





# **Operating Instructions**

# SINAMICS

# **SINAMICS G120**

Low voltage converters Built-in units with CU240B-2 and CU240E-2 Control Units

Edition

02/2023

www.siemens.com/drives

# SIEMENS

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**Operating Instructions** 

| edition                            |     |
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Changes in the current

Edition 02/2023, Firmware V4.7 SP14

#### Legal information

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#### 🛕 WARNING

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

#### 

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

#### NOTICE

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# Changes in the current edition

#### Essential changes with respect to Edition 10/2020

#### **New functions**

SINAMICS G115D converter now supports the extended function 'Safety Limited Speed (SLS)' with the firmware version V4.7 SP14.

Overview of new and modified function in firmware V4.7 SP14:

Firmware version 4.7 SP14 (Page 547)

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| 11.9<br>11.10<br><b>Appendix</b><br>A.1<br>A.1.1<br>A.1.2<br>A.1.3<br>A.1.4<br>A.1.5<br>A.1.6<br>A.1.7<br>A.1.8<br>A.1.9<br>A.1.10<br>A.2<br>A.2.1<br>A.2.2                            | Restrictions for special ambient conditions<br>Protecting persons from electromagnetic fields<br>New and extended functions.<br>Firmware version 4.7 SP14<br>Firmware version 4.7 SP13<br>Firmware version 4.7 SP10<br>Firmware version 4.7 SP9<br>Firmware version 4.7 SP9<br>Firmware version 4.7 SP3<br>Firmware version 4.7 SP3<br>Firmware version 4.6 SP6<br>Firmware version 4.6 SP6<br>Firmware version 4.6<br>Firmware version 4.5<br>Interconnecting signals in the converter<br>Fundamentals.<br>Application example   | . 544<br>. 545<br>. 547<br>. 547<br>. 547<br>. 547<br>. 547<br>. 547<br>. 553<br>. 554<br>. 555<br>. 555<br>. 555<br>. 558<br>. 559<br>. 560<br>. 560<br>. 562  |
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Α

# **Fundamental safety instructions**

# 1.1 General safety instructions



#### 

#### Electric shock and danger to life due to other energy sources

Touching live components can result in death or severe injury.

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

Generally, the following steps apply when establishing safety:

- 1. Prepare for disconnection. Notify all those who will be affected by the procedure.
- 2. Isolate the drive system from the power supply and take measures to prevent it being switched back on again.
- 3. Wait until the discharge time specified on the warning labels has elapsed.
- 4. Check that there is no voltage between any of the power connections, and between any of the power connections and the protective conductor connection.
- 5. Check whether the existing auxiliary supply circuits are de-energized.
- 6. Ensure that the motors cannot move.
- 7. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water. Switch the energy sources to a safe state.
- 8. Check that the correct drive system is completely locked.

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



#### 

Risk of electric shock and fire from supply networks with an excessively high impedance

Excessively low short-circuit currents can lead to the protective devices not tripping or tripping too late, and thus causing electric shock or a fire.

- In the case of a conductor-conductor or conductor-ground short-circuit, ensure that the short-circuit current at the point where the converter is connected to the line supply at least meets the minimum requirements for the response of the protective device used.
- You must use an additional residual-current device (RCD) if a conductor-ground short circuit does not reach the short-circuit current required for the protective device to respond. The required short-circuit current can be too low, especially for TT supply systems.



### MARNING

Risk of electric shock and fire from supply networks with an excessively low impedance

Excessively high short-circuit currents can lead to the protective devices not being able to interrupt these short-circuit currents and being destroyed, and thus causing electric shock or a fire.

• Ensure that the prospective short-circuit current at the line terminal of the converter does not exceed the breaking capacity (SCCR or Icc) of the protective device used.



### 

#### Electric shock if there is no ground connection

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

• Ground the device in compliance with the applicable regulations.



### 

#### Electric shock due to connection to an unsuitable power supply

When equipment is connected to an unsuitable power supply, exposed components may carry a hazardous voltage. Contact with hazardous voltage can result in severe injury or death.

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



#### 🛕 WARNING

#### Electric shock due to equipment damage

Improper handling may cause damage to equipment. For damaged devices, hazardous voltages can be present at the enclosure or at exposed components; if touched, this can result in death or severe injury.

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



### 

#### Electric shock due to unconnected cable shield

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

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



### WARNING

#### Arcing when a plug connection is opened during operation

Opening a plug connection when a system is operation can result in arcing that may cause serious injury or death.

• Only open plug connections when the equipment is in a voltage-free state, unless it has been explicitly stated that they can be opened in operation.



### 

#### Electric shock due to residual charges in power components

Because of the capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off. Contact with live parts can result in death or serious injury.

• Wait for 5 minutes before you check that the unit really is in a no-voltage condition and start work.

#### NOTICE

#### Damage to equipment due to unsuitable tightening tools.

Unsuitable tightening tools or fastening methods can damage the screws of the equipment.

- Only use screw inserts that exactly match the screw head.
- Tighten the screws with the torque specified in the technical documentation.
- Use a torque wrench or a mechanical precision nut runner with a dynamic torque sensor and speed limitation system.
- Adjust the tools used regularly.

#### NOTICE

#### Property damage due to loose power connections

Insufficient tightening torques or vibration can result in loose power connections. This can result in damage due to fire, device defects or malfunctions.

- Tighten all power connections to the prescribed torque.
- Check all power connections at regular intervals, particularly after equipment has been transported.

# 

#### Electromagnetic interference due to inadequate shield support

A lack of adequate shield support for the power cables can cause malfunctions and impermissibly high levels of interference.

- Use the shield connection plates supplied or recommended.
- Use the shield connection clips recommended.

# 

#### Spread of fire from built-in devices

Built-in devices can cause a fire and a pressure wave in the event of a fault. Fire and smoke can escape from the control cabinet and cause serious personal injury and property damage.

- Install built-in appliances in a robust metal control cabinet that is suitable for protecting people from fire and smoke.
- Only operate built-in devices with the control cabinet doors closed.
- Ensure that smoke can only escape via controlled and monitored paths.

### 🛕 WARNING

#### Active implant malfunctions due to electromagnetic fields

Converters generate electromagnetic fields (EMF) in operation. Electromagnetic fields may interfere with active implants, e.g. pacemakers. People with active implants in the immediate vicinity of an converter are at risk.

- As the operator of an EMF-emitting installation, assess the individual risks of persons with active implants.
- Observe the data on EMF emission provided in the product documentation.

# 

#### Symptomatic respiratory and skin reaction to chemicals

A newly purchased product might contain traces of substances that are identified as sensitizers.

Sensitizers are substances which can cause sensitization in the lungs and skin after exposure to them.

Once sensitized, individuals can have severe reactions to further exposure, even in small amounts. In the most extreme cases, individuals might develop asthma or dermatitis respectively.

• If the product has a strong smell, keep it in a well-ventilated area for 14 days.

# 

#### Unexpected machine movement caused by radio devices or mobile phones

Using radio devices, cellphones, or mobile WLAN devices in the immediate vicinity of the components can result in equipment malfunction. Malfunctions may impair the functional safety of machines and can therefore put people in danger or lead to property damage.

- Therefore, if you move closer than 20 cm to the components, be sure to switch off radio devices, cellphones or WLAN devices.
- Use the "SIEMENS Industry Online Support app" only on equipment that has already been switched off.

#### NOTICE

#### Damage to motor insulation due to excessive voltages

When operated on systems with grounded line conductors or in the event of a ground fault in the IT system, the motor insulation can be damaged by the higher voltage against ground. If you use motors that have insulation that is not designed for operation with grounded line conductors, you must perform the following measures:

- IT system: Use a ground fault monitor and eliminate the fault as quickly as possible.
- TN or TT systems with grounded line conductor: Use an isolating transformer on the line side.

# 

#### Fire due to inadequate ventilation clearances

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

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

#### NOTICE

#### Overheating due to inadmissible mounting position

The device may overheat and therefore be damaged if mounted in an inadmissible position.

• Only operate the device in admissible mounting positions.

# 

#### Unrecognized dangers due to missing or illegible warning labels

Dangers might not be recognized if warning labels are missing or illegible. Unrecognized dangers may cause accidents resulting in serious injury or death.

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

#### NOTICE

#### Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

### 

#### Unexpected movement of machines caused by inactive safety functions

Inactive or non-adapted safety functions can trigger unexpected machine movements that may result in serious injury or death.

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

#### Note

#### Important Safety instructions for Safety Integrated

If you want to use Safety Integrated functions, you must observe the Safety instructions in the Safety Integrated documentation.

# 

Malfunctions of the machine as a result of incorrect or changed parameter settings

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

- Protect the parameterization against unauthorized access.
- Handle possible malfunctions by taking suitable measures, e.g. emergency stop or emergency off.

1.2 Equipment damage due to electric fields or electrostatic discharge

# 1.2

# Equipment damage due to electric fields or electrostatic discharge

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



#### NOTICE

#### Equipment damage due to electric fields or electrostatic discharge

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

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

1.3 Warranty and liability for application examples

# 1.3 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment or any eventuality which may arise. Application examples do not represent specific customer solutions, but are only intended to provide support for typical tasks.

As the user you yourself are responsible for ensuring that the products described are operated correctly. Application examples do not relieve you of your responsibility for safe handling when using, installing, operating and maintaining the equipment.

1.4 Security information

# 1.4 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit

https://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under

https://www.siemens.com/cert.

Further information is provided on the Internet:

Industrial Security Configuration Manual (<u>https://support.industry.siemens.com/cs/ww/en/view/108862708</u>)

### 

#### Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.
- Make sure that you include all installed products into the holistic industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.
- On completion of commissioning, check all security-related settings.

#### 1.5 Residual risks of power drive systems

# 1.5 Residual risks of power drive systems

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

- 1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
  - Hardware faults and/or software errors in the sensors, control system, actuators, and connections
  - Response times of the control system and of the drive
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - Parameterization, programming, cabling, and installation errors
  - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
  - External influences/damage
  - X-ray, ionizing radiation and cosmic radiation
- 2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the components under fault conditions caused by, for example:
  - Component failure
  - Software errors
  - Operation and/or environmental conditions outside the specification
  - External influences/damage
- 3. Hazardous shock voltages caused by, for example:
  - Component failure
  - Influence during electrostatic charging
  - Induction of voltages in moving motors
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - External influences/damage
- 4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
- 5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

#### 1.5 Residual risks of power drive systems

- 6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network
- 7. Motors for use in potentially explosive areas: When moving components such as bearings become worn, this can cause enclosure components to exhibit unexpectedly high temperatures during operation, creating a hazard in areas with a potentially explosive atmosphere.

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

# Introduction

# 2.1 About the Manual

#### Who requires the operating instructions and what for?

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

#### What is described in the operating instructions?

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

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

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

#### What is the meaning of the symbols in the manual?

Reference to further information in the manual

Download from the Internet

DVD that can be ordered

End of a handling instruction.

Examples of converter function symbols

2.2 Guide through the manual

# 2.2 Guide through the manual

| Chapter                       | In this section you will find answers to the following questions:   |
|-------------------------------|---|
| Description (Page 29)         | How is the converter marked?  |
|                               | Which components make up the converter?   |
|                               | Which optional components are available for the converter?  |
|                               | What is the purpose of the optional components?   |
|                               | Which motors can be fed from the converter?   |
|                               | Which commissioning tools are there?  |
| Installing (Page 59)          | Which sequence is recommended when installing the converter?  |
|                               | What does EMC-compliant installation actually mean?   |
|                               | • Which options are available to install optional components below the converter?   |
|                               | What are the converter dimensions?  |
|                               | <ul> <li>Which mounting and installation materials are required when installing the con-<br/>verter?</li> </ul>                   |
|                               | • To which line supplies can the converter be connected?  |
|                               | How is the converter connected to the line supply?  |
|                               | How is the braking resistor connected to the converter?   |
|                               | Which terminals and fieldbus interfaces does the converter have?  |
|                               | What are the interface functions?   |
| Commissioning (Page 147)      | Which motor data is required for commissioning  |
|                               | How is the converter set in the factory?  |
|                               | What is the commissioning procedure?  |
|                               | How do you restore the converter factory settings?  |
| Uploading the converter set-  | Why is it necessary to back up the converter settings?  |
| tings (Page 199)              | Which options are available to back up the settings?  |
|                               | How does the data backup function?  |
|                               | How do you prevent the converter settings from being changed?   |
|                               | How do you prevent the converter settings from being read out?  |
| Protecting the converter set- | How do I protect the converter settings against manipulation?   |
| tings (Page 211)              | • How do I protect my know-how, which is embedded in the converter settings, so that it cannot be copied by unauthorized persons? |
| Advanced commissioning        | Which functions are included in the converter firmware?   |
| (Page 221)                    | How are the functions set?  |
| Corrective maintenance        | What is the meaning of the LEDs provided on the converter?  |
| (Page 445)                    | How does the system runtime respond?  |
|                               | How does the converter save alarms and faults?  |
|                               | What do the converter alarms and faults mean?   |
|                               | How are converter faults resolved?  |
|                               | Which I&M data is saved in the converter?   |

| Chapter                   | In this section you will find answers to the following questions:  |
|---------------------------|--|
| Alarms, faults and system | How are converter components replaced?   |
| messages (Page 425)       | How is the firmware version of the converter changed?  |
|                           | • What must be done after a converter replacement if the safety functions of the converter are active?     |
| Technical data (Page 485) | What is the converter technical data?  |
|                           | What do "High Overload" and "Low Overload" mean?   |
|                           | • What effect do the installation altitude or ambient temperature have on the con-<br>verter, for example? |
| Appendix (Page 547)       | What are the new functions of the current firmware?  |
|                           | How is the converter operated using the BOP-2 Operator Panel?  |
|                           | How can signal interconnections be changed in the converter firmware?                                      |
|                           | What does "BiCo technology" mean?  |
|                           | Where can I find additional information about the converter?   |

2.2 Guide through the manual

# Description

### 3.1 Intended use

#### Use for the intended purpose

The converter described in this manual is a device to control a three-phase motor. The converter is designed for installation in electrical installations or machines.

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

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

#### Use of third-party products

This document contains recommendations relating to third-party products. Siemens accepts the fundamental suitability of these third-party products.

You can use equivalent products from other manufacturers.

Siemens does not accept any warranty for the properties of third-party products.

3.2 OpenSSL

# 3.2 OpenSSL

### Use of OpenSSL

This product contains software developed in the OpenSSL project for use within the OpenSSL toolkit.

This product contains cryptographic software created by Eric Young.

This product contains software developed by Eric Young.

Further information is provided on the Internet:

OpenSSL (<u>https://www.openssl.org/</u>)

Cryptsoft (mailto:eay@cryptsoft.com)

# 3.3 Transferring OpenOSS license terms to a PC

#### Requirement

You have an empty memory card and a reader for the memory card.

#### Procedure

#### Procedure

To transfer OpenOSS license terms to a PC, proceed as follows:

- 1. Switch off the converter power supply.
- 2. Insert an empty memory card into the card slot of the converter.
- 3. Switch on the converter power supply.
- 4. The converter writes file "Read\_OSS.ZIP" to the memory card within approximately 30 seconds.
- 5. Switch off the converter power supply.
- 6. Withdraw the memory card from the converter.
- 7. Insert the memory card into the card reader of a PC.
- 8. Please read the license terms.

3.4 Identifying the converter

# 3.4 Identifying the converter

#### Main components of the converter

Each SINAMICS G120 converter comprises a Control Unit and a Power Module.

- The Control Unit controls and monitors the connected motor.
- The Power Module provides the connections for line supply and motor.



The following data is provided on the Power Module type plate (1):

- Designation, e.g. PM240-2 Power Module
- Technical specifications: voltage and current
- Article number, e.g. 6SL3210-1PE21-1UL0
- Version, e.g. A02

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

- Designation, e.g. Control Unit CU240E-2 DP-F
- Article number, e.g. 6SL3244-0BB13-1PA0
- Version, e.g. A02 (hardware), 4.7 (firmware)

#### Further converter components

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

- Line filter (Page 43)
- Line reactor (Page 44)
- 💭 Output reactor (Page 46)
- Sine-wave filter (Page 52)
- Braking resistor (Page 54)
- 💬 Brake relay to control a motor holding brake (Page 56)
- Control Unit Adapter Kit CUA20 (Page 57)

#### **Directives and standards** 3.5

#### Description

The following directives and standards are relevant for the converters:

#### **European Low Voltage Directive**

The converters fulfill the requirements stipulated in the Low-Voltage Directive 2014/35/EU, if they are covered by the application area of this directive.

#### **European Machinery Directive**

The converters fulfill the requirements stipulated in the Machinery Directive 2006/42/EC, if they are covered by the application area of this directive.

However, the use of the converters in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety.

#### Directive 2011/65/EU

The converter fulfills the requirements of Directive 2011/65/EU relating to the restriction of the use of certain hazardous substances in electrical and electronic devices (RoHS).

#### **European EMC Directive**

The compliance of the converter with the regulations of the Directive 2014/30/EU has been verified through full compliance with IEC/EN 61800-3.

#### **Underwriters Laboratories (North American market)**

Converters provided with one of the test symbols displayed fulfill the requirements stipulated for the North American market as a component of drive applications, and are appropriately listed.

#### **EMC requirements for South Korea**

The converters with the KC marking on the rating plate satisfy the EMC requirements for South Korea.



#### **Eurasian conformity**

The converters comply with the requirements of the Russia/Belarus/Kazakhstan customs union (EAC).

#### Australia and New Zealand (RCM formerly C-Tick)

The converters showing the test symbols fulfill the EMC requirements for Australia and New Zealand.



3.5 Directives and standards

#### Immunity to voltage drop of semiconductor process equipment.

The converters comply with the requirements of standard SEMI F47-0706.

#### DNV-GL

The SINAMICS CUA20 Control Unit Adapter Kit facilitates DNV-GL-certified cabinet designs.

#### **China RoHS**

The converters comply with the China-RoHs directive. Further information is provided on the Internet:

China RoHS (<u>https://support.industry.siemens.com/cs/ww/en/view/109738656</u>)

#### **Quality systems**

Siemens AG employs a quality management system that meets the requirements of ISO 9001 and ISO 14001.

#### **Further information**

#### Certificates for download

- EC Declaration of Conformity: (<u>https://support.industry.siemens.com/cs/ww/en/view/</u>58275445)
- Certificates for the relevant directives, prototype test certificates, manufacturers declarations and test certificates for functions relating to functional safety ("Safety Integrated"): (<u>http://support.automation.siemens.com/WW/view/en/22339653/134200</u>)
- Certificates for products that were certified by UL: (<u>http://database.ul.com/cgi-bin/XYV/</u> <u>template/LISEXT/1FRAME/index.html</u>)
- Certificates for products that were certified by TÜV SÜD: (<u>https://www.tuev-sued.de/</u> industrie\_konsumprodukte/zertifikatsdatenbank)

#### Standards that are not relevant



The converters do not fall in the area of validity of the China Compulsory Certification (CCC).
# 3.6 Overview of Control Units

Table 3-1Control Units CU240B-2 ...

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

Table 3-2 Control Units CU240E-2 ...

|                   | The CU240E-2 Control Units have, in comparison to the CU240B-2, an extended terminal strip with inte-<br>grated safety functions.<br>The CU240E-2 Control Units differ with regard to the type of fieldbus and the scope of the integrated safety<br>functions. |                    |                          |  |  |
|-------------------|---|--------------------|--------------------------|--|--|
| Designation       | CU240E-2  | CU240E-2 DP        | CU240E-2 PN              |  |  |
| Article number    | 6SL3244-0BB12-1BA1  | 6SL3244-0BB12-1PA1 | 6SL3244-0BB12-1FA0       |  |  |
| Fieldbus          | USS, Modbus RTU   | PROFIBUS DP        | PROFINET IO, EtherNet/IP |  |  |
| Safety Integrated |   | Basic functions    |                          |  |  |
| Designation       | CU240E-2 F  | CU240E-2 DP-F      | CU240E-2 PN-F            |  |  |
| Article number    | 6SL3244-0BB13-1BA1  | 6SL3244-0BB13-1PA1 | 6SL3244-0BB13-1FA0       |  |  |
| Fieldbus          | USS, Modbus RTU   | PROFIBUS DP        | PROFINET IO, EtherNet/IP |  |  |
| Safety Integrated |   | Extended functions |                          |  |  |

## Shield connection kit for the Control Unit

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

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

Table 3-3 Article Nos.

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

3.6 Overview of Control Units

#### Adapter for operating a PM230 IP55 Power Module



For operating the Control Unit with a PM230 IP55 Power Module, FSA ... FSC, an adapter is required between the Control Unit and operator panel (BOP-2 or IOP).

The adapter, which is included in the scope of delivery of the Power Module, is too short for the CU240E-2 Control Unit. The matching adapter for the CU240E-2 Control Unit can be ordered through the KnorrTec company.

Article number 10055500



Figure 3-1 Insert the KnorrTec adapter on the interface for the operator panel

# 3.7 Power Module

Important data on the Power Modules is provided in this section. Further information is contained in the Hardware Installation Manual of the Power Module.

Overview of the manuals (Page 564)

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

## Which Power Module can I use with the Control Unit?

| Control Unit | Power Module                                 |      |         |          |       |  |  |
|--------------|--|------|---------|----------|-------|--|--|
|              | PM230  |      | PM240-2 | PM240P-2 | PM250 |  |  |
|              | IP20 and<br>Push-<br>Through tech-<br>nology | IP55 |         |          |       |  |  |
| CU240B-2     | 1  |      | 1       | 1        | 1     |  |  |
| CU240E-2     | ✓  | 1    | 1       | 1        | 1     |  |  |

 Table 3-4
 Permitted combinations of Control Unit and Power Module

3.7 Power Module

## 3.7.1 Power Module with IP20 degree of protection



Figure 3-2 Examples of Power Modules with IP20 degree of protection

#### PM240-2 for standard applications

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

| Table 3-5 | 1-phase/3-phase 200 VAC | 240 VAC, article number 6SL3210-1PB. | and 6SL3210-1PC |
|-----------|-------------------------|--------------------------------------|-----------------|
|           | i phase 200 the m       |                                      |                 |

| Frame size | FSA       | FSB     | FSC     | FSD     | FSE   | FSF   |
|------------|-----------|---------|---------|---------|-------|-------|
| Power (kW) | 0.55 0.75 | 1.1 2.2 | 3.0 4.0 | 11 18.5 | 22 30 | 37 55 |

| Table 3-6 | 3 - nhase 380 VAC | 480 1/40 | article number 6SI 3210-1PE  |
|-----------|-------------------|----------|------------------------------|
| Table 5-0 | 5-priase Sou VAC  | 400 VAC, | , article number oslozio-ire |

| Frame size | FSA      | FSB     | FSC   | FSD     | FSE   | FSF    | FSG     |
|------------|----------|---------|-------|---------|-------|--------|---------|
| Power (kW) | 0.55 3.0 | 4.0 7.5 | 11 15 | 18.5 37 | 45 55 | 75 132 | 160 250 |

Table 3-73-phase 500 VAC ... 690 VAC, article number 6SL3210-1PH...

| Frame size | FSD   | FSE   | FSF    | FSG     |
|------------|-------|-------|--------|---------|
| Power (kW) | 11 37 | 45 55 | 75 132 | 160 250 |

#### PM240P-2 for pump and fan applications

The PM240P-2 Power Module is available without a filter or with an integrated class A line filter.

Table 3-8 3-phase 380 VAC ... 480 VAC, article number 6SL3210-1RE...

| Frame size | FSD   | FSE   | FSF    |
|------------|-------|-------|--------|
| Power (kW) | 22 37 | 45 55 | 75 132 |

Table 3-9 3-phase 500 VAC ... 690 VAC, article number 6SL3210-1RH...

| Frame size FSD |       | FSE   | FSE    |  |
|----------------|-------|-------|--------|--|
| Power (kW)     | 11 37 | 45 55 | 75 132 |  |

#### PM230, 3-phase 400 VAC in IP20 degree of protection for pump and fan applications

The PM230 Power Module in IP20 degree of protection is available without a filter or with an integrated class A line filter.

Table 3-10 3-phase 380 VAC ... 480 VAC, article numbers: 6SL3210-1NE...

| Frame size | FSA    | FSB   | FSC     | FSD   | FSE   | FSF   |
|------------|--------|-------|---------|-------|-------|-------|
| Power (kW) | 0.37 3 | 4 7.5 | 11 18.5 | 22 37 | 45 55 | 75 90 |

#### PM250 for standard applications with energy recovery

The PM250 Power Module is available without a filter or with integrated class A line filter. The PM250 permits dynamic braking with energy recovery into the line supply.

Table 3-11 3-phase 380 VAC ... 480 VAC, article number 6SL3225-0BE...

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

3.7 Power Module

# 3.7.2 Power Module with Push-Through technology



Figure 3-3 Examples of Power Modules with Push-Through technology FSA ... FSC

#### PM240-2 with Push-Through technology for standard applications

The PM240-2 Power Module is available with Push-Through technology without a filter or with an integrated class A line filter. The PM240-2 allows dynamic braking using an external braking resistor.

Table 3-12 1-phase/3-phase 200 VAC ... 240 VAC, article number 6SL3211-1PB...

| Frame size | FSA  | FSB | FSC | FSD  | FSE | FSF |
|------------|------|-----|-----|------|-----|-----|
| Power (kW) | 0.75 | 2.2 | 4.0 | 18.5 | 30  | 55  |

Table 3-13 3-phase 380 VAC ... 480 VAC, article number 6SL3211-1PE...

| Frame size | FSA | FSB | FSC | FSD | FSE | FSF |
|------------|-----|-----|-----|-----|-----|-----|
| Power (kW) | 3.0 | 7.5 | 15  | 37  | 55  | 132 |

Table 3-14 3 AC 500 V ... 690 V, Article No. 6SL3211-1PH...

| Frame size | FSD | FSE | FSF |
|------------|-----|-----|-----|
| Power (kW) | 37  | 55  | 132 |

#### PM230 in Push-Through technology for pump and fan applications

The PM230 Power Module is available without a filter or with integrated class A line filter.

Table 3-153-phase 380 VAC ... 480 VAC, article number 6SL3211-1NE...

| Frame size | FSA | FSB | FSC  |
|------------|-----|-----|------|
| Power (kW) | 3   | 7.5 | 18.5 |



# 3.7.3 Power Module in IP55 degree of protection / UL Type 12

Figure 3-4 PM230, 3-phase 400 VAC, degree of protection IP55 / UL Type 12

## PM230 for pumps and fan applications

The PM230 Power Module is suitable for cabinet-free installation.

| Table 3-16 | 3-phase 380 VAC 480 VAC, article number 6SL3223-0DE |
|------------|---|
|------------|---|

| Frame size |                | FSA    | FSB   | FSC     | FSD     | FSE   | FSF   |
|------------|----------------|--------|-------|---------|---------|-------|-------|
| Power (kW) | Filter Class A | 0.37 3 | 4 7.5 | 11 18.5 | 22 30   | 37 45 | 55 90 |
|            | Filter Class B | 0.37 3 | 4 7.5 | 11 15   | 18.5 30 | 37 45 | 55 90 |

# 3.8 Components for the Power Modules

# 3.8.1 Accessories for shielding

## Shield connection kit

Establish the shield and strain relief for the power connections using the shield connection kit.

The shield connection kit comprises a shield plate and serrated strips with screws.



| Table 3-17 | Article r  | numbers | for the | shield | connection | kit |
|------------|------------|---------|---------|--------|------------|-----|
|            | / little i | lumbers | ior the | Juncia | connection | N.L |

| Frame size | PM250 Power Module | PM230, PM240-2               | PM240P-2                    |
|------------|--------------------|------------------------------|-----------------------------|
| FSA        | 6SL3262-1AA00-0BA0 | The shield connection kit is |                             |
| FSB        | 6SL3262-1AB00-0DA0 | included in the scope of de- |                             |
| FSC        | 6SL3262-1AC00-0DA0 | livery                       |                             |
| FSD        | 6SL3262-1AD00-0DA0 |                              | The lower shield connec-    |
| FSE        | 6SL3262-1AD00-0DA0 |                              | tion kit is included in the |
| FSF        | 6SL3262-1AF00-0DA0 |                              | scope of delivery           |

## 3.8.2 Line filter

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

#### NOTICE

#### Overloading the line filter when connected to line supplies that are not permissible

The line filter is only suitable for operation on TN or TT line supplies with a grounded neutral point. If operated on other line supplies, the line filter will be thermally overloaded and will be damaged.

• For converters equipped with line filter, only connect to TN or TT line supplies with a grounded neutral point.

#### **External line filters for PM250**

| Power N | Лodule   | Power          | Class B line filter according to EN55011: 2009 |
|---------|--|----------------|--|
| FSC     | 6SL3225-0BE25-5AA0,<br>6SL3225-0BE27-5AA0,<br>6SL3225-0BE31-1AA0 | 7.5 kW 15.0 kW | 6SL3203-0BD23-8SA0                             |

#### 3.8.3 Line reactor

The line reactor supports the overvoltage protection, smoothes the harmonics in the line supply and bridges commutation dips. For the Power Modules subsequently listed, a line reactor is suitable in order to dampen the specified effects.



The figure on the right-hand side shows as example the line reactors for the PM240-2 Power Modules, FSB.

The line requirements for deployment of a line reactor depends on the Power Module:

Technical data (Page 485)

#### NOTICE

#### Damage to the converter as a result of a missing line reactor

Depending on the Power Module and line supply, if a line reactors is not used, this can result in damage to the converter and other components in the electrical plant or system.

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

| Line reactors | for PM24 | )-2, 380 V | 480 V |
|---------------|----------|------------|-------|
|---------------|----------|------------|-------|

| Power | Module   | Power          | Line reactor       |
|-------|--|----------------|--------------------|
| FSA   | 6SL3210-1PE11-8 . L1,<br>6SL3210-1PE12-3 . L1,<br>6SL3210-1PE13-2 . L1 | 0.55 kW 1.1 kW | 6SL3203-0CE13-2AA0 |
| FSB   | 6SL3210-1PE14-3 . L1,<br>6SL3211PE16-1 . L1,<br>6SL3211PE18-0 . L1     | 1.5 kW 3 kW    | 6SL3203-0CE21-0AA0 |
| FSC   | 6SL3210-1PE21-1 . L0,<br>6SL3210-1PE21-4 . L0,<br>6SL3211PE21-8 . L0   | 4 kW 7.5 kW    | 6SL3203-0CE21-8AA0 |
|       | 6SL3210-1PE22-7 . L0,<br>6SL3211PE23-3 . L0                            | 11 kW 15 kW    | 6SL3203-0CE23-8AA0 |

FSD ... FSG: A line reactor is not required.

#### Line reactors for PM240-2 Power Module, 500 V ... 690 V

A line reactor is not required.

## Line reactors for PM240-2, 200 V ... 240 V

| Power | Module   | Power           | Line reactor       |
|-------|--|-----------------|--------------------|
| FSA   | 6SL3210-1PB13-0 . LO,<br>6SL3210-1PB13-8 . LO                        | 0.55 kW 0.75 kW | 6SL3203-0CE13-2AA0 |
| FSB   | 6SL3210-1PB15-5 . LO,<br>6SL3210-1PB17-4 . LO,<br>6SL3211PB21-0 . LO | 1.1 kW 2.2 kW   | 6SL3203-0CE21-0AA0 |
| FSC   | 6SL3210-1PB21-4 . LO,<br>6SL3211PB21-8 . LO                          | 3 kW 4 kW       | 6SL3203-0CE21-8AA0 |
|       | 6SL3211PC22-2 . L0,<br>6SL3210-1PC22-8 . L0                          | 5.5 kW 7.5 kW   | 6SL3203-0CE23-8AA0 |

FSD ... FSF: A line reactor is not required.

## Line reactors for PM240-2 Power Modules

A line reactor is not required.

## 3.8.4 Output reactor

Output reactors reduce the voltage stress on the motor windings and the load placed on the converter as a result of capacitive recharging currents in the cables. One or two output reactors are required for longer motor cables.

You will find more information about permissible motor cable lengths in the Hardware Installation Manual for the Power Module.

Overview of the manuals (Page 564)

The figure on the right-hand side shows as example the output reactors for PM240-2 Power Modules, FSB and FSC.



#### NOTICE

#### Overheating of the output reactor if the pulse frequency is too high

The output reactor is dimensioned for the converter pulse frequency set in the factory. Converter operation with pulse frequencies higher than the factory setting can result in thermal overload of the output reactor. Excessively high temperatures damage the output reactor.

• Operate the converter with an output reactor with a maximum pulse frequency ≤ factory setting.

#### Output reactors for PM240-2 Power Modules, 380 V ... 480 V

| Power | Module   | Power          | Output reactor     |
|-------|--|----------------|--------------------|
| FSA   | 6SL3210-1PE11-8 . L1,<br>6SL3210-1PE12-3 . L1,<br>6SL3210-1PE13-2 . L1,<br>6SL3210-1PE14-3 . L1,<br>6SL3210-1PE16-1 . L1 | 0.55 kW 2.2 kW | 6SL3202-0AE16-1CA0 |
|       | 6SL3211PE18-0.L1   | 3 kW           | 6SL3202-0AE18-8CA0 |
| FSB   | 6SL3210-1PE21-1 . L0,<br>6SL3210-1PE21-4 . L0,<br>6SL3211PE21-8 . L0   | 4 kW 7.5 kW    | 6SL3202-0AE21-8CA0 |
| FSC   | 6SL3210-1PE22-7 . L0,<br>6SL3211PE23-3 . L0  | 11 kW 15 kW    | 6SL3202-0AE23-8CA0 |
| FSD   | 6SL3210-1PE23-8 . L0<br>6SL3210-1PE24-5 . L0<br>6SL3210-1PE26-0 . L0<br>6SL3211PE27-5 . L0                               | 18.5 kW 37 kW  | 6SE6400-3TC07-5ED0 |
| FSE   | 6SL3210-1PE28-8 . L0,<br>6SL3211PE31-1 . L0  | 45 kW 55 kW    | 6SE6400-3TC14-5FD0 |
| FSF   | 6SL3210-1PE31-5 . L0   | 75 kW          |                    |
|       | 6SL3210-1PE31-8 . L0   | 90 kW          |                    |
|       | 6SL3210-1PE32-1 . L0   | 110 kW         | 6SL3000-2BE32-1AA0 |
|       | 6SL3211PE32-5.L0   | 132 kW         | 6SL3000-2BE32-6AA0 |

| Power I | Module               | Power  | Output reactor     |
|---------|----------------------|--------|--------------------|
| FSG     | 6SL3210-1PE33-0 . L0 | 160 kW | 6SL3000-2BE33-2AA0 |
|         | 6SL3210-1PE33-7 . L0 | 200 kW | 6SL3000-2BE33-8AA0 |
|         | 6SL3210-1PE34-8 . L0 | 250 kW | 6SL3000-2BE35-0AA0 |

## Output reactors for PM240-2 Power Modules, 500 V ... 690 V

| Power Module |   | Power         | Output reactor     |
|--------------|---|---------------|--------------------|
| FSF          | 6SL3210-1PH28-0 . L0,<br>6SL3210-1PH31-0 . L0 | 75 kW 90 kW   | 6SL3000-2AH31-0AA0 |
|              | 6SL3210-1PH31-2 . L0,<br>6SL3210-1PH31-4 . L0 | 110 kW 132 kW | 6SL3000-2AH31-5AA0 |
| FSG          | 6SL3210-1PH31-7CL0                            | 160 kW        | 6SL3000-2AH31-8AA0 |
|              | 6SL3210-1PH32-1CL0                            | 200 kW        | 6SL3000-2AH32-4AA0 |
|              | 6SL3210-1PH32-5CL0                            | 250 kW        | 6SL3000-2AH32-6AA0 |

## Output reactors for PM240-2 Power Modules, 200 V ... 240 V

| Power | Module   | Power           | Output reactor     |
|-------|--|-----------------|--------------------|
| FSA   | 6SL3210-1PB13-0 . LO,<br>6SL3211PB13-8 . LO                      | 0.55 kW 0.75 kW | 6SL3202-0AE16-1CA0 |
| FSB   | 6SL3210-1PB15-5 . L0   | 1.1 kW          |                    |
|       | 6SL3210-1PB17-4 . L0   | 1.5 kW          | 6SL3202-0AE18-8CA0 |
| FSB   | 6SL3211PB21-0.L0   | 2.2 kW          | 6SL3202-0AE21-8CA0 |
| FSC   | 6SL3210-1PB21-4 . LO,<br>6SL3211PB21-8 . LO                      | 3 kW 4 kW       |                    |
|       | 6SL3211PC22-2 . L0,<br>6SL3210-1PC22-8 . L0                      | 5.5 kw 7.5 kW   | 6SL3202-0AE23-8CA0 |
| FSD   | 6SL3210-1PC24-2UL0,<br>6SL3210-1PC25-4UL0,<br>6SL3210-1PC26-8UL0 | 11 kW 18.5 kW   | 6SE6400-3TC07-5ED0 |
| FSE   | 6SL3210-1PC28-0UL0,<br>6SL3210-1PC31-1UL0                        | 22 kW 55 kW     | 6SE6400-3TC14-5FD0 |
| FSF   | 6SL3210-1PC31-3UL0,<br>6SL3210-1PC31-6UL0,<br>6SL3210-1PC31-8UL0 |                 |                    |

## Output reactors for PM240P-2 Power Modules, 380 V ... 480 V

| Power N | Module               | Power  | Output reactor     |
|---------|----------------------|--------|--------------------|
| FSD     | 6SL3210-1RE24-5 . L0 | 22 kW  | 6SE6400-3TC03-8DD0 |
|         | 6SL3210-1RE26-0 . L0 | 30 kW  | 6SE6400-3TC07-5ED0 |
|         | 6SL3210-1RE27-5 . L0 | 37 kW  |                    |
| FSE     | 6SL3210-1RE28-8 . L0 | 45 kW  |                    |
|         | 6SL3210-1RE31-1 . L0 | 55 KW  | 6SE6400-3TC14-5FD0 |
| FSF     | 6SL3210-1RE31-5 . L0 | 75 kW  |                    |
|         | 6SL3210-1RE31-8 . L0 | 90 kW  |                    |
|         | 6SL3210-1RE32-1 . L0 | 110 kW | 6SL3000-2BE32-1AA0 |
|         | 6SL3210-1RE32-5 . L0 | 132 kW | 6SL3000-2BE32-6AA0 |

## Output reactors for PM250 Power Module

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

## Output reactors for PM230 Power Modules (IP20)

| Power I | Module   | Power           | Output reactor     |
|---------|--|-----------------|--------------------|
| FSA     | 6SL3210-1NE11-3 . G1<br>6SL3210-1NE11-7 . G1<br>6SL3210-1NE12-2 . G1<br>6SL3210-1NE13-1 . G1<br>6SL3210-1NE14-1 . G1<br>6SL3210-1NE15-8 . G1 | 0.37 kW 2.2 kW  | 6SL3202-0AE16-1CA0 |
|         | 6SL3210-1NE17-7 . G1   | 3.0 kW          | 6SL3202-0AE18-8CA0 |
| FSB     | 6SL3210-1NE21-0 . G1<br>6SL3210-1NE21-3 . G1<br>6SL3210-1NE21-8 . G1   | 4.0 kW 7.5 kW   | 6SL3202-0AE21-8CA0 |
| FSC     | 6SL3210-1NE22-6 . G1<br>6SL3210-1NE23-2 . G1<br>6SL3210-1NE23-8 . G1   | 11.0 kW 18.5 kW | 6SL3202-0AE23-8CA0 |
| FSD     | 6SL3210-1NE24-5 . L0   | 22 kW           | 6SE6400-3TC03-8DD0 |
|         | 6SL3210-1NE26-0 . L0   | 30 kW           | 6SE6400-3TC05-4DD0 |

| Power N | <i>l</i> odule       | Power | Output reactor     |
|---------|----------------------|-------|--------------------|
| FSE     | 6SL3210-1NE27-5 . L0 | 37 kW | 6SE6400-3TC08-0ED0 |
|         | 6SL3210-1NE28-8 . L0 | 45 kW | 6SE6400-3TC07-5ED0 |
| FSF     | 6SL3210-1NE31-1 . L0 | 55 kW | 6SE6400-3TC14-5FD0 |
|         | 6SL3210-1NE31-5 . L0 | 75 kW | 6SE6400-3TC15-4FD0 |

# Output reactors for PM230 push-through Power Modules

| Power N | Nodule               | Power   | Output reactor     |
|---------|----------------------|---------|--------------------|
| FSA     | 6SL3211-1NE17-7 . G1 | 3.0 kW  | 6SL3202-0AE18-8CA0 |
| FSB     | 6SL3211-1NE21-8 . G1 | 7.5 kW  | 6SL3202-0AE21-8CA0 |
| FSC     | 6SL3211-1NE23-8 . G1 | 18.5 kW | 6SL3202-0AE23-8CA0 |

## 3.8.5 ((dv/dt filter plus VPL\_PM240-2))

A combination of dv/dt filter and a voltage peak limiter (VPL) – dv/dt filter plus VPL – is available to suppress voltage peaks.

When using a dv/dt filter plus VPL, observe the following restrictions:

- The output frequency must not exceed 150 Hz.
- The pulse frequency must not exceed 4 kHz.



#### NOTICE

#### Damage to the dv/dt filter plus VPL if it is not activated during commissioning

The dv/dt filter plus VPL may be damaged if it is not activated during commissioning.

- Activate the dv/dt filter plus VPL during commissioning via parameter p0230.
- Activate the dv/dt filter plus VPL during commissioning according to the electric specifications.

#### NOTICE

#### Damage to the dv/dt filter plus VPL if the connection to the capacitor is not removed

The dv/dt filter plus VPL may be damaged if the connection to the capacitor of the common mode filter is not removed when the dv/dt filter plus VPL operates in the IT line system.

Further information is provided on the Internet:

• Graphic FAQ of dv/dt filter plus VPL (<u>https://support.industry.siemens.com/cs/ww/en/ps/13224/</u> faq)

For applications in the USA and Canada, you can also use the dv/dt filters plus VPL recommended by Siemens Product Partner for Drive Options. For more information, see the link below:

Voltage limiter and dv/dt filter (<u>https://www.mdexx.com/wp-content/uploads/2019/11/</u> BAF-18-001-76\_Instruction\_manual.pdf)

#### dv/dt filters plus VPL for PM240-2 Power Modules, 3 AC 400 V

| Power Module |  | Power          | dv/dt filter plus VPL<br>Manufacturer: mdexx Mag- |
|--------------|--|----------------|---|
|              |  |                | netronic Devices s.r.o                            |
| FSD          | 6SL3210-1PE23-8 .L0                        | 18.5 kW        | JTA:TEF1203-0HB                                   |
|              | 6SL3210-1PE24-5 .L0<br>6SL3210-1PE26-0 .L0 | 22 kW<br>30 kW | JTA:TEF1203-0JB                                   |
| FSD<br>FSE   | 6SL3211PE27-5 .L0<br>6SL3210-1PE28-8 .L0   | 37 kW<br>45 kW | JTA:TEF1203-0KB                                   |

| Power N    | Module  | Power                     | dv/dt filter plus VPL<br>Manufacturer: mdexx Mag-<br>netronic Devices s.r.o |
|------------|---|---------------------------|---|
| FSE<br>FSF | 6SL3211PE31-1 .L0<br>6SL3210-1PE31-5 .L0                        | 55 kW<br>75 kW            | JTA:TEF1203-0LB   |
| FSF        | 6SL3210-1PE31-8 .L0<br>6SL3210-1PE32-1 .L0<br>6SL3211PE32-5 .L0 | 90 kW<br>110 kW<br>132 kW | JTA:TEF1203-0MB   |

# dv/dt filters plus VPL for PM240-2 Power Modules, 3 AC 690 V

| Power | Module  | Power                      | dv/dt filter plus VPL<br>Manufacturer: mdexx Mag-<br>netronic Devices s.r.o |
|-------|---|----------------------------|---|
| FSD   | 6SL3210-1PH21-4 .L0<br>6SL3210-1PH22-0 .L0<br>6SL3210-1PH22-3 .L0 | 11 kW<br>15 kW<br>18.5 kW  | JTA:TEF1203-0GB   |
|       | 6SL3210-1PH22-7 .L0<br>6SL3210-1PH23-5 .L0<br>6SL3210-1PH24-2 .L0 | 22 kW<br>30 kW<br>37 kW    | JTA:TEF1203-0HB   |
| FSE   | 6SL3210-1PH25-2 .L0<br>6SL3210-1PH26-2 .L0                        | 45 kW<br>55 kW             | JTA:TEF1203-0JB   |
| FSF   | 6SL3210-1PH28-0 .L0<br>6SL3210-1PH31-0 .L0                        | 75 kW<br>90 kW             | JTA:TEF1203-0KB   |
|       | 6SL3210-1PH31-2 .L0<br>6SL3210-1PH31-4 .L0                        | 110 kW<br>132 kW           | JTA:TEF1203-0LB   |
| FSG   | 6SL3210-1PH31-7CL0<br>6SL3210-1PH32-1CL0<br>6SL3210-1PH32-5CL0    | 160 kW<br>200 kW<br>250 kW | JTA:TEF1203-0MB   |

## 3.8.6 Sine-wave filter

The sine-wave filter at the converter output limits the voltage rate-ofrise and the peak voltages at the motor winding. The maximum permissible length of motor feeder cables is increased to 300 m.

The following applies when using a sine-wave filter:

• Operation is only permissible with pulse frequencies from 4 kHz to 8 kHz.

From 110 kW power rating of the Power Modules (according to the type plate) only 4 kHz is permissible.

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

#### Sine-wave filter for PM240-2 Power Module, 380 V ... 480 V

| Power | Module  | Power         | Sine-wave filter   |
|-------|---|---------------|--------------------|
| FSD   | 6SL3210-1PE23-8 . L0,<br>6SL3210-1PE24-5 . L0 | 18.5 kW 22 kW | 6SL3202-0AE24-6SA0 |
|       | 6SL3210-1PE26-0 . L0                          | 30 kW         | 6SL3202-0AE26-2SA0 |
|       | 6SL3211PE27-5.L0                              | 37 kW         | 6SL3202-0AE28-8SA0 |
| FSE   | 6SL3210-1PE28-8 . L0                          | 45 kW         |                    |
|       | 6SL3211PE31-1.L0                              | 55 kW         | 6SL3202-0AE31-5SA0 |
| FSF   | 6SL3210-1PE31-5 . L0                          | 75 kW         |                    |
|       | 6SL3210-1PE31-8 . L0                          | 90 kW         | 6SL3202-0AE31-8SA0 |
|       | 6SL3210-1PE32-1 . L0,<br>6SL3211PE32-5 . L0   | 110 kW 132 kW | 6SL3000-2CE32-3AA0 |
| FSG   | 6SL3210-1PE33-0 . L0                          | 160 kW        | 6SL3000-2CE32-8AA0 |
|       | 6SL3210-1PE33-7 . L0                          | 200 kW        | 6SL3000-2CE33-3AA0 |
|       | 6SL3210-1PE34-8 . L0                          | 250 kW        | 6SL3000-2CE34-1AA0 |

#### Sine-wave filter for PM240-2 Power Module, 200 V ... 240 V

| Power | Module                                  | Power       | Sine-wave filter   |
|-------|---|-------------|--------------------|
| FSD   | 6SL3210-1PC24-2UL0                      | 11 kW       | 6SL3202-0AE24-6SA0 |
|       | 6SL3210-1PC25-4UL0                      | 15 kW       | 6SL3202-0AE26-2SA0 |
|       | 6SL3211PC26-8UL0                        | 18.5 kW     | 6SL3202-0AE28-8SA0 |
| FSE   | 6SL3210-1PC28-0UL0                      | 22 kW       |                    |
|       | 6SL3211PC31-1UL0                        | 30 kW       | 6SL3202-0AE31-5SA0 |
| FSF   | 6SL3210-1PC31-3UL0                      | 37 kW       |                    |
|       | 6SL3210-1PC31-6UL0,<br>6SL3211PC31-8UL0 | 45 kW 55 kW | 6SL3202-0AE31-8SA0 |



## Sine-wave filter for PM250 Power Module

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

## Sine-wave filter for PM240P-2 Power Module, 380 V ... 480 V

| Power | Module               | Power  | Sine-wave filter   |
|-------|----------------------|--------|--------------------|
| FSD   | 6SL3210-1RE24-5 . L0 | 22 kW  | 6SL3202-0AE26-2SA0 |
|       | 6SL3210-1RE26-0 . L0 | 30 kW  | 6SL3202-0AE28-8SA0 |
|       | 6SL3210-1RE27-5 . L0 | 37 kW  |                    |
| FSE   | 6SL3210-1RE28-8 . L0 | 45 kW  | 6SL3202-0AE31-5SA0 |
|       | 6SL3210-1RE31-1.L0   | 55 KW  |                    |
| FSF   | 6SL3210-1RE31-5 . L0 | 75 kW  | 6SL3202-0AE31-8SA0 |
|       | 6SL3210-1RE31-8 . L0 | 90 kW  | 6SL3000-2CE32-3AA0 |
|       | 6SL3210-1RE32-1 . L0 | 110 kW |                    |
|       | 6SL3210-1RE32-5 . L0 | 132 kW | 6SL3000-2CE32-8AA0 |

## 3.8.7 Braking resistor

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

The Power Module controls the braking resistor via its integrated braking module. The figure shown on the right-hand side shows as example the braking resistor for a PM240-2 Power Module, FSB.



| Power | r Module  | Power          | Braking resistor   |
|-------|---|----------------|--------------------|
| FSA   | 6SL3210-1PE11-8 . L1,<br>6SL3210-1PE12-3 . L1,<br>6SL3210-1PE13-2 . L1,<br>6SL3210-1PE14-3 . L1 | 0.55 kW 1.5 kW | 6SL3201-0BE14-3AA0 |
|       | 6SL3211PE16-1.L1,<br>6SL3211PE18-0.L1   | 2.2 kW 3.0 kW  | 6SL3201-0BE21-0AA0 |
| FSB   | 6SL3210-1PE21-1 . L0,<br>6SL3210-1PE21-4 . L0,<br>6SL3211PE21-8 . L0                            | 4 kW 7.5 kW    | 6SL3201-0BE21-8AA0 |
| FSC   | 6SL3210-1PE22-7 . LO,<br>6SL3211PE23-3 . LO   | 11 kW 15 kW    | 6SL3201-0BE23-8AA0 |
| FSD   | 6SL3210-1PE23-8 . L0,<br>6SL3210-1PE24-5 . L0   | 18.5 kW 22 kW  | JJY:023422620001   |
|       | 6SL3210-1PE26-0 . LO,<br>6SL3210-1PE27-5 . LO   | 30 kW 37 kW    | JJY:023424020001   |
| FSE   | 6SL3210-1PE28-8 . L0,<br>6SL3210-1PE31-1 . L0   | 45 kW 55 kW    | JJY:023434020001   |
| FSF   | 6SL3210-1PE31-5 . LO,<br>6SL3210-1PE31-8 . LO,  | 75 kW 90 kW    | JJY:023454020001   |
|       | 6SL3210-1PE32-1 . LO,<br>6SL3210-1PE32-5 . LO   | 90 kW 132 kW   | JJY:023464020001   |
| FSG   | 6SL3210-1PE33-0AL0,<br>6SL3210-1PE33-7AL0,<br>6SL3210-1PE34-8AL0                                | 160 kW 250 kW  | 6SL3000-1BE32-5AA0 |

#### Braking resistors for PM240-2, 380 V ... 480 V

| Power N | Nodule  | Power         | Braking resistor   |
|---------|---|---------------|--------------------|
| FSD     | 6SL3210-1PH21-4 . L0,<br>6SL3210-1PH22-0 . L0,<br>6SL3210-1PH22-3 . L0,<br>6SL3210-1PH22-7 . L0,<br>6SL3210-1PH23-5 . L0,<br>6SL3210-1PH24-2 . L0 | 11 kW 37 kW   | JJY:023424020002   |
| FSE     | 6SL3210-1PH25-2 . L0,<br>6SL3210-1PH26-2 . L0   | 45 kW 55 kW   | JJY:023434020002   |
| FSF     | 6SL3210-1PH28-0 . L0,<br>6SL3210-1PH31-0 . L0,  | 75 kW 90 kW   | JJY:023464020002   |
|         | 6SL3210-1PH31-2 . L0,<br>6SL3210-1PH31-4 . L0   | 110 kW 132 kW | JJY:023464020002   |
| FSG     | 6SL3210-1PH31-7CL0,<br>6SL3210-1PH32-1CL0,<br>6SL3210-1PH32-5CL0  | 160 kW 250 kW | 6SL3000-1BH32-5AA0 |

## Braking resistors for PM240-2, 500 V ... 690 V

## Braking resistors for PM240-2, 200 V ... 240 V

| Power | Module   | Power           | Braking resistor  |
|-------|--|-----------------|-------------------|
| FSA   | 6SL3210-1PB13-0 . LO,<br>6SL3211PB13-8 . LO                          | 0.55 kW 0.75 kW | JJY:023146720008  |
| FSB   | 6SL3210-1PB15-5 . LO,<br>6SL3210-1PB17-4 . LO,<br>6SL3211PB21-0 . LO | 1.1 kW 2.2 kW   | JJY:023151720007  |
| FSC   | 6SL3210-1PB21-4 . LO,<br>6SL3211PB21-8 . LO                          | 3 kW 4 kW       | JJY:02 3163720018 |
|       | 6SL3210-1PC22-2 . L0,<br>6SL3210-1PC22-8 . L0                        | 5.5 kW 7.5 kW   | JJY:023433720001  |
| FSD   | 6SL3210-1PC24-2UL0,<br>6SL3210-1PC25-4UL0,<br>6SL3210-1PC26-8UL0     | 11 kW 18.5 kW   | JJY:023422620002  |
| FSE   | 6SL3210-1PC28-0UL0,<br>6SL3210-1PC31-1UL0                            | 22 kW 30 kW     | JJY:023423320001  |
| FSF   | 6SL3210-1PC31-3UL0,<br>6SL3210-1PC31-6UL0,<br>6SL3210-1PC31-8UL0     | 37 kW 55 kW     | JJY:023434020003  |

## 3.8.8 Brake Relay



The Brake Relay has a switch contact (NO contact) for controlling a motor holding brake.

Article number: 6SL3252-0BB00-0AA0

The following Power Modules have a connection possibility for the Brake Relay:

- PM240-2
- PM240P-2
- PM250

## 3.8.9 Safe Brake Relay



The Safe Brake Relay controls a 24 V motor brake and monitors the brake control for a short-circuit or interrupted cable. Article number: 6SL3252-0BB01-0AA0

The following Power Modules have a connection possibility for the Brake Relay:

- PM240-2
- PM240P-2
- PM250

## 3.8.10 Control Unit Adapter Kit CUA20

#### Overview

When using the CUA20 Control Unit Adapter Kit, the Control Unit can be installed next to the PM240-2 Power Module.

Article No: 6SL3255-0BW01-0NA0



Figure 3-5 Control Unit Adapter Kit CUA20

The SINAMICS CUA20 Control Unit Adapter Kit comprises the following components:

- Adapter which is snapped onto the Power Module
- Adapter for the Control Unit
- Prefabricated cable to connect the two adapters

3.9 Motors and multi-motor drives that can be operated

#### Motors and multi-motor drives that can be operated 3.9

#### Siemens motors that can be operated

You can connect standard induction motors to the converter.

You can find information on further motors on the Internet:

Motors that can be operated (https://support.industry.siemens.com/cs/ww/en/view/ 100426622)

#### Third-party motors that can be operated

You can operate standard asynchronous motors from other manufacturers with the converter:

#### NOTICE

#### Insulation failure due to unsuitable third-party motor

A higher load occurs on the motor insulation in converter mode than with line operation. Damage to the motor winding may occur as a result.

Please observe the notes in the System Manual "Requirements for third-party motors"

Further information is provided on the Internet:

Requirements for third-party motors (https://support.industry.siemens.com/cs/ww/en/ view/79690594)

#### **Multi-motor operation**

Multi-motor operation involves simultaneously operating several identical motors on one converter. For standard induction motors, multi-motor operation is generally permissible.

Additional preconditions and restrictions relating to multi-motor operation are available on the Internet:



Multi-motor drive (http://support.automation.siemens.com/WW/view/en/84049346)

# Installing

# 4.1 Installing the label for the North American market

#### Description



Figure 4-1 Adhesive label with danger and warning notes for North America

The converter is supplied with an adhesive label with danger and warning notes for the North American market.

Attach the adhesive label in the required language to the inside of the control cabinet where it is clearly visible at all times.

4.2 EMC-compliant setup of the machine or plant

# 4.2 EMC-compliant setup of the machine or plant

The converter is designed for operation in industrial environments where strong electromagnetic fields are to be expected.

Reliable and disturbance-free operation is only ensured for EMC-compliant installation.

To achieve this, subdivide the control cabinet and the machine or system into EMC zones:

#### EMC zones



Figure 4-2 Example of the EMC zones of a plant or machine

#### Inside the control cabinet

- Zone A: Line supply connection
- Zone B: Power electronics Devices in Zone B generate energy-rich electromagnetic fields.
- Zone C: Control and sensors Devices in Zone C do not generate any energy-rich electromagnetic fields themselves, but their functions can be impaired by electromagnetic fields.

#### Outside the control cabinet

 Zone D: Motors, braking resistors Devices in Zone D generate electromagnetic fields with a significant amount of energy

## 4.2.1 Control cabinet

- Assign the various devices to zones in the control cabinet.
- Electromagnetically uncouple the zones from each other by means of one of the following actions:
  - − Side clearance  $\ge$  25 cm
  - Separate metal enclosure
  - Large-area partition plates
- Route cables of various zones in separate cable harnesses or cable ducts.
- Install filters or isolation amplifiers at the interfaces of the zones.

#### **Control cabinet assembly**

- Connect the door, side panels, top and base plate of the control cabinet with the control cabinet frame using one of the following methods:
  - Electrical contact surface of several cm<sup>2</sup> for each contact location
  - Several screw connections
  - − Short, finely stranded, braided copper wires with cross-sections  $\ge$  95 mm<sup>2</sup> / 000 (3/0) (-2) AWG
- Install a shield support for shielded cables that are routed out of the control cabinet.
- Connect the PE bar and the shield support to the control cabinet frame through a large surface area to establish a good electrical connection.
- Mount the control cabinet components on a bare metal mounting plate.
- Connect the mounting plate to the control cabinet frame and PE bar and shield support through a large surface area to establish a good electrical connection.
- For screw connections onto painted or anodized surfaces, establish a good conductive contact using one of the following methods:
  - Use special (serrated) contact washers that cut through the painted or anodized surface.
  - Remove the insulating coating at the contact locations.

#### Measures required for several control cabinets

- Install equipotential bonding for all control cabinets.
- Screw the frames of the control cabinets together at several locations through a large surface area using serrated washers to establish a good electrical connection.
- In plants and systems where the control cabinets are lined up next to one another, and which are installed in two groups back to back, connect the PE bars of the two cabinet groups at as many locations as possible.

4.2 EMC-compliant setup of the machine or plant



Figure 4-3 Grounding and high-frequency equipotential bonding measures in the control cabinet and in the plant/system

#### **Further information**

Additional information about EMC-compliant installation is available in the Internet:

EMC installation guideline (<u>http://support.automation.siemens.com/WW/view/en/</u>60612658)

#### 4.2.2 Cables

Cables with a high level of interference and cables with a low level of interference are connected to the converter:

- Cables with a high level of interference:
  - Cable between the line filter and converter
  - Motor cable
  - Cable at the converter DC link connection
  - Cable between the converter and braking resistor
- Cables with a low level of interference:
  - Cable between the line and line filter
  - Signal and data cables

#### Cable routing inside the cabinet

- Route the power cables with a high level of interference so that there is a minimum clearance
  of 25 cm to cables with a low level of interference.
  If the minimum clearance of 25 cm is not possible, insert separating metal sheets between
  the cables with a high level of interference and cables with a low level of interference.
  Connect these separating metal sheets to the mounting plate to establish a good electrical
  connection.
- Cables with a high level of interference and cables with a low level of interference may only cross over at right angles:
- Keep all of the cables as short as possible.
- Route all of the cables close to the mounting plates or cabinet frames.
- Route signal and data cables as well as the associated equipotential bonding cables parallel and close to one another.
- Twist incoming and outgoing unshielded individual conductors. Alternatively, you can route incoming and outgoing conductors in parallel, but close to one another.
- Ground any unused conductors of signal and data cables at both ends.
- Signal and data cables must only enter the cabinet from one side, e.g. from below.
- Use shielded cables for the following connections:
  - Cable between the converter and line filter
  - Cable between the converter and output reactor or sine-wave filter



Figure 4-4 Routing converter cables inside and outside a control cabinet

#### 4.2 EMC-compliant setup of the machine or plant

#### Routing cables outside the control cabinet

- Maintain a minimum clearance of 25 cm between cables with a high level of interference and cables with a low level of interference.
- Use shielded cables for the following connections:
  - Converter motor cable
  - Cable between the converter and braking resistor
  - Signal and data cables
- Connect the motor cable shield to the motor enclosure using a PG gland that establishes a good electrical connection.

#### **Requirements relating to shielded cables**

- Use cables with finely-stranded, braided shields.
- Connect the shield to at least one end of the cable.



Figure 4-5 Examples for EMC-compliant shield support

- Attach the shield to the shield support directly after the cable enters the cabinet.
- Do not interrupt the shield.
- Only use metallic or metallized plug connectors for shielded data cables.

#### 4.2 EMC-compliant setup of the machine or plant

## 4.2.3 Electromechanical components

## Surge voltage protection circuit

- Connect surge voltage protection circuits to the following components:
  - Coils of contactors
  - Relays
  - Solenoid valves
  - Motor holding brakes
- Connect the surge voltage protection circuit directly at the coil.
- Use RC elements or varistors for AC-operated coils and freewheeling diodes or varistors for DC-operated coils.

4.3 Installing reactors, filters and braking resistors

# 4.3 Installing reactors, filters and braking resistors

#### Installing reactors, filters and braking resistors

The following supplementary components may be required depending on the Power Modules and the particular application:

- Line reactors
- Filter
- Braking resistors
- Brake Relay

Installing these components is described in the documentation provided.

## 4.4.1 Basic installation rules

#### Protection against the spread of fire

The built-in units may be operated only in closed housings or in higher-level control cabinets with closed protective covers, and when all of the protective devices are used. The installation of the built-in units in a metal control cabinet or protection with another equivalent measure must prevent the spread of fire and emissions outside the control cabinet.

Wall mounting units may be operated outside the control cabinet.

#### Protection against condensation or electrically conductive contamination

Protect the converter, e.g. by installing it in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12. Further measures may be necessary for particularly critical operating conditions.

If condensation or conductive pollution can be excluded at the installation site, a lower degree of control cabinet protection may be permitted.

#### Installing

Rules for admissible mounting:

• Only mount the Power Module in a vertical position with the motor connectors at the bottom.





- Maintain the minimum clearances to other components.
- Use the specified installation parts and components.
- Comply with the specified torques.

## 4.4.2 Dimensioned drawings, drilling dimensions for the PM240-2 Power Module, IP20

The following dimension drawings and drilling patterns are not to scale.

#### Frame sizes FSA ... FSC



#### Table 4-1 Dimensions

| Frame<br>size | Width<br>[mm] | Height [mm]             |                      | Mounting depth in the cabi-<br>net with Control Unit (CU)<br>[mm] <sup>3)</sup> |                       | Mount-<br>ing depth<br>with |
|---------------|---------------|-------------------------|----------------------|---|-----------------------|-----------------------------|
|               |               | without<br>shield plate | with shield<br>plate | without OP  | with OP <sup>1)</sup> | CUA20 <sup>2)</sup><br>[mm] |
| FSA           | 73            | 196                     | 276                  | 206   | 217                   | 194                         |
| FSB           | 100           | 292                     | 370                  | 206   | 217                   | 194                         |
| FSC           | 140           | 355                     | 432                  | 206   | 217                   | 194                         |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Control Unit Adapter Kit CUA20

<sup>3)</sup> Depth of Power Module without Control Unit: 165 mm

| Table 4-2 | Drilling | dimensions, | cooling | clearances | and fixing |
|-----------|----------|-------------|---------|------------|------------|
|           | J        |             | J       |            | J          |

| Frame | Drilling dimensions [mm] |      |   | Cooling air clearances [mm] <sup>1)</sup> |        |       | Fixing/torque [Nm] |
|-------|--------------------------|------|---|---|--------|-------|--------------------|
| size  | h                        | b    | с | Тор                                       | Bottom | Front |                    |
| FSA   | 186                      | 62.3 | 6 | 80  | 100    | 100   | 3 x M4 / 2.5       |
| FSB   | 281                      | 80   | 6 | 80  | 100    | 100   | 4 x M4 / 2.5       |
| FSC   | 343                      | 120  | 6 | 80  | 100    | 100   | 4 x M5 / 3.5       |

<sup>1)</sup> The Power Module is designed for mounting without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

#### Frame sizes FSD ... FSF



Table 4-3 Dimensions

| Frame<br>size | Width<br>[mm] | Height [mm]                      |      | Mounting depth in the cabi-<br>net with Control Unit (CU)<br>[mm] <sup>3)</sup> |                       | Mounting<br>depth<br>with   |
|---------------|---------------|----------------------------------|------|---|-----------------------|-----------------------------|
|               |               | without with shield shield plate |      | without OP  | with OP <sup>1)</sup> | CUA20 <sup>2)</sup><br>[mm] |
| FSD           | 200           | 472                              | 624  | 237   | 246                   | 237                         |
| FSE           | 275           | 551                              | 728  | 237   | 246                   | 237                         |
| FSF           | 305           | 709                              | 965  | 357   | 366                   | 357                         |
| FSG           | 305           | 1000                             | 1286 | 357   | 366                   | 357                         |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Control Unit Adapter Kit CUA20

<sup>3)</sup> Depth of Power Module without Control Unit: FSD, FSE 237 mm, FSF, FSG 357 mm

Table 4-4Drilling dimensions, cooling clearances and fixing

| Frame | Drilling dimensions [mm] |     |     | Cooling air clearances [mm] <sup>1)</sup> |                      |       | Fixing/torque [Nm] |
|-------|--------------------------|-----|-----|---|----------------------|-------|--------------------|
| size  | h                        | b   | с   | Top <sup>2)</sup>                         | Bottom <sup>2)</sup> | Front |                    |
| FSD   | 430                      | 170 | 7   | 300                                       | 350                  | 100   | 4 x M5 / 6.0       |
| FSE   | 509                      | 230 | 8.5 | 300                                       | 350                  | 100   | 4 x M6 / 10        |

| Frame | Drilling dimensions [mm] |     |    | Cooling air clearances [mm] <sup>1)</sup> |                      |       | Fixing/torque [Nm] |
|-------|--------------------------|-----|----|---|----------------------|-------|--------------------|
| size  | h                        | b   | с  | Top <sup>2)</sup>                         | Bottom <sup>2)</sup> | Front |                    |
| FSF   | 680                      | 270 | 13 | 300                                       | 350                  | 100   | 4 x M8 / 25        |
| FSG   | 970.5                    | 265 | 15 | 300                                       | 350                  | 100   | 4 x M8 / 25        |

<sup>1)</sup> The Power Module is designed for mounting without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

<sup>2)</sup> The top and bottom cooling air clearances refer to the Power Module without shield plate
## 4.4.3 Dimension drawings, drilling dimensions for PM240P-2 Power Modules, IP20

The following dimension drawings and drilling patterns are not to scale.

#### Frame sizes FSD ... FSF



Table 4-5Dimensions depend on the operator panel (OP) that is inserted 1)

| Frame<br>size | Width<br>[mm] | Heigh                   | t [mm]            | Mounting depth in<br>Control Unit | n the cabinet with<br>(CU) [mm] <sup>2)</sup> |
|---------------|---------------|-------------------------|-------------------|-----------------------------------|---|
|               |               | without shield<br>plate | with shield plate | without OP                        | with OP <sup>1)</sup>                         |
| FSD           | 200           | 472                     | 624               | 237                               | 246   |
| FSE           | 275           | 551                     | 728               | 237                               | 246   |
| FSF           | 305           | 709                     | 965               | 357                               | 366   |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Power Module depth without Control Unit: FSD, FSE 237 mm, FSF 357 mm

| Frame | Drilling | dimensio | ns [mm] | Cooling a | air clearance | Fixing/torque [Nm] |              |
|-------|----------|----------|---------|-----------|---------------|--------------------|--------------|
| size  | h        | b        | с       | Тор       | Bottom        | Front              |              |
| FSD   | 430      | 170      | 7       | 300       | 350           | 100                | 4 x M5 / 6.0 |
| FSE   | 509      | 230      | 8.5     | 300       | 350           | 100                | 4 x M6 / 10  |
| FSF   | 680      | 270      | 13      | 300       | 350           | 100                | 4 x M8 / 25  |

 Table 4-6
 Drilling dimensions, cooling clearances and fixing

<sup>1)</sup> The Power Module is designed for mounting without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

## 4.4.4 Dimension drawings, drilling dimensions for the PM230 Power Module, IP20

The following dimension drawings and drilling patterns are not to scale.

### Frame sizes FSA ... FSC



 Table 4-7
 Dimensions depend on the operator panel (OP) that is inserted

| Frame<br>size | Width<br>[mm] | Heigh                   | t [mm]            | Mounting depth in<br>Control Unit | n the cabinet with<br>(CU) [mm] <sup>2)</sup> |
|---------------|---------------|-------------------------|-------------------|-----------------------------------|---|
|               |               | without shield<br>plate | with shield plate | without OP                        | with OP <sup>1)</sup>                         |
| FSA           | 73            | 196                     | 276               | 224                               | 235   |
| FSB           | 100           | 292                     | 370               | 224                               | 235   |
| FSC           | 140           | 355                     | 432               | 224                               | 235   |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Power Module depth without Control Unit: 165 mm

| Table 4-8 | Drilling dimensions, | cooling clearances | and fixing |
|-----------|----------------------|--------------------|------------|
|-----------|----------------------|--------------------|------------|

| Frame size | Drilling dimensions<br>[mm] |     |   | Cooling a | ir clearan<br>1) | Fixing/torque<br>[Nm] |              |
|------------|-----------------------------|-----|---|-----------|------------------|-----------------------|--------------|
|            | b                           | h   | с | Тор       | Bottom           | Front                 |              |
| FSA        | 62.3                        | 186 | 6 | 80        | 100              |                       | 2 x M4 / 2.5 |
| FSB        | 80                          | 281 | 6 | 80        | 100              |                       | 4 x M4 / 2.5 |
| FSC        | 120                         | 343 | 6 | 80        | 100              |                       | 4 x M5 / 3.0 |

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

### Frame sizes FSD ... FSF



Table 4-9Dimensions depend on the operator panel (OP) that is inserted 1)

| Frame<br>size           | Width<br>[mm] | Height [mm]             |                   | Mounting depth in the cabinet with<br>Control Unit (CU) [mm] <sup>2)</sup> |                       |  |
|-------------------------|---------------|-------------------------|-------------------|--|-----------------------|--|
|                         |               | without shield<br>plate | with shield plate | without OP   | with OP <sup>1)</sup> |  |
| FSD with-<br>out filter | 275           | 419                     | 542               | 263  | 274                   |  |
| FSD with<br>filter      | 275           | 512                     | 635               | 263  | 274                   |  |
| FSE with-<br>out filter | 275           | 499                     | 622               | 263  | 274                   |  |
| FSE with<br>filter      | 275           | 635                     | 758               | 263  | 274                   |  |
| FSF with-<br>out filter | 350           | 634                     | 792               | 375  | 386                   |  |
| FSF with<br>filter      | 350           | 934                     | 1092              | 375  | 386                   |  |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Power Module depth without Control Unit: FSD, FSE 237 mm, FSF 357 mm

| Frame size         | Drilling dimensions<br>[mm] |     |    | Cooling a | air clearan<br>1) | Fixing/torque<br>[Nm] |              |
|--------------------|-----------------------------|-----|----|-----------|-------------------|-----------------------|--------------|
|                    | b                           | h   | с  | Тор       | Bottom            | Front                 |              |
| FSD without filter | 235                         | 325 | 11 | 300       | 300               | 100                   | 4 x M6 / 6.0 |
| FSD with filter    | 235                         | 419 | 11 | 300       | 300               | 100                   | 4 x M6 / 6.0 |
| FSE without filter | 235                         | 405 | 11 | 300       | 300               | 100                   | 4 x M6 / 10  |
| FSE with filter    | 235                         | 451 | 11 | 300       | 300               | 100                   | 4 x M6 / 10  |
| FSF without filter | 300                         | 598 | 11 | 350       | 350               | 100                   | 4 x M8 / 13  |
| FSF with filter    | 300                         | 899 | 11 | 350       | 350               | 100                   | 4 x M8 / 13  |

 Table 4-10
 Drilling dimensions, cooling clearances and fixing

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

#### Dimension drawings, drilling dimensions for PM230 and PM240-2 Power 4.4.5 Modules utilizing push-through technology

The following dimension drawings and drilling patterns are not to scale.

### Frame sizes FSA ... FSC

Panel thickness of the control cabinet  $\leq$  3.5 mm





| <b>F</b>   | MAC III   | the factor for an 1                      |                |
|------------|-----------|--|----------------|
| Table 4-11 | Dimension | s depend on the operator panel (OP) that | at is inserted |

| Frame<br>size | Width<br>[mm] | Heigh                   | t [mm]            | Mounting depth in the cabinet with<br>Control Unit (CU) [mm] |                       |  |
|---------------|---------------|-------------------------|-------------------|--|-----------------------|--|
|               |               | without shield<br>plate | with shield plate | without OP   | with OP <sup>1)</sup> |  |
| FSA           | 126           | 238                     | 322               | 159  | 170                   |  |
| FSB           | 154           | 345                     | 430               | 159  | 170                   |  |
| FSC           | 200           | 411                     | 500               | 159  | 170                   |  |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

| Frame   | Power Module depth [mm] | T1  | T2 | Cooling air clearances [mm] <sup>1)</sup> |        |       |
|---------|-------------------------|-----|----|---|--------|-------|
| size    |                         |     |    | Тор                                       | Bottom | Front |
| FSA FSC | 171                     | 118 | 53 | 80  | 100    | 100   |

 Table 4-12
 Cooling air clearances and additional dimensions

<sup>1)</sup> The Power Module is designed for mounting without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of 1 mm

Table 4-13 Electrical cabinet cutout and mounting holes

| Frame |     | Control ca | abinet cut | tout [mm | Fixing/torque [Nm] |               |
|-------|-----|------------|------------|----------|--------------------|---------------|
| size  | а   | b          | с          | d        | е                  |               |
| FSA   | 103 | 106        | 27         | 198      | 88                 | 8 × M5 / 3.5  |
| FSB   | 148 | 134        | 34.5       | 304      | 116                | 8 × M5 / 3.5  |
| FSC   | 123 | 174        | 30.5       | 365      | 156                | 10 × M5 / 3.5 |

## Frame sizes FSD ... FSF

Panel thickness of the control cabinet  $\leq$  3.5 mm



Cutouts of the control cabinet and mounting holes

Figure 4-7 Dimension drawing and drilling dimensions for frame sizes FSD ... FSF

| Frame<br>size | Width<br>[mm] | Heigh                   | t [mm]            | Mounting deptl<br>Control U | h in the cabinet with<br>Init (CU) [mm] |
|---------------|---------------|-------------------------|-------------------|-----------------------------|---|
|               |               | without shield<br>plate | with shield plate | without OP                  | with OP <sup>1)</sup>                   |
| FSD           | 275           | 517                     | 650               | 141                         | 148                                     |
| FSE           | 354           | 615                     | 772               | 141                         | 148                                     |
| FSF           | 384           | 785                     | 1021              | 177.5                       | 186                                     |

 Table 4-14
 Dimensions depend on the operator panel (OP) that is inserted <sup>1)</sup>

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

 Table 4-15
 Cooling air clearances and additional dimensions

| Frame    | Power Module depth [mm] | T1    | T2    | Cooling air clearances [mm] |        |       |
|----------|-------------------------|-------|-------|-----------------------------|--------|-------|
| size     |                         |       |       | Тор                         | Bottom | Front |
| FSD, FSE | 237                     | 141   | 97.5  | 350                         | 350    | 29    |
| FSF      | 358                     | 177.5 | 180.5 | 80                          | 100    | 100   |

#### Table 4-16 Mounting

| Frame<br>size | Fixing/torque [Nm] |
|---------------|--------------------|
| FSD, FSE      | 10 × M5 / 3.5      |
| FSF           | 12 × M6 / 5.9      |

## 4.4.6 Dimensioned drawings, drilling dimensions for the PM250 Power Module

The following dimension drawings and drilling patterns are not to scale.

### Frame size FSC





| Frame | Mounting depth in the cabinet with Control Unit (CU) [mm] |                       |  |  |  |
|-------|---|-----------------------|--|--|--|
| size  | without OP  | with OP <sup>1)</sup> |  |  |  |
| FSC   | 206   | 217                   |  |  |  |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

| Table 4-18 | Cooling air clearances and fas | stening |
|------------|--------------------------------|---------|
|------------|--------------------------------|---------|

| Frame Cooling air c |     | air clearances | [mm] <sup>1)</sup> | Fixing/torque [Nm] |
|---------------------|-----|----------------|--------------------|--------------------|
| size                | Тор | Bottom         | Front              |                    |
| FSC                 | 125 | 125            | 65                 | 4 x M5 / 3         |

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm

### Frame sizes FSD ... FSF



Table 4-19Dimensions depend on the operator panel (OP) that is inserted 1)

| Frame<br>size           | Width<br>[mm] | Height [mm]             |                   | Mounting depth in the cabinet with<br>Control Unit (CU) [mm] <sup>2)</sup> |                       |  |
|-------------------------|---------------|-------------------------|-------------------|--|-----------------------|--|
|                         |               | without shield<br>plate | with shield plate | without OP   | with OP <sup>1)</sup> |  |
| FSD with-<br>out filter | 275           | 419                     | 542               | 245  | 256                   |  |
| FSD with<br>filter      | 275           | 512                     | 635               | 245  | 256                   |  |
| FSE with-<br>out filter | 275           | 499                     | 622               | 245  | 256                   |  |
| FSE with<br>filter      | 275           | 635                     | 758               | 245  | 256                   |  |
| FSF with-<br>out filter | 350           | 634                     | 792               | 357  | 368                   |  |
| FSF with<br>filter      | 350           | 934                     | 1092              | 357  | 368                   |  |

<sup>1)</sup> BOP-2, IOP-2 or blanking cover

<sup>2)</sup> Power Module depth without Control Unit: FSD, FSE 204 mm, FSF 316 mm

#### Installing

## 4.4 Installing Power Modules

| Frame size         | Drilling dimensions<br>[mm] |     | Cooling air clearances<br>[mm] <sup>1)</sup> |     |        | Fixing/torque<br>[Nm] |             |
|--------------------|-----------------------------|-----|--|-----|--------|-----------------------|-------------|
|                    | b                           | h   | с  | Тор | Bottom | Front                 |             |
| FSD without filter | 235                         | 325 | 11   | 300 | 300    | 65                    | 4 x M6 / 6  |
| FSD with filter    | 235                         | 419 | 11   | 300 | 300    | 65                    | 4 x M6 / 6  |
| FSE without filter | 235                         | 405 | 11   | 300 | 300    | 65                    | 4 x M6 / 6  |
| FSE with filter    | 235                         | 541 | 11   | 300 | 300    | 65                    | 4 x M6 / 6  |
| FSF without filter | 300                         | 598 | 11   | 350 | 350    | 65                    | 4 x M8 / 13 |
| FSF with filter    | 300                         | 898 | 11   | 350 | 350    | 65                    | 4 x M8 / 13 |

Table 4-20 Drilling dimensions, cooling clearances and fixing

<sup>1)</sup> You can mount the Power Modules without any lateral cooling air clearance. For tolerance reasons, we recommend a lateral clearance of approx. 1 mm



## 

#### Electric shock when the motor terminal box is open

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

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

#### Note

#### Fault protection when insulation fails in the motor circuit at the output side

In case of insulation failure in the motor circuit, the overcurrent trip of the converter meets the requirements of IEC 60364-4-41:2005/AMD1:2017 Section 411 and Annex D for protection against electric shock.

- Observe the installation specifications for this converter.
- Ensure the continuity of the protective conductor.
- Observe the applicable installation standards.

## 4.5.1 Permissible line supplies

#### Restrictions for installation altitudes above 2000 m

Above an installation altitude of 2000 m, the permissible line supplies are restricted.

Restrictions for special ambient conditions (Page 544)

#### Screw for functional grounding on the converter, frame size FSG

If you wish to use the converters with integrated C3 line filter, please note the information in the sections "TN line system", "TT line system" and "IT system" below.



Figure 4-8 Remove screw for functional grounding

#### 4.5.1.1 TN line system

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

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

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





### Converter connected to a TN system

- Converters with integrated line filter:
  - Operation on TN line systems with grounded neutral point permissible.
  - Operation on TN line systems with grounded line conductor not permissible.

#### Note

#### Special feature of FSG converters

FSG converters with integrated C3 line filter can be operated in TN line systems  $\leq$  600 V with a grounded line conductor if you remove the screw for functional grounding.

Figure 4-8 Remove screw for functional grounding (Page 84)

If you remove the screw for functional grounding, the EMC properties deteriorate and the requirements of Class C3 are no longer met.

- Converters with external line filter:
  - Operation on TN line systems with grounded neutral point permissible.
  - Operation on TN line systems with grounded line conductor not permissible.
- Converters without line filter:
  - Operation on all TN line systems  $\leq$  600 V permissible
  - Operation on TN line systems > 600 V and grounded neutral point permissible.
  - Operation on TN line systems > 600 V and grounded line conductor not permissible.

#### 4.5.1.2 TT line system

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

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



#### Note

#### **Operation in IEC or UL systems**

For installations in compliance with IEC, operation on TT line systems is permissible. For installations in compliance with UL, operation on TT line systems is not permissible.

#### Converters connected to a TT system

- Converters with integrated line filter:
  - Operation on TT line systems with grounded neutral point permissible.
  - Operation on TT line systems without grounded neutral point not permissible.

#### Note

#### Special feature of FSG converters

FSG converters with integrated C3 line filter can be operated in TT line systems without a grounded neutral point if you remove the screw for functional grounding.

Figure 4-8 Remove screw for functional grounding (Page 84)

If you remove the screw for functional grounding, the EMC properties deteriorate and the requirements of Class C3 are no longer met.

- Converters with external line filter:
  - Operation on TT line systems with grounded neutral point permissible.
  - Operation on TT line systems without grounded neutral point not permissible.
- Converters without line filter:
  - Operation on all TT line systems permissible.

## 4.5.1.3 IT system

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

There are IT systems with and without transfer of the neutral conductor N.



#### Note

#### Behavior of the converter when a ground fault occurs

If the converter is to remain operable even when a ground fault occurs at the converter output, you must install an output reactor. This prevents an overcurrent trip or damage to the drive.

#### Converters connected to an IT system

- Converters with integrated line filter:
  - Operation on IT line systems not permissible.

#### Note

#### Special feature of FSG converters

FSG converters with integrated C3 line filter can be operated in IT line systems if you remove the screw for functional grounding.

Figure 4-8 Remove screw for functional grounding (Page 84)

If you remove the screw for functional grounding, the EMC properties deteriorate and the requirements of Class C3 are no longer met.

- Converters without line filter:
  - Operation on all IT line systems permissible.

#### Note

#### 690 V converters: Output reactors for frame sizes FSD and FSE

An output reactor is required for 690 V reactors in frame sizes FSD and FSE.

## 4.5.2 Requirements for the protective conductor

#### Overview

A high leakage current flows through the protective conductor in converter operation. The protective conductor of the converter must not be interrupted for safe touch protection in converter operation.

This primarily results in requirements for the minimum conductor cross-section of the protective conductor.

No restriction applies to the length of the protective conductor for touch protection. However, short protective conductors are advantageous for EMC-compliant installation.

### Description



## 

#### Electric shock due to interrupted protective conductor

The drive components conduct a high leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

• Comply with the requirements for the protective conductor.



