inverter does not switch to fault status after a bus fault), it means that the motor cannot be stopped via the control system unless communication has been restored beforehand with p8608 = 1.

6.5.5 General CANopen functions

6.5.5.1 COB-ID

Introduction

Each COB (communication object) can be uniquely identified by means of an identifier (COB ID), which is a part of the COB. CAN specification 2.0A supports up to 2048 COBs, which are identified by means of 11-bit identifiers.

A list of COB identifiers, which contains all the COBs that can be accessed via CAN, is available in the object directory for the relevant SINAMICS inverter.

The COB ID can be used to prioritize the communication objects. This means in particular that different processing methods (cyclic, event-controlled, on request or synchronized) can be defined for different process data.

COB IDs for SINAMICS

The following table contains the COB IDs for transmit and receive telegrams defined for the "Predefined Connection Set" for SINAMICS inverters (drive objects). The object directory index (OD index) starts at 1800 for the TPDO and at 1400 for the RPDO.

Table 6- 53 Identifier assignment

Communication objects	Function code		Resulting COB ID		OD index (hex)
	dec	bin	hex	Explanation	
TPDO	3	0011	181–1FF	180 hex + node ID	1800
RPDO	4	0100	201–27F	200 hex + node ID	1400

6.5.5.2 Network management (NMT service)

Introduction

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

The NMT services can be used to initialize, start, monitor, reset, or stop nodes. All NMT services have the COB ID = 0. This cannot be changed.

The SINAMICS inverter is an NMT slave and can adopt the following statuses in CANopen:

- Initialization
  The inverter passes through this state after Power On. In the factory setting, the inverter then enters the "Pre-Operational" state, which also corresponds to the CANopen standard. The setting can be changed using p8684 as follows:
  - p8684 = 4 Stopped
  - p8684 = 5 Operational
  - p8684 = 127 Pre-Operational (factory setting)
- Pre-Operational
  In this state, the node cannot process any process data (PDO). It can, however, be parameterized or operated via SDOs, which means that setpoints can also be specified using SDO.
- Operational
  In this state, the node can process both SDO and PDO.
- Stopped
  In this state, the node cannot process either PDO or SDO. Stopped mode is exited by specifying one of the following commands:
  - Enter Pre-Operational
  - Start Remote Node
  - Reset Node
  - Reset Communication

The NMT recognizes the following transitional states:

- Start Remote Node:
  command for switching from the "Pre-Operational" communication status to "Operational". The drive can only transmit and receive process data (PDO) in "Operational" status.
- Stop Remote Node
  command for switching from "Pre-Operational" or "Operational" to "Stopped". The node can only process NMT commands in the "Stopped" status.
- Enter Pre-Operational
  command for switching from "Operational" or "Stopped" to "Pre-Operational". In this state, the node cannot process any process data (PDO). It can, however, be parameterized or operated via SDOs, which means that setpoints can also be specified.

- Reset Node:
  command for switching from "Operational", "Pre-Operational", or "Stopped" to "Initialization". When the Reset Node command is issued, all the objects (1000 hex - 9FFF hex) are reset to the status that was present after "Power On".
- Reset Communication:
  command for switching from "Operational", "Pre-Operational", or "Stopped" to "Initialization". When the Reset Communication command is issued, all communication objects (1000 hex - 1FFF hex) are reset to the status that was present after "Power On".

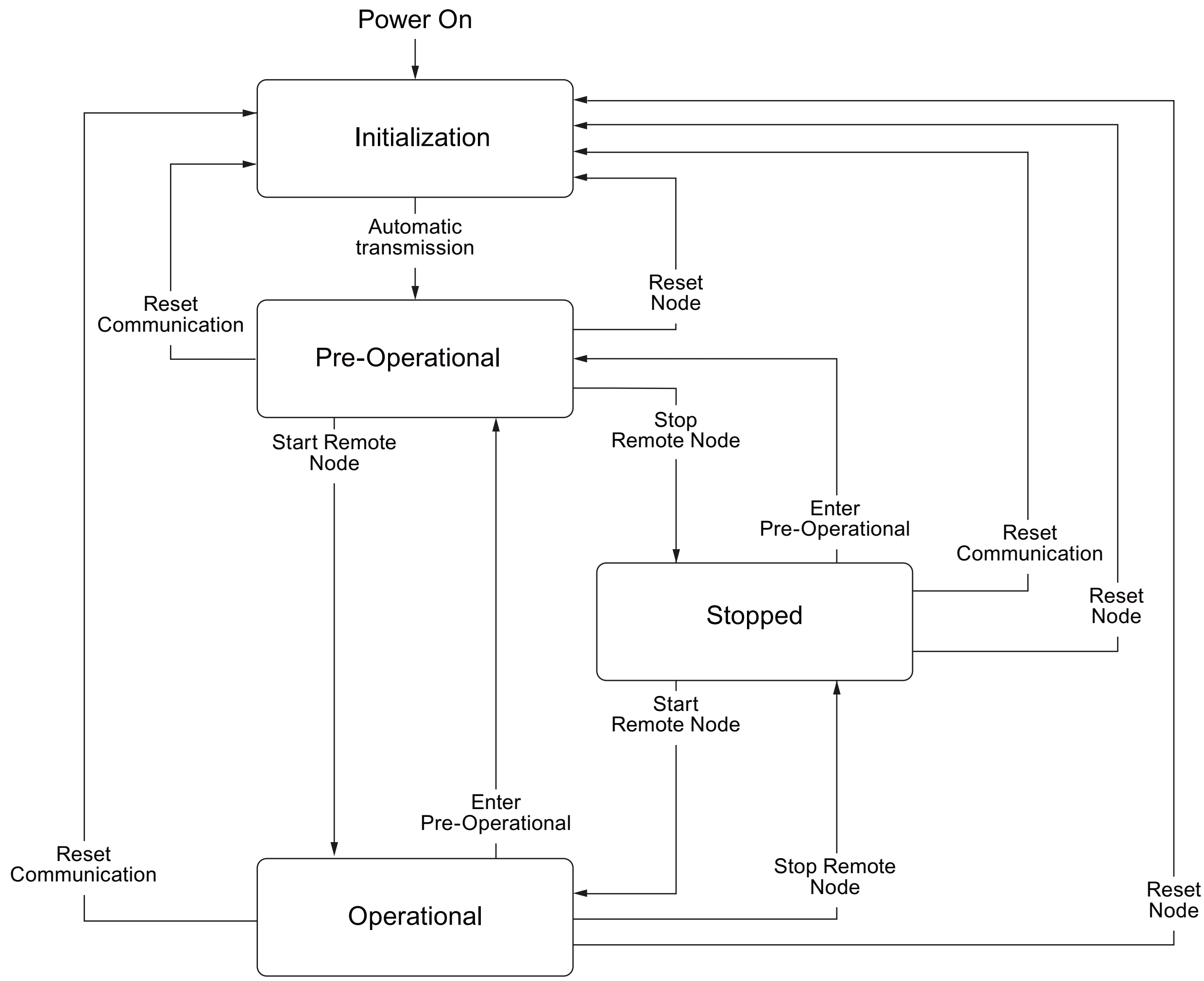


Figure 6-20 CANopen status diagram

The transition states and addressed nodes are displayed using the command specifier and the Node_ID:

Table 6- 54 Overview of NMT commands

NMT Master Request ----> NMT Slave message		
Command	Byte 0 (command specifier, CS)	Byte 1
Start	1 (01hex)	Node ID of the addressed node
Stop	2 (02hex)	Node ID of the addressed node
Enter Pre-Operational	128 (80hex)	Node ID of the addressed node
Reset Node	129 (81hex)	Node ID of the addressed node
Reset Communication	130 (82 hex)	Node ID of the addressed node

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

- Requirement of a slave:
  The slave is addressed using its node ID (1 - 127).
- Requirement for all slaves:
  Node ID = 0

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

- p8685 = 0 Initializing (cannot be changed)
- p8685 = 4 Stopped
- p8685 = 5 Operational
- p8685 = 127 Pre-Operational (factory setting)
- p8685 = 128 Reset Node
- p8685 = 129 Reset Communication

6.5.5.3 PDO and PDO services

PDO

The real-time data transfer for CANopen takes place using "Process Data Objects (PDO)".

In the configuration, the PDOs are linked with objects from the object directory that require real-time data transfer (PDO mapping).

The number of PDOs and their mapping structure is transferred to the device via SDO services (during configuration of the device).

The following variants of PDO exist:

- TPDO (Transmit PDO): Sends data.
  TPDO are sent via two preselected channels. TPDO always uses two permanently set channels.
- RPDO (Receive PDO): Receives data.
  SINAMICS drives can receive up to 24 RPDOs. One channel in the CAN controller is assigned for each activated RPDO.

RPDO parameters	in the inverter:	p8700 … p8717
	in CAN:	1400 hex ff,
TPDO parameters:	in the inverter:	p8720 … p8737
	in CAN:	1800 hex ff

The inverter supports the following PDO data transfer types:

Transmission type	Value in index 1 of the RPDO-TPDO parameter	PDO type	Explanation
Synchronous, non-cyclic	0	TPDO	• TPDO is only sent if a SYNC is received and a process data has changed in the telegram.
Synchronous, cyclic	n = 1 … 240	TPDO RPDO	• TPDO is sent after each nth SYNC, • RPDO is accepted after each nth SYNC
Asynchronous, cyclic	254, 255	TPDO, RPDO	• TPDO is sent if process data has changed in the telegram. • RPDO is directly accepted when it is received.
Asynchronous, cyclic	254, 255 + event time	TPDO	• TPDO sent in the "Event Time" interval.

CANopen devices with TPDO are known as PDO producers and CANopen devices with RPDO are known as PDO consumers.

The PDO is defined by the PDO communication parameter and the PDO mapping parameter. The structure of these two parameters is listed in the following tables.

Table 6- 55 PDO communication parameters 1400h ff (RPDO), 1800h ff (TPDO)

Subindex	Name	Data type
00h	Highest subindex that is supported	UNSIGNED8
01h	COB ID	UNSIGNED32
02h	Transfer mode	UNSIGNED8
03h	Inhibit time (only for TPDO)	UNSIGNED16
04h	Reserved (only for TPDO)	UNSIGNED8
05h	Event timer (only for TPDO)	UNSIGNED16

Table 6- 56 PDO mapping parameters 1600h ff (RPDO), 1A00h ff (TPDO)

Subindex	Name	Data type
00h	Number of objects mapped to the PDO (max. 4)	UNSIGNED8
01h	First mapped object	UNSIGNED32
02h	Second mapped object	UNSIGNED32
03h	Third mapped object	UNSIGNED32
04h	Fourth mapped object	UNSIGNED32

Note

PDO communication parameter

- For receive telegrams: p8700 to p8707,
- For transmit telegrams: p8720 to p8727.

PDO mapping parameter

- For receive telegrams: p8710 to p8717,
- For transmit telegrams: p8730 to p8737.

Transmission modes for process data objects (PDO)

The following types of transmission are possible for PDO:

- Synchronous data transmission
  - Cyclic
  - Acyclic (only for TPDO)
- Asynchronous data transmission
  - Cyclic (only for TPDO)
  - Acyclic

Synchronous data transmission

In order for the devices on the CANopen bus to remain synchronized during transmission, a synchronization object (SYNC object) must be transmitted at periodic intervals.

Each PDO that is transferred as a synchronous object must be assigned a transmission type 1 ... n. The following is applicable:

- Transmission type 1: The PDO is transferred in every SYNC cycle.
- Transmission type n: The PDO is transferred in every nth SYNC cycle.

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

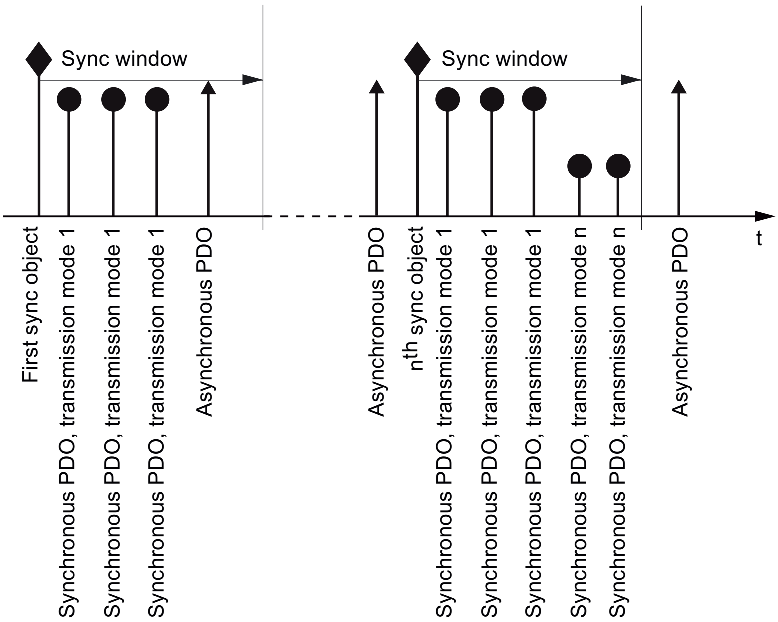


Figure 6-21 Principle of synchronous and asynchronous transmission

For synchronous TPDOs, the transmission mode also identifies the transmission rate as a factor of the SYNC object transmission intervals. Here, transmission type "1" means that the message will be transmitted in every SYNC object cycle. Transmission type "n" means that the message will be transmitted in every nth SYNC object cycle.

Data from synchronous RPDOs that are received after a SYNC signal is not transmitted to the application until after the next SYNC signal.

Note

The SYNC signal does not synchronize the applications in the SINAMICS drive, only the communication on the CANopen bus

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Asynchronous data transmission

Asynchronous PDOs are transferred - cyclically or acyclically - without reference to the SYNC signal.

PDO services

The PDO services can be subdivided as follows:

- Write PDO
- Read PDO
- SYNC service

Write PDO

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

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

Read PDO

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

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

SYNC service

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

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

Note

The COB ID of the Sync object must be set to the same value for all nodes of a bus that respond to the SYNC telegram from the master.

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

6.5.5.4 PDO mapping

Introduction

PDO mapping is used to link (map) standardized drive objects (process data, e.g. setpoints or actual values) and "free objects" from the object directory for the PDO service to telegrams.

The PDO transfers the data values for these objects.

For this purpose, a maximum of 8 receive and 8 transmit PDOS are available.

A CAN telegram can transfer up to 8 bytes of user data. The user uses the mapping to decide which user data is to be transferred in a PDO.

Example

The following diagram shows an example of PDO mapping (values are hexadecimal (e.g. object size 10 hex = 16 bits)):

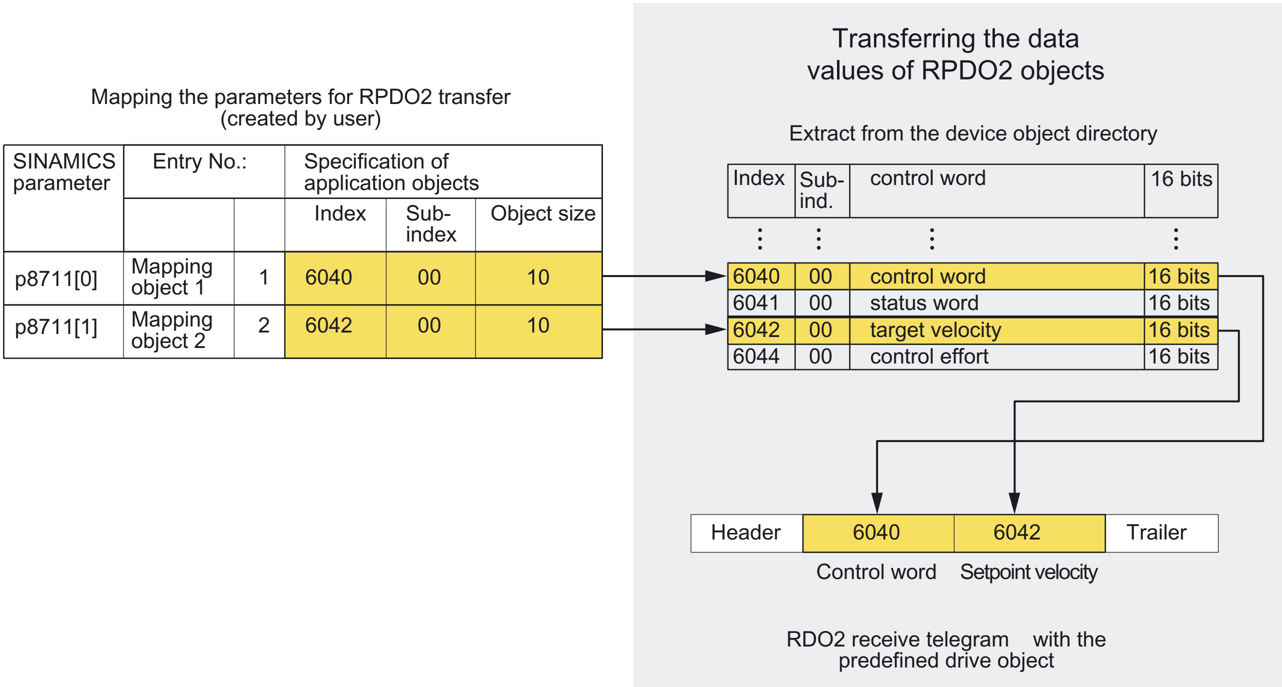


Figure 6-22 PDO mapping for control word and setpoint velocity

6.5.5.5 SDO services

Introduction

SDO services allow you to access the object directory for the connected drive unit. An SDO connection is a peer-to-peer connection between an SDO client and a server.

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

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

Receiving:	Server <= Client:	COB ID = 600 hex + node ID
Transmitting:	Server => Client:	COB ID = 580 hex + node ID

Properties

The SDOs have the following properties:

- Confirmed transfer of objects
- Transmission always asynchronous (corresponds to acyclic data exchange with PROFIBUS DB)
- Transmission of values > 4 bytes (normal transfer)
- Transmission of values ≤ 4 bytes (expedited transfer)
- All drive unit parameters can be addressed via SDO.

Structure of the SDO protocols

The SDO services use the appropriate protocol depending on the task. The most important are:

- SDO Protocol Write
- SDO Protocol Read
- SDO Protocol Cancel Transfer Protocol

SDO Protocol Write

This protocol is used to write data to the drive unit. Request by "Write Request", confirmation by "Write Response".

Table 6- 57 SDO Protocol Write

Byte 0	Bytes 1 and 2	Byte 3	Bytes 4 ... 7
Write Request (request from the CANopen master to the inverter to write data)			
cs = 2Fhex	index	subindex	data byte 4
cs = 2Bhex	index	subindex	data byte 4-5
cs = 27hex	index	subindex	data byte 4-6
cs = 23hex	index	subindex	data byte 4-7
Write Response (confirmation from the inverter to the master after successful writing)			
Cs = 60	index	subindex	Reserved

SDO Protocol Read

This protocol is used to read data from the drive unit. Read request by "Read Request", confirmation by "Read Response".

Table 6- 58 SDO Protocol Read

Byte 0	Bytes 1 and 2	Byte 3	Bytes 4 ... 7
Read Request (request from the CANopen master to the inverter to read data and send it to the master)			
cs = 40	index	subindex	Reserved
Read Response (data from the inverter is sent to the master)			
cs = 4Fhex	index	subindex	data byte 4
cs = 4Bhex	index	subindex	data byte 4-5
cs = 47hex	index	subindex	data byte 4-6
cs = 43hex	index	subindex	data byte 4-7

SDO Protocol Cancel Transfer Protocol

This protocol is used to perform the SDO service "Cancel Transfer Protocol".

Table 6- 59 SDO Protocol Cancel Transfer Protocol

Master -> Slave / Slave -> Master			
Byte 0	Bytes 1 and 2	Byte 3	Bytes 4 ... 7
Error Response			
cs = 80	index	subindex	SDO abort code (unsigned 32)

SDO abort codes

Table 6- 60 SDO abort codes

Abort code	Description
0503 0000h	Toggle bit not alternated
0504 0000h	SDO protocol timed out
0504 0001h	Client/server command specifier not valid or unknown
0504 0002h	Invalid block size (block mode only)
0504 0003h	Invalid sequence number (block mode only)
0504 0004h.	CRC error (block mode only)
0504 0005h	Out of memory
0601 0000h	Unsupported access to an object
0601 0001h	Attempt to read a write-only object
0601 0002h	Attempt to write a read-only object
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0604 0047h	General internal incompatibility in the device
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0604 0047h	General internal incompatibility in the device
0606 0000h	Access failed due to a hardware error
0607 0010h	Data type does not match, length of service parameter does not match.
0607 0012h	Data type does not match, length of service parameter too high.
0607 0013h	Data type does not match, length of service parameter too low.
0609 0011h	Subindex does not exist
0609 0030h	Value range of parameter exceeded (only for write access)
0609 0031h	Value of parameter written too high
0609 0032h	Value of parameter written too low
0609 0036h	Maximum value is less than minimum value
0800 0000h	General error
0800 0020h	Data cannot be transferred to or stored in the application
0800 0021h	Data cannot be transferred to or stored in the application because of local control
0800 0022h	Data cannot be transferred to or stored in the application because of the current device state.
0800 0023h	Object dictionary dynamic generation failed or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error).

6.5.6 Communication objects

6.5.6.1 Overview

Section content

This section lists the objects (data values) that are used in SINAMICS for communication via CANopen. The individual objects are:

- Configuration objects
- Manufacturer-specific objects
- Objects in drive profile DSP402

The objects are stored in the object directory of the inverter.

6.5.6.2 Configuration objects

Introduction

Eight PDOs per drive can be parameterized for transmitting and receiving.

For each PDO, the following configuration objects are available:

- Communication parameters and
- Mapping parameters (max. 8 bytes)

Rule

The "predefined connection set" column contains the predefined values for the "predefined connection set".

Communication parameters and indices for the configuration objects of the receive PDO

The following table lists the communication parameters together with the indices for the individual configuration objects of the receive PDOs:

Table 6- 61 Configuration objects of receive PDOs - communication parameters

OD Index (hex)	Sub-Index (hex)	Name of the object	SINAMICS parameters	Transmission	Data type	Predefined Connection Set	Read/ write
1400		Receive PDO 1 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8700.0	SDO	Unsigned32	200 hex + node ID	R/W
	2	Transmission type	p8700.1	SDO	Unsigned8	FE hex	R/W
1401		Receive PDO 2 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8701.0	SDO	Unsigned32	300 hex + node ID	R/W
	2	Transmission type	p8701.1	SDO	Unsigned8	FE hex	R/W
1402		Receive PDO 3 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8702.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8702.1	SDO	Unsigned8	FE hex	R/W
1403		Receive PDO 4 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8703.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8703.1	SDO	Unsigned8	FE hex	R/W
1404		Receive PDO 5 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8704.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8704.1	SDO	Unsigned8	FE hex	R/W
1405		Receive PDO 6 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8705.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8705.1	SDO	Unsigned8	FE hex	R/W
1406		Receive PDO 7 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8706.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8706.1	SDO	Unsigned8	FE hex	R/W
1407		Receive PDO 8 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	2	R
	1	COB ID used by PDO	p8707.0	SDO	Unsigned32	8000 06DF hex	R/W
	2	Transmission type	p8707.1	SDO	Unsigned8	FE hex	R/W

Table 6- 62 Configuration objects receive PDO - mapping parameters

OD Index (hex)	Sub-Index (hex)	Name of the object	SINAMICS parameters	Transmission	Data type	Predefined Connection Set	Read/ write
1600		Receive PDO 1 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	1	R
	1	PDO mapping for the first application object to be mapped	p8710.0	SDO	Unsigned32	6040 hex	R/W
	2	PDO mapping for the second application object to be mapped	p8710.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8710.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8710.3	SDO	Unsigned32	0	R/W
1601		Receive PDO 2 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	2	R
	1	PDO mapping for the first application object to be mapped	p8711.0	SDO	Unsigned32	6040 hex	R/W
	2	PDO mapping for the second application object to be mapped	p8711.1	SDO	Unsigned32	6042 hex	R/W
	3	PDO mapping for the third application object to be mapped	p8711.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8711.3	SDO	Unsigned32	0	R/W
1602		Receive PDO 3 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8712.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8712.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8712.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8712.3	SDO	Unsigned32	0	R/W
1603		Receive PDO 4 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8713.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8713.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8713.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8713.3	SDO	Unsigned32	0	R/W

OD Index (hex)	Sub-Index (hex)	Name of the object	SINAMICS parameters	Transmission	Data type	Predefined Connection Set	Read/ write
1604		**Receive PDO 5 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8714.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8714.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8714.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8714.3	SDO	Unsigned32	0	R/W
1605		**Receive PDO 6 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8715.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8715.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8715.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8715.3	SDO	Unsigned32	0	R/W
1606		**Receive PDO 7 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8716.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8716.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8716.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8716.3	SDO	Unsigned32	0	R/W
1607		**Receive PDO 8 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8717.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8717.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8717.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8717.3	SDO	Unsigned32	0	R/W

Communication parameters and indices for the configuration objects of the send PDO

The following table lists the communication parameters together with the indices for the individual configuration objects of the transmit PDOs:

Table 6- 63 Configuration objects of transmit PDOs - communication parameters

OD Index (hex)	Sub-Index (hex)	Object name	SINAMICS parameter	Trans-mission	Data type	Predefined connection set	Read/ write
1800		Transmit PDO 1 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8720.0	SDO	Unsigned32	180 hex + node ID	R/W
	2	Transmission type	p8720.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8720.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8720.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8720.4	SDO	Unsigned16	0	R/W
1801		Transmit PDO 2 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8721.0	SDO	Unsigned32	280 hex + node ID	R/W
	2	Transmission type	p8721.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8721.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8721.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8721.4	SDO	Unsigned16	0	R/W
1802		Transmit PDO 3 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8722.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8722.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8722.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8722.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8722.4	SDO	Unsigned16	0	R/W
1803		Transmit PDO 4 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8723.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8723.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8723.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8723.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8723.4	SDO	Unsigned16	0	R/W
1804		Transmit PDO 5 communication parameter					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8724.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8724.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8724.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8724.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8724.4	SDO	Unsigned16	0	R/W

OD Index (hex)	Sub-Index (hex)	Object name	SINAMICS parameter	Trans-mission	Data type	Predefined connection set	Read/ write
1805		**Transmit PDO 6 communication parameter**					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8725.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8725.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8725.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8725.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8725.4	SDO	Unsigned16	0	R/W
1806		**Transmit PDO 7 communication parameter**					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8726.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8726.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8726.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8726.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8726.4	SDO	Unsigned16	0	R/W
1807		**Transmit PDO 8 communication parameter**					
	0	Largest subindex supported		SDO	Unsigned8	5	R
	1	COB ID used by PDO	p8727.0	SDO	Unsigned32	C000 06DF hex	R/W
	2	Transmission type	p8727.1	SDO	Unsigned8	FE hex	R/W
	3	Inhibit time	p8727.2	SDO	Unsigned16	0	R/W
	4	Reserved	p8727.3	SDO	Unsigned8	---	R/W
	5	Event timer	p8727.4	SDO	Unsigned16	0	R/W

Table 6- 64 Configuration objects of transmit PDOs - mapping parameters

OD Index (hex)	Sub-Index (hex)	Object name	SINAMICS parameter	Trans-mission	Data type	Predefined connection set	Read/ write
1A00		**Transmit PDO 1 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	1	R
	1	PDO mapping for the first application object to be mapped	p8730.0	SDO	Unsigned32	6041 hex	R/W
	2	PDO mapping for the second application object to be mapped	p8730.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8730.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8730.3	SDO	Unsigned32	0	R/W

OD Index (hex)	Sub-Index (hex)	Object name	SINAMICS parameter	Trans-mission	Data type	Predefined connection set	Read/ write
1A01		**Transmit PDO 2 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	2	R
	1	PDO mapping for the first application object to be mapped	p8731.0	SDO	Unsigned32	6041 hex	R/W
	2	PDO mapping for the second application object to be mapped	p8731.1	SDO	Unsigned32	6044 hex	R/W
	3	PDO mapping for the third application object to be mapped	p8731.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8731.3	SDO	Unsigned32	0	R/W
1A02		**Transmit PDO 3 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8732.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8732.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8732.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8732.3	SDO	Unsigned32	0	R/W
1A03		**Transmit PDO 4 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8733.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8733.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8733.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8733.3	SDO	Unsigned32	0	R/W
1A04		**Transmit PDO 5 mapping parameter**					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8734.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8734.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8734.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8734.3	SDO	Unsigned32	0	R/W

OD Index (hex)	Sub-Index (hex)	Object name	SINAMICS parameter	Trans-mission	Data type	Predefined connection set	Read/ write
1A05		Transmit PDO 6 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8735.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8735.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8735.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8735.3	SDO	Unsigned32	0	R/W
1A06		Transmit PDO 7 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8736.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8736.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8736.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8736.3	SDO	Unsigned32	0	R/W
1A07		Transmit PDO 8 mapping parameter					
	0	Number of mapped application objects in PDO		SDO	Unsigned8	0	R
	1	PDO mapping for the first application object to be mapped	p8737.0	SDO	Unsigned32	0	R/W
	2	PDO mapping for the second application object to be mapped	p8737.1	SDO	Unsigned32	0	R/W
	3	PDO mapping for the third application object to be mapped	p8737.2	SDO	Unsigned32	0	R/W
	4	PDO mapping for the fourth application object to be mapped	p8737.3	SDO	Unsigned32	0	R/W

6.5.6.3 Free objects

OD index (hex)	Description	Data type per PZD	Default values	Can be written to/ read
5800 to 580F	16 freely-interconnectable receive process data	Integer16	0	R/W
5810 to 581F	16 freely-interconnectable transmit process data	Integer16	0	R

You can interconnect any process data objects using receive/transmit words/double words of the receive and transmit buffer.