- 1 Protective conductor for line feeder cables
- 2 Protective conductor for converter line feeder cables
- (3) Protective conductor between PE and the control cabinet
- (4) Protective conductor for motor feeder cables

The minimum cross-section of the protective conductor  $(1) \dots (4)$  depends on the cross-section of the line or motor feeder cable:

- Line or motor feeder cable ≤ 16 mm<sup>2</sup>
   ⇒ Minimum cross-section of the protective conductor = cross-section of the line or motor feeder cable
- 16 mm<sup>2</sup> < line or motor feeder cable  $\leq$  35 mm<sup>2</sup>  $\Rightarrow$  Minimum cross-section of the protective conductor = 16 mm<sup>2</sup>
- Line or motor feeder cable > 35 mm<sup>2</sup>
   ⇒ Minimum cross-section of the protective conductor = ½ cross-section of the line or motor feeder cable

Additional requirements placed on the protective conductor ① according to IEC 60204-1:

- For permanent connection, the protective conductor must fulfill at least one of the following conditions:
  - The protective conductor is routed so that it is protected against damage along its complete length.

```
Cables routed inside switch cabinets or enclosed machine housings are considered to be adequately protected against mechanical damage.
```

- As a conductor of a multi-conductor cable, the protective conductor has a cross-section  $\geq 2.5~mm^2$  Cu.
- For an individual conductor, the protective conductor has a cross-section  $\ge 10 \text{ mm}^2 \text{ Cu}$ .
- The protective conductor consists of 2 individual conductors with the same cross-section.
- When connecting a multi-core cable using an industrial plug connector according to EN 60309, the protective conductor must have a cross-section of  $\geq$  2.5 mm<sup>2</sup> Cu.
- Observe the local regulations for protective conductors subject to a high leakage current at the installation site.

## 4.5.3 Connecting a converter with the PM240-2 Power Module



Figure 4-9 Connection of the PM240-2 Power Module, 3 AC, FSA ... FSC



Figure 4-10 Connection of the PM240-2 Power Module, 3 AC, FSD ... FSF



Figure 4-11 Connection of the PM240-2 Power Module, 1 AC 200 V, FSA ... FSC





| Table 4-21 | Connection, | cross-section an | d tightening | torque for | PM240-2 | Power Modules |
|------------|-------------|------------------|--------------|------------|---------|---------------|
|------------|-------------|------------------|--------------|------------|---------|---------------|

| Converter | Conne                | ection   | Cross-section and                   | tightening torque                    | Stripped                  |  |
|-----------|----------------------|--|-------------------------------------|--------------------------------------|---------------------------|--|
|           |                      |  | Metric                              | Imperial                             | insula-<br>tion<br>length |  |
| FSA       | Line system, motor   | Line.  | 1.5 2.5 mm², 0.5 Nm                 | 16 14 AWG, 4.5 lbf in                | 8 mm                      |  |
| FSB       | and braking resistor |  | 1.5 6 mm², 0.6 Nm                   | 16 10 AWG, 5.5 lbf in                | 8 mm                      |  |
| FSC       |                      | Plug connector<br>with screw termi-<br>nals        | 616 mm², 1.3 Nm                     | 10 6 AWG, 12 lbf in                  | 10 mm                     |  |
| FSD       | Line and motor       | Screw-type termi-<br>nal                           | 10 35 mm²,<br>2.5 4.5 Nm            | 8 2 AWG,<br>22 40 lbf in             | 18 mm                     |  |
|           | Braking resistor     |  | 2.5 16 mm²,<br>1.2 1.5 Nm           | 20 6 AWG,<br>10.5 13 lbf in          | 10 mm                     |  |
| FSE       | Line and motor       | Screw-type termi-<br>nal                           | 25 70 mm²,<br>8 10 Nm               | 6 3/0 AWG,<br>71 88.5 lbf in         | 25 mm                     |  |
|           | Braking resistor     |  | 10 35 mm²,<br>2.5 4.5 Nm            | 8 2 AWG,<br>22 40 lbf in             | 18 mm                     |  |
| FSF       | Line and motor       | Cable lug according<br>to SN71322 for<br>M10 bolts | 35 2 × 120 mm²,<br>22 25 Nm         | 1 AWG 2 × 4/0 AWG,<br>195 221 lbf.in | 1                         |  |
|           | Braking resistor     | Screw-type termi-<br>nal                           | 25 <sup>1)</sup> 70 mm²,<br>8 10 Nm | 6 3/0 AWG,<br>71 88.5 lbf in         | 25 mm                     |  |
| FSG       | Line and motor       | Cable lug according<br>to SN71322 for<br>M10 bolts | 35 2 × 185 mm²,<br>22 25 Nm         | 1 AWG 2 × 350 MCM,<br>195 221 lbf.in | 1                         |  |
|           | Braking resistor     | Screw-type termi-<br>nal                           | 25 70 mm²,<br>8 10 Nm               | 6 3/0 AWG,<br>71 88.5 lbf in         | 25 mm                     |  |

<sup>1)</sup> 16 mm<sup>2</sup> allowed during short-time duty

### Connections for frame sizes FSA ... FSC



The Power Modules are equipped with withdrawable plug connectors that cannot be inadvertently interchanged.

To remove a plug connector, you must release it by pressing on the red lever.

1 Release lever

### Connections for frame sizes FSD ... FSG

You must remove the covers from the connections in order to connect the line supply, braking resistor and motor to the converter.

In addition, for frame sizes FSD and FSE, release the two terminal screws on the connections for the motor and braking resistor, and remove the dummy plug.

For frame sizes FSF and FSG, you must breakout the openings from the connection cover for the power connections. Use side cutters or a fine saw blade.



FSD ... FSG: Remove the top covers



FSD, FSE: Remove the lower cover



FSF, FSG: Remove the lower cover



Figure 4-13 Connections for the line supply, motor and braking resistor

You must re-attach the connection covers in order to re-establish the touch protection of the converter after it has been connected up.

### Additional information when connecting FSG converters

#### Note

#### Conductor cross-section 240 mm<sup>2</sup>

Cable lugs for M10 bolts according to SN71322 are suitable for cables with cross-sections of  $35 \text{ mm}^2 \dots 185 \text{ mm}^2$  (1 AWG ... 2 × 350 MCM).

If you wish to establish connections with cables of 240 mm<sup>2</sup> (500 MCM), you must use narrow cable lugs, e.g. Klauke 12SG10. Other cable lugs are not suitable due to the narrow design of the converter.

The maximum permissible width of the cable lugs is 37 mm (1.45 inches).

Remove the plastic insulating plate as shown below to gain better access to the terminals for the power connections.

#### 

#### Damage to converter as a result of operation without insulating plates

Without the insulating plates, voltage flashovers may occur between the phases.

Replace the insulating plates after connecting the cables.





## 4.5.4 Connecting the converter with the PM230 Power Module



Figure 4-14 PM230 Power Module connection overview

| Converter | Connection         |                                     | Cross-section,                 | Stripped              |                           |
|-----------|--------------------|-------------------------------------|--------------------------------|-----------------------|---------------------------|
|           |                    |                                     | Metric                         | Imperial              | insula-<br>tion<br>length |
| FSA       | Line supply, motor | Trees                               | 1 2.5 mm², 0.5 Nm              | 16 14 AWG, 4.5 lbf in | 8 mm                      |
| FSB       |                    |                                     | 1.5 6 mm², 0.6 Nm              | 16 10 AWG, 5.5 lbf in | 8 mm                      |
| FSC       |                    | Plug connector with screw terminals | 616 mm <sup>2</sup> , 1.3 Nm   | 10 6 AWG, 12 lbf in   | 10 mm                     |
| FSD       | Line supply, motor |                                     | 10 35 mm², 6 Nm                | 7 2 AWG, 53 lbf in    |                           |
| FSE       |                    | Cable lug                           | 25 50 mm², 6 Nm                | 3 1 AWG, 53 lbf in    |                           |
| FSF       |                    | Cable lug                           | 35 120 mm <sup>2</sup> , 13 Nm | 2 4/0 AWG, 115 lbf in |                           |

## Connections for frame sizes FSA ... FSC



The Power Modules are equipped with withdrawable plug connectors that cannot be inadvertently interchanged.

To remove a plug connector, you must release it by pressing on the red lever.

### Connections for frame sizes FSD ... FSF

The line and motor connections have covers to prevent them from being touched.



You must open the cover to connect the line and motor:

- 1. Release the catches on both sides of the covers using a screwdriver.
- 2. Swivel the covers upwards.

Close the covers once you have connected the line and motor.

## 4.5.5 Connecting the converter with the PM240P-2 Power Module





 Table 4-23
 Connection, cross-section and tightening torque for PM240P-2 Power Modules

| Converter | Connection            |                                   | Cross-section, tig                    | Stripped                  |                           |
|-----------|-----------------------|-----------------------------------|---------------------------------------|---------------------------|---------------------------|
|           |                       |                                   | Metric                                | Imperial                  | insula-<br>tion<br>length |
| FSD       | Line supply,          | Screw-type termi-                 | 10 35 mm², 2.5 4.5 Nm                 | 20 10 AWG, 22 lbf in      | 18 mm                     |
|           | motor                 | nai                               |                                       | 8 2 AWG, 40 lbf in        |                           |
| FSE       |                       |                                   | 25 70 mm², 8 10 Nm                    | 6 3/0 AWG, 88.5 lbf in    | 25 mm                     |
| FSF       | Line supply,<br>motor |                                   | 35 2 × 120 mm <sup>2</sup> , 22 25 Nm | 1 2 × 4/0 AWG, 210 lbf in |                           |
|           |                       | Cable lug according<br>to SN71322 |                                       |                           |                           |

### Connections, frame sizes FSD ... FSF

You must remove the covers from the connections in order to connect the line supply and motor cables to the converter.



Figure 4-16 Remove the connection covers

In addition, for frame sizes FSD and FSE, release the two terminal screws on the connections for the motor and remove the dummy plug.

For frame size FSF you must breakout the openings from the connection cover for the power connections. Use side cutters or a fine saw blade.



Figure 4-17 Line and motor connections

You must re-attach the connection covers in order to re-establish the touch protection of the converter after it has been connected up.



## 4.5.6 Connecting the converter with the PM250 Power Module

Figure 4-18 Connecting the PM250 Power Module

#### Table 4-24 Connection, cross-section and tightening torque for PM250 Power Modules

| Converter | Line supply and motor connection | Cross-section and              | Stripped              |                           |
|-----------|----------------------------------|--------------------------------|-----------------------|---------------------------|
|           |                                  | Metric                         | Imperial              | insula-<br>tion<br>length |
| FSC       | Screw-type terminal              | 410 mm <sup>2</sup> , 2.3 Nm   | 12 8 AWG, 20 lbf in   | 10 mm                     |
| FSD       |                                  | 10 35 mm², 6 Nm                | 7 2 AWG, 53 lbf in    |                           |
| FSE       | Cable lug                        | 25 50 mm², 6 Nm                | 3 1/0 AWG, 53 lbf in  |                           |
| FSF       |                                  | 35 120 mm <sup>2</sup> , 13 Nm | 2 4/0 AWG, 115 lbf in |                           |

## Connections for frame size FSC



Converters with the CU240B-2 and CU240E-2 Control Units Operating Instructions, 02/2023, FW 4.7 SP14, A5E34259001B AJ

### Connections for frame sizes FSD ... FSF

The line and motor connections have covers to prevent them from being touched.



You must open the cover to connect the line and motor:

- 1. Release the catches on both sides of the covers using a screwdriver.
- 2. Swivel the covers upwards.

Close the covers once you have connected the line and motor.

## 4.5.7 Connecting the motor to the converter in a star or delta connection

#### Overview

Standard induction motors up to a rated power of approximately 3 kW are usually connected in star/delta connection (Y/ $\Delta$ ) at 400 V/230 V. For a 400-V line supply, you can connect the motor to the converter either in a star or in a delta connection.

### **Function description**

#### Operating the motor in a star connection



In a star connection, the motor can provide its rated torque  $M_N$  in the range 0 ... rated frequency  $f_N$ .

Rated voltage  $U_N = 400$  V is available at a rated frequency  $f_N = 50$  Hz.

The motor goes into field weakening above the rated frequency. In field weakening, the available motor torque decreases proportionally with 1/f. In field weakening, the available power remains constant.

#### Operating the motor in a delta connection with 87 Hz characteristic



In a delta connection, the motor is operated with a voltage and frequency above its rated values. As a consequence, the motor power is increased by a factor  $\sqrt{3} \approx 1.73$ .

In the range f = 0 ... 87 Hz, the motor can output its rated torque  $M_N$ .

The maximum voltage U = 400 V is available at a frequency of  $f = \sqrt{3} \times 50$  Hz  $\approx$  87 Hz.

The motor only goes into field weakening above 87 Hz.

The higher motor power when operated with an 87 Hz characteristic has the following disadvantages:

- The converter must supply approximately 1.73x current. Select a converter based on its rated current and not its rated power.
- The motor temperature increases more significantly than when operated with  $f \le 50$  Hz.
- The motor must have windings that are approved for a voltage > rated voltage U<sub>N</sub>.
- As the fan impeller rotates faster, the motor has a higher noise level than operation with f  $\leq$  50 Hz.

#### 4.6 Connecting the interfaces for the converter control

## 4.6 Connecting the interfaces for the converter control

The Power Module has a holder for the Control Unit and a release mechanism. There are different release mechanisms depending on the particular Power Module.

## Inserting the Control Unit

#### Procedure



1. Place the two catches of the Control Unit in the matching grooves of the Power Module.

2. Press the Control Unit onto the Power Module until you hear that it latches.

The Control Unit is plugged onto the Power Module.  $\hfill\square$ 

## **Removing the Control Unit**

### Procedure

Remove the Control Unit from the Power Module by pressing the release mechanism.

4.6 Connecting the interfaces for the converter control

### Special features for the PM230 Power Module IP55, FSA ... FSC

To insert or detach the Control Unit, you must release eight or ten fixing screws of the cover and then remove the cover.

The Power Module release mechanism is shown in the diagram.

Attach the cover again before you commission the converter. Do not damage the seal of the cover when attaching it.



## 4.6.1 Overview of the interfaces

## Interfaces on the Control Unit

To access the interfaces at the front of the Control Unit, you must lift the Operator Panel (if one is being used) and open the front doors.



<sup>1)</sup> AI 1 is not available on the CU240B-2 Control Unit

| Table 4-2.5 Number of inputs and outputs | Table 4-25 | Number | of inputs | and | outputs |
|--|------------|--------|-----------|-----|---------|
|--|------------|--------|-----------|-----|---------|

|   | Digital in-<br>puts DI | Digital out-<br>puts DO | Analog in-<br>puts Al | Analog<br>outputs<br>AO | Failsafe digital<br>inputs F-DI <sup>1)</sup> |
|---|------------------------|-------------------------|-----------------------|-------------------------|---|
| CU240B-2, CU240B-2 DP                       | 4                      | 1                       | 1                     | 1                       | 0   |
| CU240E-2, CU240E-2 DP,<br>CU240E-2 PN       | 6                      | 3                       | 2                     | 2                       | 1   |
| CU240E-2 F, CU240E-2 DP-F,<br>CU240E-2 PN-F | 6                      | 3                       | 2                     | 2                       | 3   |

<sup>1)</sup> Each failsafe digital input F-DI used takes up two digital inputs DI

4.6 Connecting the interfaces for the converter control

#### Protection against unauthorized access via the USB interface

### 

#### Unsafe operating states resulting from manipulation of the converter software

Manipulation of the converter software can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Prevent unauthorized persons from accessing the converter's USB interface:
  - Do not route the USB interface outside the control cabinet.
  - Lock the control cabinet or the control room in which the converter is installed.

## 4.6.2 Fieldbus interface allocation

#### Interfaces at the lower side of the CU240B-2 and CU240E-2 Control Units



5 Not connected

RJ45 connector socket for PROFINET IO (X150 P1, X150 P2)



Pin

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

SUB-D socket for PROFIBUS DP (X126)



Pin

- 1 Shield, grounding connection
- 2 Not assigned 3 RxD/TxD-P re
- 3 RxD/TxD-P, receive and transmit (B/B')
   4 CNTR-P, control signal
- 5 DGND, reference potential for data (C/C')
- 6 VP, supply voltage
- 7 Not assigned
- 8 RxD/TxD-N, receive and transmit (A/A')
- 9 Not assigned
# 4.6.3 Terminal strips on CU240B-2 Control Units

# Terminal strips with wiring example



 $\rightarrow$  If you use the internal 10 V power supply, you must connect AI 0- to GND.

## Note

## Protection against overload and short circuit

All outputs such as 10V and 24V are protected against overload and short circuit using either ITS4140N or a monitored current shunt in the control system.

# Additional options for wiring the digital inputs



You must remove the jumper between terminals 28 and 69 if it is necessary to have electrical isolation between the external power supply and the internal converter power supply.

Connecting P-switching contacts with an external power supply

|                      |                      |     | -X1 | 33       |
|----------------------|----------------------|-----|-----|----------|
|                      |                      |     | 9   | +24V out |
| GND <sub>ext</sub> – | - <b>†</b>           |     | 28  | GND      |
| +24 V 🕂              | ×(40.4               |     | 69  | DI COM   |
| ext                  | -X134                | -/_ | 5   | DI 0     |
|                      | <u>-8-18 D0 0 NC</u> | -/_ | 6   | DI 1     |
|                      | <u>19 DO 0 NO</u>    |     | 7   | DI 2     |
| L                    |                      |     | 8   | DI 3     |

Connecting M-switching contacts with an external power supply

It is not permissible that terminals 28 and 69 are connected with one another.

# 4.6.4 Factory setting of the CU240B-2 interfaces

The factory setting of the terminals depends on which fieldbus the Control Unit supports.

# **Control Units with PROFIBUS interface**

The function of the fieldbus interface and digital inputs DI 0, DI 1 depends on DI 3.



Figure 4-20 Factory setting of the CU240B-2 DP Control Unit

# **Control Units with USS interface**

The fieldbus interface is not active.



Figure 4-21 Factory setting of the CU240B-2 Control Unit

# 4.6.5 Default settings of the CU240B-2 interfaces

# Default setting 7: "Fieldbus with data set switchover"

Factory setting for converters with PROFIBUS interface



# Default setting 9: "Standard I/O with MOP"



# Default setting 12: "Standard I/O with analog setpoint"

Factory setting for converters with USS interface



# Default setting 17: "2-wire (forw/backw1)"



# Default setting 18: "2-wire (forw/backw2)"



# Default setting 19: "3-wire (enable/forw/backw)"



Speed setpoint (main setpoint): p1070[0] = 755[0] Designation in the BOP-2: 3-wIrE 1

# Default setting 20: "3-wire (enable/on/reverse)"



Designation in the BOP-2: 3-wIrE 2

# Default setting 21: "USS fieldbus"



# 4.6.6 Terminal strips on CU240E-2 Control Units

# Terminal strips with wiring example



max. 0.5 A 30 V

Figure 4-22 Wiring example of the digital inputs with the internal converter 24 V power supply

| GND     | All terminals with reference potential "GND" are connected with one another in the converter.  |
|---------|--|
| DI COM1 | Reference potentials "DI COM1" and "DI COM2" are electrically isolated from "GND".   |
| DI COM2 | $\rightarrow$ if, as described above, you use the 24-V power supply from terminal 9 to supply the digital inputs, then you must connect "GND" with "DI COM1" and "DI COM2" at the terminals. |



When an optional 24-V power supply is connected to terminals 31, 32, the Control Unit remains in operation even after the Power Module has been disconnected from the line supply. The Control Unit thus maintains the fieldbus communication, for example.

 $\rightarrow$  for terminals 31, 32 only use a 24 VDC power supply with SELV (Safety Extra Low Voltage).

 $\rightarrow$  for applications in the USA and Canada: Use a 24 VDC power supply, NEC Class 2.

 $\rightarrow$  connect the 0 V of the power supply with the protective conductor.

 $\rightarrow$  if you also wish to use the power supply at terminals 31, 32 for the digital inputs, then you must connect "DI COM1/2" and "GND IN" with one another at the terminals.

| 10 | Al 1+ |  |
|----|-------|--|
| 11 | Al 1- |  |
| 3  | AI 0+ |  |
| 4  | AI 0- |  |

You may use the internal 10V power supply or an external power supply for the analog inputs.  $\rightarrow$  If you use the internal 10 V power supply, you must connect AI 0- or AI 1- to GND.

Note

## Protection against overload and short circuit

All outputs such as 10V and 24V are protected against overload and short circuit using either ITS4140N or a monitored current shunt in the control system.

# Additional options for wiring the digital inputs



If you wish to connect the external and the internal converter power supply voltages with one another, then you must connect "GND" with terminals 34 and 69 at the terminals.

Connecting P-switching contacts with an external power supply



Connecting M-switching contacts with an external power supply

## NOTICE

## Damage when the 24V output voltage is short-circuited

If the following conditions occur simultaneously, the Control Unit with PROFINET interface can be damaged:

- 1. The converter is operational.
- 2. The 24V output voltage develops a short-circuit at terminal 9.
- 3. The ambient temperature reaches the maximum permissible value.
- 4. The external 24V power supply voltage at terminals 31 and 32 reaches the maximum permissible value.
- Ensure that not all of these conditions are simultaneously satisfied.

# 4.6.7 Factory setting of the CU240E-2 interfaces

The factory setting of the terminal strip depends on the Control Unit.

# Control Units with PROFIBUS or PROFINET interface

The function of the fieldbus interface and digital inputs DI 0, DI 1 depends on DI 3.



Speed setpoint (main setpoint): p1070[0] = 2050[1]

Figure 4-23 Factory setting of CU240E-2 DP(-F) and CU240E-2 PN(-F) Control Units

# **Control Units with USS interface**

The fieldbus interface is not active.



Speed setpoint (main setpoint): p1070[0] = 755[0]

Figure 4-24 Factory setting of the CU240E-2 and CU240E-2 F Control Units

# 4.6.8 Default settings of the CU240E-2 interfaces

Default setting 1: "Conveyor technology with 2 fixed frequencies"

#### **ON/OFF1** clockwise 5DI 0 **ON/OFF1** counterclockwise 6DI 1 Acknowledge fault 7 DI 2 16DI 4Fixed speed setpoint 3:17DI 5Fixed speed setpoint 4 18D00 Fault 19 20 21 D0 1 Warning 22 12A00 Actual speed value O-26A0 1 Actual current value DO 0: p0730, DO 1: p0731 AO 0: p0771[0], AO 1: p0771[1]

DO 0: p0730, DO 1: p0731 AO 0: p0771[0], AO 1: p0771[1] DI 0: r0722.0, ..., DI 5: r0722.5 Fixed speed setpoint 3: p1003, fixed speed setpoint 4: p1004, fixed speed setpoint active: r1024 Speed setpoint (main setpoint): p1070[0] = 1024 DI 4 and DI 5 = high: The converter adds both fixed speed setpoints Designation in the BOP-2: coN 2 SP

# Default setting 2: "Conveyor systems with Basic Safety"

|     | 5DI0    | ON/OFF1 with fixed speed setpoint 1 |
|-----|---------|-------------------------------------|
| _/_ | 6DI1    | Fixed speed setpoint 2:             |
| _/_ | 7 DI 2  | Acknowledge fault                   |
|     | 16DI 4  | Reserved für a safety function      |
| _/_ | 17 DI 5 |                                     |
| -&- | 18D00   | Fault                               |
| -   | 19      |                                     |
|     | 20      |                                     |
| -&- | 21 DO 1 | Warning                             |
|     | 22      |                                     |
| -0- | 12 AO 0 | Actual speed value                  |
| -0- | 26A01   | Actual current value                |
| _   |         |                                     |

 DO 0: p0730, DO 1: p0731
 AO 0: p0771[0], AO 1: p0771[1]
 DI 0: r0722.0, ..., DI 5: r0722.5

 Fixed speed setpoint 1: p1001, fixed speed setpoint 2: p1002, fixed speed setpoint active: r1024

 Speed setpoint (main setpoint): p1070[0] = 1024

DI 0 and DI 1 = high: The converter adds both fixed speed setpoints.

Designation in the BOP-2: coN SAFE

# Default setting 3: "Conveyor systems with 4 fixed frequencies"

|          | ON/OFF1 with fixed speed setpoint 1 |
|----------|-------------------------------------|
|          | Fixed speed setpoint 2              |
|          | Acknowledge fault                   |
|          | Fixed speed setpoint 3              |
|          | Fixed speed setpoint 4              |
|          | Fault                               |
| 19       |                                     |
| 20       |                                     |
| ⊗-21D01  | Warning                             |
| 22       |                                     |
|          | Actual speed value                  |
| -Ô-26A01 | Actual current value                |
|          |                                     |

 DO 0: p0730, DO 1: p0731
 AO 0: p0771[0], AO 1: p0771[1]
 DI 0: r0722.0, ..., DI 5: r0722.5

 Fixed speed setpoint 1: p1001, ... fixed speed setpoint 4: p1004, fixed speed setpoint active: r1024

 Speed setpoint (main setpoint): p1070[0] = 1024

Several of the DI 0, DI 1, DI 4, and DI 5 = high: the converter adds the corresponding fixed speed setpoints. Designation in the BOP-2: coN 4 SP

## Default setting 4: "Conveyor system with fieldbus"



Speed setpoint (main setpoint): p1070[0] = 2050[1]

Designation in the BOP-2: coN Fb

# Default setting 5: "Conveyor systems with fieldbus and Basic Safety"



Speed setpoint (main setpoint): p1070[0] = 2050[1] Designation in the BOP-2: coN Fb S

# Default setting 6: "Fieldbus with Extended Safety"

Only with Control Units CU240E-2 F, CU240E-2 DP-F, and CU240E-2 PN-F.



DO 0: p0/30, DO 1: p0/31 AO 0: p0//1[0], AO 1: p0//1[1] DI 0: r0/22.0, ..., DI 5: r0 Speed setpoint (main setpoint): p1070[0] = 2050[1] Designation in the BOP-2: Fb SAFE

# Default setting 7: "Fieldbus with data set switchover"

Factory setting for converters with PROFIBUS or PROFINET interface



DO 0: p0730, DO 1: p0731 AO 0: p0771[0], AO 1: p0771[1] DI 0: r0722.0, ..., DI 3: r0722.3 Speed setpoint (main setpoint): p1070[0] = 2050[1]

Jog 1 speed setpoint: p1058, factory setting: 150 rpm

Jog 2 speed setpoint: p1059, factory setting: -150 rpm

Designation in the BOP-2: FB cdS

## Default setting 8: "MOP with Basic Safety"



Speed setpoint (main setpoint): p1070[0] = 1050

Designation in the BOP-2: MoP SAFE

## Default setting 9: "Standard I/O with MOP"



DO 0: p0730, DO 1: p0731 AO 0: p0771[0], AO 1: p0771[1] DI 0: r0722.0, ..., DI 3: r0722.3

Motorized potentiometer setpoint after ramp-function generator: r1050

Speed setpoint (main setpoint): p1070[0] = 1050

Designation in the BOP-2: Std MoP

# Default setting 12: "Standard I/O with analog setpoint"



# Default setting 13: "Standard I/O with analog setpoint and safety"



# Default setting 14: "Process industry with fieldbus"

PROFIdrive telegram 20



Speed setpoint (main setpoint): p1070[0] = 2050[1], p1070[1] = 1050

Switch controller via PZD01, bit 15: p0810 = r2090.15

Designation in the BOP-2: Proc Fb

# Default setting 15: "Process industry"



# Default setting 17: "2-wire (forw/backw1)"



# Default setting 18: "2-wire (forw/backw2)"



## Default setting 19: "3-wire (enable/forw/backw)"



# Default setting 20: "3-wire (enable/on/reverse)"



# Default setting 21: "USS fieldbus"



Designation in the BOP-2: FB USS

# 4.6.9 Failsafe digital input of CU240E-2

To enable a safety function via the terminal strip of the converter, you need a failsafe digital input.

For specific default settings of the terminal strip, e.g. default setting 2, the converter combines two digital inputs to form one failsafe digital input FDI 0.

# Which devices are you allowed to connect?

The failsafe digital input is designed for the following devices:

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

# Signal state

The converter expects signals with the same state at its failsafe digital input:

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

# Connecting P/P and P/M-switching fail-safe digital outputs



PP-switching digital output



PM-switching digital output

It is permissible to connect PP and PM-switching safe outputs to a fail-safe digital input.

# **Fault detection**

The converter compares the two signals of the failsafe digital input. The converter thus detects, for example the following faults:

- Cable break
- Defective sensor

The converter cannot detect the following faults:

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

## Special measures to prevent cross-circuits and short-circuits

The routing of cables over longer distances, e.g. between remote control cabinets, increases the risk of damaging cables. Damaged cables raise the risk of an undetected cross-circuit with power-conducting cables laid in parallel. A cross-circuit can cause interruption to the transfer of safety-related signals.

To avoid cross circuit faults and short-circuits, you must protect the cables between a sensor and the converter; this can be done by routing the cables separately or in a steel pipe/duct

## On and off test

The converter filters signal changes using on and off tests at the failsafe digital input using an adjustable software filter.

# 4.6.10 Connecting a failsafe digital input

## Overview

The converter has the following connection options for failsafe digital inputs:

- Sensor output
- PM-switching failsafe digital output
- PP-switching failsafe digital output



Figure 4-25 Connecting a PM-switching and PP-switching failsafe digital output

# **Function description**

The following examples comply with PL d according to EN 13849-1 and SIL2 according to IEC 61508 for the case that all components are installed within one control cabinet.



Figure 4-26 Connecting a sensor, e.g. Emergency Stop mushroom pushbutton or limit switch



Figure 4-27 Connecting a safety relay, e.g. SIRIUS 3SK11



Figure 4-28 Connecting an F digital output module, e.g. SIMATIC F digital output module

# **Further information**

Overview of the manuals (Page 564)

The Safety Integrated Function Manual provides additional connection options and connections in separate control cabinets.

# 4.6.11 Wiring the terminal strip



# 

## Electric shock due to unsuitable power supply

Death or serious injury can result when live parts are touched in the event of a fault.

For all connections and terminals of the electronic boards, only use power supplies that provide PELV (Protective Extra Low Voltage) or SELV (Safety Extra Low Voltage) output voltages.



# WARNING

## Electric shock due to unsuitable motor temperature evaluation system

Voltage flashovers to the electronics of the converter can occur in motors without safe electrical separation of the temperature sensors in accordance with IEC 61800-5-1 when the motor develops a fault.

- Install a temperature monitoring relay 3RS1... or 3RS2...
- Evaluate the temperature monitoring relay output using a digital input of the converter, e.g. using the "External fault" function.

You can find additional information about the temperature monitoring relay on the Internet:

Manual 3RS1 / 3RS2 temperature monitoring relays (<u>https://</u>support.industry.siemens.com/cs/ww/en/view/54999309)

### Note

# Malfunction caused by incorrect switching states as the result of diagnostic flows in the off state (logical state "0")

In contrast to mechanical switching contacts, e.g. emergency stop switches, diagnostic flows can also flow with semiconductor switches in the off state. If interconnection with digital inputs is faulty, the diagnostic flows can lead to incorrect switching states and thus to a malfunction of the drive.

- Observe the conditions for digital inputs and digital outputs specified in the relevant manufacturers documentation.
- Check the conditions of the digital inputs and digital outputs in regard to the flows in off state. If applicable, connect the digital inputs with suitably dimensioned, external resistors to protect against the reference potential of the digital inputs.

### Note

If your application requires UL certification, please note that the power supply of the digital output must comply with specific specifications.

Technical data (Page 485)

### NOTICE

#### Overvoltages for long signal cables

Using > 30 m long cables at the converter's digital inputs and 24 V power supply or inductive circuits at the digital inputs can lead to overvoltage. Overvoltages can damage the converter.

- Connect an overvoltage protection device between the terminal and the associated reference potential.
   We recommend using the Weidmüller overvoltage protection terminal with designation
  - MCZ OVP TAZ DIODE 24VDC.

Table 4-26 Permissible cable and wiring options

| Solid or finely-stranded<br>conductor | Finely stranded conduc-<br>tor with non-insulated<br>end sleeve | Finely stranded conduc-<br>tor with partially insula-<br>ted end sleeve | Two finely-stranded con-<br>ductors with the same<br>cross-section with parti-<br>ally insulated twin end<br>sleeves |
|---------------------------------------|---|---|--|
| 8 mm 0.5                              | 8 mm 0.5  | 8 mm  | 8 mm   |
| 1.5 mm <sup>2</sup>                   | 1.0 mm <sup>2</sup>   | 0.5 mm <sup>2</sup>   | 2 * 0.5 mm <sup>2</sup>  |

## Wiring the terminal strip in compliance with EMC

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 converter through a good electrical connection and a large surface area.

Use the shield connection plate of the Control Unit as strain relief.

Overview of Control Units (Page 35)

## EMC-compliant wiring of failsafe inputs

Use shielded signal lines. Connect the shield at both cable ends.

In order to connect two or more converter terminals, use the shortest possible jumpers directly at the terminals themselves.

## **Further information**

Further information about EMC-compliant wiring is available on the Internet:

EMC installation guideline (<u>http://support.automation.siemens.com/WW/view/en/</u>60612658)

#### **Fieldbus interfaces** 4.6.12

# Overview

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

| Fieldbus                  | Profiles   |              | S7 commu-                 | Control Unit           |   |
|---------------------------|------------|--------------|---------------------------|------------------------|---|
|                           | PROFIdrive | PROFIsafe 1) | PROFlenergy <sup>2)</sup> | nication <sup>2)</sup> |   |
| PROFINET                  | 1          | 1            | ✓                         | 1                      | CU240E-2 PN                                 |
| EtherNet/IP <sup>2)</sup> |            |              |                           |                        | CU240E-2 PN-F                               |
| PROFIBUS                  | 1          | 1            |                           | 1                      | CU240B-2 DP<br>CU240E-2 DP<br>CU240E-2 DP-F |
| USS <sup>2)</sup>         |            |              |                           |                        | CU240B-2                                    |
| Modbus RTU <sup>2)</sup>  |            |              |                           |                        | CU240E-2<br>CU240E-2 F                      |

<sup>1)</sup> Information on PROFIsafe can be found in the "Safety Integrated" Function Manual.

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

Overview of the manuals (Page 564)

#### 4.6.13 Connecting the converter to PROFINET

#### 4.6.13.1 **Communication via PROFINET IO and Ethernet**

You can either integrate the converter in a PROFINET network or communicate with the converter via Ethernet.

# The converter in PROFINET IO operation



Figure 4-29 The converter in PROFINET IO operation (examples)

The converter supports the following functions:

- RT
- IRT: The converter forwards the clock synchronism, but does not support clock synchronism.

- MRP: Media redundancy, impulsed with 200 ms. Precondition: Ring topology With MRP, you get an uninterrupted switchover if you set the failure monitoring time to a value > 200 ms.
- MRPD: Media redundancy, bumpless. Precondition: IRT and the ring topology created in the control
- Diagnostic alarms in accordance with the error classes specified in the PROFIdrive profile.
- Device replacement without removable data storage medium: The replacement converter is assigned the device name from the IO controller, not from its memory card or from the programming device.
- Shared Device for converters that support PROFIsafe.

## The converter as Ethernet node



Figure 4-30 The converter as Ethernet node (examples)

Further information on the operation as Ethernet nodes can be found in the Function Manual "Fieldbuses".

Overview of the manuals (Page 564)

# **Further information on PROFINET**

Further information on PROFINET can be found on the Internet:

- PROFINET the Ethernet standard for automation (<u>http://w3.siemens.com/mcms/</u> <u>automation/en/industrial-communications/profinet/Pages/Default.aspx</u>)
- PROFINET system description (<u>https://support.industry.siemens.com/cs/ww/en/view/</u>
   <u>19292127</u>)

# 4.6.13.2 Connecting the PROFINET cable to the converter

## Procedure

- Integrate the converter in the bus system (e.g. ring topology) of the control using PROFINET cables and the two PROFINET sockets X150-P1 and X150-P2.
   Fieldbus interface allocation (Page 106) The maximum permitted cable length from the previous station and to the next one is 100 m.
- 2. Externally supply the converter with 24 VDC through terminals 31 and 32. The external 24 V supply is only required if communications with the control should also run when the line voltage is switched off.

You have connected the converter to the control system via PROFINET.  $\hfill\square$ 

## Communication with the control system even if the line voltage is switched off

You must supply the converter with 24 V DC at terminals 31 and 32 if you wish to maintain communication with the control system when the line voltage is switched off.

In the case of brief interruptions of the 24 V power supply, the converter may signal a fault without communications with the control system being interrupted.

# 4.6.13.3 What do you have to set for communication via PROFINET?

# Configuring PROFINET communication in the I/O controller

You require the appropriate engineering system to configure PROFINET communication in the IO controller.

If required, load the GSDML file of the converter into the engineering system.

Installing GSDML (Page 138)

## **Device** name

In addition to the MAC address and IP address, PROFINET also uses the device name to identify PROFINET devices (Device name). The device name must be unique across the PROFINET network.

To assign the device name, you need an engineering software, e.g. HW-Config.

The converter saves the device name on the inserted memory card.

# **IP address**

In addition to the device name, PROFINET also uses an IP address.

You have the following options to specify the IP address of the converter:

- You specify the IP address using engineering software, e.g. via HW Config.
- The IO Controller assigns an IP address to the converter.

# Telegram

Set the same telegram in the converter as in the IO Controller. Interconnect the telegrams in the control program of the IO Controller with the signals of your choosing.

Drive control via PROFIBUS or PROFINET (Page 253)

# **Application examples**

You can find application examples for PROFINET communication on the Internet:

Controlling the speed of a SINAMICS G110M/G120/G120C/G120D with S7-300/400F via PROFINET or PROFIBUS, with Safety Integrated (via terminal) and HMI (<u>https://support.industry.siemens.com/cs/ww/en/view/60441457</u>)

Controlling the speed of a SINAMICS G110M / G120 (Startdrive) with S7-1500 (TO) via PROFINET or PROFIBUS, with Safety Integrated (via terminal) and HMI (<u>https://support.industry.siemens.com/cs/ww/en/view/78788716</u>)

# 4.6.13.4 Installing GSDML

## Procedure

1. Save the GSDML to your PC.

- With Internet access:
   GSDML (<u>https://support.industry.siemens.com/cs/ww/en/view/26641490</u>)
- Without Internet access: Insert a memory card into the converter. Set p0804 = 12. The converter writes the GSDML as a zipped file (\*.zip) into directory /SIEMENS/SINAMICS/ DATA/CFG on the memory card.
- 2. Unzip the GSDML file on your computer.
- 3. Import the GSDML into the engineering system of the controller.

You have now installed the GSDML in the engineering system of the controller.

# 4.6.14 Connecting the converter to PROFIBUS



The PROFIBUS DP interface has the following functions:

- Cyclic communication
- Acyclic communication
- Diagnostic alarms

General information on PROFIBUS DP can be found in the Internet:

- PROFIBUS user organization (<u>http://www.profibus.com/downloads/installation-guide/</u>)
- Information about PROFIBUS DP (<u>www.siemens.com/profibus</u>)

## 4.6.14.1 Connecting the PROFIBUS cable to the converter

### Procedure

- Connect the converter to socket X126 via a PROFIBUS cable with the higher-level control.
   Overview of the interfaces (Page 105) The maximum permitted cable length to the previous station or the subsequent one is 100 m at a baud rate of 12 Mbit/s.
- 2. If necessary, connect a 24 V supply voltage to terminals 31 and 32. The external 24 V supply is only required if communication with the control may not be interrupted even if the line voltage is switched off.

You connected the converter with the control via PROFIBUS.  $\hfill\square$ 

# 4.6.14.2 What do you have to set for communication via PROFIBUS?

# **Configuring PROFIBUS communication**

You require the appropriate engineering system to configure PROFIBUS communication in the PROFIBUS master.

If required, load the GSD file of the converter into the engineering system.

Installing the GSD (Page 140)

## Setting the address

Set the address of the PROFIBUS device.

Set the PROFIBUS address (Page 140)

## Setting the telegram

Set the same telegram in the converter as in the PROFIBUS master. Interconnect the telegrams in the control program of the PROFIBUS master with the signals of your choosing.

Drive control via PROFIBUS or PROFINET (Page 253)

# **Application examples**

You can find application examples for PROFIBUS communication on the Internet:

Controlling the speed of a SINAMICS G110M/G120/G120C/G120D with S7-300/400F via PROFINET or PROFIBUS, with Safety Integrated (via terminal) and HMI (<u>https://support.industry.siemens.com/cs/ww/en/view/60441457</u>)

Controlling the speed of a SINAMICS G110M / G120 (Startdrive) with S7-1500 (TO) via PROFINET or PROFIBUS, with Safety Integrated (via terminal) and HMI (<u>https://support.industry.siemens.com/cs/ww/en/view/78788716</u>)

## Communication with the control system even if the line voltage is switched off

You must supply the converter with 24 V DC at terminals 31 and 32 if you wish to maintain communication with the control system when the line voltage is switched off.

In the case of brief interruptions of the 24 V power supply, the converter may signal a fault without communications with the control system being interrupted.

# 4.6.14.3 Installing the GSD

## Procedure

- 1. Save the GSD on your PC using one of the following methods.
  - With Internet access:
     GSD (<u>http://support.automation.siemens.com/WW/view/en/22339653/133100</u>)
  - Without Internet access: Insert a memory card into the converter. Set p0804 = 12. The converter writes the GSD as zipped file (\*.zip) into directory /SIEMENS/SINAMICS/ DATA/CFG on the memory card.
- 2. Unzip the GSD file on your computer.
- 3. Import the GSD in the engineering system of the controller.

You have now installed the GSD file in the engineering system of the controller.

# 4.6.14.4 Set the PROFIBUS address

Valid address area: 1 ... 125

You have the following options for setting the address:

• Using the address switch on the Control Unit:



Figure 4-31 Address switch with example for bus address 10

The address switch has priority over the other settings.

• With a commissioning tool, e.g. an operator panel, via parameter p0918 (factory setting: p0918 = 126).

It is only possible to change p0918 if an invalid address is set in the address switch.

Overview of the interfaces (Page 105)

## Setting the bus address

## Procedure

1. Set the address using one of the subsequently listed options:

- Via the address switch
- With a commissioning tool via p0918
- 2. Switch off the converter power supply.
- 3. Wait until all LEDs on the converter are dark.
- 4. Switch on the converter power supply again. Your settings become effective after switching on.

The PROFIBUS address is set.

4.7 Connecting a motor holding brake

# 4.7 Connecting a motor holding brake

The converter uses the Brake Relay to control the motor holding brake. Two types of Brake Relay exist:

- The Brake Relay controls the motor holding brake
- The Safe Brake Relay controls a 24 V motor holding brake and monitors the brake control for short-circuit or cable breakage.

#### Note

#### Brake Relay and Safe Brake Relay

There are no differences between the Brake Relay and the Safe Brake Relay in terms of installation and connection to the converter.

#### Connection to the converter

To ensure that you have the correct cable for connecting the Brake Relay irrespective of the converter size, you are supplied with two preassembled cables with different lengths. Connect the appropriate cable to the Brake Module and to the converter as shown below.

If you are using your own cable, ensure that the cable is insulated and rated for 600 V.

## Connecting the motor holding brake via a PELV circuit

The Brake Relay must be connected to the protective conductor if the motor brake is supplied from a PELV circuit.

## **Brake Relay**





Connection 24 V DC
## 4.7 Connecting a motor holding brake

# Safe Brake Relay



4.7 Connecting a motor holding brake

# 4.7.1 Installing a Brake Relay - PM250 Power Module

### Installing the Brake Relay

If you use the optional shield plate, install the Brake Relay on the shield plate of the Power Module.

If you do not use the shield plate, install the Brake Relay as close as possible to the Power Module.

### Connecting the Brake Relay to the converter

The connector for the Brake relay is located at the front of the Power Module for the FSA ... FSC frame sizes. These Power Modules have a cable entry for the connecting cable to the Brake Relay.

The connector for the Brake Relay is located at the bottom of the Power Module for the FSD ... FSF frame sizes.





Brake relay connector for FSA ... FSC Power Modules

Brake relay connector for FSD ... FSF Power Modules

# 4.7.2 Mounting and connecting the brake relay

### Installing the Brake Relay

- FSA ... FSC: Install the Brake Relay next to the Power Module.
- **FSD** ... **FSG**: Install the Brake Relay at the rear of the lower shield plate. Attach the Brake Relay before you install the shield plate.

## Connecting the Brake Relay to the converter

The connector for the Brake Relay is located at the front of the Power Module. Lay the cable harness for the Brake Relay in the cable routing.





Brake relay connector for FSA ... FSC Power Modules without STO terminals

Brake relay connector for FSD ... FSF Power Modules with STO terminals

4.8 Monitoring the temperature of the braking resistor

# 4.8 Monitoring the temperature of the braking resistor



#### WARNING

#### Fire caused by an unsuitable or incorrectly installed braking resistor

Using an unsuitable or improperly installed braking resistor can cause fires and smoke to develop. Fire and smoke development can cause severe personal injury or material damage.

- Only use braking resistors that are approved for the converter.
- Install the braking resistor in accordance with regulations.
- Monitor the temperature of the braking resistor.

#### Procedure

1. Connect the temperature monitoring system of the braking resistor (terminals T1 and T2 on the braking resistor) to a free digital input on the converter.





Figure 4-32 Example: Temperature monitoring of the braking resistor via digital input DI 3 on the Control Unit

 Define the function of the digital input used as an external fault with p2106. As an example with temperature monitoring via digital input DI 3: p2106 = 722.3.

You have ensured that the temperature is monitored.  $\hfill\square$ 

# Commissioning

# 5.1 Commissioning guidelines

#### Overview



- Define the requirements to be met by the drive for your application.
   (Page 150)
- Restore the factory settings of the converter if necessary.
   (Page 187)
- Check if the factory setting of the converter is sufficient for your application.
   (Page 153)
- 4. Set the following for quick commissioning of the drive:
  - The closed-loop motor control
  - The inputs and outputs
  - The fieldbus interface
  - (Page 155)
- 5. Check if additional converter functions are required for the application.
   (Page 221)
- 6. If necessary, adapt the drive.
- 7. Save your settings.

5.2 Tools to commission the converter

# 5.2 Tools to commission the converter

### **Operator panel**

An operator panel is used to commission, troubleshoot and control the converter, as well as to back up and transfer the converter settings.



The **Intelligent Operator Panel (IOP-2)** can either be snapped onto a converter, or is available as handheld device with a connecting cable to the converter. The graphics-capable plain text display of the IOP-2 enables intuitive converter operation.

Additional information on the IOP-2 is available in the Internet:

SINAMICS IOP-2 release for sale (<u>https://support.industry.siemens.com/cs/ww/en/view/</u>109747625)



The **Operator Panel BOP-2** for snapping onto the converter has a two-line display for diagnostics and operating the converter.

Operating Instructions of the BOP-2 and IOP-2 operator panels:

Overview of the manuals (Page 564)

### **Smart Access**



Smart Access is snapped onto a converter, and is a web server-based operating unit with wireless connection to a PC, tablet or smartphone. Smart Access is used to commission and maintain the converter.

You can find additional information about Smart Access on the Internet:

SINAMICS G120 Smart Access Operating Instructions (<u>https://support.industry.siemens.com/cs/ww/en/view/109758122</u>)

#### PC tools



**STARTER** and **Startdrive** are PC tools that are used to commission, troubleshoot and control the converter, as well as to back up and transfer the converter settings. You can connect the PC with the converter via USB or via the PROFIBUS / PROFINET fieldbus.

Connecting cable (3 m) between PC and converter: Article number 6SL3255-0AA00-2CA0

Startdrive DVD: Article number 6SL3072-4CA02-1XG0

Startdrive, system requirements and download (<u>https://support.industry.siemens.com/cs/ww/en/view/109760844</u>)

Startdrive tutorial (<u>http://support.automation.siemens.com/WW/view/en/73598459</u>)

STARTER, system requirements and download (<u>http://</u> support.automation.siemens.com/WW/view/en/26233208)

## Compliance with the General Data Protection Regulation

Siemens respects the principles of data protection, in particular the data minimization rules (privacy by design).

For this product, this means:

The product does not process neither store any person-related data, only technical function data (e.g. time stamps). If the user links these data with other data (e.g. shift plans) or if he stores person-related data on the same data medium (e.g. hard disk), thus personalizing these data, he has to ensure compliance with the applicable data protection stipulations.

5.3 Preparing for commissioning

# 5.3 Preparing for commissioning

## 5.3.1 Collecting motor data

#### Data for a standard induction motor

Before starting commissioning, you must know the following data:

• Which motor is connected to the converter?

Note down the Article No. of the motor and the motor's nameplate data. If available, note down the motor code on the motor's nameplate.



Figure 5-1 Example of the rating plate for a standard induction motor

- In which region of the world is the motor to be used?
   Europe IEC: 50 Hz [kW]
  - North America NEMA: 60 Hz [hp] or 60 Hz [kW]

#### • How is the motor connected?

Pay attention to the connection of the motor (star connection [Y] or delta connection  $[\Delta]$ ). Note the appropriate motor data for connecting.

# 5.3.2 Forming DC link capacitors

### Description

You may have to reform the DC link capacitors if the Power Module has been stored for more than one year. When the converter is operational, DC link capacitors that have not been formed can be damaged.

 Table 5-1
 The forming duration depends on how long the converter was stored for

| Storage time from the date of manufacture | Recommended forming duration |
|---|------------------------------|
| 1 – 2 years                               | 1 hour                       |
| 2 – 3 years                               | 2 hours                      |
| > 3 years                                 | 8 hours                      |

The production date of the Power Module is coded in the 3rd and 4th digit of the serial number on the rating plate: "S X -- 3 4 X X X..."

| Digit ③ | Year of manufacture | Digit ④ | Month of manufacture |
|---------|---------------------|---------|----------------------|
| D       | 2013                | 1 9     | January September    |
| E       | 2014                | 0       | October              |
| F       | 2015                | Ν       | November             |
| Н       | 2016                | D       | December             |
| J       | 2017                |         |                      |
| К       | 2018                |         |                      |
| L       | 2019                |         |                      |
| М       | 2020                |         |                      |

Table 5-2Production year and month

## Forming the DC link of PM240-2 and PM240P-2 Power Modules

You form the DC link capacitors by supplying the converter with a line voltage of  $\leq$  100 % of the rated voltage for a defined time.



# 5.3 Preparing for commissioning

# Form DC Link of other power modules

Formation of the DC link capacitors is not required for the following power modules even after a lengthy period of storage.

- PM230
- PM250

# 5.3.3 Converter factory setting

#### Motor

In the factory, the converter is set for an induction motor matching the rated power of the Power Module.

#### **Converter control**

You can find the factory settings for the converter control in the following Chapters:

#### **Converter interfaces**

The inputs and outputs and the fieldbus interface of the converter have specific functions when set to the factory settings.

- 💬 Factory setting of the CU240B-2 interfaces (Page 109)
- Factory setting of the CU240E-2 interfaces (Page 117)

### Switching the motor on and off

The converter is set in the factory as follows:

- After the ON command, the motor accelerates with a ramp-up time of 10 s (referred to 1500 rpm) to its speed setpoint.
- After the OFF1 command, the motor brakes down to standstill with the ramp-down time.
- The motor direction of rotation reverses with the reversing command.



The ramp-up and ramp-down times define the maximum motor acceleration when the speed setpoint changes. The ramp-up and ramp-down times are derived from the time between

#### 5.3 Preparing for commissioning

motor standstill and the maximum speed, or between the maximum speed and motor standstill.

#### Traverse the motor in the jog mode

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

For a control command at the respective digital input, the motor rotates with  $\pm 150$  rpm. The same ramp-up and ramp-down times as described above apply.



Figure 5-4 Jogging the motor in the factory setting

#### Minimum and maximum speed

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

#### Operate the converter with the factory setting

We recommend that you execute quick commissioning. For quick commissioning, you must adapt the converter to the connected motor by setting the motor data in the converter.

In basic applications with a standard induction motor, you can attempt to operate the drive with a rated power of < 18.5 kW without carry out an additional commissioning steps. Check whether the control quality of the drive without commissioning is adequate for the requirements of the application.

# 5.4.1 Inserting the BOP-2

Plugging on an operator panel

Procedure



1. Locate the lower edge of the Operator Panel into the matching recess of the Control Unit.

2. Plug the Operator Panel onto the converter until the latch audibly engages.

The operator panel is plugged onto the Control Unit.

The operator panel is ready for operation when you connect the converter to the power supply.

# 5.4.2 Overview



# 5.4.3 Starting quick commissioning

### Requirement

| 58 | ° 000.0<br>0.0 | 1/min<br>1/min |
|----|----------------|----------------|

- The following requirements apply:
- The power supply is switched on.
- The operator panel displays setpoints and actual values.

### **Function description**

|                 | Procedure   |
|-----------------|---|
| ESC             | Press the ESC key.  |
|                 | Press one of the arrow keys until the BOP-2 displays menu $SETUP$ .   |
| SETUP           | To start quick commissioning, press the OK key in menu ኗር ፣ ሀዎ.   |
| RESET           | We recommend resetting the converter to the factory setting before commencing quick commissioning.                        |
|                 | Should you wish to change the default setting of the interfaces, the converter must be reset to the factory settings now. |
|                 | Proceed as follows:   |
|                 | 1. Press the OK key.  |
|                 | 2. Switch over the display using an arrow key: $ {}_{n} \square \rightarrow \Im E \Sigma$                                 |
|                 | 3. Press the OK key.  |
| ]RV APPL<br>P96 | Selecting an application class (Page 157)   |

# 5.4.4 Selecting an application class

### Overview

When selecting an application class, the converter assigns the appropriate settings to the motor control.

If you do not set the application class, but instead setting "Expert", then you must define the appropriate closed-loop motor control setting.

# Requirement

You are using one of the following Power Modules:

- PM240-2
- PM240P-2

If you are using a different Power Module, then BOP-2 does not show step  $\exists R l' R P P l$ . Continue commissioning as described under "Expert".

Expert (Page 165)

# **Function description**

]RV RPPL P96 Select one of the application classes or setting "Expert":

- 578NJRRJ 🔂 Standard Drive Control (Page 160)
- <u>]</u><u>YNRM</u>; [ ] Dynamic Drive Control (Page 162)
- EXPERT Expert (Page 165)

| Application<br>class  | Standard Drive Control   | Dynamic Drive Control  |
|---|--|--|
| Properties  | <ul> <li>Typical settling time after a speed change:<br/>100 ms 200 ms</li> <li>Typical settling time after a load surge: 500 ms</li> <li>Load</li></ul>   | <ul> <li>Typical settling time after a speed change:</li> <li>&lt; 100 ms</li> <li>Typical settling time after a load surge: 200 ms</li> <li>Loadt</li> <li>Speedt</li> <li>Motort</li> <li>Motort</li> <li>Dynamic Drive Control controls and limits the motor torque</li> <li>Torque accuracy that can be achieved: ± 5 % for 15 % 100 % of the rated speed</li> <li>We recommend Dynamic Drive Control for the following applications: <ul> <li>Motor power ratings &gt; 11 kW</li> <li>For load surges of 10 % &gt;100 % of the rated motor torque</li> </ul> </li> <li>Dynamic Drive Control is necessary for a rampup time 0 → rated speed (dependent on the rated motor power): <ul> <li>&lt; 1 s (0.1 kW) &lt; 10 s (132 kW).</li> </ul> </li> </ul> |
| Application ex-<br>amples<br>Motors that can<br>be operated<br>Power Modules<br>that can be oper- | <ul> <li>Pumps, fans, and compressors with flow characteristic</li> <li>Wet or dry blasting technology</li> <li>Mills, mixers, kneaders, crushers, agitators</li> <li>Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)</li> <li>Basic spindles         Induction motors         PM240-2,     </li> </ul> | <ul> <li>Pumps and compressors with displacement machines</li> <li>Rotary furnaces</li> <li>Extruder</li> <li>Centrifuges</li> <li>Induction and synchronous motors</li> <li>PM240P-2</li> </ul>   |
| ated<br>Max. output fre-<br>quency  | 550 Hz   | 240 Hz   |

| 5.4 Quick | commissioning | using the | BOP-2 | operator | panel |
|-----------|---------------|-----------|-------|----------|-------|
|-----------|---------------|-----------|-------|----------|-------|

| Application<br>class | Standard Drive Control  | Dynamic Drive Control   |
|----------------------|---|---|
| Torque control       | Without torque control  | Speed control with lower-level torque control                                       |
| Commissioning        | <ul> <li>Unlike "Dynamic Drive Control," no speed con-<br/>troller needs to be set</li> </ul>   | <ul> <li>Fewer parameters compared with the "EXPERT"<br/>setting</li> </ul>         |
|                      | <ul> <li>Compared with the "EXPERT" setting:         <ul> <li>Simplified commissioning using predefined motor data</li> <li>Reduced number of parameters</li> </ul> </li> </ul> | • Dynamic Drive Control is preset for Power Mod-<br>ules, frame size D frame size F |
|                      | • Standard Drive Control is preset for Power Mod-<br>ules, frame size A frame size C  |   |

# 5.4.5 Standard Drive Control

Select the motor standard:

HP 60H7 NEMA, US units
KH 60H7 NEMA, SI units
Set the converter supply voltage.

• KW 50H7 IEC

#### **Function description**

| EUR/USR<br>P100  |
|------------------|
|                  |
|                  |
|                  |
| INK KOLT<br>P210 |
|                  |

MOT TYPE P30<u>0</u> Select the motor type. If a 5-digit motor code is stamped on the motor rating plate, select the corresponding motor type with motor code.

Motors without motor code stamped on the rating plate:

- ; N ]] [[ 7 Third-party induction motor
- // // ILE1, 1LG6, 1LA7, 1LA9 induction motors

Motors with motor code stamped on the rating plate:

- {[[[[] | | | | ]] [[][] 1LE1 induction motor . 9
- IPE | INT 1PC1 induction motor
- {PHB ; N ]] 1PH8 induction motor

Depending on the converter, the motor list in BOP-2 can deviate from the list shown above.

MOT CODE P301

If you have selected a motor type with motor code, you must now enter the motor code. The converter assigns the following motor data corresponding to the motor code.

If you do not know the motor code, then you must set the motor code = 0, and enter motor data from p0304 and higher from the rating plate.

87 HZ

87 Hz motor operation The BOP-2 only indicates this step if you selected IEC as the motor standard (P100 =  $K_{H}$   $\int \square K_{L}^{7}$ ).



| MOT 13<br>P 190 <u>0</u> | Motor data identification. Select the method which the converter uses to measure the data of the connected motor:   |  |  |
|--------------------------|---|--|--|
|                          | • [] F F No motor data identification   |  |  |
|                          | • 57 : L ROT Measure the motor data at standstill and with the motor rotating.<br>The converter switches off the motor after the motor data identification has been completed.  |  |  |
|                          | <ul> <li>57 / L Recommended setting: Measure the motor data at standstill.<br/>The converter switches off the motor after the motor data identification has been completed.<br/>Select this setting if the motor cannot rotate freely.</li> </ul> |  |  |
|                          | • RI T Measure the motor data while the motor is rotating.<br>The converter switches off the motor after the motor data identification has been completed.  |  |  |
|                          | • 57 RT []P Setting the same as 5711 R[]7<br>After the motor data identification, the motor accelerates to the current setpoint.  |  |  |
|                          | <ul> <li>STILL OP Setting the same as STILL</li> <li>After the motor data identification, the motor accelerates to the current setpoint.</li> </ul>   |  |  |
| FINISH                   | Complete the data entry for quick commissioning as follows:   |  |  |
|                          | 1. Switch over the display using an arrow key: $ _{\Box} \Box \rightarrow \Im E \Box$   |  |  |
|                          | 2. Press the OK key.  |  |  |
|                          | You have entered all of the data that is necessary for the quick commissioning of the converter.  |  |  |

## 5.4.6 Dynamic Drive Control

### **Function description**

EUR/USR PIDD Select the motor standard:

- KW 50HZ IEC
- HP 50H7 NEMA, US units
- KH 60H / NEMA, SI units



Set the converter supply voltage.



Select the motor type. If a 5-digit motor code is stamped on the motor rating plate, select the corresponding motor type with motor code.

Motors without motor code stamped on the rating plate:

- ; N ]] [[[ 7 Third-party induction motor
- // // 1LE1, 1LG6, 1LA7, 1LA9 induction motors

Motors with motor code stamped on the rating plate:

- {[[[[] | []]]] [[[]]] 1LE1 induction motor . 9
- IPF | INT 1PC1 induction motor
- IPHR INT 1PH8 induction motor

Depending on the converter, the motor list in BOP-2 can deviate from the list shown above.

MOT CODE P301 If you have selected a motor type with motor code, you must now enter the motor code. The converter assigns the following motor data corresponding to the motor code. If you do not know the motor code, then you must set the motor code = 0, and enter motor data from p0304 and higher from the rating plate. 87 Hz motor operation The BOP-2 only indicates this step if you selected IEC as the motor 81 HZ standard (P100 =  $H_{H}$   $S\Pi H$  7). Rated motor voltage MOT VOLT PROY Rated motor current MOT CURR PROS MOT POW P301 Rated motor power MOT FRED P310 Rated motor frequency MOT RPM P311 Rated motor speed Motor cooling: MOT COOL • **Γ***F* | *F* Natural cooling • FURFF TForced-air cooling • [ ; [] [] ; ]] Liquid cooling • NI FRN Without fan Select the basic setting for the motor control: TEC RPPL PSD2 • *ПР* | *ППP* Recommended setting for standard applications ΓΙ Ι ΠΠΡ Recommended setting for applications with short ramp-up and ramp-down times • HIJ LORD Recommended setting for applications with a high break loose torque. MRc PRr PIS Select the default setting for the interfaces of the converter that is suitable for your application.

Default settings of the CU240B-2 interfaces (Page 111)



Default settings of the CU240E-2 interfaces (Page 119)

#### Commissioning

#### 5.4 Quick commissioning using the BOP-2 operator panel



#### Expert 5.4.7

# **Function description**

| EUR/USR   | Select the motor standard:  |
|---|---|
| 1.00  | • KW 20H2 IEC   |
|   | ・ 光戸 旨[]H Z NEMA, US units  |
|   | ・ とは 「日日」 NEMA, SI units  |
| LOAD TYP  | Specify the overload capability of the converter:   |
|   | • #+ <b>5</b> # <b>[]</b> #] Duty cycle with "high overload"  |
|   | • L 🛛 📈 🖞 🖞 L Duty cycle with "low overload"  |
|   | Cverload capability of the converter (Page 490)   |
| INK VOLT<br>P210  | Set the converter supply voltage.   |
| NOT TYPE<br>P30 <u>0</u>                                    | Select the motor type. If a 5-digit motor code is stamped on the motor rating plate, select the corresponding motor type with motor code.                             |
|   | Motors without motor code stamped on the rating plate:  |
|   | IN ]] U[ 7 Third-party induction motor  |
|   | • IL IN ] 1LE1, 1LG6, 1LA7, 1LA9 induction motors   |
|   | Motors with motor code stamped on the rating plate:   |
|   | ILE I IN] [[] 1LE1 induction motor . 9  |
|   | ・ IPE I IN ]] 1PC1 induction motor  |
|   | ・ {PHB _ ; N ]] 1PH8 induction motor  |
|   | Depending on the converter, the motor list in BOP-2 can deviate from the list shown above.  |
| MOT CODE<br>P30 <u>1</u>                                    | If you have selected a motor type with motor code, you must now enter the motor code. The converter assigns the following motor data corresponding to the motor code. |
|   | If you do not know the motor code, then you must set the motor code = 0, and enter motor data from p0304 and higher from the rating plate.                            |
| 87 HZ   | 87 Hz motor operation The BOP-2 only indicates this step if you selected IEC as the motor standard (P100 =片川 らいれご).   |
| MOT VOLT<br>P30 <u>4</u>                                    | Rated motor voltage   |
| MOT CURR<br>P30 <u>5</u>                                    | Rated motor current   |
| not Pou<br>P30 <u>1                                    </u> | Rated motor power   |
| MOT FRED<br>P310  | Rated motor frequency   |



• 5P ] N EN Sensorless vector control

| Control mode                               | U/f control or flux current control (FCC)  | Sensorless vector control   |  |
|--|--|---|--|
| Properties                                 | • Typical settling time after a speed change: 100 ms 200 ms  | <ul> <li>Typical settling time after a speed change:<br/>&lt; 100 ms</li> </ul> |  |
|  | • Typical settling time after a load surge: 500 ms   | • Typical settling time after a load surge: 200 ms                              |  |
|  | <ul> <li>Load<br/>Speed<br/>Motor<br/>torque<br/>500 ms<br/>t</li> <li>The control mode is suitable to address the following requirements:<br/>– Motor power ratings &lt; 45 kW</li> <li>Ramp-up time 0 → rated speed (depending on the motor power rating):<br/>1 s (0.1 kW) 10 s (45 kW)</li> <li>Applications with steady load torque without load surges</li> <li>The control mode is insensitive with respect to imprecise setting of the motor data</li> </ul> | <ul> <li>Load ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓</li></ul>                   |  |
| Application of                             |  | motor power): < 1 s (0.1 kW) < 10 s (250 kW).                                   |  |
| amples                                     | • Pumps, fans, and compressors with flow charac-<br>teristic   | Pumps and compressors with displacement ma-<br>chines                           |  |
|  | Wet or dry blasting technology   | Rotary furnaces   |  |
|  | Mills, mixers, kneaders, crushers, agitators   | • Extruder  |  |
|  | <ul> <li>Horizontal conveyor technology (conveyor belts,<br/>roller conveyors, chain conveyors)</li> </ul>   | Centrifuges   |  |
|  | Basic spindles   |   |  |
| Motors that can<br>be operated             | Induction motors   | Induction and synchronous motors  |  |
| Power Modules<br>that can be oper-<br>ated | No rest  | restrictions  |  |
| Max. output fre-<br>quency                 | 550 Hz   | 240 Hz  |  |
| Torque control                             | Without torque control   | Torque control with and without higher-level speed control                      |  |
| Commissioning                              | In contrast to sensorless vector control, the speed controller does not have to be set   |   |  |
| MRc PRr<br>PIS                             | Select the default setting for the interfaces of application   | the converter that is suitable for your   |  |

application.

### Commissioning

5.4 Quick commissioning using the BOP-2 operator panel



You have entered all of the data that is necessary for the quick commissioning of the converter.

# 5.4.8 Identifying the motor data and optimizing the closed-loop control

#### Overview

×

Using the motor data identification, the converter measures the data of the stationary motor. In addition, based on the response of the rotating motor, the converter can determine a suitable setting for the vector control.

To start the motor data identification routine, you must switch-on the motor via the terminal strip, fieldbus or from the operator panel.

### Identifying the motor data and optimizing the closed-loop control

#### Requirements

- You have selected a method of motor data identification during quick commissioning, e.g. measuring motor data while the motor is stationary. When quick commissioning is complete, the converter issues alarm A07991.
- The motor has cooled down to the ambient temperature. An excessively high motor temperature falsifies the motor data identification results.

## WARNING

#### Unexpected machine motion while the motor data identification is in progress

For the stationary measurement, the motor can make several rotations. The rotating measurement accelerates the motor up to the rated speed. Secure dangerous machine parts before starting motor data identification:

- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower suspended loads to the floor.

#### Procedure



Enable the control priority via the operator panel.



The BOP-2 displays the symbol indicating manual operation.



Switch on the motor.



During motor data identification MII - ; I flashes on the BOP-2.



If the converter again outputs alarm A07991, then it waits for a new ON command to start the rotating measurement.

#### Commissioning

#### 5.4 Quick commissioning using the BOP-2 operator panel

If the converter does not output alarm A07991, switch off the motor as described below, and switch over the converter control from HAND to AUTO.



Switch on the motor to start the rotating measurement.



During motor data identification MIT - ; ]] flashes on the BOP-2.

The motor data identification can take up to 2 minutes depending on the rated motor power.



Depending on the setting, after motor data identification has been completed, the converter switches off the motor - or it accelerates it to the setpoint.

If required, switch off the motor.

Disable the control priority via the operator panel.

You have completed the motor data identification.

Quick commissioning has been completed once the motor data identification has been successfully completed.

The screen forms that are shown in this manual show generally valid examples. The number of setting options available in screen forms depends on the particular converter type.

# 5.5.1 Creating a project

# Creating a new project

## Procedure

1. Start the Startdrive commissioning software.

2. In the menu, select "Project"  $\rightarrow$  "New...".

3. Specify a name of your choice for the project.

You have created a new project.

# 5.5.2 Transfer converters connected via USB into the project

## Integrating the converter into the project

#### Procedure

- 1. Switch on the converter power supply.
- 2. First insert a USB cable into your PC and then into the converter.
- 3. The PC operating system installs the USB driver when you are connecting the converter and PC together for the first time.
- 4. Press the "Accessible nodes" button.

| 🚻 Siemens - Wdefthw990dssto.ww002.siemens.netWawesx13\$Wy DocumentsVautomatisierungProject_0_V13_SP1_5Pro |
|---|
| Project Edit View Insert Online Options Tools Window Help RM meta checks Hwon                             |
| 📑 🔁 🖥 Save project 🚢 🐰 🗉 🖹 🗙 🏷 ± (* ± 🖥 🛄 🌆 🖳 🖓 Go online 🖉 Go offline 🧦 🌆 🖉 🗲                            |
| Project tree  |
| Devices (M)   |
|   |
|   |
| Project_0_V13_SP1_5   |
| Add new device  |
| 🐼 🎰 Devices & networks  |

5. When the USB interface is appropriately set, then the "Accessible nodes" screen form shows the converters that can be accessed.

| Accessible devices |                                |             |               | ×           |
|--------------------|--------------------------------|-------------|---------------|-------------|
|                    |                                |             |               |             |
|                    | Type of the PC/PC inter        | face:       |               |             |
|                    | PG/PC inter                    | face: 📈 USB |               |             |
|                    |                                |             |               |             |
| Accessible no      | des of the selected interface: |             |               |             |
| Device             | Device type                    | Туре        | Address       | MAC address |
| G120_CU240         | E_2_DP_F G120 CU240E-2         | S7USB       | XAE609-001586 | -           |
|                    |                                |             |               |             |

If you have not correctly set the USB interface, then the following "No additional nodes found" message is displayed. In this case, follow the description below.

6. Transfer the converter into the project using the menu: "Online - Upload device as new station (hardware and software)".

You have transferred a converter accessible via the USB interface into your project.

# 5.5.3 Go online and start the commissioning Wizard

### Procedure

- 1. Select your project and go online: S Go online
- 2. In the following screen form, select the converter with which you wish to go online.
- 3. Once you are online, select "Commissioning" → "Commissioning Wizard":



You have started the commissioning Wizard of the converter.  $\hfill\square$ 

# 5.5.4 Overview of quick commissioning



# 5.5.5 Commissioning wizard

# Select the application class

### Procedure

Application class

When selecting an application class, the converter assigns the motor control with the appropriate default settings:

- [1] 💬 Standard Drive Control (Page 178)
- [2] Dynamic Drive Control (Page 180)
- [0] Expert or if no application class is listed:

# Commissioning

# 5.5 Quick commissioning with a PC.

| Application<br>class                                      | Standard Drive Control  | Dynamic Drive Control  |  |
|---|---|--|--|
| Properties  | <ul> <li>Typical settling time after a speed change:<br/>100 ms 200 ms</li> <li>Typical settling time after a load surge: 500 ms</li> <li>Load</li></ul>  | <ul> <li>Typical settling time after a speed change:<br/>&lt; 100 ms</li> <li>Typical settling time after a load surge: 200 ms</li> <li>Loadt</li> <li>Speedt</li> <li>Motort</li> <li>Motort</li> <li>Dynamic Drive Control controls and limits the motor torque</li> <li>Torque accuracy that can be achieved: ± 5% for 15% 100% of the rated speed</li> <li>We recommend Dynamic Drive Control for the following applications: <ul> <li>Motor power ratings &gt; 11 kW</li> <li>For load surges of 10% &gt;100% of the rated motor torque</li> </ul> </li> <li>Dynamic Drive Control is necessary for a rampup time 0 → rated speed (dependent on the rated motor power):</li> <li>&lt; 1 \$ (0.1 kW) &lt; 10 \$ (132 kW).</li> </ul> |  |
| Application ex-<br>amples<br>Motors that can              | <ul> <li>Pumps, fans, and compressors with flow characteristic</li> <li>Wet or dry blasting technology</li> <li>Mills, mixers, kneaders, crushers, agitators</li> <li>Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)</li> <li>Basic spindles</li> <li>Induction motors</li> </ul> | <ul> <li>Pumps and compressors with displacement machines</li> <li>Rotary furnaces</li> <li>Extruder</li> <li>Centrifuges</li> <li>Induction and synchronous motors</li> </ul>   |  |
| be operated<br>Power Modules<br>that can be oper-<br>ated | <br>PM240-2, PM240P-2   |  |  |
| Max. output fre-<br>quency                                | 550 Hz  | 240 Hz   |  |

| Application<br>class | Standard Drive Control  | Dynamic Drive Control  |
|----------------------|---|--|
| Torque control       | Without torque control  | Speed control with lower-level torque control  |
| Commissioning        | <ul> <li>Unlike "Dynamic Drive Control," no speed con-<br/>troller needs to be set</li> </ul>   | <ul> <li>Fewer parameters compared with the "EXPERT"<br/>setting</li> </ul>                            |
|                      | <ul> <li>Compared with the "EXPERT" setting:</li> <li>Simplified commissioning using predefined<br/>motor data</li> <li>Beduced number of parameters</li> </ul> | <ul> <li>Dynamic Drive Control is preset for Power Mod-<br/>ules, frame size D frame size F</li> </ul> |
|                      | <ul> <li>Standard Drive Control is preset for Power Mod-<br/>ules, frame size A frame size C</li> </ul>   |  |

# 5.5.6 Standard Drive Control

# Procedure for application class [1]: Standard Drive Control

| Setpoint specification | The wizard only displays the "setpoint input" if you configured a converter with PROFINET or PROFIBUS interface.  |
|------------------------|---|
|                        | Select whether the converter is connected to a higher-level control via the fieldbus.   |
|                        | Select whether the ramp-function generator for the speed setpoint is implemented in the higher-level control or in the converter.   |
| Defaults of the setpoi | Select the I/O configuration to preassign the converter interfaces.   |
|                        | Default settings of the CU240B-2 interfaces (Page 111)  |
|                        | Default settings of the CU240E-2 interfaces (Page 119)  |
| Drive setting          | Set the applicable motor standard and the converter supply voltage.   |
| Drive options          | If an optional component is installed between converter and motor, the corresponding setting must be performed.   |
|                        | If a braking resistor is installed, you set the maximum braking power to which the braking resistor will be subjected.  |
| Motor                  | Select your motor.  |
|                        | Enter the motor data according to the rating plate of your motor.<br>If you have selected a motor based on its article number, the data has already been entered.   |
|                        | Select the temperature sensor for monitoring of the motor temperature.  |
| Motor holding brake    | Define whether the converter actuates a motor holding brake.  |
| Important parameters   | Set the most important parameters to suit your application.   |
| Drive functions        | Select the technological application:   |
|                        | [0] Constant load: Typical applications include conveyor drives   |
|                        | • [1] Speed-dependent load: Typical applications include pumps and fans   |
|                        | Motor data identification (not all the following settings may be visible in Startdrive):  |
|                        | [0]: No motor data identification   |
|                        | • [2]: Recommended setting. Measure the motor data at standstill. The converter switches off the motor after the motor data identification has been completed. Select this setting if the motor cannot freely rotate, e.g. for a mechanically limited traversing range. |
|                        | • [12]: The same setting as [2]. The motor accelerates to the currently set setpoint after the motor data identification.   |
|                        | Calculating the motor parameters: Select "Complete calculation".  |
| la Summary             | Set the check mark for "RAM data to EEPROM (save data in the drive)" to save your data in the converter so that it is not lost if the power fails.  |
|                        | Press the "Finish" button.  |
| RAM data to EEPROM (save data | in the drive) |  |
|-------------------------------|---------------|--|
| Next >>                       | Finish        |  |

You have entered all of the data that is necessary for the quick commissioning of the converter.

# 5.5.7 Dynamic Drive Control

range.

# Procedure for application class [2]: Dynamic Drive Control

| Setpoint specification | The wizard only displays the "setpoint input" if you configured a converter with PROFINET or PROFIBUS interface.   |
|------------------------|--|
|                        | Select whether the converter is connected to a higher-level control via the fieldbus.  |
|                        | Select whether the ramp-function generator for the speed setpoint is implemented in the higher-level control or in the converter.  |
| Defaults of the setpoi | Select the I/O configuration to preassign the converter interfaces.  |
|                        | Default settings of the CU240B-2 interfaces (Page 111)   |
|                        | Default settings of the CU240E-2 interfaces (Page 119)   |
| Drive setting          | Set the applicable motor standard and the converter supply voltage.  |
| Drive options          | If an optional component is installed between converter and motor, the corresponding setting must be performed.  |
|                        | If a braking resistor is installed, you set the maximum braking power to which the braking resistor will be subjected.   |
| Motor                  | Select your motor.   |
|                        | Enter the motor data according to the rating plate of your motor.<br>If you have selected a motor based on its article number, the data has already been entered.  |
| Motor holding brake    | Define whether the converter actuates a motor holding brake.   |
| Important parameters   | Set the most important parameters to suit your application.  |
| Drive functions        | Application:   |
|                        | [0]: Recommended setting for standard applications.  |
|                        | <ul> <li>[1]: Recommended setting for applications with ramp-up and ramp-down times &lt; 10 s. This<br/>setting is not suitable for hoisting gear and cranes.</li> </ul>   |
|                        | • [5] Recommended setting for applications with a high break loose torque.   |
|                        | Motor data identification:   |
|                        | [0]: No motor data identification  |
|                        | • [1]: Recommended setting. Measure the motor data at standstill and with the motor rotating.<br>The converter switches off the motor after the motor data identification has been completed.  |
|                        | • [2]: Default setting: Measure the motor data at standstill. The converter switches off the motor after the motor data identification has been completed. Select this setting if the motor cannot freely rotate, e.g. for a mechanically limited traversing |

• [3]: Measure the motor data while the motor is rotating. The converter switches off the motor after the motor data identification has been completed.

- [11]: The same setting as [1]. The motor accelerates to the currently set setpoint after the motor data identification.
- [12]: The same setting as [2]. The motor accelerates to the currently set setpoint after the motor data identification.

Calculating the motor parameters: Select "Complete calculation".

Set the check mark for "RAM data to EEPROM (save data in the drive)" to save your data in the converter so that it is not lost if the power fails.

Select "Finish".

| RAM data to EEPROM (save data in | ne drive) |
|----------------------------------|-----------|
| Next >>                          | Finish    |

You have entered all of the data that is necessary for the quick commissioning of the converter.

Summary

# 5.5.8 Expert

### Procedure without application class or for the application class [0]: Expert The wizard only displays the "setpoint input" if you configured a converter with PROFINET or Setpoint specification **PROFIBUS** interface. Select whether the converter is connected to a higher-level control via the fieldbus. Select whether the ramp-function generator for the speed setpoint is implemented in the higher-level control or in the converter. Select the control mode. Open-loop/closed-loop .. Further information is provided at the end of the section. Select the I/O configuration to preassign the converter interfaces. Defaults of the setpoi... Default settings of the CU240B-2 interfaces (Page 111) Default settings of the CU240E-2 interfaces (Page 119) Set the applicable motor standard and the converter supply voltage. Drive setting Application: "[0] Load cycle with high overload ..." for applications requiring a high dynamic performance, e.g. conveyor systems. "[1] Load cycle with low overload ..." for applications that do not require a high dynamic performance, e.g. pumps or fans. If an optional component is installed between converter and motor, the corresponding Drive options setting must be performed. If a braking resistor is installed, you set the maximum braking power to which the braking resistor will be subjected. Select your motor. Motor Enter the motor data according to the rating plate of your motor. If you have selected a motor based on its article number, the data has already been entered. Define whether the converter actuates a motor holding brake. Motor holding brake Set the most important parameters to suit your application. Important parameters Application: Drive functions • [0]: In all applications that do not fall under [1] ... [3] [1]: Applications involving pumps and fans [2]: Applications with short ramp-up and ramp-down times. However, this setting is not suitable for hoisting gear and cranes/lifting gear. • [3]: Applications involving pumps and fans with optimized efficiency. The setting only makes sense for steady-state operation with slow speed changes. We recommend setting [1] if load surges in operation cannot be ruled out.

• [5]: Applications with high breakaway torques, e.g. extruders, mills and mixers

Motor identification:

- [1]: Recommended setting. Measure the motor data at standstill and with the motor rotating. The converter switches off the motor after the motor data identification has been completed.
- [2]: Measure the motor data at standstill. The converter switches off the motor after the motor data identification has been completed. Recommended setting for the following cases:
  - You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
  - You have set "U/f control" as control mode.
- [3]: Measure the motor data while the motor is rotating. The converter switches off the motor after the motor data identification has been completed.
- [11]: The same setting as [1]. The motor accelerates to the currently set setpoint after the motor data identification.
- [12]: The same setting as [2]. The motor accelerates to the currently set setpoint after the motor data identification.

Calculating the motor parameters: Select "Complete calculation".

Set the check mark for "RAM data to EEPROM (save data in the drive)" to save your data in the converter so that it is not lost if the power fails.

Select "Finish".

| RAM data to EEPROM (save data | in the drive) |        |
|-------------------------------|---------------|--------|
| Ck Next>>                     |               | Finish |

You have entered all of the data that is necessary for the quick commissioning of the converter.

Summary

# Select a suitable control mode

| Control mode                               | U/f control or flux current control (FCC)   | Encoderless vector control   |
|--|---|--|
| Properties                                 | <ul> <li>Typical settling time after a speed change:<br/>100 ms 200 ms</li> <li>Typical settling time after a load surge: 500 ms</li> <li>Load</li></ul>  | <ul> <li>Typical settling time after a speed change:<br/>&lt; 100 ms</li> <li>Typical settling time after a load surge: 200 ms</li> <li>Loadt</li> <li>Speedt</li> <li>Motor200 ms</li> <li>The control mode controls and limits the motor torque</li> <li>Torque accuracy that can be achieved: ± 5% for 15% 100% of the rated speed</li> <li>We recommend the control mode for the following applications: <ul> <li>Motor power ratings &gt; 11 kW</li> <li>For load surges of 10% &gt;100% of the rated motor torque</li> </ul> </li> <li>The control mode is necessary for a ramp-up time 0 → Rated speed (dependent on the rated motor power): &lt; 1 s (0.1 kW) &lt; 10 s (250 kW).</li> </ul> |
| Application ex-<br>amples                  | <ul> <li>Pumps, fans, and compressors with flow characteristic</li> <li>Wet or dry blasting technology</li> <li>Mills, mixers, kneaders, crushers, agitators</li> <li>Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)</li> <li>Basic spindles</li> </ul> | <ul> <li>Pumps and compressors with displacement machines</li> <li>Rotary furnaces</li> <li>Extruder</li> <li>Centrifuges</li> </ul>   |
| Motors that can be operated                | Induction motors  | Induction and synchronous motors   |
| Power Modules<br>that can be oper-<br>ated | No rest   | rictions   |
| Max. output fre-<br>quency                 | 550 Hz  | 240 Hz   |
| Torque control                             | Without torque control  | Torque control with and without higher-level speed control   |
| Commissioning                              | Contrary to encoderless vector control, the speed controller does not have to be set  |  |

# 5.5.9 Identify motor data

#### Overview

Using the motor data identification, the converter measures the data of the stationary motor. In addition, based on the response of the rotating motor, the converter can determine a suitable setting for the vector control.

To start the motor data identification routine, you must switch on the motor.

### Identifying the motor data and optimizing the closed-loop control

#### Requirements

- You have selected a method of motor data identification during quick commissioning, e.g. measurement of the motor data while the motor is stationary.
   When quick commissioning is complete, the converter issues alarm A07991.
- The motor has cooled down to the ambient temperature. An excessively high motor temperature falsifies the motor data identification results.
- The PC and converter are connected to each other online.

# 

#### Unexpected machine motion while the motor data identification is in progress

For the stationary measurement, the motor can make several rotations. The rotating measurement accelerates the motor up to the rated speed. Secure dangerous machine parts before starting motor data identification:

- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower suspended loads to the floor.

#### Procedure



- 1. Open the control panel.
- 2. Assume master control for the converter.
- 3. Set the "Drive enables"
- 4. Switch on the motor. The converter starts the motor data identification. This measurement can take several minutes.
  Depending on the setting, after motor data identification has been completed, the converter switches off the motor - or it accelerates it to the currently set setpoint.
- 5. If required, switch off the motor.
- 6. Relinquish the master control after the motor data identification.
- 7. Save the settings in the converter (RAM  $\rightarrow$  EEPROM):

| ▼ Commissioning      | DAM    |      |
|----------------------|--------|------|
| Commissioning Wizard | KAW    |      |
| Control panel        |        |      |
| Motor optimizat      | EEPROM | Save |
| Backing up/reset     |        |      |

You have completed the motor data identification.  $\square$ 

# Self-optimization of the speed control

If you have not only selected motor data identification with the motor stationary, but also rotating measurement with self-optimization of the speed control, you must switch on the motor again as described above and wait for the optimization run to finish.

Quick commissioning has been completed once the motor data identification has been successfully completed.

### Recommendations

Induction motors

When commissioning induction machines, you are advised to proceed as follows: – Before connecting the load, a complete "rotating measurement" (p1900 = 3 or without encoder: p1960 = 1; with encoder: p1960 = 2) should be carried out. Since the induction machine is idling, you can expect highly accurate results for the saturation characteristic and the rated magnetizing current.

– When the load is connected, speed controller tuning should be repeated because the total moment of inertia has changed. This is realized by selecting parameter p1960 (without encoder: p1960 = 3; with encoder: p1960 = 4). During the speed optimization, the saturation characteristic recording is automatically deactivated in parameter p1959.

Permanent-magnet synchronous motors
 When permanent-magnet synchronous motors are commissioned, the speed controller should be tuned (p1900 = 3 or p1960 > 0) when the load is connected.

### When must you reset the converter to the factory settings?

Reset the converter to the factory settings in the following cases:

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

### Restoring the factory settings when the safety functions are enabled

If you are using the integrated safety functions of the converter, e.g. "Safe Torque Off", you must reset the safety functions separately from the remaining converter settings.

The settings of the safety functions are protected by a password.

### Settings that are not changed when restoring the factory setting

The communication settings and the settings of the motor standard (IEC/NEMA) are kept when restoring the factory setting.

# 5.6.1 Resetting the safety functions to the factory setting

### Procedure

| W     | 游 Siemens - Welfthw990dssto.vvv002.siemens.netwawesx13\$Wy DocumentsVatomatisierung@roject_0_V13_SP1_4@roject_0_V13_SP1_4   |   |  |  |  |  |  |
|-------|---|---|--|--|--|--|--|
| P     | Project Edit View Insert Online Options Tools Window Help RM meta-checks Hwon   |   |  |  |  |  |  |
|       | Project tree  | Project_0_V13_SP1_4 → Dri   | ve_0 [G120 CU2:  |  |  |  |  |
| Start | <ul> <li>Project_0_V13_SP1_4</li> <li>Add new device</li> <li>Devices &amp; networks</li> <li>Drive_0 (6120 cu)2</li> <li>Poreice configur</li> <li>Parameter</li> <li>Commissioning</li> <li>Online &amp; dial</li> </ul>  | Commissioning<br>Commissioning Woard<br>Control panel<br>Motor optimization<br>Backing up/r_set | Backing up/reset   |  |  |  |  |
|       | <ul> <li>Sa Traces</li> <li>Traces</li> <li>Traces<td></td><td>Restore factory setting:<br/>Safety parameters will be reset<br/>All parameters will be reset<br/>Safety parameters will be reset<br/>SetRIOM and perform a POWER ON.<br/>Start</td></li></ul> |   | Restore factory setting:<br>Safety parameters will be reset<br>All parameters will be reset<br>Safety parameters will be reset<br>SetRIOM and perform a POWER ON.<br>Start |  |  |  |  |

- 1. Go online.
- 2. Select "Commissioning".
- 3. Select "Backing up/reset".
- 4. Select "Safety parameters are reset".
- 5. Press the "Start" button.
- 6. Enter the password for the safety functions.
- 7. Confirm that the parameters have been saved (RAM to ROM).
- 8. Go offline.
- 9. Switch off the converter power supply.
- 10. Wait until all LEDs on the converter are dark.
- 11. Switch on the converter power supply again.

You have restored the safety functions in the converter to the factory settings.  $\hfill\square$ 

Exception: The password for the safety functions is not reset.

Password (Page 298)

#### Procedure with an operator panel

- 1. Set p0010 = 30 Activate reset settings.
- p9761 = ...
   Enter the password for the safety functions
- 3. Start the reset with p0970 = 5.
- 4. Wait until the converter sets p0970 = 0.
- 5. Set p0971 = 1.
- 6. Wait until the converter sets p0971 = 0.

- 7. Switch off the converter power supply.
- 8. Wait until all LEDs on the converter are dark.
- 9. Switch on the converter power supply again.

You have restored the safety function settings of your converter to the factory settings.  $\ensuremath{\square}$ 

# 5.6.2 Restore the factory settings (without safety functions)

### Resetting to factory settings with Startdrive

#### Procedure

| _  |                               |                             |   |
|----|-------------------------------|-----------------------------|---|
| 禍  | Siemens - Wdefthw990dssto.ww0 | 002.siemens.netwawesx13\$\\ | ły DocumentsWutomatisierungProject_0_V13_SP1_5Project_0_V13_SP1_5 |
| Pr | oject Edit View Insert Online | Options Tools Window H      | elp RM meta checks Hwon   |
| E  | 🛉 🎦 🔚 Save project ا 📕 🗶 🏥    | 🗈 🗙 🖒 ± 🖓 ± 🕼 🛄 🛙           | 🛿 🖳 🐺 🕼 Go ortine 🎆 🕼 🕼 🧩 🖃 🛄                                     |
|    | Project tree 🛛 🔳 🖣            | Project_0_V13_SP1_5 → Di    | rive_0 [G120 CU24] Commissioning                                  |
|    | Devices                       |                             |   |
|    | 1300 <b>I</b> 1               |                             |   |
|    | and the second                | ▼ Commissioning             | Destring underset   |
|    | ▼ Project_0_V13_SP1_5         | Commissioning Wizard        | backing upreset   |
| Ŧ  | 💣 Add new device              | Control panel               | Save RAM data to EEPROM:  |
| 5  | 📥 Devices & networks          | Motor optimization          |   |
|    | 🔻 湿 Drive_0 [G120 CU          | Backing unfreset            | RAM   |
|    | Device configur               | Distanting operators        | 🔛 🙀 🤟   |
|    | 🚰 Parameter                   |                             | EEPROM  |
|    | t Commissioning               |                             |   |
|    | 🗓 Online & diag               |                             |   |
|    | 🕨 🔀 Traces 🔰 🛃                |                             | Restore factory setting:  |
|    | 🕨 🕞 Unassigned devi 🤇 🎽       |                             |   |
|    | 🕨 🙀 Common data               | 2)                          | All parameters will be reset                                      |
|    | Documentation se              |                             |   |
|    | 🕨 🚺 Languages & reso          |                             | All parameters except the   |
|    | Online access                 |                             | To the factory setting  |
|    | 🕨 🤄 Card Reader/USB me        |                             | Start   |
|    |                               |                             |   |

- 1. Go online.
- 2. Select "Commissioning".
- 3. Select "Back up/reset".
- 4. Select "All parameters will be reset".
- 5. Press the "Start" button.
- 6. Wait until the converter has been reset to the factory settings.

You have reset the converter to the factory settings.

### Resetting to factory setting with the BOP-2 operator panel

#### Procedure

1. Select "Reset to factory settings"



3. Wait until the converter has been reset to the factory setting.

You have reset the converter to the factory settings.  $\hfill\square$ 

# 5.7 Series commissioning

### Overview

Series commissioning is the commissioning of several identical converters. During series commissioning, it is sufficient to commission one of the converters and then transfer the settings of the first converter to additional converters.

### Precondition

The following preconditions apply to the converters regarding series commissioning:

- All converters have the same article number
- The converters to which the settings are transferred have the same or a higher firmware version as the source converter with the original settings.

### **Function description**

#### Procedure

- 1. Commission the first converter.
- 2. Back up the settings of the first converter to an external storage medium.
- 3. Transfer the settings from the first converter to another converter via the data storage medium.

Downloading the converter settings (Page 449)

# 5.8 Handling the BOP 2 operator panel

### Overview



<sup>1)</sup> Status display once the power supply for the converter has been switched on.

Figure 5-13 Menu of the BOP-2

| •   | The motor is switched on                                 |
|-----|--|
| JOG | Jog is active  |
| *   | An alarm is active                                       |
| ×   | Flashing symbol: A fault is active                       |
| 3   | Master control of the inverter is released via the BOP-2 |

Figure 5-14 Additional symbols of the BOP-2

# 5.8.1 Switching the motor on and off

### Overview

The BOP-2 offers the option of switching the motor on and off using the control keys.

### **Function description**

#### Procedure

1. Enable the control priority via the operator panel.



2. Switch on the motor.



3. Switch off the motor.

| D 🌯 SP 0.0<br>0.0 |
|-------------------|
|-------------------|

4. Disable the control priority via the operator panel.



You switched the motor on and off again.  $\hfill\square$ 

# 5.8.2 Changing parameter values

## Overview

You can modify the settings of the converter by changing the parameter values in the converter.

### Precondition

The converter only permits changes to write parameters. Write parameters begin with a "P", e.g. P45.

The value of a read-only parameter cannot be changed. Read-only parameters begin with an "r", for example: r2.

## **Function description**

### Procedure

1. Select the menu to display and change parameter values.

| MONITOR |  | PRRRMS | ОК |
|---------|--|--------|----|
|---------|--|--------|----|

2. Select the parameter filter.

| STANDARD<br>Filler |  | E×PERT<br>FILLEr | ОК |
|--------------------|--|------------------|----|
|--------------------|--|------------------|----|

- The converter only displays the most important parameters:

STRNJARJ Filler

- The converter displays all of the parameters to you:

EXPERT FILLER

3. When the parameter number flashes, select the desired parameter number.

4. When the parameter value flashes, change the parameter value.



You changed a parameter value.

## Additional information

The converter immediately saves any changes so that they are protected against power failure.

# 5.8.3 Changing indexed parameters

### Overview

For indexed parameters, several parameter values are assigned to a parameter number. Each of the parameter values has its own index.

### Precondition

You are in the menu for displaying and changing parameter values.

The number of an indexed parameter flashes in the BOP-2 display.

### **Function description**

### Procedure

1. Set the parameter index.

|  | P840(00)<br>r2090.0 | ОК | Р840[00]<br>+ 2090.0 | ОК |
|--|---------------------|----|----------------------|----|
|--|---------------------|----|----------------------|----|

2. Set the parameter value for the selected index.

| Р840[00]<br>+ 2090,0 | ОК |
|----------------------|----|
|                      |    |

You have now changed an indexed parameter.  $\hfill\square$ 

# 5.8.4 Entering the parameter number directly

### Overview

The BOP-2 offers the possibility of setting the parameter number digit by digit.

### Precondition

You are in the menu for displaying and changing parameter values.

The number of a given parameter flashes in the BOP-2 display.

### **Function description**

#### Procedure

1. Press the OK button until the first digit of the parameter number flashes.



2. Change the parameter number digit-by-digit. If you press the OK button, the BOP-2 jumps to the next digit.



3. After you have entered all of the digits of the parameter number, press the OK button.

You set the parameter number directly.

# 5.8.5 Entering the parameter value directly

### Overview

The BOP-2 offers the option of setting the parameter value digit by digit.

### Precondition

You are in the menu for displaying and changing parameter values. The parameter value flashes in the BOP-2 display.

### **Function description**

### Procedure

1. Press the OK button until the first digit of the parameter value flashes.

| РЧ5<br>Ч.00 | OK 5 s | P45 |
|-------------|--------|-----|

2. Change the parameter value digit-by-digit.



You set the parameter value directly.  $\hfill\square$ 

# 5.8.6 Why can a parameter value not be changed?

## Overview

Whether or not a parameter value can be changed depends on the type of parameter and the operating mode of the converter.

# **Function description**

The converter indicates why it currently does not permit a parameter to be changed:

| Read parameters cannot be adjusted                                    |                                       |
|---|---------------------------------------|
| The parameter can only be adjusted during quick commissioning.        | P304 400 V OK -P 10- 0 2 S P304 400 V |
| A parameter can only be<br>adjusted when the motor<br>is switched off |                                       |

# **Further information**

For each parameter, the parameter list contains the operating state in which the parameter can be changed.

# Uploading the converter settings

### Overview

After commissioning, your settings are permanently saved in the converter.

We recommend that you additionally back up the converter settings on an external storage medium by means of an upload. Without a backup, your settings could be lost should the converter develop a fault.

The following storage media options are available:

- Memory card
- Operator panel BOP-2
- Operator panel IOP-2
- SINAMICS G120 Smart Access
- PG/PC

# 6.1 Uploading to the memory card

## 6.1.1 Recommended memory cards

### **Function description**



Table 6-1Memory cards to back up converter settings

| Scope of delivery                   | Article number     |
|-------------------------------------|--------------------|
| Memory card without firmware        | 6SL3054-4AG00-2AA0 |
| Memory card with firmware V4.7      | 6SL3054-7EH00-2BA0 |
| Memory card with firmware V4.7 SP3  | 6SL3054-7TB00-2BA0 |
| Memory card with firmware V4.7 SP6  | 6SL3054-7TD00-2BA0 |
| Memory card with firmware V4.7 SP9  | 6SL3054-7TE00-2BA0 |
| Memory card with firmware V4.7 SP10 | 6SL3054-7TF00-2BA0 |
| Memory card with firmware V4.7 SP14 | 6SL3054-7TG00-2BA0 |

### **Further information**

#### Using memory cards from other manufacturers

The converter only supports memory cards up to 2 GB. SDHC cards (SD High Capacity) and SDXC cards (SD Extended Capacity) are not permitted.

If you use a different SD memory card, then you must format it as follows:

- Insert the card into your PC's card reader.
- Command to format the card: format x: /fs:fat or format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

#### Functional restrictions with memory cards from other manufacturers

The following functions are either not possible – or only with some restrictions – when using memory cards from other manufacturers:

- Licensing functions is only possible using the recommended memory cards.
- Know-how protection is only possible with one of the recommended memory cards.
- In certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the converter.

## 6.1.2 Automatic upload

### Overview

We recommend that you insert the memory card before switching on the converter. The converter automatically backs up its settings on the inserted memory card and always keeps it up to date.

### Precondition

The converter power supply has been switched off.

### **Function description**

#### Procedure

1. Insert an empty memory card into the converter.

#### Note

#### Accidental overwrite of the converter settings

When the supply voltage is switched on, the converter automatically accepts the settings already backed up on the memory card. If you use a memory card on which settings are already backed up, you will overwrite the settings of the converter.

• Use an empty memory card for the first automatic back-up of your settings.

#### Note

#### Unintentional firmware update

If the memory card contains a converter firmware, the converter may perform a firmware update after the supply voltage has been switched on.

• Before inserting the memory card, ensure that it is empty.

```
Firmware upgrade and downgrade (Page 474)
```

2. Switch on the power supply for the converter.

After the power supply has been switched on, the converter copies its changed settings to the memory card.

# 6.1.3 Message for a memory card that is not inserted

### **Function description**

The converter identifies that a memory card is not inserted, and signals this state. The message is deactivated in the converter factory setting.

#### Activate message

#### Procedure

1. Set p2118[x] = 1101, x = 0, 1, ... 19

2. Set p2119[x] = 2

Message A01101 for a memory card that is not inserted is activated.

### 

To cyclically signal to the higher-level control that a memory card is not inserted, connect parameter r9401 to the send data of the fieldbus interface.

#### Deactivate message

### Procedure

1. Set p2118[x] = 1101, x = 0, 1, ... 19

2. Set p2119[x] = 3

Message A01101 for a memory card that is not inserted is deactivated.  $\hfill\square$ 

### Parameter

| Parameter   | Explanation                         | Factory setting |
|-------------|-------------------------------------|-----------------|
| p2118[019]  | Change message type, message number | 0               |
| p2119[0 19] | Change message type, type           | 0               |
| r9401       | Safely remove memory card status    | -               |

## 6.1.4 Manual upload with Startdrive

### Overview

If you insert the memory card into a converter that is already supplied with power, you must start the upload manually using a commissioning tool.

### Requirement

The following preconditions apply:

- The converter power supply has been switched on.
- The PC and converter are connected with one another via a USB cable or via the fieldbus.
- A memory card is inserted in the converter.

### **Function description**

#### Procedure

|                             | Backing up/reset  |                      |
|-----------------------------|---|----------------------|
| 🚔 Add new device            | Save RAM data to EEPROM:                                |                      |
| 📩 Devices & networks        |   |                      |
| Drive_1 [G120P CU230P-2 PN] | RAM   |                      |
| Device configuration        |   |                      |
| 🌃 Parameter                 | БЕРРОМ  |                      |
| 👫 Commissioning             |   | Save                 |
| 🞖 Online & diagnostic       |   |                      |
| Online ac-ss<br>Diagnostics | Save the data from the drive on memory cards:           |                      |
| Backing unfreset            | Parameter set in the drive Parameter set on memory card |                      |
|                             | [0] Source/target standar                               | Save<br>Safely remov |

- 1. Go online.
- 2. Select "Online & diagnostics".
- 3. Select "Back up/reset".
- 4. Back up the settings to the EEPROM of the converter.
- 5. Set the number of your data backup. You can back up 99 different settings on the memory card.
- 6. Start data transfer
- 7. Wait until Startdrive signals that data backup has been completed.

You have backed up the converter settings to a memory card.  $\hfill\square$ 

### 6.1.5 Manual upload with BOP-2

### Overview

If you insert the memory card into a converter that is already supplied with power, you must start the upload manually using a commissioning tool.

### Precondition

The converter power supply has been switched on.

A memory card is inserted in the converter.

### **Function description**

#### Procedure

1. Select the upload.



2. Set the number of your data backup. You can back up 99 different settings on the memory card.



3. Start the upload.



4. Wait until the converter has backed up the settings to the memory card.



You have backed up the settings of the converter to the memory card.  $\hfill\square$ 

## 6.1.6 Safely removing a memory card using the BOP-2

### **Function description**

#### NOTICE

### Data loss from improper handling of the memory card

If you remove the memory card when the converter is switched on without implementing the "safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting.

• Only remove the memory card using the "safe removal" function.

#### Procedure

1. Select the menu for changing parameter values.



2. If a memory card is inserted, p9400 = 1. Set p9400 = 2.



- 3. The converter indicates whether it is currently writing data to the memory card:
  - The converter sets p9400 = 100:



You must not remove the memory card. Wait for several seconds and then set p9400 = 2 again.

- The converter sets p9400 = 3:

P9400 3

Remove the memory card.

4. After removing the memory card, the converter sets p9400 = 0.



You have safely removed the memory card.  $\hfill\square$ 

## 6.1.7 Safely remove the memory card with Startdrive

#### **Function description**

NOTICE Data loss from improper handling of the memory card If you remove the memory card when the converter is switched on without implementing the

"safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting.

• Only remove the memory card using the "safe removal" function.

#### Procedure

| 📑 Add new device            |   |
|-----------------------------|---|
| 📥 Devices & networks        |   |
| Drive_1 [G120P CU230P-2 PN] |   |
| Device configuration        |   |
| 🌌 Parameter                 |   |
| 🕂 🕺 Commissioning           |   |
| 🖞 Online & diagnostic.      |   |
| Online actions              |   |
| Functions Backing up/reset  | Parameter set on memory card Parameter set in the drive |

- 1. In the Drive Navigator select the following screen form:
- 2. Click on the button to safely remove the memory card. Startdrive will tell you whether you can remove the memory card from the converter.

You have now safely removed the memory card from the converter.

# 6.2 Uploading to the BOP-2

### Overview

You can back up the converter settings on the BOP-2 operator panel.

### Precondition

The converter power supply has been switched on.

### **Function description**

### Procedure

1. Select the upload to the operator panel.



2. Start the upload.

ESE / OK

3. Wait until the upload is completed.

| SRUIN6 | ZIPIN6 | ELONIN6 | TO BOP | ОК |
|--------|--------|---------|--------|----|
| PR#RS  | FILES  | ***-999 | -d0nE- |    |

The upload from the converter to the BOP-2 is completed.  $\hfill\square$ 

6.3 Upload to a PC using Startdrive

# 6.3 Upload to a PC using Startdrive

### Overview

You can backup the converter settings to a PC.

### Requirement

The following preconditions apply:

- The converter power supply has been switched on.
- The PC and converter are connected with one another via a USB cable or via the fieldbus.

### **Function description**

#### Procedure

- 1. Go online.
- 2. Select "Online" > "Upload device to PG/PC."
- 3. Back up the project with "Project" > "Save."
- 4. Wait until Startdrive signals that data backup has been completed.
- 5. Go offline.

You have backed up the settings.

# 6.4 More options for the upload

### **Function description**

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

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

Further information is provided on the Internet:

Memory options (<u>http://support.automation.siemens.com/WW/view/en/43512514</u>)

# Uploading the converter settings

6.4 More options for the upload

# Protecting the converter settings

# 7.1 Write protection

### Overview

The write protection prevents unauthorized changing of the converter settings.

### **Function description**

Write protection is applicable for all user interfaces:

- Commissioning tool, e.g. operator panel or PC
- Parameter changes via fieldbus

No password is required for write protection.

#### Activate and deactivate write protection

| Parameter |       |   |  |
|-----------|-------|---|--|
| r7760     | Write | Write protection/know-how protection status |  |
|           | .00   | 1 signal: Write protection active           |  |
| p7761     | Write | Write protection (factory setting: 0)       |  |
|           | 0:    | Deactivate write protection                 |  |
|           | 1:    | Activate write protection                   |  |

### Parameter

 Table 7-1
 Parameters that can be changed with active write protection

| Number    | Name  |
|-----------|---|
| p0003     | Access level / Acc_level                                      |
| p0010     | Drive commissioning parameter filter / Drv comm par_filt      |
| p0124[0n] | CU detection using LED / CU detect LED                        |
| p0970     | Reset drive parameters / Drive par reset                      |
| p0971     | Save parameters / Sav par                                     |
| p0972     | Drive unit reset / Drv_unit reset                             |
| p2111     | Alarm counter / Alarm counter                                 |
| p3950     | Service parameter / Serv par                                  |
| p3981     | Acknowledge drive object faults / Ackn DO faults              |
| p3985     | Master control mode selection / PcCtrl mode select            |
| p7761     | Write protection / Write protection                           |
| p8805     | Identification and Maintenance 4 Configuration / I&M 4 Config |

#### Protecting the converter settings

# 7.1 Write protection

| Number     | Name   |
|------------|--|
| p8806[053] | Identification and Maintenance 1 / I&M 1                     |
| p8807[015] | Identification and Maintenance 2 / I&M 2                     |
| p8808[053] | Identification and Maintenance 3 / I&M 3                     |
| p8809[053] | Identification and Maintenance 4 / I&M 4                     |
| p9400      | Safely remove memory card / Mem_card rem                     |
| p9484      | BICO interconnections search signal source / BICO S_src srch |

#### Note

# Write protection for multimaster fieldbus systems

Via multimaster fieldbus systems, e.g. BACnet or Modbus RTU, in spite of write protection being activated, parameters can still be changed. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

# 7.2 Know-how protection

### Overview

Know-how protection prevents unauthorized reading of the converter settings.

To protect your converter settings against unauthorized copying, in addition to know-how protection, you can also activate copy protection.

### Requirement

Know-how protection requires a password.

| Combination of know-how protection and<br>copy protection  | Is a memory card necessary?                                     |  |
|--|---|--|
| Know-how protection without copy protection  | The converter can be operated with or without mem-<br>ory card. |  |
| Know-how protection with basic copy protection<br>Know-how protection with extended copy pro-<br>tection | SIEMENS<br>SIMATIC<br>Wavar Carp<br>S C-WV E33                  | The converter can only be operated<br>with a SIEMENS memory card<br>Recommended memory<br>cards (Page 200) |

### **Function description**

The active know-how protection provides the following:

- With just a few exceptions, the values of all adjustable parameters p ... are invisible.
  - Several adjustable parameters can be read and changed when know-how protection is active.

In addition, you can define an exception list of adjustable parameters, which end users may change.

- Several adjustable parameters can be read but not changed when know-how protection is active.
- The values of monitoring parameters r ... remain visible.

7.2 Know-how protection

- Locked functions:
  - Downloading converter settings using a PC
  - Automatic controller optimization
  - Stationary or rotating measurement of the motor data identification
  - Deleting the alarm history and the fault history
  - Generating acceptance documents for safety functions
- Executable functions:
  - Restoring factory settings
  - Acknowledging faults
  - Displaying faults, alarms, fault history, and alarm history
  - Reading out the diagnostic buffer
  - Controlling a converter using a PC
  - Uploading adjustable parameters that can be changed or read when know-how protection is active.
  - Displaying acceptance documents for safety functions

When know-how protection is active, support can only be provided (from Technical Support) after prior agreement from the machine manufacturer (OEM).

### Know-how protection without copy protection

You can transfer the converter settings to another converter, e.g. using a memory card or an operator panel.

### Know-how protection with basic copy protection

After replacing a converter, to be able to operate the new converter with the settings of the replaced converter without knowing the password, the memory card must be inserted in the new converter.

### Know-how protection with extended copy protection

It is not possible to insert and use the memory card in another converter without knowing the password.

### Commissioning know-how protection

- 1. Check as to whether you must extend the exception list.
- 2. Activate the know-how protection.
Table 7-2
 Parameters that can be changed with active know-how protection

| Number     | Name  |
|------------|---|
| p0003      | Access level / Acc_level                                      |
| p0010      | Drive commissioning parameter filter / Drv comm par_filt      |
| p0124[0n]  | CU detection using LED / CU detect LED                        |
| p0791[01]  | CO: Fieldbus analog outputs / Fieldbus AO                     |
| p0970      | Reset drive parameters / Drive par reset                      |
| p0971      | Save parameters / Sav par                                     |
| p0972      | Drive unit reset / Drv_unit reset                             |
| p2040      | Fieldbus interface monitoring time / Fieldbus t_monit         |
| p2111      | Alarm counter / Alarm counter                                 |
| p3950      | Service parameter / Serv par                                  |
| p3981      | Acknowledge drive object faults / Ackn DO faults              |
| p3985      | Master control mode selection / PcCtrl mode select            |
| p7761      | Write protection / Write protection                           |
| p8402[08]  | RTC daylight saving time setting / RTC DST                    |
| p8805      | Identification and Maintenance 4 Configuration / I&M 4 Config |
| p8806[053] | Identification and Maintenance 1 / I&M 1                      |
| p8807[015] | Identification and Maintenance 2 / I&M 2                      |
| p8808[053] | Identification and Maintenance 3 / I&M 3                      |
| p8809[053] | Identification and Maintenance 4 / I&M 4                      |
| p8980      | EtherNet/IP profile / Eth/IP profile                          |
| p8981      | EtherNet/IP ODVA STOP mode / Eth/IP ODVA STOP                 |
| p8982      | EtherNet/IP ODVA speed scaling / Eth/IP ODVA n scal           |
| p8983      | EtherNet/IP ODVA torque scaling / Eth/IP ODVA M scal          |
| p9400      | Safely remove memory card / Mem_card rem                      |
| p9484      | BICO interconnections search signal source / BICO S_src srch  |

| Table 7-3 | Parameters that can | he read with active | know-how protection |
|-----------|---------------------|---------------------|---------------------|
| Table 7-5 |                     | De leau with active | know-now protection |

| Number    | Name   |
|-----------|--|
| p0015     | Macro drive unit / Macro drv unit                      |
| p0100     | IEC/NEMA Standards / IEC/NEMA Standards                |
| p0170     | Number of Command Data Sets (CDS) / CDS count          |
| p0180     | Number of Drive Data Sets (DDS) / DDS count            |
| p0300[0n] | Motor type selection / Mot type sel                    |
| p0304[0n] | Rated motor voltage / Mot U_rated                      |
| p0305[0n] | Rated motor current / Mot I_rated                      |
| p0505     | Selecting the system of units / Unit sys select        |
| p0595     | Technological unit selection / Tech unit select        |
| p0730     | BI: CU signal source for terminal DO 0 / CU S_src DO 0 |

## Protecting the converter settings

## 7.2 Know-how protection

| Number    | Name   |
|-----------|--|
| p0731     | BI: CU signal source for terminal DO 1 / CU S_src DO 1                 |
| p0732     | BI: CU signal source for terminal DO 2 / CU S_src DO 2                 |
| p0806     | BI: Inhibit master control / Inhibit PcCtrl                            |
| p0870     | BI: Close main contactor / Close main cont                             |
| p0922     | PROFIdrive PZD telegram selection / PZD telegr_sel                     |
| p1080[0n] | Minimum velocity / v_min   |
| p1082[0n] | Maximum velocity / v_max   |
| p1520[0n] | CO: Torque limit upper / M_max upper                                   |
| p2000     | Reference speed reference frequency / n_ref f_ref                      |
| p2001     | Reference voltage / Reference voltage                                  |
| p2002     | Reference current / I_ref  |
| p2003     | Reference torque / M_ref   |
| p2006     | Reference temperature / Ref temp                                       |
| p2030     | Fieldbus interface protocol selection / Fieldbus protocol              |
| p2038     | PROFIdrive STW/ZSW interface mode / PD STW/ZSW IF mode                 |
| p2079     | PROFIdrive PZD telegram selection extended / PZD telegr ext            |
| p7763     | KHP OEM exception list number of indices for p7764 / KHP OEM qty p7765 |
| p7764[0n] | KHP OEM exception list / KHP OEM excep list                            |

## 7.2.1 Extending the exception list for know-how protection

In the factory setting, the exception list only includes the password for know-how protection.

Before activating know-how protection, you can additionally enter the adjustable parameters in the exception list, which must still be able to be read and changed by end users – even if know-how protection has been activated.

You do not need to change the exception list, if, with exception of the password, you do not require additional adjustable parameters in the exception list.

#### Absolute know-how protection

If you remove password p7766 from the exception list, it is no longer possible to enter or change the password for know-how protection.

You must reset the converter to the factory settings in order to be able to gain access to the converter adjustable parameters. When restoring the factory settings, you lose what you have configured in the converter, and you must recommission the converter.

| Parameter Description |   | Factory setting |
|-----------------------|---|-----------------|
| p7763                 | KHP OEM exception list, number of indices for p7764 | 1               |
| p7764[0p7763]         | 64[0p7763] KHP OEM exception list                   |                 |
|                       | p7766 is the password for know-how protection       | [1499] 0        |

7.2 Know-how protection

## 7.2.2 Activating and deactivating know-how protection

#### Requirements

- The converter has now been commissioned.
- You have generated the exception list for know-how protection.
- To guarantee know-how protection, you must ensure that the project does not remain at the end user as a file.

#### **Function description**

#### Activating know-how protection

- 1. Enter a password of your choice in p7767. Each index of p7767 corresponds with a character in the ASCII format.
- 2. Complete entry of the password with p7767[29] = 0.
- 3. Enter the same password in p7768 as that for p7767.
- 4. Complete entry of the password with p7768[29] = 0.

The know-how protection for the converter is activated.  $\hfill\square$ 

#### Deactivating know-how protection

- 1. Enter the password for the know-how protection in p7766. Each index of p7766 corresponds with a character in the ASCII format.
- 2. Complete entry of the password with p7766[29] = 0.

The know-how protection for the converter is deactivated.

| Parameter  | Description                                 | Factory setting |
|------------|---|-----------------|
| r7758[019] | KHP Control Unit serial number              |                 |
| p7759[019] | KHP Control Unit reference serial number    |                 |
| r7760      | Write protection/know-how protection status |                 |
| p7765      | KHP configuration                           | 0000 bin        |
| p7766[029] | KHP password, input                         |                 |
| p7767[029] | KHP password, new                           |                 |
| p7768[029] | KHP password, confirmation                  |                 |
| p7769[020] | KHP memory card reference serial number     |                 |
| r7843[020] | Memory card serial number                   |                 |

#### **Further information**

#### Preventing data reconstruction from the memory card

As soon as know-how protection has been activated, the converter only backs up encrypted data to the memory card.

In order to guarantee know-how protection, after activating know-how protection, we recommend that you insert a new, empty memory card. For memory cards that have already been written to, previously backed up data that was not encrypted can be reconstructed.

## Protecting the converter settings

7.2 Know-how protection

## **Advanced commissioning**



## 8.1 Overview of the converter functions

#### Overview



Figure 8-1 Overview of converter functions

#### **Drive control**

The converter receives its commands from the higher-level control via the terminal strip or the fieldbus interface of the Control Unit. The drive control defines how the converter responds to the commands.

- Sequence control when switching the motor on and off (Page 225)
- Adapt the default setting of the terminal strip (Page 228)
- Controlling clockwise and counter-clockwise rotation via digital inputs (Page 241)
- Drive control via PROFIBUS or PROFINET (Page 253)
- Drive control via Modbus RTU (Page 269)
- Drive control via USS (Page 272)
- Drive control via Ethernet/IP (Page 275)
- Jogging (Page 277)
- Limit position control (Page 279)

The converter can switch between different settings of the drive control.

Switching over the drive control (command data set) (Page 281)

#### 8.1 Overview of the converter functions

The converter provides the control for a motor holding brake. The motor holding brake holds the motor in position when it is switched off.

Motor holding brake (Page 283)

The free function blocks permit configurable signal processing within the converter.

Free function blocks (Page 288)

You can select in which physical units the converter represents its associated values.

Selecting physical units (Page 290)

#### Safety functions



The safety functions fulfill increased requirements regarding the functional safety of the drive.

Safe Torque Off (STO) safety function (Page 294)

The extended safety functions monitor the drive speed.

The setpoint generally determines the motor speed.

The extended safety functions are described in the "Safety Integrated" function manual.

Overview of the manuals (Page 564)

#### Setpoints and setpoint processing

**N** 

Setpoints (Page 310)

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

Setpoint processing (Page 320)

#### Technology controller

The technology controller controls process variables, e.g. pressure, temperature, level or flow. The closed-loop motor control receives the setpoint either from the higher-level control or from the technology controller.

PID technology controller (Page 331)

#### Motor control



**≰PID**∳

The closed-loop motor control ensures that the motor follows the speed setpoint. You can choose between various control modes.

Motor control (Page 344)

The converter provides several methods to brake the motor electrically. During electrical braking, the motor develops a torque that reduces the speed down to standstill.

Electrically braking the motor (Page 372)

#### Protection of the drive and the driven load



The protection functions prevent damage to the motor, converter and driven load.

- Overcurrent protection (Page 386)
  - Converter protection using temperature monitoring (Page 387)
- Motor protection with temperature sensor (Page 390)

8 1 Overview of the converter functions

 $\square$  Motor protection by calculating the temperature (Page 392)

Motor and converter protection by limiting the voltage (Page 395)

The monitoring of the driven load prevents impermissible operating modes, e.g. dry-running of a pump.

Monitoring the driven load (Page 397)

#### Increasing the drive availability



The kinetic buffering converts the kinetic energy of the load into electrical energy to buffer short-term power failures.

Kinetic buffering (Vdc min control) (Page 413)

The "Flying restart" function permits the fault-free switching on of the motor while it is still turning.

Flying restart – switching on while the motor is running (Page 408)

For active automatic restart, after a power failure, the converter attempts to automatically restart the motor and to acknowledge any faults that occur.

Automatic restart (Page 410)

#### **Energy saving**



For standard induction motors, the efficiency optimization reduces the motor losses in the partial load range.

Efficiency optimization (Page 415)

If necessary, the main contactor control disconnects the converter from the power system and so reduces the converter losses.

Line contactor control (Page 418)

The converter calculates how much energy controlled converter operation saves when compared to mechanical flow control (e.g. throttle).

Calculating the energy saving for fluid flow machines (Page 420)

8.2 Brief description of the parameters

## 8.2 Brief description of the parameters

#### Overview

The brief parameter description provides the most important information for all of the parameters that are assigned to a certain converter function.

If the number of parameter indices depends on the data sets, then the parameter index is shown in an abbreviated form.

|                            | Nu<br>  N<br>  N | mber of indices = number of command data sets (CDS)<br>umber of indices = number of drive data sets (DDS)<br>Jumber of indices = number of motor data sets (MDS)<br>Parameters with indices 03<br>,Parameters with bits 015 |                 |
|----------------------------|------------------|---|-----------------|
| Number                     |                  | Name  | Factory setting |
| p1234[D]                   | - - -<br>- - -   |   |                 |
| p1234[03] —<br>p1234.015 — | - <br>           |   |                 |



#### 8.3 Sequence control when switching the motor on and off

#### Overview



The sequence control defines the rules for switching the motor on and off.



Figure 8-3 Simplified representation of the sequence control

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

The converter switches on the motor with the ON command. The converter changes to the "Operation" state.

After the OFF1 command, the converter brakes the motor down to standstill. The converter switches off the motor once standstill has been reached. The converter is again "ready to start".

## **Function description**



Switch on the power supply of the inverter

Figure 8-4 Sequence control of the converter when the motor is switched on and off 8.3 Sequence control when switching the motor on and off

Converter states S1 ... S5c are defined in the PROFIdrive profile. The sequence control defines the transition from one state to another.

| The motor is switched off   |  |  | otor is switched on  |
|---|--|--|--|
| Current does not flow in the motor and the motor does not generate any torque |  | Current flows in the motor and the motor gener-<br>ates a torque |  |
| S1  | The ON command and an OFF command are active at the same time.   | S4   | The motor is switched on.  |
|   | In order for the converter to exit the state, you must deactivate OFF2 and OFF3 and activate the ON command again.                         |  |  |
| S2  | The converter waits for a new command to switch on the motor.  | S5a,<br>S5c  | The motor is still switched on. The convert-<br>er brakes the motor with the ramp-down<br>time of the ramp-function generator. |
| S3  | The converter waits for "Enable opera-<br>tion". The "Enable operation" command is<br>always active in the converter factory set-<br>ting. | S5b  | The motor is still switched on. The convert-<br>er brakes the motor with the OFF3 ramp-<br>down time.                          |

Table 8-1 Converter states

| Table 8-2 | Commands for switching the motor on and off |
|-----------|---|
|-----------|---|

| ON                     | The converter switches the motor on.   |
|------------------------|--|
| Jogging 1              |  |
| Jogging 2              |  |
| Enable opera-<br>tion  |  |
| OFF1, OFF3             | 1. The converter brakes the motor.   |
|                        | 2. The converter switches off the motor once it comes to a standstill.   |
|                        | The converter identifies that the motor is at a standstill when at least one of the following conditions is satisfied: |
|                        | • The speed actual value falls below the threshold in p1226, and the time started in p1228 has expired.                |
|                        | • The speed setpoint falls below the threshold in p1226, and the time subsequently started in p1227 has expired.       |
| OFF2                   | The converter switches off the motor immediately without first braking it.   |
| Inhibit opera-<br>tion |  |

| Number    | Name                                    | Factory setting |
|-----------|---|-----------------|
| r0046.031 | CO/BO: Missing enable signals           | -               |
| p0857     | Power unit monitoring time              | 10000 ms        |
| p0858[C]  | BI: Unconditionally close holding brake | 0               |
| p0860     | BI: Line contactor feedback signal      | 863.1           |

## 8.3 Sequence control when switching the motor on and off

| Number   | Name                                     | Factory setting |
|----------|--|-----------------|
| p0861    | Line contactor monitoring time           | 100 ms          |
| p1226[D] | Speed threshold for standstill detection | 20 rpm          |
| p1227    | Standstill detection monitoring time     | 300 s           |
| p1228    | Pulse suppression delay time             | 0.01 s          |

## 8.4 Adapt the default setting of the terminal strip

#### Overview



In the converter, the input and output signals are interconnected with specific converter functions using special parameters. The following parameters are available to interconnect signals:

- Binectors BI and BO are parameters to interconnect binary signals.
- Connectors CI and CO are parameters to interconnect analog signals.

The following chapters describe how you adapt the function of individual converter inputs and outputs using binectors and connectors.



<sup>1)</sup> Not available with Control Units CU240B-2 and CU240B-2 DP

## 8.4.1 Digital inputs

#### **Function description**

|        |                    | BI: pxxxx |
|--------|--------------------|-----------|
| <br>5  | DI 0               | -r0722.0  |
| <br>6  | DI 1               | r0722.1   |
| <br>7  | DI 2               | r0722.2   |
| <br>8  | DI 3               | r0722.3   |
| <br>16 | DI 4 <sup>1)</sup> | - r0722.4 |
| <br>17 | DI 5 <sup>1)</sup> | r0722.5   |

<sup>1)</sup> Not available with Control Units CU240B-2 and CU240B-2 DP

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

Binector inputs are designated in the parameter list with the "BI".

#### Example



To acknowledge converter fault messages using digital input DI 1, you must interconnect DI 1 with the command to acknowledge faults (p2103).

Set p2103 = 722.1.

| Parameter | Description  | Factory setting            |
|-----------|--|----------------------------|
| r0721     | CU digital inputs, terminal actual value -             |                            |
| r0722     | CO/BO: CU digital inputs, status                       | -                          |
| r0723     | CO/BO: CU digital inputs, status inverted              |                            |
| p0724     | CU digital inputs debounce time                        | 4 ms                       |
| p0810     | BI: Command data set selection CDS bit 0               | 0                          |
| p0840[C]  | BI: ON/OFF (OFF1)                                      | Dependent on the converter |
| p0844[C]  | BI: No coast down/coast down (OFF2) signal source<br>1 | Dependent on the converter |
| p0848[C]  | BI: No quick stop/quick stop (OFF3) signal source 1    | 1                          |
| p0852[C]  | BI: Enable operation/inhibit operation                 | Dependent on the converter |
| p1020[C]  | BI: Fixed speed setpoint selection, bit 0              | 0                          |
| p1021[C]  | BI: Fixed speed setpoint selection, bit 1              | 0                          |
| p1022[C]  | BI: Fixed speed setpoint selection, bit 2              | 0                          |
| p1023[C]  | BI: Fixed speed setpoint selection, bit 3              | 0                          |
| p1035[C]  | BI: Motorized potentiometer setpoint higher            | Dependent on the converter |
| p1036[C]  | BI: Motorized potentiometer setpoint lower             | Dependent on the converter |

#### Advanced commissioning

8.4 Adapt the default setting of the terminal strip

| Parameter | Description               | Factory setting            |
|-----------|---------------------------|----------------------------|
| p1055[C]  | BI: Jogging bit 0         | Dependent on the converter |
| p1056[C]  | BI: Jogging bit 1         | Dependent on the converter |
| p1113[C]  | BI: Setpoint inversion    | Dependent on the converter |
| p2103[C]  | BI: 1. Acknowledge faults | Dependent on the converter |
| p2106[C]  | BI: External fault 1      | 1                          |
| p2112[C]  | BI: External alarm 1      | 1                          |

For additional binector inputs and additional information on parameters, please refer to the parameter list.

Overview of the manuals (Page 564)

## 8.4.2 Analog inputs as digital inputs

#### **Function description**



<sup>1</sup> Not available with CU240B-2 and CU240B-2 DP Control Units

To use an analog input as additional digital input, you must interconnect the corresponding status parameter r0722.11 or r0722.12 with a binector input of your choice.

You may operate the analog input as a digital input with 10 V or with 24 V.

#### NOTICE

#### Defective analog input due to overcurrent

If the analog input switch is set to "Current input" (I), a 10 V or 24 V voltage source results in an overcurrent at the analog input. An overcurrent condition destroys the analog input.

 If you use an analog input as a digital input, then you must set the analog input switch to "Voltage" (U).

## 8.4.3 Failsafe digital inputs

## **Function description**

The converter combines two digital inputs into one failsafe digital input.

Additional information on failsafe digital inputs is provided in the description of the STO safety function.

Safe Torque Off (STO) safety function (Page 294)

## 8.4.4 Digital outputs

#### **Function description**



<sup>1)</sup> Not available with Control Units CU240B-2 and CU240B-2 DP

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

Binector outputs are designated in the parameter list with "BO".

#### Example



To output converter fault messages via digital output DO 1, you must interconnect DO 1 with these fault messages.

Set p0731 = 52.3

#### Parameter

| Table 8-3Frequently used binector outputs (BO) of the converter | e converter |
|---|-------------|
|---|-------------|

| Parameter  | Descript | ion   | Factory setting |
|------------|----------|---|-----------------|
| r0052[015] | CO/BO: S | tatus word 1                                  | -               |
|            | .00      | 1 signal: Ready for switching on              |                 |
|            | .01      | 1 signal: Ready for operation                 |                 |
|            | .02      | 1 signal: Operation enabled                   |                 |
|            | .03      | 1 signal: Fault active                        |                 |
|            | .04      | 0 signal: OFF2 active                         |                 |
|            | .05      | 0 signal: OFF3 active                         |                 |
|            | .06      | 1 signal: Switching on inhibited active       |                 |
|            | .07      | 1 signal: Alarm active                        |                 |
|            | .08      | 0 signal: Deviation, setpoint/actual speed    |                 |
|            | .09      | 1 signal: Control request                     |                 |
|            | .10      | 1 signal: Maximum speed (p1082) reached       |                 |
|            | .11      | 0 signal: I, M, P limit reached               |                 |
|            | .13      | 0 signal: Alarm, motor overtemperature        |                 |
|            | .14      | 1 signal: Motor clockwise rotation            |                 |
|            | .15      | 0 signal: Alarm, converter overload           |                 |
| r0053[011] | CO/BO: S | tatus word 2                                  | -               |
|            | .00      | 1 signal: DC braking active                   |                 |
|            | .02      | 1 signal: Speed > minimum speed (p1080)       |                 |
|            | .06      | 1 signal: Speed $\geq$ setpoint speed (r1119) |                 |

You can find additional binector outputs in the parameter list.

Cverview of the manuals (Page 564)

## 8.4.5 Analog inputs

#### **Function description**



<sup>1)</sup>Not available with Control Units CU240B-2 and CU240B-2 DP

#### Defining the analog input type

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

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

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

• Voltage input: Switch position U (factory setting)



• Current input: Switch position I

#### Defining the function of an analog input

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

Connector inputs are designated in the parameter list with "Cl".

#### Example



In order to enter the supplementary setpoint via analog input AI 0, you must interconnect AI 0 with the signal source for the supplementary setpoint.

Set p1075 = 755[0].

#### Parameter

| <b>T</b> 1 1 0 1 |                 |           |             | <b>C</b> . 1 |           |
|------------------|-----------------|-----------|-------------|--------------|-----------|
| Table 8-4        | Frequently used | connector | inputs (CI) | of the       | converter |

| Parameter | Description                            | Factory setting |
|-----------|--|-----------------|
| p1070[C]  | CI: Main setpoint                      | 0               |
| p1075[C]  | CI: Supplementary setpoint             | 0               |
| p2253[C]  | CI: Technology controller setpoint 1   | 0               |
| p2264[C]  | CI: Technology controller actual value | 0               |

You can find additional connector inputs in the parameter list.

Cverview of the manuals (Page 564)

#### **Further information**

#### Signal smoothing

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

Additional information is provided in the parameter list and in function diagram 2251 of the List Manual.

Overview of the manuals (Page 564)

#### Using an analog input as a digital input

An analog input can also be used as a digital input.

Digital inputs (Page 229)

## 8.4.6 Adjusting characteristics for analog input

#### **Function description**

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



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

#### Example

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



#### Procedure

1. Set the DIP switch for analog input 0 on the Control Unit to current input ("I").



- set p0756[0] = 3
   You have defined analog input 0 as a current input with wire-break monitoring.
- 3. Set p0757[0] = 6.0 (x1)

- 4. Set p0758[0] = -100.0 (y1)
- 5. Set p0759[0] = 12.0 (x2)
- 6. Set p0760[0] = 100.0 (y2)
- Set p0761[0] = 6 An input current < 6 mA results in fault F03505.</li>

The characteristic for the application example is set.  $\hfill \square$ 

#### Parameters

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| p0757[0n] | CU analog inputs characteristic value x1                   | 0               |
| p0758[0n] | CU analog inputs characteristic value y1                   | 0%              |
| p0759[0n] | CU analog inputs characteristic value x2                   | 10              |
| p0760[0n] | CU analog inputs characteristic value y2                   | 100%            |
| p0761[0n] | CU analog inputs wire-break monitoring, response threshold | 2               |
| p0762[0n] | CU analog inputs wire breakage monitoring time             | 100 ms          |

## 8.4.7 Setting the deadband

#### **Function description**



With the control enabled, electromagnetic interference on the signal cable can cause the motor to slowly rotate in one direction in spite of a speed setpoint = 0.

The deadband acts on the zero crossover of the analog input characteristic. Internally, the converter sets its speed setpoint = 0, even if the signal at the analog input terminals is slightly positive or negative. This prevents the converter from rotating the motor when the speed setpoint = 0.

| Parameter | Description                  | Factory setting |
|-----------|------------------------------|-----------------|
| p0764[0]  | Analog inputs deadband, Al 0 | 0               |
| p0764[1]  | Analog inputs deadband, Al 1 | 0               |

## 8.4.8 Analog outputs

#### **Function description**



<sup>1)</sup> Not available with Control Units CU240B-2 and CU240B-2 DP

#### Defining the analog output type

Define the analog output type using parameter p0776.

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

#### Defining the function of an analog output

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

Connector outputs are designated in the parameter list with "CO".

Overview of the manuals (Page 564)

#### Example

To output the converter output current via analog output 0, you must interconnect AO 0 with the signal for the output current.

Set p0771 = 27.

#### Parameter

| Table 8-5 | Frequently used connector outputs (CO) of the converter |
|-----------|---|
|-----------|---|

| Parameter | Description                           | Factory setting |
|-----------|---------------------------------------|-----------------|
| r0021     | CO: Speed actual value, smoothed      | - rpm           |
| r0025     | CO: Output voltage, smoothed          | - Vrms          |
| r0026     | CO: DC link voltage, smoothed         | - V             |
| r0027     | CO: Absolute actual current, smoothed | - Arms          |
| r0063     | CO: Speed actual value                | - rpm           |

You can find additional connector outputs in the parameter list.

Cverview of the manuals (Page 564)

#### 8.4.9 Adjusting characteristics for analog output

#### **Function description**

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



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

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

#### Example

Via analog output 0, the converter should convert a signal in the value range 0% ... 100% into an output signal 6 mA ... 12 mA.



#### Procedure

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

The characteristic for the application example is set.  $\ensuremath{\square}$ 

 Table 8-6
 Parameters for the scaling characteristic

| Parameter | Description                               | Factory setting |
|-----------|---|-----------------|
| p0777[01] | CU analog outputs characteristic value x1 | -               |
| p0778[01] | CU analog outputs characteristic value y1 | 0 V             |
| p0779[01] | CU analog outputs characteristic value x2 | 100%            |
| p0780[01] | CU analog outputs characteristic value y2 | 20 V            |

# 8.5 Controlling clockwise and counter-clockwise rotation via digital inputs

#### Overview



The converter offers various methods to start and stop the motor and reverse its direction.





## 8.5.1 Two-wire control, ON/reverse

## **Function description**



Figure 8-5 Two-wire control, ON/reverse

Command "ON/OFF1" switches the motor on and off. The "Reversing" command inverts the motor direction of rotation.

Table 8-7Function table

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

#### Examples

 Table 8-8
 Two-wire control and setting the assignment of the digital inputs

| Parameter        | Description                             |  |
|------------------|---|--|
| p3334 = 0        | 2/3 wire control selection              |  |
|                  | 0: Two-wire control, ON/reverse         |  |
| p0840[C] = 722.0 | BI: ON/OFF (OFF1)                       |  |
|                  | Command is received via digital input 0 |  |
| p1113[C] = 722.1 | BI: Setpoint inversion (reversing)      |  |
|                  | Command is received via digital input 1 |  |

| Parameter  | Description  |  |
|------------|--|--|
| p0015 = 12 | Macro drive unit                                       |  |
|            | Assigning digital inputs to the commands:              |  |
|            | Digital input 0: ON/OFF1                               |  |
|            | Digital input 1: Reversing                             |  |
|            | Default settings of the CU240B-2 interfaces (Page 111) |  |

#### Table 8-9 Set two-wire control, ON/reverse in quick commissioning

| Parameter | Description                      | Factory setting |
|-----------|----------------------------------|-----------------|
| p0840[C]  | BI: ON/OFF (OFF1)                | 0               |
| p1113[C]  | BI: Setpoint inversion           | 0               |
| r0722.0n  | CO/BO: CU digital inputs, status | -               |
| p3334     | 2/3 wire control selection       | 0               |
|           | 0: Two-wire control, ON/reverse  |                 |

## 8.5.2 Two-wire control, clockwise/counterclockwise rotation 1

#### **Function description**



Figure 8-6 Two-wire control, clockwise/counterclockwise rotation 1

Commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. The converter only accepts a new command when the motor is at a standstill.

| Table 8-10 | Function table |
|------------|----------------|
|            |                |

| ON/OFF1 clockwise rota-<br>tion | ON/OFF1 counter-clock-<br>wise rotation | Function  |
|---------------------------------|---|---|
| 0                               | 0                                       | The motor stops.  |
| 1                               | 0                                       | Clockwise motor rotation.   |
| 0                               | 1                                       | Counter-clockwise motor rotation.   |
| 1                               | 1                                       | The motor direction of rotation is defined by the command that first reaches state "1". |

#### Examples

Table 8-11 Two-wire control and setting the assignment of the digital inputs

| Parameter        | Description   |  |
|------------------|---|--|
| p3334 = 1        | 2/3 wire control selection  |  |
|                  | 1: Two-wire control, clockwise/counterclockwise rotation 1          |  |
| p3330[C] = 722.0 | BI: 2/3 wire control command 1 (ON/OFF1 clockwise rotation)         |  |
|                  | Command is received via digital input 0                             |  |
| p3331[C] = 722.1 | BI: 2/3 wire control command 2 (ON/OFF1 counter-clockwise rotation) |  |
|                  | Command is received via digital input 1                             |  |

| Parameter  | Description  |  |
|------------|--|--|
| p0015 = 17 | Macro drive unit                                       |  |
|            | Assigning digital inputs to the commands:              |  |
|            | Digital input 0: ON/OFF1 clockwise rotation            |  |
|            | Digital input 1: ON/OFF1 counter-clockwise rotation    |  |
|            | Default settings of the CU240E-2 interfaces (Page 119) |  |

#### Table 8-12 Set two-wire control, clockwise/counterclockwise rotation 1 in quick commissioning

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| r0722.0n  | CO/BO: CU digital inputs, status                           | -               |
| p0840[C]  | BI: ON/OFF (OFF1)  | 0               |
| p1113[C]  | BI: Setpoint inversion                                     | 0               |
| p3330[C]  | BI: 2/3 wire control command 1                             | 0               |
| p3331[C]  | BI: 2/3 wire control command 2                             | 0               |
| r3333.0n  | CO/BO: 2/3 wire control control word                       | -               |
| p3334     | 2/3 wire control selection                                 | 0               |
|           | 1: Two-wire control, clockwise/counterclockwise rotation 1 |                 |

## 8.5.3 Two-wire control, clockwise/counterclockwise rotation 2

#### **Function description**



Figure 8-7 Two-wire control, clockwise/counterclockwise rotation 2

Commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. The converter accepts a new command at any time, independent of the motor speed.

| ON/OFF1 clockwise rota-<br>tion | ON/OFF1 counter-clock-<br>wise rotation | Function                          |
|---------------------------------|---|-----------------------------------|
| 0                               | 0                                       | The motor stops.                  |
| 1                               | 0                                       | Clockwise motor rotation.         |
| 0                               | 1                                       | Counter-clockwise motor rotation. |
| 1                               | 1                                       | The motor stops.                  |

#### Examples

Table 8-14Two-wire control and setting the assignment of the digital inputs

| Parameter        | Description   |  |
|------------------|---|--|
| p3334 = 2        | 2/3 wire control selection  |  |
|                  | 2: Two-wire control, clockwise/counterclockwise rotation 2          |  |
| p3330[C] = 722.0 | BI: 2/3 wire control command 1 (ON/OFF1 clockwise rotation)         |  |
|                  | Command is received via digital input 0 (DI 0)                      |  |
| p3331[C] = 722.1 | BI: 2/3 wire control command 2 (ON/OFF1 counter-clockwise rotation) |  |
|                  | Command is received via digital input 1 (DI 1)                      |  |

| Parameter  | Description  |
|------------|--|
| p0015 = 18 | Macro drive unit                                       |
|            | Assigning digital inputs to the commands:              |
|            | Digital input 0: ON/OFF1 clockwise rotation            |
|            | Digital input 1: ON/OFF1 counter-clockwise rotation    |
|            | Default settings of the CU240B-2 interfaces (Page 111) |

#### Table 8-15 Set two-wire control, clockwise/counterclockwise rotation 2 in quick commissioning

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| r0722.0n  | CO/BO: CU digital inputs, status                           | -               |
| p0840[C]  | BI: ON/OFF (OFF1)  | 0               |
| p1113[C]  | BI: Setpoint inversion                                     | 0               |
| p3330[C]  | BI: 2/3 wire control command 1                             | 0               |
| p3331[C]  | BI: 2/3 wire control command 2                             | 0               |
| r3333.0n  | CO/BO: 2/3 wire control control word                       | -               |
| p3334     | 2/3 wire control selection                                 | 0               |
|           | 2: Two-wire control, clockwise/counterclockwise rotation 2 |                 |

## 8.5.4 Three-wire control, enable/clockwise/counterclockwise rotation

#### **Function description**



Figure 8-8 Three-wire control, enable/clockwise/counterclockwise rotation

The "Enable" command is a precondition for switching on the motor. Commands "ON clockwise rotation" and "ON counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. Removing the enable switches the motor off (OFF1).

| Table 8-16 Fu | inction table |
|---------------|---------------|
|---------------|---------------|

| Enable / OFF1 | ON clockwise rota-<br>tion | ON counter-clock-<br>wise rotation | Function                          |
|---------------|----------------------------|------------------------------------|-----------------------------------|
| 0             | 0 or 1                     | 0 or 1                             | The motor stops.                  |
| 1             | 0→1                        | 0                                  | Clockwise motor rotation.         |
| 1             | 0                          | 0→1                                | Counter-clockwise motor rotation. |
| 1             | 1                          | 1                                  | The motor stops.                  |

#### **Examples**

Table 8-17 Three-wire control and setting the assignment of the digital inputs

| Parameter        | Description  |
|------------------|--|
| p3334 = 3        | 2/3 wire control selection                                       |
|                  | 3: Three-wire control enable/clockwise/counterclockwise rotation |
| p3330[C] = 722.0 | BI: 2/3 wire control command 1 (enable/OFF1)                     |
|                  | Command is received via digital input 0                          |
| p3331[C] = 722.1 | BI: 2/3 wire control command 2 (ON clockwise rotation)           |
|                  | Command is received via digital input 0                          |
| p3332[C] = 722.2 | BI: 2/3 wire control command 3 (ON counter-clockwise rotation)   |
|                  | Command is received via digital input 0                          |

| Parameter  | Description  |
|------------|--|
| p0015 = 19 | Macro drive unit                                       |
|            | Assigning digital inputs to the commands:              |
|            | Digital input 0: Enable/OFF1                           |
|            | Digital input 1: ON clockwise rotation                 |
|            | Digital input 2: ON counter-clockwise rotation         |
|            | Default settings of the CU240B-2 interfaces (Page 111) |

# Table 8-18 Set three-wire control, enable/clockwise/counterclockwise rotation in quick commissioning

| Parameter | Description   | Factory setting |
|-----------|---|-----------------|
| r0722.0n  | CO/BO: CU digital inputs, status                                      | -               |
| p0840[C]  | BI: ON/OFF (OFF1)   | 0               |
| p1113[C]  | BI: Setpoint inversion  | 0               |
| p3330[C]  | BI: 2/3 wire control command 1  | 0               |
| p3331[C]  | BI: 2/3 wire control command 2  | 0               |
| p3332[C]  | BI: 2/3 wire control command 3  | 0               |
| r3333.0n  | CO/BO: 2/3 wire control control word                                  | -               |
| p3334     | 2/3 wire control selection  | 0               |
|           | 3: Three-wire control enable/clockwise/counterclockwise ro-<br>tation |                 |
8.5 Controlling clockwise and counter-clockwise rotation via digital inputs

# 8.5.5 Three-wire control, enable/ON/reverse

### **Function description**

The "Enable" command is a precondition for switching on the motor. The "ON" command switches the motor on. The "Reversing" command inverts the motor direction of rotation. Removing the enable switches the motor off (OFF1).



Figure 8-9 Three-wire control, enable/ON/reverse

#### Table 8-19 Function table

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

# Examples

 Table 8-20
 Changing the assignment of the digital inputs

| Parameter        | Description  |
|------------------|--|
| p3334 = 4        | 2/3 wire control selection                                       |
|                  | 4: Three-wire control enable/clockwise/counterclockwise rotation |
| p3330[C] = 722.0 | BI: 2/3 wire control command 1 (enable/OFF1)                     |
|                  | Command is received via digital input 0                          |
| p3331[C] = 722.1 | BI: 2/3 wire control command 2 (ON)                              |
|                  | Command is received via digital input 0                          |
| p3332[C] = 722.2 | BI: 2/3 wire control command 3 (reversing)                       |
|                  | Command is received via digital input 0                          |

# 8.5 Controlling clockwise and counter-clockwise rotation via digital inputs

| Parameter  | Description  |  |  |  |  |
|------------|--|--|--|--|--|
| p0015 = 20 | Macro drive unit                                       |  |  |  |  |
|            | Assigning digital inputs to the commands:              |  |  |  |  |
|            | Digital input 0: Enable/OFF1                           |  |  |  |  |
|            | Digital input 1: ON                                    |  |  |  |  |
|            | Digital input 2: Reversing                             |  |  |  |  |
|            | Default settings of the CU240B-2 interfaces (Page 111) |  |  |  |  |

#### Table 8-21 Set three-wire control, enable/ON/reverse in quick commissioning

#### Parameter

| Parameter | Description                             | Factory setting |
|-----------|---|-----------------|
| r0722.0n  | CO/BO: CU digital inputs, status        | -               |
| p0840[C]  | BI: ON/OFF (OFF1)                       | 0               |
| p1113[C]  | BI: Setpoint inversion                  | 0               |
| p3330[C]  | BI: 2/3 wire control command 1          | 0               |
| p3331[C]  | BI: 2/3 wire control command 2          | 0               |
| p3332[C]  | BI: 2/3 wire control command 3          | 0               |
| r3333.0n  | CO/BO: 2/3 wire control control word    | -               |
| p3334     | 2/3 wire control selection              | 0               |
|           | 4: Three-wire control enable/ON/reverse |                 |

# 8.6 Drive control via PROFIBUS or PROFINET

# 8.6.1 Receive data and send data

### Overview

#### Cyclic data exchange



The converter receives cyclic data from the higher-level control - and returns cyclic data to the control.



Figure 8-10 Cyclic data exchange

Converter and higher-level control system package their data in the form of telegrams.



Figure 8-11 Telegram structure

A telegram has the following structure:

- Header and trailer form the protocol frame.
- User data is located within the frame:
  - PKW: The control system can read or change the parameters in the converter via "PKW data".

Not every telegram has a "PKW range".

- PZD: The converter receives control commands and setpoints from the higher-level control - and sends status messages and actual values via "PZD data".

#### **PROFIdrive and telegram numbers**

For typical applications, certain telegrams are defined in the PROFIdrive profile and are assigned a fixed PROFIdrive telegram number. As a consequence, behind a PROFIdrive telegram number, there is a defined signal composition. As a consequence, a telegram number uniquely describes cyclic data exchange.

The telegrams are identical for PROFIBUS and PROFINET.

# 8.6.2 Telegrams

# Overview

The user data of the telegrams that are available are described in the following.

Telegram 1



16-bit speed setpoint

#### Telegram 20

| PZD01 | PZD02  | PZD03  | PZD04 | PZD05 | PZD06 |
|-------|--------|--------|-------|-------|-------|
| STW1  | NSOLL_ |        |       |       |       |
| 51001 | Α      |        |       |       |       |
| 701/1 | NIST_A | IAIST_ | MIST_ | PIST_ | MELD_ |
| 23001 | GLATT  | GLATT  | GLATT | GLATT | NAMUR |

16-bit speed setpoint for VIK-Namur

#### Telegram 350

| PZD01 | PZD02           | PZD03           | PZD04 |
|-------|-----------------|-----------------|-------|
| STW1  | NSOLL<br>_A     | M_LIM           | STW3  |
| ZSW1  | NIST_A<br>GLATT | IAIST_<br>GLATT | ZSW3  |

16-bit speed setpoint with torque limiting

#### Telegram 352

| PZD01 | PZD02           | PZD03             | PZD04          | PZD05         | PZD06          |  |
|-------|-----------------|-------------------|----------------|---------------|----------------|--|
| STW1  | NSOLL<br>_A     | Freely assignable |                |               |                |  |
| ZSW1  | NIST_A<br>GLATT | IAIST_<br>GLATT   | MIST_<br>GLATT | WARN_<br>CODE | FAULT_<br>CODE |  |

16-bit speed setpoint for PCS7

Telegram 353

|   |   | PZD01 | PZD02           |
|---|---|-------|-----------------|
| Π |   | STW1  | NSOLL<br>_A     |
|   | - | ZSW1  | NIST_A<br>GLATT |

16-bit speed setpoint with reading and writing to parameters

#### Telegram 354

|  |  | PZD01 | PZD02           | PZD03           | PZD04          | PZD05         | PZD06          |
|--|--|-------|-----------------|-----------------|----------------|---------------|----------------|
|  |  | STW1  | NSOLL<br>_A     | Freely a        | ssignable      | )             |                |
|  |  | ZSW1  | NIST_A<br>GLATT | IAIST_<br>GLATT | MIST_<br>GLATT | WARN_<br>CODE | FAULT_<br>CODE |

16-bit speed setpoint for PCS7 with reading and writing to parameters

#### Telegram 999

| PZD01 | PZD02   | PZD03    | PZD04       | PZD05     | PZD06  | PZD07 | PZD08 | PZD09 | PZD10 | PZD11 | PZD12 | PZD1 | 3 | PZD17 |
|-------|---------|----------|-------------|-----------|--------|-------|-------|-------|-------|-------|-------|------|---|-------|
| STW1  | Telegra | m length | for the re  | ceive dat | l<br>a |       |       |       |       |       | 1     |      |   |       |
| ZSW1  | Telegra | m length | for the tra | ansmit da | ita    |       |       | 1     |       |       | <br>  |      |   |       |

Unassigned interconnection and length

| Abbreviation | Explanation                  | Abbreviation | Explanation                      |
|--------------|------------------------------|--------------|----------------------------------|
| PZD          | Process data                 | PKW          | Parameter channel                |
| STW          | Control word                 | MIST_GLATT   | Actual smoothed torque           |
| ZSW          | Status word                  | PIST_GLATT   | Actual smoothed active power     |
| NSOLL_A      | Speed setpoint               | M_LIM        | Torque limit value               |
| NIST_A       | Speed actual value           | FAULT_CODE   | Fault code                       |
| NIST_A_GLATT | Smoothed actual speed value  | WARN_CODE    | Alarm code                       |
| IAIST_GLATT  | Smoothed current actual val- | MELD_NAMUR   | Message according to the VIK-NA- |
|              | ue                           |              | MUR definition                   |

# **Function description**

| Bit | Significance                                |                          | Explanation  | Signal inter-                       |  |
|-----|---|--------------------------|--|-------------------------------------|--|
|     | Telegram 20                                 | All other tele-<br>grams |  | connection<br>in the con-<br>verter |  |
| 0   | 0 = OFF1                                    |                          | The motor brakes with the ramp-down time<br>p1121 of the ramp-function generator. The con-<br>verter switches off the motor at standstill. | p0840[0] =<br>r2090.0               |  |
|     | $0 \rightarrow 1 = ON$                      |                          | The converter goes into the "ready" state. If, in addition bit $3 = 1$ , then the converter switches on the motor.                         |                                     |  |
| 1   | 0 = OFF2                                    |                          | Switch off the motor immediately, the motor then coasts down to a standstill.  | p0844[0] =<br>r2090.1               |  |
|     | 1 = No OFF2                                 |                          | The motor can be switched on (ON command).   |                                     |  |
| 2   | 0 = Quick stop (OFF3)                       |                          | Quick stop: The motor brakes to a standstill with the OFF3 ramp-down time p1135.   | p0848[0] =<br>r2090.2               |  |
|     | 1 = No quick stop (OFF3)                    |                          | The motor can be switched on (ON command).   |                                     |  |
| 3   | 0 = Inhibit operation                       |                          | Immediately switch-off motor (cancel pulses).  |                                     |  |
|     | 1 = Enable operation                        |                          | Switch-on motor (pulses can be enabled).   | r2090.3                             |  |
| 4   | 4 0 = Disable RFG<br>1 = Do not disable RFG |                          | The converter immediately sets its ramp-func-<br>tion generator output to 0.   | p1140[0] =<br>r2090.4               |  |
|     |   |                          | The ramp-function generator can be enabled.  |                                     |  |

# Control word 1 (STW1)

### Advanced commissioning

# 8.6 Drive control via PROFIBUS or PROFINET

| Bit  | Significance                           |                          | Explanation   | Signal inter-                       |  |
|------|--|--------------------------|---|-------------------------------------|--|
|      | Telegram 20                            | All other tele-<br>grams |   | connection<br>in the con-<br>verter |  |
| 5    | 0 = Stop RFG                           |                          | The output of the ramp-function generator stops at the actual value.  | p1141[0] =<br>r2090.5               |  |
|      | 1 = Enable RFG                         |                          | The output of the ramp-function generator follows the setpoint.   |                                     |  |
| 6    | 0 = Inhibit setpo                      | int                      | The converter brakes the motor with the ramp-<br>down time p1121 of the ramp-function gener-<br>ator.               | p1142[0] =<br>r2090.6               |  |
|      | 1 = Enable setpo                       | bint                     | Motor accelerates to the setpoint with the ramp-<br>up time p1120.  |                                     |  |
| 7    | $0 \rightarrow 1 = Acknowledge faults$ |                          | Acknowledge fault. If the ON command is still active, the converter switches to the "switching on inhibited" state. | p2103[0] =<br>r2090.7               |  |
| 8, 9 | Reserved                               |                          |   |                                     |  |
| 10   | 0 = No control v                       | ia PLC                   | Converter ignores the process data from the fieldbus.   | p0854[0] =<br>r2090.10              |  |
|      | 1 = Control via PLC                    |                          | Control via fieldbus, converter accepts the proc-<br>ess data from the fieldbus.                                    |                                     |  |
| 11   | 1 = Direction reversal                 |                          | Invert setpoint in the converter.   | p1113[0] =<br>r2090.11              |  |
| 12   | Not used                               |                          |   |                                     |  |
| 13   | 1)                                     | 1 = MOP up               | Increase the setpoint saved in the motorized po-<br>tentiometer.  | p1035[0] =<br>r2090.13              |  |
| 14   | 1)                                     | 1 = MOP down             | Reduce the setpoint saved in the motorized po-<br>tentiometer.  | p1036[0] =<br>r2090.14              |  |
| 15   | CDS bit 0                              | Reserved                 | Changes over between settings for different operation interfaces (command data sets).                               | p0810 =<br>r2090.15                 |  |

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

# Status word 1 (ZSW1)

| Bit | Significance               |                          | Remarks  | Signal inter-                       |  |
|-----|----------------------------|--------------------------|--|-------------------------------------|--|
|     | Telegram 20                | All other tele-<br>grams |  | connection<br>in the con-<br>verter |  |
| 0   | 1 = Ready for switching on |                          | Power supply switched on; electronics initial-<br>ized; pulses locked.   | p2080[0] =<br>r0899.0               |  |
| 1   | 1 = Ready                  |                          | Motor is switched on (ON/OFF1 = 1), no fault is<br>active. With the command "Enable operation"<br>(STW1.3), the converter switches on the motor. | p2080[1] =<br>r0899.1               |  |
| 2   | 1 = Operation enabled      |                          | Motor follows setpoint. See control word 1, bit 3.   | p2080[2] =<br>r0899.2               |  |
| 3   | 1 = Fault active           |                          | The converter has a fault. Acknowledge fault using STW1.7.   | p2080[3] =<br>r2139.3               |  |
| 4   | 1 = OFF2 inactive          |                          | Coast down to standstill is not active.  | p2080[4] =<br>r0899.4               |  |

| Bit | Significance                                |   | Remarks  | Signal inter-                        |  |
|-----|---|---|--|--------------------------------------|--|
|     | Telegram 20                                 | All other tele-<br>grams                      |  | connection<br>in the con-<br>verter  |  |
| 5   | 1 = OFF3 inactive                           | 1   | Quick stop is not active.  | p2080[5] =<br>r0899.5                |  |
| 6   | 1 = Switching on                            | inhibited active                              | It is only possible to switch on the motor after an OFF1 followed by ON. | p2080[6] =<br>r0899.6                |  |
| 7   | 1 = Alarm active                            |   | Motor remains switched on; no acknowledge-<br>ment is necessary.         | p2080[7] =<br>r2139.7                |  |
| 8   | 1 = Speed deviati<br>erance range           | on within the tol-                            | Setpoint / actual value deviation within the tol-<br>erance range.       | p2080[8] =<br>r2197.7                |  |
| 9   | 1 = Master control requested                |   | The automation system is requested to accept the converter control.      | p2080[9] =<br>r0899.9                |  |
| 10  | 1 = Comparison speed reached or<br>exceeded |   | Speed is greater than or equal to the corre-<br>sponding maximum speed.  | p2080[10]<br>= r2199.1               |  |
| 11  | 1 = current or<br>torque limit<br>reached   | 1 = torque limit<br>reached                   | Comparison value for current or torque has been reached or exceeded.     | p2080[11]<br>= r0056.13 /<br>r1407.7 |  |
| 12  | 1)  | 1 = Holding<br>brake open                     | Signal to open and close a motor holding brake.                          | p2080[12]<br>= r0899.12              |  |
| 13  | 0 = Alarm, motor overtemperature            |   |  | p2080[13]<br>= r2135.14              |  |
| 14  | 1 = Motor rotates clockwise                 |   | Internal converter actual value > 0.                                     | p2080[14]                            |  |
|     | 0 = Motor rotates counter-clock-<br>wise    |   | Internal converter actual value < 0.                                     | = r2197.3                            |  |
| 15  | 1 = CDS display                             | 0 = Alarm, con-<br>verter thermal<br>overload |  | p2080[15]<br>= r0836.0 /<br>r2135.15 |  |

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

# Control word 3 (STW3)

| Bit | Significance                     | Explanation                             | Signal interconnec-                 |
|-----|----------------------------------|---|-------------------------------------|
|     | Telegram 350                     |   | tion in the converter <sup>1)</sup> |
| 0   | 1 = fixed setpoint bit 0         | Selects up to 16 different fixed        | p1020[0] = r2093.0                  |
| 1   | 1 = fixed setpoint bit 1         | setpoints.                              | p1021[0] = r2093.1                  |
| 2   | 1 = fixed setpoint bit 2         |   | p1022[0] = r2093.2                  |
| 3   | 1 = fixed setpoint bit 3         |   | p1023[0] = r2093.3                  |
| 4   | 1 = DDS selection bit 0          | Changes over between settings           | p0820 = r2093.4                     |
| 5   | 1 = DDS selection bit 1          | for different motors (drive data sets). | p0821 = r2093.5                     |
| 6   | Not used                         |   |                                     |
| 7   | Not used                         |   |                                     |
| 8   | 1 = technology controller enable |   | p2200[0] = r2093.8                  |
| 9   | 1 = enable DC braking            |   | p1230[0] = r2093.9                  |
| 10  | Not used                         |   |                                     |

| Bit | Significance                          | Explanation   | Signal interconnec-                 |  |
|-----|---------------------------------------|---|-------------------------------------|--|
|     | Telegram 350                          |   | tion in the converter <sup>1)</sup> |  |
| 11  | 1 = Enable droop                      | Enable or inhibit speed control-<br>ler droop.  | p1492[0] = r2093.11                 |  |
| 12  | 1 = torque control active             | Changes over the control mode   | p1501[0] = r2093.12                 |  |
|     | 0 = speed control active              | for vector control.   |                                     |  |
| 13  | 1 = no external fault                 |   | p2106[0] = r2093.13                 |  |
|     | 0 = external fault is active (F07860) |   |                                     |  |
| 14  | Not used                              |   |                                     |  |
| 15  | 1 = CDS bit 1                         | Changes over between settings<br>for different operation interfaces<br>(command data sets). | p0811[0] = r2093.15                 |  |

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

#### Status word 3 (ZSW3)

| Bit | Significance   | Description   | Signal intercon-<br>nection in the<br>converter |
|-----|--|---|---|
| 0   | 1 = DC braking active                                  |   | p2051[3] = r0053                                |
| 1   | 1 =  n_act   > p1226                                   | Absolute current speed > stationary state detection |   |
| 2   | 1 =  n_act   > p1080                                   | Absolute actual speed > minimum speed               |   |
| 3   | 1 = i_act ≧ p2170                                      | Actual current $\geq$ current threshold value       |   |
| 4   | 1 =  n_act   > p2155                                   | Absolute actual speed > speed<br>threshold value 2  |   |
| 5   | 1 =  n_act   ≤ p2155                                   | Absolute actual speed < speed<br>threshold value 2  |   |
| 6   | 1 =  n_act   ≧ r1119                                   | Speed setpoint reached                              |   |
| 7   | 1 = DC link voltage ≦ p2172                            | Actual DC link voltage ≦ threshold value            |   |
| 8   | 1 = DC link voltage > p2172                            | Actual DC link voltage > threshold value            |   |
| 9   | 1 = ramp-up or ramp-down completed                     | Ramp-function generator is not ac-<br>tive.         |   |
| 10  | 1 = technology controller output at<br>the lower limit | Technology controller output ≦<br>p2292             |   |
| 11  | 1 = technology controller output at<br>the upper limit | Technology controller out-<br>put > p2291           |   |
| 12  | Not used   |   |   |
| 13  | Not used   |   |   |
| 14  | Not used   |   |   |
| 15  | Not used   |   |   |

| Bit | Significance  | P no.            |
|-----|---|------------------|
| 0   | 1 = Control Unit signals a fault                                | p2051[5] = r3113 |
| 1   | 1 = line fault: Phase failure or inadmissible voltage           |                  |
| 2   | 1 = DC link overvoltage   |                  |
| 3   | 1 = Power Module fault, e.g. overcurrent or overtemperature     |                  |
| 4   | 1 = converter overtemperature                                   |                  |
| 5   | 1 = ground fault/phase fault in the motor cable or in the motor |                  |
| 6   | 1 = motor overload  |                  |
| 7   | 1 = communication error to the higher-level control system      |                  |
| 8   | 1 = fault in a safety-relevant monitoring channel               |                  |
| 10  | 1 = fault in the internal converter communication               |                  |
| 11  | 1 = line fault  |                  |
| 15  | 1 = other fault   |                  |

# Fault word according to the VIK-NAMUR definition (MELD\_NAMUR)

# 8.6.3 Parameter channel

# Overview

The parameter channel allows parameter values to be cyclically read and written to.

| Parameter channel             |      |          |            |                         |       |
|-------------------------------|------|----------|------------|-------------------------|-------|
| PKE (1st word) IND (2nd word) |      |          | nd word)   | PWE (3rd and 4th words) |       |
| 1512 11                       | 10 0 | 15 8     | 70         | 15 0                    | 15 0  |
| AK S                          | PNU  | Subindex | Page index | PWE 1                   | PWE 2 |
| Р                             |      |          |            |                         |       |
| М                             |      |          |            |                         |       |

Structure of the parameter channel:

- PKE (1st word)
  - Type of task (read or write).
  - Bit 11 is reserved and is always assigned 0.
  - Parameter number
- IND (2nd word)
  - Parameter index
- PWE (3rd and 4th word)
  - Parameter value

### **Function description**

#### **AK: Request and response ID**

Table 8-23 Request identifiers, control  $\rightarrow$  converter

| AK              | Description                                    |          | Response identifier |  |
|-----------------|--|----------|---------------------|--|
|                 |  | positive | nega-<br>tive       |  |
| 0               | No request                                     | 0        | 7/8                 |  |
| 1               | Request parameter value                        | 1/2      | 7/8                 |  |
| 2               | Change parameter value (word)                  | 1        | 7/8                 |  |
| 3               | Change parameter value (double word)           | 2        | 7/8                 |  |
| 4               | Request descriptive element <sup>1)</sup>      | 3        | 7/8                 |  |
| 6 <sup>2)</sup> | Request parameter value (field) 1)             | 4/5      | 7/8                 |  |
| 7 2)            | Change parameter value (field, word) 1)        | 4        | 7/8                 |  |
| 8 <sup>2)</sup> | Change parameter value (field, double word) 1) | 5        | 7/8                 |  |
| 9               | Request number of field elements               | 6        | 7/8                 |  |

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

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

| AK | Description   |
|----|---|
| 0  | No response   |
| 1  | Transfer parameter value (word)   |
| 2  | Transfer parameter value (double word)  |
| 3  | Transfer descriptive element <sup>1)</sup>  |
| 4  | Transfer parameter value (field, word) <sup>2)</sup>  |
| 5  | Transfer parameter value (field, double word) <sup>2)</sup>   |
| 6  | Transfer number of field elements   |
| 7  | Converter cannot process the request.<br>In the most significant word of the parameter channel, the converter sends an error number to the control, refer to the following table. |
| 8  | No master controller status / no authorization to change parameters of the parameter channel interface  |

Table 8-24 Response identifiers, converter  $\rightarrow$  control

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

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

| Table 8-25 | Error numbers for response | identifier 7 |
|------------|----------------------------|--------------|
|------------|----------------------------|--------------|

| No.    | Description   |
|--------|---|
| 00 hex | Illegal parameter number (access to a parameter that does not exist)  |
| 01 hex | <b>Parameter value cannot be changed</b> (change request for a parameter value that cannot be changed)  |
| 02 hex | Lower or upper value limit exceeded (change request with a value outside the value limits)  |
| 03 hex | Incorrect subindex (access to a subindex that does not exist)   |
| 04 hex | No array (access with a subindex to non-indexed parameters)   |
| 05 hex | <b>Incorrect data type</b> (change request with a value that does not match the data type of the parameter)   |
| 06 hex | <b>Setting not permitted, only resetting</b> (change request with a value not equal to 0 without permission)  |
| 07 hex | <b>Descriptive element cannot be changed</b> (change request to a descriptive element error value that cannot be changed)   |
| 0B hex | No master control (change request but with no master control, see also p0927)   |
| 0C hex | Keyword missing   |
| 11 hex | <b>Request cannot be executed due to the operating state</b> (access is not possible for temporary reasons that are not specified)  |
| 14 hex | <b>Inadmissible value</b> (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values) |
| 65 hex | Parameter number is currently deactivated (depending on the mode of the converter)  |
| 66 hex | Channel width is insufficient (communication channel is too small for response)   |
| 68 hex | Illegal parameter value (parameter can only assume certain values)  |
| 6A hex | <b>Request not included / task is not supported</b> (the valid request identifications can be found in table "Request identifications controller $\rightarrow$ converter")          |
| 6B hex | <b>No change access for a controller that is enabled</b> . (The operating state of the converter prevents a parameter change)   |

| No.    | Description  |
|--------|--|
| 86 hex | Write access only for commissioning (p0010 = 15) (operating state of the converter prevents a parameter change)  |
| 87 hex | Know-how protection active, access locked  |
| C8 hex | <b>Change request below the currently valid limit</b> (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit) |
| C9 hex | <b>Change request above the currently valid limit</b> (example: a parameter value is too large for the converter power)  |
| CC hex | Change request not permitted (change is not permitted as the access code is not available)   |

# PNU (parameter number) and page index

| Parameter number | PNU       | Page index |
|------------------|-----------|------------|
| 0000 1999        | 0000 1999 | 0 hex      |
| 2000 3999        | 0000 1999 | 80 hex     |
| 6000 7999        | 0000 1999 | 90 hex     |
| 8000 9999        | 0000 1999 | 20 hex     |
| 10000 11999      | 0000 1999 | A0 hex     |
| 20000 21999      | 0000 1999 | 50 hex     |
| 30000 31999      | 0000 1999 | F0 hex     |
| 60000 61999      | 0000 1999 | 74 hex     |

#### Subindex

For indexed parameters, the parameter index is located in subindex as hexadecimal value.