Scaling the process data of the free objects:

- 16-bit (word): 4000hex corresponds to 100 %

If the process data is a temperature value, the scaling of the free objects appears as follows:

- 16-bit (word): 4000hex corresponds to 100 °C

6.5.6.4 Objects in drive profile DSP402

Overview

The following table lists the object directory with the index of the individual objects for the drives. The "SINAMICS parameter" column contains the SINAMICS parameter number.

Table 6- 65 Objects in drive profile DSP402

OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Transmission	Data type	Default values	Read/ write
Predefinitions							
67FF		Single device type		SDO			
Common entries in the object dictionary							
6007		Abort connection option code	p8641	SDO	Integer32	0	R/W
6502		Supported drive modes		SDO	Integer32		
6504		Drive manufacturer		SDO	String		
Device control							
6040		Control word	p8890	PDO/SDO	Unsigned16	–	R/W 1)
6041		Status word	r8784	PDO/SDO	Unsigned16	–	R
6060		Modes of operation	p1300	SDO	Integer16	–	R/ 2)
6061		Modes of operation display	p1300	SDO	Integer16	–	R/W
Profile torque mode							
6071		Target torque Set torque	p1513[0]	SDO/PDO	Integer16	–	R/W 1)
6072		Max. torque	p1520/p1521	SDO	0	0	0
6074		Torque demand value Actual torque	r0080	SDO/PDO	Integer16	–	R
Velocity mode							
6042	0	vl target velocity	r0060	SDO/PDO	Integer16	0	R/W
6044	0	vl control effort	r0063	SDO/PDO	Integer16	-	R

1) SDO access is only possible after mapping the objects and the BICO interconnection to display parameters.

2) Object cannot be written to as a CANopen device profile is not supported, only manufacturer-specific operating data

Functions

7

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

- Commissioning (Page 59)
- If necessary: Configuring the terminal strip (Page 89)
- If necessary: Connection to a fieldbus (Page 97)

7.1 Overview of inverter functions

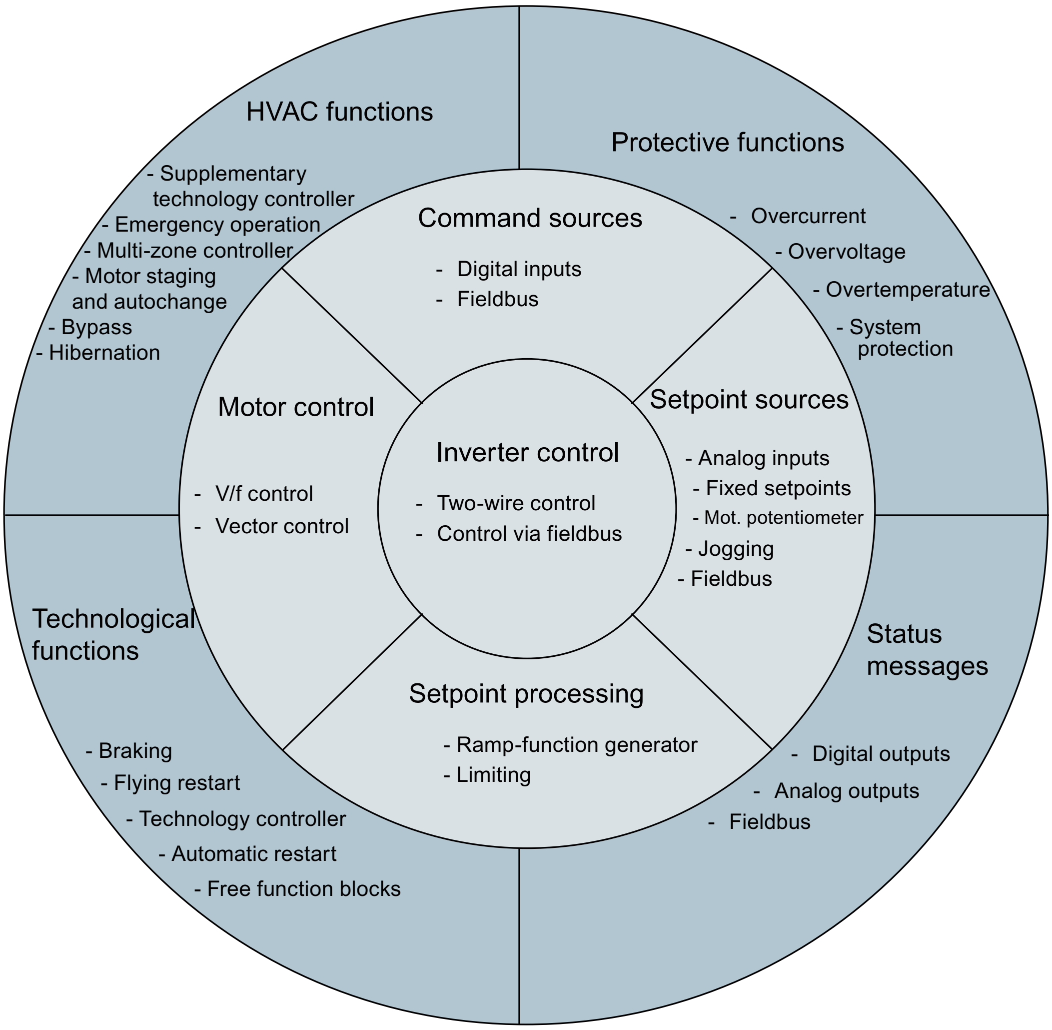
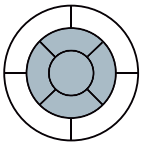
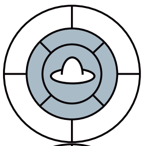


Figure 7-1 Overview of inverter functions

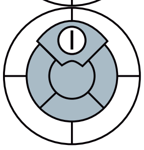
Functions relevant to all applications



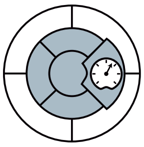
The functions that you require in each application are located at the center of the function overview above.
The parameters of these functions are provided with a matching basic setting during quick commissioning so that in many cases, the motor can be operated without requiring additional parameterization.



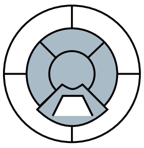
Inverter control is responsible for all of the other inverter functions. Among other things, it defines how the inverter responds to external control signals.



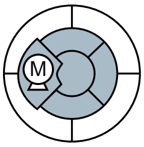
The **command source** defines from where the control signals are received to switch-on the motor, e.g. via digital inputs or a fieldbus.



The **setpoint source** defines how the speed setpoint is for the motor is entered, e.g. via an analog input or a fieldbus.

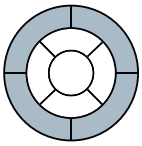


The **setpoint calculation** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value.

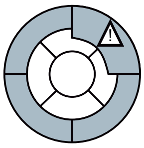


The **motor closed-loop control** ensures that the motor follows the speed setpoint.

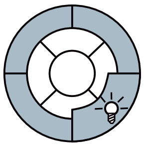
Functions required in special applications only



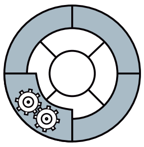
The functions, whose parameters you only have to adapt when actually required, are located at the outer edge of the function overview above.



The **production functions** avoid overloads and operating states that could cause damage to the motor, inverter and driven load. The motor temperature monitoring is, e.g. set here.

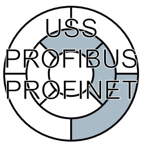


The **status messages** provide digital and analog signals at the Control Unit outputs or via the fieldbus. Examples include the actual speed of the motor or fault message output by the inverter.



The **technological functions** allow you to activate a motor holding brake or implement a higher-level pressure or temperature control using the technology controller, for example.

Connection to a fieldbus



If you wish to operate the inverter on a fieldbus, then you must connect the following inverter functions with the fieldbus:

- Command sources
- Setpoint sources
- Status messages

A connection with a fieldbus can be established via software tools in the control systems. This manual includes descriptions of how you proceed for PROFIBUS with a SIMATIC control.

7.2 Inverter control

7.2.1 Inverter control using digital inputs

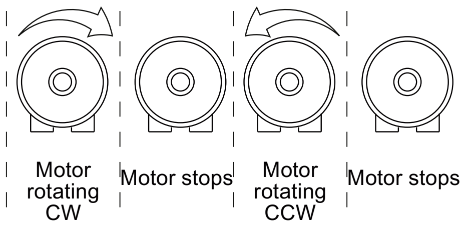
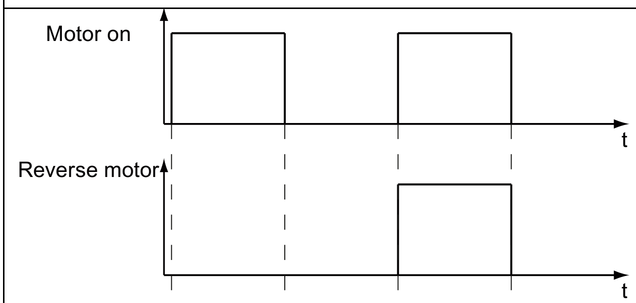
The start, stop and direction reversal control commands

If the inverter is controlled using digital inputs, two control command define when the motor starts, stops and whether clockwise or counter-clockwise rotation is selected.

Note

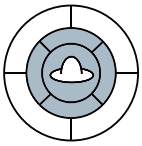
When clockwise rotation is activated, the inverter generates a clockwise voltage characteristic at its output terminals. Whether the connected motor actually rotates clockwise depends on the wiring between the inverter and motor.

Table 7- 1 Controlling the motor

Control commands	Explanation
	
Two-wire control	
	1. Control command: Switch the motor on or off 2. Control command: Reverses the motor direction of rotation

7.2.2 Two-wire control

Function description



One control command starts/stops the motor, while the other control command changes the direction of rotation.

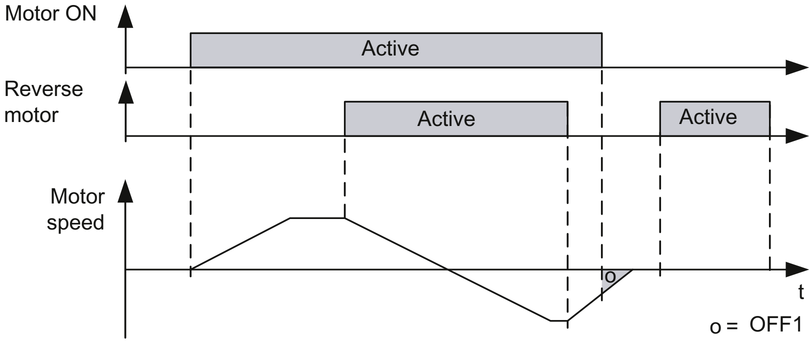


Figure 7-2 Motor control using digital inputs

Table 7- 2 Function table

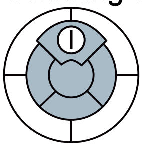
Motor ON	Reverse motor	Function
0	0	OFF1: The motor decelerates to a standstill
0	1	OFF1: The motor decelerates to a standstill
1	0	The motor accelerates to the setpoint
1	1	The motor accelerates to the inverted setpoint

Table 7- 3 **Parameterizing the function**

Parameter	Description
P0700 = 2	Controls the motor using the digital inputs of the inverter
P0701 = 1	**The motor is power-up with digital input 0 (factory setting)** Further options: The motor can be powered-up with any other digital input, e.g. with digital input 3 via P0704 = 1
P0702 = 12	**The motor is reversed with digital input 1 (factory setting)** Further options: The motor can be reversed with any other digital input, e.g. with digital input 3 via P0704 = 12

7.3 Command sources

Selecting the command source [P0700]



The motor is switched on/off via inverter control commands. The following command sources can be used to specify these control commands:

- Digital inputs (default for inverters without PROFIBUS interface, p0700 = 2)
- Fieldbus (default for inverters with PROFIBUS interface, p0700 0 = 6)

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.

Table 7- 4 Parameter for setting the source for control commands

Parameter	Description
P0700	2: Digital inputs (P0701 … P0709)' factory setting for inverters without PROFIBUS interface 6: Fieldbus (P2050 … P02091), factory setting for inverters with PROFIBUS interface

Control commands via the digital inputs

You can use the factory settings for the digital inputs to control the motor via the digital inputs. If required, you can adapt the functions of the digital inputs to your application.

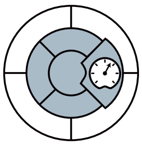
The setting options for the digital inputs are described in Section Assigning functions to digital inputs (Page 89).

Control commands via the fieldbus

To control the motor via the fieldbus, the inverter must be connected to a higher-level controller. In the case of a SIMATIC control, you also require the STEP 7 software. Additional information is provided in Chapter Connection to a fieldbus (Page 97).

7.4 Setpoint sources

7.4.1 Selecting the setpoint source



The inverter's motor control sets the motor speed according to the speed setpoint.

The speed setpoint can be calculated outside the inverter and sent to the inverter. Alternatively, the inverter receives a setpoint for the process variable, e.g. the level of a liquid container, and calculates its speed setpoint itself using the internal technology controller.

The following sources are used to specify the setpoint (speed setpoint or setpoint for technology controller):

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

Procedure

Setting options to select the setpoint source

p1000	= 0	No main setpoint
	= 1	MOP setpoint / motorized potentiometer (P1031 … P1040)
	= 2	Analog setpoint (P0756 … P0762), Factory setting for inverters without PROFIBUS interface
	= 3	Fixed setpoint (P1001 … P1023)
	= 6	Fieldbus (P2050 … P2091), Factory setting for inverters with PROFIBUS interface
	= 7	Analog setpoint 2

Adding setpoints from different sources

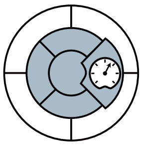
Parameter P1000 can also be used to add more setpoint sources, e.g. you can specify the speed setpoint as the result of adding together the fieldbus and analog input setpoints.

For more information, see the List Manual (P1000 in the parameter list and function diagram 3030).

7.4.2 Using analog inputs as a setpoint source

You will find an example how to parameterize an analog input as source for the speed setpoint in Section Assigning analog inputs to specific functions (Page 92) .

7.4.3 Using a motorized potentiometer as a setpoint source



The 'motorized potentiometer' (MOP) function simulates an electromechanical potentiometer for entering setpoints. The current value of the motorized potentiometer (MOP) can be set by means of the "up" and "down" control signals.

The motorized potentiometer offers the following benefits:

- The setpoint, e.g. for motor speed, is infinitely variable
- You only need two buttons to adjust the setpoint ("faster" and "slower")
- You can use the inverter's digital inputs or simply the plugged-in operator panel to control the motorized potentiometer
- If desired, the inverter will save the motorized potentiometer's setpoint in the event of a power failure

Typical applications

- Specification of speed setpoint during the commissioning phase
- Manual operation of the motor should the higher-level control fail
- Switching between automatic mode and manual operation
- Applications with largely constant setpoint and without higher-level control

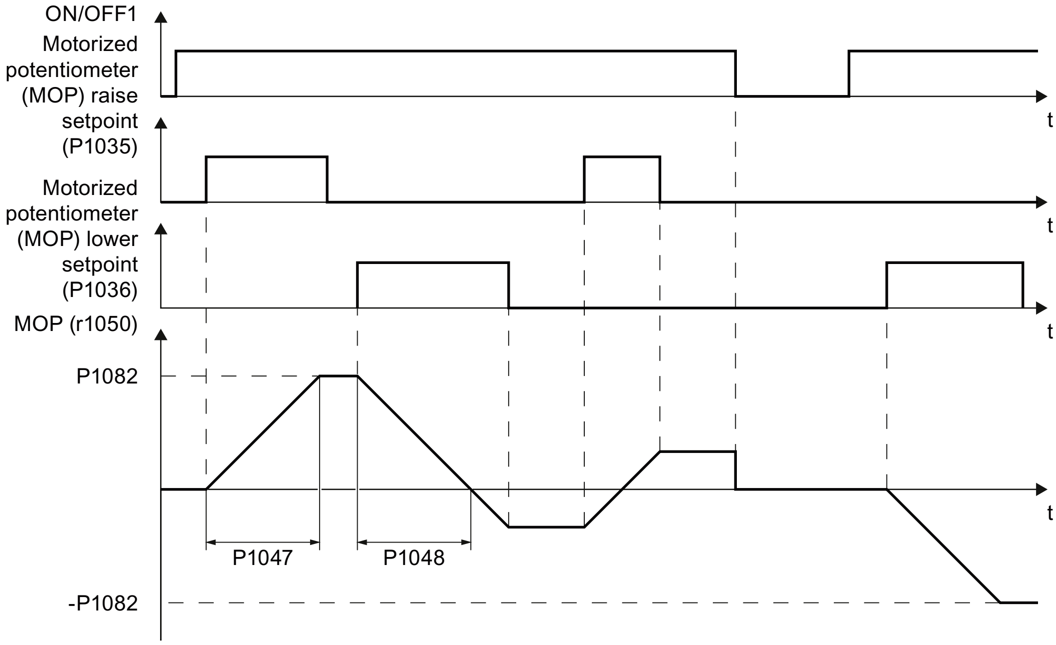


Figure 7-3 Function chart of motorized potentiometer

Configuration of motorized potentiometer

Table 7- 5 Basic setup of motorized potentiometer

Parameter	Description
P1000 = 1	**Select speed setpoint** 1: Motorized potentiometer
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- 6 Extended setup of motorized potentiometer

Parameter	Description
P1030	**Configuration of the MOP, parameter value with four independently adjustable bits 00 … 03** (factory setting 0110 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)
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)
P1041	**Signal source to switch from manual to automatic** (factory setting 0)
P1042	**Signal source for setpoint in automatic mode** (factory setting 0)
P1043	**Signal source to accept set value** (factory setting 0) E.g. command to switch on motor
P1044	**Signal source for set value** (factory setting 0)

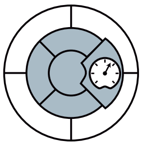
For more information about the motorized potentiometer, see the List Manual (function diagram 3020 and the parameter list).

Example of parameterization of the motorized potentiometer

Table 7- 7 Implementing a motorized potentiometer using digital inputs

Parameter	Description
P0700 = 2	**Command source** Digital inputs
P0701 = 1	**Pre-assignment for digital input 0** The motor is switched on and off via digital input 0
P0702 = 13	**Pre-assignment for digital input 1** The MOP setpoint is increased via digital input 1
P0703 = 14	**Pre-assignment for digital input 2** The MOP setpoint is reduced via digital input 2
P1000 = 1	**Setpoint selection**: MOP setpoint
P1040 = 10	**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

7.4.4 Using the fixed speed as a setpoint source



In many cases 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 speeds
- Grinding machine with constant speed depending on diameter of various grinding discs

When using the technology controller, the inverter interprets fixed setpoints as the constant specification of process variables in time, e.g.:

- Pump for controlling a constant flow
- Fan for controlling a constant temperature

Procedure

You can assign parameters to 16 different fixed setpoints and specify them via digital inputs. Once switched on, the motor accelerates to one of these setpoints or changes its speed depending on the selection of fixed speed setpoints.

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 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- 8 Parameters for direct selection of fixed setpoints

Parameter	Description
P1016 = 1	Direct selection of fixed setpoints (factory setting)
P1001	**Fixed setpoint 1**Factory setting: 0 rpm)
P1002	**Fixed setpoint 2**Factory setting: 0 rpm)
P1003	**Fixed setpoint 3**Factory setting: 0 rpm)
P1004	**Fixed setpoint 4**Factory 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)

Parameter	Description
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- 9 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.

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

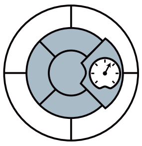
The motor is to run at two different speeds:

- 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- 10 Parameter settings for the example

Parameter	Description
P0700 = 2	Selecting the command source: Digital inputs
P0701 = 1	Switching on motor using DI 0 - factory setting
P0702 = 12	Direction reversal using DI 1 - factory setting
P1001 = 300.000	Defines the fixed setpoint 1 in [rpm]
P1002 = 2000.000	Defines the fixed setpoint 2 in [rpm]
P1020 = 722.2	Connect up fixed setpoint 2 with DI 2. r0722.2 = Parameter, which displays the status of digital input 2.
P1021 = 722.3	Connect fixed setpoint 3 with the status of DI 3. r0722.3 = Parameter, which displays the status of digital input 3.

7.4.5 Running the motor in jog mode (JOG function)



The JOG function enables you to carry out the following:

- Test the motor and inverter after commissioning to ensure that they function properly (the first traverse movement, direction of rotation etc.)
- Move a motor or motor load to a specific position
- Run a motor (e.g. following program interruption)

This function allows the motor to start up or rotate with a specific jog frequency.

Setting jogging

When this function is enabled, the motor starts up ("ready for operation" status) when the JOG button is pressed and rotates at the set JOG frequency. When the button is released, the motor stops. This button has no effect when the motor is already running.

Table 7- 11 Enabling the jog mode

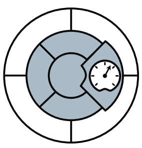
Parameter	Description
P1058	**Jogging 1 speed setpoint** (factory setting, 150 rpm) -210000.000 rpm ... 210000.000 rpm in the motor JOG mode
P1059	**Jogging 2 speed setpoint** (factory setting, 150 rpm) -210000.000 rpm ... 210000.000 rpm in the motor JOG mode

Using BICO technology, you can also assign the JOG function to other keys.

Table 7- 12 Parameter to assign the JOG function to another button

Parameters	Description
P1055	**Signal source for jogging 1 - jog bit 0** (factory setting: 0) Possible sources: 722.x (digital inputs) / r2090.8 (fieldbus)
P1056	**Signal source for jogging 2 - jog bit 1** (factory setting: 0) Possible sources: 722.x (digital inputs) / r2090.9 (fieldbus)

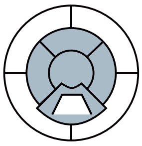
7.4.6 Specifying the motor speed via the fieldbus



To specify the setpoint via the fieldbus, the inverter must be connected to a higher-level controller. In the case of a SIMATIC control, you also require the STEP 7 software. Additional information is provided in Chapter Connection to a fieldbus (Page 97).

7.5 Setpoint calculation

Overview of setpoint calculation



The setpoint calculation 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.

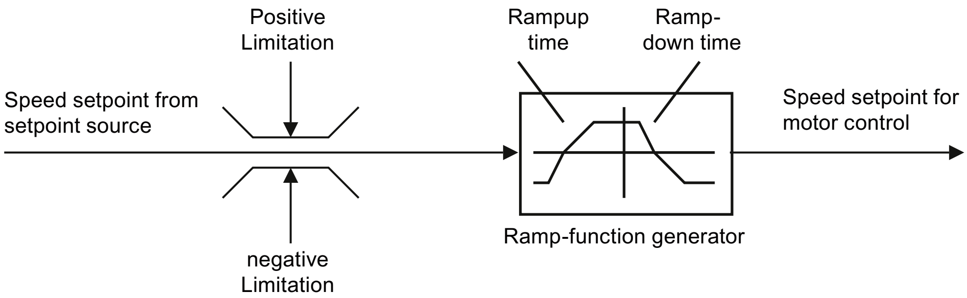
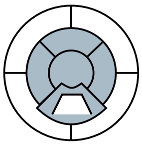


Figure 7-4 Setpoint calculation in the inverter

7.5.1 Minimum speed and maximum speed



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

Minimum 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.

Maximum speed

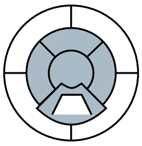
The speed setpoint is limited to the maximum speed in both directions of rotation. A message is output if the maximum speed is exceeded.

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

Table 7- 13 Parameters for minimum and maximum speed

Parameter	Description
P1080	Minimum speed
P1082	Maximum speed

7.5.2 Parameterizing the ramp-function generator



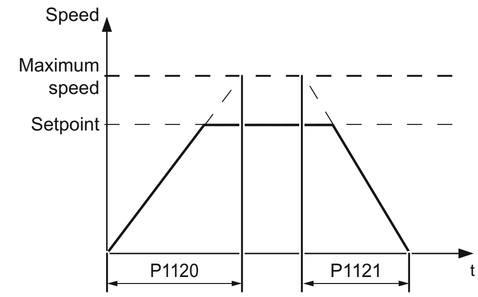
The ramp-function generator in the setpoint channel limits the speed of changes to the speed setpoint. This causes the motor to accelerate and decelerate more smoothly, thereby protecting the mechanical components of the driven machine.

Ramp-up/down time

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

Table 7- 14 Parameters for ramp-up time and ramp-down time

Parameters	Description	
P1120	**Ramp-up time** Duration of acceleration (in seconds) from zero speed to the maximum speed P1082	
P1121	**Ramp-down time** Duration of deceleration in seconds from the maximum speed P1082 to standstill	

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

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.