### PWE: Parameter value or connector

Parameter values or connectors can be located in the PWE.

|                 | PWE 1                   |              | PWE 2  |  |
|-----------------|-------------------------|--------------|--|--|
| Parameter value | Bit 15 0                | Bit 15 8     | Bit 7 0  |  |
|                 | 0                       | 0            | 8-bit value  |  |
|                 | 0                       |              | 16-bit value   |  |
|                 | 32-bit                  | 32-bit value |  |  |
| Connector       | Bit 15 0                | Bit 15 10    | Bit 9 0  |  |
|                 | Number of the connector | 3F hex       | The index or bit field<br>number of the connec-<br>tor |  |

 Table 8-26
 Parameter value or connector

# Examples

#### Read request: Read out serial number of the Power Module (r7841[2])

To obtain the value of indexed parameter r7841, you must fill the parameter channel with the following data:

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

|   | Parameter channel |          |            |                    |                 |                 |
|---|-------------------|----------|------------|--------------------|-----------------|-----------------|
| PKE, 1st word IND, 2nd word PWE1 - high, 3rd word PWE2 - low, 4th w |                   |          |            | w, 4th word        |                 |                 |
| 151211  | 1 10 0            | 15 8     | 7 0        | 15 0               | 15 8            | 7 0             |
| AK  | Parameter number  | Subindex | Page index | Parameter value    | Parameter value | Parameter value |
| 0 1 1 0 0   | 11100110001       | 0000010  | 1001000    | 000000000000000000 | 00000000        | 00000000        |

Figure 8-12 Parameter channel for read request from r7841[2]

#### Write request: Change restart mode (p1210)

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

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

|   | Parameter channel |          |            |                             |                            |  |  |
|---|-------------------|----------|------------|-----------------------------|----------------------------|--|--|
| PKE, 1st word IND, 2nd word PWE1 - high, 3rd word PWE2 - low, 4th w |                   |          |            |                             | PWE2 - low, 4th word       |  |  |
| 1512 11   | 10 0              | 15 8     | 7 0        | 15 0                        | 15 0                       |  |  |
| AK  | Parameter number  | Subindex | Page index | Parameter value (bit 16 31) | Parameter value (bit 0 15) |  |  |
| 0 1 1 1 0   | 10010101010       | 00000000 | 0000000    | 000000000000000000          | 0000000000011010           |  |  |

Figure 8-13 A parameter channel to activate the automatic restart with p1210 = 26

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

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

- PKE, bit 12 ... 15 (AK): = 7 hex (change parameter value (field, word))
- PKE, bit 0 ... 10 (PNU): = 348 hex (840 = 348 hex, no offset, as 840 < 1999)

- IND, bit 8 ... 15 (subindex): = 1 hex (CDS1 = Index 1)
- IND, bit 0 ... 7 (page index): = 0 hex (offset 0 corresponds to 0 hex)
- PWE1, Bit 0 ... 15: = 2D2 hex (722 = 2D2 hex)
- PWE2, Bit 10 ... 15: = 3F hex (drive object for SINAMICS G120, always 63 = 3f hex)
- **PWE2, Bit 0** ... **9: = 2 hex** (Index of Parameter (DI 2 = 2))

| Parameter channel  |                       |          |            |                  |                 |            |
|--|-----------------------|----------|------------|------------------|-----------------|------------|
| PKE, 1st word IND, 2nd word PWE1 - high, 3rd word PWE2 - low, 4th word |                       |          |            |                  | - low, 4th word |            |
| 1512 11  | 1 10 0                | 15 8     | 7 0        | 15 0             | 15 10           | 9 0        |
| AK   | Parameter number      | Subindex | Page index | Parameter value  | Drive Object    | Index      |
| 0 1 1 1 0  | 0 1 1 0 1 0 0 1 0 0 0 | 0000001  | 00000000   | 0000001010100010 | 1 1 1 1 1 1     | 0000000010 |

Figure 8-14 Parameter channel to assign digital input 2 with ON/OFF1

# 8.6.4 Expanding or freely interconnecting telegrams

# Overview

When you have selected a telegram, the converter interconnects the corresponding signals with the fieldbus interface. Generally, these interconnections are locked so that they cannot be changed. However, with the appropriate setting in the converter, the telegram can be extended or even freely interconnected.

# **Function description**

#### Interconnection of send data and receive data

|                         |                        | p2051[0]              | r2053[0] <sup>4)</sup>  |                           |
|-------------------------|------------------------|-----------------------|-------------------------|---------------------------|
| p2061[0]                | r2063[0] <sup>2)</sup> | > P No. 3)            | _ <b>-</b>              | PZD send word 1           |
| > P No. <sup>11</sup>   | •                      | p2051[1]              | r2053[1] <sup>4)</sup>  |                           |
| p2061[1]                | r2063[1] <sup>2)</sup> | > P No. <sup>3)</sup> |                         | PZD send word 2           |
| <u>&gt; P No. "</u> −   | •                      | p2051[2]              | r2053[2] <sup>4)</sup>  |                           |
| p2061[2]                | r2063[2] <sup>2)</sup> | > P No. 3)            |                         | PZD send word 3           |
| <u>&gt; P No. "</u>     | •                      | p2051[3]              | r2053[3] <sup>4)</sup>  |                           |
| p2061[3]                | r2063[3] <sup>2)</sup> | > P No. 3)            | $\rightarrow$ $-$       | PZD send word 4           |
| > P No. <sup>1)</sup>   | •                      |                       | ≺                       |                           |
| •••                     | ***<br>*2062[15]2)     | •••                   | · •••                   |                           |
| p2061[15]               |                        |                       | /                       |                           |
| <u>&gt; P No. "</u>     | •                      | p2051[16]             | r2053[16] <sup>4)</sup> |                           |
|                         |                        | > P No. 3)            |                         | PZD send word 17          |
| <sup>1)</sup> Send word | parameter number, do   | oubleword             | 3) Send wo              | rd parameter number, word |

<sup>2)</sup> Send word value, doubleword

<sup>4)</sup> Send word value, word

Figure 8-15 Interconnection of the send data

In the converter, the send data are available in the "Word" format (p2051) - and in the "Double word" format (p2061). If you set a specific telegram, or you change the telegram, the converter automatically interconnects parameters p2051 and p2061 with the appropriate signals.



Figure 8-16 Interconnection of the receive data

The converter saves the receive data as follows:

- "Word" format in r2050
- "Double word" format in r2060
- Bit-by-bit in r2090 ... r2093

# Extending a telegram: Procedure

- 1. Set p0922 = 999.
- 2. Set parameter p2079 to the value of the corresponding telegram.
- 3. Interconnect additional send words and receive words with signals of your choice via parameters r2050 and p2051.

You have extended a telegram.

# Freely interconnecting signals in the telegram: Procedure

- 1. Set p0922 = 999.
- 2. Set p2079 = 999.
- 3. Interconnect additional send words and receive words with signals of your choice via parameters r2050 and p2051.

You have freely interconnected a telegram.  $\Box$ 

# Example

You wish to extend telegram 1 to 6 send words and 6 receive words. You want to test the extension by initiating that the converter returns each receive word back to the higher-level control system.

### Procedure

- 1. p0922 = 999
- 2. p2079 = 1
- 3. p2051[2] = r2050[2]
- 4. ...
- 5. p2051[5] = r2050[5]
- 6. Test the telegram length for received and sent words:
  - r2067[0] = 6
  - r2067[1] = 6

You wish to extend telegram 1 to 6 send words and 6 receive words.  $\hfill\square$ 

# Parameter

| Number     | Name  | Factory setting                 |
|------------|---|---------------------------------|
| p0922      | PROFIdrive PZD telegram selection               | 1                               |
| r2050[011] | CO: PROFIdrive PZD receive word                 | -                               |
| p2051[016] | CI: PROFIdrive PZD send word                    | 0 or dependent on the converter |
| r2053[016] | PROFIdrive diagnostics send PZD word            | -                               |
| r2060[010] | CO: PROFIdrive PZD receive double word          | -                               |
| p2061[015] | CI: PROFIdrive PZD send double word             | 0                               |
| r2063[015] | PROFIdrive diagnostics PZD send double word     | -                               |
| r2067      | PZD maximum interconnected                      | -                               |
|            | [0] Receive (r2050, r2060)                      |                                 |
|            | [1] Send (p2051, p2061)                         |                                 |
| p2079      | PROFIdrive PZD telegram selection extended      | 1                               |
| p2080[015] | BI: Binector-connector converter, status word 1 | [0] 899                         |
|            |   | [1] 899.1                       |
|            |   | [2] 899.2                       |
|            |   | [3] 2139.3                      |
|            |   | [4] 899.4                       |
|            |   | [5] 899.5                       |
|            |   | [6] 899.6                       |
|            |   | [7] 2139.7                      |
|            |   | [8] 2197.7                      |
|            |   | [9] 899.9                       |
|            |   | [10] 2199.1                     |
|            |   | [11] 1407.7                     |
|            |   | [12] 0                          |
|            |   | [13] 2135.14                    |
|            |   | [14] 2197.3                     |
|            |   | [15] 2135.15                    |
| r2090.015  | BO: PROFIdrive receive PZD1 bit by bit          | -                               |
| r2091.015  | BO: PROFIdrive PZD2 receive bit-serial          | -                               |
| r2092.015  | BO: PROFIdrive PZD3 receive bit-serial          | -                               |
| r2093.015  | BO: PROFIdrive PZD4 receive bit-serial          | -                               |

# 8.6.5 Device-to-device communication

# Overview

"Direct data exchange" is sometimes called "device-to-device communication" or "data exchange broadcast". With direct data exchange, devices exchange data without any direct involvement of the master.

### Additional information

Further information about the "Direct data exchange" function is provided in the Fieldbus function manual.

Overview of the manuals (Page 564)

# 8.6.6 Acyclically reading and writing converter parameters

### Overview

The converter supports the writing and reading of parameters via acyclic communication:

- For PROFIBUS: Up to 240 bytes per write or read request via data set 47
- For PROFINET: Write or read requests via B02E hex and B02F hex

### Example

#### Application example, "Read and write to parameters"

Further information is provided on the Internet:

Application examples (<u>https://support.industry.siemens.com/cs/ww/en/view/29157692</u>)

# **Further information**

Further information about acyclic communication is provided in the Fieldbus function manual.

Overview of the manuals (Page 564)

# 8.7 Drive control via Modbus RTU

# Overview



Modbus RTU is used to transfer cyclic process data and acyclic parameter data between precisely one master and up to 247 slaves. The converter is always the slave, and sends data when requested to do so by the master. Slave-to-slave communication is not possible.

# **Function description**

# Control word 1 (STW1)

| Bit  | Meaning                                | Explanation  | Signal inter-<br>connection<br>in the con-<br>verter |  |
|------|--|--|--|--|
| 0    | 0 = OFF1                               | The motor brakes with the ramp-down time p1121 of<br>the ramp-function generator. The converter switches<br>off the motor at standstill. | p0840[0] =<br>r2090.0                                |  |
|      | $0 \rightarrow 1 = ON$                 | The converter goes into the "ready" state. If, in addi-<br>tion, bit $3 = 1$ , the converter switches on the motor.                      |  |  |
| 1    | 0 = OFF2                               | Switch off the motor immediately, the motor then coasts down to a standstill.  | p0844[0] =<br>r2090.1                                |  |
|      | 1 = No OFF2                            | The motor can be switched on (ON command).   |  |  |
| 2    | 0 = Quick stop (OFF3)                  | Quick stop: The motor brakes with the OFF3 ramp-<br>down time p1135 down to standstill.  | p0848[0] =<br>r2090.2                                |  |
|      | 1 = No quick stop (OFF3)               | The motor can be switched on (ON command).   |  |  |
| 3    | 0 = Inhibit operation                  | Immediately switch-off motor (cancel pulses).  | p0852[0] =   |  |
|      | 1 = Enable operation                   | Switch-on motor (pulses can be enabled).   | r2090.3  |  |
| 4    | 0 = Disable RFG                        | The converter immediately sets its ramp-function generator output to 0.  | p1140[0] =<br>r2090.4                                |  |
|      | 1 = Do not disable RFG                 | The ramp-function generator can be enabled.  |  |  |
| 5    | 0 = Stop RFG                           | The output of the ramp-function generator stops at the actual value.   | p1141[0] =<br>r2090.5                                |  |
|      | 1 = Enable RFG                         | The output of the ramp-function generator follows the setpoint.  |  |  |
| 6    | 0 = Inhibit setpoint                   | The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.   | p1142[0] =<br>r2090.6                                |  |
|      | 1 = Enable setpoint                    | Motor accelerates with the ramp-up time p1120 to the setpoint.   | -  |  |
| 7    | $0 \rightarrow 1 = Acknowledge faults$ | Acknowledge fault. If the ON command is still active,<br>the converter switches to the "switching on inhibited"<br>state.                | p2103[0] =<br>r2090.7                                |  |
| 8, 9 | Reserved                               |  |  |  |
| 10   | 0 = No control via PLC                 | Converter ignores the process data from the fieldbus.  | p0854[0] =   |  |
|      | 1 = Control via PLC                    | Control via fieldbus, converter accepts the process data from the fieldbus.  | r2090.10   |  |

# 8.7 Drive control via Modbus RTU

| Bit | Meaning                | Explanation  | Signal inter-<br>connection<br>in the con-<br>verter |
|-----|------------------------|--|--|
| 11  | 1 = Direction reversal | Invert setpoint in the converter.                                | p1113[0] =<br>r2090.11                               |
| 12  | Reserved               |  | -  |
| 13  | 1 = MOP up             | Increase the setpoint saved in the motorized potenti-<br>ometer. | p1035[0] =<br>r2090.13                               |
| 14  | 1 = MOP down           | Reduce the setpoint saved in the motorized potentiom-<br>eter.   | p1036[0] =<br>r2090.14                               |
| 15  | Reserved               |  |  |

# Status word 1 (ZSW1)

| Bit | Meaning  | Remarks  | Signal intercon-<br>nection in the<br>converter |
|-----|--|--|---|
| 0   | 1 = Ready for switching on                     | Power supply switched on; electronics initialized; pulses locked.  | p2080[0] =<br>r0899.0                           |
| 1   | 1 = Ready                                      | Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the converter switches on the motor. | p2080[1] =<br>r0899.1                           |
| 2   | 1 = Operation enabled                          | Motor follows setpoint. See control word 1, bit 3.   | p2080[2] =<br>r0899.2                           |
| 3   | 1 = Fault active                               | The converter has a fault. Acknowledge fault using STW1.7.   | p2080[3] =<br>r2139.3                           |
| 4   | 1 = OFF2 inactive                              | Coast down to standstill is not active.  | p2080[4] =<br>r0899.4                           |
| 5   | 1 = OFF3 inactive                              | Quick stop is not active.  | p2080[5] =<br>r0899.5                           |
| 6   | 1 = Switching on inhibited ac-<br>tive         | It is only possible to switch on the motor after an OFF1 followed by ON.   | p2080[6] =<br>r0899.6                           |
| 7   | 1 = Alarm active                               | Motor remains switched on; no acknowledgement is necessary.  | p2080[7] =<br>r2139.7                           |
| 8   | 1 = Speed deviation within the tolerance range | Setpoint / actual value deviation within the tolerance range.  | p2080[8] =<br>r2197.7                           |
| 9   | 1 = Master control requested                   | The automation system is requested to accept the converter con-<br>trol.   | p2080[9] =<br>r0899.9                           |
| 10  | 1 = Comparison speed<br>reached or exceeded    | Speed is greater than or equal to the corresponding maximum speed.   | p2080[10] =<br>r2199.1                          |
| 11  | 1 = Torque limit not reached                   | Comparison value for current or torque has been fallen below.  | p2080[11] =<br>r0056.13 /<br>r1407.7            |
| 12  | Reserved                                       |  | p2080[12] =<br>r0899.12                         |
| 13  | 0 = Alarm, motor overtemper-<br>ature          |  | p2080[13] =<br>r2135.14                         |

### 8.7 Drive control via Modbus RTU

| Bit | Meaning                                 | Remarks                             | Signal intercon-<br>nection in the<br>converter |
|-----|---|-------------------------------------|---|
| 14  | 1 = Motor rotates clockwise             | Internal converter actual value > 0 | p2080[14] =                                     |
|     | 0 = Motor rotates counter-<br>clockwise | Internal converter actual value < 0 | r2197.3   |
| 15  | 0 = Alarm, converter thermal overload   |                                     | p2080[15] =<br>r2135.15                         |

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

# Parameter

#### Settings for Modbus RTU Table 8-27

| Parameter | Description                           | Factory setting                     |
|-----------|---------------------------------------|-------------------------------------|
| p2020     | Fieldbus interface baud rate          | 8                                   |
| p2021     | Fieldbus interface address            | 0                                   |
| p2024     | Fieldbus interface times              | [0] 1000 ms<br>[1] 0 ms<br>[2] 0 ms |
| r2029     | Fieldbus interface error statistics   | -                                   |
| p2030     | Fieldbus interface protocol selection | 0                                   |
| p2031     | Fieldbus interface Modbus parity      | 2                                   |
| p2040     | Fieldbus interface monitoring time    | 100 ms                              |

# **Further information**

Further informationAdditional information about Modbus RTU is provided in the "Fieldbus" function manual.



Overview of the manuals (Page 564)

8.8 Drive control via USS

# 8.8 Drive control via USS

### Overview



USS is used to transfer cyclic process data and acyclic parameter data between precisely one master and up to 31 devices. The converter is always the device, and sends data when requested to do so by the master. Device-to-device communication is not possible.

# **Function description**

# Control word 1 (STW1)

| Bit  | Meaning                                | Explanation  | Signal inter-<br>connection<br>in the con-<br>verter |  |
|------|--|--|--|--|
| 0    | 0 = OFF1                               | The motor brakes with the ramp-down time p1121 of<br>the ramp-function generator. The converter switches<br>off the motor at standstill. | p0840[0] =<br>r2090.0                                |  |
|      | $0 \rightarrow 1 = ON$                 | The converter goes into the "ready" state. If, in addi-<br>tion, bit $3 = 1$ , the converter switches on the motor.                      |  |  |
| 1    | 0 = OFF2                               | Switch off the motor immediately, the motor then coasts down to a standstill.  | p0844[0] =<br>r2090.1                                |  |
|      | 1 = No OFF2                            | The motor can be switched on (ON command).   |  |  |
| 2    | 0 = Quick stop (OFF3)                  | Quick stop: The motor brakes with the OFF3 ramp-<br>down time p1135 down to standstill.  | p0848[0] =<br>r2090.2                                |  |
|      | 1 = No quick stop (OFF3)               | The motor can be switched on (ON command).   |  |  |
| 3    | 0 = Inhibit operation                  | Immediately switch-off motor (cancel pulses).  | p0852[0] =   |  |
|      | 1 = Enable operation                   | Switch-on motor (pulses can be enabled).   | r2090.3  |  |
| 4    | 0 = Disable RFG                        | The converter immediately sets its ramp-function generator output to 0.  | p1140[0] =<br>r2090.4                                |  |
|      | 1 = Do not disable RFG                 | The ramp-function generator can be enabled.  |  |  |
| 5    | 0 = Stop RFG                           | The output of the ramp-function generator stops at the actual value.   | p1141[0] =<br>r2090.5                                |  |
|      | 1 = Enable RFG                         | The output of the ramp-function generator follows the setpoint.  |  |  |
| 6    | 0 = Inhibit setpoint                   | The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.   | p1142[0] =<br>r2090.6                                |  |
|      | 1 = Enable setpoint                    | Motor accelerates with the ramp-up time p1120 to the setpoint.   |  |  |
| 7    | $0 \rightarrow 1 = Acknowledge faults$ | Acknowledge fault. If the ON command is still active,<br>the converter switches to the "switching on inhibited"<br>state.                | p2103[0] =<br>r2090.7                                |  |
| 8, 9 | Reserved                               |  |  |  |
| 10   | 0 = No control via PLC                 | Converter ignores the process data from the fieldbus.  | p0854[0] =   |  |
|      | 1 = Control via PLC                    | Control via fieldbus, converter accepts the process data from the fieldbus.  | r2090.10   |  |

8.8 Drive control via USS

| Bit | Meaning                | Explanation  | Signal inter-<br>connection<br>in the con-<br>verter |
|-----|------------------------|--|--|
| 11  | 1 = Direction reversal | Invert setpoint in the converter.                                | p1113[0] =<br>r2090.11                               |
| 12  | Reserved               |  |  |
| 13  | 1 = MOP up             | Increase the setpoint saved in the motorized potenti-<br>ometer. | p1035[0] =<br>r2090.13                               |
| 14  | 1 = MOP down           | Reduce the setpoint saved in the motorized potentiom-<br>eter.   | p1036[0] =<br>r2090.14                               |
| 15  | Reserved               |  |  |

# Status word 1 (ZSW1)

| Bit | Meaning   | Remarks  | Signal inter-<br>connection<br>in the con-<br>verter |
|-----|---|--|--|
| 0   | 1 = Ready for switching<br>on   | Power supply switched on; electronics initialized; pul-<br>ses locked.   | p2080[0] =<br>r0899.0                                |
| 1   | 1 = ReadyMotor is switched on (ON/OFF1 = 1), no fault is active.<br>With the command "Enable operation" (STW1.3), the<br>converter switches on the motor. |  | p2080[1] =<br>r0899.1                                |
| 2   | 1 = Operation enabled   | Motor follows setpoint. See control word 1, bit 3.                       | p2080[2] =<br>r0899.2                                |
| 3   | 1 = Fault active  | The converter has a fault. Acknowledge fault using STW1.7.               | p2080[3] =<br>r2139.3                                |
| 4   | 1 = OFF2 inactive   | Coast down to standstill is not active.                                  | p2080[4] =<br>r0899.4                                |
| 5   | 1 = OFF3 inactive   | Quick stop is not active.  | p2080[5] =<br>r0899.5                                |
| 6   | 1 = Switching on inhibi-<br>ted active  | It is only possible to switch on the motor after an OFF1 followed by ON. | p2080[6] =<br>r0899.6                                |
| 7   | 1 = Alarm active  | Motor remains switched on; no acknowledgement is necessary.              | p2080[7] =<br>r2139.7                                |
| 8   | 1 = Speed deviation with-<br>in the tolerance range   | Setpoint / actual value deviation within the tolerance range.            | p2080[8] =<br>r2197.7                                |
| 9   | 1 = Master control re-<br>quested   | The automation system is requested to accept the converter control.      | p2080[9] =<br>r0899.9                                |
| 10  | 1 = Comparison speed<br>reached or exceeded   | Speed is greater than or equal to the corresponding maximum speed.       | p2080[10] =<br>r2199.1                               |
| 11  | 1 = Torque limit not<br>reached   | Comparison value for current or torque has been fallen below.            | p2080[11] =<br>r0056.13 /<br>r1407.7                 |
| 12  | Reserved  |  | p2080[12] =<br>r0899.12                              |
| 13  | 0 = Alarm, motor over-<br>temperature   |  | p2080[13] =<br>r2135.14                              |

# 8.8 Drive control via USS

| Bit | Meaning                                  | Remarks                             | Signal inter-<br>connection<br>in the con-<br>verter |
|-----|--|-------------------------------------|--|
| 14  | 1 = Motor rotates clock-<br>wise         | Internal converter actual value > 0 | p2080[14] =<br>r2197.3                               |
|     | 0 = Motor rotates coun-<br>ter-clockwise | Internal converter actual value < 0 |  |
| 15  | 0 = Alarm, converter<br>thermal overload |                                     | p2080[15] =<br>r2135.15                              |

# Parameter

| Parameter | Description                           | Factory setting                     |
|-----------|---------------------------------------|-------------------------------------|
| p2020     | Fieldbus interface baud rate          | 8                                   |
| p2021     | Fieldbus interface address            | 0                                   |
| p2022     | Fieldbus interface USS PZD number     | 2                                   |
| p2023     | Fieldbus interface USS PKW number     | 127                                 |
| p2024     | Fieldbus interface times              | [0] 1000 ms<br>[1] 0 ms<br>[2] 0 ms |
| r2029     | Fieldbus interface error statistics   | -                                   |
| p2030     | Fieldbus interface protocol selection | 0                                   |
| p2031     | Fieldbus interface Modbus parity      | 2                                   |
| p2040     | Fieldbus interface monitoring time    | 100 ms                              |

# **Further information**

Additional information about USS is provided in the "Fieldbus" function manual.



Overview of the manuals (Page 564)

# 8.9 Drive control via Ethernet/IP

# Overview



EtherNet/IP is an Ethernet-based fieldbus. EtherNet/IP is used to transfer cyclic process data as well as acyclic parameter data.

# **Function description**

| Parameter  | Description  |  |                         |  |
|--|--|--|-------------------------|--|
| p2030 = 10   | Fieldbus interface protocol selection: Ethernet/IP           |  |                         |  |
| p8924  | PN DHCP mode   | 0: DHCP off                                  |                         |  |
|  |  | 2: DHCP on, identification b                 | ased on MAC address     |  |
|  |  | 3: DHCP on, identification b                 | ased on Name of Station |  |
| p8925  | PN interfaces configuration                                  | 0: No function                               |                         |  |
|  |  | 1: Reserved                                  |                         |  |
|  |  | 2: Save the configuration a                  | nd activate             |  |
|  |  | 3: Delete configuration                      |                         |  |
| p8980  | Ethernet/IP profile  |  | 0: SINAMICS             |  |
|  | A change only becomes active supply is switched off and swit | after the converter power<br>cched on again. | 1: ODVA AC/DC           |  |
| p8982  | Ethernet/IP ODVA speed scal                                  | ing  |                         |  |
| A change only becomes active after the converter power supply switched on again. |  | ipply is switched off and                    |                         |  |
|  | 123: 32  | 127: 2                                       | 131: 0.125              |  |
|  | 124: 16  | 128: 1                                       | 132: 0.0625             |  |
|  | 125:8  | 129: 0.5                                     | 133: 0.03125            |  |
|  | 126:4  | 130: 0.25                                    |                         |  |

### Parameter

# Settings for Ethernet/IP

| Parameter | Description                           | Factory setting |
|-----------|---------------------------------------|-----------------|
| p2030     | Fieldbus interface protocol selection | 0               |
| p8920     | PN Name of Station                    | -               |
| p8921[03] | PN IP Address                         | 0               |
| p8922[03] | PN Default Gateway                    | 0               |
| p8923[03] | PN Subnet Mask                        | 0               |
| p8924     | PN DHCP mode                          | 0               |
| p8925     | Activate PN interface configuration   | 0               |
| p8980     | EtherNet/IP profile                   | 0               |
| p8982     | EtherNet/IP ODVA speed scaling        | 128             |

8.9 Drive control via Ethernet/IP

# **Further information**

Additional information about USS is provided in the "Fieldbus" function manual.

Overview of the manuals (Page 564)

8.10 Jogging

# 8.10 Jogging

#### Overview



The "Jog" function is typically used to temporarily move a motor using local control commands.

# Requirement

The OFF1 command must be active. With an active ON command, the converter ignores the commands "Jogging 1" and "Jogging 2".

# **Function description**



Commands "Jog 1" or "Jog 2" switch the motor on and off.

The commands are only active when the converter is in the "Ready for switching on" state.



Figure 8-17 Behavior of the motor when "jogging"

After switching on, the motor accelerates to the setpoint, jog 1 or setpoint, jog 2. The two different setpoints can, for example, be assigned to motor clockwise and counter-clockwise rotation.

When jogging, the same ramp-function generator is active as for the ON/OFF1 command.

### Example

| Parameter     | Description   |
|---------------|---|
| p1055 = 722.0 | Jogging bit 0: Select jogging 1 via digital input 0 |
| p1056 = 722.1 | Jogging bit 1: Select jogging 2 via digital input 1 |

# 8.10 Jogging

# Parameter

| Number   | Name                                   | Factory setting            |
|----------|--|----------------------------|
| p1055[C] | BI: Jogging bit 0                      | Depending on the converter |
| p1056[C] | BI: Jogging bit 1                      | Depending on the converter |
| p1058[D] | Jogging 1 speed setpoint               | 150 rpm                    |
| p1059[D] | Jogging 2 speed setpoint               | -150 rpm                   |
| p1082[D] | Maximum speed                          | 1500 rpm                   |
| p1110[C] | BI: Inhibit negative direction         | Depending on the converter |
| p1111[C] | BI: Inhibit positive direction         | 0                          |
| p1113[C] | BI: Setpoint inversion                 | 0                          |
| p1120[D] | Ramp-function generator ramp-up time   | Depending on the converter |
| p1121[D] | Ramp-function generator ramp-down time | Depending on the converter |

# 8.11 Limit position control

#### Overview



An end position is a position in the direction of motion of a machine component where motion stops as a result of the inherent mechanical design. A limit switch is a sensor that signals that the end position has been reached.

The end position control of the converter controls the motor depending on 2 limit switch signals:

- When an end position is reached, the converter stops the motor.
- At end position, the converter prevents the motor from moving the machine component further in the direction of this end position.



# **Function description**

Figure 8-18 End position control of the converter

# 8.11 Limit position control

| IdDi  | e o-zo explanation   |
|-------|--|
| 1     | The higher-level control system issues a positive setpoint.  |
|       | The motor moves the machine component in the direction of the positive end position.   |
| 2     | The positive end position has been reached. The motor stops with the OFF3 ramp-down time.  |
| 3     | The higher-level control system issues a negative setpoint.  |
|       | With a signal change 0 $\rightarrow$ 1 at p3340, the motor moves the machine component in the direction of "Limit switch minus". |
| $(4)$ | The negative end position has been reached. The motor stops with the OFF3 ramp-down time.  |
| 5     | The higher-level control system issues a positive setpoint.  |
|       | With a signal change $0 \rightarrow 1$ at p3340, the motor moves the machine component in the direction of "Limit switch plus".  |

# Table 8-28 Explanation

# Parameter

| Parameter | Description                     | Factory setting |
|-----------|---------------------------------|-----------------|
| p3340[C]  | BI: Start limit switch          | 0               |
| p3342[C]  | BI: Plus limit switch           | 1               |
| p3343[C]  | BI: Minus limit switch          | 1               |
| r3344     | CO/BO: Limit switch status word | -               |

8.12 Switching over the drive control (command data set)

# 8.12 Switching over the drive control (command data set)

#### Overview



Several applications require the option of switching over the master control to operate the converter.



Figure 8-19 Converter control either via fieldbus or via terminal strip

# **Function description**

#### Command data set (CDS)

You can set the converter control in various ways and toggle between the settings.

The settings in the converter, which are assigned to a specific master control, are called the command data set.

You select the command data set using parameters p0810 and p0811. To do this, you must interconnect parameters p0810 and p0811 with control commands of your choice, e.g. a digital input.

### Changing the number of command data sets

Up to 4 command data sets are possible.

- 1. Set p0010 = 15.
- 2. The number of command data sets is configured with p0170.
- 3. Set p0010 = 0.

You have changed the number of command data sets.

### Copying command data sets

- 1. Set p0809[0] to the number of the command data set whose settings you wish to copy (source).
- 2. Set p0809[1] to the number of the command data set into which you wish to copy the settings.
- 3. Set p0809[2] = 1
- 4. The converter sets p0809[2] = 0.

You have copied the settings of a command data set into another command data set.  $\hfill\square$ 

### Advanced commissioning

8.12 Switching over the drive control (command data set)

# Example



The converter evaluates its control commands depending on digital input DI 3:

- Via a fieldbus from a central control system
- Via the converter digital inputs at the installation.

#### Note

The converter requires approx. 4 ms to switch over the command data set.

#### Parameters

| Number     | Name                                     | Factory setting            |
|------------|--|----------------------------|
| p0010      | Drive commissioning parameter filter     | 1                          |
| r0050      | CO/BO: Command data set CDS effective    | -                          |
| p0170      | Number of command data sets (CDS)        | 2                          |
| p0809[0 2] | Copy command data set CDS                | 0                          |
| p0810      | BI: Command data set selection CDS bit 0 | Dependent on the converter |
| p0811      | BI: Command data set selection CDS bit 1 | 0                          |

# 8.13 Motor holding brake

# Overview



The motor holding brake holds the motor in position when it is switched off.

When the "Motor holding brake" function is correctly set, the motor remains switched on as long as the motor holding brake is open. The converter only switches the motor off when the motor holding brake is closed.

# **Function description**



Figure 8-20 Motor holding brake function

### After the ON command:

- 1. The converter switches on the motor with the ON command.
- 2. At the end of the "motor excitation build-up time" (p0346), the converter issues the command to open the brake.
- 3. The converter keeps the motor at a standstill until the "motor holding brake opening time" p1216 has ended.

The motor holding brake must be opened within time p1216.

4. The converter accelerates the motor to the speed setpoint.

#### After the OFF1 or OFF3 command:

- 1. The converter brakes the motor down to a standstill using the OFF1 or OFF3 command.
- 2. When braking, the converter compares the speed setpoint and the actual speed with the "standstill detection speed threshold" p1226:
  - Speed setpoint < p1226: The "standstill detection monitoring time" p1227 starts
  - Current speed < p1226: The "pulse cancellation deceleration time" p1228 starts
- 3. When the first of the two times (p1227 or p1228) has elapsed, the converter issues the command to close the brake.
- 4. After the "motor holding brake closing time" p1217, the converter switches off the motor. The motor holding brake must close within the time p1217.

#### After the OFF2 command



Figure 8-21 Controlling the motor holding brake after OFF2

After the OFF2 command, the converter issues the signal to immediately close the motor holding brake, irrespective of the motor speed.

### Commissioning a motor holding brake

# 🛕 WARNING

#### Load can fall if the "Motor holding brake" function is incorrectly set

For applications with a suspended load, such as cranes and elevators, there is a danger to life if the "Motor holding brake" function is not completely set or is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any suspended loads, e.g. by applying the following measures:
  - Lower the load down to the floor.
  - Secure the dangerous area so that nobody can inadvertently enter it.
- Set the "Motor holding brake" function according to the following description.
- After commissioning, check that the motor holding brake and the motor control function reliably.
- For applications involving suspended loads, we recommend that you use vector control with an encoder.

#### Requirement

The motor holding brake is connected to the converter.

#### Procedure

- Set p1215 = 1. The "Motor holding brake" function is enabled.
- 2. Check the magnetizing time p0346. The magnetizing time must be greater than zero. The converter assigns the magnetizing time when it is being commissioned.
- 3. Find out the mechanical opening and closing times from the technical data of the motor holding brake.
  - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
  - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.
- 4. Set the following parameters in the converter suitably for the mechanical opening and closing times of the motor holding brake:
  - $p1216 \ge$  mechanical opening time of the motor holding brake
  - p1217 > mechanical closing time of the motor holding brake
- 5. Switch on the motor.

# 8.13 Motor holding brake

- 6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
  - If the motor holding brake opens too late, the converter will accelerate the motor suddenly against the closed motor holding brake.
     Set p1216 larger.
  - If the motor waits too long before accelerating after the motor holding brake has opened, reduce p1216.
     For applications involving a pulling load, e.g. lifting gear/crane, if p1216 is too long, then the load can briefly sag/sink after the motor holding brake is opened. If you reduce p1216, then the amount that the load sags/sinks is reduced.
- 7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
  - U/f control (p1300 = 0 to 3): Increase p1310 in small steps. Increase p1351 in small steps.
  - Vector control (p1300 ≥ 20): Increase p1475 in small steps.
- 8. Switch off the motor.
- 9. Check the behavior of the drive immediately after the motor has been switched off:
  - If the motor holding brake closes too late, the load briefly sags before the motor holding brake closes.
     Set a larger value for p1217.
  - If the motor waits too long before switching off after the motor holding brake has closed, reduce p1217.

The "Motor holding brake" function has been commissioned.

# Parameter

Table 8-29Setting the control logic of the motor holding brake

| Parameter | Description                       | Factory setting |
|-----------|-----------------------------------|-----------------|
| r0052.015 | CO/BO: Status word 1              | -               |
| p1215     | Motor holding brake configuration | 0               |
| p1216     | Motor holding brake opening time  | 100 ms          |
| p1217     | Motor holding brake closing time  | 100 ms          |

#### Table 8-30 Advanced settings

| Parameter | Description                            | Factory setting |
|-----------|--|-----------------|
| p0346[M]  | Motor excitation build-up time         | 0 s             |
| p0855[C]  | BI: Unconditionally open holding brake | 0               |
8.13 Motor holding brake

| Parameter | Description   | Factory setting |
|-----------|---|-----------------|
| p0858[C]  | BI: Unconditionally close holding brake                           | 0               |
| p1226[D]  | Speed threshold for standstill detection                          | 20 rpm          |
| p1227     | Standstill detection monitoring time                              | 300 s           |
| p1228     | Pulse suppression delay time                                      | 0.01 s          |
| p1351[D]  | CO: Motor holding brake start frequency                           | 0               |
| p1352[C]  | CI: Motor holding brake start frequency signal source             | 1351            |
| p1475[C]  | CI: Speed controller torque setting value for motor holding brake | 0               |

8.14 Free function blocks

# 8.14 Free function blocks

## 8.14.1 Overview

## Overview



The free function blocks permit configurable signal processing in the converter.

## **Function description**

The following free function blocks are available:

| Logic blocks          | AND 0                | OR 0                     | XOR 0      | NOT 0         |                 |                   |          |
|-----------------------|----------------------|--------------------------|------------|---------------|-----------------|-------------------|----------|
|                       | AND 1                | OR 1                     | XOR 1      | NOT 1         |                 |                   |          |
|                       | AND 2                | OR 2                     | XOR 2      | NOT 2         |                 |                   |          |
|                       | AND 3                | OR 3                     | XOR 3      | NOT 3         |                 |                   |          |
|                       |                      |                          |            | NOT 4         |                 |                   |          |
|                       |                      |                          |            | NOT 5         |                 |                   |          |
| Calculation<br>blocks | Adder                | Subtractor               | Multiplier | Divider       | Compara-<br>tor | Absolute<br>value | Polyline |
|                       | ADD 0                | SUB 0                    | MUL 0      | DIV 0         | NCM 0           | AVA 0             | PLI O    |
|                       | ADD 1                | SUB 1                    | MUL 1      | DIV 1         | NCM 1           | AVA 1             | PLI 1    |
|                       | ADD 2                |                          |            |               |                 |                   |          |
| Timer blocks          | Pulse gen-<br>erator | Pulse<br>shorten-<br>ing | ON delay   | OFF delay     | Pulse stretc    | hing              |          |
|                       | MFP 0                | PCL 0                    | PDE 0      | PDF 0         | PST 0           |                   |          |
|                       | MFP 1                | PCL 1                    | PDE 1      | PDF 1         | PST 1           |                   |          |
|                       | MFP 2                |                          | PDE 2      | PDF 2         |                 |                   |          |
|                       | MFP 3                |                          | PDE 3      | PDF 3         |                 |                   |          |
| Memory block          | RS flip-flop         | D flip-flop              |            | -             |                 |                   |          |
|                       | RSR 0                | DFR 0                    |            |               |                 |                   |          |
|                       | RSR 1                | DFR 1                    |            |               |                 |                   |          |
|                       | RSR 2                | DFR 2                    |            |               |                 |                   |          |
| Breaker block         | Analog<br>switch     | Binary swite             | :h         |               |                 |                   |          |
|                       | NSW 0                | BSW 0                    |            |               |                 |                   |          |
|                       | NSW 1                | BSW 1                    |            |               |                 |                   |          |
| Control block         | Limiter              | Smooth-<br>ing           | Integrator | Differentiato | or              |                   |          |
|                       | LIM 0                | PT1 0                    | INT 0      | DIF 0         |                 |                   |          |
|                       | LIM 1                | PT1 1                    |            |               |                 |                   |          |

Table 8-31 Free function blocks

8.14 Free function blocks

| Complex block | Limit monitor |
|---------------|---------------|
|               | LVM 0         |
|               | LVM 1         |

You can only use a function block once. The converter has 3 adders for instance, ADD 0, ADD 1, and ADD 2. If you have already configured 3 adders, then no other adders are available.

## 8.14.2 Further information

## Application description for the free function blocks

Further information is provided on the Internet:

FAQ (http://support.automation.siemens.com/WW/view/en/85168215)

## 8.15 Selecting physical units

## 8.15.1 Motor standard

#### Selection options and parameters involved



The converter represents the motor data corresponding to motor standard IEC or NEMA in different system units: SI units or US units.

| Parame- | Designation                     | Motor standard IEC/NEMA, p0100 = |                    |                  |
|---------|---------------------------------|----------------------------------|--------------------|------------------|
| ter     |                                 | <b>0</b> <sup>1)</sup>           | 1                  | 2                |
|         |                                 | IEC motor                        | NEMA motor         | NEMA motor       |
|         |                                 | 50 Hz, SI units                  | 60 Hz, US units    | 60 Hz, SI units  |
| r0206   | Power Module rated power        | kW                               | hp                 | kW               |
| p0219   | Braking resistor braking power  | kW                               | hp                 | kW               |
| p0307   | Rated motor power               | kW                               | hp                 | kW               |
| p0316   | Motor torque constant           | Nm/A                             | lbf ft/A           | Nm/A             |
| r0333   | Rated motor torque              | Nm                               | lbf ft             | Nm               |
| p0341   | Motor moment of inertia         | kgm <sup>2</sup>                 | lb ft <sup>2</sup> | kgm <sup>2</sup> |
| p0344   | Motor weight                    | kg                               | Lb                 | kg               |
| r0394   | Rated motor power               | kW                               | hp                 | kW               |
| r1493   | Total moment of inertia, scaled | kgm <sup>2</sup>                 | lb ft <sup>2</sup> | kgm <sup>2</sup> |

Table 8-32 Parameters involved when selecting the motor standard

<sup>1)</sup> Factory setting

It is only possible to change the motor standard during quick commissioning.

### 8.15.2 Unit system

Some physical units depend on the system of units selected (SI or US), for example the power [kW or hp] or the torque [Nm or lbf ft]. You can select in which system of units the converter represents its physical values.

### Options when selecting the system of units

The following options apply when selecting the system of units:

- p0505 = 1: System of units SI (factory setting) Torque [Nm], power [kW], temperature [°C or K]
- p0505 = 2: Referred system of units/SI Represented as [%]

- p0505 = 3: US system of units Torque [lbf ft], power [hp], temperature [°F]
- p0505 = 4: System of units, referred/US Represented as [%]

#### **Special features**

The values for p0505 = 2 and for p0505 = 4 - represented in the converter - are identical. However, the reference to SI or US units is required for internal calculations and to output physical variables.

For variables, which cannot be represented as [%], then the following applies:

- p0505 = 1 corresponds to setting p0505 = 2
- p0505 = 3 corresponds to setting p0505 = 4

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:

- p0505 = 1 corresponds to setting p0505 = 3
- p0505 = 2 corresponds to setting p0505 = 4

#### **Reference variables**

There is a reference variable in the converter for most parameters with physical units. When the referred representation [%] is set, then the converter scales the physical variables based on the particular reference variable.

When the reference variable changes, then the significance of the scaled value also changes. Example:

- Reference speed = 1500 rpm  $\rightarrow$  fixed speed = 80 % corresponds to the speed = 1200 rpm
- Reference speed = 3000 rpm  $\rightarrow$  fixed speed = 80 % corresponds to the speed = 2400 rpm

For each parameter you can find the associated reference variable for scaling in the parameter list. Example: r0065 is scaled with reference variable p2000.

If scaling is not specified in the parameter list, then the converter always shows/displays the parameter unscaled.

#### Groups of units

In the parameter list you will find the following information for parameters with changeable units:

- Unit group Designates the group to which the parameter belongs
- Unit selection Designates the parameter that changes over the unit

#### Example:

Unit group: 7\_1, unit selection: p0505

The parameter belongs to the unit group 7\_1 and p0505 changes over the unit.

| Unit group | Unit selection for p0100 = |                     |       |
|------------|----------------------------|---------------------|-------|
|            | 0                          | 1                   | 2     |
| 7_4        | Nm                         | lbf ft              | Nm    |
| 14_6       | kW                         | hp                  | kW    |
| 25_1       | kg m²                      | lbf ft <sup>2</sup> | kg m² |
| 27_1       | kg                         | lb                  | kg    |
| 28_1       | Nm/A                       | lbf ft/A            | Nm/A  |

Table 8-33 Unit group (p0100)

Table 8-34 Unit group (p0505)

| Unit group | Unit selection for p0505 = |    |                  | Reference value for % |       |
|------------|----------------------------|----|------------------|-----------------------|-------|
|            | 1                          | 2  | 3                | 4                     |       |
| 2_1        | Hz                         | %  | Hz               | %                     | p2000 |
| 3_1        | rpm                        | %  | rpm              | %                     | p2000 |
| 5_1        | Vrms                       | %  | Vrms             | %                     | P2001 |
| 5_2        | V                          | %  | V                | %                     | p2001 |
| 5_3        | V                          | %  | V                | %                     | p2001 |
| 6_2        | Arms                       | %  | Arms             | %                     | p2002 |
| 6_5        | А                          | %  | А                | %                     | p2002 |
| 7_1        | Nm                         | %  | lbf ft           | %                     | p2003 |
| 7_2        | Nm                         | Nm | lbf ft           | lbf ft                | -     |
| 14_5       | kW                         | %  | hp               | %                     | r2004 |
| 14_10      | kW                         | kW | hp               | hp                    | -     |
| 21_1       | °C                         | °C | ° F              | °F                    | -     |
| 21_2       | К                          | К  | ° F              | °F                    | -     |
| 39_1       | 1/s <sup>2</sup>           | %  | 1/s <sup>2</sup> | %                     | p2007 |

## 8.15.3 Technological unit of the technology controller

## Options when selecting the technological unit

p0595 defines in which technological unit the input and output variables of the technology controller are calculated, e.g. [bar], [m<sup>3</sup>/min] or [kg/h].

### **Reference variable**

p0596 defines the reference variable of the technological unit for the technology controller.

## Unit group

Parameters involved with p0595 belong to unit group 9\_1. The values that can be set and the technological units are shown in p0595.

### **Special features**

You must optimize the technology controller after changing p0595 or p0596.

## 8.15.4 Setting the system of units and technology unit

### Setting using Startdrive

#### Requirement

You are offline with Startdrive.

#### Procedure

- 1. In the project, select "Parameter".
- 2. Select "Units".



- 3. Select the system of units.
- 4. Select the technological unit of the technology controller.
- 5. Save your settings.
- 6. Go online. The converter signals that offline, other units and process variables are set than in the converter itself.
- 7. Accept these settings in the converter.

You have selected the motor standard and system of units.  $\ensuremath{\square}$ 

## 8.16 Safe Torque Off (STO) safety function

## 8.16.1 Where are the safety functions described?

#### Overview

The operating instructions describe how to commission the STO safety function as basic function for control via a failsafe digital input.

A description of all the safety functions is provided in the "Safety Integrated" Function Manual:

- The basic functions and the extended functions
- Controlling safety functions via PROFIsafe

Overview of the manuals (Page 564)

## 8.16.2 Principle of operation

#### Overview



An active STO function prevents energy from being fed to the motor. The motor can no longer generate torque on the motor shaft.

Consequently, the STO function prevents the starting of an electrically-driven machine component.

#### Requirement

The machine manufacturer has already performed a risk assessment, e.g. in compliance with EN ISO 1050, "Safety of machinery - Principles of risk assessment". The risk assessment must confirm that it is permissible to use the STO safety function.

## **Function description**

| Table 8-35 | Principle of | operation | of STO |
|------------|--------------|-----------|--------|
|            | i micipic or | operation | 01210  |

|    | Safe Torque Off (STO)  | Standard converter functions linked with STO                                    |
|----|--|---|
| 1. | The converter identifies when STO is selected via a failsafe digital input or via PROFIsafe. |   |
| 2. | The converter interrupts the energy supply to the motor.                                     | If you use a motor holding brake, the converter closes the motor holding brake. |
|    |  | If you use a line contactor, the converter opens the line contactor.            |
| 3. | The converter signals "STO is active" via a failsafe   |   |



Figure 8-22 STO when the motor is at standstill (A), and rotating (B)

(A): When selecting STO, if the motor is already stationary (zero speed), then STO prevents the motor from starting.

(B): If the motor is still rotating (B) when STO is selected, it coasts down to standstill.

### The STO safety function is standardized

The STO function is defined in IEC/EN 61800-5-2:

"[...] [The converter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)".

 $\Rightarrow$  The STO converter function conforms to IEC/EN 61800-5-2.

## Example

The STO function is suitable for applications where the motor is already at a standstill or will come to a standstill in a short, safe period of time through friction. STO does not shorten the runon time of machine components.

| Application  | Possible solution  |
|--|--|
| When the EMERGENCY STOP button is pressed, it is not permissible for a stationary motor to inadvertently accelerate. | <ul> <li>Connect the EMERGENCY STOP pushbutton with a failsafe converter digital input.</li> <li>Select STO via the failsafe digital input.</li> </ul> |
| A central EMERGENCY STOP button  | • Evaluate the EMERGENCY STOP button in a central control.   |
| ation of several motors that are at a standstill.  | Select STO via PROFIsafe.  |

## 8.16.3 EMERGENCY SWITCHING OFF and EMERGENCY STOP

### Overview



In plants, systems and machines a distinction must be made between "EMERGENCY OFF" and "EMERGENCY STOP". The STO safety function is only suitable for implementing an "EMERGENCY STOP".

## **Function description**

EN 60204-1 defines "EMERGENCY OFF" and "EMERGENCY STOP":

- "EMERGENCY OFF" and "EMERGENCY STOP" are functions that are used in an emergency.
- "EMERGENCY OFF" and "EMERGENCY STOP" minimize different risks in the system or machine.
  - "EMERGENCY OFF" minimizes the risk of electric shock.
  - "EMERGENCY STOP" minimizes the risk of unexpected motion.
- Stop Categories 0, 1 and 2 are available for EMERGENCY STOP.

| Action:             | EMERGENCY OFF  | EMERGENCY STOP                          |
|---------------------|--|---|
|                     |  | Stop Category 0 according to EN 60204-1 |
| Risk:               |  |   |
|                     | Electric shock   | Unexpected movement                     |
| Measure to minimize | Switch off the power supply                                  | Prevent movement                        |
| risk:               | Either completely or partially switch off hazardous voltages | Prevent any hazardous movement          |

 Table 8-36
 The distinction between "EMERGENCY OFF" and "EMERGENCY STOP"

| Action:               | EMERGENCY OFF                           | EMERGENCY STOP  |
|-----------------------|---|---|
|                       |   | Stop Category 0 according to EN 60204-1   |
| Classic solution:     | Switch off the power supply:            | Switch-off the drive power supply:  |
|                       |   |   |
| Solution with the STO | STO is not suitable for switching off a | Select STO:   |
| grated in the drive:  | voltage.                                |   |
|                       |   | It is permissible that you also switch off<br>the converter supply voltage. Howev-<br>er, switching off the voltage is not re-<br>guired as a risk reduction measure. |

## 8.16.4 Functional restrictions as a result of the Power Modules

## Overview

The use of the STO safety function is possible with almost every Power Module. For some Power Modules restrictions apply?

## **Function description**

| Power Module               | Article number  | Constraint                          |
|----------------------------|-----------------|-------------------------------------|
| PM230 in degree of protec- | 6SL3223-0DE A . | Safety functions cannot be used.    |
| tion IP55                  | 6SL3223-0DE G . | The STO basic function can be used. |
| PM230 in degree of protec- | 6SL3211NEL.     | Safety functions cannot be used.    |
| tion IP20 and Push Through | 6SL3211NEG.     | The STO basic function can be used. |

Advanced commissioning

8.16 Safe Torque Off (STO) safety function

## 8.16.5 Commissioning STO

#### 8.16.5.1 Commissioning tools

#### Overview

We recommend that you commission the safety functions using the Startdrive PC tool.

#### 8.16.5.2 Password

#### Overview

The password protects the settings of the safety functions from being changed by unauthorized persons.

### **Function description**

#### Do you have to assign a password?

The probabilities of failure (PFH) and certification of the safety functions also apply without password.

The machine manufacturer decides whether or not a password is required.

## **Further information**

#### What do I do if I lose the password?

You have forgotten the password, however, you would nevertheless like to change the setting of the safety functions.

#### Procedure

- 1. Create a new project for the converter using Startdrive. Leave all the settings in the project on those set in the factory.
- 2. Load the project in the converter. After loading, the converter has the factory settings.
- 3. If a memory card inserted in the converter, remove it.
- 4. Recommission the converter.

You can obtain additional information or learn about alternative procedures from Product Support.

Product Support (Page 567)

#### 8.16.5.3 Configuring a safety function

## Overview

You must enable the STO safety function and define how STO is selected.

#### **Function description**

#### Procedure

1. Select "Select safety functionality".

| Basic settings                            |                                |
|---|--------------------------------|
| Inputs/outputs                            | Selecting safety functionality |
| Setpoint channel                          |                                |
| <ul> <li>Operating mode</li> </ul>        |                                |
| ▼ Drive functions                         | No safety function             |
| Shutdown functions                        |                                |
| Brake control                             |                                |
| ▼ Safety Integrated                       |                                |
| Selecting safety functionality            |                                |
| Vdc controller                            |                                |
| Automatic restart function 🚺 🎦            | 1                              |
| Flying restart                            | 1                              |
| Messages/monitoring                       |                                |
| <ul> <li>Application functions</li> </ul> |                                |
|   |                                |

2. Select "Basic Functions".

| Selecting safety functionality |
|--------------------------------|
|                                |
| No cofety function             |
|                                |
| Basic function                 |
| No.                            |

3. Select "Control type/safety functions".

| <ul> <li>Safety Integrated</li> </ul> |  |
|---------------------------------------|--|
| Selecting safety functionality        | Control type:                                  |
| Actual value sensing                  | control () por                                 |
| <ul> <li>Functions</li> </ul>         | via terminals (4)                              |
| Control type/safety functions         | Via PROFIsafe                                  |
| STO STO                               | via terminals (basic) and PROFIsafe (extended) |
| SS1                                   | F-DI assignment                                |
| SLS                                   |  |
| SDI                                   | TTY AT   |
| SSM                                   | •  |
| Test stop                             |  |
| F-DI / F-DO / PROFIsafe               |  |
| Acceptance                            |  |

4. Select "Via terminals" as control type for the safety functions.

You have configured the safety functions.

Additional safety function configurations are described in the "Safety Integrated" Function Manual.



Overview of the manuals (Page 564)

## Parameter

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| p0010     | Drive commissioning parameter filter                       | 1               |
| p9601     | SI enable, functions integrated in the drive (processor 1) | 0000 0000 bin   |
| p9761     | SI password input  | 0000 hex        |
| p9762     | SI password new  | 0000 hex        |
| p9763     | SI password acknowledgment                                 | 0000 hex        |

## 8.16.5.4 Interconnecting the "STO active" signal

### Overview

If you require the feedback signal "STO active" of the converter in your higher-level control system, then you must appropriately interconnect the signal.

## Requirement

You are online with Startdrive.

## **Function description**

#### Procedure



The screen form varies depending on the converter and the interface that has been selected.

- (A) Control type
- (B) Delay time for SS1 and enable SBC for a converter with CU250S-2 Control Unit
- (C) STO via the Power Module terminals for a PM240-2 or PM240P-2, FSD ... FSF Power Module
- (D) Enable SBC for a converter with CU250S-2 Control Unit
- 1. Select the button for the feedback signal.
- 2. Select the signal that matches your particular application.
- You have interconnected the "STO active" checkback signal.

After STO has been selected, the converter signals "STO active" to the higher-level control.

#### Parameter

| Parameter  | Description |                                      | Factory setting |
|------------|-------------|--------------------------------------|-----------------|
| r9773[031] | CO/BO: SI   | status (processor 1 + processor 2)   | -               |
|            | .01         | 1 signal: STO is active in the drive |                 |

## 8.16.5.5 Signal filter for STO selection

#### Overview

Two filters are available for a failsafe digital input:

- When the discrepancy time is active, the converter tolerates input signals that briefly differ.
- When the debounce time is active, the converter suppresses brief signal changes.

## **Function description**

#### **Discrepancy time**

The converter checks that the two input signals of the failsafe digital input always have the same signal state (high or low).

With electromechanical sensors (e.g. emergency stop buttons or door switches), the two sensor contacts switch, but never at exactly the same time, and are therefore temporarily inconsistent (discrepancy).

Only a permanent discrepancy signifies a fault in the failsafe digital input circuit, e.g. wire breakage.

You must set the discrepancy time to ignore signals that are briefly inconsistent.





The discrepancy time does not extend the converter response time. The converter activates the safety functions as soon as one of the two F-DI signals changes its state from high to low.

#### **Debounce time**

In the following cases, an immediate converter response to signal changes of the failsafe digital inputs is not desirable:

- If a failsafe digital input of the converter is interconnected with an electromechanical sensor, brief signal changes can occur due to contact bounce.
- In order to identify faults due to short-circuit or cross faults, several control modules test their failsafe digital outputs with "bit pattern tests" (on/off test). If a failsafe digital input of the converter is interconnected with a failsafe digital output of an open-loop control module, then the converter responds with a bit pattern test.

The typical duration of the signal change within a bit pattern test:

- On test: 1 ms
- Off test: 4 ms

Too many signal changes within a specific time result in a converter fault.



Figure 8-24 Converter response to a bit pattern test

You must set the debounce time to ignore temporary signal changes.





The debounce time extends the response time of the safety function.

### **Further information**

#### Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence over the failsafe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

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

If you use an input as a failsafe input, set the debounce time as described above.

### 8.16.5.6 Setting the signal filter for STO selection

#### Overview

If required, you must set the signal filter for selecting the STO safety function.

#### Requirement

You are online with Startdrive.

### **Function description**

#### Procedure



- 1. Navigate to the filter settings.
- 2. Set the debounce time for the F-DI input filter.
- 3. Set the discrepancy time for the simultaneity monitoring.

You have set the signal filter of the failsafe digital input.  $\hfill \square$ 

#### Parameter

| Parameter | Description                                 | Factory setting |
|-----------|---|-----------------|
| p9650     | SI F-DI switchover discrepancy time (CPU 1) | 500 ms          |
| p9651     | SI STO debounce time (processor 1)          | 1 ms            |

## 8.16.5.7 Forced checking procedure

#### Overview

The forced checking procedure (test stop) is a converter self test, which is necessary when you have enabled at least one safety function.

#### **Function description**

Each time the forced checking procedure starts, the converter checks its circuits to switch off the torque.

You start the forced checking procedure each time that the STO function is selected.

Using a timer block, the converter monitors as to whether the forced checking procedure is regularly started.



Figure 8-26 Starting and monitoring the forced checking procedure (test stop)

## 8.16.5.8 Setting forced checking procedure

#### Overview

You must set the time interval in which, as a minimum, you must start the forced checking procedure at least once.

#### Requirement

You are online with Startdrive.

#### **Function description**

#### Procedure



- 1. Select the screen form for setting the forced checking procedure.
- 2. Set the monitoring time to a value to match your application.
- 3. Using this signal, the converter signals that a forced checking procedure (test stop) is required.

Interconnect this signal with a converter signal of your choice.

You have set the forced checking procedure (test stop) for the Basic Functions.

## Parameter

| Parameter | Description                                  | Factory setting |
|-----------|--|-----------------|
| p9659     | SI forced checking procedure timer           | 8 h             |
| r9660     | SI forced checking procedure remaining time  | - h             |
| r9773.031 | CO/BO: SI status (processor 1 + processor 2) | -               |

## 8.16.5.9 Complete commissioning

#### Overview

You must exit commissioning the safety functions and save the settings.

#### Requirement

You are online with Startdrive.

#### **Function description**

#### Procedure



- 1. Press the "End safety commissioning" button.
- 2. Confirm the prompt for saving your settings (copy RAM to ROM).
- 3. Disconnect the online connection.
- 4. Select the "Load from device (software)" button.
- 5. Save the project.
- 6. Switch off the converter power supply.
- 7. Wait until all LEDs on the converter go dark (no voltage condition).
- 8. Switch on the converter power supply again.

Your settings are now active.

#### Parameter

| Parameter | Description                          | Factory setting |
|-----------|--------------------------------------|-----------------|
| p0010     | Drive commissioning parameter filter | 1               |
| p0971     | Save parameters                      | 0               |
| p9700     | SI copy function                     | 0000 hex        |
| p9701     | Acknowledge SI data change           | 0000 hex        |

## 8.16.5.10 Checking the assignment of the digital inputs

#### Overview

The simultaneous connection of digital inputs with a safety function and a "standard" function may lead to the drive behaving in unexpected ways.

If you control the safety functions in the converter via failsafe digital inputs, then you must check as to whether the failsafe digital inputs are in some instances interconnected with a "standard" function.

## **Function description**

#### Procedure

| A start short y commissioning  |      |                      |                |
|--|------|----------------------|----------------|
| ▼ Basic settings Dirichel insute   |      |                      |                |
| Data sets  |      |                      |                |
| Units  |      |                      |                |
| Reference variables Current I/O configuration: [7] Fieldbus with data set changeover |      |                      |                |
| I/O configuration  |      |                      |                |
| ▼ Inputs/outputs DI0 Digital input 0   |      | Digital input 0 inve | rted           |
| Digital inputs 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0                                 | 110  | <u> </u>             |                |
| Bidirektionale Dig Digital input 1   |      | Digital input 1 inve | rted           |
| Relay outputs  | 10-  | 0-                   |                |
| Analog inputs (  |      |                      |                |
| Analog outputs   |      |                      |                |
| Probes DI 2 Digital input 2  |      | Digital input 2 inve | rted           |
| Setpoint channel   | 10-  | 0                    |                |
| Operating mode     Digital input 3   |      | Digital input 3 inve | rted           |
| Drive functions     B      Drive functions     B      Drive functions                | 10-  | 0-                   |                |
| Application functions     65      DI3-   |      |                      |                |
| Communication  |      |                      |                |
| Interconnections     DI 4     Digital input 4  |      | Digital input 4 inve | rted           |
|  | 10-  | - p9705 BI: SI Motio | n: Test stop s |
| F-DI 0 Digital input 5   |      | Digital input 5 inve | rted           |
|  | 10-  | 0-1                  |                |
| 66015-   |      |                      |                |
|  |      |                      |                |
| DI 6 Digital input 6   |      | Digital input 6 inve | rted           |
|  | 110- | 0—                   |                |
| 69 O   |      |                      |                |
| Di com t   |      |                      |                |

- 1. Select the screen for the digital inputs.
- 2. Remove all interconnections of the digital inputs that you use as failsafe digital input F-DI:
- 3. You must delete the digital input connections for all CDS if you use the switchover of the command data sets (CDS).

You can find a description of the CDS switchover in the operating instructions.

You have ensured that the failsafe digital inputs only control the safety functions in the converter.

#### 8.16.5.11 Acceptance test

#### Overview

The machine manufacturer is responsible in ensuring that his plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions or have them checked by specialist personnel, which represent an increased risk of injury or material damage. This acceptance or validation is, for example, also specified in the European machinery directive and essentially comprises two parts:

- Checking the safety-relevant functions and machine parts.
   → Acceptance test.
- Generate an "Acceptance report" that describes the test results.
   → Documentation.

Supply information for the validation, e.g. the harmonized European standards EN ISO 13849-1 and EN ISO 13849-2.

## **Function description**

#### Acceptance test of the machine or plant

The acceptance test checks whether the safety-relevant functions in the plant or machine function correctly. The documentation of the components used in the safety functions can also provide information about the necessary tests.

Testing the safety-related functions includes, e.g. the following:

- Are all safety equipment such as protective door monitoring devices, light barriers or emergency-off switches connected and ready for operation?
- Does the higher-level control respond as expected to the safety-relevant feedback signals of the converter?
- Do the converter settings match the configured safety-relevant function in the machine?

#### Acceptance test of the converter

The acceptance test of the converter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the converter checks whether the integrated drive safety functions are set up correctly for the planned safety function of the machine.

#### Documentation of the converter

The following must be documented for the converter:

- The results of the acceptance test.
- The settings of the integrated drive safety functions.

The documentation must be signed.

#### Who may perform the acceptance test of the converter?

The following are authorized to perform a converter acceptance test: Only personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge

of the safety functions, are in a position to perform the acceptance test in the correct and appropriate manner.

#### Wizard for the acceptance test

The "Startdrive Advanced" commissioning tool (requires an appropriate license) includes a wizard for the acceptance test of the safety functions integrated in the drive.

"Startdrive Advanced" guides you through the acceptance test, generates the appropriate traces to analyze the machine response – and generates an acceptance report as Excel file.

Further information is provided on the Internet:

Startdrive, system requirements and download (<u>https://</u>support.industry.siemens.com/cs/ww/en/view/109760844)

#### Reduced acceptance test after function expansions

A full acceptance test is necessary only after first commissioning. A reduced acceptance test is sufficient when safety functions are expanded.

| Measure  | Acceptance test   |   |  |
|--|---|---|--|
|  | Acceptance test   | Documentation   |  |
| Functional expansion of the ma-<br>chine (additional drive).                                       | Yes.<br>Only check the safety<br>functions of the new<br>drive.       | <ul> <li>Supplement machine overview</li> <li>Supplement converter data</li> <li>Add function table</li> <li>Log the new checksums</li> <li>Countersignature</li> </ul> |  |
| Transfer of converter settings to<br>other identical machines by means<br>of series commissioning. | No.<br>Only check the control<br>of all of the safety func-<br>tions. | <ul><li>Add machine description</li><li>Check checksums</li><li>Checking the firmware versions</li></ul>  |  |

8.17 Setpoints

## 8.17 Setpoints

### 8.17.1 Overview

#### Overview



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



Figure 8-27 Setpoint sources for the converter

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

- Converter fieldbus interface
- Analog input of the converter
- · Motorized potentiometer emulated in the converter
- · Fixed setpoints saved in the converter

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

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

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

## 8.17.2 Analog input as setpoint source

## **Function description**



Figure 8-28 Example: Analog input 0 as setpoint source

In the quick commissioning, you define the preassignment for the converter interfaces. Depending on what has been preassigned, after quick commissioning, the analog input can be interconnected with the main setpoint.

## Example

Setting with analog input 0 as setpoint source:

| Parameter      | Description  |
|----------------|--|
| p1070 = 755[0] | Interconnects main setpoint with analog input 0          |
| p1075 = 755[0] | Interconnects supplementary setpoint with analog input 0 |

## Parameters

| Number     | Name  | Factory setting            |
|------------|---|----------------------------|
| r0755[0 1] | CO: CU analog inputs, actual value in percent | - %                        |
| p1070[C]   | CI: Main setpoint                             | Dependent on the converter |
| p1071[C]   | CI: Main setpoint scaling                     | 1                          |
| r1073      | CO: Main setpoint active                      | - rpm                      |
| p1075[C]   | CI: Supplementary setpoint                    | 0                          |
| p1076[C]   | CI: Supplementary setpoint scaling            | 1                          |
| r1077      | CO: Supplementary setpoint effective          | - rpm                      |

8.17 Setpoints

## 8.17.3 Specifying the setpoint via the fieldbus

## **Function description**



Figure 8-29 Fieldbus as setpoint source

In the quick commissioning, you define the preassignment for the converter interfaces. Depending on what has been preassigned, after quick commissioning, the receive word PZD02 can be interconnected with the main setpoint.

### Example

Setting with receive word PZD02 as setpoint source:

| Parameter       | Description  |
|-----------------|--|
| p1070 = 2050[1] | Interconnects the main setpoint with the receive word PZD02 from the fieldbus.           |
| p1075 = 2050[1] | Interconnects the supplementary setpoint with receive word PZD02 from the field-<br>bus. |

## Parameters

| Number     | Name                                 | Factory setting            |
|------------|--------------------------------------|----------------------------|
| p1070[C]   | CI: Main setpoint                    | Dependent on the converter |
| p1071[C]   | CI: Main setpoint scaling            | 1                          |
| r1073      | CO: Main setpoint active             | - rpm                      |
| p1075[C]   | CI: Supplementary setpoint           | 0                          |
| p1076[C]   | CI: Supplementary setpoint scaling   | 1                          |
| r1077      | CO: Supplementary setpoint effective | - rpm                      |
| r2050[011] | CO: PROFIdrive PZD receive word      | -                          |

## 8.17.4 Motorized potentiometer as setpoint source

## **Function description**

The "Motorized potentiometer" function emulates an electromechanical potentiometer. The output value of the motorized potentiometer can be set with the "higher" and "lower" control signals.



Figure 8-30 Motorized potentiometer as setpoint source



Figure 8-31 Function chart of the motorized potentiometer

## Example

Setting with the motorized potentiometer as setpoint source:

| Parameter    | Description  |
|--------------|--|
| p1070 = 1050 | Interconnects the main setpoint with the motorized potentiometer output. |

8.17 Setpoints

## Parameter

 Table 8-37
 Basic setup of motorized potentiometer

| Number   | Name  | Factory setting            |
|----------|---|----------------------------|
| p1035[C] | BI: Motorized potentiometer setpoint higher                         | 0                          |
| p1036[C] | BI: Motorized potentiometer setpoint lower                          | Dependent on the converter |
| p1040[D] | Motorized potentiometer start value                                 | 0 rpm                      |
| p1047[D] | Motorized potentiometer, ramp-up time                               | 10 s                       |
| p1048[D] | Motorized potentiometer, ramp-down time                             | 10 s                       |
| r1050    | Motorized potentiometer, setpoint after the ramp-function generator | - rpm                      |
| p1070[C] | CI: Main setpoint   | Dependent on the converter |
| p1071[C] | CI: Main setpoint scaling   | 1                          |
| r1073    | CO: Main setpoint active  | - rpm                      |
| p1075[C] | CI: Supplementary setpoint  | 0                          |
| p1076[C] | CI: Supplementary setpoint scaling                                  | 1                          |

 Table 8-38
 Extended setup of motorized potentiometer

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p1030[D] | Motorized potentiometer configuration             | 0000 0110 bin   |
| p1037[D] | Motorized potentiometer, maximum speed            | 0 rpm           |
| p1038[D] | Motorized potentiometer, minimum speed            | 0 rpm           |
| p1043[C] | BI: Motorized potentiometer, accept setting value | 0               |
| p1044[C] | CI: Motorized potentiometer, setting value        | 0               |

## 8.17.5 Fixed speed setpoint as setpoint source

## **Function description**



Figure 8-32 Fixed speed setpoint as setpoint source

The converter makes a distinction between two methods when selecting the fixed speed setpoints:

## Directly selecting a fixed speed setpoint



Figure 8-33 Direct selection of the fixed speed setpoint

| Table 8-39 | Resulting setpoint |
|------------|--------------------|
|            | Resulting selpoint |

| p1020 | p1021 | p1022 | p1023 | Resulting setpoint    |
|-------|-------|-------|-------|-----------------------|
| 0     | 0     | 0     | 0     | 0                     |
| 1     | 0     | 0     | 0     | p1001                 |
| 0     | 1     | 0     | 0     | p1002                 |
| 1     | 1     | 0     | 0     | p1001 + p1002         |
| 0     | 0     | 1     | 0     | p1003                 |
| 1     | 0     | 1     | 0     | p1001 + p1003         |
| 0     | 1     | 1     | 0     | p1002 + p1003         |
| 1     | 1     | 1     | 0     | p1001 + p1002 + p1003 |
| 0     | 0     | 0     | 1     | p1004                 |

#### 8.17 Setpoints

| p1020 | p1021 | p1022 | p1023 | Resulting setpoint            |
|-------|-------|-------|-------|-------------------------------|
| 1     | 0     | 0     | 1     | p1001 + p1004                 |
| 0     | 1     | 0     | 1     | p1002 + p1004                 |
| 1     | 1     | 0     | 1     | p1001 + p1002 + p1004         |
| 0     | 0     | 1     | 1     | p1003 + p1004                 |
| 1     | 0     | 1     | 1     | p1001 + p1003 + p1004         |
| 0     | 1     | 1     | 1     | p1002 + p1003 + p1004         |
| 1     | 1     | 1     | 1     | p1001 + p1002 + p1003 + p1004 |

#### Selecting the fixed speed setpoint, binary



Figure 8-34 Binary selection of the fixed speed setpoint

| p1020 | p1021 | p1022 | p1023 | Resulting setpoint |
|-------|-------|-------|-------|--------------------|
| 0     | 0     | 0     | 0     | 0                  |
| 1     | 0     | 0     | 0     | p1001              |
| 0     | 1     | 0     | 0     | p1002              |
| 1     | 1     | 0     | 0     | p1003              |
| 0     | 0     | 1     | 0     | p1004              |
| 1     | 0     | 1     | 0     | p1005              |
| 0     | 1     | 1     | 0     | p1006              |
| 1     | 1     | 1     | 0     | p1007              |
| 0     | 0     | 0     | 1     | p1008              |
| 1     | 0     | 0     | 1     | p1009              |
| 0     | 1     | 0     | 1     | p1010              |
| 1     | 1     | 0     | 1     | p1011              |
| 0     | 0     | 1     | 1     | p1012              |
| 1     | 0     | 1     | 1     | p1013              |
| 0     | 1     | 1     | 1     | p1014              |
| 1     | 1     | 1     | 1     | p1015              |

Table 8-40 Resulting setpoint

## Example

After it has been switched on, a conveyor belt only runs with two different velocities. The motor should now operate with the following corresponding speeds:

- The signal at digital input 0 switches the motor on and accelerates it up to 300 rpm.
- The signal at digital input 1 accelerates the motor up to 2000 rpm.
- With signals at both digital inputs, the motor accelerates up to 2300 rpm.

|            |          | · ·     |             |         |
|------------|----------|---------|-------------|---------|
| lable 8-41 | Settings | for the | application | example |
|            |          |         |             |         |

| Parameter              | Description  |
|------------------------|--|
| p1001[0] =<br>300.000  | Fixed speed setpoint 1   |
| p1002[0] =<br>2000.000 | Fixed speed setpoint 2   |
| p0840[0] = 722.0       | ON/OFF1: Switches on the motor with digital input 0  |
| p1070[0] = 1024        | Main setpoint: Interconnects the main setpoint with a fixed speed setpoint.                                  |
| p1020[0] = 722.0       | Fixed speed setpoint selection bit 0: Interconnects fixed speed setpoint 1 with dig-<br>ital input 0 (DI 0). |
| p1021[0] = 722.1       | Fixed speed setpoint selection bit 1: Interconnects fixed speed setpoint 2 with dig-<br>ital input 1 (DI 1). |
| p1016 = 1              | Fixed speed setpoint mode: Directly selects fixed speed setpoints.   |

 Table 8-42
 Resulting fixed speed setpoints for the application example

| Fixed speed setpoint selected via | Resulting setpoint |
|-----------------------------------|--------------------|
| DI 0 = 0                          | Motor stops        |
| DI 0 = 1 and DI 1 = 0             | 300 rpm            |
| DI 0 = 1 and DI 1 = 1             | 2300 rpm           |

## Parameter

| Parameter | Description                 | Factory setting |
|-----------|-----------------------------|-----------------|
| p1001[D]  | CO: Fixed speed setpoint 1  | 0 rpm           |
| p1002[D]  | CO: Fixed speed setpoint 2  | 0 rpm           |
| p1003[D]  | CO: Fixed speed setpoint 3  | 0 rpm           |
| p1004[D]  | CO: Fixed speed setpoint 4  | 0 rpm           |
| p1005[D]  | CO: Fixed speed setpoint 5  | 0 rpm           |
| p1006[D]  | CO: Fixed speed setpoint 6  | 0 rpm           |
| p1007[D]  | CO: Fixed speed setpoint 7  | 0 rpm           |
| p1008[D]  | CO: Fixed speed setpoint 8  | 0 rpm           |
| p1009[D]  | CO: Fixed speed setpoint 9  | 0 rpm           |
| p1010[D]  | CO: Fixed speed setpoint 10 | 0 rpm           |
| p1011[D]  | CO: Fixed speed setpoint 11 | 0 rpm           |
| p1012[D]  | CO: Fixed speed setpoint 12 | 0 rpm           |

### 8.17 Setpoints

| Parameter | Description                           | Factory setting            |
|-----------|---------------------------------------|----------------------------|
| p1013[D]  | CO: Fixed speed setpoint 13           | 0 rpm                      |
| p1014[D]  | CO: Fixed speed setpoint 14           | 0 rpm                      |
| p1015[D]  | CO: Fixed speed setpoint 15           | 0 rpm                      |
| p1016     | Fixed speed setpoint selection mode   | 1                          |
| p1020[C]  | Fixed speed setpoint selection, bit 0 | 0                          |
| p1021[C]  | Fixed speed setpoint selection, bit 1 | 0                          |
| p1022[C]  | Fixed speed setpoint selection, bit 2 | 0                          |
| p1023[C]  | Fixed speed setpoint selection, bit 3 | 0                          |
| r1024     | Fixed speed setpoint active           | - rpm                      |
| r1025.0   | Fixed speed setpoint status           | -                          |
| p1070[C]  | CI: Main setpoint                     | Dependent on the converter |
| p1071[C]  | CI: Main setpoint scaling             | 1                          |
| r1073     | CO: Main setpoint active              | - rpm                      |
| p1075[C]  | CI: Supplementary setpoint            | 0                          |
| p1076     | CI: Supplementary setpoint scaling    | 1                          |
| r1077     | CO: Supplementary setpoint effective  | - rpm                      |

## Example

#### Directly selecting two fixed speed setpoints

The motor should operate at different speeds as follows:

- The signal on digital input 0 switches the motor on and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.
- With signals at both digital inputs, the motor accelerates up to 2300 rpm.

Table 8-43Settings for the application example

| Parameter        | Description  |
|------------------|--|
| p1001 = 300.000  | Fixed speed setpoint 1   |
| p1002 = 2000.000 | Fixed speed setpoint 2   |
| p0840 = 722.0    | ON/OFF1: Switches on the motor with digital input 0  |
| p1070 = 1024     | Main setpoint: Interconnects the main setpoint with a fixed speed setpoint.                                    |
| p1020 = 722.0    | <b>Fixed speed setpoint selection bit 0:</b> Interconnects fixed speed setpoint 1 with digital input 0 (DI 0). |
| p1021 = 722.1    | <b>Fixed speed setpoint selection bit 1:</b> Interconnects fixed speed setpoint 2 with digital input 1 (DI 1). |
| p1016 = 1        | Fixed speed setpoint mode: Directly selects fixed speed setpoints.   |

8.17 Setpoints

| Table 8-44 | Resulting fixed spee | d setpoints for the | application e | example |
|------------|----------------------|---------------------|---------------|---------|
|            | nesuning inter spee  | a seeponnes for the | application   | manipie |

| Fixed speed setpoint selected via | Resulting setpoint |  |
|-----------------------------------|--------------------|--|
| DI 0 = 0                          | Motor stops        |  |
| DI 0 = 1 and DI 1 = 0             | 300 rpm            |  |
| DI 0 = 1 and DI 1 = 1             | 2300 rpm           |  |

## Parameter

| Parameter | Description                               | Factory setting                       |
|-----------|---|---------------------------------------|
| p0840[C]  | BI: ON/OFF (OFF1)                         | [0] 2090.0<br>[1] 0<br>[2] 0<br>[3] 0 |
| p1001     | CO: Fixed speed setpoint 1                | 0 rpm                                 |
| p1002     | CO: Fixed speed setpoint 2                | 0 rpm                                 |
| p1016     | Fixed speed setpoint selection mode       | 1                                     |
| p1020[C]  | BI: Fixed speed setpoint selection, bit 0 | 0                                     |
| p1021[C]  | BI: Fixed speed setpoint selection, bit 1 | 0                                     |
| p1070[C]  | CI: Main setpoint                         | [0] 755[0]                            |
|           |   | [1] 0                                 |
|           |   | [2] 0                                 |
|           |   | [3] 0                                 |

8.18 Setpoint processing

## 8.18 Setpoint processing

### 8.18.1 Overview

#### Overview



Setpoint processing influences the setpoint using the following functions:

- "Invert" inverts the motor direction of rotation.
- The "Inhibit direction of rotation" function prevents the motor from rotating in the incorrect direction; this function can make sense for conveyor belts, extruders, pumps and fans, for example.
- The "Skip frequency bands" prevent the motor from being continuously operated within these skip bands. This function avoids mechanical resonance effects by only permitting the motor to operate briefly at specific speeds.
- The "Speed limitation" function protects the motor and the driven load against excessively high speeds.
- The "Ramp-function generator" function prevents the setpoint from suddenly changing. As a consequence, the motor accelerates and brakes with a reduced torque.



Figure 8-35 Setpoint processing in the converter

## 8.18.2 Invert setpoint

## **Function description**



The function inverts the sign of the setpoint using a binary signal.

## Example

To invert the setpoint via an external signal, interconnect parameter p1113 with a binary signal of your choice.

| Table 8-45 | Application | examples | showing | how a | setpoint | is inverte | d |
|------------|-------------|----------|---------|-------|----------|------------|---|
|            |             |          | J       |       |          |            |   |

| Parameter       | Description  |
|-----------------|--|
| p1113 = 722.1   | Digital input 1 = 0: Setpoint remains unchanged.<br>Digital input 1 = 1: Converter inverts the setpoint. |
| p1113 = 2090.11 | Inverts the setpoint via the fieldbus (control word 1, bit 11).  |

### Parameter

| Number   | Name                   | Factory setting            |
|----------|------------------------|----------------------------|
| p1113[C] | BI: Setpoint inversion | Dependent on the converter |

8.18 Setpoint processing

## 8.18.3 Inhibit direction of rotation

## **Function description**



In the factory setting of the converter, both motor directions of rotation are enabled. Set the corresponding parameter to a value = 1 to permanently block directions of rotation.

## Example

 Table 8-46
 Application examples for inhibiting and enabling a direction of rotation

| Parameter        | Description   |
|------------------|---|
| p1110[0] = 1     | Negative direction of rotation is permanently inhibited.          |
| p1110[0] = 722.3 | Digital input 3 = 0: Negative direction of rotation is enabled.   |
|                  | Digital input 3 = 1: Negative direction of rotation is inhibited. |

## Parameter

| Parameter | Description                    | Factory setting |
|-----------|--------------------------------|-----------------|
| p1110[C]  | BI: Inhibit negative direction | 0               |
| p1111[C]  | BI: Inhibit positive direction | 0               |
# 8.18.4 Skip frequency bands and minimum speed

### Overview

The converter has a minimum speed and four skip frequency bands:

- The minimum speed prevents continuous motor operation at speeds less than the minimum speed.
- Each skip frequency band prevents continuous motor operation within a specific speed range.

### **Function description**

### **Minimum speed**



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

### Skip frequency bands

Additional information on the skip frequency bands is provided in the function diagram.

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| p1051[C] | CI: Speed limit of ramp-function generator, positive direction of rotation | 9733            |
| p1052[C] | CI: Speed limit of ramp-function generator, negative direction of rotation | 1086            |
| p1080[D] | Minimum speed  | 0 rpm           |
| p1083[D] | CO: Speed limit in positive direction of rotation                          | 210000 rpm      |
| r1084    | CO: Speed limit positive active  | - rpm           |
| p1085[C] | CI: Speed limit in positive direction of rotation                          | 1083            |

| Tablo | 8-17 | Minimum     | cnood |
|-------|------|-------------|-------|
| lable | 0-47 | wiiniiniuni | speed |

#### Advanced commissioning

#### 8.18 Setpoint processing

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p1091[D] | Skip speed 1                                      | 0 rpm           |
| p1092[D] | Skip speed 2                                      | 0 rpm           |
| p1093[D] | Skip speed 3                                      | 0 rpm           |
| p1094[D] | Skip speed 4                                      | 0 rpm           |
| p1098[C] | CI: Skip speed scaling                            | 1               |
| r1099    | CO/BO: Skip frequency band of status word         | -               |
| p1101    | Skip speed bandwidth                              | 0 rpm           |
| p1106    | CI: Minimum speed signal source                   | 0               |
| r1112    | CO: Speed setpoint according to minimum limit     | - rpm           |
| r1114    | CO: Setpoint after direction limiting             | - rpm           |
| r1119    | CO: Ramp-function generator setpoint at the input | - rpm           |
| r1170    | CO: Speed controller setpoint sum                 | - rpm           |

#### Note

In order that a stationary motor – after all of the enable signals have been switched on, can operate at the minimum

speed/minimum velocity once all of the enable signals are available, the direction must be entered using one of the

following options:

- direction input via small setpoint.

- direction input by inhibiting the negative or positive direction (p1110, p1111).

### NOTICE

#### Incorrect direction of motor rotation if the parameterization is not suitable

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

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

# 8.18.5 Speed limitation

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



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

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

### Parameters

Table 8-48 Parameters for the speed limitation

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p1082[D] | Maximum speed                                     | 1500 rpm        |
| p1083[D] | CO: Speed limit in positive direction of rotation | 210000 rpm      |
| p1085[C] | CI: Speed limit in positive direction of rotation | 1083            |
| p1086[D] | CO: Speed limit in negative direction of rotation | -210000 rpm     |
| p1088[C] | CI: Speed limit in negative direction of rotation | 1086            |

8.18 Setpoint processing

### 8.18.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate change of the speed setpoint (acceleration). A reduced acceleration reduces the accelerating torque of the motor. In this case, the motor reduces the load on the mechanical system of the driven machine.

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

• Extended ramp-function generator

The expanded ramp-function generator limits not only the acceleration but also the change in acceleration (jerk) by rounding the setpoint. In this case, the torque does not rise suddenly in the motor.

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

### Extended ramp-function generator

The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimal times depend on the application, and can lie in the range from a few 100 ms to several minutes.



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

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

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

### Parameter

| Table 8-49 | Additional | parameters to set t | he extended   | ramp-function generator |
|------------|------------|---------------------|---------------|-------------------------|
|            | nuuntionui |                     | ine externaca | amp function generator  |

| Parameter | Description   | Factory setting |
|-----------|---|-----------------|
| p1115     | Ramp-function generator selection   | 1               |
| p1120[D]  | Ramp-function generator ramp-up time  | 10 s            |
| p1121[D]  | Ramp-function generator ramp-down time  | 30 s            |
| p1130[D]  | Ramp-function generator initial rounding time   | 0 s             |
| p1131[D]  | Ramp-function generator final rounding time   | 2 s             |
| p1134[D]  | Ramp-function generator round-<br>ing type<br>0: Continuous smoothing<br>1: Discontinuous smoothing<br>y<br>y<br>p = 1134 = 0<br>y<br>p = 1134 = 1<br>t | 0               |
| p1135[D]  | OFF3 ramp-down time   | 30 s / 0 s      |
| p1136[D]  | OFF3 initial rounding time  | 2 s / 0 s       |
| p1137[D]  | OFF3 final rounding time  | 0 s             |

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

### Setting the extended ramp-function generator

#### Procedure

- 1. Enter the highest possible speed setpoint.
- 2. Switch on the motor.
- 3. Evaluate your drive response.
  - If the motor accelerates too slowly, then reduce the ramp-up time.
     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
  - If the motor accelerates too fast, then extend the ramp-up time.
  - Increase the initial rounding if the acceleration is jerky.
  - In most applications, it is sufficient when the final rounding is set to the same value as the initial rounding.
- 4. Switch off the motor.

#### 8.18 Setpoint processing

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

You have set the extended ramp-function generator.

#### **Basic ramp-function generator**



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

| Table 8-50 | Parameters for | setting th | he ramp-function | generator |
|------------|----------------|------------|------------------|-----------|
|            |                |            |                  | 5         |

| Parame-<br>ter | Description                            | Factory setting |
|----------------|--|-----------------|
| p1082[D]       | Maximum speed                          | 1500 rpm        |
| p1115          | Ramp-function generator selection      | 1               |
| p1120[D]       | Ramp-function generator ramp-up time   | 10 s            |
| p1121[D]       | Ramp-function generator ramp-down time | 10 s            |
| p1135[D]       | OFF3 ramp-down time                    | 30 s            |

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

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

#### Requirements

- You have commissioned the communication between the converter and the control system.
- Free telegram 999 has been set in the converter and in your higher-level control system.
   Expanding or freely interconnecting telegrams (Page 265)
- The control sends the scaling value to the converter in PZD 3.

#### Procedure

- Set p1138 = 2050[2]. This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 3.
- 2. Set p1139 = 2050[2].

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

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

Further information is provided on the Internet:

FAQ (https://support.industry.siemens.com/cs/ww/en/view/82604741)

### Application example

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



Figure 8-36 Application example for changing the ramp-function generator times in operation

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Table 8-51Parameters for setting the scaling

| Parame-<br>ter | Description                                      | Factory setting |
|----------------|--|-----------------|
| p1138[C]       | CI: Ramp-function generator ramp-up time scaling | 1               |
| p1139[C]       | Down ramp scaling                                | 1               |
| r2050          | CO: PROFIdrive PZD receive word                  | -               |

# 8.19.1 PID technology controller

### Overview

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



Figure 8-37 Example: Technology controller as a level controller

### Requirement

The U/f control or the vector control have been set.

# **Function description**

### Function diagram

The technology controller is implemented as a PID controller (controller with proportional, integral, and derivative action).



① The converter uses the start value when all the following conditions are simultaneously satisfied:

• The technology controller supplies the main setpoint (p2251 = 0).

• The ramp-function generator output of the technology controller has not yet reached the start value.

Figure 8-38 Simplified representation of the technology controller

### **Basic settings**

The settings required as a minimum are marked in gray in the function diagram:

- Interconnect setpoint and actual values with signals of your choice
- Set ramp-function generator and controller parameters  $K_P$ ,  $T_I$  and  $T_d$ .

### Set controller parameters $K_P$ , $T_I$ and $T_d$ .

### Procedure

- 1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
- 2. Enter a setpoint step and monitor the associated actual value. The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.





3. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.

You have manually set the technology controller.  $\hfill\square$ 

### Limiting the output of the technology controller

In the factory setting, the output of the technology controller is limited to  $\pm$  maximum speed. You must change this limit, depending on your particular application. Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.

| Table 8-52 | <b>Basic settings</b> |
|------------|-----------------------|
|            | Dasic settings        |

| Number     | Name  | Factory setting    |
|------------|---|--------------------|
| r0046[031] | CO/BO: Missing enable signals   | -                  |
| r0052[015] | CO/BO: Status word 1  | -                  |
| r0056[015] | CO/BO: Status word, closed-loop control                                   | -                  |
| r1084      | CO: Speed limit positive active   | -                  |
| r1087      | CO: Speed limit negative active   | - rpm              |
| p2200[C]   | BI: Technology controller enable  | 0                  |
| p2252      | Technology controller configuration                                       | See parameter list |
| p2253[C]   | CI: Technology controller setpoint 1                                      | 0                  |
| p2254[C]   | CI: Technology controller setpoint 2                                      | 0                  |
| p2255      | Technology controller setpoint 1 scaling                                  | 100%               |
| p2256      | Technology controller setpoint 2 scaling                                  | 100%               |
| p2257      | Technology controller ramp-up time  | 1 s                |
| p2258      | Technology controller ramp-down time                                      | 1 s                |
| r2260      | CO: Technology controller setpoint after ramp-function gen-<br>erator     | - %                |
| p2261      | Technology controller setpoint filter time constant                       | 0 s                |
| r2262      | CO: Technology controller setpoint after filter                           | - %                |
| p2263      | Technology controller type  | 0                  |
| r2273      | CO: Technology controller system deviation                                | - %                |
| p2274      | Technology controller differentiation time constant                       | 0 s                |
| p2280      | Technology controller proportional gain                                   | See parameter list |
| p2285      | Technology controller integral time                                       | See parameter list |
| p2286      | BI: Hold technology controller integrator                                 | 56.13              |
| p2289[C]   | CI: Technology controller precontrol signal                               | 0                  |
| p2306      | Technology controller system deviation inversion                          | 0                  |
| p2339      | Technology controller threshold value for I proportion stop at skip speed | - S                |
| r2344      | CO: Technology controller last speed setpoint (smoothed)                  | - %                |
| p2345      | Technology controller fault response                                      | 0                  |
| r2349[013] | CO/BO: Technology controller status word                                  | -                  |
| r3889[010] | CO/BO: ESM status word  | -                  |

 Table 8-53
 Limiting the output of the technology controller

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| p2290[C] | BI: Technology controller limitation enable  | 1               |
| p2291    | CO: Technology controller maximum limiting   | 100%            |
| p2292    | CO: Technology controller minimum limiting   | 0%              |
| p2293    | Technology controller ramp-up/ramp-down time | 1 s             |

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| r2294    | CO: Technology controller output signal                  | - %             |
| p2295    | CO: Technology controller output scaling                 | 100%            |
| p2296[C] | CI: Technology controller output scaling                 | 2295            |
| p2297[C] | CI: Technology controller maximum limiting signal source | 1084            |
| p2298[C] | CI: Technology controller minimum limiting signal source | 1087            |
| p2299[C] | CI: Technology controller limitation offset              | 0               |
| p2302    | Technology controller output signal start value          | 0%              |

 Table 8-54
 Adapting the actual value of the technology controller

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p2264[C] | CI: Technology controller actual value                  | 0               |
| p2265    | Technology controller actual value filter time constant | 0 s             |
| p2266    | CO: Technology controller actual value after filter     | - %             |
| p2267    | Technology controller upper limit actual value          | 100%            |
| p2268    | Technology controller lower limit actual value          | -100%           |
| p2269    | Technology controller gain actual value                 | 100%            |
| p2270    | Technology controller actual value function             | 0               |
| p2271    | Technology controller actual value inversion            | 0               |
| r2272    | CO: Technology controller actual value scaled           | - %             |

 Table 8-55
 PID technology controller, fixed values (binary selection)

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| p2201[D] | CO: Technology controller fixed value 1            | 10%             |
| p2202[D] | CO: Technology controller fixed value 2            | 20%             |
| p2203[D] | CO: Technology controller fixed value 3            | 30%             |
| p2204[D] | CO: Technology controller fixed value 4            | 40%             |
| p2205[D] | CO: Technology controller fixed value 5            | 50%             |
| p2206[D] | CO: Technology controller fixed value 6            | 60%             |
| p2207[D] | CO: Technology controller fixed value 7            | 70%             |
| p2208[D] | CO: Technology controller fixed value 8            | 80%             |
| p2209[D] | CO: Technology controller fixed value 9            | 90%             |
| p2210[D] | CO: Technology controller fixed value 10           | 100%            |
| p2211[D] | CO: Technology controller fixed value 11           | 110%            |
| p2212[D] | CO: Technology controller fixed value 12           | 120%            |
| p2213[D] | CO: Technology controller fixed value 13           | 130%            |
| p2214[D] | CO: Technology controller fixed value 14           | 140%            |
| p2215[D] | CO: Technology controller fixed value 15           | 150%            |
| p2216[D] | Technology controller fixed value selection method | 1               |
| r2224    | CO: Technology controller fixed value active       | - %             |

| Number | Name   | Factory setting |
|--------|--|-----------------|
| r2225  | CO/BO: Technology controller fixed value selection status word | - %             |
| r2229  | Technology controller number actual                            | -               |

### Table 8-56 PID technology controller, fixed values (direct selection)

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| p2216[D] | Technology controller fixed value selection method             | 1               |
| p2220[C] | BI: Technology controller fixed value selection bit 0          | 0               |
| p2221[C] | BI: Technology controller fixed value selection bit 1          | 0               |
| p2222[C] | BI: Technology controller fixed value selection bit 2          | 0               |
| p2223[C] | BI: Technology controller fixed value selection bit 3          | 0               |
| r2224    | CO: Technology controller fixed value active                   | - %             |
| r2225    | CO/BO: Technology controller fixed value selection status word | - %             |
| r2229    | Technology controller number actual                            | -               |

| Table 8-57 | PID technology controller | , motorized potentiometer |
|------------|---------------------------|---------------------------|
|------------|---------------------------|---------------------------|

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| r2231    | Technology controller motorized potentiometer setpoint memory          | - %             |
| p2235[C] | BI: Technology controller motorized potentiometer, setpoint, raise     | 0               |
| p2236[C] | BI: Technology controller motorized potentiometer, setpoint, lower     | 0               |
| p2237[D] | Technology controller motorized potentiometer maximum value            | 100%            |
| p2238[D] | Technology controller motorized potentiometer minimum value            | -100%           |
| p2240[D] | Technology controller motorized potentiometer start value              | 0%              |
| r2245    | CO: Technology controller motorized potentiometer, setpoint before RFG | - %             |
| p2247[D] | Technology controller motorized potentiometer ramp-up time             | 10 s            |
| p2248[D] | Technology controller motorized potentiometer ramp-down time           | 10 s            |
| r2250    | CO: Technology controller motorized potentiometer, setpoint after RFG  | - %             |

### **Further information**

You will find additional information on the following PID controller components on the Internet at:

- Setpoint input: Analog value or fixed setpoint
- Setpoint channel: Scaling, ramp-function generator and filter
- Actual value channel: Filter, limiting and signal processing
- PID controller: Principle of operation of the D component, inhibiting the I component and the control sense
- Enable, limiting the controller output and fault response
- **FAQ** (http://support.automation.siemens.com/WW/view/en/92556266)

# 8.19.2 Autotuning the PID technology controller

### Overview

Autotuning is a converter function for the automatic optimization of the PID technology controller.

### Requirement

The following requirements apply:

- The motor closed-loop control is set
- The PID technology controller must be set the same as when used in subsequent operation:
  - The actual value is interconnected.
  - Scalings, filter and ramp-function generator have been set.
  - The PID technology controller is enabled (p2200 = 1 signal).

### **Function description**

For active autotuning, the converter interrupts the connection between the PID technology controller and the speed controller. Instead of the PID technology controller output, the autotuning function specifies the speed setpoint.



Figure 8-39 Autotuning using closed-loop level control as example

The speed setpoint results from the technology setpoint and a superimposed rectangular signal with amplitude p2355. If actual value = technology setpoint  $\pm$  p2355, the autotuning function switches the polarity of the superimposed signal. This causes the converter to excite the process variable for an oscillation.



Figure 8-40 Example for speed setpoint and actual process value for autotuning

The converter calculates the parameters of the PID controller from the determined oscillation frequency.

#### **Executing autotuning**

- 1. Select with p2350 the appropriate controller setting.
- 2. Switch on the motor. The converter signals Alarm A07444.
- 3. Wait until alarm A07444 goes away. The converter has recalculated parameters p2280, p2274 and p2285. If the converter signals fault F07445:
  - If possible, double p2354 and p2355.
  - Repeat the autotuning with the changed parameters.
- 4. Back up the calculated values so that they are protected against power failure, e.g. using the BOP-2: OPTIONS → RAM-ROM.

You have auto tuned the PID controller.

| Number | Name  | Factory setting    |
|--------|---|--------------------|
| p2274  | Technology controller differentiation time constant | 0.0 s              |
| p2280  | Technology controller proportional gain             | See parameter list |
| p2285  | Technology controller integral time                 | See parameter list |

| Number | Name   | Factory setting |
|--------|--|-----------------|
| p2350  | Enable PID autotuning  | 0               |
|        | Automatic controller setting based on the "Ziegler Nichols" method.  |                 |
|        | After completion of the autotuning, the converter sets $p2350 = 0$ .   |                 |
|        | 0: No function   |                 |
|        | 1: The process variable follows the setpoint after a sudden<br>setpoint change (step function) relatively quickly, however<br>with an overshoot. |                 |
|        |  |                 |
|        | 2: Faster controller setting than for p2350 = 1 with larger overshoot of the controlled variable.  |                 |
|        |  |                 |
|        | 3: Slower controller setting than for p2350 = 1. Overshoot of the controlled variable is, to a large extent, avoided.                            |                 |
|        |  |                 |
|        | 4: Controller setting after completion of the autotuning as for p2350 = 1. Optimize only the P and I action of the PID controller.               |                 |
|        |  |                 |
| p2354  | PID autotuning monitoring time   | 240 s           |
| p2355  | PID autotuning offset  | 5%              |

# 8.19.3 Adapting Kp and Tn

### Overview

This function adapts the PID technology controller to the process, e.g. depending on the control deviation of the technology controller.

### **Function description**





| Number | Name  | Factory setting            |
|--------|---|----------------------------|
| p2252  | Technology controller configuration                               | 0000 0000 0000<br>0000 bin |
| p2280  | Technology controller proportional gain                           | see parameter list         |
| p2285  | Technology controller integral time                               | see parameter list         |
| p2310  | CI: Technology controller Kp adaptation input value signal source | 0                          |
| p2311  | Technology controller, lower Kp adaptation value                  | 1                          |
| p2312  | Technology controller, upper Kp adaptation value                  | 10                         |
| p2313  | Technology controller lower Kp adaptation transition point        | 0%                         |
| p2314  | Technology controller upper Kp adaptation transition point        | 100%                       |
| p2315  | CI: Technology controller Kp adaptation scaling signal source     | 1                          |
| r2316  | CO: Technology controller Kp adaptation output                    | -                          |
| p2317  | CI: Technology controller Tn adaptation input value signal source | 0                          |
| p2318  | Technology controller, lower Tn adaptation value                  | 3 s                        |

# Advanced commissioning

# 8.19 PID technology controller

| Number | Name   | Factory setting |
|--------|--|-----------------|
| p2319  | Technology controller, upper Tn adaptation value           | 10 s            |
| p2320  | Technology controller lower Tn adaptation transition point | 0%              |
| p2321  | Technology controller upper Tn adaptation transition point | 100%            |
| r2322  | CO: Technology controller Tn adaptation output             | - S             |

# 8.20 Reactor, filter and cable resistance at the converter output

### Overview

Components between the converter and the motor influence the closed-loop control quality of the converter:

- Output reactor or sine-wave filter In the factory setting, for the motor data identification, the converter assumes that neither output reactor nor sine wave filter are connected at the converter output.
- Motor cable with unusually high cable resistance.
   For the motor data identification, the converter assumes a cable resistance = 20 % of the stator resistance of the cold motor.

### **Function description**

You must correctly set the components between the converter and motor to achieve an optimum closed-loop control quality

### Procedure

- 1. Set p0010 = 2.
- 2. Set the cable resistance in p0352.
- 3. Set p0230 to the appropriate value.
- 4. Set p0235 to the appropriate value.
- 5. Set p0010 = 0.
- 6. Carry out the quick commissioning and the motor identification again.
   Commissioning (Page 147)
  - You have set the reactor, filter and cable resistance between the converter and motor.

### Parameter

| Number   | Name                                 | Factory setting |
|----------|--------------------------------------|-----------------|
| p0010    | Drive commissioning parameter filter | 1               |
| p0230    | Drive filter type, motor side        | 0               |
| p0235    | Number of motor reactors in series   | 1               |
| p0350[M] | Motor stator resistance, cold        | 0 Ω             |
| p0352[M] | Cable resistance                     | 0 Ω             |

For further information on parameters, please refer to the parameter list.

# 8.21 Motor control

### Overview



The converter has two alternative methods to ensure the motor speed follows the configured speed setpoint:

- U/f control
- Vector control

### 8.21.1 U/f control

### 8.21.1.1 U/f control

### Overview



<sup>1)</sup> In the "Flux Current Control (FCC)" U/f version, the converter controls the motor current (starting current) at low speeds.

Figure 8-42 Simplified function diagram of the U/f control

The U/f control is a speed feedforward control with the following properties:

- The converter sets the output voltage on the basis of the U/f characteristic.
- The output frequency is essentially calculated from the speed setpoint and the number of pole pairs of the motor.
- The slip compensation corrects the output frequency depending on the load and thus increases the speed accuracy.
- The omission of a control loop means that the U/f control is stable in all cases.
- In applications with higher speed accuracy requirements, a load-dependent voltage boost can be selected (flux current control, FCC)

For operation of the motor with U/f control, you must set at least the following subfunctions appropriate for your application:

- U/f characteristic
- Voltage boost

### **Function description**



The converter has different U/f characteristics.

- ① The voltage boost of the characteristic improves speed control at low speeds
- 2 With the flux current control (FCC), the converter compensates for the voltage drop in the stator resistor of the motor

Figure 8-43 Characteristics of U/f control

With increasing speed or output frequency, the converter increases its output voltage U. The maximum possible output voltage of the converter depends on the line voltage.

The converter can increase the output frequency even at the maximum output voltage. The motor is then operated with field weakening.

The value of the output voltage at the rated motor frequency p0310 also depends on the following variables:

- Ratio between the converter size and the motor size
- Line voltage

- Line impedance
- Actual motor torque

The maximum possible output voltage as a function of the input voltage is provided in the technical data.

Technical data (Page 485)

#### Table 8-58The characteristic that matches the application

| Requirement  | Application exam-<br>ples  | Remark   | Charac-<br>teristic  | Parameter              |
|--|--|--|--|------------------------|
| The required<br>torque is inde-<br>pendent of the<br>speed | Conveyor belts,<br>roller conveyors,<br>chain conveyors,<br>eccentric worm<br>pumps, compres-<br>sors, extruders,<br>centrifuges, agita-<br>tors, mixers | -<br>The converter compensates for the<br>voltage drops across the stator re-<br>sistance. Recommended for mo-<br>tors less than 7.5 kW.<br>Precondition: You have set the mo-<br>tor data according to the rating<br>plate and have performed the mo-<br>tor identification after quick com-<br>missioning. | Linear<br>Linear<br>with Flux<br>Current<br>Control<br>(FCC) | p1300 = 0<br>p1300 = 1 |
| The required<br>torque increa-<br>ses with the<br>speed    | Centrifugal<br>pumps, radial fans,<br>axial fans   | Lower losses in the motor and con-<br>verter than for a linear characteris-<br>tic.  | Parabolic  | p1300 = 2              |

Table 8-59Characteristics for special applications

| Requirement  | Application exam-<br>ples                        | Remark  | Charac-<br>teristic                           | Parameter                    |
|--|--|---|---|------------------------------|
| Applications<br>with a low dy-<br>namic response<br>and constant                                   | Centrifugal<br>pumps, radial fans,<br>axial fans | If the speed setpoint is reached and<br>remains unchanged for 5 seconds,<br>then the converter reduces its out-<br>put voltage. | ECO<br>mode                                   | p1300 = 4<br>or<br>p1300 = 7 |
| speed  |  | As a consequence, the ECO mode saves energy with respect to the parabolic characteristic.                                       |   |                              |
| The converter<br>must maintain<br>the motor<br>speed constant<br>for the longest<br>possible time. | Drives in the textile<br>sector                  | When reaching the maximum cur-<br>rent limit, the converter only re-<br>duces the output voltage, but not<br>the frequency.     | Precise<br>frequen-<br>cy charac-<br>teristic | p1300 = 5<br>or<br>p1300 = 6 |
| Freely adjusta-<br>ble U/f charac-<br>teristic   | -  | -   | Adjusta-<br>ble char-<br>acteristic           | p1300 = 3                    |
| U/f characteris-<br>tic with inde-<br>pendent volt-<br>age setpoint                                | -  | The interrelationship between the frequency and voltage is not calculated in the converter, but is specified by the user.       | Inde-<br>pendent<br>voltage<br>setpoint       | p1300 = 19                   |

| Parameter | Description                                      | Factory setting |
|-----------|--|-----------------|
| r0025     | CO: Output voltage, smoothed                     | - Vrms          |
| r0066     | CO: Output frequency                             | - Hz            |
| r0071     | Output voltage, maximum                          | - Vrms          |
| p0304[M]  | Rated motor voltage                              | 0 Vrms          |
| p0310[M]  | Rated motor frequency                            | 0 Hz            |
| p1300[D]  | Open-loop/closed-loop control operating mode     | 0               |
| p1333[D]  | U/f control FCC starting frequency               | 0 Hz            |
| p1334[D]  | U/f control slip compensation starting frequency | 0 Hz            |
| p1335[D]  | Slip compensation scaling                        | 0%              |
| p1338[D]  | U/f mode resonance damping gain                  | 0               |

## 8.21.1.2 Optimizing motor starting

### Overview

After selection of the U/f characteristic, no further settings are required in most applications.

In the following circumstances, the motor cannot accelerate to its speed setpoint after it has been switched on:

- Load moment of inertia too high
- Load torque too large
- Ramp-up time p1120 too short

To improve the starting behavior of the motor, a voltage boost can be set for the U/f characteristic at low speeds.

### Requirement

The ramp-up time of the ramp-function generator is, depending on the motor rated power, 1 s (< 1 kW) ... 10 s (> 10 kW).

### **Function description**

### Setting the voltage boost for U/f control

The converter boosts the voltage corresponding to the starting currents p1310 ... p1312.



Figure 8-44 The resulting voltage boost using a linear characteristic as example

Increase parameter values p1310 ... p1312 in steps of  $\leq$  5 %. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the converter due to overcurrent.

If message A07409 appears, it is not permissible that you further increase the value of any of the parameters.

#### Procedure

- 1. Switch on the motor with a setpoint of a few revolutions per minute.
- 2. Check whether the motor rotates smoothly.

- 3. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until the motor runs smoothly.
- 4. Accelerate the motor to the maximum speed with maximum load.
- 5. Check that the motor follows the setpoint.
- 6. If necessary, increase the voltage boost p1311 until the motor accelerates without problem.

In applications with a high break loose torque, you must also increase parameter p1312 in order to achieve a satisfactory motor response.

You have set the voltage boost. **D** 

### Parameter

| Number   | Name   | Factory setting |
|----------|--|-----------------|
| r0071    | Output voltage, maximum                            | Vrms            |
| p0310[M] | Rated motor frequency                              | 0 Hz            |
| p1310[D] | Starting current (voltage boost) permanent         | 50%             |
| p1311[D] | Starting current (voltage boost) when accelerating | 0%              |
| p1312[D] | Starting current (voltage boost) when starting     | 0%              |

### 8.21.1.3 U/f control with Standard Drive Control

### Overview



Figure 8-45 Default setting of the U/f control after selecting Standard Drive Control

Selecting application class Standard Drive Control in the quick commissioning adapts the structure and the setting options of the U/f control as follows:

- Starting current closed-loop control: At low speeds, a controlled motor current reduces the tendency of the motor to oscillate.
- With increasing speed, the converter changes from closed-loop starting current control to U/f control with load-dependent voltage boost.
- The slip compensation is activated.
- Soft starting is not possible.
- Reduced setting options

### **Function description**



### Characteristics after selecting the application class Standard Drive Control

① The closed-loop starting current control optimizes the speed control at low speeds

2 The converter compensates the voltage drop across the motor stator resistance Figure 8-46 Characteristics after selecting Standard Drive Control

The application class Standard Drive Control reduces the number of characteristics and setting options:

- A linear and a parabolic characteristic are available.
- Selecting a technological application defines the characteristics.

| Requirement  | Application exam-<br>ples  | Remark  | Charac-<br>teristic | Parameter |
|--|--|---|---------------------|-----------|
| The required<br>torque is inde-<br>pendent of the<br>speed | Conveyor belts,<br>roller conveyors,<br>chain conveyors,<br>eccentric worm<br>pumps, compres-<br>sors, extruders,<br>centrifuges, agita-<br>tors, mixers | -   | Linear              | p0501 = 0 |
| The required<br>torque increa-<br>ses with the<br>speed    | Centrifugal<br>pumps, radial fans,<br>axial fans   | Lower losses in the motor and converter than for a linear characteristic. | Parabol-<br>ic      | p0501 = 1 |

Table 8-60Linear and parabolic characteristics

| Parameter | Description                  | Factory setting |
|-----------|------------------------------|-----------------|
| r0025     | CO: Output voltage, smoothed | - Vrms          |
| r0066     | CO: Output frequency         | - Hz            |
| r0071     | Output voltage, maximum      | - Vrms          |
| p0310[M]  | Rated motor frequency        | 0 Hz            |
| p501      | Technology application       | 0               |

## 8.21.1.4 Optimizing motor starting using Standard Drive Control

### Overview

After selecting application class Standard Drive Control, in most applications no additional settings need to be made.

At standstill, the converter ensures that at least the rated motor magnetizing current flows. Magnetizing current p0320 approximately corresponds to the no-load current at 50 % ... 80 % of the rated motor speed.

In the following circumstances, the motor cannot accelerate to its speed setpoint after it has been switched on:

- Load moment of inertia too high
- Load torque too large
- Ramp-up time p1120 too short

The current can be increased at low speeds to improve the starting behavior of the motor.

### Requirement

The ramp-up time of the ramp-function generator is, depending on the motor rated power, 1 s (< 1 kW) ... 10 s (> 10 kW).

### **Function description**



### Starting current (boost) after selecting the application class Standard Drive Control



The converter boosts the voltage corresponding to the starting currents p1310 ... p1312.

Increase parameter values p1310 ... p1312 in steps of  $\leq$  5 %. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the converter due to overcurrent.

If message A07409 appears, it is not permissible that you further increase the value of any of the parameters.

#### Procedure

- 1. Switch on the motor with a setpoint of a few revolutions per minute.
- 2. Check whether the motor rotates smoothly.
- 3. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until the motor runs smoothly.
- 4. Accelerate the motor with the maximum load.
- 5. Check that the motor follows the setpoint.
- 6. If necessary, increase the voltage boost p1311 until the motor accelerates without problem.

In applications with a high break loose torque, you must also increase parameter p1312 in order to achieve a satisfactory motor response.

You have set the voltage boost.

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| r0071    | Output voltage, maximum                                 | Vrms            |
| p0310[M] | Rated motor frequency                                   | 0 Hz            |
| p0320[M] | Rated motor magnetizing current / short-circuit current | 0 Arms          |
| p1310[D] | Starting current (voltage boost) permanent              | 50%             |
| p1311[D] | Starting current (voltage boost) when accelerating      | 0%              |
| p1312[D] | Starting current (voltage boost) when starting          | 0%              |

# 8.21.2 Sensorless vector control with speed controller

### 8.21.2.1 Structure of vector control without encoder (sensorless)

#### Overview

The vector control comprises closed-loop current control and a higher-level closed-loop speed control.



- <sup>1)</sup> for induction motors
- <sup>2)</sup> Settings that are required

Figure 8-48 Simplified function diagram for sensorless vector control with speed controller

Using the motor model, the converter calculates the following closed-loop control signals from the measured phase currents and the output voltage:

- Current component I<sub>a</sub>
- Current component I<sub>q</sub>
- Speed actual value

The setpoint of the current component  $I_d$  (flux setpoint) is obtained from the motor data. For speeds above the rated speed, the converter reduces the flux setpoint along the field weakening characteristic.

When the speed setpoint is increased, the speed controller responds with a higher setpoint for current component  $I_q$  (torque setpoint). The closed-loop control responds to a higher torque setpoint by adding a higher slip frequency to the output frequency. The higher output frequency also results in a higher motor slip, which is proportional to the accelerating torque.

 $I_q$  and  $I_d$  controllers keep the motor flux constant using the output voltage, and adjust the matching current component  $I_q$  in the motor.

### Settings that are required

Restart quick commissioning and select the vector control in quick commissioning.

Commissioning (Page 147)

In order to achieve a satisfactory control response, as a minimum you must set the partial functions – shown with gray background in the diagram above – to match your particular application:

- **Motor and current model**: In the quick commissioning, correctly set the motor data on the rating plate corresponding to the connection type  $(Y|\Delta)$ , and carry out the motor data identification routine at standstill.
- **Speed limits** and **torque limits**: In the quick commissioning, set the maximum speed (p1082) and current limit (p0640) to match your particular application. When exiting quick commissioning, the converter calculates the torque and power limits corresponding to the current limit. The actual torque limits are obtained from the converted current and power limits and the set torque limits.
- **Speed controller**: Start the rotating measurement of the motor data identification. You must manually optimize the controller if the rotating measurement is not possible.

# 

#### The load falls due to incorrect closed-loop control settings

For encoderless vector control, the converter calculates the actual speed based on an electric motor model. In applications with pulling loads - e.g. hoisting gear, lifting tables or vertical conveyors - an incorrectly set motor model or other incorrect settings can mean that the load falls. A falling load can result in death or serious injury.

- Correctly set the motor data during the quick commissioning.
- Carry out the motor data identification.
- Correctly set the "Motor holding brake" function.
  - Motor holding brake (Page 283)
- For pulling loads, carefully comply with the recommended settings for vector control.
   Advanced settings (Page 358)

## 8.21.2.2 Default setting as a result of the application class Dynamic Drive Control

Selecting application class Dynamic Drive Control in the quick commissioning adapts the structure of the vector control, and reduces the setting options:

|  | Vector control after selecting the ap-<br>plication class Dynamic Drive Control | Vector control without se-<br>lecting an application class |
|--|---|--|
| Closed-loop torque control<br>without higher-level speed<br>controller | Not possible  | Possible   |
| Droop  | Not possible  | Possible   |
| $K_{P}$ - and $T_{I}$ adaptation                                       | Simplified  | Advanced   |
| Hold or set the integral com-<br>ponent of the speed control-<br>ler   | Not possible  | Possible   |
| Acceleration model for pre-<br>control                                 | Default setting   | Can be activated   |
| Motor data identification at standstill or with rotating measurement   | Shortened, with optional transition into operation                              | Complete   |

### 8.21.2.3 Optimizing the speed controller

### Optimum control response - post optimization not required

Preconditions for assessing the controller response:

- The moment of inertia of the load is constant and does not depend on the speed
- The converter does not reach the set torque limits during acceleration
- You operate the motor in the range 40 % ... 60 % of its rated speed

If the motor exhibits the following response, the speed control is well set and you do not have to adapt the speed controller manually:

The speed setpoint (broken line) increases with the set ramp-up time and rounding.

The speed actual value follows the setpoint without any overshoot.

## **Control optimization required**

In some cases, the self optimization result is not satisfactory, or self optimization is not possible as the motor cannot freely rotate.



Initially, the speed actual value follows the speed setpoint with some delay, and then overshoots the speed setpoint.

First, the actual speed value increases faster than the speed setpoint. Before the setpoint reaches its final value, it passes the actual value. Finally, the actual value approaches the setpoint without any significant overshoot.

In the two cases describe above, we recommend that you manually optimize the speed control.

### Optimizing the speed controller

### Requirements

- Torque precontrol is active: p1496 = 100 %.
- The load moment of inertia is constant and independent of the speed.
- The converter requires 10 % ... 50 % of the rated torque to accelerate. When necessary, adapt the ramp-up and ramp-down times of the ramp-function generator (p1120 and p1121).

### Procedure

- 1. Switch on the motor.
- 2. Enter a speed setpoint of approximately 40 % of the rated speed.
- 3. Wait until the actual speed has stabilized.
- 4. Increase the setpoint up to a maximum of 60% of the rated speed.
- 5. Monitor the associated characteristic of the setpoint and actual speed.
- 6. Optimize the controller by adapting the ratio of the moments of inertia of the load and motor (p0342):



- 7. Switch off the motor.
- 8. Set p0340 = 4. The converter again calculates the speed controller parameters.
- 9. Switch on the motor.
- 10. Over the complete speed range check as to whether the speed control operates satisfactorily with the optimized settings.

You have optimized the speed controller.

When necessary, set the ramp-up and ramp-down times of the ramp-function generator (p1120 and p1121) back to the value before optimization.

### Mastering critical applications

The drive control can become unstable for drives with a high load moment of inertia and gearbox backlash or a coupling between the motor and load that can possibly oscillate. In this case, we recommend the following settings:

- Increase p1452 (smoothing the speed actual value).
- Increase p1472 (integral time  $T_i$ ):  $T_i \ge 4 \cdot p1452$
- If, after these measures, the speed controller does not operate with an adequate dynamic performance, then increase p1470 (gain K<sub>P</sub>) step-by-step.

### Parameters

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p0342[M] | Ratio between the total and motor moments of inertia                  | 1               |
| p1452    | Speed controller actual speed value smoothing time (enco-<br>derless) | 10 ms           |
| p1470[D] | Speed controller encoderless operation P gain                         | 0.3             |
| p1472[D] | Speed controller encoderless operation integral time                  | 20 ms           |
| p1496[D] | Acceleration precontrol scaling                                       | 0%              |

Table 8-61 Encoderless speed control

### 8.21.2.4 Advanced settings

### $K_{P}$ - and $T_{I}$ adaptation

 $K_p$  and  $T_1$  adaptation suppress speed control oscillations that may occur. The "rotating measurement" of the motor data identification optimizes the speed controller. If you have performed the rotating measurement, then the  $K_p$ - and  $T_n$  adaptation has been set.
Additional information is provided in the List Manual:

- Vector control with speed controller: Function diagram 6050
- Vector control after presetting the application class Dynamic Drive Control: Function diagram 6824

# **Function description**

For mechanically coupled drives, there is the risk that the drives oppose one another: Small deviations in the speed setpoint or actual value of the coupled drives can mean that the drives are operated with significantly different torques.

The droop function ensures even torque distribution between several mechanically coupled drives.

The droop function reduces the speed setpoint as a function of the torque setpoint.



Figure 8-49 Effect of droop in the speed controller

#### Parameter

| Parameter | Description                          | Factory setting |
|-----------|--------------------------------------|-----------------|
| r1482     | CO: Speed controller I torque output | - Nm            |
| p1486     | Droop compensation torque            | 0               |
| p1487     | Droop compensation torque scaling    | 100.0%          |
| p1488[D]  | Droop input source                   | 0               |
| p1489[D]  | Droop feedback scaling               | 0.05            |
| r1490     | CO: Droop feedback speed reduction   | - rpm           |
| p1492[C]  | BI: Droop feedback enable            | 0               |

When droop is active, the ramp-function generators of all of the coupled drives must be set to have identical ramp-up and ramp-down times as well as rounding-off.

After selecting application class "Dynamic Drive Control", droop is no longer possible.

Additional information is provided in the List Manual, function diagram 6030.

# Overview

### Special settings for a pulling load

For a pulling load, e.g. a hoisting gear, a permanent force is exerted on the motor, even when the motor is stationary.

For a pulling load, we recommend that you use vector control with an encoder.

# **Function description**

If you use sensorless vector control with a pulling load, then the following settings are required:

- Set the following parameters:
- When opening the motor holding brake, enter a speed setpoint > 0. For speed setpoint = 0, and with the motor holding brake open, the load drops because the induction motor rotates with the slip frequency as a result of the pulling load.
- Set the ramp-up and ramp-down times  $\leq 10$  s in the ramp-function generator.
- If, in quick commissioning, you have selected application class Dynamic Drive Control then set p0502 = 1 (technological application: dynamic starting or reversing).

### Parameter

| Parameter | Description                              | Factory setting            |
|-----------|--|----------------------------|
| p1610[D]  | Torque setpoint static (without encoder) | 50%                        |
| p1750[D]  | Motor model configuration                | 0000 0000 0000<br>1100 bin |

# 8.21.2.5 Friction characteristic

### Overview

In many applications, e.g. applications with geared motors or belt conveyors, the frictional torque of the load is not negligible.

The converter provides the possibility of precontrolling the torque setpoint, bypassing the speed controller. The precontrol reduces overshooting of the speed after speed changes.



Figure 8-50 Precontrol of the speed controller with frictional torque

The converter calculates the current frictional torque from a friction characteristic with 10 intermediate points.



Figure 8-51 Friction characteristic

The intermediate points of the friction characteristic are defined for positive speeds. In the negative direction of rotation, the converter uses the intermediate points with a negative sign.

# **Function description**

### **Recording a friction characteristic**

After quick commissioning, the converter sets the speeds of the intermediate points to values suitable for the rated speed of the motor. The frictional torque of all intermediate points is still equal to zero. On request, the converter records the friction characteristic: The converter accelerates the motor step by step up to the rated speed, measures the frictional torque and writes the frictional torque into the intermediate points of the friction characteristic.

### Requirement

The motor is permitted to accelerate up to the rated speed without endangering persons or property.

### Procedure

- 1. Set P3845 = 1: The converter accelerates the motor successively in both directions of rotation and averages the measurement results of the positive and negative directions.
- 2. Switch on the motor (ON/OFF1 = 1).
- The converter accelerates the motor. During measurement, the converter signals the alarm A07961. When the converter has determined all the intermediate points of the friction characteristic without fault code F07963, the converter stops the motor.

You have recorded the friction characteristic.  $\hfill \square$ 

### Adding friction characteristic for the torque setpoint

If you enable the friction characteristic (p3842 = 1), the converter adds the output of the friction characteristic r3841 to the torque setpoint.

### Parameter

| Parameter | Description   | Factory setting |
|-----------|---|-----------------|
| p3820[D]  | Friction characteristic, value n0                   | 15 rpm          |
| p3821[D]  | Friction characteristic, value n1                   | 30 rpm          |
| p3822[D]  | Friction characteristic, value n2                   | 60 rpm          |
| p3823[D]  | Friction characteristic, value n3                   | 120 rpm         |
| p3824[D]  | Friction characteristic, value n4                   | 150 rpm         |
| p3825[D]  | Friction characteristic, value n5                   | 300 rpm         |
| p3826[D]  | Friction characteristic, value n6                   | 600 rpm         |
| p3827[D]  | Friction characteristic, value n7                   | 1200 rpm        |
| p3828[D]  | Friction characteristic, value n8                   | 1500 rpm        |
| p3829[D]  | Friction characteristic, value n9                   | 3000 rpm        |
| p3830[D]  | Friction characteristic, value M0                   | 0 Nm            |
| p3831[D]  | Friction characteristic, value M1                   | 0 Nm            |
| p3832[D]  | Friction characteristic, value M2                   | 0 Nm            |
| p3833[D]  | Friction characteristic, value M3                   | 0 Nm            |
| p3834[D]  | Friction characteristic, value M4                   | 0 Nm            |
| p3835[D]  | Friction characteristic, value M5                   | 0 Nm            |
| p3836[D]  | Friction characteristic, value M6                   | 0 Nm            |
| p3837[D]  | Friction characteristic, value M7                   | 0 Nm            |
| p3838[D]  | Friction characteristic, value M8                   | 0 Nm            |
| p3839[D]  | Friction characteristic, value M9                   | 0 Nm            |
| r3840.08  | CO/BO: Friction characteristic status word          | -               |
| r3841     | CO: Friction characteristic, output                 | - Nm            |
| p3842     | Activate friction characteristic                    | 0               |
| p3845     | Activate friction characteristic plot               | 0               |
| p3846[D]  | Friction characteristic plot ramp-up/ramp-down time | 10 s            |
| p3847[D]  | Friction characteristic plot warm-up period         | 0 s             |

Further information on this topic is provided in the List Manual.

# 8.21.2.6 Moment of inertia estimator

### Overview

From the load moment of inertia and the speed setpoint change, the converter calculates the accelerating torque required for the motor. Via the speed controller precontrol, the accelerating torque specifies the main percentage of the torque setpoint. The speed controller corrects inaccuracies in the precontrol (feed-forward control).



Figure 8-52 Influence of the moment of inertia estimator on the speed control

The more precise the value of the moment of inertia in the converter, the lower the overshoot after speed changes.



Figure 8-53 Influence of the moment of inertia on the speed

# **Function description**

The converter calculates the total moment of inertia of the load and motor. The calculation comprises the following components:

- Current speed
- Actual motor torque
- Reduce the load



Figure 8-54 Overview of the function of the moment of inertia estimator

When using the moment of inertia estimator, we recommend that you also activate the friction characteristic.

Friction characteristic (Page 361)

### How does the converter calculate the load torque?



Figure 8-55 Calculating the load torque

At low speeds, the converter calculates the load torque  $M_L$  from the actual motor torque.

The calculation takes place under the following conditions:

- Speed  $\geq$  p1226
- Acceleration setpoint < 8 1/s<sup>2</sup> (≜ speed change 480 rpm per s)
- Acceleration × moment of inertia (r1493) < 0.9 × p1560





Figure 8-56 Calculating the moment of inertia

For higher speed changes, the converter initially calculates the accelerating torque  $M_B$  as difference between the motor torque  $M_M$ , load torque  $M_L$  and frictional torque  $M_R$ :

### $M_{\rm B} = M_{\rm M} - M_{\rm L} - M_{\rm R}$

Moment of inertia J of the motor and load is obtained from the accelerating torque  $M_B$  and angular acceleration  $\alpha$  ( $\alpha$  = rate at which the speed changes):

 $J = M_B / \alpha$ 

If all of the following conditions are met, the converter calculates the moment of inertia:

- (1) The rated accelerating torque  $M_B$  must satisfy the following two conditions:
  - The sign of  $M_B$  is the same as the direction of the actual acceleration
  - $M_B > p1560 \times rated motor torque (r0333)$
- ② speed > p1755
- The converter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 1/s<sup>2</sup> (≜ speed change 480 rpm per s)

③ The converter calculates the load torque again after acceleration.

#### Moment of inertia precontrol

In applications where the motor predominantly operates with a constant speed, the converter can only infrequently calculate the moment of inertia using the function described above. Moment of inertia precontrol is available for situations such as these. The moment of inertia precontrol assumes that there is an approximately linear relationship between the moment of inertia and the load torque.

Example: For a horizontal conveyor, in a first approximation, the moment of inertia depends on the load.



Figure 8-57 Moment of inertia precontrol

The relationship between load torque and torque is saved in the converter as linear characteristic.

- In a positive direction of rotation: Moment of inertia J =  $p5312 \times load$  torque M<sub>L</sub> + p5313
- In a negative direction of rotation: Moment of inertia J =  $p5314 \times load$  torque M<sub>L</sub> + p5315

You have the following options to determine the characteristic:

- You already know the characteristic from other measurements. In this case, you must set the parameters to known values when commissioning the system.
- The converter iteratively determines the characteristic by performing measurements while the motor is operational.

# Activating the moment of inertia estimator

The moment of inertia estimator is deactivated in the factory setting. p1400.18 = 0, p1400.20 = 0, p1400.22 = 0.

If you performed the rotating measurement for the motor identification during quick commissioning, we recommend leaving the moment of inertia estimator deactivated.

# Requirements

- You have selected sensorless vector control.
- The load torque must be constant whilst the motor accelerates or brakes. Typical of a constant load torque are conveyor applications and centrifuges, for example. Fan applications, for example, are not permitted.
- The speed setpoint is free from superimposed unwanted signals.
- The motor and load are connected to each other with an interference fit. Drives with slip between the motor shaft and load are not permitted, e.g. as a result of loose or worn belts.

If the preconditions are not met, you must not activate the moment of inertia estimator.

# Procedure

- 1. Set p1400.18 = 1
- 2. Check: p1496 ≠ 0
- 3. Activate the acceleration model of the speed controller pre-control: p1400.20 = 1.

You have activated the moment of inertia estimator.

# Parameter

# The most important settings

| Parameter | Description  | Factory setting                                   |
|-----------|--|---|
| r0333[M]  | Rated motor torque                                   | - Nm  |
| p0341[M]  | Motor moment of inertia                              | 0 kgm²  |
| p0342[M]  | Ratio between the total and motor moments of inertia | 1   |
| p1400[D]  | Speed control configuration                          | 0000 0000 0000<br>0000 1000 0000<br>0010 0001 bin |
| r1407.027 | CO/BO: Status word, speed controller                 | -   |
| r1493     | CO: Total moment of inertia, scaled                  | - kgm²  |
| p1496[D]  | Acceleration precontrol scaling                      | 0%  |
| p1498[D]  | Load moment of inertia                               | 0 kgm²  |
| p1502[C]  | BI: Freezing the moment of inertia estimator         | 0   |
| p1755[D]  | Motor model changeover speed encoderless operation   | 210000 rpm  |

# Advanced settings

| Parameter | Description   | Factory setting  |
|-----------|---|------------------|
| p1226[D]  | Speed threshold for standstill detection  | 20 rpm           |
| p1560[D]  | Moment of inertia estimator accelerating torque threshold value                 | 10%              |
| p1561[D]  | Moment of inertia estimator change time moment of inertia                       | 500 ms           |
| p1562[D]  | Inertia estimator, change time, load  | 10 ms            |
| p1563[D]  | CO: Moment of inertia estimator load torque positive direc-<br>tion of rotation | 0 Nm             |
| p1564[D]  | CO: Moment of inertia estimator load torque negative direc-<br>tion of rotation | 0 Nm             |
| p5310[D]  | Moment of inertia precontrol configuration                                      | 0000 bin         |
| r5311[D]  | Moment of inertia precontrol status word  | -                |
| p5312[D]  | Moment of inertia precontrol linear positive                                    | 0 s <sup>2</sup> |
| p5313[D]  | Moment of inertia precontrol constant positive                                  | 0 kgm²           |
| p5314[D]  | Moment of inertia precontrol linear negative                                    | 0 s <sup>2</sup> |
| p5315[D]  | Moment of inertia precontrol constant negative                                  | 0 kgm2           |

# 8.21.3 Torque control

### Overview

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 converter then no longer controls the motor speed, but the torque that the motor generates.



Figure 8-58 Simplified function diagram of the closed-loop torque control

# **Function description**

### 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 follower drives: The master drive is speed controlled, the follower drive is torque controlled.
- Winding machines

### The most important settings

Preconditions for the correct functioning of the torque control:

- You have set the motor data correctly during the quick commissioning
   Commissioning (Page 147)
- You have performed a motor data identification on the cold motor

# Parameter

| Parameter   | Description   | Factory setting |
|-------------|---|-----------------|
| p0300 p0360 | <b>Motor data</b> is transferred from the motor type plate during quick commissioning and calculated with the motor data identification | -               |
| p1300[D]    | Open-loop/closed-loop control operating mode  | 0               |
| p1511[C]    | CI: Supplementary torque 1  | 0               |
| p1520[D]    | CO: Torque limit, upper   | 0 Nm            |
| p1521[D]    | CO: Torque limit, lower   | 0 Nm            |
| p1530[D]    | Power limit, motoring   | 0 kW            |
| p1531[D]    | Power limit, generating   | -0.01 kW        |

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

# 8.21.4 Application examples for closed-loop motor control

Additional information for setting the closed-loop motor control in certain applications is provided in the Internet:

- C Engineering and commissioning series lifting equipment/cranes (<u>https://support.industry.siemens.com/cs/de/en/view/103156155</u>)
- Commissioning a compressor with closed-loop pressure control (<u>https://</u> <u>support.industry.siemens.com/cs/ww/en/view/77491582</u>)

# 8.22 Electrically braking the motor

# Overview



# Braking with the motor in generating mode

If the motor brakes the connected load electrically, it converts the kinetic energy of the motor into electrical energy. The electrical energy E released when braking the load is proportional to the moment of inertia J of the motor and load and to the square of the speed n. The motor attempts to transfer the energy on to the converter.

# Main features of the braking functions

# DC braking

DC braking prevents the motor from transferring braking energy to the converter. The converter impresses a DC current into the motor, therefore braking the motor. The motor converts braking energy E of the load into heat.

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

### **Compound braking**

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

# **Dynamic braking**

Using a braking resistor, the converter converts the electrical energy into heat.

- *Advantages:* Defined braking response; motor temperature does not increase any further; constant braking torque
- *Disadvantages:* Braking resistor required; braking energy E is lost in the form of heat





# Braking with energy recovery into the line supply

The converter feeds electrical energy back into the line supply (energy recovery).

- Advantages: Constant braking torque; the braking energy E is not completely converted into heat, but regenerated back into the line supply; suitable for all applications; continuous regenerative operation is possible - e.g. when lowering a suspended load
- Disadvantage: Does not function with a power failure



# Which Power Module permits which braking method?

| Electrical braking method                         | Power Modules that can be used |  |
|---|--------------------------------|--|
| DC braking, compound braking                      | PM240-2, PM240P-2              |  |
| Dynamic braking                                   | PM240-2                        |  |
| Braking with energy recovery into the line supply | PM250                          |  |

# 8.22.1 DC braking

### Overview

DC braking is used for applications where the motor must be actively braked, but where the converter is neither capable of energy recovery nor does it have a braking resistor.

Typical applications for DC braking include:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

DC braking is not permissible in applications involving suspended loads, e.g. lifting equipment/cranes and vertical conveyors.

# Requirement

The DC braking function is possible only for induction motors.

### NOTICE

### Motor overheating as a result of DC braking

The motor will overheat if you use DC braking too frequently or use it for too long. This may damage the motor.

- Monitor the motor temperature.
- Allow the motor to adequately cool down between braking operations.
- If necessary, select another motor braking method.

# **Function description**

With DC braking, a constant braking current flows through the motor. As long as the motor is rotating, the DC current generates a braking torque.

The following configurations are available for DC braking:

- DC braking initiated by a control command
- DC braking when falling below a starting speed
- DC braking when the motor is switched off

Regardless of the configuration, you also can define the DC braking as a reaction to certain converter faults.

# MARNING

### Unexpected motor acceleration

In the following configurations, the converter can accelerate the motor to the set speed without requiring a further ON command:

- DC braking initiated by a control command

- DC braking when falling below a starting speed

An unexpected acceleration of the motor can cause serious injury or material damage.

• Consider the behavior of the drive in the higher-level controller.

### DC braking initiated by a control command



Figure 8-59 Activating DC braking via a control command

Set p1231 = 4 and p1230 = control command.

The control command "DC braking activation" activates and deactivates the DC braking:

• 1 signal:

The converter de-energizes the motor for the motor de-excitation time p0347 in order to demagnetize the motor.

The converter activates the DC braking.

• 0 signal: The drive switches back to normal operation.

### DC braking when falling below a starting speed



Figure 8-60 DC braking when falling below a starting speed

Set p1231 = 14 and p1230 = control command.

With an active DC braking command (p1230 = 1 signal), the following occurs:

- If motor speed < starting speed p1234: The converter de-energizes the motor for the motor de-excitation time p0347 in order to demagnetize the motor.
- 2. The converter activates the DC braking.
- 3. The drive switches back to normal operation if at least one of the following conditions has been fulfilled:
  - "DC braking duration" p1233 has expired.
  - The DC braking command is inactive (p1230 = 0 signal).

#### DC braking when the motor is switched off



Figure 8-61 DC braking when the motor is switched off Set p1231 = 5.

The following occurs after an OFF1 or OFF3 command:

- 1. The motor brakes along the OFF1 or OFF3 deceleration ramp to starting speed p1234.
- 2. The converter de-energizes the motor for the motor de-excitation time p0347 in order to demagnetize the motor.
- 3. The converter activates the DC braking.
- 4. After "DC braking duration" p1233 expires, the converter de-energizes the motor.

If the OFF1 command is deactivated before "DC braking duration" p1233 expires, the converter terminates the DC braking and switches to normal operation.

### DC braking as reaction to a fault



Figure 8-62 DC braking as a fault reaction

Set p2101[x] = 6 and p2100[x] to the corresponding fault code.

If you have defined the DC braking as a reaction to a fault, then the following will occur:

- 1. The converter brakes the motor with OFF1.
- 2. The converter de-energizes the motor for the motor de-excitation time p0347 in order to demagnetize the motor.
- 3. The converter activates the DC braking.
- 4. After "DC braking duration" p1233 expires, the converter de-energizes the motor.

### Parameter

#### Settings for DC braking

| Parameter  | Description                      | Factory setting |
|------------|----------------------------------|-----------------|
| p0347[M]   | Motor de-excitation time         | 0 s             |
| p1230[C]   | BI: DC braking activation        | 0               |
| p1231[M]   | Configuring DC braking           | 0               |
| p1232[M]   | DC braking, braking current      | 0 Arms          |
| p1233[M]   | DC braking duration              | 1 s             |
| p1234[M]   | Speed at the start of DC braking | 210000 rpm      |
| r1239[813] | CO/BO: DC braking status word    | -               |

| Parameter  | Description                             | Factory setting |
|------------|---|-----------------|
| p2100[019] | Changing the fault reaction, fault code | 0               |
| p2101[019] | Changing the fault reaction, reaction   | 0               |

### Table 8-62 Configuring DC braking as a response to faults

# 8.22.2 Compound braking

### Overview

Compound braking is suitable for applications in which the motor is normally operated at a constant speed and is only braked down to standstill in longer time intervals.

Typically, the following applications are suitable for compound braking:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

Compound braking is not permissible for applications with suspended loads, e.g. lifting equipment/cranes all vertical conveyors.

# **Function description**



Figure 8-63 Motor brakes with and without active compound braking

Compound braking prevents the DC-link voltage increasing above a critical value. The converter activates compound braking depending on the DC-link voltage. Above a DC-link voltage threshold (r1282), the converter adds a DC current to the motor current. The DC current brakes the motor and prevents an excessive increase in the DC-link voltage.

### Note

Compound braking is possible only with the U/f control.

Compound braking does not operate in the following cases:

- The "flying restart" function is active
- DC braking is active
- Vector control is selected

#### NOTICE

# Overheating of the motor due to compound braking

The motor will overheat if you use compound braking too frequently or for too long. This may damage the motor.

- Monitor the motor temperature.
- Allow the motor to adequately cool down between braking operations.
- If necessary, select another motor braking method.

# Parameter

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| r1282     | Vdc_max controller switch-on level (U/f)                   | - V             |
| p3856[D]  | Compound braking current (%)                               | 0%              |
| r3859.0   | CO/BO: Compound braking/equal quantity control status word | -               |

### Table 8-63 Setting and enabling compound braking

# 8.22.3 Dynamic braking

# Overview

Dynamic braking processes the regenerative power that occurs during braking of the motor. In this way, the converter can accelerate and brake the motor with the same dynamic response.

The following are typical applications for dynamic braking:

- Centrifuge
- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

# Requirement

You are using a PM240-2 power module and a braking resistor.

# **Function description**



The motor supplies regenerative power to the converter when braking. The regenerative power means that the DC-link voltage in the converter increases. Above the activation threshold for the braking module, the converter forwards the regenerative power to the braking resistor. The braking resistor converts the regenerative power into heat, thereby preventing converter faults due to excessive DC-link voltage.

Factory setting for the activation threshold for the braking module:

- 690 V converter: 1120 V
- 400 V converters: 760 V
- 200 V converter: 385 V

# NOTICE

#### Overload of motor insulation during braking

When the motor brakes, the DC-link voltage, and thus also the voltage load of the motor, increases. Particularly when you operate a 500 V motor on a 690 V converter, the converter can overload the motor insulation and damage the motor.

• Reduce the activation threshold for the braking module

#### Procedure

#### 1. Setting the braking power

Using p0219, you define the maximum braking power that the braking resistor must absorb.



P<sub>max</sub> Maximum braking power of the braking resistor

p021 Maximum braking power of the application

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Figure 8-65 Example of maximum braking power in an application

p0219 > 0 activates dynamic braking. Boundary conditions for p0219:

- p0219 is too low:

The converter cannot fully convert the generated braking power into heat. The converter extends the ramp-down time of the motor in order to reduce the braking power.

p0219 > maximum braking power of the braking resistor:
 The temperature monitoring of the braking resistor can trigger a converter fault.
 Monitoring the temperature of the braking resistor (Page 146)

You can find the maximum braking power of the braking resistor in the Hardware Installation Manual of the power module.

Overview of the manuals (Page 564)

The SIZER PC tool supports you when calculating the maximum braking power.

2. If necessary: Reduce the activation threshold for the braking module

You can reduce the activation threshold for the braking module for the following converters:

- 690 V converter
- 400 V converter

We recommend the following settings, particularly when using a 500 V motor:

- Set p0212.8 = 1
- Enter the rated value of the converter supply voltage in p0210.
   Enter the voltage value at the intended place of use of the converter, if known, in p0210.

You have now set the dynamic braking.  $\hfill\square$ 

# Example

You can find an example for configuring and commissioning a drive with braking resistor on the Internet:

Engineering and commissioning series lifting equipment/cranes (<u>https://support.industry.siemens.com/cs/de/en/view/103156155</u>)

# Parameters

| Parameter | Description                           | Factory setting |
|-----------|---------------------------------------|-----------------|
| r0063     | CO: Actual speed value                | - rpm           |
| r0070     | CO: Actual DC link voltage value      | - V             |
| p0210     | Device supply voltage                 | 400 V           |
| p0212     | Power unit configuration              | 0000 0000 bin   |
| p0219     | Braking resistor braking power        | 0 kW            |
| r0297     | DC-link voltage overvoltage threshold | - V             |

# **Further information**

# Interaction with other functions

When you set the braking power of the braking resistor (p0219 > 0), the converter disables the Vdc\_max control.

Motor and converter protection by limiting the voltage (Page 395)

At the same time, p0219 defines the regenerative power limit p1531 for vector control.

Structure of vector control without encoder (sensorless) (Page 354)

# 8.22.4 Braking with regenerative feedback to the line

# Overview

The typical applications for braking with energy recovery (regenerative feedback into the line supply) are as follows:

- Hoist drives
- Centrifuges
- Unwinders

For these applications, the motor must brake for longer periods of time.

The converter can feed back up to 100% of its rated power into the line supply (referred to "High Overload" base load).

Technical data, PM250 Power Module (Page 537)

# Parameter

### Setting the braking with regenerative feedback to the line

| Parameter   | Description             | Factory setting |
|---|-------------------------|-----------------|
| Limiting the regenerative feedback for U/f control (p1300 < 20) |                         |                 |
| p0640[D]  | Current limit           | 0 Arms          |
| Limiting feedback with vector control (p1300 ≥ 20)              |                         |                 |
| p1531[D]  | Power limit, generating | -0.01 kW        |

8.23 Overcurrent protection

# 8.23 Overcurrent protection

### Overview



The U/f control prevents too high a motor current by influencing the output frequency and the motor voltage (I-max controller).

### Requirement

You have selected U/f control.

The application must allow the motor torque to decrease at a lower speed.

### **Function description**

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

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

If the motor load is so high during steady-state operation that the motor current reaches the current limit, then the I-max controller reduces the speed and the motor voltage until the motor current returns to the permissible range again.

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

### Changing the settings

The factory setting for proportional gain and the integral time of the I-max controller ensures faultless operation in the vast majority of cases.

The factory setting of the I-max controller must only be changed in the following exceptional cases:

- Speed or torque of the motor tend to cause vibrations upon reaching the current limit.
- The converter goes into the fault state with an overcurrent message.

### Parameter

| Number     | Name   | Factory setting |
|------------|--|-----------------|
| r0056.0 13 | CO/BO: Status word, closed-loop control      | -               |
| p0305[M]   | Rated motor current                          | 0 Arms          |
| p0640[D]   | Current limit                                | 0 Arms          |
| p1340[D]   | I_max frequency controller proportional gain | 0               |
| p1341[D]   | I_max frequency controller integral time     | 0.300 s         |
| r1343      | CO: I_max controller frequency output        | - rpm           |

# 8.24 Converter protection using temperature monitoring

# Overview



The converter temperature is essentially defined by the following effects:

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

# **Monitoring types**

The converter monitors its temperature using the following monitoring types:

- I<sup>2</sup>t monitoring (alarm A07805, fault F30005)
- Measuring the chip temperature of the Power Module (alarm A05006, fault F30024)
- Measuring the heat sink temperature of the Power Module (alarm A05000, fault F30004)

# **Function description**

# Overload response for p0290 = 0

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

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

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

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

### Overload response for p0290 = 1

The converter immediately switches off the motor with fault F30024.

# Overload response for p0290 = 2

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

### 8.24 Converter protection using temperature monitoring

The converter responds in 2 stages:

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

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





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

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

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

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

### Overload response for p0290 = 3

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

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

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

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

### 8.24 Converter protection using temperature monitoring

### Overload response for p0290 = 12

The converter responds in 2 stages:

- If you operate the converter with increased pulse frequency setpoint p1800, then the converter reduces its pulse frequency starting at p1800. There is no current derating as a result of the higher pulse frequency setpoint. Once the overload condition has been removed, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.
- 2. If it is not possible to temporarily reduce the pulse frequency, or the risk of converter thermal overload cannot be prevented, then stage 2 follows:
  - In vector control, the converter reduces the output current.
  - In U/f control, the converter reduces the speed.

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

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

### Overload response for p0290 = 13

We recommend this setting for drives with a high starting torque.

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

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

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

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

# Parameters

| Number     | Name                                   | Factory setting     |
|------------|--|---------------------|
| r0036      | CO: Power unit overload I2t            | %                   |
| r0037[019] | Power unit temperatures                | °C                  |
| p0290      | Power unit overload response           | 2                   |
| p0292[01]  | Power unit temperature alarm threshold | [0] 5 °C, [1] 15 °C |
| p0294      | Power Module alarm for I2t overload    | 95%                 |

8.25 Motor protection with temperature sensor

# 8.25 Motor protection with temperature sensor

### Overview



The converter can evaluate one of the following sensors to protect the motor against overtemperature:



# Function description

### **KTY84** sensor

### NOTICE

Overheating of the motor due to KTY sensor connected with the incorrect polarity

If a KTY sensor is connected with incorrect polarity, the motor can be damaged by overheating, as the converter cannot detect a motor overtemperature condition.

• Connect the KTY sensor with the correct polarity.



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

 Temperature monitoring: The converter uses a KTY sensor to evaluate the motor temperature in the range from -48 °C ... +248 °C.

Set the temperature for the alarm and fault thresholds with parameter p0604 or p0605.

- Overtemperature alarm (A07910):
   motor temperature > p0604 and p0610 = 0
- Overtemperature fault (F07011): The converter responds with a fault in the following cases:
  - motor temperature > p0605
  - motor temperature > p0604 and p0610 > 0
- Sensor monitoring (A07015 or F07016):
  - Wire-break:

The converter interprets a resistance > 2120  $\Omega$  as a wire-break and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

- Short-circuit:

The converter interprets a resistance < 50  $\Omega$  as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

#### 8.25 Motor protection with temperature sensor

### **Temperature switch**



The converter interprets a resistance  $\ge 100 \Omega$  as an opened bimetallic switch and responds according to the setting for p0610.

### PTC sensor



The converter interprets a resistance > 1650  $\Omega$  as being an overtemperature condition and responds according to the setting of p0610.

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

### Pt1000 sensor



Using a Pt1000 sensor, the converter monitors the motor temperature and the sensor itself for wire breakage and/or short-circuit:

 Temperature monitoring: Using a Pt1000 sensor, the converter evaluates the motor temperature in the range from -48 °C ... +248 °C.

Set the temperature for the alarm and fault thresholds with parameter p0604 or p0605.

- Overtemperature alarm (A07910):
   motor temperature > p0604 and p0610 = 0
- Overtemperature fault (F07011): The converter responds with a fault in the following cases:
  - motor temperature > p0605
  - motor temperature > p0604 and p0610 > 0
- Sensor monitoring (A07015 or F07016):
  - Wire-break:

The converter interprets a resistance > 2120  $\Omega$  as a wire-break and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

– Short-circuit:

The converter interprets a resistance < 603  $\Omega$  as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

# Parameters

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p0335[M] | Type of motor cooling                                   | 0               |
| p0601[M] | Motor temperature sensor type                           | 0               |
| p0604[M] | Mot_temp_mod 2/sensor alarm threshold                   | 130 °C          |
| p0605[M] | Mot_temp_mod 1/2/sensor threshold and temperature value | 145 °C          |
| p0610[M] | Motor overtemperature response                          | 12              |
| p0640[D] | Current limit   | 0 Arms          |

8.26 Motor protection by calculating the temperature

# 8.26 Motor protection by calculating the temperature

### Overview



The converter calculates the motor temperature based on a thermal motor model. After commissioning, the converter sets the thermal motor type to match the motor.

The thermal motor model responds far faster to temperature increases than a temperature sensor.

If the thermal motor model is used together with a temperature sensor, e.g. a Pt1000, then the converter corrects the model according to the measured temperature.

# **Function description**

### Thermal motor model 2 for induction motors

The thermal motor model 2 for induction motors is a thermal 3-mass model, consisting of stator core, stator winding and rotor. Thermal motor model 2 calculates the temperatures - both in the rotor as well as in the stator winding.



Figure 8-67 Thermal motor model 2 for induction motors

# Parameter

| Table 8-64 Therm | al motor model 2 | for induction | motors |
|------------------|------------------|---------------|--------|
|------------------|------------------|---------------|--------|

| Number     | Name  | Factory setting            |
|------------|---|----------------------------|
| r0068[0 1] | CO: Absolute actual current value                       | - Arms                     |
| p0344[M]   | Motor weight (for thermal motor model)                  | 0 kg                       |
| p0604[M]   | Mot_temp_mod 2/KTY alarm threshold                      | 130 °C                     |
| p0605[M]   | Mot_temp_mod 1/2/sensor threshold and temperature value | 145 °C                     |
| p0610[M]   | Motor overtemperature response                          | 12                         |
| p0612[M]   | Mot_temp_mod activation                                 | 0000 0010 0000<br>0010 bin |
| p0625[M]   | Motor ambient temperature during commissioning          | 20 °C                      |
| p0627[M]   | Motor overtemperature, stator winding                   | 80 K                       |
| r0632[M]   | Mot_temp_mod stator winding temperature                 | - °C                       |
| p0640[D]   | Current limit   | 0 Arms                     |

# 8.26 Motor protection by calculating the temperature

# Thermal motor model 1 for synchronous motors

Further information about thermal motor model 1 for synchronous motors is provided in the function charts 8016 and 8017 of the List Manual.

8.27 How do I achieve a motor overload protection in accordance with IEC/UL 61800-5-1?

# 8.27 How do I achieve a motor overload protection in accordance with IEC/UL 61800-5-1?

# Overview

The thermal motor model of the converter fulfills motor overload protection according to IEC/ UL 61800-5-1.

For motor overload protection according to IEC/UL 61800-5-1, some parameters of the thermal motor model may also need to be adjusted.

### Requirement

You have correctly entered the motor data during quick commissioning.

### NOTICE

### Thermal overload of third-party motors due to a trip threshold that is too high

With a Siemens motor, the converter sets the trip threshold of the thermal motor model to match the motor. With a third-party motor, the converter cannot ensure in every case that the trip threshold is exactly right for the motor. A trip threshold that is set too high can lead to a thermal overload, thus causing damage to the motor.

• If required for a third-party motor, reduce the corresponding trip threshold p0605, p0615, or p5391.

### Procedure

- 1. Set p0610 = 12.
- 2. Set the following parameters depending on the motor:
  - Induction motor:
     p0612.1 = 1
     p0612.9 = 1
     For a motor without temperature sensor: p0625 = 40 °C
  - Synchronous motor
     p0612.0 = 1
     p0612.8 = 1
     For a motor without temperature sensor: p0613 = 40 °C

The trip threshold p0605, p0615 or p5391 parameterized in the motor data set may not be increased.

Changing additional parameters of the thermal motor model can lead to the converter no longer satisfying the motor overload protection in accordance with IEC/UL 61800-5-1.
# 8.28 Motor and converter protection by limiting the voltage

# Overview

An electric motor converts electrical energy into mechanical energy to drive the load. If the motor is driven by its load, e.g. by the inertia of the load during braking, the energy flow reverses: The motor operates temporarily as a generator, and converts mechanical energy into electrical energy. The electrical energy flows from the motor to the converter. If the converter cannot output the electrical energy supplied by the motor, e.g. to a braking resistor, then the converter stores the energy in its DC link capacitance. As a consequence, the DC link voltage Vdc in the converter is higher.

An excessively high DC link voltage damages both the converter and the motor. The converter therefore monitors its DC-link voltage and, when necessary, switches off the connected motor and outputs the fault "DC-link overvoltage".

# **Function description**



### Protecting the motor and converter against overvoltage

Figure 8-68 Simplified representation of the Vdc\_max control

The Vdc\_max control lengthens the motor ramp-down time when braking. Consequently, the motor feeds only so much energy back into the converter to cover the losses in the converter. The DC link voltage remains within the permissible range.

The Vdc\_max control is not suitable for applications where the motor is in continuous regenerative operation, e.g. as is the case for cranes and centrifuges.

Electrically braking the motor (Page 372)

#### 8.28 Motor and converter protection by limiting the voltage

The Vdc\_max control can be used only with the PM230, PM240-2 and PM240P-2 Power Modules. The Vdc\_max control is not required if you use a braking resistor.

PM250 Power Modules feed back regenerative energy into the line supply. Therefore, the Vdc\_max control is not required for a PM250 Power Module.

### Parameter

The parameters differ depending on the motor control mode.

| Parameter | Description   | Factory setting |
|-----------|---|-----------------|
| p0210     | Device supply voltage                                 | 400 V           |
| p1280[D]  | Vdc controller configuration (U/f)                    | 1               |
| r1282     | Vdc_max controller switch-on level (U/f)              | - V             |
| p1283[D]  | Vdc_max controller, dynamic factor (U/f)              | 100%            |
| p1284[D]  | Vdc_max controller time threshold (U/f)               | 4 s             |
| p1290[D]  | Vdc controller proportional gain (U/f)                | 1               |
| p1291[D]  | Vdc controller integral time (U/f)                    | 40 ms           |
| p1292[D]  | Vdc controller derivative-action time (U/f)           | 10 ms           |
| p1294     | Vdc_max controller automatic ON level detection (U/f) | 0               |

Table 8-65 Parameters for U/f control

| Table 8-66 | Parameters f | or vector | control |
|------------|--------------|-----------|---------|
|------------|--------------|-----------|---------|

| Parameter | Description                                     | Factory setting |
|-----------|---|-----------------|
| p0210     | Device supply voltage                           | 400 V           |
| p1240[D]  | Vdc controller configuration (vector control)   | 1               |
| r1242     | Vdc_max controller switch-in level              | - V             |
| p1243[D]  | Vdc_max controller, dynamic factor              | 100%            |
| p1250[D]  | Vdc controller proportional gain                | 1               |
| p1251[D]  | Vdc controller integral time                    | 0 ms            |
| p1252[D]  | Vdc controller derivative-action time           | 0 ms            |
| p1254     | Vdc_max controller automatic ON level detection | 0               |

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



In many applications, the speed and the torque of the motor can be used to determine whether the driven load is in an impermissible operating state. The use of an appropriate monitoring function in the converter prevents failures and damage to the machine or plant.

Examples:

- For fans or conveyor belts, an excessively low torque can mean a broken drive belt.
- For pumps, insufficient torque can indicate a leakage or dry-running.
- For extruders and mixers, an excessive torque together with low speed can indicate machine blockage.

# Functions for monitoring the driven load

The converter provides the following options to monitor the driven load based on the output current:

|                                       | The stall protection recognizes a stalled asynchronous motor.  |
|---------------------------------------|--|
|                                       | The no-load monitoring evaluates the motor current. An insufficient current can mean that the motor cable is disconnected.   |
| A A A A A A A A A A A A A A A A A A A | The blocking protection triggers for a motor current that corresponds to the set current limit coupled with motor standstill.  |
|                                       | The torque monitoring assumes that a specific torque is associated with each speed for pumps and fans. Insufficient torque indicates that the motor and the load are no longer mechanically connected. |
|                                       | An excessive torque can indicate problems in the mechanical system of the driven load, e.g. a mechanically blocked load.   |
|                                       | Blocking protection, leakage protection and dry-running protection are a monitor-<br>ing method for pumps or fans. The monitoring combines a torque monitoring with<br>a blocking protection.          |

Monitoring the driven load using a binary signal:



# 8.29.1 Stall protection

# **Function description**



If the load of a standard induction motor exceeds the stall torque of the motor, the motor can also stall during operation on the converter. A stalled motor is stationary and does not develop sufficient torque to accelerate the load.

If the "Motor model fault signal stall detection" r1746 for the time p2178 is present via the "Motor model error threshold stall detection" p1745, the converter signals "Motor stalled" and fault F07902.

### Parameter

| Number      | Name  | Factory setting |
|-------------|---|-----------------|
| r1408[0 14] | CO/BO: Status word, current controller      | -               |
| p1745[D]    | Motor model error threshold stall detection | 5%              |
| r1746       | Motor model fault signal stall detection    | - %             |
| p2178[D]    | Motor stalled delay time                    | 0.01 s          |
| r2198       | CO/BO: Status word monitoring functions 2   | -               |

### See also

Blocking protection (Page 399)

# 8.29.2 No-load monitoring

### **Function description**



An insufficient motor current indicates that the motor cable is disconnected.

If the motor current for the time p2180 lies below the current level p2179, the converter signals the alarm A07929.

### Parameters

| Number      | Name                                      | Factory setting |
|-------------|---|-----------------|
| r0068[0 1]  | CO: Absolute actual current value         | - Arms          |
| p2179[D]    | Output load detection current limit       | 0 Arms          |
| p2180[D]    | Output load detection delay time          | 2000 ms         |
| r2197[0 13] | CO/BO: Status word monitoring functions 1 | -               |

# 8.29.3 Blocking protection

# **Function description**



If the mechanical load is too high, the motor may block. For a blocked motor, the motor current corresponds to the set current limit without the speed reaching the specified setpoint.

If the speed lies below the speed threshold p2175 for the time p2177 while the motor current reaches the current limit, the converter signals "Motor blocked" and fault F07900.

# Parameter

| Number   | Name                                      | Factory settings |
|----------|---|------------------|
| p0045    | Display values of smoothing time constant | 4 ms             |
| r0063    | CO: Speed actual value                    | - rpm            |
| p2175[D] | Motor blocked speed threshold             | 120 rpm          |
| p2177[D] | Motor blocked delay time                  | 3 s              |
| r2198    | Status word monitoring functions 2        | -                |

# 8.29.4 Torque monitoring

# **Function description**



In applications with fans, pumps or compressors with the flow characteristic, the torque follows the speed according to a specific characteristic. An insufficient torque for fans indicates that the power transmission from the motor to the load is interrupted. For pumps, insufficient torque can indicate a leakage or dry-running.

The converter monitors the torque based on the envelope curve depending on the speed against a lower and upper torque.



If the torque lies in the impermissible range longer than time p2192, the converter reacts as specified in p2181.

The monitoring is not active below speed threshold 1 and above speed threshold 3.

### Setting monitoring

- 1. Operate the drive at three different speeds in succession.
- 2. Set the speed thresholds p2182 ... p2184 to the respective values.
- 3. Set the torque thresholds for each speed. The converter displays the current torque in r0031.
- 4. Set p2193 = 1.

You have now set monitoring.

### Parameter

| Number   | Name                               | Factory setting |
|----------|------------------------------------|-----------------|
| r0031    | Torque actual value, smoothed      | -               |
| p2181[D] | Load monitoring, response          | 0               |
| p2182[D] | Load monitoring, speed threshold 1 | 150 rpm         |
| p2183[D] | Load monitoring, speed threshold 2 | 900 rpm         |
| p2184[D] | Load monitoring, speed threshold 3 | 1500 rpm        |

| Number   | Name                                       | Factory setting |
|----------|--|-----------------|
| p2185[D] | Load monitoring, torque threshold 1, upper | 10000000 Nm     |
| p2186[D] | Load monitoring torque threshold 1, lower  | 0 Nm            |
| p2187[D] | Load monitoring torque threshold 2, upper  | 10000000 Nm     |
| p2188[D] | Load monitoring torque threshold 2, lower  | 0 Nm            |
| p2189[D] | Load monitoring torque threshold 3, upper  | 10000000 Nm     |
| p2190[D] | Load monitoring torque threshold 3, lower  | 0 Nm            |
| p2191[D] | Load monitoring torque threshold, no load  | 0 Nm            |
| p2192[D] | Load monitoring, delay time                | 10 s            |
| p2193[D] | Load monitoring configuration              | 1               |

# 8.29.5 Blocking protection, leakage protection and dry-running protection

### Overview



In applications with fans, pumps or compressors with the flow characteristic, the torque follows the speed according to a specific characteristic. An insufficient torque for fans indicates that the power transmission from the motor to the load is interrupted. For pumps, insufficient torque can indicate a leakage or dry-running.

# **Function description**



If the torque and speed lie in the impermissible range longer than time p2192, the converter reacts as specified in p2181.

For applications with pumps, the converter detects the following states of the driven load:

- Blocked
- Leakage
- Dry running

For applications with fans or compressors, the converter detects the following states of the driven load:

- Blocked
- Torn belt

The monitoring is not active below speed threshold 1 and above speed threshold 3.

When using the control mode "U/f control" (p1300 < 10), the "Blocking protection" function becomes active when the current limit is reached.

No-load monitoring (Page 398)

# Setting pump monitoring

- 1. Set p2193 = 4.
- 2. The converter sets the monitoring as shown.



p2183 = (p1080+p1082)/2

#### Figure 8-69 Default settings for pumps

- 3. The converter sets monitoring response p2181 = 7
- 4. If necessary, adjust the speed thresholds p2182 ... p2184.
- 5. If necessary, adjust the torque threshold for each speed. The converter displays the current torque in r0031.

You have now set monitoring.

#### Setting fan and compressor monitoring

- 1. Set p2193 = 5.
- 2. The converter sets the monitoring as shown.





3. The converter sets monitoring response p2181 = 7

- 4. If necessary, adjust the speed thresholds p2182 ... p2184.
- 5. Set the torque threshold for each speed. The converter displays the current torque in r0031.

You have now set monitoring.

### Parameter

| Number   | Name   | Factory setting    |
|----------|--|--------------------|
| r0031    | Torque actual value, smoothed                        | -                  |
| p0311[M] | Rated motor speed                                    | 0 rpm              |
| r0333[M] | Rated motor torque                                   | -                  |
| p1080[D] | Minimum speed  | 0 rpm              |
| p1082[D] | Maximum speed  | 1500 rpm           |
| p1300[D] | Open-loop/closed-loop control operating mode         | See parameter list |
| p2165[D] | Load monitoring blocking monitoring threshold, upper | 0 rpm              |
| p2168[D] | Load monitoring blocking monitoring torque threshold | 10000000 Nm        |
| p2181[D] | Load monitoring, response                            | 0                  |
| p2182[D] | Load monitoring, speed threshold 1                   | 150 rpm            |
| p2183[D] | Load monitoring, speed threshold 2                   | 900 rpm            |
| p2184[D] | Load monitoring, speed threshold 3                   | 1500 rpm           |
| p2186[D] | Load monitoring torque threshold 1, lower            | 0 Nm               |
| p2188[D] | Load monitoring torque threshold 2, lower            | 0 Nm               |
| p2190[D] | Load monitoring torque threshold 3, lower            | 0 Nm               |
| p2191[D] | Load monitoring torque threshold, no load            | 0 Nm               |
| p2192[D] | Load monitoring, delay time                          | 10 s               |
| p2193[D] | Load monitoring configuration                        | 1                  |

# **Further information**

If you deselect monitoring with p2193 < 4, the converter then resets the load monitoring parameters to factory settings.

# See also

Torque monitoring (Page 400)

# 8.29.6 Rotation monitoring

## **Function description**



The converter monitors the speed or velocity of a machine component via an electromechanic or electronic encoder, e.g. a proximity switch. Examples of how the function can be used:

- · Gearbox monitoring for traction drives and hoisting gear
- Drive belt monitoring for fans and conveyor belts
- Blocking protection for pumps and conveyor belts

The converter checks whether the encoder consistently supplies a 24 V signal during motor operation. If the encoder signal fails for time p2192, the converter signals fault F07936.



Figure 8-71 Function plan and time response of the speed monitoring

### Parameter

| Parameter | Description                            | Factory setting |
|-----------|--|-----------------|
| r0722     | CO/BO: CU digital inputs, status       | -               |
| p2192[D]  | Load monitoring, delay time            | 10 s            |
| p2193[D]  | Load monitoring configuration          | 1               |
| p3232[C]  | BI: Load monitoring, failure detection | 1               |

Additional information is provided in the List Manual (the parameter list and function diagram 8013).

# **Function diagrams**

Torque monitoring (Page 400)

# 8.29.7 Speed deviation monitoring



The converter calculates and monitors the speed or velocity of a machine component.

Examples of how the function can be used:

- Gearbox monitoring for traction drives and hoisting gear
- Drive belt monitoring for fans and conveyor belts
- Blocking protection for conveyor belts

You need an electronic sensor, e.g. a proximity switch, for the "Speed monitoring" function. The converter analyzes an encoder signal at max. 32 kHz.

The function is only available with the CU240E-2 Control Unit via digital input DI 3.



Figure 8-72 Speed deviation monitoring

# **Function description**



Figure 8-73 Time response of the speed monitoring

The converter compares speed r0586 with the actual speed value r2169 and signals an excessive deviation between the encoder signal and the motor speed. p2181 specifies the converter response for an excessive deviation.

<sup>1)</sup> The "Probe" subfunction calculates the speed from the pulse signal of the digital input.

Additional information is provided in the List Manual (the parameter list and function diagram 8013).

# Parameter

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| p0490     | Invert measuring probe <sup>1)</sup>                   | 0000 bin        |
| p0580     | Measuring probe input terminal <sup>1)</sup>           | 0               |
| p0581     | Measuring probe signal edge 1)                         | 0               |
| p0582     | Measuring probe pulses per revolution <sup>1)</sup>    | 1               |
| p0583     | Maximum measuring probe measurement time <sup>1)</sup> | 10 s            |
| p0585     | Measuring probe gear ratio <sup>1)</sup>               | 1               |
| r0586     | CO: Measuring probe speed actual value 1)              | - rpm           |
| r2169     | CO: Actual speed value smoothed messages               | - rpm           |
| p2181[D]  | Load monitoring, response                              | 0               |
| p2192     | Load monitoring, delay time                            | 10 s            |
| p2193[D]  | Load monitoring configuration                          | 1               |
| p3230[C]  | CI: Load monitoring, speed actual value                | 0               |
| p3231[D]  | Load monitoring speed deviation                        | 150 rpm         |

8.30 Flying restart - switching on while the motor is running

# 8.30 Flying restart – switching on while the motor is running

### Overview



If you switch on the motor while it is still rotating, without the "Flying restart" function, there is a high probability that a fault will occur as a result of overcurrent (F30001 or F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

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

# **Function description**

The "Flying restart" function comprises the following steps:

- 1. After the on command, the converter impresses the search current in the motor and increases the output frequency.
- 2. When the output frequency reaches the actual motor speed, the converter waits for the motor excitation build up time.
- 3. The converter accelerates the motor to the actual speed setpoint.



Figure 8-74 Principle of operation of the "flying restart" function

# Parameter

### Setting "flying restart" function

| Parameter  | Description   | Factory setting |
|--|---|-----------------|
| p1200[D]   | Flying restart operating mode   | 0               |
|  | 0 = flying restart is inhibited   |                 |
| 1 = Flying restart is enabled, search for the motor in both directions, start in the direction of the setpoint |   |                 |
|  | 4 = Flying restart is enabled, search for the motor only in the direction of the setpoint |                 |

# No "Flying restart" function for group drives

It is not permissible that you enable the "Flying restart" function if the converter is simultaneously driving several motors.

Exception: A mechanical coupling ensures that all of the motors always operate with the same speed.