Rounding

Acceleration can be "smoothed" further by means of rounding. The jerk occurring when the motor starts and when it begins to decelerate can be reduced independently of each other. Rounding can be used to lengthen the motor acceleration/deceleration times. The ramp-up/down time parameterized in the ramp-function generator is exceeded.

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

Table 7- 15 Rounding parameters

Parameter	Description
P1130	**Initial rounding time for ramp-up and ramp-down** (factory setting: 0 s)
P1131	**Final rounding time for ramp-up and ramp-down** (factory setting: 0 s)
P1134	**Rounding type**

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

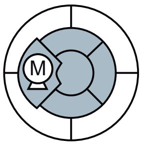
7.6 Motor control

Overview

There are two different open-loop and closed-loop control techniques for inverters used with synchronous and induction motors.

- Closed-loop control with V/f-characteristic (called V/f control)
- Field-oriented control technology (called vector control)

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 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.

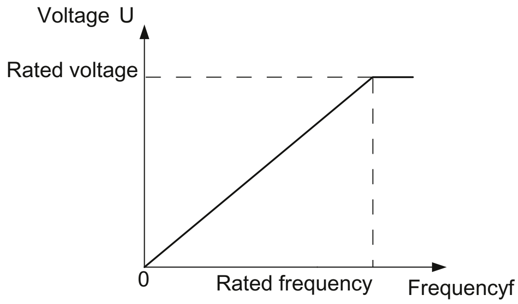
Typical applications for V/f control

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

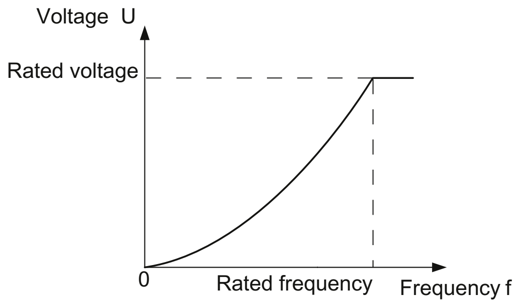
7.6.1.1 V/f control with linear and square-law characteristic

V/f control with a linear characteristic is 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 a parabolic characteristic is 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.



Parameters	Description
P1300	**Open-loop/closed-loop control operating mode** 0: V/f control with linear characteristic 2: V/f control with parabolic characteristic

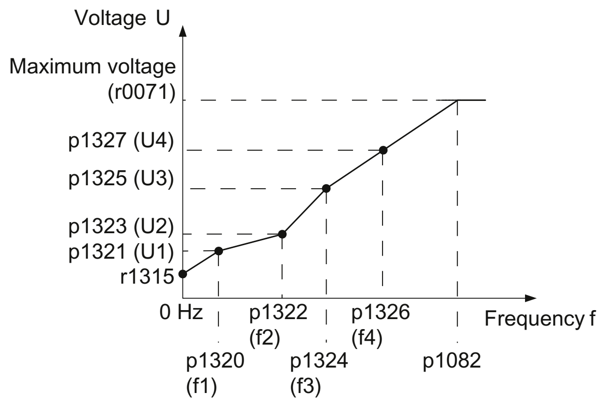
Note

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

7.6.1.2 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.

Table 7- 16 Additional V/f control versions (P1300)

Parameters	Application
P1300 = 1	**Linear V/f characteristic with Flux Current Control (FCC)** 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.
P1300 = 3	**Freely adjustable V/f characteristic**, which supports the torque behavior of synchronous motors (SIEMOSYN motors) 
P1300 = 4 P1300 = 7	**Linear V/f characteristic with ECO** **Square-law V/f characteristic with ECO** ECO mode is suitable for applications requiring a lower level of dynamic performance and a constant speed setpoint and delivers an energy saving 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.
P1300 = 5 P1300 = 6	**Linear V/f characteristic for textile applications** where it is important that the motor speed is kept constant under all circumstances. This setting has the following effects: 1. When the maximum current limit is reached, the stator voltage is reduced but not the speed. 2. Slip compensation is locked.
P1300 = 19	**V/f control without characteristic.** 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).

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

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 breakaway torque
- Utilizing the brief overload capability of the motor when accelerating

Voltage increase in V/f control (boost)

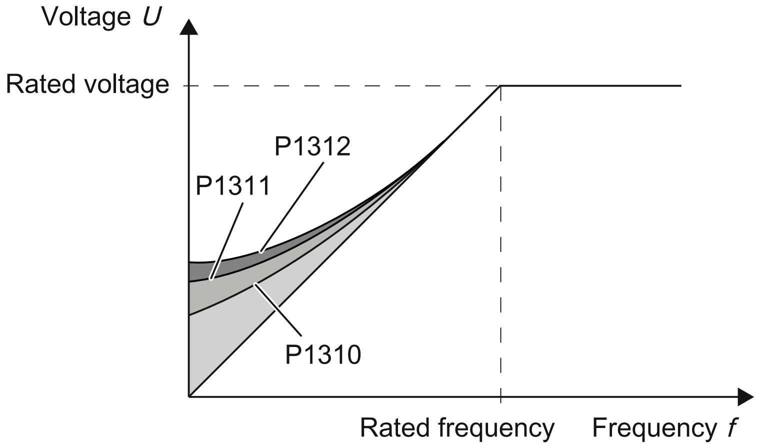


Figure 7-5 Voltage boost using a linear V/f characteristic as example

The voltage loss as a result of long motor cables and the ohmic losses in the motor are compensated 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.

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 overhead and switch off (trip) the inverter due to overcurrent .

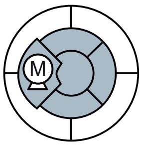
Table 7- 17 Optimizing the starting characteristics for a linear characteristic

Parameters	Description
P1310	**Permanent voltage boost** (factory setting 50%) The voltage boost is effective for all speeds below the rated speed and continually decreases as the speed increases. The maximum voltage boost is effective at zero speed and is in V: 1.732 x P0305 (rated motor current [A]) x r0395 (stator resistance [ohm]) x P1310 /100%
P1311	**Voltage boost when accelerating** The voltage boost follows a positive setpoint increase and ends as soon as the setpoint is reached. The voltage boost is not dependent on speed. The voltage boost is in V: 1.732 x P0305 (rated motor current [A]) x r0395 (stator resistance [ohm]) x P1310 / 100 %
P1312	**Voltage boost when starting** p1312 results in an additional voltage boost when accelerating, however, only the first time the motor accelerates after it has been switched-on. The voltage boost is V: 1.732 x P0305 (rated motor current [A]) x r0395 (stator resistance [ohm]) x P1310 /100%

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



The vector control can be used to control (closed-loop) the speed and the torque of a motor.

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

Vector control in comparison to 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

Vector control must not be used 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:

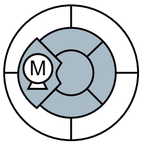
	Inverter pulse frequency					
	2 kHz			4 kHz and higher		
Pole number of the motor	2-pole	4-pole	6-pole	2-pole	4-pole	6-pole
Maximum motor speed [rpm]	9960	4980	3320	14400	7200	4800

7.6.2.2 Typical applications of vector control

Vector control is typically used for the following applications:

- Hoisting gear and vertical conveyor belts
- Winders
- Extruders

7.6.2.3 Commissioning vector control



Vector control with and without speed encoder requires careful commissioning and therefore must only be performed by commissioning engineers that are experienced in handling this type of control.

Steps when commissioning the vector control

1. Carry out quick commissioning (P0010 = 1)
   In order to ensure that the vector control functions perfectly, it is absolutely imperative that the motor data is entered correctly
2. Run the motor data identification (P1900 = 2)
   The motor data identification must be carried out with the motor in the cold state. The motor data identification must be carried out after the quick commissioning as the quick commissioning supplies output data for the motor model and the motor data identification makes these even more precise
3. Carry out the automatic speed controller optimization (P1960 = 1)

Table 7- 18 The most important vector control parameters

Parameter	Description
P1300 = 20	**Control type:** Vector control without speed encoder
P0300 … P0360	**Motor data** are transferred from the motor rating plate during the quick commissioning and calculated with the motor data identification
P1442 … 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):

7.6.2.4 Torque control

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

Typical applications for torque control

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

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

Steps when commissioning the torque control

1. Carry out quick commissioning (P0010 = 1)
   In order to ensure that the torque control functions perfectly, it is absolutely imperative that the motor data is entered correctly.
2. Run the motor data identification (P1900 = 2)
   The motor data identification must be carried out with the motor in the cold state. The motor data identification must be carried out after the quick commissioning as the quick commissioning supplies output data for the motor model and the motor data identification makes these even more precise.

Table 7- 19 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 are transferred from the motor rating plate during the quick 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

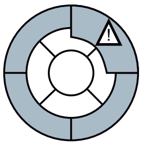
Additional information about this function is provided in the parameter list and in function diagrams 6030 onwards in the List Manual.

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.

The load torque monitoring functions provide effective plant and system protection.

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.

I2t 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)

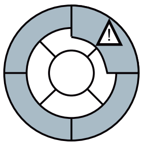
The power unit heat sink temperature is monitored using A05000 and F30004. The values are specified in r0037[0] [°C].

Parameterizing the monitoring

The way the inverter responds to overtemperature or overload can be set using p0290. We would however recommend that only experienced staff change the factory setting.

Parameter	Description
P0290 = 2	**Temperature monitoring of the Power Module** This defines the response of the inverter to an **internal overtemperature**. 0: Reduce the output speed 1: Shutdown (F30024) 2: Reduce pulse frequency and output speed (factory setting) 3: Reduce pulse frequency, then shut down (F30024)
P0292	**Parameterizes the alarm threshold** for heatsink and module temperature monitoring (Power Module)

7.7.2 Motor temperature monitoring using a temperature sensor



You can use temperature recording in the motor to offer the motor thermal protection as follows:

- with 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 recording 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 initiated.

Temperature recording via ThermoClick sensor

The ThermoClick sensor responds at values ≥100 Ω. 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- 20 Parameters for detecting the motor temperature via a temperature sensor

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td>P0335</td><td colspan="3">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)</td></tr>
<tr><td rowspan="3">P0601</td><td rowspan="3">Motor temperature sensor type
0: No sensor (factory setting)
1: PTC thermistor (→ P0604)
2: KTY84 (→ P0604)
4: ThermoClick sensor</td><td colspan="2">Terminal no.</td></tr>
<tr><td>14</td><td>PTC+
KTY anode
ThermoClick</td></tr>
<tr><td>15</td><td>PTC-
KTY cathode
ThermoClick</td></tr>
<tr><td>P0604</td><td colspan="3">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)</td></tr>
<tr><td>P0605</td><td colspan="3">Motor temperature fault threshold (Factory setting: 145℃)</td></tr>
<tr><td>P0610</td><td colspan="3">Motor overtemperature response
Determines the response when the motor temperature reaches the alarm threshold.
0: No motor response, alarm an alarm
1: Alarm and reduction of I_{max} (factory setting)
reduces the output speed
2: Fault message and shutdown (F07011)</td></tr>
<tr><td>P0640</td><td colspan="3">Current limit (input in A)</td></tr>
</table>

*****You will find detailed information on classifying the cooling technique in EN 60034-6

7.7.3 Protecting the motor by calculating the motor temperature

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

Table 7- 21 Parameter to sense the temperature without using a temperature sensor

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

7.7.4 Overcurrent protection

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

During V/f control, the maximum current controller (I_{max} controller) protects the motor and 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

NOTICE
The factory setting of the I_{max} controller only needs to be changed in exceptional cases by appropriately trained personnel.

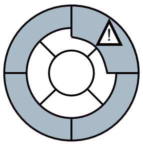
Table 7- 22 I_{max} controller parameters

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
P1345	Proportional gain of the I_{max} controller for voltage reduction
P1346	Integral time of the I_{max} controller for voltage 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.
r1344	Voltage output of I_{max} controller Shows the amount by which the I-max controller reduces the inverter output voltage.

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 can operate as a generator if it is driven by the connected load, In this case, the motor converts mechanical energy into electrical energy. The motor feeds the regenerative energy back to the inverter.

As a consequence, the DC link voltage is increased. The inverter can only reduce the increased DC link voltage if it is capable of regenerative feedback into the line supply or is equipped with a braking resistor.

Without being capable of regenerating into the line supply, only extremely low or brief regenerative loads – relative to the inverter power – are possible because the inverter may be damaged if the DC link voltage reaches critical levels. 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 is technically possible – 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 subject to braking. For applications such as these, you must select an inverter that is equipped with a braking resistor (Power Module PM240 plus external braking resistor) or can feed energy back into the line supply (Power Modules PM250 and PM260).

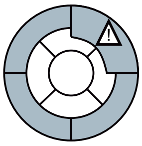
There are two different groups of parameters for the V_{DCmax} controller, depending on whether the motor is being operated with V/f control or vector control.

Table 7- 23 V_{DCmax} controller parameters

Parameter for V/f control	Parameter for vector control	Description
P1280 = 1	P1240 = 1	**V_{DC} controller or V_{DC} monitoring configuration** 1: Enable V_{DCmax} controller
r1282	r1242	**V_{DCmax} controller switch-on level** Shows the value of the DC-link voltage above which the V_{DCmax} controller is active
P1283	P1243	**V_{DCmax} controller dynamic factor** Scaling the controller parameters P1290, P1291 and P1292
P1290	P1250	**V_{DCmax} controller proportional gain**
P1291	P1251	**V_{DCmax} controller integral time**
P1292	P1252	**V_{DCmax} controller rate time**
P1294	P1254	**V_{DCmax}controller automatic recording of ON level** Activates or deactivates automatic recognition of the switch-on levels of the V_{DCmax} controller

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

7.7.6 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

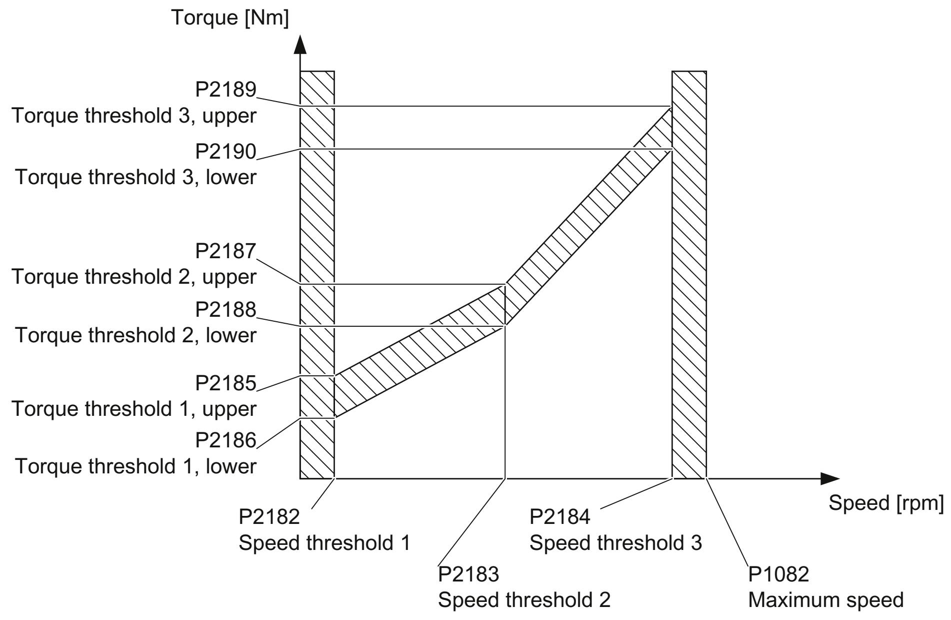
The inverter monitors the torque of the motor in different ways:

1. No-load monitoring:
   The inverter generates a message if the motor torque is too low.
2. Blocking protection:
   The inverter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.
3. Stall protection:
   The inverter generates a message if the inverter control has lost the orientation of the motor.
4. Speed-dependent torque monitoring
   The inverter measures the actual torque and compares it with a parameterized speed/torque characteristic.

Table 7- 24 Parameterizing the monitoring functions

Parameter	Description
No-load monitoring	
P2179	**Current limit for no-load detection** If the inverter current is below this value, the message "no load" is output.
P2180	**Delay time for the "no load" message**
Blocking protection	
P2177	**Delay time for the "motor locked" message**
Stall protection	
P2178	**Delay time for the "motor stalled" message**
P1745	**Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated** This parameter is only evaluated as part of encoderless vector control.
Speed-dependent torque monitoring	
P2181	**Load monitoring, response** Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
P2182	**Load monitoring, speed threshold 1**
P2183	**Load monitoring, speed threshold 2**

Parameter	Description
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).

7.7.7 Load failure monitoring via digital input

Using this function, you can directly monitor the load failure of the driven machine, e.g. for fans or conveyor belts.

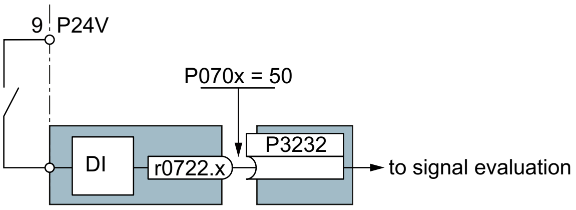


Figure 7-6 Load failure monitoring by means of a digital input

If you parameterize the function of a digital input for load failure monitoring (P070x = 50), you automatically interconnect this input to signal evaluation via BICO technology.

Table 7- 25 Setting load failure monitoring

Parameters	Description
P2193 = 3	**Load monitoring configuration** (factory setting: 1) 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring
P070x = 50	**Pre-assignment of digital input** 50: Load monitoring failure detection Monitoring is possible via each of the CU's digital inputs. If you want to use digital input 2, for example, parameterize P0703 = 50
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)
P1040	**Start value of MOP** (factory setting 0 rpm) Determines the start value [rpm] that becomes effective when the motor is switched on

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

7.8 Status messages

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 .

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 Connection to a fieldbus (Page 97).

7.8.1 System runtime

By evaluating the system runtime of the inverter, you can decide when you should replace components subject to wear in time before they fail - 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.

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

You cannot reset the system runtime.

7.9 Technological functions

The inverter offers the following technological functions, e.g.:

- 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.

The inverter also offers the following HVAC functions which are described in section (Page 242).

- Emergency operation
- Multi-zone controller
- Motor staging and autochange
- Bypass
- Hibernation

7.9.1 Braking functions of the converter

Electrical braking and 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. In this case, 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. Examples include:

- Centrifuges
- Cranes
- Conveyor belts with downward movement of load

Inverter braking methods

Depending on the particular application and the inverter type, there are different technologies to handle regenerative power.

- The regenerative power is converted into heat in the motor (DC and compound braking)
- The inverter converts the regenerative power to heat using a braking resistor (dynamic braking)
- The inverter feeds the regenerative power back into the line supply (regenerative braking)

Different electrical braking methods for different applications

Table 7- 26 Braking methods and Power Modules depending on the application

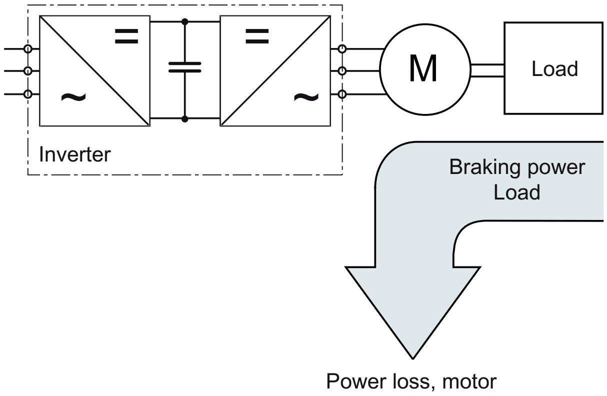
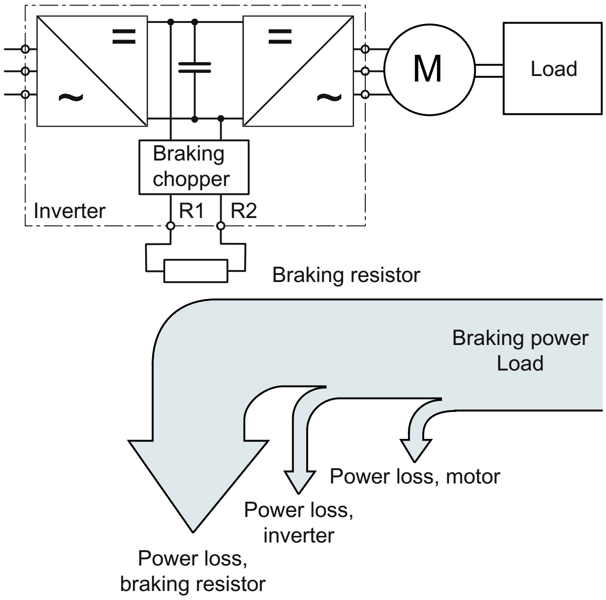
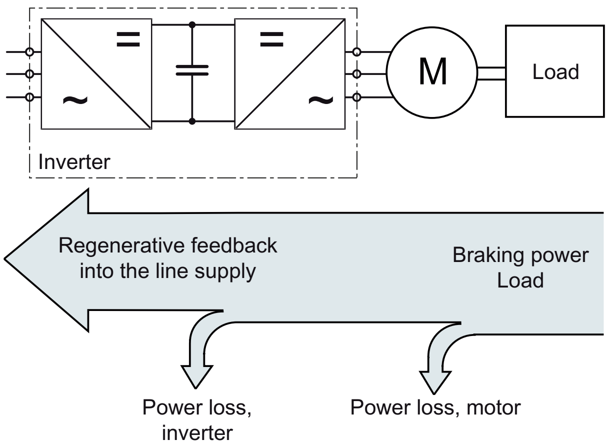
Application examples	Electrical braking method	Power Modules that can be used
Pumps, fans, compressors, extruders, mixers	Not required	PM230, PM240, PM250, PM260
Grinding machines, conveyor belts	DC braking, compound braking	PM240
Centrifuges, vertical conveyors, hoisting gear, cranes, winders	Dynamic braking	PM240
	Regenerative braking	PM250, PM260

Braking methods depending on the drive inverter being used

Table 7- 27 Power Modules depending on the braking method

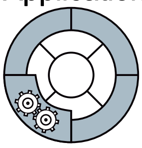
	SINAMICS G120 Power Module			
	PM230	PM240	PM250	PM260
DC injection braking	X	X	X	X
Compound braking	---	X	X	X
Dynamic braking	---	X	---	---
Regenerative braking	---	---	X	X

Advantages and disadvantages of the braking methods

DC braking • *Advantage:* The motor is braked without the inverter having to convert the regenerative power • *Disadvantages:* significant increase in the motor temperature; no defined braking characteristics; no constant braking torque; no braking torque at standstill; braking power is lost as heat; does not function when the power fails Compound braking • *Advantage:* Defined braking characteristics, the motor is braked without the inverter having to convert any regenerative power • *Disadvantages:* significant motor temperature rise; no constant braking torque; braking power is dissipated as heat; does not function when the power fails	
Dynamic braking • *Advantages:* defined braking characteristics; no additional motor temperature increase; constant braking torque; in principle, also functions when the power fails • *Disadvantages:* A braking resistor is required; regenerative power is lost as heat; the permissible thermal load of the braking resistor must be taken into account	
Regenerative braking • *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	

7.9.1.1 DC braking

Applications of DC braking



DC 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
- Conveyor belts

DC braking is available with all G120 Power Modules.

DC braking only works after an OFF1 or OFF3 command.

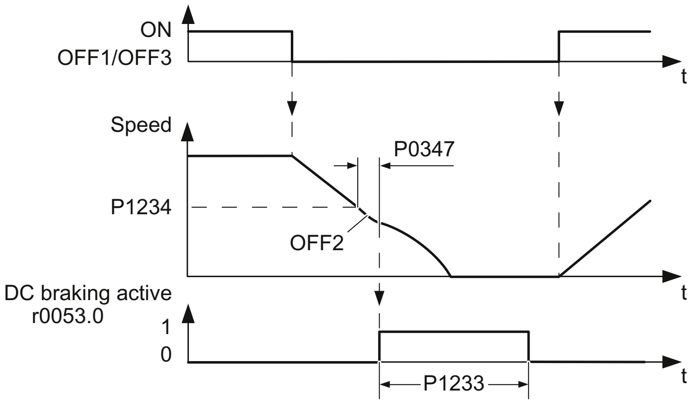


Figure 7-7 DC braking after an OFF1 or OFF3 command

DC braking sequence:

1. Initially, the motor speed is reduced along the down ramp of the ramp-function generator until an adjustable speed threshold is reached.
2. If the motor speed falls below this threshold, the inverter issues an internal OFF2 command.
3. If the motor is demagnetized, then the inverter starts the actual DC braking by allowing a DC current to flow through the motor. The magnitude and duration of the DC current can be set.

⚠ 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.

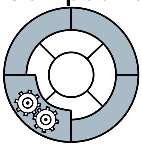
Parameterizing DC braking

Table 7- 28 Enabling and setting DC braking

Parameter	Description
P1230	**Enable DC braking via external command** Enables DC braking via a signal that was used by an external source (BICO). The function remains active as long as the external signal is active.
P1231	**DC brake configuration** Activate DC brake. 0: No function (factory setting) 4: DC brake
P1232	**DC braking current** (factory setting: 0 %) Defines the strength of the direct current [%] relative to the rated motor current (P0305)
P1233	**Duration of DC braking with OFF1 or OFF3 command** (factory setting: 1 s) Defines the duration of DC braking in seconds after an OFF1 or OFF3 command
P1234	**DC brake start speed** (factory setting: 210000 rpm) If the actual speed (according to the frequency set) falls below this threshold, DC braking is activated.
P0347	**Demagnetizing time of the motor** The inverter calculates this value from the motor data during commissioning. Only commissioning engineers, who have the appropriate experience, may change the parameter values. The inverter can trip due to an overcurrent during DC braking if the demagnetizing time is too short.

7.9.1.2 Compound braking

Compound braking applications



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
- Conveyor belts

Operating characteristics of compound braking

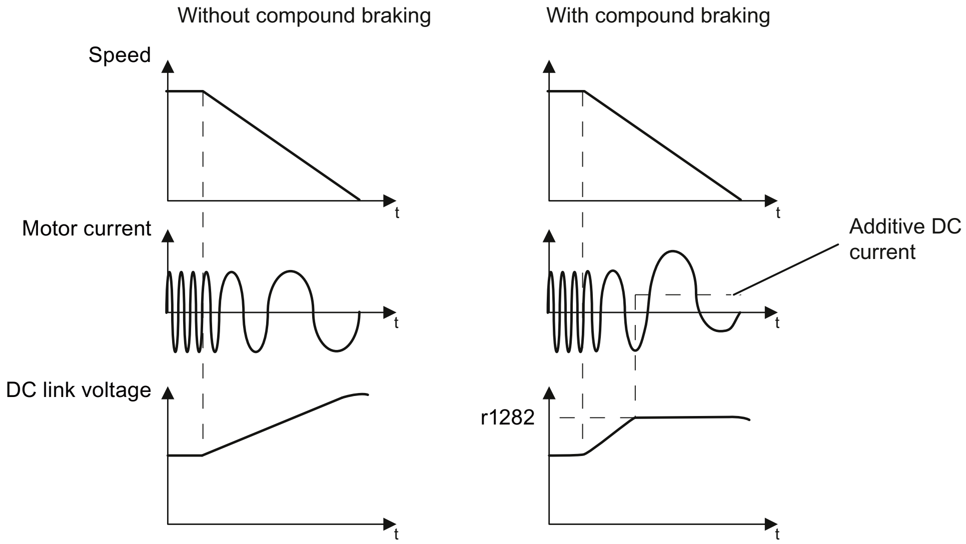


Figure 7-8 Compound braking

When the motor is in the regenerative mode, the inverter DC link voltage increases. Compound braking is active 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

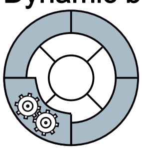
Table 7- 29 Parameters to enable and set compound braking

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.