Table 8-67Advanced settings

| Parameter | Description                             | Factory setting                                       |
|-----------|---|---|
| p0346[M]  | Motor excitation build-up time          | 0 s   |
| p0347[M]  | Motor de-excitation time                | 0 s   |
| p1201[C]  | BI: Flying restart enable signal source | 1   |
| p1202[D]  | Flying restart detection current        | Factory setting de-<br>pendent on the<br>Power Module |
| p1203[D]  | Flying restart search rate factor       | Factory setting de-<br>pendent on the<br>Power Module |

8.31 Automatic restart

# 8.31 Automatic restart

### Overview



The automatic restart includes two different functions:

- The converter automatically acknowledges faults.
- After a fault occurs or after a power failure, the converter automatically switches-on the motor again.

The converter interprets the following events as power failure:

- The converter signals fault F30003 (undervoltage in the DC link), after the converter line voltage has been briefly interrupted.
- All the converter power supplies have been interrupted and all the energy storage devices in the converter have discharged to such a level that the converter electronics fail.

# **Function description**

# Setting the automatic restart function

# 

Unexpected machine motion caused by the active automatic restart function

When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a line supply phase. Unexpected movement of machine parts can result in serious injury and material damage.

• Block off hazardous areas within the machine to prevent inadvertent access.

If it is possible that the motor is still rotating for a longer period of time after a power failure or after a fault, then you must also activate the "flying restart" function.

Flying restart – switching on while the motor is running (Page 408)

Using p1210, select the automatic restart mode that best suits your application.



Figure 8-75 Automatic restart modes

8.31 Automatic restart



The principle of operation of the other parameters is explained in the following diagram and in the table below.

<sup>1)</sup> The converter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: Always.
- p1210 = 4 or 6: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).
- p1210 = 14 or 16: Never.

<sup>2)</sup> The converter attempts to automatically switch the motor on under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch-on the motor is available at a digital input or via the fieldbus (ON/OFF1 = 1).

<sup>3)</sup> If, after a flying restart and magnetization (r0056.4 = 1) no fault occurs within one second, then the start attempt was successful.

Figure 8-76 Time response of the automatic restart

Further information is provided in the parameter list.

### **Advanced settings**

If you with to suppress the automatic restart function for certain faults, then you must enter the appropriate fault numbers in p1206[0 ... 9].

Example:  $p1206[0] = 07331 \Rightarrow$  No restart for fault F07331.

# 8.31 Automatic restart

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

#### Note

#### Motor starts in spite of an OFF command via the fieldbus

The converter responds with a fault if fieldbus communication is interrupted. For one of the settings p1210 = 6, 16 or 26, the converter automatically acknowledges the fault and the motor restarts, even if the higher-level control attempts to send an OFF command to the converter.

• In order to prevent the motor automatically starting when the fieldbus communication fails, you must enter the fault number of the communication error in parameter p1206.

### Parameter

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| p1206    | Automatic restart faults not active                         | 0               |
| p1210    | Automatic restart mode                                      | 0               |
| p1211    | Automatic restart, start attempts                           | 3               |
| p1212    | Automatic restart, wait time start attempts                 | 1 s             |
| p1213[0] | Automatic restart monitoring time for restart               | 60 s            |
| p1213[1] | Reset automatic restart monitoring time for startup counter | 0 s             |

# 8.32 Kinetic buffering (Vdc min control)

# Overview



Kinetic buffering increases the drive availability. The kinetic buffering utilizes the kinetic energy of the load to buffer line dips and failures. During a line dip, the converter keeps the motor in the switched-on state for as long as possible. One second is a typical maximum buffer time.

# Requirement

The following requirements must be fulfilled to practically use the "kinetic buffering" function:

- The driven machine has a sufficiently high inertia.
- The application allows a motor to be braked when the line supply fails.

The Vdc\_min control is possible only with the PM240-2 and PM240P-2 Power Modules.

# **Function description**

When the line supply dips, the DC-link voltage in the converter decreases. The kinetic buffering  $(V_{DCmin} \text{ control})$  intervenes at an adjustable threshold. The  $V_{DCmin}$  control forces the load to go into slightly regenerative operation. As a consequence, the converter covers its power loss and the losses in the motor with the kinetic energy of the load. The load speed decreases, but the DC-link voltage remains constant during the kinetic buffering. After the line supply returns, the converter immediately resumes normal operation.



Figure 8-77 Principle mode of operation of kinetic buffering

# Parameter

| Parameter  | Description                             | Factory setting |
|------------|---|-----------------|
| r0056[015] | CO/BO: Status word, closed-loop control | -               |
| p0210      | Device supply voltage                   | 400 V           |

# Advanced commissioning

# 8.32 Kinetic buffering (Vdc min control)

| Parameter | Description  | Factory setting |
|-----------|--|-----------------|
| p1240[D]  | Vdc controller configuration (vector control)          | 1               |
| p1245[D]  | Vdc_min controller switch-in level (kinetic buffering) | 73 % or 76 %    |
| r1246     | Vdc_min controller switch-in level (kinetic buffering) | - V             |
| p1247[D]  | Vdc_min controller dynamic factor (kinetic buffering)  | 300%            |
| p1255[D]  | Vdc_min controller, time threshold                     | 0 s             |
| p1257[D]  | Vdc_min controller, speed threshold                    | 50 rpm          |

# 8.33 Efficiency optimization

# Overview



The efficiency optimization reduces the motor losses as far as possible.

Active efficiency optimization has the following advantages:

- Lower energy costs
- Lower motor temperature rise
- Lower motor noise levels

Active efficiency optimization has the following disadvantage:

• Longer acceleration times and more significant speed dips during torque surges.

The disadvantage is only relevant when the motor must satisfy high requirements relating to the dynamic performance. Even when efficiency optimization is active, the converter closed-loop motor control prevents the motor from stalling.

# Requirement

Efficiency optimization functions under the following preconditions:

- Operation with an induction motor
- Vector control is set in the converter.

# **Function description**



Figure 8-78 Efficiency optimization by changing the motor flux

The three variables that the converter can directly set, which define efficiency of an induction motor, are speed, torque and flux.

However, in all applications, speed and torque are specified by the driven machine. As a consequence, the remaining variable for the efficiency optimization is the flux.

The converter has two different methods of optimizing the efficiency.

8.33 Efficiency optimization

### Efficiency optimization, method 2

Generally, energy efficiency optimization method 2 achieves a better efficiency than method 1.

We recommend that you set method 2.



Figure 8-79 Determining the optimum flux from the motor thermal model

Based on its thermal motor model, the converter continually determines - for the actual operating point of the motor - the interdependency between efficiency and flux. The converter then sets the flux to achieve the optimum efficiency.



1 Efficiency optimization is not active

2 Efficiency optimization is active

Figure 8-80 Qualitative result of efficiency optimization, method 2

Depending on the motor operating point, the converter either decreases or increases the flux in partial load operation of the motor.

# Efficiency optimization, method 1



Figure 8-81 Reduce the flux setpoint in the partial load range of the motor

The motor operates in partial load mode between no-load operation and the rated motor torque. Depending on p1580, in the partial load range, the converter reduces the flux setpoint linearly with the torque.



Figure 8-82 Qualitative result of efficiency optimization, method 1

The reduced flux in the motor partial load range results in higher efficiency.

# Parameters

| Number   | Name   | Factory setting            |
|----------|--|----------------------------|
| p1401[D] | Flux control configuration                         | 0000 0000 0000<br>0110 bin |
| p1570[D] | CO: Flux setpoint                                  | 100%                       |
| p3315[D] | Efficiency optimization 2 minimum flux limit value | 50%                        |
| p3316[D] | Efficiency optimization 2 maximum flux limit value | 110 %                      |

Table 8-68 Efficiency optimization, method 2

Table 8-69 Efficiency optimization, method 1

| Number   | Name                    | Factory setting |
|----------|-------------------------|-----------------|
| p1570[D] | CO: Flux setpoint       | 100%            |
| p1580[D] | Efficiency optimization | 80%             |

8.34 Line contactor control

# 8.34 Line contactor control

### Overview



A line contactor disconnects the converter from the line supply, and therefore reduces the converter losses when the motor is not operational.

# Requirement

The line contactor control requires a 24 V power supply from the converter. The 24 V power supply must be maintained, even when the line contactor is open.

# **Function description**

The converter controls its own line contactor using a digital output.



Figure 8-83 Line contactor control via DO 2 with feedback signal via DI 3

### Activating the line contactor control

Connect the digital output that controls the line contactor with signal r0863.1. Example for DO 2: p0732 = 863.1.

### Line contactor control with feedback signal

Interconnect p0860 with the signal of the corresponding digital input:

- p0860 = 722.x: Feedback signal of an NO contact via DIx
- p0860 = 723.x: Feedback signal of an NC contact via DIx

8.34 Line contactor control



Figure 8-84 Line contactor control via DO 2 with feedback signal via DI 3

If the line contactor feedback signal is not available for longer than the time set in p0861, then the converter issues fault F07300.

# Parameter

| Number   | Name  | Factory setting |
|----------|---|-----------------|
| r0046.0n | CO/BO: Missing enable signals                     | -               |
| p0860    | BI: Line contactor feedback signal                | 863.1           |
| p0861    | Line contactor monitoring time                    | 100 ms          |
| r0863.01 | CO/BO: Drive coupling status word / control word  | -               |
| p0867    | Power unit main contactor holding time after OFF1 | 50 ms           |
| p0869    | Configuration sequence control                    | 0000 bin        |
| p0870    | BI: close main contactor                          | 0               |

Further information is provided in the parameter list.

8.35 Calculating the energy saving for fluid flow machines

# 8.35 Calculating the energy saving for fluid flow machines

### Overview



Fluid flow machines, which mechanically control the flow rate using valves or throttle flaps, operate with a constant speed corresponding to the line frequency.



Figure 8-85 Flow control with pump and throttle connected to a 50 Hz line supply

The lower the flow rate, the poorer the efficiency of the fluid flow machine (pump). The fluid flow machine (pump) has the poorest efficiency when the throttle or valve is completely closed. Further, undesirable effects can occur, for example the formation of vapor bubbles in liquids (cavitation) or the temperature of the medium being pumped can increase.

The converter controls the flow rate by appropriately varying the speed of the fluid flow machine. By controlling the flow rate, the fluid flow machine operates at the optimum efficiency for each flow rate. This situation means that in the partial load range less electric power is required than when controlling the flow rate using valves and throttles.



Figure 8-86 Flow

Flow control with pump and converter

# **Function description**



The converter calculates the energy saving from the flow characteristic associated with a mechanical flow control and the measured electric power that is drawn.

The calculation is suitable for centrifugal pumps, fans, radial and axial compressors, for instance.

### 8.35 Calculating the energy saving for fluid flow machines

# Flow characteristic



Figure 8-87 Factory setting of the flow characteristic

To set the characteristic, you require the following data from the machine manufacturer for each speed interpolation point:

- The flow rate of the fluid-flow machine associated with the 5 selected converter speeds
- At constant speed, the power drawn which is associated with the 5 flow rates corresponds to the line frequency and mechanical throttling of the flow rate.

| Number    | Name                                    | Factory setting |
|-----------|---|-----------------|
| r0039[0n] | CO: Energy display                      | -               |
| p0040     | Reset energy consumption display        | 0               |
| r0041     | Energy saved                            | -               |
| r0042[0n] | CO: Process energy display              | -               |
| p0043     | BI: Energy consumption display enabled. | 0               |
| p3320[0n] | Fluid flow machine power, point 1       | 25              |
| p3321[0n] | Fluid flow machine speed, point 1       | 0               |
| p3322[0n] | Fluid flow machine power, point 2       | 50              |
| p3323[0n] | Fluid flow machine speed, point 2       | 25              |
| p3324[0n] | Fluid flow machine power, point 3       | 77              |
| p3325[0n] | Fluid flow machine speed, point 3       | 50              |
| p3326[0n] | Fluid flow machine power, point 4       | 92              |
| p3327[0n] | Fluid flow machine speed, point 4       | 75              |
| p3328[0n] | Fluid flow machine power, point 5       | 100             |
| p3329[0n] | Fluid flow machine speed, point 5       | 100             |

### **Parameters**

8.36 Switchover between different settings

# 8.36 Switchover between different settings

# Overview

There are applications that require different converter settings.

### Example:

Different motors are operated on one converter. Depending on the particular motor, the converter must operate with the associated motor data and the appropriate ramp-function generator.

# **Function description**

### Drive Data Sets (DDS)

You can set several converter functions differently and then switch over between the different settings.

#### Note

You can only switch over the motor data of the drive data sets in the "ready" state with the motor switched off. The switchover time is approx. 50 ms.

If you do not switch over the motor data together with the drive data sets (i.e. same motor number in p0826), then the drive data sets can also be switched over in operation.

The associated parameters are indexed (index 0, 1, 2, or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the converter with the same index are called the drive data set.



### 8.36 Switchover between different settings

# Selecting the number of drive data sets

The number of drive data sets (1 ... 4) is defined by parameter p0180.

| Parameter  | Description                     |
|------------|---------------------------------|
| p0010 = 0  | Drive commissioning: Ready      |
| p0010 = 15 | Drive commissioning: Data sets  |
| p0180      | Number of Drive Data Sets (DDS) |

### Copying the drive data sets

| Parameter    | Description               |
|--------------|---------------------------|
| p0819[0]     | Source drive data set     |
| p0819[1]     | Target drive data set     |
| p0819[2] = 1 | Starts the copy operation |

# Parameter

| Parameter  | Description                             | Factory setting |
|------------|---|-----------------|
| p0010      | Drive commissioning parameter filter    | 1               |
| r0051      | CO/BO: Drive data set DDS effective     | -               |
| p0180      | Number of Drive Data Sets (DDS)         | 1               |
| p0819[0 2] | Copy drive data set DDS                 | 0               |
| p0820[C]   | BI: Drive data set DDS selection, bit 0 | 0               |
| p0821[C]   | BI: Drive data set DDS selection, bit 1 | 0               |
| p0826[M]   | Motor changeover, motor number          | 0               |

# **Further information**

The converter switches the motor data set (MDS) and the power unit data set (PDS) together with the drive data set (DDS).

8.36 Switchover between different settings

# Alarms, faults and system messages

The converter has the following diagnostic types:

• LED

The LEDs at the front of the converter immediately inform you about the most important converter states.

- System runtime The system run time is the total time that the converter has been supplied with power since the initial commissioning.
- Alarms and faults The converter signals alarms and faults via the following interfaces:
  - Fieldbus
  - Terminal strip with the appropriate setting
  - Interface for an operator panel
  - Interface for a PC
- Identification & maintenance data (I&M) If requested, the converter sends data to the higher-level control via PROFIBUS or PROFINET:
  - Converter-specific data
  - Plant-specific data

# 9.1 LED

# 9.1.1 Operating states indicated via LEDs

# Table 9-1Explanation of symbols for the following tables

| LED is ON                           |
|-------------------------------------|
| LED is OFF                          |
| LED flashes slowly                  |
| LED flashes quickly                 |
| LED flashes with variable frequency |

Please contact Technical Support for LED states that are not described in the following.

## Table 9-2 Basic states

| RDY        | Explanation  |
|------------|--|
| <b>;;;</b> | Temporary state after the supply voltage is switched on.   |
| <b></b>    | The converter is free of faults  |
|            | Commissioning or reset to factory settings   |
| *          | A fault is active  |
| 黨          | Firmware update is active  |
| *          | Converter waits until the power supply is switched off and switched on again after a firmware update |

| SAFE | Explanation   |
|------|---|
|      | One or more safety functions are enabled, but not active.                         |
|      | One or more safety functions are active and error-free.                           |
|      | The converter has detected a safety function fault and initiated a stop response. |

Table 9-3Integrated safety functions

### Table 9-4 PROFINET fieldbus

| LNK | Explanation                              |  |  |
|-----|--|--|--|
|     | Communication via PROFINET is error-free |  |  |
|     | Device naming is active                  |  |  |
|     | No communication via PROFINET            |  |  |

# Table 9-5Fieldbuses via RS 485 interface

| BF | Explanat   | Explanation  |  |  |  |  |
|----|--|--|--|--|--|--|
|    | Data excl  | Data exchange between the converter and control system is active                                     |  |  |  |  |
|    | The fieldbus is active, however, the converter is not receiving any process data |  |  |  |  |  |
|    | RDY  | When LED RDY flashes simultaneously:   |  |  |  |  |
|    |  | Converter waits until the power supply is switched off and switched on again after a firmware update |  |  |  |  |
|    | No fieldbus connection available   |  |  |  |  |  |
|    | RDY  | When LED RDY flashes simultaneously:   |  |  |  |  |
|    |  | Incorrect memory card  |  |  |  |  |
|    | Firmware update failed   |  |  |  |  |  |
|    | Firmware update is active  |  |  |  |  |  |

# Communication via Modbus or USS:

If the fieldbus monitoring is deactivated with p2040 = 0, the BF-LED remains dark, independent of the communication state.

| BF      | Explanat   | Explanation  |  |  |  |
|---------|--|--|--|--|--|
|         | Data exchange between the converter and control system is active |  |  |  |  |
|         | The fieldbus is improperly configured.                           |  |  |  |  |
|         | RDY  | In conjunction with a synchronously flashing LED RDY:  |  |  |  |
|         | *  | Converter waits until the power supply is switched off and switched on again after a firmware update |  |  |  |
|         | No communication with higher-level controller                    |  |  |  |  |
|         | RDY  | In conjunction with an asynchronously flashing LED RDY:  |  |  |  |
|         | 渫  | Incorrect memory card  |  |  |  |
| <b></b> | Firmware   | update failed  |  |  |  |
|         | Firmware update is active  |  |  |  |  |

### Table 9-6 PROFINET fieldbus

#### Table 9-7 PROFIBUS fieldbus

| BF | Explanation  |  |  |  |  |  |
|----|--|--|--|--|--|--|
| *  | Data exchange between the converter and control system is active |  |  |  |  |  |
|    | Fieldbus   | interface is not being used  |  |  |  |  |
|    | The field  | bus is improperly configured.  |  |  |  |  |
|    | RDY  | In conjunction with a synchronously flashing LED RDY:  |  |  |  |  |
|    | <b>※</b>   | Converter waits until the power supply is switched off and switched on again after a firmware update |  |  |  |  |
|    | No communication with higher-level controller                    |  |  |  |  |  |
|    | RDY  | In conjunction with an asynchronously flashing LED RDY:  |  |  |  |  |
|    | *  | Incorrect memory card  |  |  |  |  |
| *  | Firmware update failed   |  |  |  |  |  |
|    | Firmware update is active  |  |  |  |  |  |

# 9.2 System runtime

# Overview

By evaluating the system runtime of the converter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

# **Function description**

The converter starts the system runtime as soon as it is supplied with power. The system runtime stops when the converter is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

If r2114[0] has reached a value of 86,400,000 ms (24 hours), the converter sets r2114[0] the value 0 and increases the value of r2114[1] by 1.

Using system runtime, you can track the chronological sequence of faults and alarms over time. When a corresponding message is triggered, the converter transfers the parameter values r2114 to the corresponding parameters of the alarm or fault buffer.

# Example

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

You cannot reset the system runtime.

### Parameter

| Parameter  | Description          | Factory setting |
|------------|----------------------|-----------------|
| r2114[0 1] | Total system runtime | -               |

9.3 Identification & maintenance data (I&M)

# 9.3 Identification & maintenance data (I&M)

# I&M data

The converter supports the following identification and maintenance (I&M) data.

| I&M data  | Format              | Explanation   | Associated param-<br>eters | Example for the content            |  |
|---|---------------------|---|----------------------------|------------------------------------|--|
| I&M0 u8[64] PROFIBUS Converter-specific data, read only |                     | -   | See below                  |                                    |  |
|   | u8[54] PROFINET     |   |                            |                                    |  |
| I&M1 Visible String [32] Plant/system identifier        |                     | Plant/system identifier   | p8806[0 31]                | "ak12-ne.bo2=fu1"                  |  |
|   | Visible String [22] | Location code   | p8806[32 53]               | "sc2+or45"                         |  |
| 1&M2  | Visible String [16] | Date  | p8807[0 15]                | "2013-01-21 16:15"                 |  |
| 1&M3  | Visible String [54] | le String [54] Any comment  |                            | -                                  |  |
| I&M4 Octet String[54]                                   |                     | Check signature to track changes for Safe-<br>ty Integrated.                            | p8809[0 53]                | Values of r9781[0]<br>and r9782[0] |  |
|   |                     | This value can be changed by the user.  |                            |                                    |  |
|   |                     | The test signature is reset to the value generated by the machine if p8805 = 0 is used. |                            |                                    |  |

When requested, the converter transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7 or TIA Portal.

# I&M0

| Designation           | Format              | Example for the con-<br>tent | Valid for PROFI-<br>NET | Valid for PROFI-<br>BUS |
|-----------------------|---------------------|------------------------------|-------------------------|-------------------------|
| Manufacturer-specific | u8[10]              | 00 00 hex                    |                         | ✓                       |
| MANUFACTURER_ID       | u16                 | 42d hex (=Siemens)           | 1                       | ✓                       |
| ORDER_ID              | Visible String [20] | "6SL3246-0BA22-1FA0"         | ~                       | ✓                       |
| SERIAL_NUMBER         | Visible String [16] | "T-R32015957"                | ~                       | ✓                       |
| HARDWARE_REVISION     | u16                 | 0001 hex                     | ✓                       | ✓                       |
| SOFTWARE_REVISION     | char, u8[3]         | "V" 04.70.19                 | 1                       | ✓                       |
| REVISION_COUNTER      | u16                 | 0000 hex                     | ✓                       | ✓                       |
| PROFILE_ID            | u16                 | 3A00 hex                     | ✓                       | ✓                       |
| PROFILE_SPECIFIC_TYPE | u16                 | 0000 hex                     | ✓                       | 1                       |
| IM_VERSION            | u8[2]               | 01.02                        | ✓                       | ✓                       |
| IM_SUPPORTED          | bit[16]             | 001E hex                     | ✓                       | ✓                       |
9.4 Alarms, alarm buffer, and alarm history

# 9.4 Alarms, alarm buffer, and alarm history

### Overview

An alarm generally indicates that the converter may no longer be able to maintain the operation of the motor in future.

The extended diagnostics have an alarm buffer and an alarm history, in which the converter stores the most recent alarms.

### **Function description**

Alarms have the following properties:

- Incoming alarms have no direct influence on the converter.
- A warning disappears as soon as its cause is eliminated.
- Alarms do not have to be acknowledged.

Alarm code or alarm value describe the cause of the alarm.

#### Alarm buffer

| Alarm code | Alarm    | value    | Alarn    | n time recei | ived | Alarm time | e removed |
|------------|----------|----------|----------|--------------|------|------------|-----------|
| _          | 132      | float    | Days     | ms           |      | Days       | ms        |
| r2122[0]   | r2124[0] | r2134[0] | r2145[0] | r2123[0]     | old  | r2146[0]   | r2125[0]  |
| [1]        | [1]      | [1]      | [1]      | [1]          | -    | [1]        | [1]       |
| [2]        | [2]      | [2]      | [2]      | [2]          | -    | [2]        | [2]       |
| [3]        | [3]      | [3]      | [3]      | [3]          | -    | [3]        | [3]       |
| [4]        | [4]      | [4]      | [4]      | [4]          | -    | [4]        | [4]       |
| [5]        | [5]      | [5]      | [5]      | [5]          | -    | [5]        | [5]       |
| [6]        | [6]      | [6]      | [6]      | [6]          | -    | [6]        | [6]       |
| [7]        | [7]      | [7]      | [7]      | [7]          | new  | [7]        | [7]       |

Figure 9-1 Alarm buffer

The converter saves incoming alarms in the alarm buffer. An alarm includes an alarm code, an alarm value, and two alarm times:

- Alarm code: r2122
- Alarm value: r2124 in fixed-point format "I32", r2134 in floating-point format "Float"
- Alarm time received = r2145 + r2123
- Alarm time removed = r2146 + r2125

The converter takes its internal time calculation to save the alarm times.

System runtime (Page 429)

Up to 8 alarms can be saved in the alarm buffer.

In the alarm buffer, the alarms are sorted according to "Alarm time received". If the alarm buffer is completely filled and an additional alarm occurs, then the converter overwrites the values with Index [7].

9.4 Alarms, alarm buffer, and alarm history

#### Alarm history



Figure 9-2 Shifting removed alarms into the alarm history

If the alarm buffer is completely filled and an additional alarm occurs, the converter shifts all removed alarms into the alarm history. The following occurs in detail:

- 1. To create space after position [8] in the alarm history, the converter shifts the alarms already stored in the alarm history "down" by one or more positions. If the alarm history is completely full, the converter will delete the oldest alarms.
- 2. The converter moves the removed alarms from the alarm buffer to the now freed up positions of the alarm history.

Alarms that have not been removed remain in the alarm buffer.

- 3. The converter closes gaps in the alarm buffer that occurred when the removed alarms were shifted in the alarm history by shifting the alarms that have not been removed "up".
- 4. The converter saves the received alarm as the latest alarm in the alarm buffer.

The alarm history saves up to 56 alarms.

In the alarm history, alarms are sorted according to the "alarm time removed". The latest alarm to be removed has Index [8].

### Parameter

| Parameter   | Description                         | Factory setting |
|-------------|-------------------------------------|-----------------|
| p2111       | Alarm counter                       | 0               |
| r2122[0 63] | Alarm code                          | -               |
| r2123[0 63] | Alarm time received in milliseconds | - ms            |
| r2124[0 63] | Alarm value                         | -               |
| r2125[0 63] | Alarm time removed in milliseconds  | - ms            |

Table 9-8 Parameters of the alarm buffer and the alarm history

### 9.4 Alarms, alarm buffer, and alarm history

| Parameter   | Description                  | Factory setting |
|-------------|------------------------------|-----------------|
| r2132       | CO: Actual alarm code        | -               |
| r2134[0 63] | Alarm value for float values | -               |
| r2145[0 63] | Alarm time received in days  | -               |
| r2146[0 63] | Alarm time removed in days   | -               |

#### Table 9-9Extended settings for alarms

| Parameter Description   |                           | Factory setting |  |
|---|---------------------------|-----------------|--|
| You can change up to 20 different alarms into a fault or suppress alarms: |                           |                 |  |
| p2118[019] Change message type, message number 0                          |                           | 0               |  |
| p2119[0 19]   | Change message type, type | 1               |  |

Further information is provided in the parameter list.

9.5 Faults, alarm buffer and alarm history

# 9.5 Faults, alarm buffer and alarm history

### Overview

A fault generally indicates that the converter can no longer maintain the operation of the motor.

The extended diagnostics have a fault buffer and a fault history, in which the converter stores the most recent faults.

### **Function description**

Faults have the following properties:

- In general, a fault leads to the motor being switched off.
- A fault must be acknowledged.

#### Fault buffer

| Fault code | Fault    | value    | Faul     | t time receiv | ved | Fault time | removed  |
|------------|----------|----------|----------|---------------|-----|------------|----------|
|            | 132      | float    | Days     | ms            |     | Days       | ms       |
| r0945[0]   | r0949[0] | r2133[0] | r2130[0] | r0948[0]      | Old | r2136[0]   | r2109[0] |
| [1]        | [1]      | [1]      | [1]      | [1]           |     | [1]        | [1]      |
| [2]        | [2]      | [2]      | [2]      | [2]           |     | [2]        | [2]      |
| [3]        | [3]      | [3]      | [3]      | [3]           | -   | [3]        | [3]      |
| [4]        | [4]      | [4]      | [4]      | [4]           | -   | [4]        | [4]      |
| [5]        | [5]      | [5]      | [5]      | [5]           |     | [5]        | [5]      |
| [6]        | [6]      | [6]      | [6]      | [6]           | •   | [6]        | [6]      |
| [7]        | [7]      | [7]      | [7]      | [7]           | New | [7]        | [7]      |

Figure 9-3 Fault buffer

The converter saves incoming faults in the fault buffer. A fault includes a fault code, a fault value, and two fault times:

- Fault code: r0945 The fault code and fault value describe the cause of the fault.
- Fault value: r0949 in fixed-point format "I32", r2133 in floating-point format "Float"
- Fault time received = r2130 + r0948
- Fault time removed = r2136 + r2109

The converter takes its internal time calculation to save the fault times.

System runtime (Page 429)

Up to 8 faults can be saved in the fault buffer.

In the fault buffer, the faults are sorted according to "Fault time received". If the fault buffer is completely full, and an additional fault is received in the fault buffer, then the converter overwrites the values with Index [7].

9.5 Faults, alarm buffer and alarm history

### Acknowledge fault

To acknowledge a fault, you have the following options:

- PROFIdrive control word 1, bit 7 (r2090.7)
- Acknowledge via a digital input
- Acknowledge via the Operator Panel
- Switch off the converter power supply and switch on again

Faults detected during the converter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again. In the list of faults in the List Manual, at the corresponding fault codes you may find the information on limitations when acknowledging.

#### **Fault history**



Figure 9-4 Fault history after acknowledging the faults

If at least one of the fault causes in the fault buffer has been removed and you acknowledge the faults, the following takes place:

- 1. The converter shifts the values previously saved in the fault history each by eight indices. The converter deletes the faults that were saved in the indexes [56 ... 63] before the acknowledgement.
- 2. The converter copies the contents of the fault buffer to the memory locations [8 ... 15] in the fault history.
- 3. The converter deletes the faults that have been removed from the fault buffer. The faults that have not been removed are now saved both in the fault buffer and in the fault history.
- 4. The converter writes the time of acknowledgement of the removed faults to "Fault time removed".

The "Fault time removed" of the faults that have not been removed retains the value = 0.

The fault history can contain up to 56 faults.

### Deleting the fault history

To delete all faults from the fault history, set parameter p0952 = 0.

9.5 Faults, alarm buffer and alarm history

### Parameter

Table 9-10Parameters of the fault buffer and the fault history

| Parameter   | Description                         | Factory setting |
|-------------|-------------------------------------|-----------------|
| r0945[0 63] | Fault code                          | -               |
| r0948[0 63] | Fault time received in milliseconds | - ms            |
| r0949[063]  | Fault value                         | -               |
| p0952       | Fault cases counter                 | 0               |
| r2109[0 63] | Fault time removed in milliseconds  | - ms            |
| r2130[0 63] | Fault time received in days         | -               |
| r2131       | CO: Actual fault code               | -               |
| r2133[0 63] | Fault value for float values        | -               |
| r2136[0 63] | Fault time removed in days          | -               |

### Extended settings for faults

| Parameter   | Description                                 | Factory setting |
|-------------|---|-----------------|
| p2100[019]  | Changing the fault reaction, fault number   | 0               |
| p2101[019]  | Changing the fault reaction, reaction       | 0               |
| p2118[019]  | Change message type, message number         | 0               |
| p2119[0 19] | Change message type, type                   | 1               |
| p2126[0 19] | Changing the acknowledge mode, fault number | 0               |
| p2127[0 19] | Changing the acknowledge mode               | 1               |

Further information is provided in the parameter list.

Axxxxx Alarm Fyyyyy: Fault

Table 9-11The most important alarms and faults

| Number | Cause   | Remedy  |
|--------|---|---|
| F01000 | Software error in the CU  | Replacing the Control Unit.   |
| F01001 | Floating point exception  | Switch the Control Unit off and on again.   |
| F01015 | Software error in the CU  | Upgrade firmware or contact technical support.  |
| F01018 | Power-up aborted more than once   | 1. Switch the module off and on again.  |
|        |   | 2. After this fault has been output, the module is powered up with the factory settings.  |
|        |   | 3. Recommission the converter.  |
| A01028 | Configuration error   | Explanation: Parameterization on the memory card has been created with a different type of module (Article number, MLFB).   |
|        |   | Check the module parameters and recommission if necessary.  |
| F01033 | Switching over units: Reference pa-<br>rameter value invalid  | Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).  |
| F01034 | Switching over units: Calculation of<br>the parameter values after refer-<br>ence value change unsuccessful | Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004). |
| F01040 | Parameters must be saved  | Save parameters (p0971).<br>Switch the Control Unit off and on again.   |
| F01044 | Error loading data from memory card   | Replace the memory card or the Control Unit.  |
| A01053 | System overload measured  | The maximum computing power of the Control Unit was exceeded. The   |
| F01054 | System limit exceeded   | following measures reduce the load on the Control Unit:   |
|        |   | Use only one data record (CDS and DDS)  |
|        |   | Only use the safety features of the basic functions   |
|        |   | Deactivate the technology controller  |
|        |   | • Use the simple ramp-function generator rather than the extended ramp-<br>function generator   |
|        |   | Do not use any free function components   |
|        |   | Reduce the sampling time of the free function blocks  |
| A01101 | Memory card not available   | Insert a memory card or deactivate alarm A01101.  |
| F01105 | CU: Insufficient memory   | Reduce number of data sets.   |
| F01122 | Frequency at the probe input too high   | Reduce the frequency of the pulses at the probe input.  |
| F01205 | CU: Time slice overflow   | Contact technical support.  |
| F01250 | CU hardware fault   | Replacing the Control Unit.   |
| F01512 | An attempt has been made to estab-<br>lish a conversion factor for scaling<br>which does not exist          | Create scaling or check transfer value.   |
| A01590 | Motor maintenance interval expired  | Carry out maintenance and reset the maintenance interval (p0651).   |

| Number | Cause  | Remedy  |  |
|--------|--|---|--|
| F01600 | STOP A initiated   | Select the STO sa   | afety function and then deselect again.  |
| F01625 | Sign-of-life error in the Safety data                    | Check the ele<br>ance.  | ectrical cabinet design and cable routing for EMC compli-  |
|        |  | Check wheth ital outputs.   | er an impermissible voltage is connected at one of the dig-  |
|        |  | Check wheth   | er a digital output is loaded with an impermissible current.   |
|        |  | Check wheth cable.  | er additional faults exist and perform diagnostics if appli-   |
|        |  | Select STO sa   | fety function and then deselect again.   |
|        |  | Switch off the  | e converter power supply and switch it on again.   |
| F01650 | Acceptance test required                                 | Perform an acce<br>ance certificate.  | ptance test for the safety functions and create the accept-  |
|        |  | To confirm the fa   | ault, switch the Control Unit off and on again.  |
| F01659 | Write task for parameter rejected                        | Cause: The conve<br>permissible to re-<br>enabled.  | erter should be reset to the factory setting. However, it is not<br>set the safety functions as the safety functions are currently |
|        |  | Remedy with op  | erator panel:  |
|        |  | p0010 = 30  | Parameter reset  |
|        |  | p9761 =   | If required, enter the password for the safety functions.  |
|        |  | p0970 = 5   | Reset start safety parameter.  |
|        |  |   | The converter sets p0970 = 5 once it has reset the parameters.   |
|        |  | Then reset the co   | onverter to the factory setting again.   |
| F01662 | Error, internal communications                           | Check the ele<br>ance.  | ectrical cabinet design and cable routing for EMC compli-  |
|        |  | Check wheth ital outputs.   | er an impermissible voltage is connected at one of the dig-  |
|        |  | Check wheth   | er a digital output is loaded with an impermissible current.   |
|        |  | If the checks are   | unsuccessful:  |
|        |  | Switch off the  | e converter power supply and switch it on again  |
|        |  | • Upgrade the   | firmware   |
|        |  | Contact tech  | nical support  |
| A01666 | Static 1 signal at the F-DI for safe ac-<br>knowledgment | Set failsafe digita   | al input F-DI to a logical 0 signal.   |
| A01698 | Commissioning mode active for safety functions           | The converter revokes the alarm after completion of the safety commission-<br>ing.        |  |
| A01699 | Switch-off signal path test required                     | After the next deselection of the STO safety function, the converter revokes the message. |  |
| A01900 | PROFIBUS: Configuration telegram faulty                  | Explanation: A P with a faulty cor  | ROFIBUS master is attempting to establish a connection<br>figuration telegram.   |
|        |  | Check the bus co  | onfiguration on the master and device side.  |

| Number   | Cause  | Remedy   |
|--|--|--|
| A01910   | Setpoint timeout                                     | The alarm is generated when $p2040 \neq 0$ ms and one of the following causes  |
| F01910   |  | is present:  |
|  |  | The bus connection is interrupted  |
|  |  | The Modbus master is switched off  |
|  |  | Communications error (CRC, parity bit, logical error)  |
|  |  | An excessively low value for the fieldbus monitoring time (p2040)  |
| A01920   | PROFIBUS: Cyclic connection inter-                   | Explanation: The cyclic connection to PROFIBUS master is interrupted.  |
|  | rupt   | Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.  |
| F03505   | Analog input, wire break                             | Check the wiring for interruptions.<br>Check the level of the injected signal.<br>The input current measured by the analog input can be read out in r0752.                             |
| A03520   | Temperature sensor fault                             | Check that the sensor is connected correctly.  |
| A05000<br>A05001<br>A05002<br>A05004<br>A05006 | Power Module overtemperature                         | Check the following:<br>- Is the ambient temperature within the defined limit values?<br>- Are the load conditions and duty cycle configured accordingly?<br>- Has the cooling failed? |
| F06310   | Supply voltage (p0210) incorrectly                   | Check the set supply voltage and if required change (p0210).   |
|  | set  | Check the line voltage.  |
| F07011   | Motor overtemperature                                | Reduce the motor load.   |
|  |  | Check ambient temperature.   |
|  |  | Check the wiring and connection of the sensor.   |
| A07012   | I2t motor model overtemperature                      | Check and if necessary reduce the motor load.  |
|  |  | Check the motor's ambient temperature.   |
|  |  | Check the thermal time constant p0611.   |
|  |  | Check overtemperature fault threshold p0605.   |
| A07015   | Motor temperature sensor alarm                       | Check that the sensor is connected correctly.  |
|  |  | Check the parameter assignment (p0601).  |
| F07016   | Motor temperature sensor fault                       | Make sure that the sensor is connected correctly.  |
|  |  | Check the parameterization (p0601).  |
|  |  | Deactivate the motor temperature sensor fault evaluation (p0607 = 0).  |
| F07086<br>F07088                               | Switching over units: Parameter lim-<br>it violation | Check the adapted parameter values and if required correct.  |
| F07320   | Automatic restart aborted                            | Increase the number of restart attempts (p1211). The current number of start attempts is shown in r1214.   |
|  |  | Increase the wait time in p1212 and/or monitoring time in p1213.   |
|  |  | Connect an ON command (p0840).   |
|  |  | Increase the monitoring time of the power unit or switch off (p0857).  |
|  |  | Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.  |
| A07321   | Automatic restart active                             | Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.            |
| F07330   | Search current measured too low                      | Increase the search current (p1202), check the motor connection.   |

| Number                     | Cause                                  | Remedy  |
|----------------------------|--|---|
| A07400                     | DC-link voltage maximum controller     | If the controller is not to intervene:  |
|                            | active                                 | Increase the ramp-down times.   |
|                            |  | <ul> <li>Deactivate the Vdc_max control (p1240 = 0 for vector control, p1280 =<br/>0 for U/f control).</li> </ul>                                     |
| A07409                     | U/f control, current limiting control- | The alarm automatically disappears after one of the following measures:   |
|                            | ler active                             | Increase the current limit (p0640).   |
|                            |  | Reduce the load.  |
|                            |  | • Slow down the ramp up to the setpoint speed.  |
| F07426                     | Technology controller actual value     | • Adapt the limits to the signal level (p2267, p2268).  |
|                            | limited                                | Check the actual value scaling (p2264).   |
| A07444                     | PID autotuning is activated            | Automatic setting of the PID controller (autotuning) is active (p2350 > 0).<br>The alarm disappears automatically after completion of the autotuning. |
| F07445                     | PID autotuning canceled                | The converter has canceled the automatic setting of the PID controller (au-<br>totuning) because of a fault.  |
|                            |  | Remedy: Increase p2355 and restart autotuning.  |
| F07801                     | Motor overcurrent                      | Check current limits (p0640).   |
|                            |  | Vector control: Check current controller (p1715, p1717).  |
|                            |  | U/f control: Check the current limiting controller (p1340 p1346).   |
|                            |  | Increase the acceleration ramp (p1120) or reduce the load.  |
|                            |  | Check the motor and motor cables for short-circuit and ground fault.  |
|                            |  | Check the motor regarding the star/delta connection and rating plate pa-<br>rameterization.   |
|                            |  | Check power unit / motor combination.   |
|                            |  | Select the flying restart function (p1200) if switched to rotating motor.   |
| A07805                     | Drive: Power unit overload I2t         | Reduce the continuous load.   |
|                            |  | Adapt the load cycle.   |
|                            |  | Check the assignment of rated currents of the motor and power unit.   |
| F07806                     | Regenerative power limit exceeded      | Increase the deceleration ramp.   |
|                            |  | Reduce the driving load.  |
|                            |  | Use a power unit with higher energy recovery capability.  |
|                            |  | For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.                                      |
| F07807                     | Short circuit detected                 | <ul> <li>Check the converter connection on the motor side for any phase-phase<br/>short-circuit.</li> </ul>   |
|                            |  | Rule out that line and motor cables have been interchanged.   |
| A07850                     | External alarm 1 3                     | The signal for "external alarm 1" has been triggered.   |
| A07851<br>A07852           |  | Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1 3.  |
|                            |  | Remedy: Remove the causes of these alarms.  |
| F07860<br>F07861<br>F07862 | External fault 1 3                     | Remove the external causes for this fault.  |

| Number | Cause                              | Remedy   |
|--------|------------------------------------|--|
| A07891 | Load monitoring, pump/fan blocked  | Check the pump/fan for blockage and rectify if necessary.  |
|        |                                    | Check the fan for sluggishness and rectify if necessary.   |
|        |                                    | • Adapt the parameterization depending on the load (p2165, p2168).   |
| A07892 | Load monitoring, pump/fan without  | • For a pump, check the conveyor medium and provide if necessary.  |
|        | load                               | For a fan, check the belt and replace if necessary   |
|        |                                    | • If necessary, increase the torque threshold for detection (p2191).   |
| A07893 | Load monitoring, pump leakage      | Rectify the leakage in the pump circuit.   |
|        |                                    | • For a false tripping, reduce the torque thresholds of the leakage charac-<br>teristic (p2186, p2188, p2190).     |
| F07894 | Load monitoring, pump/fan blocked  | Check the pump/fan for blockage and rectify if necessary.  |
|        |                                    | Check the fan for sluggishness and rectify if necessary.   |
|        |                                    | • Adapt the parameterization depending on the load (p2165, p2168).   |
| F07895 | Load monitoring, pump/fan without  | • For a pump, check the conveyor medium and provide if necessary.  |
|        | load                               | • For a fan, check the belt and replace if necessary   |
|        |                                    | • If necessary, increase the torque threshold for detection (p2191).   |
| F07896 | Load monitoring, pump leakage      | Rectify the leakage in the pump circuit.   |
|        |                                    | • For a false tripping, reduce the torque thresholds of the leakage charac-<br>teristic (p2186, p2188, p2190).     |
| F07900 | Motor blocked                      | Check that the motor can run freely.   |
|        |                                    | Check the torque limits (r1538 and r1539).   |
|        |                                    | Check the parameters of the "Motor blocked" message (p2175, p2177).  |
| F07901 | Motor overspeed                    | Activate the precontrol for the speed limiting controller (p1401 bit $7 = 1$ ).                                    |
|        |                                    | Increase the hysteresis for overspeed signal p2162.  |
| F07902 | Motor stalled                      | Check whether the motor data has been set correctly and perform a motor identification.                            |
|        |                                    | Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. |
|        |                                    | Check whether motor cables are disconnected during operation.  |
| A07903 | Motor speed deviation              | Increase p2163 and/or p2166.   |
|        |                                    | Increase the torque, current and power limits.   |
| A07910 | Motor overtemperature              | Check the motor load.  |
|        |                                    | Check the motor's ambient temperature.   |
|        |                                    | Check the KTY84 or PT1000 sensor.  |
| 407020 | The standard back                  | Check the overtemperatures of the thermal model (p0626 p0628).   |
| A07920 | Torque/speed too low               | The torque deviates from the torque/speed envelope curve.  |
| A07921 | lorque/speed too high              | Check the connection between the motor and the load.   |
| A07922 | lorque/speed out of tolerance      | • Adapt the parameterization corresponding to the load.  |
| F0/923 | lorque/speed too low               | Check the connection between the motor and the load.   |
| FU/924 | lorque/speed too high              | Adapt the parameterization corresponding to the load.  |
| A07927 | DC braking active                  | Not required   |
| A07980 | Rotary measurement activated       | Not required   |
| A07981 | No enabling for rotary measurement | Acknowledge pending faults.  |
|        |                                    | Establish missing enables (see r00002, r0046).   |

| Number | Cause   | Remedy   |  |  |
|--------|---|--|--|--|
| A07991 | Motor identification activated                                | Switch on the motor and identify the motor data.   |  |  |
| F08501 | Setpoint timeout  | Check the PROFINET connection.   |  |  |
|        |   | • Set the controller to RUN mode.  |  |  |
|        |   | • If the fault occurs repeatedly, check the monitoring time set p2044.   |  |  |
| F08502 | Monitoring time, sign-of-life expired                         | Check the PROFINET connection.   |  |  |
| F08510 | Send configuration data not valid                             | Check the PROFINET configuration   |  |  |
| A08511 | Receive configuration data not valid                          |  |  |  |
| A08526 | No cyclic connection  | Activate the control with cyclic operation.  |  |  |
|        |   | <ul> <li>Check the parameters "Name of Station" and "IP of Station" (r61000,<br/>r61001).</li> </ul>                             |  |  |
| A08565 | Consistency error affecting adjusta-                          | Check the following:   |  |  |
|        | ble parameters  | IP address, subnet mask or default gateway is not correct.   |  |  |
|        |   | • IP address or station name used twice in the network.  |  |  |
|        |   | Station name contains invalid characters.  |  |  |
| F08700 | Communications error  | A CAN communications error has occurred. Check the following:  |  |  |
|        |   | Bus cable  |  |  |
|        |   | • Baud rate (p8622)  |  |  |
|        |   | • Bit timing (p8623)   |  |  |
|        |   | • Manager  |  |  |
|        |   | Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!                                 |  |  |
| F13100 | Know-how protection: Copy protec-<br>tion error               | The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. |  |  |
|        |   | • Insert a suitable memory card and switch the converter supply voltage temporarily off and then on again (POWER ON).            |  |  |
|        |   | • Deactivate the copy protection (p7765).  |  |  |
| F13101 | Know-how protection: Copy protec-<br>tion cannot be activated | Insert a valid memory card.  |  |  |
| F30001 | Overcurrent   | Check the following:   |  |  |
|        |   | Motor data, if required, carry out commissioning   |  |  |
|        |   | • Motor connection method (Y / $\Delta$ )  |  |  |
|        |   | • U/f operation: Assignment of rated currents of motor and Power Module  |  |  |
|        |   | Line quality   |  |  |
|        |   | Make sure that the line commutating reactor is connected properly  |  |  |
|        |   | Power cable connections  |  |  |
|        |   | Power cables for short-circuit or ground fault   |  |  |
|        |   | Power cable length   |  |  |
|        |   | Line phases  |  |  |
|        |   | If this doesn't help:  |  |  |
|        |   | U/f operation: Increase the acceleration ramp  |  |  |
|        |   | Reduce the load  |  |  |
|        |   | Replace the power unit   |  |  |

| Number | Cause   | Remedy   |  |  |
|--------|---|--|--|--|
| F30002 | DC-link voltage overvoltage                                   | Increase the ramp-down time (p1121).   |  |  |
|        |   | Set the rounding times (p1130, p1136).   |  |  |
|        |   | Activate the DC-link voltage controller (p1240, p1280).  |  |  |
|        |   | Check the line voltage (p0210).  |  |  |
|        |   | Check the line phases.   |  |  |
| F30003 | DC-link voltage undervoltage                                  | Check the line voltage (p0210).  |  |  |
| F30004 | Converter overtemperature                                     | Check whether the converter fan is running.  |  |  |
|        |   | Check whether the ambient temperature is in the permissible range.                                 |  |  |
|        |   | Check whether the motor is overloaded.   |  |  |
|        |   | Reduce the pulse frequency.  |  |  |
| F30005 | I2t converter overload  | Check the rated currents of the motor and Power Module.  |  |  |
|        |   | Reduce the current limit p0640.  |  |  |
|        |   | When operating with U/f characteristic: Reduce p1341.  |  |  |
| F30011 | Line phase failure  | Check the converter's input fuses.   |  |  |
|        |   | Check the motor feeder cables.   |  |  |
| F30015 | Motor cable phase failure                                     | Check the motor cables.  |  |  |
|        |   | Increase the ramp-up or ramp-down time (p1120).  |  |  |
| F30021 | Ground fault  | Check the power cable connections.   |  |  |
|        |   | Check the motor.   |  |  |
|        |   | Check the current transformer.   |  |  |
|        |   | • Check the cables and contacts of the brake connection (a wire might be                           |  |  |
|        |   | broken).   |  |  |
| F30022 | Power Module: Monitoring U <sub>CE</sub>                      | Check or replace Power Module.   |  |  |
| F30027 | Lime monitoring for DC link pre-                              | Check the line voltage at the input terminals.   |  |  |
| 530035 |   | Check the line voltage setting (p0210).  |  |  |
| F30035 | Overtemperature, intake air                                   | Check whether the fan is running.  |  |  |
| F30036 | Overtemperature, inside area                                  | Check the fan filter elements.   |  |  |
|        |   | Check whether the ambient temperature is in the permissible range.                                 |  |  |
| F30037 | Rectifier overtemperature                                     | See F30035 and, in addition:   |  |  |
|        |   | Check the motor load.  |  |  |
|        |   | Check the line phases  |  |  |
| A30049 | Internal fan defective  | Check the internal fan and if required replace.  |  |  |
| F30052 | Incorrect Power Module data                                   | Replace the Power Module or upgrade the Control Unit firmware.                                     |  |  |
| F30053 | Error in FPGA data  | Replace the Power Module.  |  |  |
| F30059 | Internal fan defective  | Check the internal fan and if required replace.  |  |  |
| F30074 | Communications error between<br>Control Unit and Power Module | There is a communications fault between the Control Unit and the Power<br>Module. Possible causes: |  |  |
|        |   | The Control Unit may have been removed or inserted incorrectly.                                    |  |  |
|        |   | • The external 24 V Control Unit power supply has dipped to ≤95% of the rated voltage for ≤3 ms    |  |  |
| A30502 | DC link overvoltage   | Check the device supply voltage (p0210).   |  |  |
|        |   | Check the line reactor dimensioning  |  |  |
| F30600 | STOP A triggered  | Select STO safety function and then deselect again.  |  |  |

| Number | Cause                              | Remedy   |
|--------|------------------------------------|--|
| F30662 | CU hardware fault                  | Switch the Control Unit off and on again, upgrade the firmware or contact technical support.   |
| F30664 | CU power up aborted                | Switch the Control Unit off and on again, upgrade the firmware or contact technical support.   |
| F30850 | Software fault in the Power Module | Replace Power Module or contact technical support.   |
| A30920 | Temperature sensor fault           | Check that the sensor is connected correctly.  |
| A50001 | PROFINET configuration error       | A PROFINET control is attempting to establish a connection with an incorrect configuration telegram. Check whether "Shared Device" is activated (p8929 = 2). |
| A50010 | PROFINET name of station invalid   | Correct the name of station (p8920) and activate (p8925 = 2).  |
| A50020 | PROFINET: Second control missing   | "Shared Device" is activated (p8929 = 2). However, only the connection to a PROFINET control is available.   |

Further information on this topic is provided in the List Manual.

Overview of the manuals (Page 564)

# **Corrective maintenance**

# 

#### Fire or electric shock due to defective components

If an overcurrent protection device is triggered, the converter may be defective. A defective converter can cause a fire or electric shock.

• Have the converter and the overcurrent protection device checked by a specialist.

### Repair

### 

#### Fire or electric shock due to improper repair

Improper repair of the converter may cause malfunctions or result in consequential damage such as fire or electric shock.

- Only commission the following persons to repair the converter:
  - Siemens customer service
  - A repair center that has been authorized by Siemens
  - Specialist personnel who are thoroughly acquainted with all the warnings and operating procedures contained in this manual.
- Only use original spare parts when carrying out repairs.

### **Recycling and disposal**



For environmentally-friendly recycling and disposal of your old device, please contact a company certified for the disposal of waste electrical and electronic equipment, and dispose of the old device as prescribed in the respective country of use.

### Continuous development within the scope of product maintenance

Converter components are being continuously developed within the scope of product maintenance. Product maintenance includes, for example, measures to increase the ruggedness or hardware changes which become necessary as components are discontinued.

These further developments are "spare parts-compatible" and do not change the article number.

In the scope of such spare parts-compatible ongoing development, plug connector or connection positions are sometimes slightly modified. This does not cause any problems when the components are properly used. Please take this fact into consideration in special installation situations (e.g. allow sufficient reserve regarding the cable length).

# 10.1 Replace Control Unit

### Overview

You are only permitted to replace a Control Unit with a different Control Unit under certain preconditions. After the replacement, you must transfer the settings of the Control Unit that was replaced to the new Control Unit.

### Requirement

The following preconditions apply for making a replacement:

- The new Control Unit is the same type as the Control Unit that was replaced.
- The new Control Unit has the same or more recent firmware version than that of the Control Unit that was replaced.

### Description

# 

#### Unexpected machine motion caused when using an inappropriate Control Unit

Replacing Control Units of different types can result in incomplete or inappropriate/incorrect converter settings. As a consequence, machines can unexpectedly move, e.g. speed oscillation, overspeed or incorrect direction of rotation. Unexpected machine motion can result in death, injury and/or material damage.

• In all cases not permitted according to the above precondition, you must recommission the drive after replacing the Control Unit.

# 

### Unexpected machine motion caused by inappropriate/incorrect converter settings

Missing or incorrect converter settings can lead to unexpected operating states or machine movements, e.g. a non-functioning EMERGENCY STOP or an incorrect direction of rotation. As a consequence, machine components or devices can become damaged or death or bodily injury may result.

- If possible, back up the settings of the Control Unit to be replaced by uploading them to an external storage medium, e.g. a memory card.
- Transfer the settings of the Control Unit that was replaced per download to the new Control Unit.
- If you do not have a backup of the converter settings, commission the converter as new converter.
- After replacing the Control Unit, you must check the function of the converter.

### Procedure

- 1. Switch off the line voltage to the Power Module.
- 2. If being used, switch off the supply voltage for the digital outputs on the Control Unit.

10.1 Replace Control Unit

- 3. If being used, switch off the external 24 V supply of the Control Unit.
- 4. Carefully check that the Control Unit terminals have a no voltage condition.
- 5. Remove the signal cables from the Control Unit.
- 6. Remove the defective Control Unit.
- 7. Mount the new Control Unit on the Power Module.
- 8. Reconnect the signal cables of the Control Unit.
- 9. Switch on all of the converter power supplies again.

10. Set the new converter to suit the application:

- If the settings of the replaced Control Unit are backed up on an external storage medium, transfer the settings using a download.
  - Downloading the converter settings (Page 449)
- If there is no data backup of the replaced Control Unit, commission the converter as new converter.

You have replaced the Control Unit.

# 10.2 Downloading the converter settings

## 10.2.1 Converter without enabled safety functions

### 10.2.1.1 Automatic download from the memory card

#### Overview

We recommend that you insert the memory card before switching on the converter. The converter automatically imports its settings from the inserted memory card.

#### Precondition

The following requirements apply:

- The converter power supply has been switched off.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

#### **Function description**

#### Procedure

- 1. Insert the memory card into the converter.
- 2. Switch on the power supply for the converter.
- 3. The converter loads the settings from the memory card.
- 4. After loading, check whether the converter outputs Alarm A01028.
  - Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
  - No alarm A01028: The converter accepts the settings that have been loaded.

You have transferred the settings to the converter.  $\hfill\square$ 

### 10.2.1.2 Manual downloading from the memory card with the BOP-2

#### Overview

If you have backed up the settings of several converters on the memory card, the settings download must be started manually.

### Precondition

The following requirements apply:

- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### Function description

#### Procedure

- 1. Insert the memory card into the converter.
- 2. Select the download.



3. Set the number of your data backup. You can back up 99 different settings on the memory card.



4. Start the data transfer.



5. Wait until the converter has transferred the settings from the memory card.



6. Back up the settings so that they are protected against power failure.



You have transferred the settings from the memory card to the converter.  $\hfill\square$ 

# 10.2.1.3 Manual download from the memory card using Startdrive

### Overview

If you have backed up the settings of several converters on the memory card, the settings download must be started manually.

### Requirement

The following preconditions apply:

- The converter power supply has been switched on.
- The PC and converter are connected with one another via a USB cable or via the fieldbus.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

| Add new device  Add new device  Control of the second sec |                                  |   |                      |
|---|----------------------------------|---|----------------------|
| Online & diagnostic Traces Online av 555 Diagnostic   | Load data from memory card to dr | ive:  |                      |
| Functions<br>Backing volreset   | Parameter set on memory card     | Parameter set in the drive [0] Source/target standart | Load<br>Safely remov |

- 1. Go online.
- 2. Select "Online & diagnostics".
- 3. Select "Back up/reset".
- 4. Set the number of your data backup. You can back up 99 different settings on the memory card.
- 5. Start the data transfer.
- 6. Wait until Startdrive has signaled that the data transfer has been completed.
- 7. Go offline.

You have transferred your settings from a memory card to the converter.  $\hfill\square$ 

### 10.2.1.4 Download from BOP-2 operator panel

### Overview

You can transfer the converter settings that are backed up on the BOP-2 operator panel back into the converter.

### Precondition

The following requirements apply:

- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### Function description

#### Procedure

- 1. Attach the Operator Panel to the converter.
- 2. Select the download from the operator panel to the converter.



3. Start the download.



4. Wait until the download is completed.



5. After loading, check whether the converter outputs Alarm A01028.

| EXTRRS |  | DIRENOS | ОК | FRULTS | ОК |
|--------|--|---------|----|--------|----|
|--------|--|---------|----|--------|----|

– Alarm A01028:

The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.

- No alarm A01028: Proceed with the next step.
- 6. Back up the settings so that they are protected against power failure.

| MONITOR  | ExTRRS   | OK 🔽 | RAM -> | ROM | ОК |
|----------|----------|------|--------|-----|----|
| ESE / DH | рк.      |      |        |     |    |
| - ∄USY - | - 30NE - | ĸ    |        |     |    |

You have transferred the settings to the converter.  $\hfill\square$ 

### 10.2.1.5 Download from IOP-2 operator panel

### Overview

You can transfer the converter settings that are backed up on the IOP-2 operator panel back into the converter.

#### Precondition

The following requirements apply:

- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Connect the operator panel to the converter.
- 2. Start the download.



3. Wait until the download is completed.

4. After loading, check whether the converter outputs Alarm A01028.



- Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
- No alarm A01028: Proceed with the next step.
- 5. Back up the settings so that they are protected against power failure.



You transferred the settings to the converter.  $\hfill\square$ 

### 10.2.1.6 Download from Smart Access

### Overview

You can transfer the converter settings that are backed up on the digital terminal device back into the converter.

### Precondition

The following requirements apply:

- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

# **Function description**

### Procedure

- 1. Attach the Smart Access to the converter.
- 2. Connect your terminal device with the Smart Access.
- 3. Select the file for restoring the converter settings.



4. Back up the settings so that they are protected against power failure.



5. After loading, check whether the converter outputs Alarm A01028.



- Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
- No alarm A01028: Proceed with the next step.

You transferred the settings from the Smart Access to the new converter.  $\hfill\square$ 

### 10.2.1.7 Download from the PC using Startdrive

#### Overview

You can transfer the converter settings that have been backed up to a PC back to the converter.

### Requirement

The following preconditions apply:

- The PC and converter are connected with one another.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Open the Startdrive project that matches the drive.
- 2. Select "Load to device".
- 3. Confirm the prompt for saving your settings (copy RAM to ROM).

You transferred the settings from the PC to the new converter.

### 10.2.2 Converter with enabled safety functions

### 10.2.2.1 Automatic download from the memory card

### Overview

We recommend that you insert the memory card before switching on the converter. The converter automatically imports its settings from the inserted memory card.

### Requirement

The following preconditions apply:

- The converter power supply has been switched off.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

### Procedure

- 1. Insert the memory card into the converter.
- 2. Switch on the power supply for the converter.

- 3. The converter loads the settings from the memory card.
- 4. After loading, check whether the converter outputs Alarm A01028.
  - Alarm A01028:

The loaded settings are not compatible with the converter. Set p0971 = 1 to delete the alarm. Check the converter settings. We recommend that you recommission the drive.

 No alarm A01028: Perform a reduced acceptance test.
 Reduced acceptance test after component replacement and firmware change (Page 481)

You have transferred the settings to the converter.  $\hfill \square$ 

### 10.2.2.2 Manual downloading from the memory card with the BOP-2

### Overview

If you have backed up the settings of several converters on the memory card, the settings download must be started manually.

### Requirement

The following preconditions apply:

- You know the password for the converter safety functions.
- The converter power supply has been switched on.
- The converter settings are not protected against copying.
- Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Insert a memory card into the converter.
- 2. Select the download.



3. Set the number of your data backup. You can back up 99 different settings on the memory card.



4. Start the data transfer.



5. Wait until the converter has transferred the settings from the memory card.

| LLUNIN6<br>***-999 | - 40nE - | OK |
|--------------------|----------|----|

6. Back up the settings so that they are protected against power failure.

| MONITOR  | Extras   | OK 🔽 | RAM -> ROM | OK |
|----------|----------|------|------------|----|
| ESC / OK | ОК       |      |            |    |
| - BUSY - | - JONE - | OK   |            |    |

7. Start to commission the safety functions.



8. Enter the password for the safety functions.

9. Confirm the setting of the safety functions.



10. Exit commissioning of the safety functions.



11. Back up the settings so that they are protected against power failure.



- 12. Switch off the converter power supply.
- 13. Wait until all LEDs on the converter are dark.
- 14. Switch on the converter power supply again.
- 15. Perform a **reduced** acceptance test.

Reduced acceptance test after component replacement and firmware change (Page 481)

You have transferred the settings from the memory card to the converter.

### 10.2.2.3 Download from BOP-2 operator panel

#### Overview

You can transfer the converter settings that are backed up on the BOP-2 operator panel back into the converter.

### Requirement

The following preconditions apply:

- You know the password for the converter safety functions.
- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Attach the Operator Panel to the converter.
- 2. Select the download from the operator panel to the converter.



3. Start the download.

ESE / DH OK

4. Wait until the download is completed.



5. After loading, check whether the converter outputs Alarm A01028.



- Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
- No alarm A01028: Proceed with the next step.

6. Back up the settings so that they are protected against power failure.

| MONITOR  | Extras   | OK 🔽 | RRM -> RDM |
|----------|----------|------|------------|
| ESE / DK | )K       |      |            |
| - £N2A - | - ]ONE - | OK   |            |

7. Start to commission the safety functions.



8. Enter the password for the safety functions.



9. Confirm the setting of the safety functions.



10. Exit commissioning of the safety functions.



11. Back up the settings so that they are protected against power failure.



- 12. Switch off the converter power supply.
- 13. Wait until all LEDs on the converter are dark.
- 14. Switch on the converter power supply again.
- 15. Perform a **reduced** acceptance test.

Reduced acceptance test after component replacement and firmware change (Page 481)

You have transferred the settings to the converter.

### 10.2.2.4 Download from IOP-2 operator panel

#### Overview

You can transfer the converter settings that are backed up on the IOP-2 operator panel back into the converter.

### Requirement

The following preconditions apply:

- You know the password for the converter safety functions.
- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Attach the Operator Panel to the converter.
- 2. Start the download.



- 3. Wait until the transfer is complete.
- 4. After loading, check whether the converter outputs Alarm A01028.



- Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
- No alarm A01028: Proceed with the next step.

5. Back up the settings so that they are protected against power failure.



Extras -Status screen wizard -Drive identity -Parameter settings -Panel settings

| <ul> <li>Drive factory reset</li> </ul>   |  |
|---|--|
| <ul> <li>Safe factory reset</li> </ul>    |  |
| <ul> <li>Default dataset</li> </ul>       |  |
| <ul> <li>Parameter saving mode</li> </ul> |  |
| <ul> <li>Save RAM to ROM</li> </ul>       |  |
|   |  |

#### 6. Select menu "Parameter".



- 7. To start commissioning of the safety functions, set p10 = 95.
- 8. Enter the password for the safety functions in p9761.
- 9. To confirm the settings of the safety functions, set p9701 = AC.
- 10. To exit commissioning of the safety functions, set p10 = 0.
- 11. Back up the settings so that they are protected against power failure.



- 12. Switch off the converter power supply.
- 13. Wait until all LEDs on the converter are dark.
- 14. Switch on the converter power supply again.
- 15. Perform a **reduced** acceptance test.

Reduced acceptance test after component replacement and firmware change (Page 481)

You have replaced the converter and transferred the safety function settings from the operator panel to the new converter.  $\Box$ 

### 10.2.2.5 Download from Smart Access

#### Overview

You can transfer the converter settings that are backed up on the digital terminal device back into the converter.

#### Requirement

The following preconditions apply:

- You know the password for the converter safety functions.
- The converter power supply has been switched on.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

### **Function description**

#### Procedure

- 1. Attach the Smart Access to the converter.
- 2. Connect your terminal device with the Smart Access.
- 3. Select the file for restoring the converter settings.



4. Back up the settings so that they are protected against power failure.



5. After loading, check whether the converter outputs Alarm A01028.



- Alarm A01028: The loaded settings are not compatible with the converter. Delete the alarm with p0971 = 1. Recommission the drive.
- No alarm A01028: Proceed with the next step.

6. Select menu "Parameter".



- 7. To start commissioning of the safety functions, set p10 = 95.
- 8. Enter the password for the safety functions in p9761.
- 9. To confirm the settings of the safety functions, set p9701 = AC.
- 10. To exit commissioning of the safety functions, set p10 = 0.
- 11. Back up the settings so that they are protected against power failure.

| Save to non-volatile memory   | $\times$ |  |  |  |
|---|----------|--|--|--|
| All parameter settings will be saved to r volatile memory.                          | 10N-     |  |  |  |
| You can choose between:<br>• The standard parameter set<br>• Suser default settings |          |  |  |  |
| Apply   |          |  |  |  |
| ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  | —∫ر      |  |  |  |
| 🗳 🖺 🖢   | Jø       |  |  |  |
|   |          |  |  |  |

- 12. Switch off the converter power supply.
- 13. Wait until all LEDs on the converter are dark.
- 14. Switch on the converter power supply again.
- 15. Perform a **reduced** acceptance test.

Reduced acceptance test after component replacement and firmware change (Page 481)
You transferred the settings from the Smart Access to the new converter.  $\hfill\square$ 

#### 10.2.2.6 Download from the PC using Startdrive

#### Overview

You can transfer the converter settings that have been backed up to a PC back to the converter.

#### Requirement

The following preconditions apply:

- The converter power supply has been switched on.
- The PC and converter are connected with one another via a USB cable or via the fieldbus.
- The converter settings are not protected against copying.
   Download with active know-how protection with copy protection (Page 468)

#### **Function description**

#### Procedure

- 1. In Startdrive, open the project that matches the drive.
- 2. Select "Load to device".
- 3. Connect Startdrive online with the drive. The converter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
- 4. Press the "Start safety commissioning" button.

| DDS: 0 (Active) CDS: 0 (Active)           | X Start safety commissioning                                  |
|---|---|
| ▶ Basic settings                          | Selecting cafety fund   |
| Inputs/outputs                            | Selecting salety lunci  |
| <ul> <li>Setpoint channel</li> </ul>      |   |
| <ul> <li>Operating mode</li> </ul>        | Activate the safety commissioning mode via the toolbar, ( 🕅 ) |
| <ul> <li>Drive functions</li> </ul>       | to configure and activate the safety functionality.           |
| Shutdown functions                        |   |
| Brake control                             | No safety function  |
| <ul> <li>Safety Integrated</li> </ul>     |   |
| Selecting safety functionality            |   |
| Vdc controller                            |   |
| Automatic restart function                |   |
| Flying restart                            |   |
| Messages/monitoring                       |   |
| <ul> <li>Application functions</li> </ul> |   |

5. Enter the password for the safety functions.

6. Press the "End safety commissioning" button.

| Pr    | oject Edit View Insert Online<br>🖥 🎦 🔒 Save project ا 🐰 🗎                               | Options Tools Window Help    | RM mets checks Hwcn<br>🙀 🖉 Go online 🦉 Go offline 🏭 🖪 🖪 🗶 🖃               |
|-------|---|------------------------------|---|
|       | Project_0_V13_SP1 ► Drive_0_:   | 2_PN_VECTOR [G120 CU250S-2 F | N Vector] > Parameter   |
|       | DDS: 0 (Active) CDS: 0 (Activ   | End safety commissioning 🗙   | 9   |
| itart | <ul> <li>Basic settings</li> <li>Inputs/outputs</li> <li>Setpoint channel</li> </ul>    | Selecting safety fu          | Selecting safety functionality  |
|       | <ul> <li>Operating mode</li> <li>Drive functions</li> <li>Shutdown functions</li> </ul> | Actual value sensing         | Configuring the actual value sensing                                      |
|       | Line contactor control  Brake control  Safety Integrated                                | Functions                    | Configuring the selected safety functions                                 |
|       | Vdc controller<br>Automatic restart function<br>Flying restart                          | Test stop                    | Setting the time interval for the test stop, to test the correct shutdown |
|       | Application functions     Communication     Interconnections                            | F-DI / F-DO / PROFIsafe      | Setting the filter time, discrepancy time, PROFIsafe<br>address           |

- 7. Confirm the prompt for saving your settings (copy RAM to ROM).
- 8. Disconnect the online connection.
- 9. Switch off the converter power supply.

10. Wait until all LEDs on the converter are dark.

- 11. Switch on the converter power supply again.
- 12. Perform a reduced acceptance test.

Reduced acceptance test after component replacement and firmware change (Page 481)

You transferred the settings from the PC to the new converter.

## 10.2.3 Download with active know-how protection with copy protection

#### Overview

The know-how protection function prevents converter settings from being copied. There are two options to avoid recommissioning after a converter has been replaced.

#### Requirement

The following preconditions apply:

- The end user uses a SIEMENS memory card.
- The machine manufacturer (OEM) has an identical machine.

#### **Function description**

# Procedure 1: The machine manufacturer only knows the serial number of the new converter

- 1. The end customer provides the machine manufacturer with the following information:
  - For which machine must the converter be replaced?
  - What is the serial number (r7758) of the new converter?
- 2. The machine manufacturer performs the following steps online on the prototype machine:
  - Deactivating know-how protection
     Activating and deactivating know-how protection (Page 218)
  - Enter the serial number of the new converter in p7759.
  - Enter the serial number of the inserted memory card as reference serial number in p7769.
  - Activate know-how protection with copy protection. "Copy RAM to ROM" must be activated.
  - Write the configuration with p0971 = 1 to the memory card.
  - Send the memory card to the end customer.
- 3. The end user inserts the memory card.
- 4. The end user switches on the converter power supply.
- 5. The converter checks the serial numbers of the card and the converter, and when there is a match the converter goes into the "Ready for switching on" state. If the numbers do not match, then the converter signals fault F13100 (no valid memory card).

The settings have been transferred to the converter.  $\hfill \square$ 

# Procedure 2: The machine manufacturer knows the serial number of the new converter and the serial number of the memory card

- 1. The end customer provides the machine manufacturer with the following information:
  - For which machine must the converter be replaced?
  - What is the serial number (r7758) of the new converter?
  - What is the serial number of the memory card?
- 2. The machine manufacturer performs the following steps online on the prototype machine:
  - Deactivating know-how protection
     Activating and deactivating know-how protection (Page 218)
  - Enter the serial number of the new converter in p7759.
  - Enter the serial number of the customer's memory card as reference serial number in p7769.
  - Activate know-how protection with copy protection. "Copy RAM to ROM" must be activated.
  - Write the configuration with p0971 = 1 to the memory card.
  - Copy the encrypted project from the card to the associated PC.
  - Send the encrypted project to the end customer, e.g. via e-mail.
- 3. The end user copies the project to the Siemens memory card that belongs to the machine.
- 4. The end user inserts the Siemens memory card into the converter.
- 5. The end user switches on the converter power supply.
- 6. The converter checks the serial numbers of the card and the converter, and when there is a match the converter goes into the "Ready for switching on" state. If the numbers do not match, then the converter signals fault F13100 (no valid memory card).

The settings have been transferred to the converter.  $\hfill\square$ 

10.3 Replacing a Power Module

## 10.3 Replacing a Power Module

#### Overview

You are only permitted to replace the Power Module by another Power Module under certain specific preconditions.

#### Requirement

The following preconditions apply when making a replacement:

- The new and replaced Power Modules have the same power rating.
- The new Power Module has a different power rating than the replaced Power Module, however still the same frame size.
   In this case, the rated power of the Power Module and the rated power of the motor must not differ too much.
   The following values are permissible for the quotients (rated motor power)/(rated Power Module power):
  - 200 V Power Modules and 400 V Power Modules: 0.25 ... 1.5
  - 690 V Power Modules: 0.5 ...1.5

#### Description

#### Procedure

- 1. Switch off the line voltage to the Power Module. You do not have to switch off an external 24 V power supply for the Control Unit if one is being used.
- 2. Remove the connecting cables of the Power Module.
- 3. Remove the Control Unit from the Power Module.
- 4. Replace the previous Power Module with the new Power Module.
- 5. Mount the Control Unit onto the new Power Module.
- 6. Connect up the new Power Module using the connecting cables.

#### NOTICE

#### Motor damage due to interchanged motor connecting cables

The direction in which the motor rotates switches if you exchange the two phases of the motor line. A motor with an incorrect direction of rotation can damage the machine or installation. Driven loads with only one permissible direction of rotation include certain compressors, saws and pumps, for example.

- Connect the 3 phases of the motor lines in the correct sequence.
- After replacing the Power Module, check the direction of motor rotation.

#### 10.3 Replacing a Power Module

- 7. Switch on the line supply and, if necessary, the 24 V supply of the Control Unit.
- 8. Perform a reduced acceptance test if the converter outputs fault F01641.
   Reduced acceptance test after component replacement and firmware change (Page 481)

You have successfully replaced the Power Module.  $\hfill\square$ 

10.4 PROFINET device name

## 10.4 PROFINET device name

#### Overview

Converters with PROFINET interface support "Device replacement without removable data storage medium".

#### Requirement

The topology of the PROFINET IO system with the IO device involved is configured in the higher-level control system.

#### **Function description**

The converter can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device names in the converter – or having to reassign the device names using a PG.

#### **Further information**

Details of the device replacement without removable storage medium can be found on the Internet:

PROFINET system description (<u>http://support.automation.siemens.com/WW/view/en/</u> 19292127)

## 10.5 Firmware upgrade and downgrade

## 10.5.1 Overview



## 10.5.2 Preparing the memory card

#### Overview

You can load the converter firmware from the Internet to a memory card.

#### Precondition

You have the appropriate memory card.

Recommended memory cards (Page 200)

#### **Function description**

#### Procedure

- Download the required firmware to your PC from the Internet.
   Download (<u>https://support.industry.siemens.com/cs/ww/en/view/67364620</u>)
- 2. Extract the files to a directory of your choice on your PC.
- 3. Transfer the unzipped files into the root directory of the memory card.

| USER.       | ATMG168.UFW | B2XX_BE.10     |
|-------------|-------------|----------------|
| B2XX_BE.15  | B2XX_DSP.10 | B2XX_DSP.15    |
| B2XX_S.5    | B2XX_S. 10  | B230.10        |
| BET200.10   | BG110M.10   | cbe20_1.ufw    |
| CONTENT.TXT | F230P.BIN   | F230P_BT.BIN   |
| F240B.BIN   | F240D.BIN   | F240E.BIN      |
| F250D.BIN   | F250S.BIN   | FET200.BIN     |
| FG110M.BIN  | FG120C.BIN  | img_G120MC.lst |
| UPDATE.CTR  | UPDATER.INF |                |

Figure 10-2 Example of memory card contents after the file transfer

Depending on the firmware, the filenames and the number of files may differ from the display above.

The "USER" directory does not exist on unused memory cards. After the memory card is plugged in for the first time, the converter creates a new "USER" directory.

You have prepared the memory card for the firmware upgrade or downgrade.  $\hfill\square$ 

## 10.5.3 Upgrading the firmware

#### Introduction

When upgrading the firmware, you replace the converter firmware by a later version.

#### Requirements

- Your converter's firmware is at least version V4.5.
- Converter and memory card have different firmware versions.

#### **Function Description**

#### Procedure

- 1. Switch off the converter power supply.
- 2. Wait until all LEDs on the converter are dark.
- 3. Insert the card with the matching firmware into the converter slot until it latches into place.
- 4. Switch on the converter power supply again.
- 5. The converter transfers the firmware from the memory card into its memory.

The transfer takes between 5 and 10 minutes.

While data is being transferred, the LED RDY on the converter stays red. The BF LED flashes orange with a variable frequency.

At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).
 Power supply failure during transfer

The converter firmware will be incomplete if the power supply fails during the transfer.

• Start again with step 1 of the instructions.



RDY

- 7. Switch off the converter power supply.
- 8. Wait until all LEDs on the converter are dark. Decide whether you want to withdraw the memory card from the converter:
  - You remove the memory card:
     ⇒ The converter keeps its settings.
  - You leave the memory card in the converter:
     ⇒ If the memory card still does not have a data backup of the converter settings, in step 9 the converter writes its settings to the memory card.
     ⇒ If the memory card already includes a data backup, the converter imports the settings from the memory card in step 9.
- 9. Switch on the converter power supply again.
- 10. If the firmware upgrade was successful, the converter LED RDY turns green after several seconds.

If the memory card is still inserted, depending on the previous content of the memory card, one of the two following cases has occurred:

- The memory card contains a data backup:
   ⇒ The converter has taken the settings from the memory card.
- There was no data backup on the memory card:
  - $\Rightarrow$  The converter has written its settings to the memory card.

You have upgraded the converter firmware.





## 10.5.4 Firmware downgrade

#### Overview

When downgrading the firmware, you replace the converter firmware by an older version.

#### Requirement

- Your converter's firmware is at least version V4.6.
- Converter and memory card have different firmware versions.
- You have backed up your settings on the memory card, in an Operator Panel or in a PC.

#### **Function Description**

#### Procedure

- 1. Switch off the converter power supply.
- 2. Wait until all LEDs on the converter are dark.
- 3. Insert the card with the matching firmware into the converter slot until it latches into place.
- 4. Switch on the converter power supply again.
- 5. The converter transfers the firmware from the memory card into its memory.

The transfer takes between 5 and 10 minutes.

While data is being transferred, the LED RDY on the converter stays red. The BF LED flashes orange with a variable frequency.

6. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

#### Power supply failure during transfer

The converter firmware will be incomplete if the power supply fails during the transfer.

• Start again with Step 1 of these instructions.



#### Corrective maintenance

#### 10.5 Firmware upgrade and downgrade

- 7. Switch off the converter power supply.
- 8. Wait until all LEDs on the converter are dark.
  - Decide whether you want to withdraw the memory card from the converter:
  - The memory card contains a data backup:
     ⇒ The converter has taken the settings from the memory card.
  - There was no data backup on the memory card:
     ⇒ The converter has the factory setting.
- 9. Switch on the converter power supply again.
- 10. If the firmware downgrade was successful, after several seconds the converter LED RDY turns green.

If the memory card is still inserted, depending on the previous content of the memory card, one of the two following cases has occurred:

- The memory card contains a data backup:
   ⇒ The converter has taken the settings from the memory card.
- There was no data backup on the memory card:
   ⇒ The converter has the factory setting.
- 11. If the memory card did not contain a data backup of the converter settings, then you must transfer your settings to the converter from another data backup.

Downloading the converter settings (Page 449)

You have replaced the converter firmware by an older version.





## 10.5.5 Correcting an unsuccessful firmware upgrade or downgrade

#### Requirements

- When upgrading, the converter has firmware version V4.5 as a minimum.
- When downgrading, as a minimum the converter has firmware version V4.6.

#### **Function Description**

- RDY

RF

To correct a failed firmware upgrade or downgrade you can check the following:

- Have you inserted the card properly?
- Does the card contain the correct firmware?

Repeat the firmware upgrade or downgrade

# 10.6 Reduced acceptance test after component replacement and firmware change

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

| Measure   | Acceptance test  |   |  |
|---|--|---|--|
|   | Acceptance test  | Documentation   |  |
| Replacing the Control Unit.   | No.<br>Only check the direc-<br>tion of rotation of the<br>motor.  | <ul><li>Supplement the converter data</li><li>Log the new checksums</li><li>Countersignature</li></ul>                          |  |
| Replacing the Power Module.   |  | Supplement the hardware version in the converter data   |  |
| Replacing the motor with an identi-<br>cal pole pair number           |  | No change.  |  |
| Replace the gearbox with an identi-<br>cal ratio                      |  |   |  |
| Replacing safety-related I/O devices<br>(e.g. Emergency Stop switch). | No.<br>Only check the control<br>of the safety functions<br>that are influenced by<br>the components that<br>have been replaced. | No change.  |  |
| Converter firmware update.  | No.  | <ul> <li>Supplement firmware version in the converter data</li> <li>Log the new checksums</li> <li>Countersignature.</li> </ul> |  |

10.7 If the converter no longer responds

## 10.7 If the converter no longer responds

#### If the converter no longer responds

For example, when loading an incorrect file from the memory card, the converter can go into a state where it can no longer respond to commands from the operator panel or from a higher-level control system. In this case, you must reset the converter to its factory setting and recommission it. This converter state is manifested in two different ways:

#### Case 1

- The motor is switched off.
- You cannot communicate with the converter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the converter has still not powered up.

#### Procedure

- 1. Remove the memory card if one is inserted in the converter.
- 2. Switch off the converter power supply.
- 3. Wait until all LEDs on the converter are dark. Then switch on the converter power supply again.
- 4. Repeat steps 2 and 3 as often as required until the converter outputs fault F01018.
- 5. Set p0971 = 1.
- 6. Switch off the converter power supply.
- 7. Wait until all LEDs on the converter are dark. Then switch on the converter power supply again.

The converter now powers up with the factory settings.

8. Recommission the converter.

You have restored the converter factory settings.

#### Case 2

- The motor is switched off.
- You cannot communicate with the converter, either via the operator panel or other interfaces.
- The LEDs flash and are dark this process is continually repeated.

#### Procedure

- 1. Remove the memory card if one is inserted in the converter.
- 2. Switch off the converter power supply.
- 3. Wait until all LEDs on the converter are dark. Then switch on the converter power supply again.
- 4. Wait until the LEDs flash orange.

- 5. Repeat steps 2 and 3 as often as required until the converter outputs fault F01018.
- 6. Now set p0971 = 1.
- 7. Switch off the converter power supply.
- 8. Wait until all LEDs on the converter are dark. Then switch on the converter power supply again.

The converter now powers up with the factory settings.

9. Recommission the converter.

You have restored the converter factory settings.  $\hfill\square$ 

#### The motor cannot be switched-on

If the motor cannot be switched-on, then check the following:

- Is a fault present? If there is, then remove the fault cause and acknowledge the fault.
- Has the converter been completely commissioned p0010 = 0? If not, the converter is e.g. still in a commissioning state.
- Is the converter reporting the "ready to start" status (r0052.0 = 1)?
- Is the converter missing some enable signals (r0046)?
- How does the converter receive its setpoint and commands? Digital inputs, analog inputs or fieldbus?

10.7 If the converter no longer responds

| Feature             | Data                         |  |
|---------------------|------------------------------|--|
| Fieldbus interface  | CU240B-2                     | With RS485 interface for the fol-<br>lowing protocols:Article numbers:• USSOverview of Control• USSUnits (Page 35)• Modbus RTU   |
|                     | CU240B-2 DP                  | With PROFIBUS interface  |
| Operating voltage   | You have two options for th  | e Control Unit power supply:   |
|                     | • Supply from the Power M    | Лodule   |
|                     | • External 20.4 V 28.8 \     | / DC supply via terminals 31 and 32.   |
|                     | The power supply is electric | ally isolated from the control terminals.  |
| Current consumption | ≤ 1.5 A                      |  |
| Power loss          | 5.0 W                        | Plus power loss of the output voltages.  |
| Output voltages     | +24 V out (terminal 9),18 V  | 28.8 V, max. 200 mA  |
|                     | +10 V out (terminals 1 and 3 | 35), 9.5 V 10.5 V, max. 10 mA  |
| Setpoint resolution | 0.01 Hz                      |  |
| Digital inputs      | 4 (DI 0 DI 3)                | Electrically isolated  |
|                     |                              | • Voltage: $\leq$ 30 V   |
|                     |                              | <ul> <li>Voltage for "low" state: &lt; 5 V</li> </ul>  |
|                     |                              | <ul> <li>Voltage for "high" state: &gt; 11 V</li> </ul>  |
|                     |                              | Current for 24 V input voltage: 2.7 mA 4.7 mA  |
|                     |                              | • Minimum current for the "high" state: 1.8 mA 3.9 mA  |
|                     |                              | Compatible to SIMATIC outputs  |
|                     |                              | • Response time for debounce time p0724 = 0: 5 ms  |
| Analog input        | 1 (AI 0)                     | Differential input   |
|                     |                              | • 12-bit resolution  |
|                     |                              | • 13 ms ± 1 ms response time   |
|                     |                              | • Switchable:  |
|                     |                              | <ul> <li>0 V 10 V or -10 V +10 V (typical power consumption:</li> <li>0.1 mA, voltage &lt; 35 V)</li> </ul>  |
|                     |                              | <ul> <li>0 mA 20 mA (120 Ω input resistance, voltage &lt; 10 V,<br/>current &lt; 80 mA)</li> </ul>   |
|                     |                              | <ul> <li>If AI 0 has been configured as additional digital input: Voltage &lt; 35 V, low &lt; 1.6 V, high &gt; 4.0 V, 13 ms ± 1 ms response time for debounce time p0724 = 0.</li> </ul> |
| Digital output      | 1 (DO 0)                     | • Relay output, 30 V DC / max. 0.5 A for ohmic loads   |
|                     |                              | Update time 2 ms   |

## 11.1 Technical data, CU240B-2 Control Unit

## 11.1 Technical data, CU240B-2 Control Unit

| Feature               | Data                                     |  |
|-----------------------|--|--|
| Analog output         | 1 (AO 0)                                 | • 0 V 10 V or 0 mA 20 mA   |
|                       |  | • 16-bit resolution  |
|                       |  | • 4 ms update time   |
|                       |  | • <400 mV offset at 0 %  |
| Temperature sensor    | РТС                                      | • Short-circuit monitoring $< 20 \Omega$                                 |
|                       |  | Overtemperature 1650 Ω   |
|                       | KTY84                                    | • Short-circuit monitoring $< 50 \Omega$                                 |
|                       |  | • Wire-break: > 2120 Ω   |
|                       | Pt1000                                   | <ul> <li>Short-circuit monitoring &lt; 603 Ω</li> </ul>                  |
|                       |  | • Wire-break > 2120 $\Omega$   |
|                       | Temperature switch with NC               | contact  |
| USB interface         | Mini-B                                   |  |
| Dimensions (WxHxD)    | 73 mm × 199 mm × 39 mm                   | The depth specification is valid when mounting on the Power Mod-<br>ule. |
| Weight                | 0.49 kg                                  |  |
| Memory cards          | Slot for SD or MMC memory                | cards  |
|                       | Recommended memo                         | ory cards (Page 200)   |
| Operating temperature | -10 °C 55 °C                             | Without inserted Operator Panel  |
|                       | 0 °C 50 °C                               | With inserted BOP-2 or IOP-2 operator panel                              |
|                       | Observe any possible restrict<br>Module. | ions regarding the operating temperature as a result of the Power        |
| Storage temperature   | - 40 °C 70 °C                            |  |
| Relative humidity     | < 95 %                                   | Condensation is not permissible.   |

| 11.2 | Technical data, CU240E-2 Control Unit |  |
|------|---------------------------------------|--|
|------|---------------------------------------|--|

| Feature             | Data                          |   |   |
|---------------------|-------------------------------|---|---|
| Fieldbus interface  | CU240E-2, CU240E-2 F          | With RS485 interface for the fol-<br>lowing protocols:<br>• USS<br>• Modbus RTU   | Article numbers:<br>() Overview of Control<br>Units (Page 35)                           |
|                     | CU240E-2 DP, CU240E-2 DP-F    | With PROFIBUS interface   | -   |
|                     | CU240E-2 PN,<br>CU240E-2 PN-F | With PROFINET interface   | -   |
| Operating voltage   | You have two options for the  | Control Unit power supply:  |   |
|                     | • Supply from the Power M     | odule   |   |
|                     | • External 20.4 V 28.8 V      | DC supply via terminals 31 and 32   | 2.  |
|                     | The power supply is electrica | lly isolated from the control termin  | nals.   |
| Current consumption | ≤ 1.5 A                       |   |   |
| Power loss          | 5.0 W                         | Plus power loss of the output vo  | ltages.   |
| Output voltages     | +24 V out (terminal 9),18 V . | 28.8 V, max. 200 mA   |   |
|                     | +10 V out (terminals 1 and 3  | 5), 9.5 V 10.5 V, max. 10 mA  |   |
| Setpoint resolution | 0.01 Hz                       |   |   |
| Digital inputs      | 6 (DI 0 DI 5)                 | Electrically isolated   |   |
|                     |                               | <ul> <li>Voltage: ≤ 30 V</li> </ul>   |   |
|                     |                               | • Voltage for "low" state: < 5 V  |   |
|                     |                               | • Voltage for "high" state: > 11  | V   |
|                     |                               | • Current for 24 V input voltag   | e: 2.7 mA 4.7 mA  |
|                     |                               | • Minimum current for the "hig  | gh" state: 1.8 mA 3.9 mA  |
|                     |                               | Compatible to SIMATIC output  | uts   |
|                     |                               | Response time for debounce  | time p0724 = 0: 5 ms  |
| Pulse input         | 1 (DI 3)                      | Maximum frequency 32 kHz  |   |
| Analog inputs       | 2 (AI 0, AI 1)                | Differential input  |   |
|                     |                               | • 12-bit resolution   |   |
|                     |                               | • 13 ms ± 1 ms response time  |   |
|                     |                               | • AI 0 and AI 1 can be switched   | d over:   |
|                     |                               | <ul> <li>0 V 10 V or -10 V +1</li> <li>0.1 mA, voltage &lt; 35 V)</li> </ul>  | 0 V (typical power consumption:   |
|                     |                               | <ul> <li>– 0 mA 20 mA (120 Ω in<br/>current &lt; 80 mA)</li> </ul>  | put resistance, voltage < 10 V,   |
|                     |                               | <ul> <li>If AI 0 and AI 1 are configured<br/>Voltage &lt; 35 V, low &lt; 1.6 V, hi<br/>time for debounce time p07.</li> </ul> | as supplementary digital inputs:<br>$gh > 4.0 V$ , 13 ms $\pm$ 1 ms response<br>24 = 0. |

## 11.2 Technical data, CU240E-2 Control Unit

| Feature                | Data   |  |
|------------------------|--|--|
| Digital outputs        | 3 (DO 0 DO 2)  | <ul> <li>DO 0: Relay output, 30 V DC / max. 0.5 A with resistive load</li> <li>DO 1: Transistor output, 30 VDC / max. 0.5 A with resistive load, protection against incorrect voltage polarity.</li> <li>Output current from DO1 for "low" state: ≤ 0.5 mA</li> <li>DO 2: Relay output, 30 V DC / max. 0.5 A with resistive load.</li> </ul> |
|                        |  | • 2 ms update time   |
|                        | For applications which requir referred to ground potential a                           | e UL certification, the voltage at DO 0 must not exceed 30 VDC and must be supplied via a grounded class 2 power supply.   |
| Analog outputs         | 2 (AO 0, AO 1)   | • 0 V 10 V or 0 mA 20 mA   |
|                        |  | 16-bit resolution  |
|                        |  | 4 ms update time   |
|                        |  | • <400 mV offset at 0 %  |
| Temperature sensor     | PTC  | • Short-circuit monitoring $< 20 \Omega$   |
|                        |  | Overtemperature 1650 Ω   |
|                        | KTY84  | • Short-circuit monitoring $< 50 \Omega$   |
|                        |  | • Wire-break: > 2120 Ω   |
|                        | Pt1000   | • Short-circuit monitoring < 603 $\Omega$  |
|                        |  | • Wire-break > 2120 Ω  |
|                        | Temperature switch with NC   | contact  |
| Failsafe digital input | 1 (DI 4 and DI 5)  | • If you enable safety function STO, then the failsafe digital input comprises the two digital inputs DI 4 and DI 5.   |
|                        |  | • Maximum input voltage 30 V, 5.5 mA   |
|                        |  | Response time:   |
|                        |  | <ul> <li>Typical: 5 ms + debounce time p9651</li> </ul>  |
|                        |  | <ul> <li>Typical, if debounce time = 0: 6 ms</li> </ul>  |
|                        |  | <ul> <li>Worst-case scenario: 15 ms + debounce time</li> </ul>   |
|                        |  | <ul> <li>Worst case, if debounce time = 0: 16 ms</li> </ul>  |
|                        | Extended safety function data can be found in the "Safety Integrated" function manual. |  |
| PFH                    | 5 × 10E-8  | Probability of failure of the safety functions (Probability of Failure per Hour)   |
| USB interface          | Mini-B   |  |
| Dimensions (WxHxD)     | 73 mm × 199 mm × 39 mm   | The depth specification is valid when mounting on the Power Mod-<br>ule.   |
| Weight                 | 0.49 kg  |  |
| Memory cards           | Slot for SD or MMC memory o  | cards.<br>ry cards (Page 200)  |

## 11.2 Technical data, CU240E-2 Control Unit

| Feature               | Data                              |   |
|-----------------------|-----------------------------------|---|
| Operating temperature | -10 °C 55 °C                      | CU240E-2, CU240E-2 F, CU240E-2 DP, CU240E-2 DP-F                          |
|                       |                                   | Without inserted Operator Panel   |
|                       | -10 °C 53 °C                      | CU240E-2 PN, CU240E-2 PN-F  |
|                       |                                   | Without inserted Operator Panel   |
|                       | 0 °C 50 °C                        | With inserted BOP-2 or IOP-2 operator panel                               |
|                       | Observe any possible r<br>Module. | restrictions regarding the operating temperature as a result of the Power |
| Storage temperature   | - 40 °C 70 °C                     |   |
| Relative humidity     | < 95 %                            | Condensation is not permissible.  |

11.3 Overload capability of the converter

## 11.3 Overload capability of the converter

Overload capability is the property of the converter to temporarily supply a current that is higher than the rated current to accelerate a load. Two typical load cycles are defined to clearly demonstrate the overload capability: "Low Overload" and "High Overload"

#### Definitions

#### Base load

Constant load between the accelerating phases of the drive

#### Low Overload

- LO base load input current Permissible input current for a "Low Overload" load cycle
- LO base load output current Permissible output current for a "Low Overload" load cycle
- LO base load power Rated power based on the LO base load output current

#### High Overload

- HO base load input current Permissible input current for a "High Overload" load cycle
- HO base load output current Permissible output current for a "High Overload" load cycle
- HO base load power Rated power based on the HO base load output current

If not specified otherwise, the power and current data in the technical data always refer to a load cycle according to Low Overload.

We recommend using the "SIZER" engineering software to select the converter.

You can find additional information about SIZER on the Internet:

Download SIZER (<u>http://support.automation.siemens.com/WW/view/en/</u> 10804987/130000)

#### Load cycles and typical applications:

#### "Low Overload" load cycle

The "Low Overload" load cycle assumes a uniform base load with low requirements placed on brief accelerating phases. Typical applications when designing according to "Low Overload" include:

- Pumps, fans and compressors
- Wet or dry blasting technology
- Mills, mixers, kneaders, crushers, agitators
- Basic spindles
- Rotary furnaces
- Extruders

#### "High Overload" load cycle

The "High Overload" load cycle permits dynamic accelerating phases at a reduced base load. Typical applications when designing according to "High Overload" include:

- Horizontal and vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors)
- Centrifuges
- Escalators/moving stairways
- Lifters/Lowerers
- Elevators
- Gantry cranes
- Cable railways
- Storage and retrieval machines

#### Protective devices for the Power Module

The fuses listed in the following tables are examples of suitable fuses.

Additional components for branch protection are available in the Internet:

Branch protection and short-circuit strength according to UL and IEC (<u>https://support.industry.siemens.com/cs/ww/en/view/109486009</u>)

## 11.4.1 High overload - low overload PM240-2

#### Typical converter load cycles



Figure 11-1 "Low Overload" and "High Overload" load cycles

| Property                           | Version   |  |
|------------------------------------|---|--|
| Ambient conditions for tran        | nsport in the transport packaging   |  |
| Air-conditioning                   | - 40 °C + 70 °C, according to Class 2K4 to EN 60721-3-2:1997<br>maximum humidity 95% at 40 °C |  |
| Mechanical system                  | Shocks and vibrations permissible according to 2M3 to IEC 60721-3-2:1997                      |  |
| Chemical substances                | Protected according to Class 2C2 to IEC 60721-3-2:1997  |  |
| Biological ambient condi-<br>tions | Suitable according to Class 2B1 to IEC 60721-3-2:1997   |  |
| Ambient conditions for long        | g-term storage in the product packaging or in transport packaging                             |  |
| Air-conditioning                   | - 25 °C + 55 °C, according to Class 1K3 to IEC 60721-3-1:1997                                 |  |
| Chemical substances                | Protected according to Class 1C2 to IEC 60721-3-1:1997  |  |
| Biological ambient condi-<br>tions | Suitable according to Class 1B1 to IEC 60721-3-1:1997   |  |
| Ambient conditions in operation    |   |  |
| Installation altitude              | Up to 1000 m above sea level without limitations  |  |
|                                    | Restrictions for special ambient conditions (Page 544)  |  |

| Property                           | Version   |
|------------------------------------|---|
| Air-conditioning 1)                | • FSA FSC ambient operating temperature <sup>2)</sup>   |
|                                    | <ul> <li>For operation according to Low Overload: -10 °C +40 °C</li> </ul>  |
|                                    | <ul> <li>For operation according to High Overload: -10 °C +50 °C</li> </ul>   |
|                                    | <ul> <li>–</li></ul>  |
|                                    | • FSD FSG ambient operating temperature <sup>2)</sup>   |
|                                    | <ul> <li>For operation according to Low Overload: -20 °C +40 °C</li> </ul>  |
|                                    | <ul> <li>For operation according to High Overload: -20 °C +50 °C</li> </ul>   |
|                                    | <ul> <li>–</li></ul>  |
|                                    | Relative humidity: 5 95%, condensation not permitted  |
|                                    | • Oil mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted |
| Mechanical system                  | Vibration test during operation according to IEC 60068-2-6 Test Fc (sinusoidal)   |
|                                    | • 0 57 Hz: 0.075 mm deflection amplitude  |
|                                    | • 57 150 Hz: 1 g acceleration amplitude   |
|                                    | 10 frequency cycles per axis  |
|                                    | Shock test according to IEC 60068-2-27 Test Ea (half-sine)  |
|                                    | 5 g peak acceleration   |
|                                    | 30 ms duration  |
|                                    | 3 shocks in all three axes in both directions   |
| Chemical substances                | Protected according to 3C2 to IEC 60721-3-3:2002  |
| Biological ambient condi-<br>tions | Suitable according to 3B1 to IEC 60721-3-3: 2002  |
| Pollution                          | Suitable for environments with degree of pollution 2 according to EN 61800-5-1  |
| Cooling                            | Forced air cooling AF, according to EN 60146  |
| Cooling air                        | Clean and dry air   |
| Noise emission                     | Maximum 75 db(A)  |

<sup>1)</sup> Increased ruggedness regarding temperature range and relative humidity; therefore better than 3K3 according to IEC 60721-3-3: 2002

<sup>2)</sup> Observe the permissible ambient operating temperatures for the Control Unit and the Operator Panel (IOP-2 or BOP-2).

| Property   | Version  |   |   |  |  |
|--|--|---|---|--|--|
| Line voltage   | FSA FSC  | 200 V 240 V 1 AC ± 10%  | 0.55 kW 4 kW - LO   |  |  |
|  |  |   | 0.37 kW 3 kW - HO   |  |  |
|  |  | 200 V 240 V 3 AC ± 10%  | 0.55 kW 7.5 kW - LO   |  |  |
|  |  |   | 0.37 kW 5.5 kW - HO   |  |  |
|  | FSD FSF  | 200 V 240 V 3 AC ± 10% (in op-  | 11 kW 55 kW - LO  |  |  |
|  |  | eration -20% < 1 min)   | 7.5 kW 45 kW - HO   |  |  |
| Line supply configurations                                 | Grounded TN/T  | T line supplies or non-grounded IT lin<br>cting the line supply and motor (Page   | ne supplies<br>e 83)  |  |  |
| Line impedance   | FSA FSC  | $2\% \le Uk < 4\%$ . For $Uk < 2\%$ , we rec<br>with the next higher power rating.  | commend a line reactor, or a Power Module                               |  |  |
|  | FSD FSF  | No restrictions   |   |  |  |
| Power factor $\lambda$                                     | FSA FSC  | 0.7 without line reactor for Uk $\ge 2\%$<br>0.85 with line reactor for Uk $< 2\%$  | 6   |  |  |
|  | FSD FSF  | > 0.9   |   |  |  |
| Output voltage   | 0 V 3 AC 0.9   | 5 × input voltage   |   |  |  |
| Input frequency  | 50 Hz 60 Hz,   | ± 3 Hz  |   |  |  |
| Output frequency   | 0 550 Hz, de   | 0 550 Hz, depending on the control mode   |   |  |  |
| Inrush current   | < LO base load                                       | < LO base load input current  |   |  |  |
| Overvoltage category ac-<br>cording to EN 61800-5-1        | III for line supplies                                |   |   |  |  |
| Pulse frequency  | 4 kHz (factory setting),                             |   |   |  |  |
|  | Adjustable in st                                     | eps of 2 kHz.<br>reduction as a function of the pulse   | frequency (Page 501)  |  |  |
|  | If you increase                                      | the pulse frequency, the converter re   | educes the maximum output current.                                      |  |  |
| Short-circuit current<br>(SCCR) and branch protec-<br>tion | Maximum pern   | nissible line short-circuit current $\leq$ 1C otection and short-circuit strength ac $y$ , siemens.com/cs/ww/en/view/1094 | 00 kA rms<br>ccording to UL and IEC ( <u>https://</u><br><u>79152</u> ) |  |  |
| Degree of protection ac-                                   | IP20   |   |   |  |  |
| cording to EN 60529  | IP55 PT device                                       | es outside the control cabinet  |   |  |  |
| Protection class according<br>to EN 61800-5-1              | The converters are devices with protection class I   |   |   |  |  |
| Touch protection according to EN 50274                     | DGUV regulation 3 when used for the intended purpose |   |   |  |  |
| Cooling in compliance with EN 60146                        | Forced air cooling AF                                |   |   |  |  |
| Safety Integrated  | See function m                                       | anual "Safety Integrated"   |   |  |  |
|  | () "Safety Inter <u>109751320</u> )                  | egrated" function manual ( <u>https://su</u>  | pport.industry.siemens.com/cs/ww/en/view/                               |  |  |

## 11.4.2 General technical data, 200 V converters

## 11.4.3 Specific technical data, 200 V converters

Table 11-1 PM240-2, IP20, frame size A, 200 V ... 240 V 1 AC / 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PB13-0UL0<br>6SL3210-1PB13-0AL0 | 6SL3210-1PB13-8UL0<br>6SL3210-1PB13-8AL0 |  |
|--|--|--|--|
| LO base load power                                     | 0.55 kW                                  | 0.75 kW                                  |  |
| 1 AC LO base load input current                        | 7.5 A                                    | 9.6 A                                    |  |
| 3 AC LO base load input current                        | 4.2 A                                    | 5.5 A                                    |  |
| LO base load output current                            | 3.2 A                                    | 4.2 A                                    |  |
| HO base load power                                     | 0.37 kW                                  | 0.55 kW                                  |  |
| 1 AC HO base load input current                        | 6.6 A                                    | 8.4 A                                    |  |
| 3 AC HO base load input current                        | 3.0 A                                    | 4.2 A                                    |  |
| HO base load output current                            | 2.3 A                                    | 3.2 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3805 (16 A)<br>15 A                   | 3NA3805 (16 A)<br>15 A                   |  |
| Power loss   | 0.04 kW                                  | 0.04 kW                                  |  |
| Required cooling air flow                              | 5 l/s                                    | 5 l/s                                    |  |
| Weight without filter                                  | 1.4 kg                                   | 1.4 kg                                   |  |
| Weight with filter                                     | 1.6 kg                                   | 1.6 kg                                   |  |

#### Table 11-2 PM240-2, PT, frame size A, 200 V ... 240 V 1 AC / 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PB13-8UL0<br>6SL3211-1PB13-8AL0 |  |
|--|--|--|
| LO base load power                                     | 0.75 kW                                  |  |
| 1 AC LO base load input current                        | 9.6 A                                    |  |
| 3 AC LO base load input current                        | 5.5 A                                    |  |
| LO base load output current                            | 4.2 A                                    |  |
| HO base load power                                     | 0.55 kW                                  |  |
| 1 AC HO base load input current                        | 8.4 A                                    |  |
| 3 AC HO base load input current                        | 4.2 A                                    |  |
| HO base load output current                            | 3.2 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3 805 (16 A)<br>15 A                  |  |
| Power loss   | 0.04 kW                                  |  |
| Required cooling air flow                              | 5 l/s                                    |  |
| Weight without filter                                  | 1.8 kg                                   |  |
| Weight with filter                                     | 2.0 kg                                   |  |

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PB15-5UL0<br>6SL3210-1PB15-5AL0 | 6SL3210-1PB17-4UL0<br>6SL3210-1PB17-4AL0 | 6SL3210-1PB21-0UL0<br>6SL3210-1PB21-0AL0 |
|--|--|--|--|
| LO base load power                                     | 1.1 kW                                   | 1.5 kW                                   | 2.2 kW                                   |
| 1 AC LO base load input current                        | 13.5 A                                   | 18.1 A                                   | 24.0 A                                   |
| 3 AC LO base load input current                        | 7.8 A                                    | 9.7 A                                    | 13.6 A                                   |
| LO base load output current                            | 6 A                                      | 7.4 A                                    | 10.4 A                                   |
| HO base load power                                     | 0.75 kW                                  | 1.1 kW                                   | 1.5 kW                                   |
| 1 AC HO base load input current                        | 11.8 A                                   | 15.8 A                                   | 20.9 A                                   |
| 3 AC HO base load input current                        | 5.5 A                                    | 7.8 A                                    | 9.7 A                                    |
| HO base load output current                            | 4.2 A                                    | 6 A                                      | 7.4 A                                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3812 (32 A)<br>35 A                   | 3NA3812 (32 A)<br>35 A                   | 3NA3812 (32 A)<br>35 A                   |
| Power loss   | 0.05 kW                                  | 0.07 kW                                  | 0.12 kW                                  |
| Required cooling air flow                              | 9.2 l/s                                  | 9.2 l/s                                  | 9.2 l/s                                  |
| Weight without filter                                  | 2.8 kg                                   | 2.8 kg                                   | 2.8 kg                                   |
| Weight with filter                                     | 3.1 kg                                   | 3.1 kg                                   | 3.1 kg                                   |

Table 11-3 PM240-2, IP20, frame size B, 200 V ... 240 V 1 AC / 3 AC

#### Table 11-4 PM240-2, PT, frame size B, 200 V ... 240 V 1 AC / 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PB21-0UL0<br>6SL3211-1PB21-0AL0 |  |
|--|--|--|
| LO base load power                                     | 2.2 kW                                   |  |
| 1 AC LO base load input current                        | 24.0 A                                   |  |
| 3 AC LO base load input current                        | 13.6 A                                   |  |
| LO base load output current                            | 10.4 A                                   |  |
| HO base load power                                     | 1.5 kW                                   |  |
| 1 AC HO base load input current                        | 20.9 A                                   |  |
| 3 AC HO base load input current                        | 9.7 A                                    |  |
| HO base load output current                            | 7.4 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3812 (32 A)<br>35 A                   |  |
| Power loss   | 0.12 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 9.2 l/s                                  |  |
| Weight without filter                                  | 3.4 kg                                   |  |
| Weight with filter                                     | 3.7 kg                                   |  |

<sup>1)</sup> approx. 0.08 kW through the heat sink

#### Table 11-5 PM240-2, IP 20, frame size C, 200 V ... 240 V 1 AC / 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PB21-4UL0<br>6SL3210-1PB21-4AL0 | 6SL3210-1PB21-8UL0<br>6SL3210-1PB21-8AL0 |  |
|--|--|--|--|
| LO base load power                                     | 3 kW                                     | 4 kW                                     |  |
| 1 AC LO base load input current                        | 35.9 A                                   | 43.0 A                                   |  |
| 3 AC LO base load input current                        | 17.7 A                                   | 22.8 A                                   |  |
| LO base load output current                            | 13.6 A                                   | 17.5 A                                   |  |
| HO base load power                                     | 2.2 kW                                   | 3 kW                                     |  |
| 1 AC HO base load input current                        | 31.3 A                                   | 37.5 A                                   |  |
| 3 AC HO base load input current                        | 13.6 A                                   | 17.7 A                                   |  |
| HO base load output current                            | 10.4 A                                   | 13.6 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.14 kW                                  | 0.18 kW                                  |  |
| Required cooling air flow                              | 18.5 l/s                                 | 18.5 l/s                                 |  |
| Weight without filter                                  | 5.0 kg                                   | 5.0 kg                                   |  |
| Weight with filter                                     | 5.2 kg                                   | 5.2 kg                                   |  |

#### Table 11-6 PM240-2, PT, frame size C, 200 V ... 240 V 1 AC / 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PB21-8UL0<br>6SL3211-1PB21-8AL0 |  |
|--|--|--|
| LO base load power                                     | 4 kW                                     |  |
| 1 AC LO base load input current                        | 43.0 A                                   |  |
| 3 AC LO base load input current                        | 22.8 A                                   |  |
| LO base load output current                            | 17.5 A                                   |  |
| HO base load power                                     | 3 kW                                     |  |
| 1 AC HO base load input current                        | 37.5 A                                   |  |
| 3 AC HO base load input current                        | 17.7 A                                   |  |
| HO base load output current                            | 13.6 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.18 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 18.5 l/s                                 |  |
| Weight without filter                                  | 5.9 kg                                   |  |
| Weight with filter                                     | 6.2 kg                                   |  |

<sup>1)</sup> approx. 0.09 kW through the heat sink

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PC22-2UL0<br>6SL3210-1PC22-2AL0 | 6SL3210-1PC22-8UL0<br>6SL3210-1PC22-8AL0 |  |
|--|--|--|--|
| LO base load power                                     | 5.5 kW                                   | 7.5 kW                                   |  |
| LO base load input current                             | 28.6 A                                   | 36.4 A                                   |  |
| LO base load output current                            | 22.0 A                                   | 28.0 A                                   |  |
| HO base load power                                     | 4 kW                                     | 5.5 kW                                   |  |
| HO base load input current                             | 22.8 A                                   | 28.6 A                                   |  |
| HO base load output current                            | 17.5 A                                   | 22.0 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.2 kW                                   | 0.26 kW                                  |  |
| Required cooling air flow                              | 18.5 l/s                                 | 18.5 l/s                                 |  |
| Weight without filter                                  | 5.0 kg                                   | 5.0 kg                                   |  |
| Weight with filter                                     | 5.2 kg                                   | 5.2 kg                                   |  |

| Table 11-7 | PM240-2     | IP 20  | frame size    | C 200 V  | 240 V 3 AC |
|------------|-------------|--------|---------------|----------|------------|
|            | 1 101240-2, | II 20, | II allie size | C, 200 V | ZHU V J AC |

#### Table 11-8 PM240-2, PT, frame size C, 200 V ... 240 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PC22-2UL0<br>6SL3211-1PC22-2AL0 | 6SL3211-1PC22-8UL0<br>6SL3211-1PC22-8AL0 |  |
|--|--|--|--|
| LO base load power                                     | 5.5 kW                                   | 7.5 kW                                   |  |
| LO base load input current                             | 28.6 A                                   | 36.4 A                                   |  |
| LO base load output current                            | 22.0 A                                   | 28.0 A                                   |  |
| HO base load power                                     | 4 kW                                     | 5.5 kW                                   |  |
| HO base load input current                             | 22.8 A                                   | 28.6 A                                   |  |
| HO base load output current                            | 17.5 A                                   | 22.0 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.2 kW <sup>1)</sup>                     | 0.26 kW <sup>2)</sup>                    |  |
| Required cooling air flow                              | 18.5 l/s                                 | 18.5 l/s                                 |  |
| Weight without filter                                  | 5.9 kg                                   | 5.9 kg                                   |  |
| Weight with filter                                     | 6.2 kg                                   | 6.2 kg                                   |  |

<sup>1)</sup> approx. 0.2 kW through the heatsink

<sup>2)</sup> approx. 0.25 kW through the heatsink

| Table 11-9 | PM240-2, IP20, | frame size D, | 200 V . | 240 V 3 AC |
|------------|----------------|---------------|---------|------------|
|------------|----------------|---------------|---------|------------|

| Article No. without filter | 6SL3210-1PC24-2UL0 | 6SL3210-1PC25-4UL0 | 6SL3210-1PC26-8UL0 |
|----------------------------|--------------------|--------------------|--------------------|
| LO base load power         | 11 kW              | 15 kW              | 18.5 kW            |
| LO base load input current | 40 A               | 51 A               | 64 A               |

| Article No. without filter                             | 6SL3210-1PC24-2UL0     | 6SL3210-1PC25-4UL0     | 6SL3210-1PC26-8UL0      |
|--|------------------------|------------------------|-------------------------|
| LO base load output current                            | 42 A                   | 54 A                   | 68 A                    |
| HO base load power                                     | 7.5 kW                 | 11 kW                  | 15 kW                   |
| HO base load input current                             | 36 A                   | 43 A                   | 56 A                    |
| HO base load output current                            | 35 A                   | 42 A                   | 54 A                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3822 (63 A)<br>60 A | 3NA3824 (80 A)<br>70 A | 3NA3830 (100 A)<br>90 A |
| Power loss   | 0.45 kW                | 0.61 kW                | 0.82 kW                 |
| Required cooling air flow                              | 55 l/s                 | 55 l/s                 | 55 l/s                  |
| Weight   | 18.3 kg                | 18.3 kg                | 18.3 kg                 |

#### Table 11-10 PM240-2, PT, frame size D, 200 V ... 240 V 3 AC

| Article No. without filter                             | 6SL3211-1PC26-8UL0      |  |
|--|-------------------------|--|
| LO base load power                                     | 18.5 kW                 |  |
| LO base load input current                             | 64 A                    |  |
| LO base load output current                            | 68 A                    |  |
| HO base load power                                     | 15 kW                   |  |
| HO base load input current                             | 56 A                    |  |
| HO base load output current                            | 54 A                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3830 (100 A)<br>90 A |  |
| Power loss   | 0.82 kW <sup>1)</sup>   |  |
| Required cooling air flow                              | 55 l/s                  |  |
| Weight   | 19.5 kg                 |  |

<sup>1)</sup> approx. 0.72 kW through the heatsink

| Table 11-11 PM24 | 0-2, IP20, | , frame size E, | 200 V | 240 V 3 AC |
|------------------|------------|-----------------|-------|------------|
|------------------|------------|-----------------|-------|------------|

| Article No. without filter                             | 6SL3210-1PC28-0UL0       | 6SL3210-1PC31-1UL0       |  |
|--|--------------------------|--------------------------|--|
| LO base load power                                     | 22 kW                    | 30 kW                    |  |
| LO base load input current                             | 76 A                     | 98 A                     |  |
| LO base load output current                            | 80 A                     | 104 A                    |  |
| HO base load power                                     | 18.5 kW                  | 22 kW                    |  |
| HO base load input current                             | 71 A                     | 83 A                     |  |
| HO base load output current                            | 68 A                     | 80 A                     |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3830 (100 A)<br>100 A | 3NA3836 (160 A)<br>150 A |  |
| Power loss   | 0.92 kW                  | 1.28 kW                  |  |

| Article No. without filter | 6SL3210-1PC28-0UL0 | 6SL3210-1PC31-1UL0 |  |
|----------------------------|--------------------|--------------------|--|
| Required cooling air flow  | 83 l/s             | 83 l/s             |  |
| Weight                     | 26.8 kg            | 26.8 kg            |  |

#### Table 11-12 PM240-2, PT, frame size E, 200 V to 240 V 3 AC

| Article No. without filter                             | 6SL3211-1PC31-1UL0       |  |
|--|--------------------------|--|
| LO base load power                                     | 30 kW                    |  |
| LO base load input current                             | 98 A                     |  |
| LO base load output current                            | 104 A                    |  |
| HO base load power                                     | 22 kW                    |  |
| HO base load input current                             | 83 A                     |  |
| HO base load output current                            | 80 A                     |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3836 (160 A)<br>150 A |  |
| Power loss   | 1.28 kW <sup>1)</sup>    |  |
| Required cooling air flow                              | 83 l/s                   |  |
| Weight   | 29.5 kg                  |  |

<sup>1)</sup> approx. 1.1 kW through the heatsink

| Article No. without filter                             | 6SL3210-1PC31-3UL0       | 6SL3210-1PC31-6UL0       | 6SL3210-1PC31-8UL0       |
|--|--------------------------|--------------------------|--------------------------|
| LO base load power                                     | 37 kW                    | 45 kW                    | 55 kW                    |
| LO base load input current                             | 126 A                    | 149 A                    | 172 A                    |
| LO base load output current                            | 130 A                    | 154 A                    | 178 A                    |
| HO base load power                                     | 30 kW                    | 37 kW                    | 45 kW                    |
| HO base load input current                             | 110 A                    | 138 A                    | 164 A                    |
| HO base load output current                            | 104 A                    | 130 A                    | 154 A                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3140 (200 A)<br>175 A | 3NA3140 (200 A)<br>200 A | 3NA3142 (224 A)<br>250 A |
| Power loss   | 1.38 kW                  | 1.72 kW                  | 2.09 kW                  |
| Required cooling air flow                              | 153 l/s                  | 153 l/s                  | 153 l/s                  |
| Weight   | 58 kg                    | 58 kg                    | 58 kg                    |

#### Table 11-13 PM240-2, IP20, frame size F, 200 V ... 240 V 3 AC

#### Table 11-14 PM240-2, PT, frame size F, 200 V to 240 V 3 AC

| Article No. without filter                             | 6SL3211-1PC31-8UL0       |  |
|--|--------------------------|--|
| LO base load power                                     | 55 kW                    |  |
| LO base load input current                             | 172 A                    |  |
| LO base load output current                            | 178 A                    |  |
| HO base load power                                     | 45 kW                    |  |
| HO base load input current                             | 164 A                    |  |
| HO base load output current                            | 154 A                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3142 (224 A)<br>250 A |  |
| Power loss   | 2.09 kW <sup>1)</sup>    |  |
| Required cooling air flow                              | 153 l/s                  |  |
| Weight   | 60.5 kg                  |  |

<sup>1)</sup> approx. 1.9 kW through the heatsink

## 11.4.4 Current derating depending on the pulse frequency, 200 V converters

#### LO base load

| Article number       | LO    | Pulse frequency [kHz] |      |         |         |          |          |      |      |
|----------------------|-------|-----------------------|------|---------|---------|----------|----------|------|------|
|                      | power | 2                     | 4 *) | 6       | 8       | 10       | 12       | 14   | 16   |
|                      | [KVV] |                       |      | LO base | load ou | tput cur | rent [A] |      |      |
| 6SL3210-1PB13-0.L0   | 0.55  | 3.2                   | 3.2  | 2.7     | 2.2     | 1.9      | 1.6      | 1.4  | 1.3  |
| 6SL3211PB13-8.L0     | 0.75  | 4.2                   | 4.2  | 3.6     | 2.9     | 2.5      | 2.1      | 1.9  | 1.7  |
| 6SL3210-1PB15-5.L0   | 1.1   | 6                     | 6    | 5.1     | 4.2     | 3.6      | 3        | 2.7  | 2.4  |
| 6SL3210-1PB17-4.L0   | 1.5   | 7.4                   | 7.4  | 6.3     | 5.2     | 4.4      | 3.7      | 3.3  | 3    |
| 6SL3211PB21-0.L0     | 2.2   | 10.4                  | 10.4 | 8.8     | 7.3     | 6.2      | 5.2      | 4.7  | 4.2  |
| 6SL3210-1PB21-4.L0   | 3     | 13.6                  | 13.6 | 11.6    | 9.5     | 8.2      | 6.8      | 6.1  | 5.4  |
| 6SL3211PB21-8.L0     | 4     | 17.5                  | 17.5 | 14.9    | 12.3    | 10.5     | 8.8      | 7.9  | 7    |
| 6SL3210-1PC22-2 . L0 | 5.5   | 22                    | 22   | 18.7    | 15.4    | 13.2     | 11       | 9.9  | 8.8  |
| 6SL3210-1PC22-8 . L0 | 7.5   | 28                    | 28   | 23.8    | 19.6    | 16.8     | 14       | 12.6 | 11.2 |
| 6SL3210-1PC24-2UL0   | 11    | 42                    | 42   | 35.7    | 29.4    | 25.2     | 21       | 18.9 | 16.8 |
| 6SL3210-1PC25-4UL0   | 15    | 54                    | 54   | 45.9    | 37.8    | 32.4     | 27       | 24.3 | 21.6 |
| 6SL3211PC26-8UL0     | 18.5  | 68                    | 68   | 57.8    | 47.6    | 40.8     | 34       | 30.6 | 27.2 |
| 6SL3210-1PC28-0UL0   | 22    | 80                    | 80   | 68      | 56      | 48       | 40       | 36   | 32   |
| 6SL3211PC31-1UL0     | 30    | 104                   | 104  | 88.4    | 72.8    | 62.4     | 52       | 46.8 | 41.6 |
| 6SL3210-1PC31-3UL0   | 37    | 130                   | 130  | 110.5   | 91      |          |          |      |      |
| 6SL3210-1PC31-6UL0   | 45    | 154                   | 154  | 130.9   | 107.8   |          |          |      |      |
| 6SL3211PC31-8UL0     | 55    | 178                   | 178  | 151.3   | 124.6   |          |          |      |      |

\*) Factory setting

The permissible motor cable length depends on the particular cable type and the pulse frequency that has been selected.

## 11.4.5 General technical data, 400 V converters

| Property  | Version  |   |  |  |  |
|---|--|---|--|--|--|
| Line voltage  | FSA FSC  | 380 V 480 V 3 AC ± 10%  |  |  |  |
|   | FSD FSG  | 380 V (-20 %) 480 V 3 AC + 10%  |  |  |  |
| Line supply configurations                          | Grounded TN/T  | T line supplies or non-grounded IT line supplies ing the line supply and motor (Page 83)  |  |  |  |
| Line impedance                                      | FSA FSC $1\% \le Uk < 4\%$ , for values smaller than 1%, we recommend a line reac<br>Power Module with the next higher power rating. |   |  |  |  |
|   | FSD FSG  | No restrictions   |  |  |  |
| Power factor $\lambda$                              | FSA FSC0.7 without line reactor for Uk $\geq$ 1%0.85 with line reactor for Uk < 1%   |   |  |  |  |
|   | FSD FSG  | > 0.9   |  |  |  |
| Output voltage                                      | 0 V 3 AC 0.9   | 5 x input voltage (max.)  |  |  |  |
| Input frequency                                     | 50 Hz 60 Hz  | , ± 3 Hz  |  |  |  |
| Output frequency                                    | 0 550 Hz, de   | pending on the control mode   |  |  |  |
| Inrush current                                      | < LO base load   | input current   |  |  |  |
| Overvoltage category ac-<br>cording to EN 61800-5-1 | III for line supp  | lies  |  |  |  |
| Pulse frequency                                     | Factory setting  |   |  |  |  |
|   | • 4 kHz for de   | evices with an LO base load power < 110 kW  |  |  |  |
|   | • 2 kHz for de   | evices with an LO base load power $\geq$ 110 kW   |  |  |  |
|   | Can be adjuste   | d in 2 kHz steps as follows:  |  |  |  |
|   | • 2 kHz 16   | kHz for devices with an LO base load power < 55 kW  |  |  |  |
|   | • 2 kHz 8 k  | Hz for devices with an LO base load output of 55 kW 250 kW  |  |  |  |
|   | If you increase  | the pulse frequency, the converter reduces the maximum output current.  |  |  |  |
|   | Current  | reduction as a function of the pulse frequency (Page 511)   |  |  |  |
| Short-circuit current (SCCR)                        | Maximum perr   | nissible line short-circuit current ≤ 100 kA rms  |  |  |  |
| and branch protection                               | Branch pr<br>support.indust  | otection and short-circuit strength according to UL and IEC ( <u>https://</u><br>r <u>y.siemens.com/cs/ww/en/view/109801083</u> ) |  |  |  |
| Braking methods                                     | DC braking, co   | mpound braking, dynamic braking with integrated braking chopper   |  |  |  |
| Degree of protection accord-                        | IP20   |   |  |  |  |
| ing to EN 60529                                     | IP55 PT devic  | es outside the control cabinet  |  |  |  |
| Protection class according to EN 61800-5-1          | The converters are devices with protection class I   |   |  |  |  |
| Touch protection according to EN 50274              | DGUV regulation  | on 3 when used for the intended purpose   |  |  |  |
| Cooling in compliance with<br>EN 60146              | Forced air coo   | ling AF   |  |  |  |
| Safety Integrated                                   | See function m   | anual "Safety Integrated"   |  |  |  |
|   | () "Safety Int<br><u>109751320</u> )   | egrated" function manual ( <u>https://support.industry.siemens.com/cs/ww/en/view/</u>   |  |  |  |
# 11.4.6 Specific technical data, 400 V converters

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE11-8UL1<br>6SL3210-1PE11-8AL1 | 6SL3210-1PE12-3UL1<br>6SL3210-1PE12-3AL1 | 6SL3210-1PE13-2UL1<br>6SL3210-1PE13-2AL1 |
|--|--|--|--|
| LO base load power                                     | 0.55 kW                                  | 0.75 kW                                  | 1.1 kW                                   |
| LO base load input current                             | 2.3 A                                    | 2.9 A                                    | 4.1 A                                    |
| LO base load output current                            | 1.7 A                                    | 2.2 A                                    | 3.1 A                                    |
| HO base load power                                     | 0.37 kW                                  | 0.55 kW                                  | 0.75 kW                                  |
| HO base load input current                             | 2.0 A                                    | 2.6 A                                    | 3.3 A                                    |
| HO base load output current                            | 1.3 A                                    | 1.7 A                                    | 2.2 A                                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3803 (10 A)<br>10 A                   | 3NA3803 (10 A)<br>10 A                   | 3NA3805 (16 A)<br>15 A                   |
| Power loss   | 0.04 kW                                  | 0.04 kW                                  | 0.04 kW                                  |
| Required cooling air flow                              | 5 l/s                                    | 5 l/s                                    | 5 l/s                                    |
| Weight without filter                                  | 1.3 kg                                   | 1.3 kg                                   | 1.3 kg                                   |
| Weight with filter                                     | 1.5 kg                                   | 1.5 kg                                   | 1.5 kg                                   |

Table 11-15 PM240-2, IP20, frame size A, 380 V ... 480 V 3 AC

#### Table 11-16 PM240-2, IP20, frame size A, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE14-3UL1<br>6SL3210-1PE14-3AL1 | 6SL3210-1PE16-1UL1<br>6SL3210-1PE16-1AL1 | 6SL3210-1PE18-0UL1<br>6SL3210-1PE18-0AL1 |
|--|--|--|--|
| LO base load power                                     | 1.5 kW                                   | 2.2 kW                                   | 3.0 kW                                   |
| LO base load input current                             | 5.5 A                                    | 7.7 A                                    | 10.1 A                                   |
| LO base load output current                            | 4.1 A                                    | 5.9 A                                    | 7.7 A                                    |
| HO base load power                                     | 1.1 kW                                   | 1.5 kW                                   | 2.2 kW                                   |
| HO base load input current                             | 4.7 A                                    | 6.1 A                                    | 8.8 A                                    |
| HO base load output current                            | 3.1 A                                    | 4.1 A                                    | 5.9 A                                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3805 (16 A)<br>15 A                   | 3NA3805 (16 A)<br>15 A                   | 3NA3805 (16 A)<br>15 A                   |
| Power loss   | 0.07 kW                                  | 0.1 kW                                   | 0.12 kW                                  |
| Required cooling air flow                              | 5 l/s                                    | 5 l/s                                    | 5 l/s                                    |
| Weight without filter                                  | 1.4 kg                                   | 1.4 kg                                   | 1.4 kg                                   |
| Weight with filter                                     | 1.6 kg                                   | 1.6 kg                                   | 1.6 kg                                   |

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE18-0UL1<br>6SL3211-1PE18-0AL1 |  |
|--|--|--|
| LO base load power                                     | 3.0 kW                                   |  |
| LO base load input current                             | 10.1 A                                   |  |
| LO base load output current                            | 7.7 A                                    |  |
| HO base load power                                     | 2.2 kW                                   |  |
| HO base load input current                             | 8.8 A                                    |  |
| HO base load output current                            | 5.9 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3805 (16 A)<br>15 A                   |  |
| Power loss without filter                              | 0.12 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 7 l/s                                    |  |
| Weight without filter                                  | 1.8 kg                                   |  |
| Weight with filter                                     | 2.0 kg                                   |  |

Table 11-17 PM240-2, PT, frame size A, 380 V ... 480 V 3 AC

1) approx. 0.1 kW through the heatsink

| Table 11-18 | PM240-2, IP20, | , frame size B, | 380 V | 480 V 3 AC |
|-------------|----------------|-----------------|-------|------------|
|-------------|----------------|-----------------|-------|------------|

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE21-1UL0<br>6SL3210-1PE21-1AL0 | 6SL3210-1PE21-4UL0<br>6SL3210-1PE21-4AL0 | 6SL3210-1PE21-8UL0<br>6SL3210-1PE21-8AL0 |
|--|--|--|--|
| LO base load power                                     | 4.0 kW                                   | 5.5 kW                                   | 7.5 kW                                   |
| LO base load input current                             | 13.3 A                                   | 17.2 A                                   | 22.2 A                                   |
| LO base load output current                            | 10.2 A                                   | 13.2 A                                   | 18.0 A                                   |
| HO base load power                                     | 3.0 kW                                   | 4.0 kW                                   | 5.5 kW                                   |
| HO base load input current                             | 11.6 A                                   | 15.3 A                                   | 19.8 A                                   |
| HO base load output current                            | 7.7 A                                    | 10.2 A                                   | 13.2 A                                   |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3812 (32 A)<br>35 A                   | 3NA3812 (32 A)<br>35 A                   | 3NA3812 (32 A)<br>35 A                   |
| Power loss   | 0.11 kW                                  | 0.15 kW                                  | 0.2 kW                                   |
| Required cooling air flow                              | 9.2 l/s                                  | 9.2 l/s                                  | 9.2 l/s                                  |
| Weight without filter                                  | 2.9 kg                                   | 2.9 kg                                   | 3.0 kg                                   |
| Weight with filter                                     | 3.1 kg                                   | 3.1 kg                                   | 3.2 kg                                   |

Table 11-19 PM240-2, PT, frame size B, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter | 6SL3211-1PE21-8UL0<br>6SL3211-1PE21-8AL0 |  |
|---|--|--|
| LO base load power                                    | 7.5 kW                                   |  |
| LO base load input current                            | 22.2 A                                   |  |
| LO base load output current                           | 18.0 A                                   |  |

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE21-8UL0<br>6SL3211-1PE21-8AL0 |  |
|--|--|--|
| HO base load power                                     | 5.5 kW                                   |  |
| HO base load input current                             | 19.8 A                                   |  |
| HO base load output current                            | 13.7 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3812 (32 A)<br>35 A                   |  |
| Power loss   | 0.2 kW <sup>1)</sup>                     |  |
| Required cooling air flow                              | 9.2 l/s                                  |  |
| Weight without filter                                  | 3.6 kg                                   |  |
| Weight with filter                                     | 3.9 kg                                   |  |

1) approx. 0.16 kW through the heatsink

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE22-7UL0<br>6SL3210-1PE22-7AL0 | 6SL3210-1PE23-3UL0<br>6SL3210-1PE23-3AL0 |  |
|--|--|--|--|
| LO base load power                                     | 11.0 kW                                  | 15.0 kW                                  |  |
| LO base load input current                             | 32.6 A                                   | 39.9 A                                   |  |
| LO base load output current                            | 26.0 A                                   | 32.0 A                                   |  |
| HO base load power                                     | 7.5 kW                                   | 11.0 kW                                  |  |
| HO base load input current                             | 27.0 A                                   | 36.0 A                                   |  |
| HO base load output current                            | 18.0 A                                   | 26.0 A                                   |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.3 kW                                   | 0.37 kW                                  |  |
| Required cooling air flow                              | 18.5 l/s                                 | 18.5 l/s                                 |  |
| Weight without filter                                  | 4.7 kg                                   | 4.8 kg                                   |  |
| Weight with filter                                     | 5.3 kg                                   | 5.4 kg                                   |  |

| Table 11-20 | PM240-2, | , IP20, fram | e size C, 380 | V 480 V 3 AC |
|-------------|----------|--------------|---------------|--------------|
|-------------|----------|--------------|---------------|--------------|

| Article No. without filter<br>Article No. with filter | 6SL3211-1PE23-3UL0<br>6SL3211-1PE23-3AL0 |  |
|---|--|--|
| LO base load power                                    | 15.0 kW                                  |  |
| LO base load input current                            | 39.9 A                                   |  |
| LO base load output current                           | 32.0 A                                   |  |
| HO base load power                                    | 11.0 kW                                  |  |
| HO base load input current                            | 36.0 A                                   |  |
| HO base load output current                           | 26.0 A                                   |  |

Table 11-21 PM240-2, PT, frame size C, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE23-3UL0<br>6SL3211-1PE23-3AL0 |  |
|--|--|--|
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3820 (50 A)<br>50 A                   |  |
| Power loss   | 0.37 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 18.5 l/s                                 |  |
| Weight without filter                                  | 5.8 kg                                   |  |
| Weight with filter                                     | 6.3 kg                                   |  |

1) approx. 0.3 kW through the heatsink

#### Table 11-22 PM240-2, IP20, frame size D, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE23-8UL0<br>6SL3210-1PE23-8AL0 | 6SL3210-1PE24-5UL0<br>6SL3210-1PE24-5AL0 | 6SL3210-1PE26-0UL0<br>6SL3210-1PE26-0AL0 |
|--|--|--|--|
| LO base load power                                     | 18.5 kW                                  | 22 kW                                    | 30 kW                                    |
| LO base load input current                             | 36 A                                     | 42 A                                     | 57 A                                     |
| LO base load output current                            | 38 A                                     | 45 A                                     | 60 A                                     |
| HO base load power                                     | 15 kW                                    | 18.5 kW                                  | 22 kW                                    |
| HO base load input current                             | 33 A                                     | 38 A                                     | 47 A                                     |
| HO base load output current                            | 32 A                                     | 38 A                                     | 45 A                                     |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3822 (63 A)<br>60 A                   | 3NA3824 (80 A)<br>70 A                   | 3NA3830 (100 A)<br>90 A                  |
| Power loss without filter                              | 0.57 kW                                  | 0.70 kW                                  | 0.82 kW                                  |
| Power loss with filter                                 | 0.58 kW                                  | 0.71 kW                                  | 0.83 kW                                  |
| Required cooling air flow                              | 55 l/s                                   | 55 l/s                                   | 55 l/s                                   |
| Weight without filter                                  | 16.6 kg                                  | 16.6 kg                                  | 18.3 kg                                  |
| Weight with filter                                     | 18.3 kg                                  | 18.3 kg                                  | 19 kg                                    |

Table 11-23 PM240-2, IP20, frame size D, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE27-5UL0<br>6SL3210-1PE27-5AL0 |  |
|--|--|--|
| LO base load power                                     | 37 kW                                    |  |
| LO base load input current                             | 70 A                                     |  |
| LO base load output current                            | 75 A                                     |  |
| HO base load power                                     | 30 kW                                    |  |
| HO base load input current                             | 62 A                                     |  |
| HO base load output current                            | 60 A                                     |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3830 (100 A)<br>100 A                 |  |
| Power loss without filter                              | 1.09 kW                                  |  |

| Article No. without filter<br>Article No. with filter | 6SL3210-1PE27-5UL0<br>6SL3210-1PE27-5AL0 |
|---|--|
| Power loss with filter                                | 1.10 kW                                  |
| Required cooling air flow                             | 55 l/s                                   |
| Weight without filter                                 | 18.3 kg                                  |
| Weight with filter                                    | 19 kg                                    |

#### Table 11-24 PM240-2, PT, frame size D, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE27-5UL0<br>6SL3211-1PE27-5AL0 |  |
|--|--|--|
| LO base load power                                     | 37 kW                                    |  |
| LO base load input current                             | 70 A                                     |  |
| LO base load output current                            | 75 A                                     |  |
| HO base load power                                     | 30 kW                                    |  |
| HO base load input current                             | 62 A                                     |  |
| HO base load output current                            | 60 A                                     |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3830 (100 A)<br>100 A                 |  |
| Power loss without filter                              | 1.09 kW <sup>1)</sup>                    |  |
| Power loss with filter                                 | 1.10 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 55 l/s                                   |  |
| Weight without filter                                  | 20 kg                                    |  |
| Weight with filter                                     | 22 kg                                    |  |

<sup>1)</sup> Approx. 1 kW through the heatsink

| Article No. without filter    | 6SL3210-1PE28-8UL0 | 6SL3210-1PE31-1UL0 |  |
|-------------------------------|--------------------|--------------------|--|
| Article No. with litter       | 03L3210-1FE20-0AL0 | 03L3210-1PE31-1AL0 |  |
| LO base load power            | 45 kW              | 55 kW              |  |
| LO base load input current    | 86 A               | 104 A              |  |
| LO base load output current   | 90 A               | 110 A              |  |
| HO base load power            | 37 kW              | 45 kW              |  |
| HO base load input current    | 78 A               | 94 A               |  |
| HO base load output current   | 75 A               | 90 A               |  |
| Fuse according to IEC         | 3NA3832 (125 A)    | 3NA3836 (160 A)    |  |
| Fuse according to UL, class J | 125 A              | 150 A              |  |
| Power loss without filter     | 1.29 kW            | 1.65 kW            |  |
| Power loss with filter        | 1.30 kW            | 1.67 kW            |  |
| Required cooling air flow     | 83 l/s             | 83 l/s             |  |

#### Table 11-25 PM240-2, IP20, frame size E, 380 V ... 480 V 3 AC

### Technical data

## 11.4 Technical data, PM240-2 Power Module

| Article No. without filter<br>Article No. with filter | 6SL3210-1PE28-8UL0<br>6SL3210-1PE28-8AL0 | 6SL3210-1PE31-1UL0<br>6SL3210-1PE31-1AL0 |  |
|---|--|--|--|
| Weight without filter                                 | 26.4 kg                                  | 26.4 kg                                  |  |
| Weight with filter                                    | 28.4 kg                                  | 28.4 kg                                  |  |

#### Table 11-26 PM240-2, PT, frame size E, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE31-1UL0<br>6SL3211-1PE31-1AL0 |  |
|--|--|--|
| LO base load power                                     | 55 kW                                    |  |
| LO base load input current                             | 104 A                                    |  |
| LO base load output current                            | 110 A                                    |  |
| HO base load power                                     | 45 kW                                    |  |
| HO base load input current                             | 94 A                                     |  |
| HO base load output current                            | 90 A                                     |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3836 (160 A)<br>150 A                 |  |
| Power loss without filter                              | 1.65 kW <sup>1)</sup>                    |  |
| Power loss with filter                                 | 1.67 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 83 l/s                                   |  |
| Weight without filter                                  | 30.5 kg                                  |  |
| Weight with filter                                     | 32 kg                                    |  |

<sup>1)</sup> Approx. 1.4 kW through the heatsink

#### Table 11-27 PM240-2, IP20, frame size F, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE31-5UL0<br>6SL3210-1PE31-5AL0 | 6SL3210-1PE31-8UL0<br>6SL3210-1PE31-8AL0 | 6SL3210-1PE32-1UL0<br>6SL3210-1PE32-1AL0 |
|--|--|--|--|
| LO base load power                                     | 75 kW                                    | 90 kW                                    | 110 kW                                   |
| LO base load input current                             | 140 A                                    | 172 A                                    | 198 A                                    |
| LO base load output current                            | 145 A                                    | 178 A                                    | 205 A                                    |
| HO base load power                                     | 55 kW                                    | 75 kW                                    | 90 kW                                    |
| HO base load input current                             | 117 A                                    | 154 A                                    | 189 A                                    |
| HO base load output current                            | 110 A                                    | 145 A                                    | 178 A                                    |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3140 (200 A)<br>200 A                 | 3NA3142 (224 A)<br>250 A                 | 3NA3250 (300 A)<br>300 A                 |
| Power loss without filter                              | 1.91 kW                                  | 2.46 kW                                  | 2.28 kW                                  |
| Power loss with filter                                 | 1.93 kW                                  | 2.48 kW                                  | 2.30 kW                                  |
| Required cooling air flow                              | 153 l/s                                  | 153 l/s                                  | 153 l/s                                  |

| Article No. without filter<br>Article No. with filter | 6SL3210-1PE31-5UL0<br>6SL3210-1PE31-5AL0 | 6SL3210-1PE31-8UL0<br>6SL3210-1PE31-8AL0 | 6SL3210-1PE32-1UL0<br>6SL3210-1PE32-1AL0 |
|---|--|--|--|
| Weight without filter                                 | 58 kg                                    | 58 kg                                    | 62 kg                                    |
| Weight with filter                                    | 64 kg                                    | 64 kg                                    | 66 kg                                    |

#### Table 11-28 PM240-2, IP20, frame size F, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3210-1PE32-5UL0<br>6SL3210-1PE32-5AL0 |  |
|--|--|--|
| LO base load power                                     | 132 kW                                   |  |
| LO base load input current                             | 242 A                                    |  |
| LO base load output current                            | 250 A                                    |  |
| HO base load power                                     | 110 kW                                   |  |
| HO base load input current                             | 218 A                                    |  |
| HO base load output current                            | 205 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3252 (315 A)<br>350 A                 |  |
| Power loss without filter                              | 2.98 kW                                  |  |
| Power loss with filter                                 | 3.02 kW                                  |  |
| Required cooling air flow                              | 153 l/s                                  |  |
| Weight without filter                                  | 62 kg                                    |  |
| Weight with filter                                     | 66 kg                                    |  |

#### Table 11-29 PM240-2, PT, frame size F, 380 V ... 480 V 3 AC

| Article No. without filter<br>Article No. with filter  | 6SL3211-1PE32-5UL0<br>6SL3211-1PE32-5AL0 |  |
|--|--|--|
| LO base load power                                     | 132 kW                                   |  |
| LO base load input current                             | 242 A                                    |  |
| LO base load output current                            | 250 A                                    |  |
| HO base load power                                     | 110 kW                                   |  |
| HO base load input current                             | 218 A                                    |  |
| HO base load output current                            | 205 A                                    |  |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3252 (315 A)<br>350 A                 |  |
| Power loss without filter                              | 2.98 kW <sup>1)</sup>                    |  |
| Power loss with filter                                 | 3.02 kW <sup>1)</sup>                    |  |
| Required cooling air flow                              | 153 l/s                                  |  |

### Technical data

### 11.4 Technical data, PM240-2 Power Module

| Article No. without filter<br>Article No. with filter | 6SL3211-1PE32-5UL0<br>6SL3211-1PE32-5AL0 |  |
|---|--|--|
| Weight without filter                                 | 63.5 kg                                  |  |
| Weight with filter                                    | 68.5 kg                                  |  |

<sup>1)</sup> Approx. 2.6 kW through the heatsink

#### Table 11-30 PM240-2, frame size G, 380 V ... 480 V 3 AC

| Article No. with filter class C3<br>Article No. with filter class C2               | 6SL3210-1PE33-0CL0<br>6SL3210-1PE33-0AL0     | 6SL3210-1PE33-7CL0<br>6SL3210-1PE33-7AL0     | 6SL3210-1PE34-8CL0<br>6SL3210-1PE34-8AL0     |
|--|--|--|--|
| LO base load power   | 160 kW                                       | 200 kW                                       | 250 kW                                       |
| LO base load input current   | 300 A  | 365 A  | 470 A  |
| LO base load output current  | 302 A  | 370 A  | 477 A  |
| HO base load power   | 132 kW                                       | 160 kW                                       | 200 kW                                       |
| HO base load input current   | 275 A  | 330 A  | 400 A  |
| HO base load output current  | 250 A  | 302 A  | 370 A  |
| Fuse according to IEC<br>Fuse according to UL, class J<br>Fuse according to IEC/UL | 3NA3254 (355 A)<br>400 A<br>3NE1334-2 (500A) | 3NA3260 (400 A)<br>500 A<br>3NE1334-2 (500A) | 3NA3372 (630 A)<br>600 A<br>3NE1436-2 (630A) |
| Power loss with filter class C3<br>Power loss with filter class C2                 | 3.67 kW<br>3.67 kW                           | 4.62 kW<br>4.62 kW                           | 6.18 kW<br>6.18 kW                           |
| Required cooling air flow  | 210 l/s                                      | 210 l/s                                      | 210 l/s                                      |
| Weight with filter class C3<br>Weight with filter class C2                         | 105 kg<br>107 kg                             | 113 kg<br>114 kg                             | 120 kg<br>122 kg                             |

# 11.4.7 Current derating depending on the pulse frequency, 400 V converters

### LO base load

| Article number       | LO    | Pulse frequency [kHz] |                 |              |              |          |          |      |      |
|----------------------|-------|-----------------------|-----------------|--------------|--------------|----------|----------|------|------|
|                      | power | 2                     | 4 <sup>*)</sup> | 6            | 8            | 10       | 12       | 14   | 16   |
|                      | [KVV] |                       |                 | LO base      | load ou      | tput cur | rent [A] |      |      |
| 6SL3210-1PE11-8.L1   | 0.55  | 1.7                   | 1.7             | 1.4          | 1.2          | 1        | 0.9      | 0.8  | 0.7  |
| 6SL3210-1PE12-3 . L1 | 0.75  | 2.2                   | 2.2             | 1.9          | 1.5          | 1.3      | 1.1      | 1    | 0.9  |
| 6SL3210-1PE13-2.L1   | 1.1   | 3.1                   | 3.1             | 2.6          | 2.2          | 1.9      | 1.6      | 1.4  | 1.2  |
| 6SL3210-1PE14-3 . L1 | 1.5   | 4.1                   | 4.1             | 3.5          | 2.9          | 2.5      | 2.1      | 1.8  | 1.6  |
| 6SL3210-1PE16-1.L1   | 2.2   | 5.9                   | 5.9             | 5            | 4.1          | 3.5      | з        | 2.7  | 2.4  |
| 6SL3211PE18-0.L1     | 3     | 7.7                   | 7.7             | 6.5          | 5.4          | 4.6      | 3.9      | 3.5  | 3.1  |
| 6SL3210-1PE21-1.L0   | 4     | 10.2                  | 10.2            | 8.7          | 7.1          | 6.1      | 5.1      | 4.6  | 4.1  |
| 6SL3210-1PE21-4 . L0 | 5.5   | 13.2                  | 13.2            | 11.2         | 9.2          | 7.9      | 6.6      | 5.9  | 5.3  |
| 6SL3211PE21-8.L0     | 7.5   | 18                    | 18              | 15.3         | 12.6         | 10.8     | 9        | 8.1  | 7.2  |
| 6SL3210-1PE22-7 . L0 | 11    | 26                    | 26              | 22.1         | 18.2         | 15.6     | 13       | 11.7 | 10.4 |
| 6SL3211PE23-3.L0     | 15    | 32                    | 32              | 27.2         | 22.4         | 19.2     | 16       | 14.4 | 12.8 |
| 6SL3210-1PE23-8 . L0 | 18.5  | 38                    | 38              | 32.3         | 26.6         | 22.8     | 19       | 17.1 | 15.2 |
| 6SL3210-1PE24-5 . L0 | 22    | 45                    | 45              | 38.3         | 31.5         | 27       | 22.5     | 20.3 | 18   |
| 6SL3210-1PE26-0 . L0 | 30    | 60                    | 60              | 51           | 42           | 36       | 30       | 27   | 24   |
| 6SL3211PE27-5.L0     | 37    | 75                    | 75              | 63.8         | 52.5         | 45       | 37.5     | 33.8 | 30   |
| 6SL3210-1PE28-8 . L0 | 45    | 90                    | 90              | 76.5         | 63           | 54       | 45       | 40.5 | 36   |
| 6SL3211PE31-1.L0     | 55    | 110                   | 110             | 93.5         | 77           |          |          |      |      |
| 6SL3210-1PE31-5 . L0 | 75    | 145                   | 145             | 123.3        | 101.5        |          |          |      |      |
| 6SL3210-1PE31-8.L0   | 90    | 178                   | 178             | 151.3        | 124.6        |          |          |      |      |
| Article number       |       |                       | -               | Pu           | se frequ     | ency [k  | Hz]      |      |      |
|                      |       | <b>2</b> *)           | 4               | <b>6</b> **) | <b>8</b> **) | 10       | 12       | 14   | 16   |
|                      |       |                       |                 | LO base      | load ou      | tput cur | rent [A] |      |      |
| 6SL3210-1PE32-1 . L0 | 110   | 205                   | 143.5           | 102.5        | 82           |          |          |      |      |
| 6SL3211PE32-5 . LO   | 132   | 250                   | 175             | 125          | 100          |          |          |      |      |
| 6SL3210-1PE33-0 .L0  | 160   | 302                   | 211.4           | 151          | 120.8        |          |          |      |      |
| 6SL3210-1PE33-7 .L0  | 200   | 370                   | 259             | 185          | 148          |          |          |      |      |
| 6SL3210-1PE34-8 .L0  | 250   | 477                   | 333.9           | 238.5        | 190.8        |          |          |      |      |

\*) Factory setting

\*\*) Available from Functional State (FS) 12

The permissible motor cable length depends on the particular cable type and the pulse frequency that has been selected.

# 11.4.8 General technical data, 690 V converters

| Property   | Version  |
|--|--|
| Line voltage   | <ul> <li>for systems according to IEC: 500 V 690 V 3 AC ± 10% (in operation<br/>-20% &lt; 1 min)</li> </ul>                                  |
|  | <ul> <li>for systems according to UL 500 V 600 V 3 AC ± 10% (in operation - 20% &lt; 1 min)</li> </ul>                                       |
|  | filtered devices only with Slash Rating (600Y/347V AC)   |
| Line supply configu-<br>rations                        | Grounded TN/TT line supplies or non-grounded IT line supplies  |
| Line impedance   | No restrictions  |
| Power factor $\lambda$                                 | > 0.9  |
| Output voltage   | 0 V 3 AC 0.95 x input voltage (max.)   |
| Input frequency  | 50 Hz 60 Hz, ± 3 Hz  |
| Output frequency                                       | 0 550 Hz, depending on the control mode  |
| Inrush current   | < LO base load input current   |
| Overvoltage catego-<br>ry according to EN<br>61800-5-1 | III for line supplies  |
| Pulse frequency  | 2 kHz (factory setting), can be adjusted to 4 kHz  |
|  | Adjustable in steps of 2 kHz.  |
|  | If you increase the pulse frequency, the converter reduces the maximum output current.   |
| Short-circuit current                                  | Maximum permissible line short-circuit current $\leq$ 100 kA rms   |
| (SCCR) and branch protection                           | Branch protection and short-circuit strength according to UL and IEC ( <u>https://support.industry.siemens.com/cs/ww/en/view/109801083</u> ) |
| Braking methods  | DC braking, compound braking, dynamic braking with integrated braking chopper  |
| Degree of protection<br>according to EN<br>60529       | IP20; must be installed in a control cabinet   |
| Protection class ac-<br>cording to EN<br>61800-5-1     | The converters are devices with protection class I   |
| Touch protection ac-<br>cording to EN 50274            | DGUV regulation 3 when used for the intended purpose   |
| Cooling in compli-<br>ance with EN 60146               | Forced air cooling AF  |
| Safety Integrated                                      | See function manual "Safety Integrated"  |
|  | Safety Integrated" function manual ( <u>https://</u><br>support.industry.siemens.com/cs/ww/en/view/109751320)                                |

# 11.4.9 Specific technical data, 690 V converters

| Article No without filter<br>Article No with filter    | 6SL3210-1PH21-4UL0<br>6SL3210-1PH21-4AL0 | 6SL3210-1PH22-0UL0<br>6SL3210-1PH22 -0AL0 | 6SL3210-1PH22-3UL0<br>6SL3210-1PH22 -3AL0 |
|--|--|---|---|
| LO base load power                                     | 11 kW                                    | 15 kW                                     | 18.5 kW                                   |
| LO base load input current                             | 14 A                                     | 18 A                                      | 22 A                                      |
| LO base load output current                            | 14 A                                     | 19 A                                      | 23 A                                      |
| HO base load power                                     | 7.5 kW                                   | 11 kW                                     | 15 kW                                     |
| HO base load input current                             | 11 A                                     | 14 A                                      | 20 A                                      |
| HO base load output current                            | 11 A                                     | 14 A                                      | 19 A                                      |
| Fuse according to IEC<br>Fuse according to UL, class J | 3NA3807-6 (20 A)<br>20 A                 | 3NA3810-6 (25 A)<br>25 A                  | 3NA3812-6 (32 A)<br>30 A                  |
| Power loss without filter                              | 0.35 kW                                  | 0.44 kW                                   | 0.52 kW                                   |
| Power loss with filter                                 | 0.35 kW                                  | 0.45 kW                                   | 0.52 kW                                   |
| Required cooling air flow                              | 55 l/s                                   | 55 l/s                                    | 55 l/s                                    |
| Weight without filter                                  | 17.4 kg                                  | 17.4 kg                                   | 17.4 kg                                   |
| Weight with filter                                     | 18.9 kg                                  | 18.9 kg                                   | 18.9 kg                                   |

Table 11-31 PM240-2, IP20, frame size D, 500 V ... 690 V 3 AC

### Table 11-32 PM240-2, IP20, frame size D, 500 V ... 690 V 3 AC

| Article No without filter<br>Article No with filter            | 6SL3210-1PH22-7UL0<br>6SL3210-1PH22-7AL0 | 6SL3210-1PH23-5UL0<br>6SL3210-1PH23 -5AL0 | 6SL3210-1PH24-2UL0<br>6SL3210-1PH24-2AL0 |
|--|--|---|--|
| LO base load power   | 22 kW                                    | 30 kW                                     | 37 kW                                    |
| LO base load input current                                     | 25 A                                     | 33 A                                      | 40 A                                     |
| LO base load output current                                    | 27 A                                     | 35 A                                      | 42 A                                     |
| HO base load power   | 18.5 kW                                  | 22 kW                                     | 30 kW                                    |
| HO base load input current                                     | 24 A                                     | 28 A                                      | 36 A                                     |
| HO base load output current                                    | 23 A                                     | 27 A                                      | 35 A                                     |
| Siemens fuse according to IEC<br>Fuse according to UL, class J | 3NA3817-6KJ (40 A)<br>35 A               | 3NA3820-6KJ (50 A)<br>45 A                | 33NA3822-6 (63 A)<br>60 A                |
| Power loss without filter                                      | 0.60 kW                                  | 0.77 kW                                   | 0.93 kW                                  |
| Power loss with filter   | 0.60 kW                                  | 0.78 kW                                   | 0.94 kW                                  |
| Required cooling air flow                                      | 55 l/s                                   | 55 l/s                                    | 55 l/s                                   |
| Weight without filter  | 17.4 kg                                  | 17.4 kg                                   | 17.4 kg                                  |
| Weight with filter   | 18.9 kg                                  | 18.9 kg                                   | 18.9 kg                                  |

| Article No without filter<br>Article No with filter            | 6SL3210-1PH25-2UL0<br>6SL3210-1PH25-2AL0 | 6SL3210-1PH26-2UL0<br>6SL3210-1PH26-2AL0 |  |
|--|--|--|--|
| LO base load power   | 45 kW                                    | 55 kW                                    |  |
| LO base load input current                                     | 50 A                                     | 59 A                                     |  |
| LO base load output current                                    | 52 A                                     | 62 A                                     |  |
| HO base load power   | 37 kW                                    | 45 kW                                    |  |
| HO base load input current                                     | 44 A                                     | 54 A                                     |  |
| HO base load output current                                    | 42 A                                     | 52 A                                     |  |
| Siemens fuse according to IEC<br>Fuse according to UL, class J | 3NA3824-6 (80A)<br>80 A                  | 3NA3824-6 (80A)<br>80 A                  |  |
| Power loss without filter                                      | 1.07 kW                                  | 1.30 kW                                  |  |
| Power loss with filter   | 1.08 kW                                  | 1.31 kW                                  |  |
| Required cooling air flow                                      | 83 l/s                                   | 83 l/s                                   |  |
| Weight without filter  | 27.1 kg                                  | 27.1 kg                                  |  |
| Weight with filter   | 28.5 kg                                  | 28.5 kg                                  |  |

#### Table 11-33 PM240-2, IP20, frame size E, 500 V ... 690 V 3 AC

#### Table 11-34 PM240-2, IP20, frame size F, 500 V ... 690 V 3 AC

| Article No without filter<br>Article No with filter            | 6SL3210-1PH28-0UL0<br>6SL3210-1PH28-0AL0 | 6SL3210-1PH31-0UL0<br>6SL3210-1PH31-0AL0 | 6SL3210-1PH31-2UL0<br>6SL3210-1PH31-2AL0 |
|--|--|--|--|
| LO base load power   | 75 kW                                    | 90 kW                                    | 110 kW                                   |
| LO base load input current                                     | 78 A                                     | 97 A                                     | 111 A                                    |
| LO base load output current                                    | 80 A                                     | 100 A                                    | 115 A                                    |
| HO base load power   | 55 kW                                    | 75 kW                                    | 90 kW                                    |
| HO base load input current                                     | 66 A                                     | 85 A                                     | 106 A                                    |
| HO base load output current                                    | 62 A                                     | 80 A                                     | 100 A                                    |
| Siemens fuse according to IEC<br>Fuse according to UL, class J | 3NA3830-6 (100 A)<br>100 A               | 3NA3132-6 (125 A)<br>125 A               | 3NA3136-6 (160 A)<br>150 A               |
| Power loss without filter                                      | 1.37 kW                                  | 1.74 kW                                  | 1.95 kW                                  |
| Power loss with filter   | 1.38 kW                                  | 1.76 kW                                  | 1.97 kW                                  |
| Required cooling air flow                                      | 153 l/s                                  | 153 l/s                                  | 153 l/s                                  |
| Weight without filter  | 61 kg                                    | 61 kg                                    | 61 kg                                    |
| Weight with filter   | 65 kg                                    | 65 kg                                    | 65 kg                                    |

#### Table 11-35 PM240-2, IP20, frame size F, 500 V ... 690 V 3 AC

| Article No without filter<br>Article No with filter | 6SL3210-1PH31-4UL0<br>6SL3210-1PH31-4AL0 |  |
|---|--|--|
| LO base load power                                  | 132 kW                                   |  |
| LO base load input current                          | 137 A                                    |  |

| Article No without filter<br>Article No with filter | 6SL3210-1PH31-4UL0<br>6SL3210-1PH31-4AL0 |
|---|--|
| LO base load output current                         | 142 A                                    |
| HO base load power                                  | 110 kW                                   |
| HO base load input current                          | 122 A                                    |
| HO base load output current                         | 115 A                                    |
| Siemens fuse according to IEC                       | 3NA3140-6 (200 A)                        |
| Fuse according to UL, class J                       | 200 A                                    |
| Power loss without filter                           | 2.48 kW                                  |
| Power loss with filter                              | 2.51 kW                                  |
| Required cooling air flow                           | 153 l/s                                  |
| Weight without filter                               | 61 kg                                    |
| Weight with filter                                  | 65 kg                                    |

#### Table 11-36 PM240-2, frame size G, 500 V ... 690 V 3 AC

| Article No. with filter      | 6SL3210-1PH31-7CL0 | 6SL3210-1PH32-1CL0 | 6SL3210-1PH32-5CL0 |
|------------------------------|--------------------|--------------------|--------------------|
| LO base load power           | 160 kW             | 200 kW             | 250 kW             |
| LO base load input current   | 170 A              | 205 A              | 250 A              |
| LO base load output current  | 171 A              | 208 A              | 250 A              |
| HO base load power           | 132 kW             | 160 kW             | 200 kW             |
| HO base load input current   | 160 A              | 185 A              | 225 A              |
| HO base load output current  | 144 A              | 171 A              | 208 A              |
| Fuse according to the IEC/UL | 3NE1227-0 (250A)   | 3NE1230-0 (315A)   | 3NE1331-0 (350A)   |
| Power loss                   | 2.94 kW            | 3.70 kW            | 4.64 kW            |
| Required cooling air flow    | 210 l/s            | 210 l/s            | 210 l/s            |
| Weight                       | 114 kg             | 114 kg             | 114 kg             |

# 11.4.10 Current derating depending on the pulse frequency, 690 V converters

### LO base load

| Article number       | LO power [kW] | Pulse frequency [kHz] |                  |
|----------------------|---------------|-----------------------|------------------|
|                      |               | 2 <sup>*)</sup>       | 4                |
|                      |               | LO base load ou       | tput current [A] |
| 6SL3210-1PH21-4 . L0 | 11            | 14                    | 8.4              |
| 6SL3210-1PH22-0 . L0 | 15            | 19                    | 11.4             |
| 6SL3210-1PH22-3 . L0 | 18.5          | 23                    | 13.8             |
| 6SL3210-1PH22-7 . L0 | 22            | 27                    | 16.2             |
| 6SL3210-1PH23-5 . L0 | 30            | 35                    | 21               |
| 6SL3211PH24-2.L0     | 37            | 42                    | 25.2             |
| 6SL3210-1PH25-2 . L0 | 45            | 52                    | 31.2             |
| 6SL3211PH26-2.L0     | 55            | 62                    | 37.2             |
| 6SL3210-1PH28-0 . L0 | 75            | 80                    | 48               |
| 6SL3210-1PH31-0 . L0 | 90            | 100                   | 60               |
| 6SL3210-1PH31-2 . L0 | 110           | 115                   | 69               |
| 6SL3210-1PH31-4 . L0 | 132           | 142                   | 85.2             |
| 6SL3210-1PH31-7CL0   | 160           | 171                   | 102.6            |
| 6SL3210-1PH32-1CL0   | 200           | 208                   | 124.8            |
| 6SL3210-1PH32-5CL0   | 250           | 250                   | 150              |

\*) Factory setting

The permissible motor cable length depends on the particular cable type and the pulse frequency that has been selected

### Protective devices for the Power Module

The fuses listed in the following tables are examples of suitable fuses.

Additional components for branch protection are available in the Internet:

Branch protection and short-circuit strength according to UL and IEC (<u>https://</u>support.industry.siemens.com/cs/ww/en/view/109479152)

### Typical converter load cycles



Figure 11-2 "Low Overload" and "High Overload" load cycles

# 11.5.1 Ambient conditions

| Property                               | Version   |  |
|--|---|--|
| Ambient conditions for tran            | sport in the transport packaging  |  |
| Climatic ambient conditions            | - 40 °C + 70 °C, according to Class 2K4 to EN 60721-3-2:1997<br>maximum humidity 95% at 40 °C |  |
| Mechanical ambient condi-<br>tions     | Shocks and vibrations permissible according to 2M3 to IEC 60721-3-2:1997                      |  |
| Protection against chemical substances | Protected according to Class 2C2 to IEC 60721-3-2:1997  |  |
| Biological environmental conditions    | Suitable according to Class 2B1 to IEC 60721-3-2:1997   |  |
| Ambient conditions for long            | -term storage in the product packaging  |  |
| Climatic ambient conditions            | - 25 °C + 55 °C, according to Class 1K3 to IEC 60721-3-1:1997                                 |  |
| Protection against chemical substances | Protected according to Class 1C2 to IEC 60721-3-1:1997  |  |
| Biological environmental conditions    | Suitable according to Class 1B1 to IEC 60721-3-1:1997   |  |
| Ambient conditions in operation        |   |  |

| Property                               | Version   |
|--|---|
| Installation altitude                  | Up to 1000 m above sea level without derating, > 1000 m 🔛 Restrictions for special ambient conditions (Page 544)          |
| Climatic ambient                       | • Frame sizes FSD FSF temperature range <sup>2)</sup>   |
| conditions <sup>1)</sup>               | <ul> <li>in operation acc. to LO: -20 °C +40 °C</li> </ul>  |
|  | – in operation acc. to HO: $-20 ^\circ \text{C}$ $+50 ^\circ \text{C}$  |
|  | <ul> <li>for higher temperatures</li> <li>Restrictions for special ambient conditions (Page 544)</li> </ul>               |
|  | Relative humidity: 5 95%, condensation not permitted  |
|  | • Oil mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted |
| Mechanical ambient condi-              | Vibration levels permissible according to Class 3M1 to EN 60721-3-3:2002  |
| tions                                  | <ul> <li>Shocks permissible according to Class 3M1 to EN 60721-3-3:2002</li> </ul>  |
| Protection against chemical substances | Protected according to 3C2 to IEC 60721-3-3:2002  |
| Biological environmental conditions    | Suitable according to 3B1 to IEC 60721-3-3: 2002  |
| Pollution                              | Suitable for environments with degree of pollution 2 according to EN 61800-5-1  |
| Cooling                                | Forced air cooling AF, according to EN 60146  |
| Cooling air                            | Clean and dry air   |

<sup>1)</sup> Increased ruggedness regarding temperature range and relative humidity; therefore better than 3K3 according to IEC 60721-3-3: 2002

<sup>2)</sup> Observe the permissible ambient temperatures for the Control Unit and possibly the operator panel (IOP-2 or BOP-2).

| Property  | Version  |
|---|--|
| Line voltage  | 3 AC 380 V 480 V ± 10% (in operation -20% < 1 min)   |
| Line system configurations                          | Grounded TN/TT line systems or non-grounded IT line systems  |
| Line impedance                                      | Uk < 4%, line reactor is not required  |
| Power factor $\lambda$                              | > 0.9  |
| Output voltage                                      | 3 AC 0 V 0.95 x input voltage (max.)   |
| Input frequency                                     | 50 Hz 60 Hz, ± 3 Hz  |
| Output frequency                                    | 0 550 Hz, depending on the control mode  |
| Inrush current                                      | < LO base load input current   |
| Overvoltage category ac-<br>cording to EN 61800-5-1 | III for line supplies  |
| Pulse frequency                                     | Factory setting  |
|   | <ul> <li>4 kHz for devices with an LO base load power &lt; 75 kW</li> </ul>  |
|   | • 2 kHz for devices with an LO base load power $\ge$ 75 kW   |
|   | Can be adjusted in 2 kHz steps as follows:   |
|   | <ul> <li>2 kHz 16 kHz for devices with an LO base load power &lt; 55 kW</li> </ul>   |
|   | • 2 kHz 8 kHz for devices with an LO base load power $\ge$ 55 kW   |
|   | • 2 kHz 4 kHz for devices with an LO base load power $\ge$ 110 kW  |
|   | If you increase the pulse frequency, the converter reduces the maximum output current.   |
| Short-circuit current rating                        | ≤ 100 kA rms   |
| (SCCR) and branch protec-<br>tion                   | Branch protection and short-circuit strength according to UL and IEC ( <u>https://support.industry.siemens.com/cs/ww/en/view/109479152</u> ) |
| Braking methods                                     | DC braking, compound braking   |
| Degree of protection ac-<br>cording to EN 60529     | IP20 Must be installed in a control cabinet  |
| Protection class according to EN 61800-5-1          | The converters are devices with protection class I   |
| Touch protection according to EN 50274              | DGUV regulation 3 when used for the intended purpose   |
| Cooling in compliance with EN 60146                 | Forced air cooling AF  |

# 11.5.2 General technical data, 400 V converters

### 11.5.3 Specific technical data, 400 V converters

The fuses listed in the following tables are examples of suitable fuses.