7.9.1.3 Dynamic braking

Dynamic braking applications



Dynamic braking is typically used in applications in which dynamic motor behavior is required at different speeds or continuous direction changes, e.g.:

- Conveyor drives
- Hoisting gear

Power Module PM240 with a braking chopper and external braking resistor are needed for dynamic braking.

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 $V_{DC\ link,\ max}$.

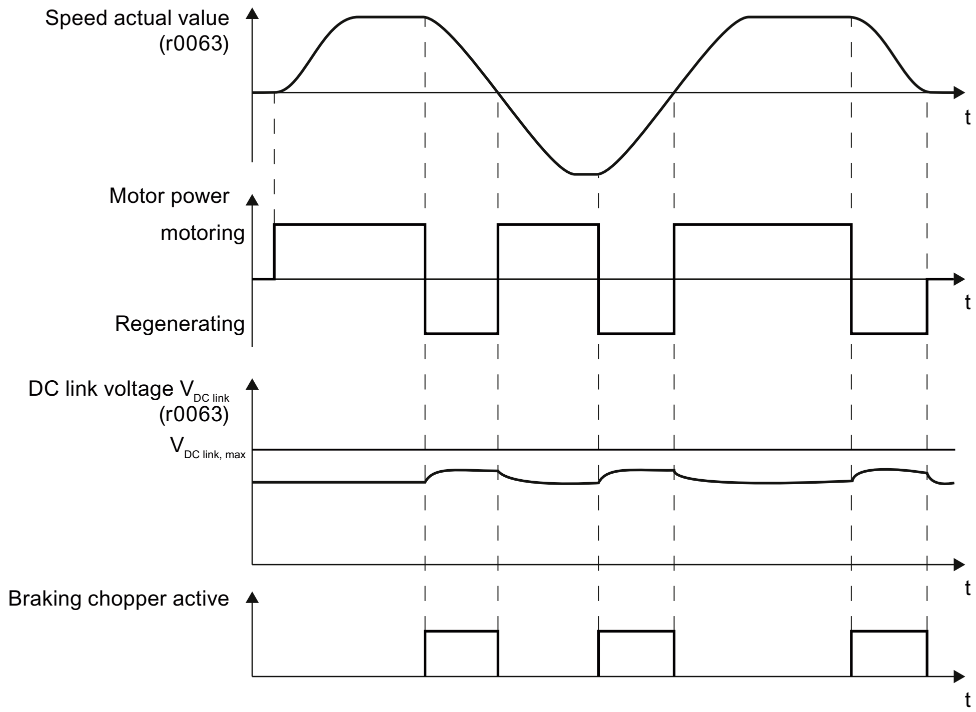


Figure 7-9 Simplified representation of dynamic braking with respect to time

Braking resistor connection

1. Connect the braking resistor to terminals R1 and R2 of the Power Module
2. Ground the braking resistor directly to the control cabinet's grounding bar. The braking resistor must not be grounded via the PE terminals on the Power Module
3. Evaluate the braking resistor's temperature monitoring (terminals T1 and T2) such that the motor is switched off when the resistor has an overtemperature condition.
   You can do this in the following two ways:
   - Use a contactor to disconnect the inverter from the line as soon as temperature monitoring requests it
   - Specify the inverter's OFF2 command via the braking resistor's temperature monitoring

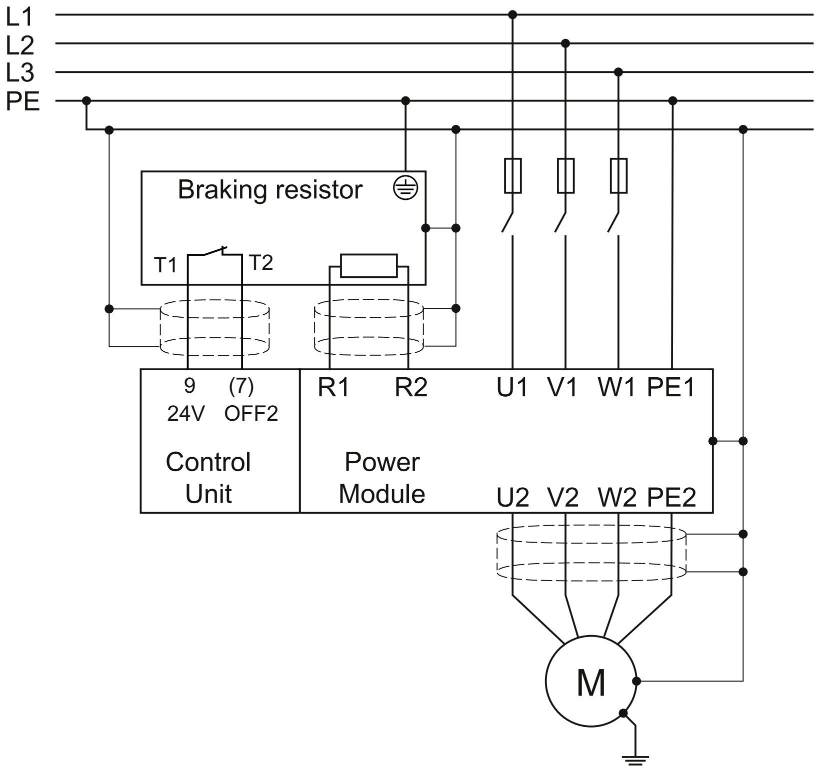


Figure 7-10 Braking resistor connection

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 inverter.
>
> 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

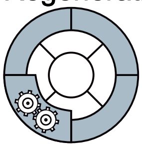
The dynamic braking does not have to be parameterized.

If the V_{DC} controller intervenes earlier than the dynamic braking, deactivate the V_{DC} controller. The V_{DC} controller is described in Chapter Limiting the maximum DC link voltage (Page 216).

You will find more information about the braking resistor in the parameter list and in the Installation Manual for the Power Module PM240.

7.9.1.4 Regenerative braking

Regenerative braking applications



Regenerative braking is typically used in applications in which braking energy is generated either frequently or for longer periods of time, e.g. centrifuges, unwinders or cranes.
The condition for regenerative deceleration is Power Module PM250 or PM260.

The inverter can feed back up to 100% of its power (for HO base load) into the line supply.

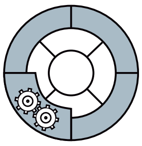
Parameterizing regenerative braking

Table 7- 30 Setting regenerative braking

Parameters	Description
Energy recovery option for V/f control (P1300 < 20)	
p0640	**Motor overload factor** Setting the maximum regenerative power. If the regenerative power exceeds this value for longer than 10 s, the inverter shuts down with fault message F07806.
Energy recovery option for vector control (P1300 ≥ 20)	
P1531	**Regenerative power limit** The maximum regenerative load is entered as negative value via p1531. (-0.01 … -100000.00 kW). Values higher than the rated value of the power unit (r0206) are not possible.

7.9.2 Automatic restart and flying restart

7.9.2.1 Flying restart: switching on the converter when the motor is running



The "flying restart" function, which is activated by P1200, allows the inverter to be switched to a rotating motor. The function must be used whenever a motor may still be running. This could be:

- After a brief line interruption
- When an inverter is shut down but air currents cause a fan impeller to rotate (either CW or CCW)
- If the motor is driven by a load

This function is useful, therefore, with motors whose load exhibits a high moment of inertia since it can help prevent sudden loads in the mechanical components.

If this function is not used in such cases, then there is a high probability that the motor will be shut down due to overcurrent (overcurrent fault F07801).

The "flying restart" function can be used to synchronize the inverter with the motor speed.

> ⚠ WARNING
>
> **Drive starts automatically**
>
> When this function is enabled (P1200 > 0), all those working with the system must be informed of the following:
>
> - The drive starts automatically.
> - Although the drive is at a standstill, it can be started by the search current.

Setting "flying restart" function

Table 7- 31 Basic setting

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

Table 7- 32 Additional commissioning parameters

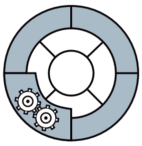
Parameter	Description
P1201	**Flying restart enable signal source** (factory setting: 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
P1202	**Motor current: Flying restart** (factory setting 100 %) Defines the search current with respect to the motor magnetization current. (r0331), which is used during the flying restart
P1203	**Search rate/speed: Flying restart** (factory setting 100 %) Sets the speed at which the output frequency changes during the flying restart to synchronize itself with the running motor. A higher value results in a longer search time.

Note

The "flying restart" function decelerates the motor slightly. The smaller the drive torque, the more the drive is decelerated.

The "flying restart" function should not be activated for motors in group drives due to the different coasting characteristics of the individual motors.

7.9.2.2 Automatic restart



The automatic restart function is predominantly used to restart the drive automatically once the power has been restored following a power failure. Since the function is not restricted to line supply faults, it can also be used to automatically acknowledge faults and restart the motor after any tripping. To allow the drive to be switched to a motor shaft that is still rotating, the "flying restart" function must be activated via P1200.

The activated automatic restart function automatically acknowledges all faults and the motor is switched-on 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 and respond appropriately.

General conditions

To automatically restart the motor, the ON command to switch-on the motor must be present.

> ⚠ WARNING
>
> When the "automatic restart" function is active (P1210 > 1), the motor can restart automatically once the power has been restored. This is particularly critical if it is incorrectly assumed that the motors have been shut down after a long power failure.
>
> For this reason, death, serious injury, or considerable material damage can occur if personnel enters the working area of motors in this condition.

Commissioning the automatic restart

1. Set the automatic restart to function as required for your application using P1210
2. Set the number of start attempts using P1211
3. Set the wait time (P1212) and monitoring time (P1213)
4. If, for an automatic restart, the inverter is to be connected to an already rotating motor, then the "flying restart" function should also be activated using P1200, see Flying restart: switching on the converter when the motor is running (Page 231) .
5. Make sure that this functions properly.

Parameterizing the automatic restart

The following table provides an overview of the parameters for the automatic restart function. Details of the parameters can be found underneath.

Table 7- 33 Overview of parameters to set the automatic restart

Parameter		
P1210	**Automatic restart mode** (factory setting: 0)	
	0:	Disable automatic restart
	1:	Acknowledge all faults without restarting
	4:	Restart after power failure without further restart attempts
	6:	Restart after fault with further restart attempts
	14:	Restart after power failure after manual fault acknowledgement
	16:	Restart after fault after manual fault acknowledgement
P1211	**Automatic restart start attempts** (factory setting: 3)	
P1212	**Automatic restart wait time start attempt** (factory setting: 1.0 s)	
P1213	**Automatic restart monitoring time**	
P1206	**Set fault number without automatic restart** The parameter is only effective if P1210 = 6 or P1201 = 16. Details can be found below in the information on setting P1210 = 6	

P1210: Automatic restart mode

- **P1210 = 0: Automatic restart disabled** (this is a useful setting when connected to a fieldbus)
  When the power is restored, all faults are acknowledged. The motor is only switched on after a further ON command
- **P1210 = 1: Acknowledge all faults without restart**
  Any faults that are present are acknowledged automatically once the cause has been rectified. If further faults occur after faults have been acknowledged, these will also be acknowledged automatically. If the ON/OFF1 signal (control word 1, bit 0) is set to HIGH, a period of P1212 + 1s must elapse between when a fault is acknowledged and another one occurs. If the ON/OFF1 signal is set to LOW, the time between a fault being acknowledged and another fault occurring must be at least 1 s.
  No F07320 fault is generated if the acknowledgement attempt faults, for example due to too great a frequency of fault occurrence.
- **P1210 = 4: Restart after power failure without further start attempts**
  Automatic restart only takes place if fault F30003 (undervoltage in the DC link) has occurred on the Power Module in addition to the power failure. If other faults are present they are also acknowledged and the start attempt proceeds.
  A failure of the 24 V power supply to the CU is interpreted as a power failure.
- **P1210 = 6: Restart after fault with further start attempts**
  An automatic restart takes place after any fault. If the faults occur one after the other, the number of start attempts can be defined by means of P1211. Time monitoring can be set with P1213.

Note

If P1210 = 6 or 16, automatic restart is suppressed for the fault numbers listed in P1206[0 … 9].

Example: P1206[3] = 07331 ⇒ No restart with fault F07331.

⚠ WARNING

In the case of communication via the fieldbus interface, the motor restarts with the setting P1210 = 6 even if the communication link is interrupted. This means that the 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 PROFIBUS failure is reported with the fault code F01910. You should therefore set P1206[n] = 1910 (n = 0 … 9).

- **P1210 = 14: Restart after power failure after manual fault acknowledgement**
  Same procedure as with P1210 = 4, but fault F30003 and any other faults present must be acknowledged manually.
- **P1210 = 16: Restart after fault after manual fault acknowledgement**
  Same procedure as with P1210 = 6, but faults must be acknowledged manually.

P1211 and P1212: Start attempts and wait time

The number of start attempts can be set via P1211. The number is decremented internally after each successful fault acknowledgement (the line voltage must be re-applied or the infeed signals that it is ready). The inverter shuts down with F07320 if the number of parameterized start attempts is exceeded.

If P1211 = x, x + 1 start attempts will be made.

Note

The first start attempt starts immediately after the fault has occurred.

Each fault is automatically acknowledged after half of the P1212 wait time.

Following successful acknowledgement and power restoration, the system is automatically powered up again.

The start attempt has been completed successfully once the flying restart and magnetization of the motor (induction motor) have been completed (r0056.4 = 1) and one additional second has expired. The startup counter is not reset to the initial value P1211 until this point.

If additional faults occur between successful acknowledgement and the end of the start attempt, then the startup counter is also decremented when it is acknowledged.

P1213: Monitoring time for power restoration

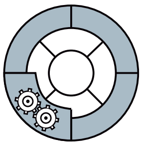
The monitoring time starts when the faults are detected. If the automatic acknowledgements are not successful, the monitoring time will continue. If the drive has not successfully restarted by the time the monitoring time expires (flying restart and motor magnetization must have been completed: r0056.4 = 1), fault F07320 is output. When P1213 = 0, monitoring is deactivated.

Monitoring time for restart (P1213[0])
If P1213 is set lower than the sum of P1212, the magnetizing time P0346 and the additional wait time due to flying restart, then fault F07320 is generated at each restart. If a fault is active after P1213 has elapsed (even though P1210 = 1), fault F07320 is generated. The monitoring time must be extended if the faults that occur cannot be immediately and successfully acknowledged (e.g. if other machine components are not yet ready).

Reset the monitoring time for the startup counter (P1213[1])
The error counter (see r1214) is only reset to start value P1211 once the time in P1213[1] has expired after a successful restart. The wait time is not effective in the case of a fault acknowledgment without an automatic restart (P1210 = 1). If the power supply fails (blackout), the wait time only starts once the power has been restored and the Control Unit is ramped up. The fault counter is set to P1211 if F07320 occurs (automatic restart aborted), the switch-on command is canceled and the fault is acknowledged.

If start value P1211 or mode P1210 is changed, the fault counter is immediately updated.

7.9.3 PID technology controller



The technology controller supports all kinds of simple process control tasks. For example, it is used for controlling pressures, levels, or flow rates.

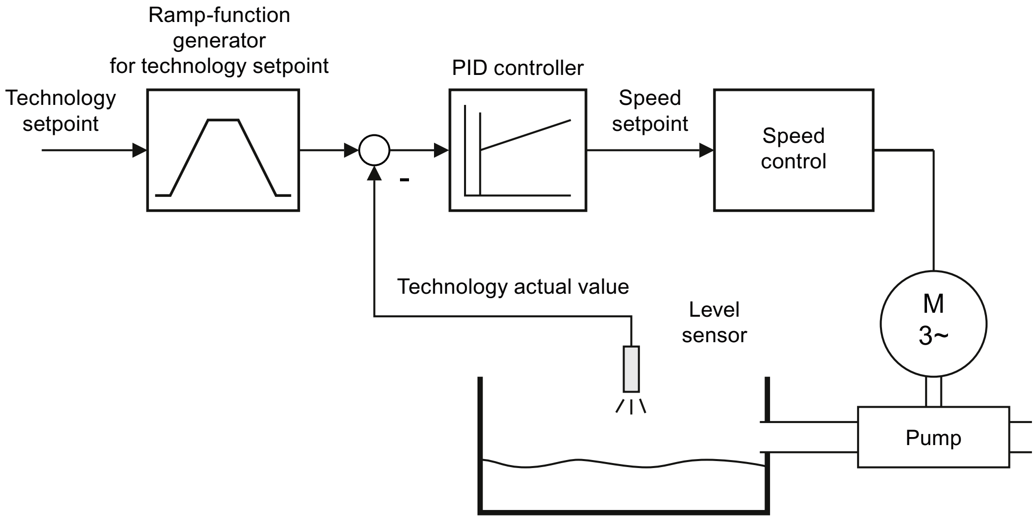


Figure 7-11 Example: technology controller as a level controller

Function of the technology controller

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 can be supplied via the same setpoint sources as those available for the speed setpoint. The technology controller is also equipped with its own motorized potentiometer and own fixed speeds.

The setpoints, actual values, and control signals of the technology controller are defined by means of BICO technology.

Table 7- 34 Technology controller parameters

Parameter	Description
P2200 = …	Enable technology controller
P2201 … r2225	Fixed speeds
P2231 … P2248	Motorized potentiometer
P2251 … r2294	Technology controller parameters
P2345 = …	Technology controller, fault reaction

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

Note

Changing over the setpoint source between the main setpoint (p1070) and PID setpoint (p2200)

The technology setpoint has priority if, in addition to the technology setpoint, the main setpoint is also active. If the technology setpoint is deactivated while the main setpoint is still active, then the main setpoint is used as setpoint for the motor.

Additional fault reaction for the technology controller

For the technology controller, the actual value is monitored for an upper (p2267) and lower limit (p2268). If the actual value lies outside these limits, then the inverter goes into a fault condition with F07426 and the motor is shut down with OFF1.

There are applications where this response is not suitable. This is the reason that for fault F07426, in addition to the fault reaction defined in p2101, there is also option of setting additional fault responses using p2345.

Fault reactions for F07426, adjustable via p2345

- Continue to operate with the last known setpoint (r2344).
  Exception: If fault F07426 already occurs when ramping up to the start value of the technology controller (p2302), then this start value is kept as setpoint, without changing to the setpoint defined for the particular fault case.
- Continue to operate with fixed speed 15 for the technology controller (p2215).

As long as the technology actual value lies outside the permissible limits, the technology controller setpoint is supplied with the setpoint (r2344 or p2215) selected in p2345.

Constraints and preconditions

The fault reaction for F07426 (technology controller limiting) must be set to no reaction using 2100 and 2101.

The technology controller must be activated (p2200 = 1) as main setpoint (2251 = 0).

Additional technology controller

Via the parameter ranges

- p11000 … p11099: free technology controller 0
- p11100 … p11199: free technology controller 1
- p11200 … p11299: free technology controller 2

additional technology controllers can be parameterized. Refer to the parameter descriptions and in function block diagram 7970 of the associated Parameter Manual for additional details.

7.9.4 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 Parameter Manual, in Chapter "Function block diagrams" in the section "Free function blocks" (function block 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 block 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.

Table 7- 35 Runtime groups and possible assignments of the free function blocks

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

✓: The block can be assigned to the runtime group
-: The block cannot be assigned to this runtime group

Analog signal scaling

If you interconnect a physical quantity, e.g. speed or voltage to the input of a free function block using BICO technology, then the signal is automatically scaled to a value of 1. The analog output signals of the free function blocks are also available as scaled quantities (0 ≙ 0 %, 1≙ 100 %).

As soon as you have interconnected the scaled output signal of a free function block to functions, which require physical input quantities - e.g. the signal source of the upper torque limit (p1522) - then the signal is automatically converted into the physical quantity.

The quantities with their associated scaling parameters are listed in the following:

- Speeds P2000 Reference speed (≙100 %)
- Voltage values P2001 Reference voltage (≙100 %)
- Current values P2002 Reference current (≙100 %)
- Torque values P2003 Reference torque (≙100 %)
- Power values P2004 Reference power (≙100 %)
- Angle P2005 Reference angle (≙100 %)
- Acceleration P2007 Reference acceleration (≙100 %)
- Temperature 100 °C ≙ 100 %

Scaling examples

- Speed:
  Reference speed p2000 = 3000 rpm, actual speed 2100 rpm. As a consequence, the following applies to the scaled input quantity: 2100 / 3000 = 0,7.
- Temperature:
  Reference quantity is 100 °C. For an actual temperature of 120 °C, the input value is obtained from 120 °C / 100 °C = 1.2.

Note

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

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

Example: Logic combination of two digital inputs

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

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

Table 7- 36 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.
P0701 = 0	**Pre-assignment of digital input 0** (factory setting: 1) Delete pre-assignment of digital input 0 to allow for interconnection via BICO
P0702 = 0	**Pre-assignment of digital input 1** (factory setting: 12) Delete pre-assignment of digital input 1 to allow for interconnection via BICO
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 Extended scope for adaptation (Page 21)chapter.

Detailed descriptions of the free function blocks are provided in the following manuals:

Function Manual "Free Function Blocks" (http://support.automation.siemens.com/WW/view/en/35125827)

Function Manual "Description of the Standard DCC Blocks" (http://support.automation.siemens.com/WW/view/en/35125827)

7.10 HVAC functions

7.10.1 Real Time Clock

The real time clock is the basis for time-dependent process controls, e.g.:

- To reduce the temperature of a heating control during the night
- Increase the pressure of a water supply at certain times during the day

Real time clock: Format and commissioning

The real time clock starts as soon as the Control Unit power supply is switched-on for the first time. The real time clock comprises the clock time in a 24 hour format and the date in the "day, month, year" format.

After a Control Unit power supply interruption, the real time clock continues to run for approx. five days.

If you wish to use the real time clock, you must set the time and date once when commissioning. If you restore the inverter factory setting, the real time clock parameters are not reset.

Parameters	Real time clock (RTC)
p8400[0]	**RTC time**, hour (0 … 23)
p8400[1]	**RTC time**, minute (0 … 59)
p8400[2]	**RTC time**, second (0 … 59)
p8401[0]	**RTC date** , day (1 … 31)
p8401[1]	**RTC date** , month (1 … 12)
p8401[2]	**RTC date** , day (1 … 9999)
p8404	**RTC weekday** 1: Monday 2: Tuesday 3: Wednesday 4: Thursday 5: Friday 6: Saturday 7: Sunday
p8405	**RTC activate/deactivate alarm A01098** Sets whether the real time clock issues an alarm if the time is not running in synchronism (e.g. after a longer power supply interruption). 0: Alarm A01098 deactivated 1: Alarm A01098 activated

Time-controlled technology controller

The real time clock can influence the technology controller of the inverter via the "time switch" function (DTC). If you wish to control process quantities, e.g. temperature, pressure or level, time-controlled, then you must parameterize one or several of the time switches corresponding to your requirements. Using BICO technology, interconnect the output of the time switch to the corresponding control signals of your technology controller.

Table 7- 37 Example: Time switch DTC1

Parameters	Description
p8410[0 … 6]	**RTC DTC1 weekday activation** Sets the weekday to activate time switch 1 0: Weekday deactivated 1: Weekday activated [0] = Monday [1] = Tuesday [2] = Wednesday [3] = Thursday [4] = Friday [5] = Saturday [6] = Sunday
p8411[0 … 1]	**RTC DTC1 switch-on time** Sets the switch-on time of the time switch in hours and minutes [0] = Hour (0 ... 23) [1] = Minute (0 ... 59)
p8412[0 … 1]	**RTC DTC1 switch-off time** Sets the switch-off time of the time switch in hours and minutes [0] = Hour (0 ... 23) [1] = Minute (0 ... 59)
r8413.0 … 1	**BO: RTC DTC1 output** Day (1 … 31)

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

Accept the real time clock in the alarm and fault buffer

Using the real time clock, you can track the sequence of alarms and faults over time. When an appropriate message occurs, the real time clock is converted into the UTC time format (Universal Time Coordinated):

Date, time ⇒ 01.01.1970, 0:00 + d (days) + m (milliseconds)

The number "d" of the days and the number "m" of milliseconds is transferred into the alarm and fault times of the alarm or fault buffer, see Chapter Alarms, faults and system messages (Page 281).

Converting UTC into RTC

An RTC can be again calculated from the UTC. Proceed as follows to calculate a date and time from a fault or alarm time saved in the UTC format:

1. Calculate the number of seconds of UTC:
   Number of seconds = ms / 1000 + days × 86400
2. In the Internet, you will find programs to convert from UTC into RTC, e.g.:
   UTC to RTC (http://unixtime-converter.com/)
3. Enter the number of seconds in the corresponding mask and start the calculation.

Example:

Saved as alarm time in the alarm buffer:

r2123[0] = 2345 [ms]
r2145[0] = 14580 [days]

Number of seconds = 2345 / 1000 + 14580 × 86400 = 1259712002
Converting this number of seconds in RTC provides the date: 02.12.2009, 01:00:02.

7.10.2 Temperature measurement via PT1000 or NI1000

Analog input AI2

Analog input AI2 can be used as a current input or resistance input for a temperature sensor. Both the DIP switch and parameter p0756.2 must be set accordingly for this purpose.

- P0756.2 = 2 or 3 -> options for setting as current input
- P0756.2 = 6, 7 or 8 -> options for setting as temperature sensor

Analog input AI3

Analog input AI3 is designed as a resistance input for a temperature sensor.

Setting options:

- P0756.3 = 6, 7 or 8 -> options for setting as temperature sensor

Permissible temperature sensors

The temperature-dependent PT1000 or NI1000 resistors can be used as sensors. The values of these sensors are supplied via analog input AI2 or AI3 (p2264 = 756.2 or 756.3) as actual values for the technology controller.

The connection is established at AI2 (terminals 50, 51) or AI3 (terminals 52, 53).

- NI1000 measuring range: -88 °C … 165 °C (p0756 = 6)
- Pt1000 measuring range: -88 °C … 240 °C (p0756 = 7)

For temperatures outside this range, alarm A03520 "Temperature sensor error" is output.

More detailed information is provided in r2124. The following is applicable:

- r2124 = 21 (hex) => sensed via AI2, wire breakage or sensor not connected
- r2124 = 22 (hex) => sensed via AI2, short circuit
- r2124 = 31 (hex) => sensed via AI3, wire breakage or sensor not connected
- r2124 = 32 (hex) => sensed via AI3, short circuit

Please refer to the parameter list for more details.

7.10.3 Emergency operation

Description

Emergency operation, Essential Service Mode (ESM) ensures that in an emergency, the motor can be operated as long as possible so that, for example, smoke gases can be extracted allowing people in a fire to escape. On the inverter side, emergency operation can be activated without any additional measures. On the plant or system side, the design and components used must be suitable for emergency operation.

Application example

In order to improve air circulation in stairwells, frequently, a slight underpressure is generated using the technology controller. With this control, a fire would mean that smoke would be drawn into the stairwell. This would then mean that the stairway would be blocked as escape or evacuation route.

Using the emergency operation function, in this particular case, a setpoint can be entered that generates a pressure, therefore preventing the propagation of smoke and other gases caused by the fire in the stairwell. This will then keep the escape or evacuation route free.

Basis setting options

The "Emergency operation" function must be connected to a digital input in order that emergency operation can be activated. To do this, the parameter involved must be set to 26, e.g. p0704[1] (DI3) = 26. Emergency operation is activated with a 1 signal via DI3.

Additional setting options (BiCo) for analog outputs

Emergency operation can be connected to any digital input via p3880. It can be activated using either a high or a low level signal.

Note

Command source for emergency operation

We recommend that the command source for emergency operation is not logically combined with any other functions.

- The setting of the source for emergency operation via p3880 is always referred to the data set that is currently active.
- Emergency operation can only be switched on precisely via one source.

The last setpoint recognized is taken as the emergency setpoint in the factory setting. You can use p3881 to define another value:

- P3881 = 0: Last recognized setpoint (factory setting)
- P3881 = 1: Fixed setpoint 15
- P3881 = 2: Analog setpoint
- P3881 = 3: Fieldbus
- P3881 = 4: Technology controller

If you specify the emergency setpoint via the analog setpoint, fieldbus or technology controller, you must ensure monitoring so that an alternative setpoint can be used in the event of failure.

Possible forms of monitoring for the different setpoint sources:

- Analog setpoint: Using F03505
- Fieldbus status in r2043
- Technology controller r2349

You will find additional details on this in the parameter list in the function block diagrams for emergency operation, setpoint channel and technology controller.

When in the factory setting, if the setpoint is lost, the drive continues using the last recognized setpoint. p3882 can be used to switch to the following values:

- P3882 = 0: Last recognized setpoint (factory setting)
- p3882 = 1: Fixed speed setpoint which is defined in p1015
- p3882 = 2: Maximum speed (value of p1082)

Note

Technology controller as setpoint source for the emergency operation setpoint

In order that the technology controller can enter the emergency setpoint, it must be set as main setpoint (p2251 = 0).

Direction of rotation in emergency operation

- Emergency setpoint using p3881 = 0, 1, 2, 3

  Depending on your system, you may have to invert the setpoint locally for emergency operation. The customer can therefore use p3883 to determine the direction of rotation of the emergency setpoint. To do this, p3883 must be linked with a free digital input, e.g. p3883 = r722.12.

  – p3883 = 0 -> normal emergency direction of rotation,

  – p3883 = 1 -> inverted emergency direction of rotation.

- Emergency setpoint using p3881 = 4

  If the emergency setpoint is specified using the technology controller, it is depicted using variables within the process and depends on these. Inversion using a digital input is therefore locked in such cases. If the direction of rotation has to be inverted, this should be done within the technology controller.

Bypass operation in emergency operation

- If the motor is running in bypass operation when the emergency happens, the user must query the "Bypass control/status word" (r1261) and undertake appropriate interconnection to ensure that the motor is switched to the inverter and continues to run with the emergency setpoint.
- If the inverter has failed in emergency operation because of an internal fault and if it cannot be switched back on using the automatic restart function, the user can interconnect bit 7 of the status word for the automatic restart (r1214.7) with P1266 to run the motor directly on the line. You will find additional information about bypass operation in section Bypass (Page 257).

Special features of emergency operation

- The automatic restart function is activated when p1210 = 6 as soon as emergency operation kicks in. This results in the inverter being started up again if a pulse inhibit (OFF2) occurs due to internal critical faults.
- In emergency operation, inverter shutdown due to faults is suppressed, with the exception of faults that would lead to the destruction of the inverter. You will find a a list of these faults in Section Emergency operation (Page 246).
- Emergency operation is triggered by a continuous signal (level-triggered) using the digital input which was defined in p3880 as the source for emergency operation.
- In emergency operation, the motor can only be stopped if the line voltage is switched off or emergency operation is exited.
- If emergency operation is deactivated, the inverter reverts to normal operation and its behavior depends on the pending commands and setpoints.
- Emergency operation takes priority over all other operating modes (e.g. hibernation or energy-saving mode).

NOTICE
Loss of warranty for an inverter in emergency operation
Should emergency operation apply, the customer can no longer lodge any claims for warranty. Emergency operation and the faults which arise during emergency operation are logged in a password protected memory and can be read by the repair center.

Refer to parameters p3880 … r3889 for more information on emergency operation.

Note

Other preconditions for emergency operation

In order to run the inverter in an emergency, the appropriate degrees of protection and connection and installation guidelines applicable to the system should be noted. You will find details of this in the Australian Standard: AS/NZS 1668.1:1998.

Table 7- 38 Parameters needed to set emergency operation

Parameter	Description
Setting the source for emergency operation	
p0704[1] = 26	Via a **digital input**(here, using DI3 as an example)
Or via	
p3880 = 722.3	**ESM activation** (here, DI3, high-active) Signal source for activating emergency operation 722.x for high active, 723.x for low active
Additional parameters to activate emergency operation	
p3881	**ESM setpoint source,** 0 … 4
p3882	**ESM substitute setpoint source** Setpoint should the parameterized ESM setpoint be lost
p3883	**ESM direction of rotation** Signal source for direction of rotation in emergency operation, is not evaluated when p3881 = 4
p3884	**ESM setpoint technology controller** If p3884 is not connected up, then the technology controller uses the main setpoint corresponding to p2251 = 0.
r3887	**ESM: Number of activations and faults** Indicates how frequently ESM has been activated (index 0) and how many faults occurred during ESM (index 1).
p3888	**ESM: Reset the number of activations and faults** p3888 = 1 resets 3887[0] and 3887[1].
r3889	ESM status word

Faults, which are not ignored even in emergency operation

F01000	Internal software error
F01001	Floating Point Exception
F01002	Internal software error
F01003	Time-out for memory access
F01015	Internal software error
F01040	Back up parameters and perform a POWER ON
F01044	Error in description data
F01205	Timeslice overflow
F01512	BICO: No normalization
F01662	Error, internal communications
F07901	Drive: Motor overspeed
F30001	Power unit: Overcurrent
F30002	Power unit: DC-link voltage overvoltage
F30003	Power unit: DC-link voltage undervoltage
F30004	Power unit: Overtemperature heatsink inverter

F30005	Power unit: Overload I2t
F30017	Power unit: Hardware current limit has responded too often
F30021	Power unit: Ground fault
F30024	Power unit: Overtemperature, thermal model
F30025	Power unit: Chip overtemperature
F30027	Power unit: Time monitoring for DC link pre-charging
F30036	Power unit: Overtemperature, inside area
F30071	No new actual values received from the Power Module
F30072	Setpoints can no longer be transferred to the Power Module
F30105	PU: Actual value sensing error
F30662	Internal communication error
F30664	Fault during power-up
F30802	Power unit: Timeslice overflow
F30805	Power unit: EPROM checksum not correct
F30809	Power unit: Switching information invalid

7.10.4 Multi-zone controller

Description

The multi-zone control is used to control, for example, the temperature in several rooms.

The setpoints and actual values are used as scaled quantities referred to the setpoint for further processing in the control.

e.g. setpoint = 20 °C ≙ 100 % ≙ 1, actual value = 25 °C ≙ 100 % ≙ 1.25

The following control versions with different setting options are available for multi-zone control:

- **One setpoint and one, two or three actual values**

  The actual value for the control can be calculated as mean value, maximum value or minimum value. You can find all of the setting options in the parameter list in parameter p31022.
- **Two setpoint/actual value pairs as maximum value control**
  - The upper limit is monitored for this control setting
  - The control evaluates the setpoint/actual value pair, which has the largest deviation upwards.
- **Two setpoint/actual value pairs as minimum value control (heating)**
  - The lower limit is monitored for this control setting
  - The control evaluates the setpoint/actual value pair, which has the largest deviation downwards.
- Using a **day/night changeover** other setpoints can be entered for specific times. The day/night changeover control can be realized e.g. using an external signal via DI4 or using free blocks and the real time clock via p31025.

When the multi-zone control is activated, the analog inputs as well as the sources for the setpoint and actual value of the technology controller are newly interconnected (see table).

Table 7- 39 Parameters to set the multi-zone control:

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p2200 = …</td><td colspan="2">Technology controller enable</td></tr>
<tr><td>p2251</td><td colspan="2">Set technology controller as main setpoint</td></tr>
<tr><td rowspan="3">P31020 = …</td><td colspan="2">Multi-zone control interconnection
(factory setting = 0)
A subsequent parameterization is performed by activating or deactivating the multi-zone control.</td></tr>
<tr><td>Subsequent connection for p31020 = 1 (activate multi-zone control)</td><td>Subsequent connection for p31020 = 0 (deactivate multi-zone control)</td></tr>
<tr><td>p31023[0] = 0755.0 (AI0)
p31023[2] = 0755.1 (AI1)
p31026[0] = 0755.2 (AI2)
p31026[1] = 0755.3 (AI3)
p2253 = 31024 (setpoint, technology controller)
p2264 = 31027 (actual value, technology controller)</td><td>p31023[0] = 0
p31023[2] = 0
p31026[0] = 0
p31026[1] = 0
p2253 = 0
p2264 = 0</td></tr>
<tr><td>P31021 = …</td><td colspan="2">Configuration of multi-zone control
• 0 = Setpoint 1 / several actual values
• 1 = Two zones / maximum value setting
• 2 = Two zones / minimum value setting (factory setting)</td></tr>
<tr><td>p31022 = …</td><td colspan="2">Processing of actual values for multi-zone control(only for p31021 = 0)
Possible values: 0 … 11 (factory setting = 0)</td></tr>
<tr><td>p31023[0 … 3] = …</td><td colspan="2">Setpoints for multi-zone control
Parameters for selecting the source for setpoints in multi-zone control (factory setting = 0)</td></tr>
<tr><td>r31024 = …</td><td colspan="2">Multi-zone control setpoint output for technology controller
CO parameters</td></tr>
<tr><td>p31025 = …</td><td colspan="2">Day/night changeover for multi-zone control
Parameter for selecting the source for day/night changeover of the multi-zone control (factory setting = 0)</td></tr>
<tr><td>p31026[0 … 2] = …</td><td colspan="2">Actual values for multi-zone control
Parameters for selecting the source for actual values of the multi-zone control (factory setting = 0)</td></tr>
<tr><td>r31027 = …</td><td colspan="2">Multi-zone control actual value output for technology controller
CO parameters</td></tr>
</table>

Note

Please note that when multi-zone control is activated, any BiCo interconnections present for analog inputs and for the technology controller's setpoint and actual value are cancelled and interconnected with the links defined in the factory.

When you deactivate multi-zone control, the associated BiCo interconnections are cancelled.

Example

The temperature in a large office is measured at three points and transferred to the inverter using analog inputs. The average temperature should be 22 °C. Overnight, the average temperature should be 20 °C.

Parameter settings

p2200 = 1	Technology controller enable
p2251 = 0	Set technology controller as main setpoint
p2900.0 = 91	Temperature setpoint overnight as a fixed value in %.
p31020 = 1	Activate multi-zone control
p31021 = 0	Select multi-zone control with one setpoint and three actual values
p31022.0 = 7	Three actual values, one setpoint. The average value of the three actual values is used for the control.
p31023.0 = 755.0	Temperature setpoint via analog input 0 as a %.
p31023.1 = 2900.1	Supply p31023.1 with the value written in P2900 to reduce the temperature overnight
p31026.0 = 755.2	Temperature actual value 1 via analog input 2 as a %
p31026.1 = 755.3	Temperature actual value 2 via analog input 3 as a %
p31026.2 = 755.1	Temperature actual value 3 via analog input 1 as a %
p31025 = 722.4	Changeover from day to night via digital input 4

You will find more information about this multi-zone control in the parameter list and in (function diagram 7972 of the List manual).

7.10.5 Motor staging and autochange

Description

The motor staging function is used in applications which require between one and four motors to be run at the same time depending on load, so that e.g. highly variable pressure ratios or flow volumes can be corrected.

The system consists of the speed-controlled main drive and up to three other drives which are activated via contactors or motor starters.

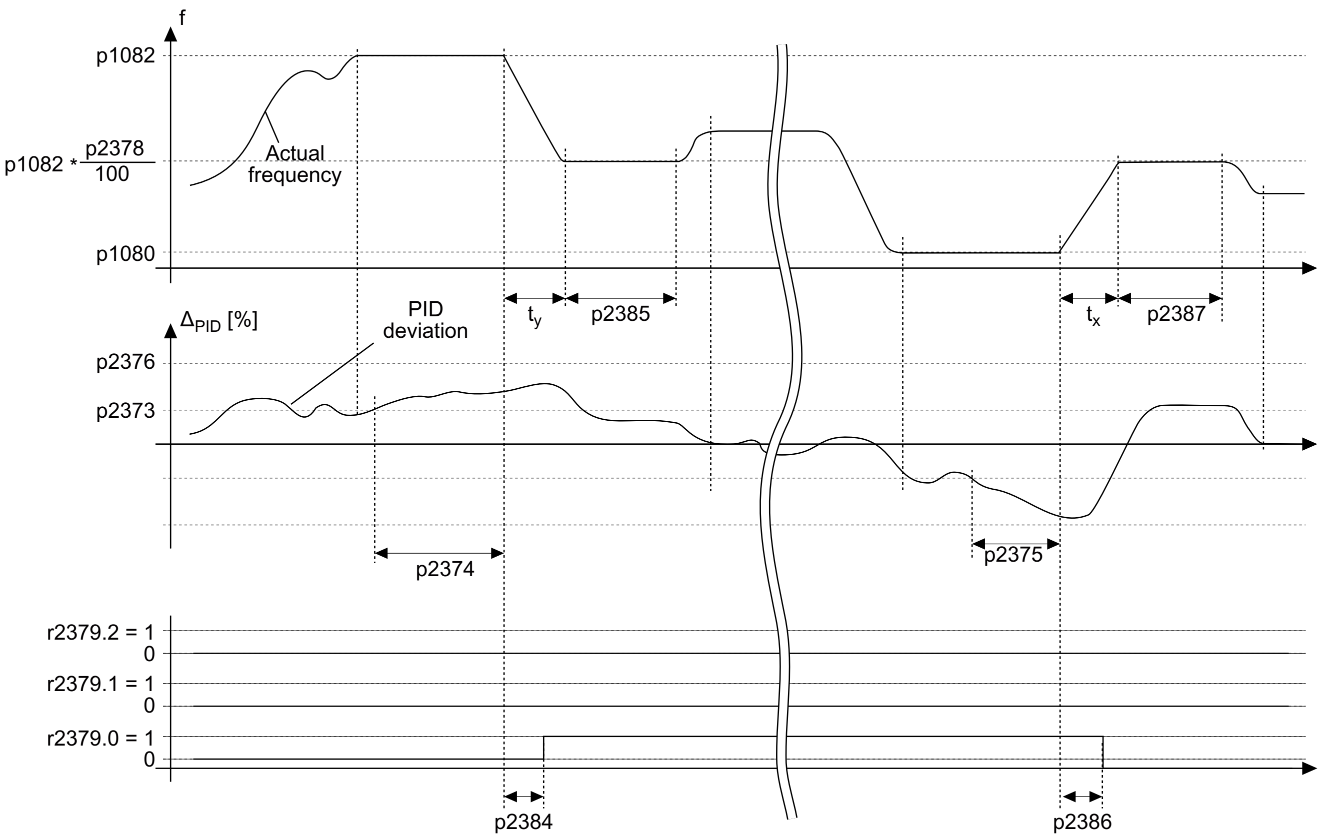
The PID deviation serves as the input signal for activating the other motors. The contactors or motor starters are switched by the inverter's digital outputs.

Operating principle

If the main drive is run at maximum speed and the deviation on the technology controller input continues to increase, the control also switches the external motors on the line.

At the same time the main drive is reduced to the staging speed (see p2378) using ramp down to keep the total output power as constant as possible. The technology controller is deactivated while ramping down to the staging speed.

If the main drive is running at minimum speed and the deviation on the technology controller input continues to decrease, the control switches external motors M1 to M3 off the line. At the same time the main drive is increased to maximum speed (see p1082) using ramp up to keep the total output power as constant as possible.



The diagram shows the situation when the first motor is activated. If the PID deviation continues to increase for the period set in p2374 above that set in p2373 after the second motor has been activated, another motor is activated.

The motors are deactivated in the same way.

Controlling the activation and deactivation of motors

Use p2371 to determine the order of activation/deactivation for the individual external motors.

Table 7- 40 Order of activation for external motors depending on setting in p2371

p2371	Significance	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	Staging deactivated	---					
1	One motor can be activated	M1					
2	Two motors can be activated	M1	M1+M2				
3	Two motors can be activated	M1	M2	M1+M2			
4	Three motors can be activated	M1	M1+M2	M1+M2+M3			
5	Three motors can be activated	M1	M3	M1+M3	M1+M2+M3		
6	Three motors can be activated	M1	M2	M1+M2	M2+M3	M1+M2+M3	
7	Three motors can be activated	M1	M1+M2	M3	M1+M3	M1+M2+M3	
8	Three motors can be activated	M1	M2	M3	M1+M3	M2+M3	M1+M2+M3

Table 7- 41 Order of deactivation for external motors depending on setting in p2371

p2371	Activated motors	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
1	M1	M1					
2	M1+M2	M1+M2	M1				
3	M1+M2	M1+M2	M2	M1			
4	M1+M2+M3	M1+M2+M3	M1+M2	M1			
5	M1+M2+M3	M1+M2+M3	M3+M1	M3	M1		
6	M1+M2+M3	M1+M2+M3	M3+M2	M2+M1	M2	M1	
7	M1+M2+M3	M1+M2+M3	M3+M1	M3	M2+M1	M1	
8	M1+M2+M3	M1+M2+M3	M3+M2	M3+M1	M3	M2	M1

If you are using motors of the same power rating, you can use p2372 to define whether the motors are to be activated following the setting specified in p2371 (p2372 = 0), or whether the activation is to be controlled using the inverter's operating hours.

Parameters for setting and activating the motor staging function:

Table 7- 42 Parameters for setting and activating the motor staging function

p2369	**Staging control word** Signal source for "Staging" selection.
p2370	**Staging enable** Signal source for staging On/Off
p2371	**Staging configuration** Activate staging and define order of activation
p2372	**AutoChange staging mode** Define automatic motor activation
p2373	**Staging switch-on threshold** Define switch-on threshold
p2374	**Staging delay time** Define delay time
p2375	**Destaging delay time** Define delay time for destaging
p2376	**Staging override threshold** Define override threshold
p2377	**Staging interlock time** Define interlock time
p2378	**Staging / destaging speed** Define staging / destaging speed
r2379	**Staging status word**
p2380	**Staging operating hours**
p2381	**Staging time limit for continuous operation**
p2382	**Staging absolute operating time limit**
p2383	**Staging stop mode** Define deactivation order for OFF command
p2384	**Staging motor ON delay** Define motor ON delay
p2385	**Staging speed holding time** Define speed holding time after activation of an external motor
p2386	**Staging motor OFF delay** Define motor OFF delay
p2387	**Destaging speed holding time** Define speed holding time after shutdown of an external motor

For more information about the parameters, see the List Manual.

7.10.6 Bypass

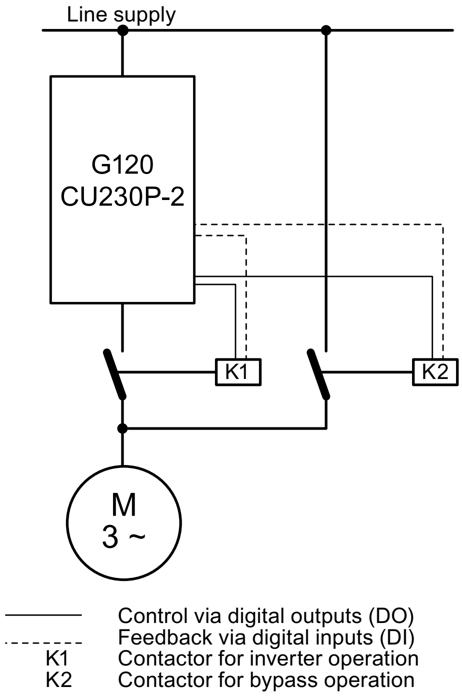
Description

In the bypass function, the motor is either operated by the inverter or directly on the line.

The bypass control can either be realized depending on the speed via the inverter or independently of the speed via a signal from the inverter or via a higher-level control.

If the bypass is controlled by a higher-level control, the control must lock the contactors so they cannot switch on at the same time.

If controlled by inverter, the digital outputs are used to activate two contactors via which the motor is powered. The inverter is provided with contactor position feedback via the digital inputs. This is evaluated. If using direct connection logic (high level = ON), both contactors should be NO contacts.



Bypass circuit for control using the inverter

Note

Flying restart must be activated for the bypass function (p1200 = 1 or 4).

Changeover operation between line and inverter operation

At changeover to line operation, contactor K1 is opened (after the inverter pulses have been inhibited). The system then waits for the motor de-excitation time to elapse, after which contactor K2 is closed, connecting the motor directly to the line supply.

When the motor is switched to the line supply, an equalizing current flows that must be taken into account when the protective equipment is selected and dimensioned.

When changing over to inverter operation, initially contactor K2 must be opened and after the de-excitation time, contactor K1 is closed. The inverter then captures the rotating motor and the motor is operated on the inverter.

Bypass function when activating via a control signal (p1267.0 = 1)

The status of the bypass contactors is evaluated when the inverter is switched on. If the automatic restart function is active (p1210 = 4) and an ON command (r0054.0 = 1) as well as the bypass signal (p1266 = 1) are still present at power up, then after power up, the inverter goes into the "ready and bypass" state (r899.0 = 1 and r0046.25 = 1) and the motor continues to run directly connected to the line supply.

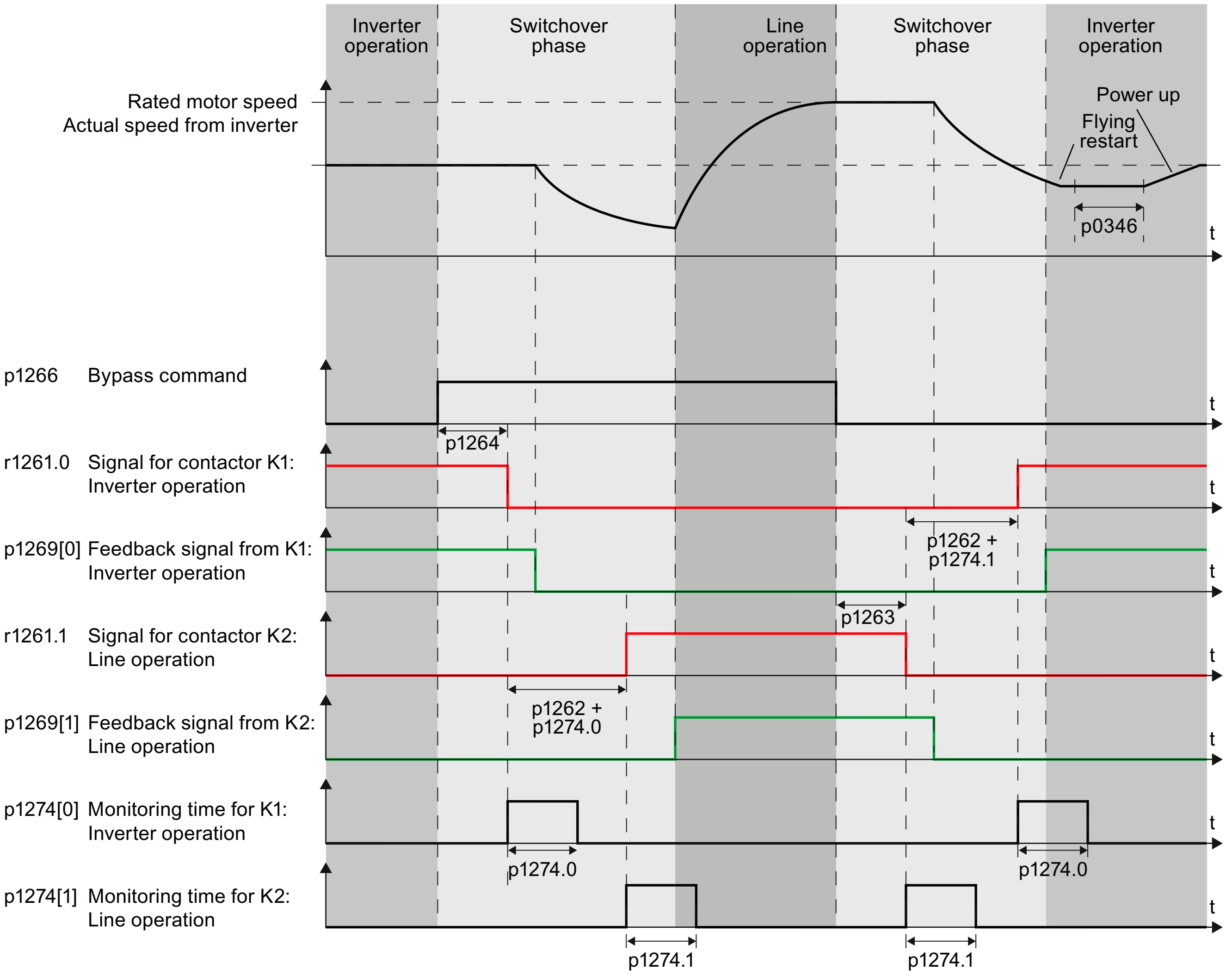


Figure 7-12 Bypass control independent of the speed via a control signal (p1267.0 = 1)

Bypass function is dependent on the speed (p1267.1 = 1)

With this function, changeover to line operation is realized corresponding to the following diagram, if the setpoint lies above the bypass threshold.

If the setpoint falls below the bypass threshold, the inverter captures the motor and the motor is fed from the inverter.

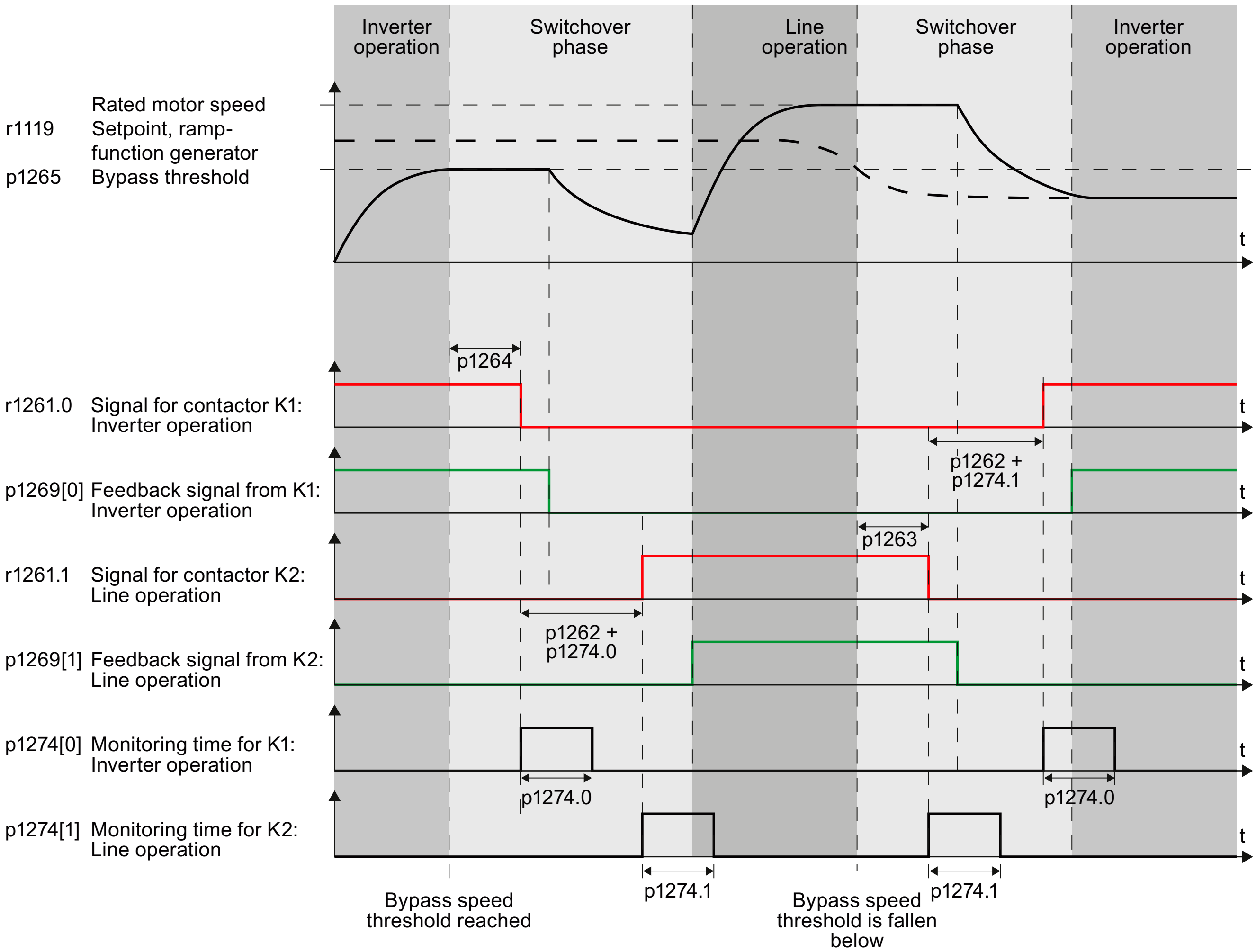


Figure 7-13 Switchover behavior from inverter to line operation dependent on the speed

General properties of the bypass function

- The two motor contactors must be designed for switching under load.
- Contactor K2 must be designed for switching an inductive load.
- Contactors K1 and K2 must be mutually interlocked so that they cannot close at the same time.

Shutdown behavior in bypass operation

- If the motor is in the bypass mode, it cannot be shutdown with OFF 1. The motor coasts down after an OFF2 or OFF3.
- If the motor is running in the bypass mode and the inverter is disconnected from the line supply, then also the bypass contactor does not receive control signals from the inverter and the motor coasts down. If the motor is to continue running once the inverter is switched off, the signal for the bypass contactor must therefore come from the control.

Temperature monitoring and overload protection in the bypass mode

- If the motor is running in the bypass mode, while the inverter is in the "ready and bypass" state (r899.0 = 1 and r0046.25 = 1), then the motor temperature monitoring via the temperature sensor is active.
- If the motor is running in the bypass mode, while the inverter is in the "ready and bypass" state (r899.0 = 1 and r0046.25 = 1), then the overload protection for the motor must be realized on the plant or system side.

Parameters for setting the bypass function

Parameter	Description
p1260	**Bypass configuration** Activating the bypass function
r1261	**Bypass control/status word** Control and feedback signals for the bypass function.
p1262	**Bypass dead time** Changeover time for contactors. This should be longer than the motor's demagnetizing time!
p1263	**Debypass delay time** Delay time for switching back to inverter operation.
p1264	**Bypass delay time** Delay time for switching to bypass operation.
p1265	**Bypass speed threshold** Speed threshold for switching to bypass operation.
p1266	**Bypass control command** Signal source for switching to bypass operation.
p1267	**Bypass changeover source configuration** Switch to bypass operation using speed threshold or control signal.
p1269	**Bypass switch feedback** Signal source for contactor feedback for the bypass mode.
p1274	**Bypass switch monitoring time** Monitoring time setting for bypass contactors.

For more details about parameters, please refer to the List Manual.

7.10.7 Hibernation

Description - operation

The "Hibernation" function is mainly used for pumps and fans. Typical applications include pressure and temperature controls.

In the hibernation mode, the inverter stops and starts the motor depending on the system conditions. Hibernation can be activated via the technology controller (without external commands via terminals or bus interface) and via an external setpoint input.

Hibernation mode offers the advantages of energy saving, lowering mechanical wear and reduced noise.

Note

Restrictions in entering a setpoint in the hibernation mode

In the hibernation state, the impulses are inhibited and it is not possible to enter a setpoint via the MOP as the MOP signal cannot withdrawn the pulse inhibit.

This is the reason that the "hibernation" function is therefore not suitable for setpoint input via the MOP.

NOTICE
After the inverter has been powered-up, the motor goes into the hibernation mode if the hibernation start frequency has still not been reached after the highest value from p1120 (ramp-up time), p2391 (hibernation delay time) and 20 s has expired.

Operating principle

Hibernation mode starts as soon as the absolute motor speed drops below the hibernation start speed. However, the motor is only switched off after an adjustable time has expired. If, during this time, the speed setpoint rises above the hibernation start speed due to pressure or temperature changes, hibernation is exited and the inverter functions in normal operation.

In the hibernation mode, the motor is shut down; however, the speed setpoint and/or the technology controller deviation are monitored.

- **For an external setpoint input (without technology controller) the speed setpoint is monitored** and the motor is switched-on again as soon as the setpoint increases above the restart speed. The restart speed is calculated as follows: Restart speed = P1080 + p2390 + p2393.

  In the factory setting, the absolute value of the speed setpoint is monitored, i.e. the motor is switched-on as soon as the setpoint exceeds the restart speed, independent of the direction of rotation.

  If the direction of rotation is also to be monitored, then the monitoring must be limited to one direction of rotation. This can be set e.g. using p1110 = 1 (block monitoring of the negative direction of rotation). Additional setting options are described in the parameter list, in function block diagrams 3030 and 3040 as well as in the associated parameter descriptions.

- When the setpoint is entered from the technology controller, the technology controller deviation (r2273) is monitoredand the motor is switched-on if the deviation of the technology controller exceeds the hibernation restart value (2392).

  In the factory setting, the deviation of the technology controller absolute value is monitored, i.e. the motor is switched-on as soon as the technology controller deviation is greater than the hibernation restart value (p2392) - independent of the sign.

  If, for example, the motor should only be switched-on again for a positive technology controller deviation, then the monitoring of the deviation in the negative direction must be disabled. This can be done by setting p2298 to 0. Additional setting options are provided in the parameter list in function block diagram 7958 and in the associated parameter descriptions.

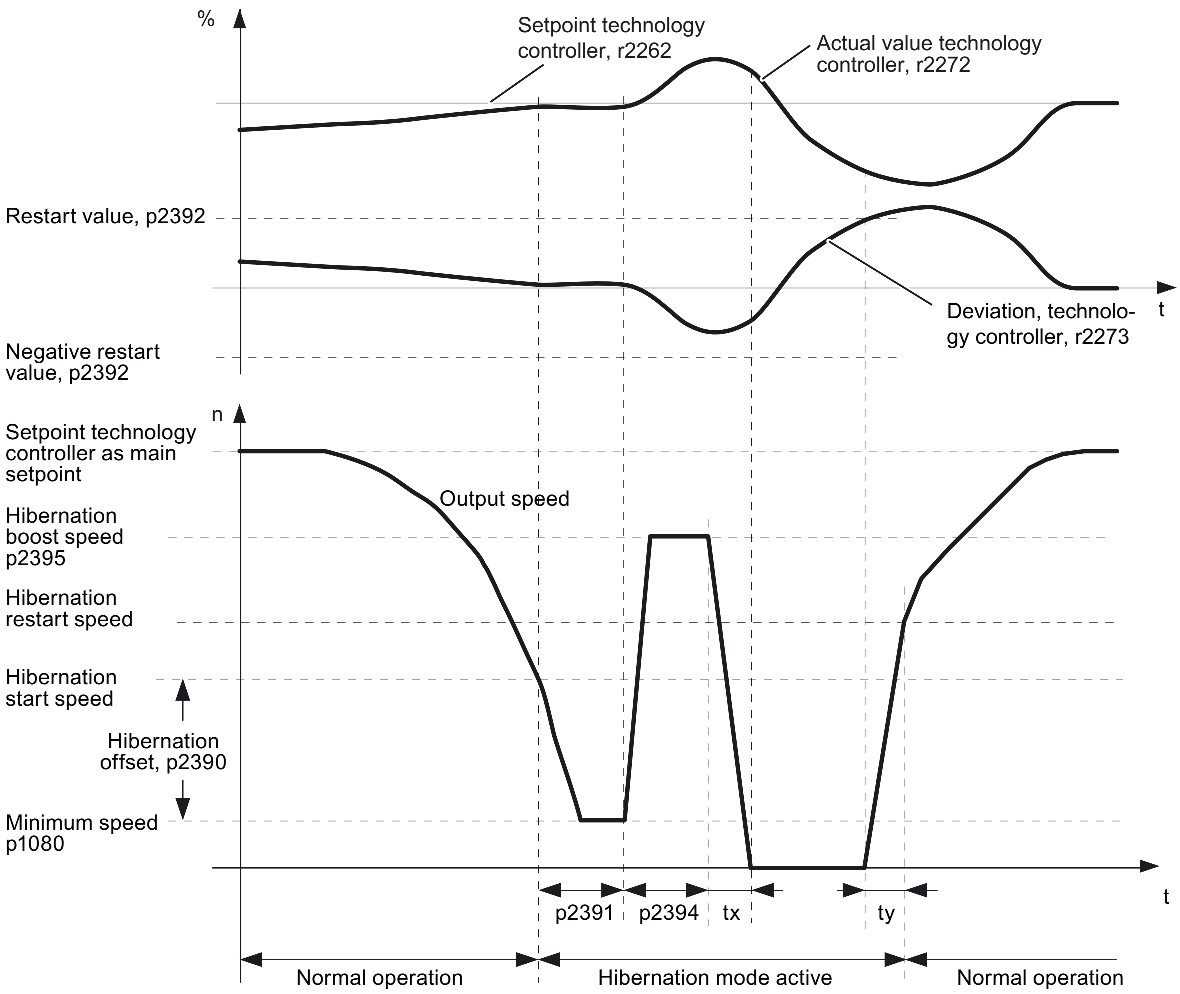
In order to prevent frequent startups and shutdowns, the speed may be boosted for a short time before shutdown (hibernation boost). This function can be disabled by setting the time for the hibernation boost (p2394) to 0.

To avoid tank deposits, particularly where liquids are present, it is possible to exit hibernation mode after an adjustable time (p2396) has expired and to switch to normal operation.

The parameter settings required for the respective variant can be found in the following tables.

Hibernation with setpoint input using the internal technology controller

In this operating mode, the technology controller must be activated as the setpoint source (p2200) and used as the main setpoint (p2251). The function can be operated both with and without the hibernation boost.



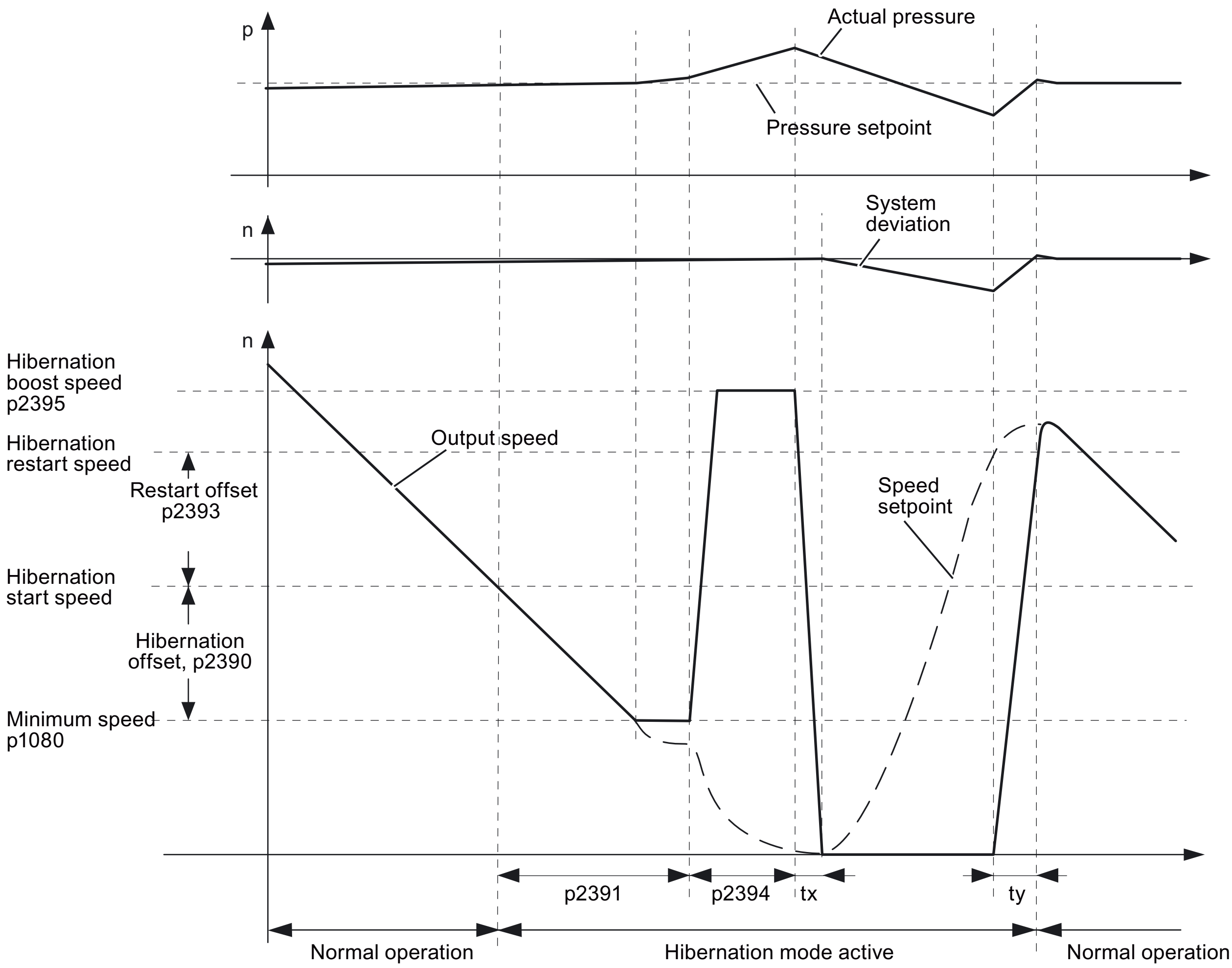
Hibernation restart speed = p1080+p2390)*1.05(
Hibernation start speed = p1080 + p2390

tx = p2395 / p1082*p1121
ty = Hibernation restart speed / p1082*p1120

Figure 7-14 Hibernation using the technology setpoint as the main setpoint with the hibernation boost

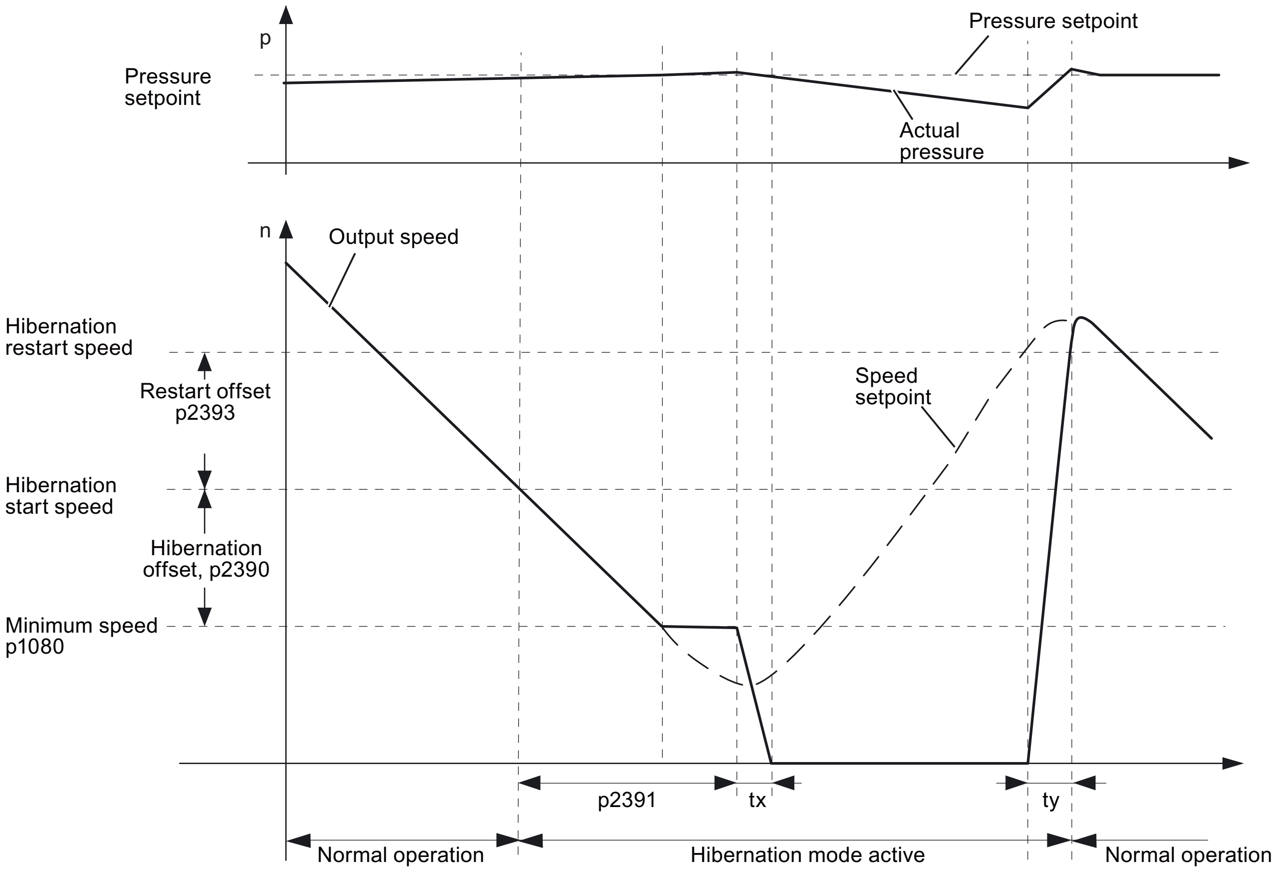
Hibernation with external setpoint input

In this operating mode, the setpoint is specified by an external source (e.g. a temperature sensor); the technology setpoint can be used here as a supplementary setpoint.



Hibernation restart speed = 1080 + p2390 + p2393 tx = p2395 / p1082 * p1121
Hibernation start speed = p1080 + p2390 ty = Hibernation restart speed / p1082 * p1120

Figure 7-15 Hibernation using an external setpoint with hibernation boost



Hibernation restart speed = 1080 + p2390 + p2393
Hibernation start speed = p1080 + p2390

tx = p1080 / p1082 * p1121
ty = Hibernation restart speed / p1082 * p1120

Figure 7-16 Hibernation using an external setpoint without hibernation boost

Adjustable parameters for the hibernation mode function

Table 7- 43 Main function parameters

Parameters	Description	Via tech. setpoint	Via external setpoint
P1080 = …	**Minimum speed** 0 (factory setting) … 19500 rpm. Lower limit of the motor speed is independent of the speed setpoint.	x	x
P1110 = …	**Block negative direction** Parameter to block the negative direction	-	x
P2200 = …	**Technology controller enable** 0: Technology controller deactivated (factory setting), 1: Technology controller activated	x	-
P2251 = 1	**Technology controller mode** 0: Technology controller as main setpoint (factory setting), 1: Technology controller as supplementary setpoint	x	-
p2298 = …	**Technology controller minimum limiting** Parameter for the minimum limiting of the technology controller	x	-

Parameters	Description	Via tech. setpoint	Via external setpoint
P2398 = …	**Hibernation mode** 0: Hibernation disabled (factory setting) 1: Hibernation enabled	x	x
P2390 = …	**Hibernation start speed** 0 (factory setting) … 21000 rpm. As soon as this speed is fallen below, the hibernation delay time starts and switches-off the motor once it expires. The hibernation start speed is calculated as follows: Start speed = P1080 + p2390 P1080 = minimum speed p2390 = hibernation start speed.		
P2391 = …	**Hibernation delay time** 0 ... 3599 s (factory setting 120). The hibernation delay time starts as soon as the output frequency of the inverter drops below the hibernation start speed p2390. If the output frequency increases above this threshold during the delay time, the hibernation delay time is interrupted. Otherwise, the motor is switched off after the delay time has expired (if necessary, after a short boost).	x	x
P2392 = …	**Hibernation restart value** required if the technology controller is used as the main setpoint. The restart value p2392 should be specified as a %. As soon as the technology controller deviation (r2273) exceeds the hibernation restart value, the inverter switches to normal operation and the motor starts up with a setpoint of 1.05 * (p1080 + p2390). As soon as this value is reached, the motor continues to operate with the setpoint of the technology controller (r2260).	x	-
P2393 = …	**Hibernation restart speed (rpm),** required in the case of external setpoint input. The motor starts as soon as the setpoint exceeds the restart speed. The restart speed is calculated as follows: Restart speed = P1080 + p2390 + p2393 P1080 = minimum speed p2390 = hibernation start speed p2393 = hibernation restart speed	-	x
P2394 = …	**Hibernation boost duration** 0 (factory setting) … 3599 s. Before the inverter switches over to hibernation mode, the motor is accelerated for the time set in p2394 according to the acceleration ramp, but not to more than the speed set in P2395.	x	x
P2395 = …	**Hibernation boost speed** 0 (factory setting) … 21000 rpm. Before the inverter switches over to hibernation mode, the motor is accelerated for the time set in p2394 according to the acceleration ramp, but not to more than the speed set in P2395. **Caution:** Make sure that the hibernation boost does not cause any overpressure or overflows.	x	x
P2396 = …	**Maximum hibernation shutdown time** 0 (factory setting) … 863999 s. At the expiration of this time at the latest, the inverter switches to normal operation and is accelerated up to the start speed (P1080 + P2390). If the inverter is switched to normal operation in advance, the shutdown time is reset to the value set in this parameter. With p2396 = 0, automatic changeover to normal operation after a certain time is deactivated.	x	x

Display parameters

Parameters	Description
r2273	Display of the setpoint/actual value deviation of the technology controller
r2397	Actual hibernation output speed Actual boost speed before the pulses are inhibited or the actual start speed after restart.
r2399	Hibernation status word 00 Hibernation enabled (P2398 <> 0) 01 Hibernation active 02 Hibernation delay time active 03 Hibernation boost active 04 Hibernation motor switched off 05 Hibernation motor switched off, cyclical restart active 06 Hibernation motor restarted 07 Hibernation supplies the total setpoint of the ramp-function generator 08 Hibernation bridges the ramp-function generator in the setpoint channel

7.11 Switchover between different settings

7.11.1 Changing over the command data sets (manual, automatic)

Switching over master control

In some applications, the inverter is operated from different locations.

Example: Switchover from the automatic mode into the manual mode
A central control can switch a motor on/off or change its speed either via a fieldbus or via local switches. A key-operated switch close to the motor can be used to switch the master control of the inverter from "control via fieldbus" to "local control".

Command data set (CDS)

The inverter offers options to parameterize the settings for the command sources, setpoint sources and status messages (with the exception of analog outputs) in up to four different ways. The associated parameters are indexed (index 0, 1, 2 or 3). When the inverter is operational, control commands select one of the four indices and therefore one of the four settings that has been saved. This means that as described in the example above, the master control of the inverter can be switched over.

All of the switchable parameters for command sources, setpoint sources and status messages with the same index are known as a "command data set".

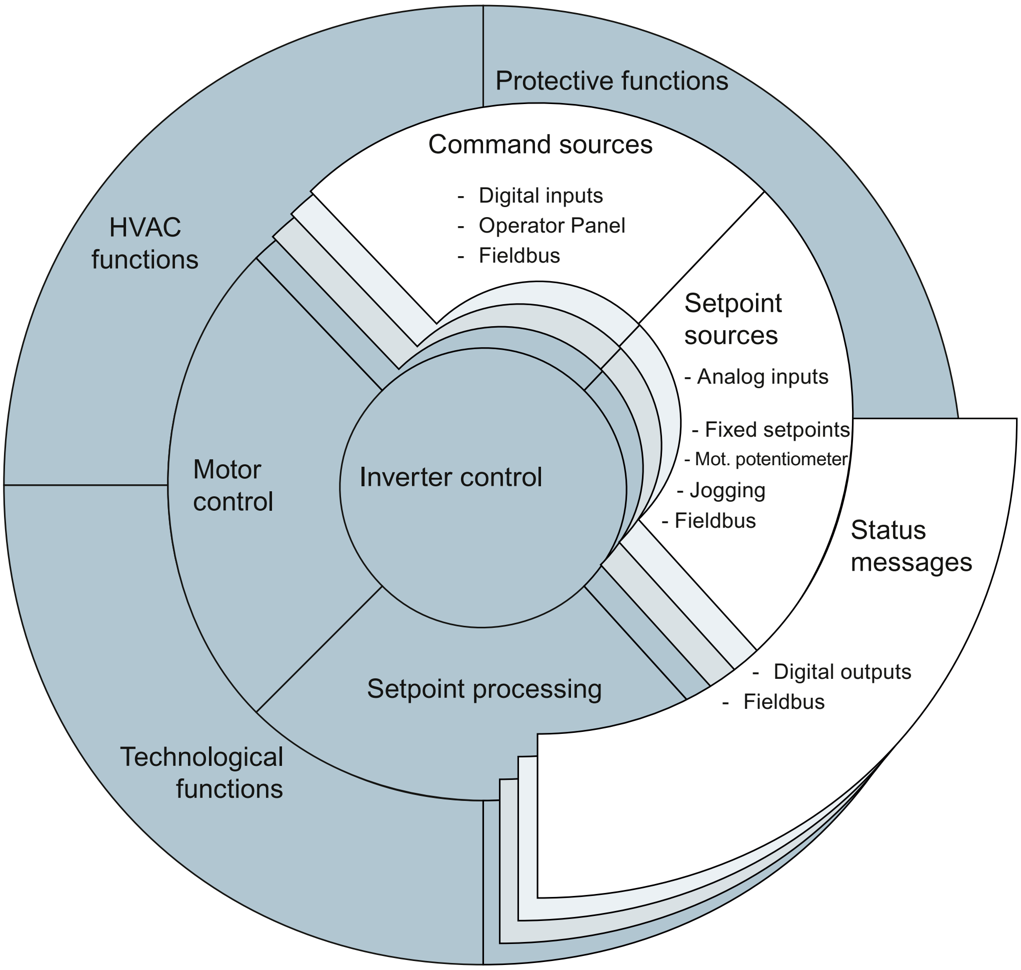


Figure 7-17 CDS switchover in the inverter

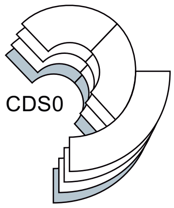
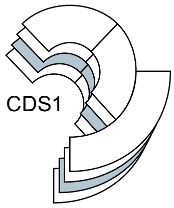
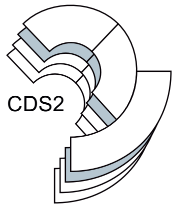
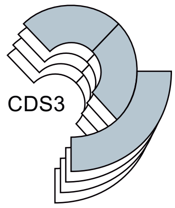
Use parameter P0170 to define the number of command data sets (2, 3 or 4).

Table 7- 44 Selecting 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

The command data sets are switched over using parameters P0810 and P0811. Parameters P0810 and P0811 are interlinked to control commands, e.g. the digital inputs of the inverter, using BICO technology.

Table 7- 45 Command data set changeover using parameters P0810 and P0811.

Status of binector P0810	0	1	0	1
Status of binector P0811	0	0	1	1
The command data set that is presently active has a gray background.			 CDS2 is only available when P0170 = 3 or 4	 CDS3 is only available when P0170 = 4
Selected parameter index	0	1	2	3
Examples	Fieldbus as setpoint source: The speed setpoint is specified via the fieldbus.	Analog input as setpoint source: The speed setpoint is specified via an analog input	-	-
	Fieldbus as command source: The motor is switched on/off via the fieldbus.	Digital inputs as command source: The motor is switched on/off via digital inputs	-	-

Note

Command data sets can be switched over in the "ready for operation" and "operation" state. The switchover time is approx. 4 ms.

Table 7- 46 Parameters for switching the command data sets

Parameter	Description
P0810	**1st control command for switching the command data sets** Example: When P0810 = 722.0, the system switches from command data set 0 to command data set 1 via digital input 0.
P0811	**2nd control command for switching the command data sets**
r0050	**Displaying the number of the CDS that is currently active**

For an overview of all the parameters that belong to the drive data sets and can be switched, see the Parameter Manual.

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

Table 7- 47 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	Start copying Once the data has been copied, p0809[2] is automatically set to 0
Example	
P0809[0] = 0	The parameters of command data set 0 are copied to command data set 1
P0809[1] = 1	
P0809[2] = 1	

7.11.2 Switching over drive data sets (different motors connected to an inverter)

When the drive's properties change, the inverter's parameterization must be changed.

Example: Operating different motors on one inverter
One inverter should operate one of two different motors. Depending on which motor is to run at any given time, the motor data and the ramp-function generator times for the different motors must be adjusted accordingly in the inverter.

Drive data sets (DDS)

The inverter provides the possibility of parameterizing the following functions in up to four different ways:

1. Setpoint sources
   (exceptions: Analog inputs and fieldbus)
2. Setpoint processing
3. Motor control
4. Motor and inverter protection
5. Technological functions
   (Exception: Technology controller, brake control, automatic restart and unassigned function blocks)

The associated parameters are indexed (index 0, 1, 2 or 3). Control commands select one of the four indices and therefore one of the four saved settings.

This means, that as described in the example above, you can switch over all of the settings of the inverter matching the particular motor.

The term "command data set" is used to indicate all of the switchable parameters of the five functions mentioned above with the same index.

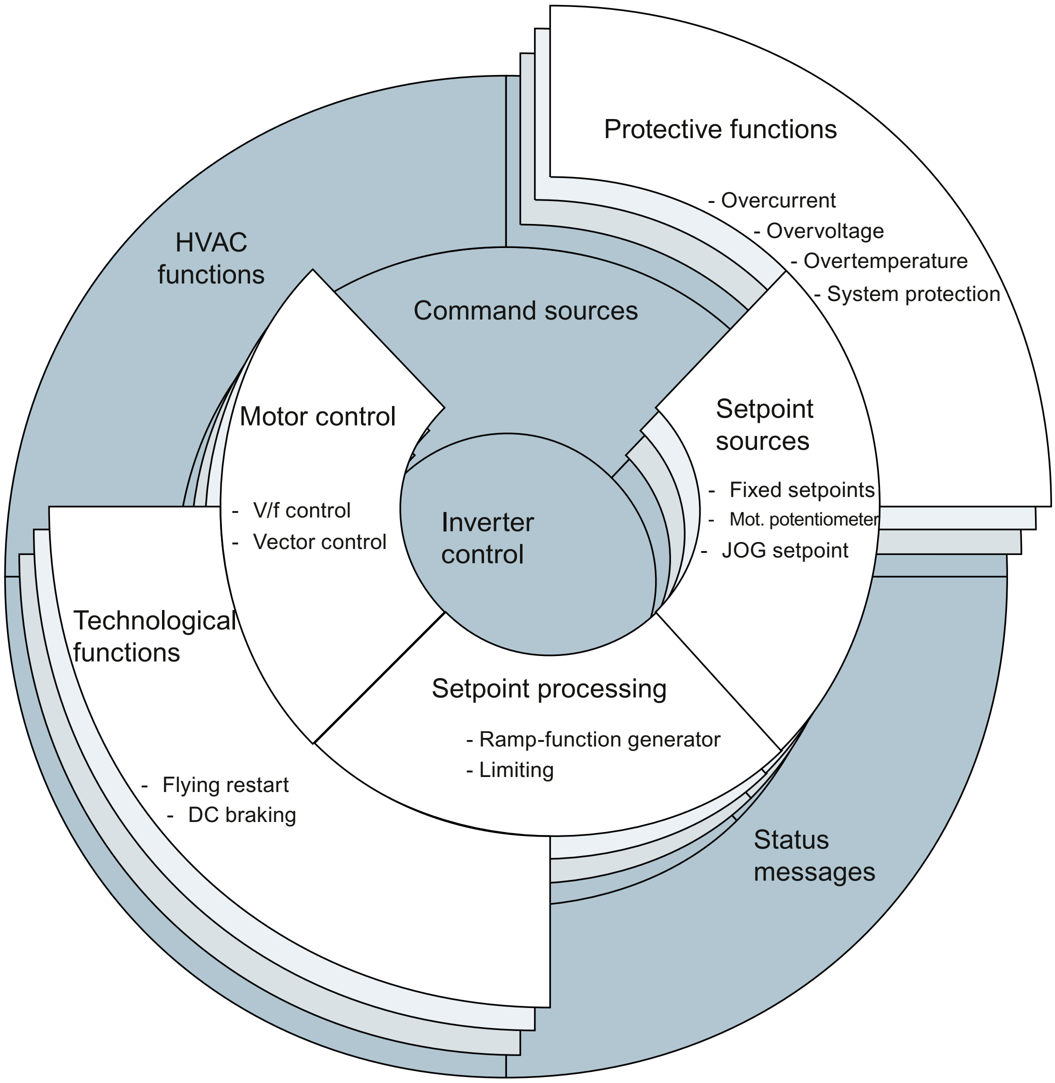


Figure 7-18 DDS switchover in the inverter

Use parameter P0180 to define the number of command data sets (2, 3 or 4).

Table 7- 48 Selecting the number of command data sets

Parameter	Description
P0010 = 15	**Drive commissioning:** Data sets
P0180	**Number of drive data sets** (factory setting: 1) P0180 = 1, 2, 3 or 4
P0010 = 0	**Drive commissioning:** Ready

The drive data sets are switched over using parameters P0820 and P0821. Parameters P0820 and P0821 are interlinked to control commands, e.g. the digital inputs of the inverter, using BICO technology.

Table 7- 49 Parameters for switching the drive data sets:

Parameter	Description
P0820	**1st cntrol command for switching the drive data sets** Example: When P0820 = 722.0, the system switches from drive data set 0 to drive data set 1 via digital input 0
P0821	**2nd control command for switching the drive data sets**
P0826	**Motor switchover, motor number** If the motor is to be switched over at the same time as the data set, different motor numbers should be used. If this happens, the data set can only be switched over under pulse inhibit.
r0051	**Displaying the number of the DDS that is currently effective**

Note

The motor data of the drive data sets can only be changed over in the "ready for operation" state. The switchover time is approx. 50 ms.

If you do not switch motor data over along with the drive data sets (i.e. same motor number in P0826), you can switch the drive data sets over during operation.

For an overview of all the parameters that belong to the drive data sets and can be switched, see the Parameter Manual.

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

Table 7- 50 Parameters for copying the drive data sets

Parameter	Description
P0819[0]	Number of the drive data set to be copied (source)
P0819[1]	Number of the drive data to which the data is to be copied (target)
P0819[2] = 1	Start copying
Example	
P0819[0] = 0	The parameters of drive data set 0 are copied to drive data set 1
P0819[1] = 1	
P0819[2] = 1	

8 Service and maintenance

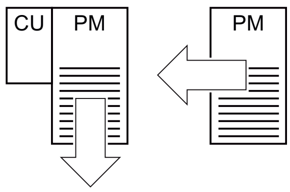
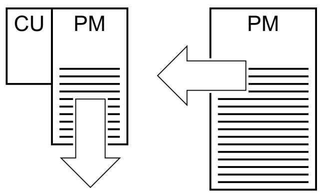
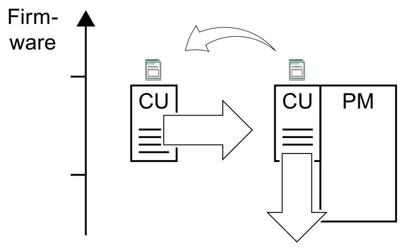
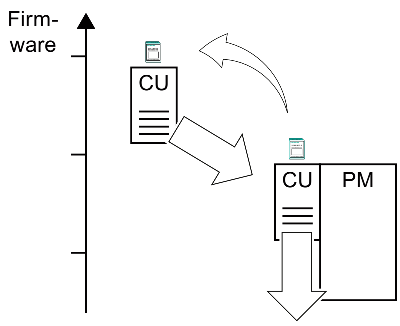
8.1 Behavior of the frequency inverter when replacing components

In the event of a long-term function fault, you can replace the inverter's Power Module or Control Unit separately. In many cases, you can switch the motor back on again straight after the replacement.

Replacing components without recommissioning the drive

In the scenarios listed below, the inverter can be used straight after components have been replaced:

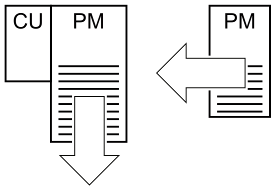
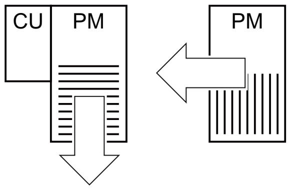
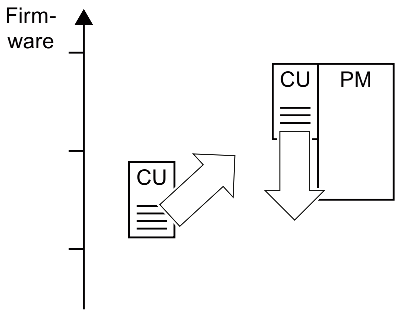
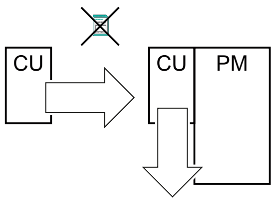
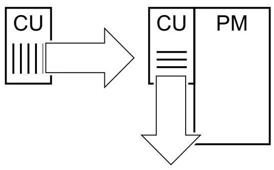
Table 8- 1 Replacing components where recommissioning is not needed

Component replacement		Note
	Replacing Power Module with a Power Module • of the same type and • same power rating	-
	Replacing Power Module with a Power Module • of the same type and • *greater* power rating	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)
	Replacing Control Unit with memory card with a Control Unit • of the same type and • same firmware version	The settings, which are saved on the memory card of the CU that has been replaced, are transferred into the new CU
	Replacing Control Unit with memory card with a Control Unit • of the same type and • *higher* firmware version: (e.g. replacing a CU with FW V4.2 by a CU with FW V4.3)	

Replacing components where recommissioning is needed

In the cases below, you will need to reparameterize the inverter when the components have been replaced:

Table 8- 2 Replacing components after which recommissioning is needed

Component replacement	
	Replacing Power Module with a Power Module • of the same type and • *lower*power rating
	Replacing Power Module with a Power Module of a *different* type (e.g. replacing a PM240 with a PM250)
	Replacing Control Unit with a Control Unit • of the same type and • *lower* firmware version (e.g. replacing a CU with FW V4.3 with a CU with FW V4.2)
	Replacing Control Unit *without* a memory card
	Replacing Control Unit with a Control Unit of a *different* type (e.g. replacing a CU230P-2 with a CU240E-2 DP)

8.2 Replacing the Control Unit

Procedure for replacing a Control Unit with a memory card

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply to the Control Unit.
2. Remove the signal cables of the Control Unit
3. Remove the defective CU from the Power Module.
4. Plug the new CU on to the Power Module.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
6. Reconnect the signal cables of the Control Unit.
7. Connect up the line voltage again.
8. The inverter 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.
9. For Control Units of the same type and an equal or higher firmware version, you can switch on the inverter without any additional commissioning.
   Alarm A01028 will be output for Control Units of different types. This alarm indicates that the parameter settings are not compatible with the CU. In this case, delete the message using p0971 = 1 and recommission the drive.

Procedure for replacing a Control Unit without a memory card

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply to the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective CU from the Power Module.
4. Plug the new CU on to the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Connect up the line voltage again.
7. The inverter goes into the "ready-to-switch-on" state.
8. Recommission the drive.

8.3 Replacing the Power Module

You can replace the Power Module without interrupting Control Unit communication with the higher-level control. The CU must however be supplied by its own 24V supply.

Procedure when replacing the Power Module with 24V Control Unit supply

Proceed as follows if you do not for example want to interrupt Control Unit bus communication during replacement:

1. Disconnect the Power Module from the line supply without switching off the 24V supply of the Control Unit.
2. After switching off the line voltage, wait 5 minutes until the Power Module has discharged.
3. Remove the line supply cables of the Power Module.
4. Remove the Control Unit from the power unit.
5. Replace the old Power Module with the new Power Module.
6. Snap the Control Unit onto the new Power Module.
7. Correctly connect the line supply cables to the new Power Module.
8. Switch on the supply voltage.
9. If necessary, recommission. See section Behavior of the frequency inverter when replacing components (Page 275).

Procedure when replacing the Power Module without the 24V supply of the Control Unit.

Proceed as follows if the Control Unit does not have its own 24V supply:

1. Switch off the supply voltage to the Power Module.
2. After switching off the line voltage, wait 5 minutes until the device has discharged itself.
3. Remove the line supply cables of the Power Module.
4. Remove the Control Unit from the power unit.
5. Replace the old Power Module with the new Power Module.
6. Snap the Control Unit onto the new Power Module.
7. Correctly connect the line supply cables to the new Power Module.
8. Switch on the supply voltage.
9. If necessary, recommission. See section Behavior of the frequency inverter when replacing components (Page 275).

Alarms, faults and system messages 9

9.1 Indicators (LEDs)

The inverter has the following diagnostic types:

- LED

  You can obtain an overview of the inverter state locally at the Control Unit LED.

- Alarms and faults

  Alarms and faults have a unique number. The inverter displays the numbers on the Operator Panel and via STARTER - or signals them to a higher-level control.

9.2 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 on the Control Unit indicate the inverter state.

LED RDY and LED BF displays

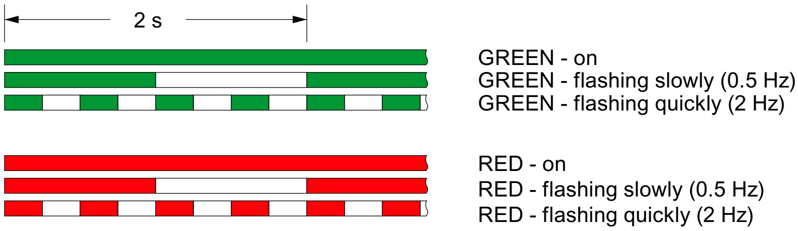


Table 9- 1 Inverter diagnostics

LED		Explanation
RDY	BF	
GREEN - on	---	Ready for operation (no active fault)
GREEN - slow	OFF	Commissioning or reset to factory settings
RED - on	OFF	Firmware update in progress
RED - fast	---	General fault
RED - fast	RED - on	Fault during firmware update
RED - fast	RED - fast	Incompatible firmware / incorrect memory card

Table 9- 2 Communication diagnostics via RS485

LED BF	Explanation
OFF	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

LED BF display on the CU230P-2 CAN

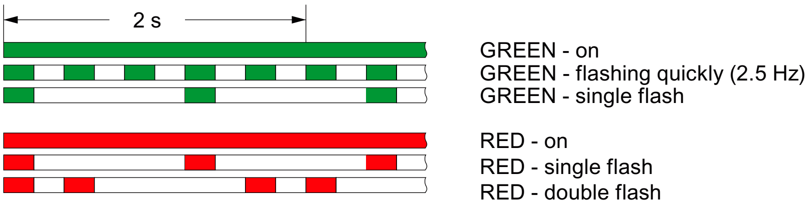


Table 9- 4 Communication diagnostics via CANopen

BF LED	Explanation
GREEN - on	Bus state "Operational"
GREEN - fast	Bus state "Pre-Operational" (flashing)
GREEN - single flash	Bus state "Stopped"
RED - on	No bus
RED - single flash	Alarm - limit reached
RED - double flash	Error event in control (Error Control Event)

9.3 Alarms

Alarms have the following properties:

- They do not have a direct effect in the inverter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - at the Operator Panel with a Axxxxx
  - via STARTER, if you click on TAB at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm. You can access the alarm code and alarm value using display parameters.

Alarm buffer

For each incoming alarm, the inverter saves the alarm, alarm value and the time that the alarm was received.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		I32	Float	Days	ms	Days	ms

Figure 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 Real Time Clock (Page 242).

As soon as the alarm has been removed, the inverter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 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 time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3. Alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4. Alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5. Alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6. Alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7. Alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 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.

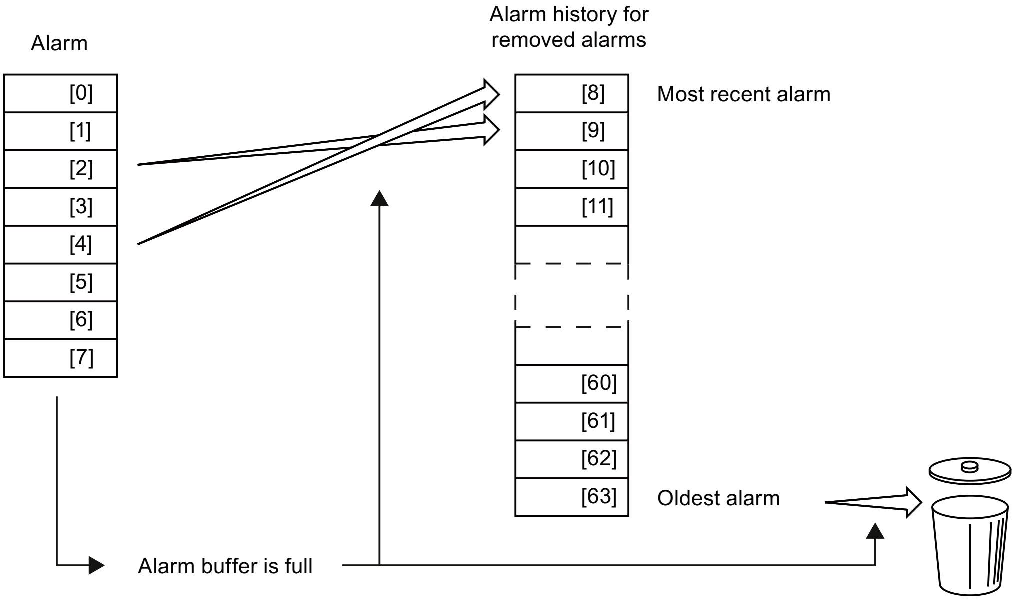


Figure 9-4 Shifting alarms that have been removed into the alarm history

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

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 [0...7] are transferred into the alarm history [8...63]
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

NOTICE
You may only change the following settings if you precisely know the significance of the parameters and the effect of the change. You will find details in function block diagram 8075 and in the parameter description of the Parameter Manual.

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

9.4 List of warnings

Number	Cause	Remedy
A01028	Configuration error	Explanation: Parameterization on the memory card has been produced with a different type of module (order number, MLFB) Check the module parameters and recommission if necessary
A01590	Motor maintenance interval lapsed	Undertake 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
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
A03520	Temperature sensor fault	Check that the sensor is connected correctly
A05000 A50001	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?
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)
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
A07903	Motor speed deviation	Increase p2163 and/or p2166 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)
A07927	DC brake active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults Establish missing enabling (see r00002, r0046)
A07991	Motor data identification activated	Switching-on the motor and identifying the motor data
A30920	Temperature sensor fault	Check that the sensor is connected correctly

You will find additional information in the parameter manual or in the online help of STARTER.

9.5 Faults

Faults have the following properties:

- In the factory setting, they immediately result in an OFF2 (the motor is switched-off and it coasts down)
- They must be acknowledged once the cause has been removed
- They are signaled 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, if you click on TAB at the bottom left of the STARTER screen

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Note

The inverter does not enter the "ready for switching on" state until all active faults have been eliminated and the faults acknowledged.

In order to pinpoint the cause of a fault, each fault has a unique fault code and in addition, a fault value. You access the fault code and fault value using display parameters.

Fault buffer of actual values

For each fault received, the inverter saves the fault code, fault value and the time of the fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
		I32	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 only written into parameters r2109 and r2136 after 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 Real Time Clock (Page 242).

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 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 time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 9-7 Complete fault buffer

Fault acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch the inverter off and then on again
- (switch off the main power supply and the external 24 V supply for the Control Unit and switch it 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 parameter manual.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

When acknowledging a fault, you shift the faults, whose cause has been removed, from the fault buffer into the fault history. When acknowledging, the associated time is written to parameters r2136 and r2109 (fault time removed).

The faults that still cannot be acknowledged remain in the fault buffer.

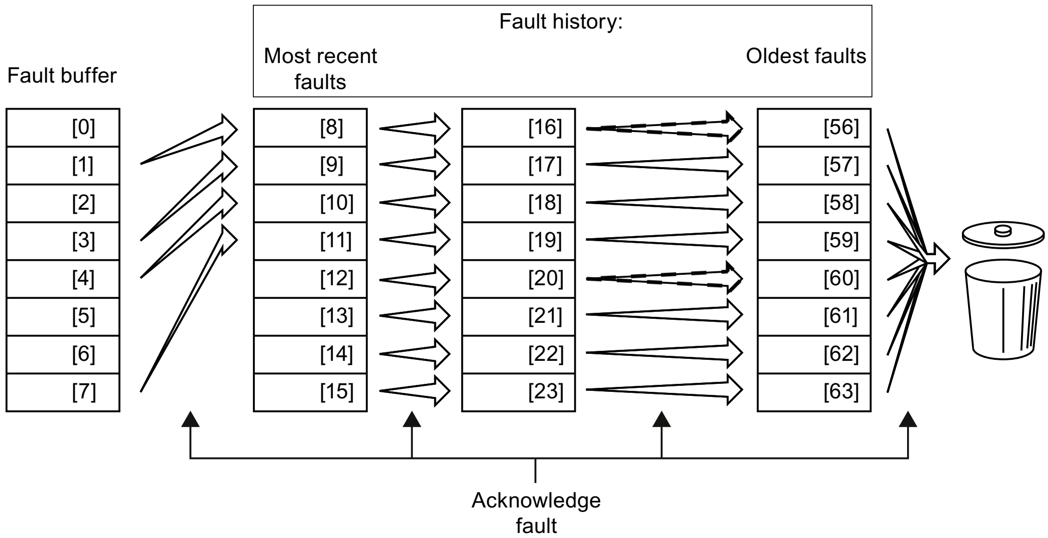

Figure 9-8 Fault history after acknowledging the faults

The first eight memory locations of the fault history (indices 8 … 15) now contain the youngest faults that have been acknowledged. If less than eight faults were shifted into the fault history, the memory locations with the higher indices remain empty.

The values previously saved in the fault history are shifted by eight indices. Faults, which were saved in indices 56 … 63 before the acknowledgement, are deleted.

Deleting the fault history

You have two options of deleting the complete fault history:

- Either you acknowledge the inverter eight times
- Or you 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 (p0700 and p1000) 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

NOTICE
You may only change the following settings if you precisely know the significance of the parameters and the effect of the change. You will find details in function block diagram 8075 and in the parameter description of the Parameter Manual.

Table 9- 8 Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	**Setting the fault number for fault response** Selecting the faults for which the fault response should be changed
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgement mode** Selecting the faults for which the acknowledgement type should be changed
p2127	**Setting, acknowledgement mode** Setting the acknowledgement type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgment after removing the fault cause
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	**Setting the message number for the message type** Selecting the message for which the message type should be selected
p2119	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

9.6 List of faults

Table 9- 9 The most important faults

Number	Cause	Remedy
F01910	Fieldbus SS setpoint timeout	Check the bus connection and communication partner, e.g. switch the PROFIBUS master to the RUN status
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.
F07011	Motor overtemperature	Reduce motor load Check ambient temperature Check sensor's wiring and connection
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly Check the parameterization (P0601) Deactivate the temperature sensor fault (P0607 = 0).
F07320	Automatic restart aborted	Increase number of hot restart attempts (P1211). The current number of start attempts is shown in r1214 Increase wait time in P1212 and/or monitoring time in P1213 Create ON command (P0840) Increase monitoring time of Power Module or switch off (P0857) Reduce the wait time for resetting the fault counter P1213[1] such that fewer faults are registered in the time interval
F07330	Search current measured too low	Increase search current (P1202), check motor connection
F07801	Motor overcurrent	Check current limits (P0640) Vector control: Check current controller (P1715, P1717) V/f control: Check 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 Module / motor combination Select flying restart function (P1200) if switched to rotating motor
F07806	Regenerative power limit exceeded	Increase deceleration ramp Reduce driving load Use Power Module with greater energy recovery capability During vector control, the regenerative power limit in P1531 can be reduced until the fault is no longer activated
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for this fault
F07900	Motor blocked	Check that the motor can run freely Check the torque limits (r1538 and r1539) Check the parameters of the "Motor blocked" message (P2175, P2177)
F07901	Motor overspeed	Activate precontrol of speed limiting controller (P1401 bit 7 = 1) Increase hysteresis for overspeed message P2162

Number	Cause	Remedy
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
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor's connection method (Y / Δ) • V/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: • V/f operation: Increase the acceleration ramp • Reduce the load • Replace the Power Module
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121) Set the rounding times (P1130, P1136) Activate the DC-link voltage controller (P1240, P1280) Check the line voltage (P0210) Check the line phases
F30003	DC-link voltage undervoltage	Check the line voltage (P0210)
F30004	Inverter overtemperature	Check whether the inverter fan is running Check whether the ambient temperature is in the permissible range Check whether the motor is overloaded Reduce the pulse frequency
F30005	I2t inverter overload	Check the rated currents of the motor and Power Module Reduce current limit P0640 When operating with U/f characteristic: Reduce P1341
F30011	Line phase failure	Check the inverter'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)
F30027	Time monitoring for DC link pre-charging	Check the supply voltage on the input terminals Check the line voltage setting (P0210)

You will find additional information in the Parameter Manual and in the online help of STARTER.

Table 9- 10 Faults which can only be acknowledged by switching off and on again

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU
F01004	Software fault in CU	Upgrade firmware or contact hotline
F01015	Software fault in CU	Upgrade firmware or contact hotline
F01018	CU power up aborted	Switch CU off and on again
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	A PROFIdrive telegram has been set (p0922). An interconnection contained in the telegram could not be established.	Establish other interconnection via BICO.
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 hotline
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware or contact hotline
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware or contact hotline
F30850	Software fault in Power Module	Replace Power Module or contact hotline

You will find additional information in the parameter manual or in the online help of STARTER.

Technical data 10

10.1 High Overload and Low Overload

Explanation of High Overload and Low Overload

For some inverters, different power ratings are specified for "High Overload" and "Low Overload".

Select the inverter corresponding to the duty cycle expected in operation. A duty cycle always refers to 300 s.

If no other specification is made when entering power data or if rated values are specified, then the Low Overload values are always specified.

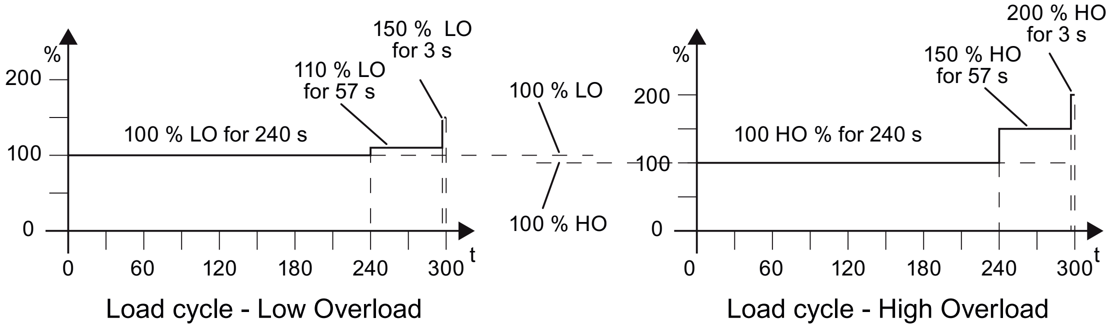

Figure 10-1 Duty cycle, High Overload and Low Overload

Note

Please note that 100 % power or current for Low Overload is higher than 100 % for High Overload.

The load characteristics shown in the diagram are examples. To select the Power Module on the basis of duty cycles, we recommend the "SIZER" engineering software. See section Overview of documentation (Page 12).

10.2 Technical data for CU230P-2

Table 10- 1 General technical data of the CU230P-2

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
Open-loop/closed-loop control procedure	V/f control for motor speeds between 0 rpm and 210000 rpm: • Linear V/f control, • Linear V/f control with FCC, • Linear V/f control with ECO mode, • Quadratic V/f control, • Multipoint V/f control, • V/f control for applications in the textile industry, • V/f control with FCC for applications in the textile industry, • V/f control with independent voltage setpoint, Vector control for motor speeds between 0 rpm and 14400 rpm: • Speed control without encoder • Torque control without encoder
Fixed speeds	16, parameterizable
Skip speeds	4, parameterizable
Digital inputs	• 6 digital inputs, DI 0 … DI 5, isolated; SIMATIC compatible, • Low < 5 V, high > 10 V, maximum input voltage 30 V, current consumption 5.5 mA • Switchable via terminals – PNP: Bridge terminal 69 with terminal 9 – NPN: Bridge terminal 69 with terminal 28 • Response time: 6 ms ± 1 ms without debounce time (p0724)
Analog inputs (differential inputs, resolution 12 bits)	• AI 0: Switchable (current/voltage), can be configured as additional digital inputs. 0 V … 10 V, 0 mA … 20 mA and -10 V … +10 V • AI 1: Switchable (current/voltage), can be configured as additional digital inputs. 0 V … 10 V and 0 mA … 20 mA • AI 2: Switchable (current / Ni1000) 0/4 mA … 20 mA and NI1000: - 50°C … 150 °C / PT1000: - 50 °C … 250 C • AI 3: (NI1000, PT1000) NI1000: - 50°C … 150 °C and PT1000: - 50 °C … 250 C • Response times of all AI: 13 ms ± 1 ms without debounce time (p0724)
Digital outputs / relay outputs	• DO 0: 30 V DC / max. 5 A with resistive load, 250 V AC / 2 A • DO 1: 30 V DC / max. 0.5 A with resistive load, protection from incorrect voltage polarity • DO 2: 30 V DC / max. 5 A with resistive load, 250 V AC / 2 A • Update time of all DO: 2 ms
Analog outputs	AO 0 and AO 1: 0 V … 10 V or 0 mA … 20 mA, update time: 4 ms
Dimensions (WxHxD)	73 mm x 199 mm x 65.5 mm
Weight	0.61 kg
Operating temperature	- 10°C … +60 °C (possible restrictions as a result of the Power Module should be observed)
Storage temperature	- 40°C … +70 °C
Humidity	< 95 % RH, non-condensing

Table 10- 2 Data dependent on the control unit

Feature	CU230P-2 HVAC 6SL3243-0BB30-1HA1	CU230P-2 DP 6SL3243-0BB30-1PA1	CU230P-2 CAN 6SL3243-0BB30-1CA1
RS485 interface for USS protocol	x	---	---
RS485 interface for BacNet MS/TP	x	---	---
RS485 interface for Modbus RTU	x	---	---
PROFIBUS DP interface	---	x	---
CANopen interface	---	---	x

The control terminals on the Control Unit are galvanically isolated from the supply voltage (PELV).

10.3 General technical data, Power Module PM230 - IP55

Feature	Version	
Line voltage	3-ph. 380 V AC… 480 V ± 10 %	The actual permissible line voltage depends on the installation altitude
Input frequency	47 Hz … 63 Hz	
Power factor λ	0.7 ... 0.85	
Pulse frequency (factory setting)	4 kHz The pulse frequency can be increased in 2 kHz steps. A higher pulse frequency reduces the permissible output current.	
Electromagnetic Compatibility (EMC)	The Power Modules can be ordered with an integrated class A or class B filter according to EN 55011	
Braking methods	DC braking	
Degree of protection	IP55 / UL type 12	
Operating temperature	-10 °C … +60 °C (14 °F … 140 °F) The output power must be reduced for higher temperatures (see the Hardware Installation Manual).	
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)	
Relative humidity	< 95 % RH - condensation not permissible	
Installation altitude	Up to 1000 m (3300 ft) above sea level At higher installation altitudes, the output power must be reduced (see Hardware Installation Manual).	
Standards	UL, CE, C-tick In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.	

10.4 Power dependent technical data, Power Module PM230 - IP55

Note

The specified input currents apply for a 400 V line where V_k = 1 % referred to the inverter power. When using a line reactor, the currents are reduced by a few percent.

NOTICE

UL-certified fuses are required

In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.

Table 10- 3 PM230 frame size A, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE13-7AA0 …0DE13-7BA0	…0DE15-5AA0 …0DE15-5BA0	…0DE17-5AA0 …0DE17-5BA0
Values are based on Low Overload					
• Rated power		kW	0,37	0,55	0,75
• Input current I_{rated}		A	1,3	1,8	2,3
• Output current		A	1,3	1,7	2,2
Values are based on High Overload					
• HO power		kW	0,25	0,37	0,55
• HO input current		A	0,9	1,3	1,8
• HO output current		A	0,9	1,3	1,7
General values					
• Power loss		kW	0,06	0,06	0,06
• Fuse		A	10	10	10
• Cooling air requirement		l/s	7	7	7
• Cable cross-section for line and motor connections		mm^2	1 … 2,5	1 … 2,5	1 … 2,5
• Torque for line and motor connection		Nm	0,5	0,5	0,5
• Weight		kg	4,3	4,3	4,3

Table 10- 4 PM230 frame size A, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE21-1AA0 …0DE21-1BA0	…0DE21-5AA0 …0DE21-5BA0	…0DE22-2AA0 …0DE22-2BA0
Values are based on Low Overload					
• Rated power		kW	1,1	1,5	2,2
• Input current I_{rated}		A	3,2	4,2	6,1
• Output current		A	3,1	4,1	5,9
Values are based on High Overload					
• HO power		kW	0,75	1,1	1,5
• HO input current		A	2,3	3,2	4,2
• HO output current		A	2,2	3,1	4,1
General values					
• Power loss		kW	0,07	0,08	0,1
• Fuse		A	10	10	10
• Cooling air requirement		l/s	7	7	7
• Cable cross-section for line and motor connections		mm^2	1 … 2,5	1 … 2,5	1,5 … 2,5
• Torque for line and motor connection		Nm	0,5	0,5	0,5
• Weight		kg	4,3	4,3	4,3

Table 10- 5 PM230 frame size A, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE23-0AA0 …0DE23-0BA0
Values are based on Low Overload			
• Rated power		kW	3
• Input current I_{rated}		A	8,0
• Output current		A	7,7
Values are based on High Overload			
• HO power		kW	2,2
• HO input current		A	6,1
• HO output current		A	5,9
General values			
• Power loss		kW	0,12
• Fuse		A	10
• Cooling air requirement		l/s	7
• Cable cross-section for line and motor connections		mm^2	1,5 … 2,5
• Torque for line and motor connection		Nm	0,5
• Weight		kg	4,3

Table 10- 6 PM230 frame size B, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE24-0AA0 …0DE24-0BA0	…0DE25-5AA0 …0DE25-5BA0	…0DE27-5AA0 …0DE27-5BA0
Values are based on Low Overload					
• Rated power		kW	4	5,5	7,5
• Input current I_{rated}		A	10,5	13,6	18,6
• Output current		A	10,2	13,2	18
Values are based on High Overload					
• HO power		kW	3	4	5,5
• HO input current		A	8,0	10,5	13,6
• HO output current		A	7,7	10,2	13,2
General values					
• Power loss		kW	0,14	0,18	0,24
• Fuse		A	16	20	25
• Cooling air requirement		l/s	9	9	9
• Cable cross-section for line and motor connections		mm^2	1,5 … 6	4 … 6	4 … 6
• Torque for line and motor connection		Nm	0,5	0,5	0,5
• Weight		kg	6,3	6,3	6,3

Table 10- 7 PM230 frame size C, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE31-1AA0 …0DE31-1BA0	…0DE31-5AA0 …0DE31-5BA0	…0DE31-8AA0 …0DE31-8BA0
Values are based on Low Overload					
• Rated power		kW	11	15	18.5
• Input current I_{rated}		A	26,9	33,1	39,2
• Output current		A	26	32	38
Values are based on High Overload					
• HO power		kW	7,5	11	15
• HO input current		A	18,6	26,9	33,1
• HO output current		A	18	26	32
General values					
• Power loss		kW	0,32	0.39	0.46
• Fuse		A	35	50	50
• Cooling air requirement		l/s	20	20	20
• Cable cross-section for line and motor connections		mm^2	4 … 16	10 … 16	10 … 16
• Torque for line and motor connection		Nm	2,0	2,0	2,0
• Weight		kg	9,5	9,5	9,5

Table 10- 8 PM230 frame size D, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE32-2AA0 …0DE32-2BA0	…0DE33-0AA0 …0DE33-0BA0
Values are based on Low Overload				
• Rated power		kW	22	30
• Input current I_{rated}		A	42	56
• Output current		A	45	60
Values are based on High Overload				
• HO power		kW	18,5	22
• HO input current		A	36	42
• HO output current		A	38	45
General values				
• Power loss		kW	0.52	0.68
• Fuse		A	63	80
• Cooling air requirement		l/s	39	39
• Cable cross-section for line and motor connections		mm^2	10 … 35	10 … 35
• Torque for line and motor connection		Nm	6	6
• Weight		kg	30,2	30,2

Table 10- 9 PM230 frame size E, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE33-7AA0 …0DE33-7BA0	…0DE34-5AA0 …0DE34-5BA0
Values are based on Low Overload				
• Rated power		kW	37	45
• Input current I_{rated}		A	70	84
• Output current		A	75	90
Values are based on High Overload				
• HO power		kW	30	37
• HO input current		A	56	70
• HO output current		A	60	75
General values				
• Power loss		kW	0,99	1,2
• Fuse		A	100	125
• Cooling air requirement		l/s	39	39
• Cable cross-section for line and motor connections		mm^2	25 … 50	25 … 50
• Torque for line and motor connection		Nm	6	6
• Weight		kg	35,8	35,8

Table 10- 10 PM230 frame size F, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	Class A filter Class B filter	6SL3223-… 6SL3223-…	…0DE35-5AA0 …0DE35-5BA0	…0DE37-5AA0 …0DE37-5BA0	…0DE38-8AA0 …0DE38-8BA0
Values are based on Low Overload					
• Rated power		kW	55	75	90
• Input current I_{rated}		A	102	135	166
• Output current		A	110	145	178
Values are based on High Overload					
• HO power		kW	45	55	75
• HO input current		A	84	102	135
• HO output current		A	90	110	145
General values					
• Power loss		kW	1,4	1,9	2,3
• Fuse		A	160	200	250
• Cooling air requirement		l/s	117	117	117
• Cable cross-section for line and motor connections		mm^2	35 … 120	35 … 120	35 … 120
• Torque for line and motor connection		Nm	13	13	13
• Weight		kg	70.0	70.0	70.0

10.5 General technical data, PM240 Power Modules

Feature	Version		
Line voltage	3-ph. 380 V AC… 480 V ± 10 %		The actual permissible line voltage depends on the installation altitude
Input frequency	47 Hz … 63 Hz		
Power factor λ	0.7 ... 0.85		
Pulse frequency	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.		
Possible braking methods	DC braking, compound braking, dynamic braking with integrated braking chopper		
Degree of protection	IP20		
Operating temperature	LO	-10 °C … +40 °C (14 °F … 104 °F)	At higher temperatures, the output power must be reduced (see Hardware Installation Manual).
	HO	0.37 kW ... 110 kW -10 °C … +50 °C (14 °F … 122 °F)	
	HO	132 kW ... 200 kW -10 °C … +40 °C (14 °F … 104 °F)	
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)		
Relative humidity	< 95 % RH - condensation not permissible		
Installation altitude	0.37 kW ... 132 kW Up to 1000 m (3300 ft) above sea level		At higher installation altitudes, the output power must be reduced (see Hardware Installation Manual).
	160 kW ... 250 kW Up to 2000 m (6500 ft) above sea level		
Standards	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		

10.6 Power-dependent technical data, PM240 Power Modules

Note

The specified input currents apply for a 400 V line where V_k = 1 % referred to the inverter power. When using a line reactor, the currents are reduced by a few percent.

NOTICE

UL-certified fuses are required

In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.

Table 10- 11 PM240 frame size A, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3224-…	…0BE13-7UA0	…0BE15-5UA0	…0BE17-5UA0
Values are based on Low Overload				
• Rated power	kW	0,37	0,55	0,75
• Input current I_{rated}	A	1,6	2,0	2,5
• Output current	A	1,3	1,7	2,2
Values are based on High Overload				
• HO power	kW	0,37	0,55	0,75
• HO input current	A	1,6	2,0	2,5
• HO output current	A	1,3	1,7	2,2
General values				
• Power loss	kW	0,097	0,099	0,102
• Fuse	A	10	10	10
• Cooling air requirement	l/s	4,8	4,8	4,8
• Cable cross-section for line and motor connections	mm^2	1 … 2,5	1 … 2,5	1 … 2,5
• Torque for line and motor connection	Nm	1,1	1,1	1,1
• Weight	kg	1,2	1,2	1,2

Table 10- 12 PM240 frame size A, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3224-…	0BE21-1UA0	0BE21-5UA0
Values are based on Low Overload			
• Rated power	kW	1,1	1,5
• Input current I_{rated}	A	3,8	4,8
• Output current	A	3,1	4,1
Values are based on High Overload			
• HO power	kW	1,1	1,5
• HO input current	A	3,8	4,8
• HO output current	A	3,1	4,1
General values			
• Power loss	kW	0,108	0,114
• Fuse	A	10	10
• Cooling air requirement	l/s	4,8	4,8
• Cable cross-section for line and motor connections	mm^2	1 … 2,5	1 … 2,5
• Torque for line and motor connection	Nm	1,1	1,1
• Weight	kg	1,2	1,2

Table 10- 13 PM240 frame size B, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered filtered	6SL3224-… 6SL3224-…	…0BE22-2AA0 …0BE22-2UA0	…0BE23-0AA0 …0BE23-0UA0	…0BE24-0AA0 …0BE24-0UA0
Values are based on Low Overload					
• Rated power		kW	2,2	3	4
• Input current I_{rated}		A	7,6	10,2	13,4
• Output current		A	5,9	7,7	10,2
Values are based on High Overload					
• HO power		kW	2,2	3	4
• HO input current		A	7,6	10,2	13,4
• HO output current		A	5,9	7,7	10,2
General values					
• Power loss		kW	0,139	0,158	0,183
• Fuse		A	16	16	16
• Cooling air requirement		l/s	24	24	24
• Cable cross-section for line and motor connections		mm^2	1,5 … 6	1,5 … 6	1,5 … 6
• Torque for line and motor connection		Nm	1,5	1,5	1,5
• Weight		kg	4,3	4,3	4,3

Table 10- 14 PM240 frame size C, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered filtered	6SL3224-… 6SL3224-…	…0BE25-5AA0 …0BE25-5UA0	…0BE27-5AA0 …0BE27-5UA0	…0BE31-1AA0 …0BE31-1UA0
Values are based on Low Overload					
• Rated power		kW	7,5	11	15
• Input current I_{rated}		A	21,9	31,5	39,4
• Output current		A	18	25	32
Values are based on High Overload					
• HO power		kW	5,5	7,5	11
• HO input current		A	16,7	23,7	32,7
• HO output current		A	13,2	19	26
General values					
• Power loss		kW	0,240	0,297	0,396
• Fuse		A	20	32	35
• Cooling air requirement		l/s	55	55	55
• Cable cross-section for line and motor connections		mm^2	4 … 10	4 … 10	4 … 10
• Torque for line and motor connection		Nm	2,3	2,3	2,3
• Weight		kg	6,5	6,5	6,5

Table 10- 15 PM240 frame size D, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered filtered	6SL3224-… 6SL3224-…	…0BE31-5AA0 …0BE31-5UA0	…0BE31-8AA0 …0BE31-8UA0	…0BE32-2AA0 …0BE32-2UA0
Values are based on Low Overload					
• Rated power		kW	18,5	22	30
• Input current I_{rated}		A	46	53	72
• Output current		A	38	45	60
Values are based on High Overload					
• HO power		kW	15	18,5	22
• HO input current		A	40	46	56
• HO output current		A	32	38	45
General values					
• Power loss		kW	0,44	0,55	0,72
• Fuse		A	50	63	80
• Cooling air requirement		l/s	55	55	55
• Cable cross-section for line and motor connections		mm^2	10 … 35	10 … 35	10 … 35
• Torque for line and motor connection		Nm	6	6	6
• Weight	filtered unfiltered	kg	16 13	16 13	16 13

Table 10- 16 PM240 frame size E, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered filtered	6SL3224-… 6SL3224-…	…0BE33-0AA0 …0BE33-0UA0	…0BE33-7AA0 …0BE33-7UA0
Values are based on Low Overload				
• Rated power		kW	37	45
• Input current I_{rated}		A	88	105
• Output current		A	75	90
Values are based on High Overload				
• HO power		kW	30	37
• HO input current		A	73	90
• HO output current		A	60	75
General values				
• Power loss		kW	1,04	1,2
• Fuse		A	100	125
• Cooling air requirement		l/s	110	110
• Cable cross-section for line and motor connections		mm^2	25 … 35	25 … 35
• Torque for line and motor connection		Nm	6	6
• Weight	filtered unfiltered	kg	23 16	23 16

Table 10- 17 PM240 frame size F, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered filtered	6SL3224-… 6SL3224-…	…0BE34-5AA0 …0BE34-5UA0	…0BE35-5AA0 …0BE35-5UA0	…0BE37-5AA0 …0BE37-5UA0
Values are based on Low Overload					
• Rated power		kW	55	75	90
• Input current I_{rated}		A	129	168	204
• Output current		A	110	145	178
Values are based on High Overload					
• HO power		kW	45	55	75
• HO input current		A	108	132	169
• HO output current		A	90	110	145
General values					
• Power loss		kW	1,5	2,0	2,4
• Fuse		A	160	200	250
• Cooling air requirement		l/s	150	150	150
• Cable cross-section for line and motor connections		mm^2	35 … 120	35 … 120	35 … 120
• Torque for line and motor connection		Nm	13	13	13
• Weight	filtered unfiltered	kg	52 36	52 36	52 36

Table 10- 18 PM240 frame size F, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	unfiltered	6SL3224-…	…0BE38-8UA0	…0BE41-1UA0
Values are based on Low Overload				
• Rated power		kW	110	132
• Input current I_{rated}		A	234	284
• Output current		A	205	250
Values are based on High Overload				
• HO power		kW	90	110
• HO input current		A	205	235
• HO output current		A	178	205
General values				
• Power loss		kW	2,4	2,5
• Fuse		A	250	315
• Cooling air requirement		l/s	150	150
• Cable cross-section for line and motor connections		mm^2	35 … 120	35 … 120
• Torque for line and motor connection		Nm	13	13
• Weight		kg	39	39

Table 10- 19 PM240 frame size GX, 3-ph. 380 V AC… 480 V, ± 10 %

Order number unfiltered	6SL3224-…	…0BE41-3UA0	…0BE41-6UA0	…0BE42-0UA0
Values are based on Low Overload				
• Rated power	kW	160	200	250
• Input current I_{rated}	A	297	354	442
• Output current	A	302	370	477
Values are based on High Overload				
• HO power	kW	132	160	200
• HO input current	A	245	297	354
• HO output current	A	250	302	370
General values				
• Power loss	kW	3,9	4,4	5,5
• Fuse	A	355	400	630
• Cooling air requirement	l/s	360	360	360
• Cable cross-section for line and motor connections	mm^2	95 ... 240	120 ... 240	185 ... 240
• Torque for line and motor connection	Nm	14	14	14
• Weight	kg	176	176	176

10.7 General technical data, PM250 Power Modules

Feature	Version	
Line voltage	3-ph. 380 V AC… 480 V ± 10 %	The actual permissible line voltage depends on the installation altitude
Input frequency	47 Hz … 63 Hz	
Power factor λ	0.9	
Pulse frequency	4 kHz The pulse frequency can be increased in 2 kHz steps. A higher pulse frequency reduces the permissible output current.	
Braking methods	Regenerative energy	
Degree of protection	IP20	
Operating temperature	LO -10 °C … +40 °C (14 °F … 104 °F) HO -10 °C … +50 °C (14 °F … 122 °F)	At higher temperatures, the output power must be reduced (see Hardware Installation Manual).
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)	
Relative humidity	< 95 % RH - condensation not permissible	
Installation altitude	Up to 1000 m (3300 ft) above sea level At higher installation altitudes, the output power must be reduced (see Hardware Installation Manual).	
Standards	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	

10.8 Power-dependent technical data, PM250 Power Modules

Note

The specified input currents apply for a 400 V line where V_k = 1 % referred to the inverter power. When using a line reactor, the currents are reduced by a few percent.

NOTICE

UL-certified fuses are required

In order that the system is UL-compliant, UL-certified fuses, overload circuit-breakers or intrinsically safe motor protection devices must be used.

Table 10- 20 PM250 frame size C, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3225-…	…0BE25-5AA0	…0BE27-5AA0	…0BE31-1AA0
Values are based on Low Overload				
• Rated power	kW	7,5	11,0	15
• Input current I_{rated}	A	18,0	25,0	32,0
• Output current	A	18,0	25,0	32,0
Values are based on High Overload				
• HO power	kW	5,5	7,5	11,0
• HO input current	A	13,2	19,0	26,0
• HO output current	A	13,2	19,0	26,0
General values				
• Power loss	kW	Available soon	Available soon	Available soon
• Fuse	A	20	32	35
• Cooling air requirement	l/s	38	38	38
• Cable cross-section for line and motor connections	mm^2	2,5 … 10	4 … 10	6 … 10
• Torque for line and motor connection	Nm	2,3	2,3	2,3
• Weight	kg	7,5	7,5	7,5

Table 10- 21 PM250 frame size D, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3225-…	…0BE31-5AA0	…0BE31-8AA0	…0BE32-2AA0
Values are based on Low Overload				
• Rated power	kW	18,5	22,0	30
• Input current I_{rated}	A	36,0	42,0	56,0
• Output current	A	38,0	45,0	60,0
Values are based on High Overload				
• HO power	kW	15,0	18,5	22,0
• HO input current	A	30,0	36,0	42,0
• HO output current	A	32,0	38,0	45,0
General values				
• Power loss	kW	0,44	0,55	0,72
• Fuse	A	50	63	80
• Cooling air requirement	l/s	22	22	39
• Cable cross-section for line and motor connections	mm^2	10 … 35	10 … 35	16 … 35
• Torque for line and motor connection	Nm	6	6	6
• Weight	kg	15	15	16

Table 10- 22 PM250 frame size E, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3225-…	…0BE33-0AA0	…0BE33-7AA0
Values are based on Low Overload			
• Rated power	kW	37	45
• Input current I_{rated}	A	70	84
• Output current	A	75	90
Values are based on High Overload			
• HO power	kW	30,0	37,0
• HO input current	A	56	70
• HO output current	A	60	75
General values			
• Power loss	kW	1	1,3
• Fuse	A	100	125
• Cooling air requirement	l/s	22	39
• Cable cross-section for line and motor connections	mm^2	25 … 35	25 … 35
• Torque for line and motor connection	Nm	6	6
• Weight	kg	21	21

Table 10- 23 PM250 frame size F, 3-ph. 380 V AC… 480 V, ± 10 %

Order number	6SL3225-…	…0BE34-5AA0	…0BE35-5AA0	…0BE37-5AA0
Values are based on Low Overload				
• Rated power	kW	55,0	75	90
• Input current I_{rated}	A	102	190	223
• Output current	A	110	145	178
Values are based on High Overload				
• HO power	kW	45,0	55,0	75
• HO input current	A	84	103	135
• HO output current	A	90	110	145
General values				
• Power loss	kW	1,5	2	2,4
• Fuse	A	160	200	250
• Cooling air requirement	l/s	94	94	117
• Cable cross-section for line and motor connections	mm^2	35 … 150	70 … 150	95 … 150
• Torque for line and motor connection	Nm	13	13	13
• Weight	kg	51,0	51,0	51,0

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