You can find additional suitable fuses in the Internet:

Branch protection and short-circuit strength according to UL and IEC (<u>https://support.industry.siemens.com/cs/ww/en/view/109479152</u>)

Table 11-37 PM240P-2, IP20, Frame Size D, 3-ph. AC 380 V ... 480 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RE24-5UL0<br>6SL3210-1RE24-5AL0 | 6SL3210-1RE26-0UL0<br>6SL3210-1RE26-0AL0 | 6SL3210-1RE27-5UL0<br>6SL3210-1RE27-5AL0 |
|---|--|--|--|
| LO base load power  | 22 kW                                    | 30 kW                                    | 37 kW                                    |
| LO base load input current  | 42 A                                     | 57 A                                     | 70 A                                     |
| LO base load output current   | 45 A                                     | 60 A                                     | 75 A                                     |
| HO base load power  | 18.5 kW                                  | 22 kW                                    | 30 kW                                    |
| HO base load input current  | 38 A                                     | 47 A                                     | 62 A                                     |
| HO base load output current   | 38 A                                     | 45 A                                     | 60 A                                     |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1820-0 / 80 A<br>70 A                 | 3NE1021-0 / 100 A<br>90 A                | 3NE1021-0 / 100 A<br>100 A               |
| Power loss without filter   | 0.68 kW                                  | 0.76 kW                                  | 1.01 kW                                  |
| Power loss with filter  | 0.68 kW                                  | 0.77 kW                                  | 1.02 kW                                  |
| Required cooling air flow   | 55 l/s                                   | 55 l/s                                   | 55 l/s                                   |
| Weight without filter   | 16 kg                                    | 17 kg                                    | 17 kg                                    |
| Weight with filter  | 17.5 kg                                  | 18.5 kg                                  | 18.5 kg                                  |

#### Table 11-38 PM240P-2, IP20, Frame Size E, 3-ph. AC 380 V ... 480 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RE28-8UL0<br>6SL3210-1RE28-8AL0 | 6SL3210-1RE31-1UL0<br>6SL3210-1RE31-1AL0 |  |
|---|--|--|--|
| LO base load power  | 45 kW                                    | 55 kW                                    |  |
| LO base load input current  | 86 A                                     | 104 A                                    |  |
| LO base load output current   | 90 A                                     | 110 A                                    |  |
| HO base load power  | 37 kW                                    | 45 kW                                    |  |
| HO base load input current  | 78 A                                     | 94 A                                     |  |
| HO base load output current   | 75 A                                     | 90 A                                     |  |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1022-0 / 125 A<br>125 A               | 3NE1224-0 / 160 A<br>150 A               |  |
| Power loss without filter   | 1.19 kW                                  | 1.54 kW                                  |  |
| Power loss with filter  | 1.2 kW                                   | 1.55 kW                                  |  |
| Required cooling air flow   | 83 l/s                                   | 83 l/s                                   |  |
| Weight without filter   | 26 kg                                    | 26 kg                                    |  |
| Weight with filter  | 28 kg                                    | 28 kg                                    |  |

| Article number without filter<br>Article number with filter           | 6SL3210-1RE31-5UL0<br>6SL3210-1RE31-5AL0 | 6SL3210-1RE31-8UL0<br>6SL3210-1RE31-8AL0 | 6SL3210-1RE32-1UL0<br>6SL3210-1RE32-1AL0 |
|---|--|--|--|
| LO base load power  | 75 kW                                    | 90 kW                                    | 110 kW                                   |
| LO base load input current  | 140 A                                    | 172 A                                    | 198 A                                    |
| LO base load output current   | 145 A                                    | 178 A                                    | 205 A                                    |
| HO base load power  | 55 kW                                    | 75 kW                                    | 90 kW                                    |
| HO base load input current  | 117 A                                    | 154 A                                    | 189 A                                    |
| HO base load output current   | 110 A                                    | 145 A                                    | 178 A                                    |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1225-0 / 200 A<br>200 A               | 3NE1227-0 / 250 A<br>250 A               | 3NE1230-0 / 315 A<br>300 A               |
| Power loss without filter   | 1.95 kW                                  | 2.54 kW                                  | 2.36 kW                                  |
| Power loss with filter  | 1.97 kW                                  | 2.56 kW                                  | 2.38 kW                                  |
| Required cooling air flow   | 153 l/s                                  | 153 l/s                                  | 153 l/s                                  |
| Weight without filter   | 57 kg                                    | 57 kg                                    | 61 kg                                    |
| Weight with filter  | 63 kg                                    | 63 kg                                    | 65 kg                                    |

Table 11-39 PM240P-2, IP20, Frame Size F, 3-ph. AC 380 V ... 480 V

Table 11-40 PM240P-2, IP20, Frame Size F, 3-ph. AC 380 V ... 480 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RE32-5UL0<br>6SL3210-1RE32-5AL0 |  |
|---|--|--|
| LO base load power  | 132 kW                                   |  |
| LO base load input current  | 242 A                                    |  |
| LO base load output current   | 250 A                                    |  |
| HO base load power  | 110 kW                                   |  |
| HO base load input current  | 218 A                                    |  |
| HO base load output current   | 205 A                                    |  |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1331-0 / 350 A<br>350 A               |  |
| Power loss without filter   | 3.09 kW                                  |  |
| Power loss with filter  | 3.12 kW                                  |  |
| Required cooling air flow   | 153 l/s                                  |  |
| Weight without filter   | 61 kg                                    |  |
| Weight with filter  | 65 kg                                    |  |

| Article number        | LO<br>power<br>[kW] | LO base load output current [A] |       |       |       |    |      |      |    |
|-----------------------|---------------------|---------------------------------|-------|-------|-------|----|------|------|----|
| Pulse frequency [kHz] |                     | 2                               | 4 *)  | 6     | 8     | 10 | 12   | 14   | 16 |
| 6SL3210-1RE24-5 . L0  | 22                  | 45                              | 45    | 38.3  | 31.5  | 27 | 22.5 | 20.3 | 18 |
| 6SL3210-1RE26-0 . L0  | 30                  | 60                              | 60    | 51    | 42    | 36 | 30   | 27   | 24 |
| 6SL3210-1RE27-5 . L0  | 37                  | 75                              | 75    | 63.8  | 52.5  | 45 | 37.5 | 33.8 | 30 |
| 6SL3210-1RE28-8 . L0  | 45                  | 90                              | 90    | 76.5  | 63    | 54 | 45   | 40.5 | 36 |
| 6SL3210-1RE31-1 . L0  | 55                  | 110                             | 110   | 93.5  | 77    |    |      |      |    |
| Pulse frequency [kHz] |                     | <b>2</b> *)                     | 4     | 6     | 8     | 10 | 12   | 14   | 16 |
| 6SL3210-1RE31-5 . L0  | 75                  | 145                             | 145   | 123.3 | 101.5 |    |      |      |    |
| 6SL3210-1RE31-8.L0    | 90                  | 178                             | 178   | 151.3 | 124.6 |    |      |      |    |
| 6SL3210-1RE32-1.L0    | 110                 | 205                             | 143.5 |       |       |    |      |      |    |
| 6SL3210-1RE32-5 . L0  | 132                 | 250                             | 175   |       |       |    |      |      |    |

# 11.5.4 Current derating depending on the pulse frequency, 400 V converters

\*) Factory setting

The permissible motor cable length depends on the particular cable type and the pulse frequency that has been selected

| Property   | Version   |
|--|---|
| Line voltage   | 3 AC 500 V 690 V $\pm$ 10% (in operation -20% < 1 min) with Class J fuses, maximum 600 V  |
| Line system configurations                                     | Grounded TN/TT line systems or non-grounded IT line systems   |
| Line impedance   | Uk < 4%, line reactor is not required   |
| Power factor $\lambda$   | > 0.9   |
| Output voltage   | 3 AC 0 V 0.95 × input voltage (max.)  |
| Input frequency  | 50 Hz 60 Hz, ± 3 Hz   |
| Output frequency   | 0 550 Hz, depending on the control mode   |
| Inrush current   | < LO base load input current  |
| Overvoltage category ac-<br>cording to EN 61800-5-1            | III for line supplies   |
| Pulse frequency  | 2 kHz (factory setting), can be adjusted to 4 kHz   |
|  | If you increase the pulse frequency, the converter reduces the maximum output current.  |
| Short-circuit current rating (SCCR) and branch protec-<br>tion | ≤ 100 kA rms Branch protection and short-circuit strength according to UL and IEC ( <u>https://support.industry.siemens.com/cs/ww/en/view/109479152</u> ) |
| Braking methods  | DC braking, compound braking  |
| Degree of protection accord-<br>ing to EN 60529                | IP20; must be installed in a control cabinet  |
| Protection class according to EN 61800-5-1                     | The converters are devices with protection class I  |
| Touch protection according to EN 50274                         | DGUV regulation 3 when used for the intended purpose  |
| Cooling in compliance with<br>EN 60146                         | Forced air cooling AF   |

# 11.5.5 General technical data, 690 V converters

## 11.5.6 Specific technical data, 690 V converters

The fuses listed in the following tables are examples of suitable fuses.

You can find additional suitable fuses in the Internet:

Branch protection and short-circuit strength according to UL and IEC (<u>https://support.industry.siemens.com/cs/ww/en/view/109479152</u>)

Table 11-41 PM240P-2, IP20, frame size D, 3 AC 500 V ... 690 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RH21-4UL0<br>6SL3210-1RH21-4AL0 | 6SL3210-1RH22-0UL0<br>6SL3210-1RH22-0AL0 | 6SL3210-1RH22-3UL0<br>6SL3210-1RH22-3AL0 |
|---|--|--|--|
| LO base load power  | 11 kW                                    | 15 kW                                    | 18.5 kW                                  |
| LO base load input current  | 14 A                                     | 18 A                                     | 22 A                                     |
| LO base load output current   | 14 A                                     | 19 A                                     | 23 A                                     |
| HO base load power  | 7.5 kW                                   | 11 kW                                    | 15 kW                                    |
| HO base load input current  | 11 A                                     | 14 A                                     | 20 A                                     |
| HO base load output current   | 11 A                                     | 14 A                                     | 19 A                                     |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1815-0 / 25 A<br>20 A                 | 3NE1815-0 / 25 A<br>25 A                 | 3NE1803-0 / 35 A<br>30 A                 |
| Power loss  | 0.32 kW                                  | 0.41 kW                                  | 0.48 kW                                  |
| Required cooling air flow   | 55 l/s                                   | 55 l/s                                   | 55 l/s                                   |
| Weight without filter   | 17 kg                                    | 17 kg                                    | 17 kg                                    |
| Weight with filter  | 18.5 kg                                  | 18.5 kg                                  | 18.5 kg                                  |

Table 11-42 PM240P-2, IP20, frame size D, 3 AC 500 V ... 690 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RH22-7UL0<br>6SL3210-1RH22-7AL0 | 6SL3210-1RH23-5UL0<br>6SL3210-1RH23-5AL0 | 6SL3210-1RH24-2UL0<br>6SL3210-1RH24-2AL0 |
|---|--|--|--|
| LO base load power  | 22 kW                                    | 30 kW                                    | 37 kW                                    |
| LO base load input current  | 25 A                                     | 33 A                                     | 40 A                                     |
| LO base load output current   | 27 A                                     | 35 A                                     | 42 A                                     |
| HO base load power  | 18.5 kW                                  | 22 kW                                    | 30 kW                                    |
| HO base load input current  | 24 A                                     | 28 A                                     | 36 A                                     |
| HO base load output current   | 23 A                                     | 27 A                                     | 35 A                                     |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1803-0 / 35 A<br>35 A                 | 3NE1817-0 / 50 A<br>50 A                 | 3NE1818-0 / 63 A<br>60 A                 |
| Power loss without filter   | 0.56 kW                                  | 0.72 kW                                  | 0.88 kW                                  |
| Power loss with filter  | 0.56 kW                                  | 0.73 kW                                  | 0.88 kW                                  |
| Required cooling air flow   | 55 l/s                                   | 55 l/s                                   | 55 l/s                                   |
| Weight without filter   | 17 kg                                    | 17 kg                                    | 17 kg                                    |
| Weight with filter  | 18.5 kg                                  | 18.5 kg                                  | 18.5 kg                                  |

| Article number without filter     | 6SL3210-1RH25-2UL0  | 6SL3210-1RH26-2UL0  |  |
|-----------------------------------|---------------------|---------------------|--|
|                                   | 0323210-111123-2720 | 0525210-11(120-2720 |  |
| LO base load power                | 45 kW               | 55 kW               |  |
| LO base load input current        | 50 A                | 59 A                |  |
| LO base load output current       | 52 A                | 62 A                |  |
| HO base load power                | 37 kW               | 45 kW               |  |
| HO base load input current        | 44 A                | 54 A                |  |
| HO base load output current       | 42 A                | 52 A                |  |
| Siemens fuse according to IEC/UL  | 3NA1820-0 / 80 A    | 3NE1820-0 / 80 A    |  |
| Fuse according to IEC/UL, Class J | 80 A                | 80 A                |  |
| Power loss without filter         | 1.00 kW             | 1.21 kW             |  |
| Power loss with filter            | 1.00 kW             | 1.22 kW             |  |
| Required cooling air flow         | 83 l/s              | 83 l/s              |  |
| Weight without filter             | 26 kg               | 26 kg               |  |
| Weight with filter                | 28 kg               | 28 kg               |  |

Table 11-43 PM240P-2, IP20, frame sizes E, 3 AC 500 V ... 690 V

Table 11-44 PM240-2, IP20, frame size F, 3 AC 500 V ... 690 V

| Article number without filter<br>Article number with filter           | 6SL3210-1RH28-0UL0<br>6SL3210-1RH28-0AL0 | 6SL3210-1RH31-0UL0<br>6SL3210-1RH31-0AL0 | 6SL3210-1RH31-2UL0<br>6SL3210-1RH31-2AL0 |
|---|--|--|--|
| LO base load power  | 75 kW                                    | 90 kW                                    | 110 kW                                   |
| LO base load input current  | 78 A                                     | 97 A                                     | 111 A                                    |
| LO base load output current   | 80 A                                     | 100 A                                    | 115 A                                    |
| HO base load power  | 55 kW                                    | 75 kW                                    | 90 kW                                    |
| HO base load input current  | 66 A                                     | 85 A                                     | 106 A                                    |
| HO base load output current   | 62 A                                     | 80 A                                     | 100 A                                    |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1021-0 / 100 A<br>110 A               | 3NE1022-0 / 125 A<br>150 A               | 3NE1224-0 / 160 A<br>150 A               |
| Power loss without filter   | 1.34 kW                                  | 1.71 kW                                  | 2 kW                                     |
| Power loss with filter  | 1.35 kW                                  | 1.72 kW                                  | 2.02 kW                                  |
| Required cooling air flow   | 153 l/s                                  | 153 l/s                                  | 153 l/s                                  |
| Weight without filter   | 60 kg                                    | 60 kg                                    | 60 kg                                    |
| Weight with filter  | 64 kg                                    | 64 kg                                    | 64 kg                                    |

Table 11-45 PM240-2, IP20, frame size F, 3 AC 500 V ... 690 V

| Article number without filter<br>Article number with filter | 6SL3210-1RH31-4UL0<br>6SL3210-1RH31-4AL0 |  |
|---|--|--|
| LO base load power  | 132 kW                                   |  |
| LO base load input current                                  | 137 A                                    |  |
| LO base load output current                                 | 142 A                                    |  |
| HO base load power  | 110 kW                                   |  |

| Article number without filter<br>Article number with filter           | 6SL3210-1RH31-4UL0<br>6SL3210-1RH31-4AL0 |  |
|---|--|--|
| HO base load input current  | 122 A                                    |  |
| HO base load output current   | 115 A                                    |  |
| Siemens fuse according to IEC/UL<br>Fuse according to IEC/UL, Class J | 3NE1225-0 / 200 A<br>200 A               |  |
| Power loss without filter   | 2.56 kW                                  |  |
| Power loss with filter  | 2.59 kW                                  |  |
| Required cooling air flow   | 153 l/s                                  |  |
| Weight without filter   | 60 kg                                    |  |
| Weight with filter  | 64 kg                                    |  |

# 11.5.7 Current derating depending on the pulse frequency, 690 V converters

| Article number        | LO pow-<br>er [kW] | LO base load output current [A] |      |
|-----------------------|--------------------|---------------------------------|------|
| Pulse frequency [kHz] |                    | 2                               | 4    |
| 6SL3210-1RH21-4 . L0  |                    | 14                              | 8.4  |
| 6SL3210-1RH22-0 . L0  |                    | 19                              | 11.4 |
| 6SL3210-1RH22-3 . L0  |                    | 23                              | 13.8 |
| 6SL3210-1RH22-7 . L0  |                    | 27                              | 16.2 |
| 6SL3210-1RH23-5 . L0  |                    | 35                              | 21   |
| 6SL3210-1RH24-2 . L0  |                    | 42                              | 25.2 |
| 6SL3210-1RH25-2 . L0  |                    | 52                              | 31.2 |
| 6SL3210-1RH26-2 . L0  |                    | 62                              | 37.2 |
| 6SL3210-1RH28-0 . L0  |                    | 80                              | 48   |
| 6SL3210-1RH31-0 . L0  |                    | 100                             | 60   |
| 6SL3210-1RH31-2 . L0  |                    | 115                             | 69   |
| 6SL3210-1RH31-4 . L0  |                    | 142                             | 85.2 |

The permissible motor cable length depends on the cable type and the selected pulse frequency.

# 11.6 Technical data, PM230 Power Module

### Typical converter load cycles



Figure 11-3 Duty cycles, "High Overload" and "Low Overload"

# 11.6.1 Ambient conditions

| Property                               | Version   |
|--|---|
| Ambient conditions for tran            | sport in the transport packaging  |
| Climatic ambient conditions            | - 40 °C + 70 °C, according to Class 2K4 to EN 60721-3-2<br>maximum humidity 95 % at 40 °C |
| Mechanical ambient condi-              | FSA FSC: Shock and vibration permissible according to 1M2 to EN 60721-3-2                 |
| tions                                  | FSD FSF: Shock and vibration permissible according to 2M3 to EN 60721-3-2                 |
| Protection against chemical substances | Protected according to Class 2C2 to EN 60721-3-2  |
| Biological ambient condi-<br>tions     | Suitable according to Class 2B1 to EN 60721-3-2   |
| Ambient conditions for long            | -term storage in the product packaging  |
| Climatic ambient conditions            | - 25 °C + 55 °C, according to Class 1K3 to EN 60721-3-1                                   |
| Protection against chemical substances | Protected according to Class 1C2 to EN 60721-3-1  |
| Biological ambient condi-<br>tions     | Suitable according to Class 1B1 according to EN 60721-3-1                                 |

| Property                               | Version  |
|--|--|
| Ambient conditions in oper             | ation  |
| Installation altitude                  | Up to 1000 m above sea level without derating, > 1000 m 🔛 Restrictions for special ambient conditions (Page 544)   |
| Climatic ambient                       | • Temperature range without derating <sup>2)</sup>   |
| conditions <sup>1)</sup>               | <ul> <li>LO base load power: 0 °C40 °C</li> </ul>  |
|  | <ul> <li>HO base load power: 0 °C50 °C</li> </ul>  |
|  | For higher temperatures.   |
|  | Relative humidity: 5 95%, condensation not permitted   |
|  | <ul> <li>Oil mist, salt mist, ice formation, condensation, dripping water, spraying water, splashing<br/>water and water jets are not permitted</li> </ul> |
| Mechanical ambient condi-              | FSA FSF: Vibration levels permissible according to Class 3M1 to EN 60721-3-3   |
| tions                                  | FSA FSC: Shock, permissible according to Class 3M2 to EN 60721-3-3   |
|  | FSD FSF: Shock permissible according to Class 3M1 to EN 60721-3-3  |
| Protection against chemical substances | Protected according to 3C2 to EN 60721-3-3   |
| Biological ambient condi-<br>tions     | Suitable according to 3B1 to EN 60721-3-3  |
| Pollution                              | Suitable for environments with degree of pollution 2 according to EN 61800-5-1   |
| Cooling                                | Forced air cooling AF, according to EN 60146   |
| Cooling air                            | clean and dry air  |

<sup>1)</sup> Increased ruggedness regarding temperature range and relative humidity; therefore better than Class 3K3 to EN 60721-3-3

<sup>2)</sup> Observe the permissible ambient temperatures for the Control Unit and possibly the operator panel (IOP-2 or BOP-2).

# 11.6.2 General technical data, PM230

| Property                               | Version   |
|--|---|
| Line voltage                           | 380 480 V 3 AC ± 10%  |
| Output voltage                         | 3-phase 0 VAC input voltage x 0.95 (max.)   |
| Input frequency                        | 50 Hz 60 Hz, ± 3 Hz   |
| Output frequency                       | 0 Hz 550 Hz, depending on the control mode  |
| Power factor λ                         | 0.9   |
| Line impedance                         | Uk ≤ 1%, line reactor not permissible   |
| Inrush current                         | < LO base load input current  |
| Pulse frequency (factory set-<br>ting) | 4 kHz<br>The pulse frequency can be increased in 2 kHz steps up to 16 kHz (up to 8 kHz for 55 kW and<br>75 kW). An increase in the pulse frequency results in a lower output current.     |
| Electromagnetic compatibility          | Devices with filters in compliance with EN 61800-3: 2004 are suitable for Category C2 environments.   |
| Braking methods                        | DC braking  |
| Degree of protection                   | IP20 built-in unitsIP20 when mounted in a control cabinetPT devicesIP54 on the control cabinet wall   |
| Operating temperature at               | LO base load power without derating $0^{\circ}$ C +40° C  |
|  | HO base load power without derating 0° C +50° C   |
|  | LO/HO base load power with derating: Up to 60° C  |
|  | Restrictions for special ambient conditions (Page 544)  |
| Storage temperature                    | -40° C +70° C   |
| Relative humidity                      | < 95% - condensation not permissible  |
| Pollution                              | Protected according to pollution degree 2 according to EN 61800-5-1: 2007   |
| Ambient conditions                     | Protected against damaging chemical substances according to environmental class 3C2 ac-<br>cording to EN 60721-3-3: 1995  |
| Shock and vibration                    | <ul> <li>Long-term storage in the transport packaging according to Class 1M2 according to<br/>EN 60721-3-1: 1997</li> </ul>   |
|  | • Transport in the transport packaging according to Class 2M3 according to EN 60721-3-2: 1997   |
|  | • Vibration during operation according to Class 3M2 according to EN 60721-3-3: 1995   |
| Installation altitude                  | without derat-<br>ing:       up to 1000 m above<br>sea level       Restrictions for special ambient conditions<br>(Page 544)         with derating:       up to 4000 m above<br>sea level |
| Permissible short-circuit cur-<br>rent | Frame size D F: 65 kA <sup>1)</sup>   |
| Overvoltage category                   | Supply circuits:Overvoltage category IIINon-supply circuits:Overvoltage category II   |
| Standards                              | UL <sup>1),2)</sup> , CE, C-tick<br>The drive only satisfies the UL requirements when UL-certified fuses are used.  |

<sup>1)</sup> If fuse-protected with a listed Class J or 3NE1 fuse, rated voltage 600 VAC with the rated current of the specific converter.

<sup>2)</sup> UL available soon for frame sizes D ... F

### 11.6.3 Detailed technical data, PM230

| Article number without filter<br>Article number with filter | 6SL3210-1NE11-3UG1<br>6SL3210-1NE11-3AG1 | 6SL3210-1NE11-7UG1<br>6SL3210-1NE11-7AG1 | 6SL3210-1NE12-2UG1<br>6SL3210-1NE12-2AG1 |
|---|--|--|--|
| LO base load power  | 0.37 kW                                  | 0.55 kW                                  | 0.75 kW                                  |
| LO base load input current                                  | 1.3 A                                    | 1.8 A                                    | 2.3 A                                    |
| LO base load output current                                 | 1.3 A                                    | 1.7 A                                    | 2.2 A                                    |
| HO base load power  | 0.25 kW                                  | 0.37 kW                                  | 0.55 kW                                  |
| HO base load input current                                  | 0.9 A                                    | 1.3 A                                    | 1.8 A                                    |
| HO base load output current                                 | 0.9 A                                    | 1.3 A                                    | 1.7 A                                    |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1813-0<br>2 A                         | 3NE1813-0<br>4 A                         | 3NE1813-0<br>4 A                         |
| Circuit breaker 3RV2711-1KD10                               | 12.5 A                                   | 12.5 A                                   | 12.5 A                                   |
| Power loss  | 0.04 kW                                  | 0.04 kW                                  | 0.05 kW                                  |
| Required cooling air flow                                   | 1.5 l/s                                  | 1.5 l/s                                  | 4.5 l/s                                  |
| Weight without filter                                       | 1.4 kg                                   | 1.4 kg                                   | 1.4 kg                                   |
| Weight with filter  | 1.6 kg                                   | 1.6 kg                                   | 1.6 kg                                   |

Table 11-46 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

#### Table 11-47 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE13-1UG1<br>6SL3210-1NE13-1AG1 | 6SL3210-1NE14-1UG1<br>6SL3210-1NE14-1AG1 | 6SL3210-1NE15-8UG1<br>6SL3210-1NE15-8AG1 |
|---|--|--|--|
| LO base load power  | 1.1 kW                                   | 1.5 kW                                   | 2.2 kW                                   |
| LO base load input current                                  | 3.2 A                                    | 4.2 A                                    | 6.1 A                                    |
| LO base load output current                                 | 3.1 A                                    | 4.1 A                                    | 5.9 A                                    |
| HO base load power  | 0.75 kW                                  | 1.1 kW                                   | 1.5 kW                                   |
| HO base load input current                                  | 2.3 A                                    | 3.2 A                                    | 4.2 A                                    |
| HO base load output current                                 | 2.2 A                                    | 3.1 A                                    | 4.1 A                                    |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1813-0<br>6 A                         | 3NE1813-0<br>6 A                         | 3NE1813-0<br>10 A                        |
| Power loss  | 0.06 kW                                  | 0.07 kW                                  | 0.08 kW                                  |
| Circuit breaker N3RV2711-1KD10                              | 12.5 A                                   | 12.5 A                                   | 12.5 A                                   |
| Required cooling air flow                                   | 4.5 l/s                                  | 4.5 l/s                                  | 4.5 l/s                                  |
| Weight without filter                                       | 1.4 kg                                   | 1.4 kg                                   | 1.4 kg                                   |
| Weight with filter  | 1.6 kg                                   | 1.6 kg                                   | 1.6 kg                                   |

#### Table 11-48 PM230, IP20, frame size A, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE17-7UG1<br>6SL3210-1NE17-7AG1 |  |
|---|--|--|
| LO base load power  | 3 kW                                     |  |
| LO base load input current                                  | 8.0 A                                    |  |

| Article number without filter<br>Article number with filter | 6SL3210-1NE17-7UG1<br>6SL3210-1NE17-7AG1 |  |
|---|--|--|
| LO base load output current                                 | 7.7 A                                    |  |
| HO base load power  | 2.2 kW                                   |  |
| HO base load input current                                  | 6.1 A                                    |  |
| HO base load output current                                 | 5.9 A                                    |  |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1813-0<br>10 A                        |  |
| Circuit breaker N3RV2711-1KD10                              | 12.5 A                                   |  |
| Power loss  | 0.11 kW                                  |  |
| Required cooling air flow                                   | 4.5 l/s                                  |  |
| Weight without filter                                       | 1.4 kg                                   |  |
| Weight with filter  | 1.6 kg                                   |  |

#### Table 11-49 PM230, PT, frame size A, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3211-1NE17-7UG1<br>6SL3211-1NE17-7AG1 |  |
|---|--|--|
| LO base load power  | 3 kW                                     |  |
| LO base load input current                                  | 8.0 A                                    |  |
| LO base load output current                                 | 7.7 A                                    |  |
| HO base load power  | 2.2 kW                                   |  |
| HO base load input current                                  | 6.1 A                                    |  |
| HO base load output current                                 | 5.9 A                                    |  |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1813-0<br>10 A                        |  |
| Power loss  | 0.11 kW                                  |  |
| Required cooling air flow                                   | 4.5 l/s                                  |  |
| Weight without filter                                       | 1.7 kg                                   |  |
| Weight with filter  | 1.9 kg                                   |  |

Table 11-50 PM230, IP20, frame size B, 3-phase 380 ... 480 VAC

| Article number without filter<br>Article number with filter | 6SL3210-1NE21-0UG1<br>6SL3210-1NE21-0AG1 | 6SL3210-1NE21-3UG1<br>6SL3210-1NE21-3AG1 | 6SL3210-1NE21-8UG1<br>6SL3210-1NE21-8AG1 |
|---|--|--|--|
| LO base load power  | 4 kW                                     | 5.5 kW                                   | 7.5 kW                                   |
| LO base load input current                                  | 10.5 A                                   | 13.6 A                                   | 18.6 A                                   |
| LO base load output current                                 | 10.2 A                                   | 13.2 A                                   | 18 A                                     |
| HO base load power  | 3 kW                                     | 4 kW                                     | 5.5 kW                                   |
| HO base load input current                                  | 8.0 A                                    | 10.5 A                                   | 13.6 A                                   |
| HO base load output current                                 | 7.7 A                                    | 10.2 A                                   | 13.2 A                                   |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1813-0<br>15 A                        | 3NE1814-0<br>20 A                        | 3NE1815-0<br>25 A                        |

| Article number without filter<br>Article number with filter | 6SL3210-1NE21-0UG1<br>6SL3210-1NE21-0AG1 | 6SL3210-1NE21-3UG1<br>6SL3210-1NE21-3AG1 | 6SL3210-1NE21-8UG1<br>6SL3210-1NE21-8AG1 |
|---|--|--|--|
| Power loss  | 0.12 kW                                  | 0.15 kW                                  | 0.22 kW                                  |
| Required cooling air flow                                   | 9.2 l/s                                  | 9.2 l/s                                  | 9.2 l/s                                  |
| Weight without filter                                       | 2.8 kg                                   | 2.8 kg                                   | 2.8 kg                                   |
| Weight with filter  | 3 kg                                     | 3 kg                                     | 3 kg                                     |

#### Table 11-51 PM230, PT, frame size B, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3211-1NE21-8UG1<br>6SL3211-1NE21-8AG1 |  |
|---|--|--|
| LO base load power  | 7.5 kW                                   |  |
| LO base load input current                                  | 18.6 A                                   |  |
| LO base load output current                                 | 18 A                                     |  |
| HO base load power  | 5.5 kW                                   |  |
| HO base load input current                                  | 13.6 A                                   |  |
| HO base load output current                                 | 13.2 A                                   |  |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1815-0<br>25 A                        |  |
| Power loss  | 0.22 kW                                  |  |
| Required cooling air flow                                   | 9.2 l/s                                  |  |
| Weight without filter                                       | 3.4 kg                                   |  |
| Weight with filter  | 3.6 kg                                   |  |

#### Table 11-52 PM230, IP20, frame size C, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE22-6UG1<br>6SL3210-1NE22-6AG1 | 6SL3210-1NE23-2UG1<br>6SL3210-1NE23-2AG1 | 6SL3210-1NE23-8UG1<br>6SL3210-1NE23-8AG1 |
|---|--|--|--|
| LO base load power  | 11 kW                                    | 15 kW                                    | 18.5 kW                                  |
| LO base load input current                                  | 26.9 A                                   | 33.1 A                                   | 39.2 A                                   |
| LO base load output current                                 | 26 A                                     | 32 A                                     | 38 A                                     |
| HO base load power  | 7.5 kW                                   | 11 kW                                    | 15 kW                                    |
| HO base load input current                                  | 18.6 A                                   | 26.9 A                                   | 33.1 A                                   |
| HO base load output current                                 | 18 A                                     | 26 A                                     | 32 A                                     |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1803-0<br>35 A                        | 3NE1817-0<br>45 A                        | 3NE1817-0<br>50 A                        |
| Power loss  | 0.3 kW                                   | 0.35 kW                                  | 0.45 kW                                  |
| Required cooling air flow                                   | 18.5 l/s                                 | 18.5 l/s                                 | 18.5 l/s                                 |
| Weight without filter                                       | 4.5 kg                                   | 4.5 kg                                   | 4.5 kg                                   |
| Weight with filter  | 5.1 kg                                   | 5.1 kg                                   | 5.1 kg                                   |

#### Table 11-53 PM230, PT, frame size C, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3211-1NE23-8UG1<br>6SL3211-1NE23-8AG1 |  |
|---|--|--|
| LO base load power  | 18.5 kW                                  |  |
| LO base load input current                                  | 39.2 A                                   |  |
| LO base load output current                                 | 38 A                                     |  |
| HO base load power  | 15 kW                                    |  |
| HO base load input current                                  | 33.1 A                                   |  |
| HO base load output current                                 | 32 A                                     |  |
| Fuse according to IEC / UL<br>Fuse according to UL, Class J | 3NE1817-0<br>50 A                        |  |
| Power loss  | 0.45 kW                                  |  |
| Required cooling air flow                                   | 18.5 l/s                                 |  |
| Weight without filter                                       | 5.4 kg                                   |  |
| Weight with filter  | 6 kg                                     |  |

#### Table 11-54 PM230, IP20, frame size D, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE24-5UL0<br>6SL3210-1NE24-5AL0 | 6SL3210-1NE26-0UL0<br>6SL3210-1NE26-0AL0 |  |
|---|--|--|--|
| LO base load power  | 22 kW                                    | 30 kW                                    |  |
| LO base load input current                                  | 42 A                                     | 56 A                                     |  |
| LO base load output current                                 | 45 A                                     | 60 A                                     |  |
| HO base load power  | 18.5 kW                                  | 22 kW                                    |  |
| HO base load input current                                  | 36 A                                     | 42 A                                     |  |
| HO base load output current                                 | 38 A                                     | 45 A                                     |  |
| Fuse according to IEC / UL                                  | 3NE1818-0                                | 3NE1820-0                                |  |
| Power loss  | 0.52 kW                                  | 0.68 kW                                  |  |
| Required cooling air flow                                   | 80 l/s                                   | 80 l/s                                   |  |
| Weight without filter                                       | 11 kg                                    | 11 kg                                    |  |
| Weight with filter  | 14 kg                                    | 14 kg                                    |  |

#### Table 11-55 PM230, IP20, frame size E, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE27-5UL0<br>6SL3210-1NE27-5AL0 | 6SL3210-1NE28-8UL0<br>6SL3210-1NE28-8AL0 |  |
|---|--|--|--|
| LO base load power  | 37 kW                                    | 45 kW                                    |  |
| LO base load input current                                  | 70 A                                     | 84 A                                     |  |
| LO base load output current                                 | 75 A                                     | 90 A                                     |  |
| HO base load power  | 30 kW                                    | 37 kW                                    |  |
| HO base load input current                                  | 56 A                                     | 70 A                                     |  |
| HO base load output current                                 | 60 A                                     | 75 A                                     |  |
| Fuse according to IEC / UL                                  | 3NE1021-0                                | 3NE1022-0                                |  |

| Article number without filter<br>Article number with filter | 6SL3210-1NE27-5UL0<br>6SL3210-1NE27-5AL0 | 6SL3210-1NE28-8UL0<br>6SL3210-1NE28-8AL0 |  |
|---|--|--|--|
| Power loss  | 0.99 kW                                  | 1.2 kW                                   |  |
| Required cooling air flow                                   | 80 l/s                                   | 80 l/s                                   |  |
| Weight without filter                                       | 15 kg                                    | 15 kg                                    |  |
| Weight with filter  | 22 kg                                    | 22 kg                                    |  |

#### Table 11-56 PM230, IP20, frame size F, 3 AC 380 V ... 480 V

| Article number without filter<br>Article number with filter | 6SL3210-1NE31-1UL0<br>6SL3210-1NE31-1AL0 | 6SL3210-1NE31-5UL0<br>6SL3210-1NE31-5AL0 |  |
|---|--|--|--|
| LO base load power  | 55 kW                                    | 75 kW                                    |  |
| LO base load input current                                  | 102 A                                    | 135 A                                    |  |
| LO base load output current                                 | 110 A                                    | 145 A                                    |  |
| HO base load power  | 45 kW                                    | 55 kW                                    |  |
| HO base load input current                                  | 84 A                                     | 102 A                                    |  |
| HO base load output current                                 | 90 A                                     | 110 A                                    |  |
| Fuse according to IEC / UL                                  | 3NE1224-0                                | 3NE1225-0                                |  |
| Power loss  | 1.4 kW                                   | 1.9 kW                                   |  |
| Required cooling air flow                                   | 150 l/s                                  | 150 l/s                                  |  |
| Weight without filter                                       | 33 kg                                    | 33 kg                                    |  |
| Weight with filter  | 48 kg                                    | 48 kg                                    |  |

# 11.6.4 Current reduction depending on pulse frequency

Current derating depending on the pulse frequency

| LO base | Output base-load current at a pulse frequency of |       |       |       |        |        |        |        |
|---------|--|-------|-------|-------|--------|--------|--------|--------|
| load    | 2 kHz  | 4 kHz | 6 kHz | 8 kHz | 10 kHz | 12 kHz | 14 kHz | 16 kHz |
| kW      | Α  | Α     | Α     | А     | Α      | А      | Α      | А      |
| 0.37    |  | 1.3   | 1.11  | 0.91  | 0.78   | 0.65   | 0.59   | 0.52   |
| 0.55    |  | 1.7   | 1.45  | 1.19  | 1.02   | 0.85   | 0.77   | 0.68   |
| 0.75    |  | 2.2   | 1.87  | 1.54  | 1.32   | 1.10   | 0.99   | 0.88   |
| 1.1     |  | 3.1   | 2.64  | 2.17  | 1.86   | 1.55   | 1.4    | 1.24   |
| 1.5     |  | 4.1   | 3.49  | 2.87  | 2.46   | 2.05   | 1.85   | 1.64   |
| 2.2     |  | 5.9   | 5.02  | 4.13  | 3.54   | 2.95   | 2.66   | 2.36   |
| 3.0     |  | 7.7   | 6.55  | 5.39  | 4.62   | 3.85   | 3.47   | 3.08   |
| 4.0     |  | 10.2  | 8.67  | 7.14  | 6.12   | 5.1    | 4.59   | 4.08   |
| 5.5     |  | 13.2  | 11.22 | 9.24  | 7.92   | 6.6    | 5.94   | 5.28   |
| 7.5     |  | 18    | 15.3  | 12.6  | 10.8   | 9      | 8.1    | 7.2    |
| 11.0    |  | 26    | 22.1  | 18.2  | 15.6   | 13     | 11.7   | 10.4   |
| 15.0    |  | 32    | 27.2  | 22.4  | 19.2   | 16     | 14.4   | 12.8   |
| 18.5    |  | 38    | 32.3  | 26.6  | 22.8   | 19     | 17.1   | 15.2   |
| 22      |  | 45    | 38.25 | 31.5  | 27     | 22.5   | 20.25  | 18     |
| 30      |  | 60    | 51    | 42    | 36     | 30     | 27     | 24     |
| 37      |  | 75    | 63.75 | 52.5  | 45     | 37.5   | 33.75  | 30     |
| 45      |  | 90    | 76.5  | 63    | 54     | 45     | 40.5   | 36     |
| 55      |  | 110   | 93.5  | 77    | 66     | 55     | 49.5   | 44     |
| 75      |  | 145   | 123.3 | 101.5 |        |        |        |        |
| 90      |  | 178   | 151.3 | 124.6 |        |        |        |        |

The permissible cable length to the motor also depends on the cable type and the selected pulse frequency.

# 11.7 Technical data, PM250 Power Module

# 11.7.1 High overload – low overload

## Typical converter load cycles



## 11.7.2 Ambient conditions

## Ambient conditions during operation

| Property  | Version  |  |  |  |  |
|---|--|--|--|--|--|
| Ambient conditions for tran                                       | Ambient conditions for transport in the transport packaging                              |  |  |  |  |
| Climatic ambient conditions                                       | - 40° C + 70° C, according to Class 2K4 to EN 60721-3-2<br>maximum humidity 95% at 40 °C |  |  |  |  |
| Mechanical ambient condi-   | FSC: Shock and vibration permissible according to 1M2 to EN 60721-3-2                    |  |  |  |  |
| tions   | FSD FSF: Shock and vibration permissible according to 2M3 to EN 60721-3-2                |  |  |  |  |
| Protection against chemical substances                            | Protected according to Class 2C2 to EN 60721-3-2   |  |  |  |  |
| Biological ambient condi-<br>tions                                | Suitable according to Class 2B1 to EN 60721-3-2  |  |  |  |  |
| Ambient conditions for long-term storage in the product packaging |  |  |  |  |  |
| Climatic ambient conditions                                       | - 25 °C + 55 °C, according to Class 1K3 to EN 60721-3-1                                  |  |  |  |  |
| Protection against chemical substances                            | Protected according to Class 1C2 to EN 60721-3-1   |  |  |  |  |
| Biological ambient condi-<br>tions                                | Suitable according to class 1B1 to EN 60721-3-1  |  |  |  |  |
| Ambient conditions in operation                                   |  |  |  |  |  |
| Installation altitude   | Up to 1000 m above sea level without limitations   |  |  |  |  |
|   | Restrictions for special ambient conditions (Page 544)                                   |  |  |  |  |

| Property                               | Version  |  |
|--|--|--|
| Climatic ambient                       | Ambient operating temperature <sup>2)</sup>  |  |
| conditions <sup>1)</sup>               | – For operation according to Low Overload: $0^{\circ}$ C +40° C  |  |
|  | – For operation according to High Overload: $0^{\circ}$ C +50° C   |  |
|  | <ul> <li>Restrictions for special ambient conditions (Page 544)</li> </ul>   |  |
|  | Relative humidity: 5 95%, condensation not permitted   |  |
|  | • Oil mist, salt mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted |  |
| Mechanical ambient condi-              | • FSC FSF: Vibration levels permissible according to Class 3M1 to EN 60721-3-3   |  |
| tions                                  | • FSC: Shock, permissible according to Class 3M2 to EN 60721-3-3   |  |
|  | • FSD FSF: Shock permissible according to Class 3M1 to EN 60721-3-3  |  |
| Protection against chemical substances | Protected according to 3C2 to EN 60721-3-3   |  |
| Biological ambient condi-<br>tions     | Suitable according to 3C2 to EN 60721-3-3  |  |
| Pollution                              | Suitable for environments with degree of pollution 2 according to EN 61800-5-1, condensation not permitted                           |  |
| Cooling                                | Forced air cooling AF, according to EN 60146   |  |
| Cooling air                            | Clean and dry air  |  |

<sup>1)</sup> Increased ruggedness regarding temperature range and relative humidity; therefore better than 3K3 according to EN 60721-3-3

<sup>2)</sup> Observe the permissible ambient temperatures for the Control Unit and possibly the operator panel (IOP-2 or BOP-2).
| Property                               | Version   |
|--|---|
| Line voltage                           | 380 480 V 3 AC ± 10%  |
| Line impedance                         | Uk < 1% (RSC > 100), a line reactor is not permitted  |
| Output voltage                         | 3-phase 0 VAC input voltage x 0.87 (max.)   |
| Input frequency                        | 50 Hz 60 Hz, ± 3 Hz   |
| Output frequency                       | 0 550 Hz, depending on the control mode   |
| Power factor $\lambda$                 | 0.9   |
| Inrush current                         | < LO base load input current  |
| Pulse frequency (factory set-<br>ting) | 4 kHz<br>The pulse frequency can be adjusted up to 16 kHz in 2 kHz steps. The higher the pulse frequency,<br>the lower the available output current.<br>Current reduction depending upon pulse frequency (Page 542) |
| Electromagnetic compatibili-<br>ty     | The devices comply with EN 61800-3: 2004 suitable for Category C2 and C3 environments.  |
| Braking methods                        | DC braking  |
|  | <ul> <li>Regenerative feedback (energy recovery)<br/>max. with rated power based on high overload (HO)</li> </ul>   |
| Degree of protection                   | IP20 chassis units  |

# 11.7.3 General technical data, PM250

## 11.7.4 Specific technical specifications

### Note

The values for Low Overload (LO) are identical with those of the rated values.

Table 11-57 PM250, IP20, Frame Size C, 3-ph. AC 380 V ... 480 V

| Article No.                                | 6SL3225-0BE25-5AA1 | 6SL3225-0BE27-5AA1 | 6SL3225-0BE31-1AA1 |
|--|--------------------|--------------------|--------------------|
| LO base load output                        | 7.5 kW             | 11 kW              | 15 kW              |
| LO base load input current                 | 18 A               | 25 A               | 32 A               |
| LO base load output current                | 18 A               | 25 A               | 32 A               |
| HO base load output                        | 5.5 kW             | 7.5 kW             | 11 kW              |
| HO base load input current                 | 13.2 A             | 19 A               | 26 A               |
| HO base load output current                | 13.2 A             | 19 A               | 26 A               |
| Fuse                                       | 20 A, Class J      | 32 A, Class J      | 35 A, Class J      |
| Power loss                                 | 0.24 kW            | 0.30 kW            | 0.31 kW            |
| Required cooling air flow                  | 38 l/s             | 38 l/s             | 38 l/s             |
| Sound pressure level L <sub>pA</sub> (1 m) | < 60 dB            | < 60 dB            | < 60 dB            |
| Weight                                     | 7.5 kg             | 7.5 kg             | 7.5 kg             |

### Table 11-58 PM250, IP20, Frame Size D, 3-ph. AC 380 V ... 480 V

| Article No.                                   | 6SL3225-0BE31-5 . A0                  | 6SL3225-0BE31-8 . A0                  | 6SL3225-0BE32-2 . A0                  |
|---|---------------------------------------|---------------------------------------|---------------------------------------|
| LO base load output                           | 18.5 kW                               | 22 kW                                 | 30 kW                                 |
| LO base load input current                    | 36 A                                  | 42 A                                  | 56 A                                  |
| LO base load output current                   | 38 A                                  | 45 A                                  | 60 A                                  |
| HO base load output                           | 15 kW                                 | 18.5 kW                               | 22 kW                                 |
| HO base load input current                    | 30 A                                  | 36 A                                  | 42 A                                  |
| HO base load output current                   | 32 A                                  | 38 A                                  | 45 A                                  |
| Fuse according to IEC<br>Fuse according to UL | 3NA3820<br>50 A, Class J<br>3NE1817-0 | 3NA3822<br>63 A, Class J<br>3NE1818-0 | 3NA3824<br>80 A, Class J<br>3NE1820-0 |
| Power loss                                    | 0.44 kW                               | 0.55 kW                               | 0.72 kW                               |
| Required cooling air flow                     | 22 l/s                                | 22 l/s                                | 39 l/s                                |
| Sound pressure level L <sub>pA</sub> (1 m)    | < 60 dB                               | < 60 dB                               | < 61 dB                               |
| Weight  | 15 kg                                 | 15 kg                                 | 16 kg                                 |

| Article No.                                | 6SL3225-0BE33-0 . A0 | 6SL3225-0BE33-7 . A0 |  |
|--|----------------------|----------------------|--|
| LO base load output                        | 37 kW                | 45 kW                |  |
| LO base load input current                 | 70 A                 | 84 A                 |  |
| LO base load output current                | 75 A                 | 90 A                 |  |
| HO base load output                        | 30 kW                | 37 kW                |  |
| HO base load input current                 | 56 A                 | 70 A                 |  |
| HO base load output current                | 60 A                 | 75 A                 |  |
| Fuse according to IEC                      | 3NA3830              | 3NA3832              |  |
| Fuse according to UL                       | 100 A, Class J       | 125 A, Class J       |  |
| -  | 3NE1821-0            | 3NE1822-0            |  |
| Power loss                                 | 1.04 kW              | 1.2 kW               |  |
| Required cooling air flow                  | 22 l/s               | 39 l/s               |  |
| Sound pressure level L <sub>pA</sub> (1 m) | < 60 dB              | < 62 dB              |  |
| Weight                                     | 21 kg                | 21 kg                |  |

Table 11-59 PM250, IP20, Frame Size E, 3-ph. AC 380 V ... 480 V

Table 11-60 PM250, IP20, Frame size F, 3-ph. AC 380 V ... 480 V

| Article No.                                   | 6SL3225-0BE34-5 . A0                   | 6SL3225-0BE35-5 . A0                   | 6SL3225-0BE37-5 . A0                   |
|---|--|--|--|
| LO base load output                           | 55 kW                                  | 75 kW                                  | 90 kW                                  |
| LO base load input current                    | 102 A                                  | 135 A                                  | 166 A                                  |
| LO base load output current                   | 110 A                                  | 145 A                                  | 178 A                                  |
| HO base load output                           | 45 kW                                  | 55 kW                                  | 75 kW                                  |
| HO base load input current                    | 84 A                                   | 102 A                                  | 135 A                                  |
| HO base load output current                   | 90 A                                   | 110 A                                  | 145 A                                  |
| Fuse according to IEC<br>Fuse according to UL | 3NA3836<br>160 A, Class J<br>3NE1824-0 | 3NA3140<br>200 A, Class J<br>3NE1825-0 | 3NA3144<br>250 A, Class J<br>3NE1827-0 |
| Power loss                                    | 1.5 kW                                 | 2.0 kW                                 | 2.4 kW                                 |
| Required cooling air flow                     | 94 l/s                                 | 94 l/s                                 | 117 l/s                                |
| Sound pressure level L <sub>pA</sub> (1 m)    | < 60 dB                                | < 60 dB                                | < 65 dB                                |
| Weight  | 51 kg                                  | 51 kg                                  | 51 kg                                  |

# 11.7.5 Current reduction depending upon pulse frequency

## Relationship between pulse frequency and current reduction

| Rated<br>Power<br>(LO) | Base load<br>current<br>(LO) | Base load | current (LO) | at pulse fre | quency of |        |        |
|------------------------|------------------------------|-----------|--------------|--------------|-----------|--------|--------|
|                        | 4 kHz                        | 6 kHz     | 8 kHz        | 10 kHz       | 12 kHz    | 14 kHz | 16 kHz |
| kW                     | Α                            | Α         | Α            | Α            | Α         | А      | Α      |
| 0,55                   | 1,7                          |           |              |              |           |        |        |
| 0,75                   | 2,2                          | ,         |              |              |           |        |        |
| 1,1                    | 3,1                          | ,         |              |              |           |        |        |
| 1,5                    | 4,1                          |           |              |              |           |        |        |
| 2,2                    | 5,9                          |           |              |              |           |        |        |
| 3                      | 7,7                          |           |              |              |           |        |        |
| 4                      | 10.2                         | a),       |              |              |           |        |        |
| 5,5                    | 13.2                         |           |              |              |           |        |        |
| 7.5                    | 18.0                         | 12.5      | 11.9         | 10.6         | 9.20      | 7.90   | 6.60   |
| 11                     | 25.0                         | 18.1      | 17.1         | 15.2         | 13.3      | 11.4   | 9.50   |
| 15                     | 32.0                         | 24.7      | 23.4         | 20.8         | 18.2      | 15.6   | 12.8   |
| 18.5                   | 38.0                         | 32.3      | 26.6         | 22.8         | 19.0      | 17.1   | 15.2   |
| 22                     | 45.0                         | 38.3      | 31.5         | 27.0         | 22.5      | 20.3   | 18.0   |
| 30                     | 60.0                         | 51.0      | 42.0         | 36.0         | 30.0      | 27.0   | 24.0   |
| 37                     | 75.0                         | 63.8      | 52.5         | 45.0         | 37.5      | 33.8   | 30.0   |
| 45                     | 90.0                         | 76.5      | 63.0         | 54.0         | 45.0      | 40.5   | 36.0   |
| 55                     | 110                          | 93.5      | 77.0         |              |           |        |        |
| 75                     | 145                          | 123       | 102          |              |           |        |        |
| 90                     | 178                          | 151       | 125          |              |           |        |        |

 Table 11-61
 Current reduction depending on pulse frequency

11.8 Data regarding the power loss in partial load operation

# 11.8 Data regarding the power loss in partial load operation

You can find data regarding power loss in partial load operation in the Internet:

Partial load operation (<u>http://support.automation.siemens.com/WW/view/en/94059311</u>)

11.9 Restrictions for special ambient conditions

# 11.9 Restrictions for special ambient conditions

### Permissible line supplies dependent on the installation altitude

- For installation altitudes ≤ 2000 m above sea level, it is permissible to connect the converter to any of the line supplies that are specified for it.
- For installation altitudes 2000 m ... 4000 m above sea level, the following applies:
  - Connection to a TN line system with grounded neutral point is permissible.
  - TN systems with grounded line conductor are not permitted.
  - The TN line system with grounded neutral point can also be supplied using an isolation transformer.
  - The phase-to-phase voltage does not have to be reduced.

### Note

Using Power Modules connected to TN line supplies with voltages  $\ge$  600 V for installation altitudes 2000 m ... 4000 m

For voltages  $\geq$  600 V, the TN line supply must have a grounded neutral point established using an isolating transformer.

### Current derating as a function of the installation altitude

The permissible converter output current is reduced above an installation altitude of 1000 m.







Figure 11-5 Characteristic for PM230 Power Modules and PM250 Power Modules

# 11.10 Protecting persons from electromagnetic fields

### Overview

Protection of workers from electromagnetic fields is specified in the European EMF Directive 2013/35/EU. This directive is implemented in national law in the European Economic Area (EEA). Employers are obligated to design workplaces in such a way that workers are protected from impermissibly strong electromagnetic fields.

To this end, assessments and/or measurements must be performed for workplaces.

### **General conditions**

The following general conditions apply for the evaluations and measurements:

- 1. The laws for protection from electromagnetic fields in force in individual EU member states can go beyond the minimum requirements of the EMF Directive 2013/35/EU and always take precedence.
- 2. The ICNIRP 2010 limits for the workplace are the basis for the assessment.
- 3. The 26th BImSchV (German Federal Emission Protection Regulation) defines 100  $\mu$ T (RMS) for the assessment of active implants. According to Directive 2013/35/EU, 500  $\mu$ T (RMS) at 50 Hz is applicable here.
- 4. The routing of power cables has a significant impact on the electromagnetic fields that occur. Install and operate the components inside metallic cabinets in compliance with the documentation and use shielded motor cables.

EMC-compliant setup of the machine or plant (Page 60)

### Evaluation of the converter

The converters are normally used in machines. The assessment and testing is based on DIN EN 12198.

Compliance with the limit values was assessed for the following frequencies:

- Line frequency 47 ... 63 Hz
- Pulse frequency, for example 4/8/16 kHz and multiples thereof, assessed up to a maximum of 100 kHz

The indicated minimum distances apply to the head and complete torso of the human body. Shorter distances are possible for extremities.

| Table 11-62 Minimum distances to the converte |
|---|
|---|

| Individuals witho | ut active implants      | Individuals with active implants |                          |  |  |  |
|-------------------|-------------------------|----------------------------------|--------------------------|--|--|--|
| Control cabinet   | Control cabinet         | Control cabinet                  | Control cabinet          |  |  |  |
| closed            | open                    | closed                           | open                     |  |  |  |
| 0 cm              | Forearm length (approx. | Must be separately asses         | sed depending on the ac- |  |  |  |
|                   | 35 cm)                  | tive in                          | plant.                   |  |  |  |

11.10 Protecting persons from electromagnetic fields

# Appendix

# A.1 New and extended functions

## A.1.1 Firmware version 4.7 SP14

| Table A-1 | New functions and | function chang | es in | firmware 4 | 4.7 | SP14 |
|-----------|-------------------|----------------|-------|------------|-----|------|
|           |                   |                |       |            |     |      |

|   | Function   | SINAMICS |       |          |          |          |          |          |          |  |
|---|--|----------|-------|----------|----------|----------|----------|----------|----------|--|
|   |  |          |       |          | G1       | 20       |          | G120D    |          |  |
|   |  | G115D    | G120C | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 |  |
| 1 | The G115D converter now supports the extended safety function 'Safety Limited Speed (SLS)' when using motors from SIEMENS and third-party manufacturers. | 1        | -     | -        | -        | 1        | -        | ✓        | -        |  |

# A.1.2 Firmware version 4.7 SP13

### Table A-2New functions and function changes in firmware 4.7 SP13

|   | Function   | SINAMICS |       |       |          |  |   |       |   |          |
|---|--|----------|-------|-------|----------|--|---|-------|---|----------|
|   |  |          |       |       |          | G1   |   | G120D |   |          |
|   |  | G115D    | G110M | G120C | CU230P-2 | CU230P-2<br>CU240B-2<br>CU240E-2<br>CU250S-2 |   |       |   | CU250D-2 |
| 1 | SIMOTICS 1FP1 and 1FP3 synchronous-reluctance motors have also been approved for operation with SINAMICS G120C.  | -        | ~     | 1     | 1        | 1  | 1 | -     | ~ | -        |
| 2 | The extended safety functions SS1, SLS, SSM and SDI are approved when using synchronous-reluctance motors from Siemens and third-party manufacturers.  | -        | -     | -     | -        | -  | 1 | -     | 1 | -        |
| 3 | The converter transmits the state of the fail-safe digital input F-DI 0 via PROFIsafe when using the basic functions.  | 1        | 1     | 1     | -        | -  | 1 | ~     | 1 | ~        |
|   | You can find more information in the "Safety Integrated" Function Manual.<br>Safety Integrated" function manual ( <u>https://</u><br><u>support.industry.siemens.com/cs/ww/en/view/109751320</u> ) |          |       |       |          |  |   |       |   |          |

## Appendix

## A.1 New and extended functions

|   | Function  | SINAMICS |   |   |   |    |    |   |       |   |  |
|---|---|----------|---|---|---|----|----|---|-------|---|--|
|   |   |          |   |   |   | G1 | 20 |   | G120D |   |  |
| 4 | Modbus RTU:   | -        | - | 1 | 1 | ✓  | ✓  | 1 | -     | - |  |
|   | The converter supports the combination "1 stop bit" and "no parity".  |          |   |   |   |    |    |   |       |   |  |
| 5 | EtherNet/IP:  | ✓        | ✓ | 1 | 1 | -  | 1  | 1 | 1     | ✓ |  |
|   | When selecting the ODVA AC/DC drive profile, although telegram 1 is pre-<br>defined, it can be extended to include additional process data. |          |   |   |   |    |    |   |       |   |  |
|   | The EDS file has been extended accordingly by a telegram with a length of 6 words.  |          |   |   |   |    |    |   |       |   |  |
|   | More information is provided in the "Fieldbuses" Function Manual.   |          |   |   |   |    |    |   |       |   |  |
|   | 😯 "Fieldbus" function manual ( <u>https://</u>  |          |   |   |   |    |    |   |       |   |  |
|   | support.industry.siemens.com/cs/ww/en/view/109751350)   |          |   |   |   |    |    |   |       |   |  |
|   | EDS ( <u>https://support.industry.siemens.com/cs/ww/de/view/78026217</u> )  |          |   |   |   |    |    |   |       |   |  |

# A.1.3 Firmware version 4.7 SP10

|   | Function  | SINAMICS |       |          |          |          |          |          |          |                |
|---|---|----------|-------|----------|----------|----------|----------|----------|----------|----------------|
|   |   |          |       |          | G1       | 20       |          | G1200    |          |                |
|   |   | G110M    | G120C | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 | ET 200pro FC-2 |
| 1 | New parameter r7844 [1] for displaying the firmware version in plain text.  | 1        | 1     | 1        | 1        | 1        | 1        | 1        | 1        | 1              |
|   | "04070901" is equivalent to firmware version V4.7 SP9 HF1, for example  |          |       |          |          |          |          |          |          |                |
| 2 | Modbus RTU:   | 1        | ✓     | 1        | 1        | 1        | ✓        | -        | -        | -              |
|   | • The factory setting of parameter p2040 was increased to provide more robust converter operation. Monitoring time for data failure at the Modbus interface: p2040 = 10 s |          |       |          |          |          |          |          |          |                |
|   | • r2057 indicates how the address switch on the converter is set  |          |       |          |          |          |          |          |          |                |
| 3 | BACnet MS/TP:   | -        | -     | 1        | -        | -        | -        | -        | -        | -              |
|   | New factory setting for more robust converter operation:  |          |       |          |          |          |          |          |          |                |
|   | <ul> <li>Baud rate p2020 = 38.4 kBd</li> </ul>  |          |       |          |          |          |          |          |          |                |
|   | <ul> <li>Monitoring time for data failure at the BACnet interface was in-<br/>creased: p2040 = 10 s</li> </ul>  |          |       |          |          |          |          |          |          |                |
|   | - Factory setting for the maximum number of info frames p2025 [1] = 5   |          |       |          |          |          |          |          |          |                |
|   | <ul> <li>Factory setting for the maximum number of manager addresses<br/>p2025 [3] = 32</li> </ul>  |          |       |          |          |          |          |          |          |                |
|   | • r2057 indicates how the address switch on the converter is set  |          |       |          |          |          |          |          |          |                |
| 4 | Further technological unit kg/cm <sup>2</sup> for unit switchover   | ✓        | ✓     | ✓        | ✓        | 1        | ✓        | ✓        | ✓        | ✓              |
| 5 | Further technological unit kg/cm <sup>2</sup> for additional technology controllers   | -        | -     | 1        | -        | -        | -        | -        | -        | -              |

Table A-3New functions and function changes in firmware 4.7 SP10

## A.1 New and extended functions

|   | Function  | SINAMICS |   |   |    |         |   |     |       |   |
|---|---|----------|---|---|----|---------|---|-----|-------|---|
|   |   |          |   |   | G1 | 20      |   | G12 | G120D |   |
| 6 | Commissioning with predefined motor data for SIMOTICS GP/SD synchro-<br>nous-reluctance motors:   | ~        | - | ~ | -  | ✓<br>1) | - | <   | -     | - |
|   | • Second generation: 1FP1 . 04 $\rightarrow$ 1FP1 . 14  |          |   |   |    |         |   |     |       |   |
|   | Further frame sizes:  |          |   |   |    |         |   |     |       |   |
|   | <ul> <li>1.1 kW 3 kW, 1500 1/min, 1800 1/min, 2810 1/min</li> </ul>   |          |   |   |    |         |   |     |       |   |
|   | – 0.75 kW 4 kW, 3000 1/min, 3600 1/min  |          |   |   |    |         |   |     |       |   |
|   | • In planning:  |          |   |   |    |         |   |     |       |   |
|   | <ul> <li>37 kW 45 kW, 1500 1/min, 1800 1/min, 2810 1/min</li> </ul>   |          |   |   |    |         |   |     |       |   |
|   | <ul> <li>– 5.5 kW 18.5 kW, 3000 1/min, 3600 1/min</li> </ul>  |          |   |   |    |         |   |     |       |   |
|   | – 45 kW, 3000 1/min, 3600 1/min   |          |   |   |    |         |   |     |       |   |
|   | <ul> <li>The predefined motor data is already included in the firmware</li> </ul>   |          |   |   |    |         |   |     |       |   |
| 7 | Extended setting option for evaluating the STOP cam in the "basic positioner" function  | -        | - | - | -  | -       | 1 | -   | ~     | - |
|   | Two different functions to evaluate STOP cams can be set:   |          |   |   |    |         |   |     |       |   |
|   | Edge-triggered evaluation (factory setting)   |          |   |   |    |         |   |     |       |   |
|   | Level-triggered evaluation  |          |   |   |    |         |   |     |       |   |
|   | For more information, refer to the "Basic Positioner" Function Manual or the operating instructions for "SINAMICS G120D Converter with CU250D-2 Control Units". |          |   |   |    |         |   |     |       |   |
|   | Basic positioner" function manual ( <u>https://</u> support.industry.siemens.com/cs/ww/en/view/109477922)   |          |   |   |    |         |   |     |       |   |
|   | Operating instructions SINAMICS G120D with CU250D-2 ( <u>https://</u> support.industry.siemens.com/cs/ww/en/view/109477365)                                     |          |   |   |    |         |   |     |       |   |

<sup>1)</sup> Installation with PM240-2 or PM240P-2 Power Modules

# A.1.4 Firmware version 4.7 SP9

|    | Function  | SINAMICS |       |          |          |          |          |          |          |                |
|----|---|----------|-------|----------|----------|----------|----------|----------|----------|----------------|
|    |   |          |       |          | G1       | 20       |          | G12      | 20D      |                |
|    |   | G110M    | G120C | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 | ET 200pro FC-2 |
| 1  | Support of PM240-2 FSG Power Modules  | -        | -     | ✓        | 1        | 1        | ✓        | -        | -        | -              |
| 2  | <ul> <li>Support of PM240-2 Power Modules in push-through technology, frame sizes FSD FSF, for the following voltages:</li> <li>3 AC 200 V 240 V</li> <li>3 AC 380 V 480 V</li> </ul>   | -        | -     | 1        | 1        | •        | 1        | -        | -        | -              |
|    | • 3 AC 500 V 690 V  |          |       |          |          |          |          |          |          |                |
| 3  | Shortened switch-on time for PM330 Power Modules  | -        | -     | ✓        | -        | -        | -        | -        | -        | -              |
| 4  | <ul> <li>Expansion of the support for 1FP1 synchronous-reluctance motor with the following converters:</li> <li>SINAMICS G110M</li> <li>SINAMICS G120D</li> <li>SINAMICS G120 with CU240B-2 or CU240E-2 Control Unit</li> <li>A PM240-2 Power Module is required to operate a 1FP1 synchronous-reluctance motor with SINAMICS G120</li> </ul> | -        | -     | •        | -        |          | -        | -        | -        | -              |
| 5  | Support of 1FP3 synchronous-reluctance motors   | -        | -     |          | -        | -        | -        | -        | -        | -              |
|    | A PM240-2 Power Module is required to operate a 1FP3 synchronous-reluc-<br>tance motor along with a selective release from SIEMENS  |          |       |          |          |          |          |          |          |                |
| 6  | Support of 1LE5 induction motors  | -        | ✓     | ✓        | 1        | ✓        | ✓        | -        | -        | -              |
| 7  | The converter supports forming of the PM330 Power Module DC link capac-<br>itors  | -        | -     | ~        | -        | -        | -        | -        | -        | -              |
| 8  | Setting option for two output reactors using parameter p0235 at the SI-<br>NAMICS G120C and SINAMICS G120 with PM240-2 FSD FSF Power Module   | -        | ~     | 1        | 1        | ~        | ~        | -        | -        | -              |
| 9  | Efficiency-optimized operation of induction motors<br>Improved method "Efficiency optimization 2"   | 1        | 1     | 1        | 1        | 1        | 1        | 1        | 1        | 1              |
| 10 | New setting option for the "Technology application" p0500 = 5 during quick commissioning  | 1        | ~     | 1        | 1        | 1        | ~        | 1        | 1        | 1              |
| 11 | Expansion of the available PROFIdrive telegrams in the SINAMICS G120C to include telegram 350   | -        | ~     | 1        | 1        | 1        | ~        | -        | -        | -              |
| 12 | An SSI encoder can be parameterized as motor encoder  | -        | -     | -        | -        | -        | ✓        | -        | 1        | -              |
| 13 | Expansion of the "Basic positioner" function to include the feedback signal from traversing blocks to the higher-level control system   | -        | -     | -        | -        | -        | 1        | -        | ~        | -              |
| 14 | <ul> <li>Feedback signal supplemented to indicate that a memory card is not inserted in the converter:</li> <li>Parameter r9401 as BiCo parameter for the optional feedback signal to the higher-level control system.</li> <li>New alarm A01101</li> </ul>   | •        | •     | •        | •        | •        | •        | •        | •        | •              |

Table A-4New functions and function changes in firmware 4.7 SP9

## A.1 New and extended functions

|    | Function   | SINAMICS |   |            |   |   |   |   |   |   |
|----|--|----------|---|------------|---|---|---|---|---|---|
|    |  |          |   | G120 G120D |   |   |   |   |   |   |
| 15 | Expansion of the "End stop control" function on the following converters:                | 1        | ✓ | 1          | 1 | ✓ | ✓ | 1 | 1 | - |
|    | SINAMICS G120  |          |   |            |   |   |   |   |   |   |
|    | SINAMICS G120C   |          |   |            |   |   |   |   |   |   |
|    | SINAMICS G120D   |          |   |            |   |   |   |   |   |   |
| 16 | Expansion of the technology controller to include the following functions:               | -        | - | 1          | - | 1 | - | - | - | - |
|    | • Gain $K_P$ and integral time $T_N$ can be adapted.                                     |          |   |            |   |   |   |   |   |   |
|    | The system deviation can be used as adaptation signal                                    |          |   |            |   |   |   |   |   |   |
| 17 | Expansion to the torque limiting for SINAMICS G120 converters with CU230P-2 Control Unit | 1        | 1 | 1          | 1 | 1 | 1 | 1 | 1 | - |
| 18 | The converter displays the state "PROFlenergy pause" as follows:                         | 1        | 1 | 1          | 1 | ✓ | 1 | 1 | 1 | 1 |
|    | • LED RDY "green on": 0.5 s  |          |   |            |   |   |   |   |   |   |
|    | • LED RDY off: 3 s   |          |   |            |   |   |   |   |   |   |

# A.1.5 Firmware version 4.7 SP6

|   | Function   | SINAMICS |                     |          |                       |                       |          |          |          |                |
|---|--|----------|---------------------|----------|-----------------------|-----------------------|----------|----------|----------|----------------|
|   |  |          |                     |          | G1                    | 20                    |          | G120D    |          |                |
|   |  | G110M    | G120C               | CU230P-2 | CU240B-2              | CU240E-2              | CU250S-2 | CU240D-2 | CU250D-2 | ET 200pro FC-2 |
| 1 | Support for the Power Module PM240-2, FSF frame sizes  | -        | -                   | 1        | 1                     | 1                     | 1        | -        | -        | -              |
|   | Support of PM240P-2 Power Modules frame sizes FSD FSF  | -        | -                   | 1        | 1                     | 1                     | -        | -        | -        | -              |
|   | Support of safety function Safe Torque Off (STO) via the terminals of the PM240-2 Power Module, frame size FSF and PM240P-2 Power Module FSD FSF | -        | -                   | -        | -                     | 1                     | 1        | -        | -        | -              |
| 2 | Support for Power Module PM330 JX frame size   | -        | -                   | ✓        | -                     | -                     | -        | -        | -        | -              |
| 3 | Support for 1PC1 induction motors  | 1        | 1                   | 1        | 1                     | 1                     | 1        | ✓        | 1        | ✓              |
| 4 | The control of synchronous reluctance takes into account the inductance of the output reactor.   | -        | -                   | ~        | -                     | -                     | -        | -        | -        | -              |
| 5 | Support of motor temperature sensor Pt1000   | 1        | 1                   | 1        | 1                     | 1                     | 1        | 1        | 1        | 1              |
| 6 | New p4621 parameter for disabling PTC short-circuit monitoring   | -        | -                   | -        | -                     | -                     | -        | 1        | 1        | 1              |
| 7 | Revision of the thermal motor model for protecting the motor against dam-<br>age due to overheating in the stator or rotor                       | -        | ~                   | ~        | 1                     | 1                     | ~        | ~        | -        | 1              |
| 8 | Changing the quick commissioning in the "Standard Drive Control" applica-<br>tion class:   | -        | 1                   | ~        | 1                     | 1                     | 1        | -        | -        | -              |
|   | The motor data identification is no longer permanently set to p1900 = 12; instead, users select the appropriate motor data identification.       |          |                     |          |                       |                       |          |          |          |                |
|   | Factory setting: p1900 = 2.  |          |                     |          |                       |                       |          |          |          |                |
| 9 | The free function blocks are also available in the SINAMICS G120C.   | 1        | <ul><li>✓</li></ul> | 1        | <ul> <li>✓</li> </ul> | <ul> <li>✓</li> </ul> | ✓        | 1        | -        | -              |

 Table A-5
 New functions and function changes in firmware 4.7 SP6

A.1 New and extended functions

# A.1.6 Firmware version 4.7 SP3

Table A-6New functions and function changes in firmware 4.7 SP3

|    | Function  | SINAMICS |       |          |          |          |          |          |          |                |
|----|---|----------|-------|----------|----------|----------|----------|----------|----------|----------------|
|    |   |          |       |          | G1       | 20       |          | G12      | 20D      |                |
|    |   | G110M    | G120C | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 | ET 200pro FC-2 |
| 1  | PM240-2 Power Modules, frame sizes FSD and FSE are supported  | -        | -     | ✓        | 1        | ✓        | ✓        | -        | -        | -              |
|    | The Safety Integrated Basic Function Safe Torque Off (STO) is supported via the terminals of the PM240-2 Power Module, frame sizes FSD and FSE  | -        | -     | -        | -        | 1        | ~        | -        | -        | -              |
| 2  | Revised PM230 Power Module with new article numbers supported:  | -        | -     | ✓        | 1        | ✓        | -        | -        | -        | -              |
|    | IP55 degree of protection: 6SL3223-0DE G .  |          |       |          |          |          |          |          |          |                |
|    | • IP20 degree of protection and Push Through: 6SL3211NE <b>G</b> .  |          |       |          |          |          |          |          |          |                |
|    | The Safety Integrated Basic Function Safe Torque Off (STO) is supported with the revised PM230 Power Module   | -        | -     | -        | -        | ~        | -        | -        | -        | -              |
| 3  | PM330 Power Module, frame size HX is supported  | -        | -     | 1        | -        | -        | -        | -        | -        | -              |
| 4  | Support of 1FP1 synchronous-reluctance motors   | -        | -     | ✓        | -        | -        | -        | -        | -        | -              |
| 5  | Encoderless 1FG1 geared synchronous motors are supported  | -        | -     | -        | -        | -        | -        | 1        | -        | -              |
| 6  | Selection list for 1PH8 induction motors in the STARTER and Startdrive com-<br>missioning wizard  | -        | ~     | ~        | ~        | ~        | ~        | -        | -        | -              |
| 7  | Updated selection list for 1LE1 induction motors in the STARTER and Start-<br>drive commissioning wizard  | 1        | 1     | 1        | 1        | 1        | 1        | ~        | ~        | ~              |
| 8  | Motor support expanded with 1LE1, 1LG6, 1LA7 and 1LA9 induction motors  | ✓        | -     | -        | -        | -        | -        | -        | -        | -              |
| 9  | Speed and position control obtain their respective actual value from an SSI encoder with incremental tracks. The output signals of the encoder are available as encoder 2 for position control and timer 1 for speed control. | -        | -     | -        | -        | -        | 1        | -        | 1        | -              |
| 10 | Power Module with temperature-controlled fan  | ✓        | -     | -        | -        | -        | -        | -        | -        | -              |
| 11 | SINAMICS "Standard Drive Control" and "Dynamic Drive Control" application<br>classes to simplify commissioning and increase the degree of ruggedness of<br>the closed-loop motor control.                                     | -        | 1     | 1        | 1        | 1        | 1        | -        | -        | -              |
|    | ers:  |          |       |          |          |          |          |          |          |                |
|    | SINAMICS G120C  |          |       |          |          |          |          |          |          |                |
|    | SINAMICS G120 with PM240, PM240-2 and PM330 Power Modules   |          |       |          |          |          |          |          |          |                |
| 12 | Moment of inertia estimator with moment of inertia precontrol to optimize the speed controller in operation   | 1        | ~     | -        | 1        | 1        | ~        | 1        | 1        | 1              |
| 13 | Friction torque characteristic with automatic plotting to optimize the speed controller   | ~        | 1     | -        | 1        | 1        | 1        | 1        | ~        | ~              |
| 14 | Automatic optimization of the technology controller   | -        | -     | ✓        | 1        | ✓        | -        | -        | -        | -              |
| 15 | The sign of the system deviation for the additional, free technology control-<br>ler can be switched over.  | -        | -     | ✓        | -        | -        | -        | -        | -        | -              |
|    | A new parameter defines the sign of the system deviation matching the particular application, e.g. for cooling or heating applications.   |          |       |          |          |          |          |          |          |                |

|    | Function   | SINAMICS |   |   |   |                      |   |     |     |   |
|----|--|----------|---|---|---|----------------------|---|-----|-----|---|
|    |  |          |   |   | G1  | 20                   |   | G12 | 20D | 1 |
| 16 | The technology controller output can be enabled and disabled during oper-<br>ation   | -        | ~ | ~ | <ul> <li>Image: A start of the start of</li></ul> | <ul> <li></li> </ul> | ~ | -   | -   | - |
| 17 | Ramp-function generator remains active with enabled technology controller  | -        | - | ✓ | -   | -                    | - | -   | -   | - |
| 18 | Line contactor control using a digital output of the converter to save energy when the motor is switched off   | 1        | 1 | ~ | 1   | 1                    | 1 | 1   | 1   | - |
| 19 | Fast flying restart for PM330 Power Modules:   | -        | - | 1 | -   | -                    | - | -   | -   | - |
|    | The "Flying restart" function does not have to wait for the motor demagnet-<br>ization time, and identifies the motor speed without requiring a search op-<br>eration. |          |   |   |   |                      |   |     |     |   |
| 20 | Load torque monitoring extended to include the following functions:  | 1        | - | 1 | 1   | 1                    | - | -   | -   | - |
|    | Protection against blocking, leakage and dry running operation in pump applications  |          |   |   |   |                      |   |     |     |   |
|    | Protection against blocking and broken belts in fan applications   |          |   |   |   |                      |   |     |     |   |
| 21 | Automatic switchover of the real time clock from daylight saving time (summer time) to standard time (winter time).  | -        | - | ~ | -   | -                    | - | -   | -   | - |
| 22 | New or revised default settings of the interfaces: p0015 macros 110, 112 and 120   | -        | - | ~ | -   | -                    | - | -   | -   | - |
| 23 | Expansion of the temperature sensors to include DIN-Ni1000 for analog inputs AI 2 and AI 3   | -        | - | ~ | -   | -                    | - | -   | -   | - |
| 24 | Communication via AS-Interface.  | 1        | - | - | -   | -                    | - | -   | -   | - |
|    | Default setting of the communication via AS-i: p0015 macros 30, 31, 32 and 34  |          |   |   |   |                      |   |     |     |   |
| 25 | Communication expansion via Modbus:  | 1        | 1 | 1 | 1   | 1                    | 1 | -   | -   | - |
|    | Adjustable parity bit, access to parameters and analog inputs  |          |   |   |   |                      |   |     |     |   |
| 26 | Extending communication via BACnet:  | -        | - | ✓ | -   | -                    | - | -   | -   | - |
|    | Access to parameters and analog inputs   |          |   |   |   |                      |   |     |     |   |
| 27 | The bus error LED for communication via USS and Modbus can be switched off   | -        | ~ | ~ | -   | 1                    | ~ | -   | -   | - |
| 28 | Default of the minimum speed to 20 % of the rated motor speed  | -        | - | ✓ | -   | -                    | - | -   | -   | - |
| 29 | For commissioning with an operator panel, the converter automatically backs up the measured data retentively in the ROM after identification of the motor data.        | 1        | 1 | 1 | 1   | 1                    | 1 | 1   | 1   | 1 |
| 30 | The result of the energy savings calculation for flow machines is available as a connector   | -        | ~ | ~ | ~   | 1                    | ~ | ~   | ~   | - |
| 31 | New "ppm" unit (parts per million) for unit switching  | 1        | 1 | 1 | 1   | 1                    | 1 | ✓   | 1   | 1 |
| 32 | Displaying speeds during commissioning via operator panel in units of Hz instead of rpm. Conversion from Hz to rpm via p8552   | -        | - | 1 | -   | -                    | - | -   | -   | - |
| 33 | Voltage-dependent current limit for 600V devices of Power Module PM330 and PM240-2   | -        | - | ~ | ~   | ~                    | ~ | -   | -   | - |

A.1 New and extended functions

# A.1.7 Firmware version 4.7

Table A-7New functions and function changes in Firmware 4.7

|    | Function  | SINAMICS |       |          |          |          |          |          |          |
|----|---|----------|-------|----------|----------|----------|----------|----------|----------|
|    |   |          |       |          | G1       | 20       |          | G12      | 20D      |
|    |   | G110M    | G120C | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 |
| 1  | Supporting the identification & maintenance datasets (I&M1 4)   | 1        | 1     | 1        | 1        | 1        | 1        | 1        | 1        |
| 2  | Fall in pulse rate with increased drive power required by the motor   | 1        | 1     | 1        | 1        | -        | 1        | 1        | <        |
|    | • The converter temporarily lowers the pulse frequency if required when the motor is started up, and simultaneously increases the current limit.        |          |       |          |          |          |          |          |          |
| 3  | S7 communication  | 1        | 1     | 1        | 1        | -        | 1        | 1        | <        |
|    | • Direct data exchange between the converter and human-machine interface (HMI).   |          |       |          |          |          |          |          |          |
|    | <ul> <li>Increase in communication performance with the engineering tools and support of the S7 routing</li> </ul>                                      |          |       |          |          |          |          |          |          |
| 4  | The basic functions of Safety Integrated are unrestrictedly available in all control types with 1FK7 encoderless permanent-field synchronous motors     | -        | -     | -        | -        | -        | -        | 1        | -        |
| 5  | Encoderless 1FK7 synchronous motors are supported   | -        | -     | -        | -        | -        | -        | 1        | -        |
|    | Direct motor selection based on the article number with associated code     number  |          |       |          |          |          |          |          |          |
|    | It is not necessary to input individual motor data  |          |       |          |          |          |          |          |          |
| 6  | Pulse input as source of setpoint value   | -        | -     | -        | -        | -        | 1        | -        | -        |
|    | • The converter calculates its speed setpoint from a sequence of pulses at the digital input.   |          |       |          |          |          |          |          |          |
| 7  | Dynamic IP address assignment (DHCP) and temporary device names for PROFI-<br>NET   | 1        | ~     | ~        | -        | ~        | 1        | 1        | ~        |
| 8  | PROFlenergy device profile 2 and 3  | ✓        | ✓     | ✓        | -        | ✓        | ✓        | ✓        | ✓        |
| 9  | Uniform behavior for component replacement  | 1        | ✓     | -        | -        | ✓        | 1        | 1        | ✓        |
|    | • After a component is replaced, a converter with activated Safety Integrated will report what type of component has been replaced using a unique code. |          |       |          |          |          |          |          |          |
| 10 | Improved direct-component control in PM230  | -        | -     | ✓        | -        | -        | -        | -        | -        |
|    | Optimized efficiency for pump and fan applications  |          |       |          |          |          |          |          |          |
| 11 | Rounding down of BACnet and macros  | -        | -     | ✓        | -        | -        | -        | -        | -        |

# A.1.8 Firmware version 4.6 SP6

| Table A-8  | New functions and | function changes | in firmware 4.6 SP6 |
|------------|-------------------|------------------|---------------------|
| Tuble / CO | New runctions and | runedon chunges  |                     |

|   | Function                          | SINAMICS |          |          |          |          |          |          |  |  |
|---|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|--|--|
|   |                                   |          | G120     |          |          |          |          | G120D    |  |  |
|   |                                   | G120C    | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 |  |  |
| 1 | Support for the new Power Modules | -        | ✓        | -        | -        | -        | -        | -        |  |  |
|   | • PM330 IP20 GX                   |          |          |          |          |          |          |          |  |  |

A.1 New and extended functions

# A.1.9 Firmware version 4.6

Table A-9New functions and function changes in Firmware 4.6

|    | Function  | SINAMICS |          |          |          |          |          |          |  |
|----|---|----------|----------|----------|----------|----------|----------|----------|--|
|    |   |          |          | G1       | 20       |          | G12      | 20D      |  |
|    |   | G120C    | CU230P-2 | CU240B-2 | CU240E-2 | CU250S-2 | CU240D-2 | CU250D-2 |  |
| 1  | Support for the new Power Modules   | -        | 1        | 1        | ✓        | 1        | -        | -        |  |
|    | • PM240-2 IP20 FSB FSC  |          |          |          |          |          |          |          |  |
|    | • PM240-2 in through-hole technology FSB FSC  |          |          |          |          |          |          |          |  |
| 2  | Support for the new Power Modules   | -        | 1        | 1        | 1        | -        | -        | -        |  |
|    | PM230 in through-hole technology FSD FSF  |          |          |          |          |          |          |          |  |
| 3  | Motor data preassignment for the 1LA/1LE motors via code number   | 1        | 1        | 1        | ✓        | 1        | 1        | ✓        |  |
|    | • During quick commissioning with the operator panel, set the motor data using a code number                      |          |          |          |          |          |          |          |  |
| 4  | Extension to communication via CANopen  | 1        | 1        | -        | -        | 1        | -        | -        |  |
|    | CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm |          |          |          |          |          |          |          |  |
| 5  | Extension to communication via BACnet   | -        | 1        | -        | -        | -        | -        | -        |  |
|    | • Multistate value objects for alarms, commandable AO objects, objects for config-<br>uring the PID controller    |          |          |          |          |          |          |          |  |
| 6  | Communication via EtherNet/IP   | 1        | 1        | -        | ✓        | 1        | 1        | ✓        |  |
| 7  | Skip frequency band for analog input  | 1        | 1        | 1        | 1        | 1        | 1        | -        |  |
|    | • A symmetrical skip frequency band can be set for each analog input around the 0 V range.                        |          |          |          |          |          |          |          |  |
| 8  | Changing the control of the motor holding brake   | ✓        | -        | ✓        | ✓        | ✓        | ✓        | -        |  |
| 9  | Safety function SBC (Safe Brake Control)  | -        | -        | -        | -        | 1        | -        | -        |  |
|    | • Secure control of a motor holding brake when using the "Safe Brake Module" option                               |          |          |          |          |          |          |          |  |
| 10 | Safety function SS1 (Safe Stop 1) without speed monitoring  | -        | -        | -        | -        | ✓        | -        | -        |  |
| 11 | Straightforward selection of standard motors  | 1        | ✓        | 1        | 1        | 1        | 1        | ✓        |  |
|    | • Selection of 1LA and 1LE motors with an operator panel using a list containing code numbers                     |          |          |          |          |          |          |          |  |
| 12 | Firmware update via memory card   | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        |  |
| 13 | Safety info channel   | -        | -        | -        | ✓        | ✓        | ✓        | ✓        |  |
|    | • BICO source r9734.014 for the status bits of the extended safety functions                                      |          |          |          |          |          |          |          |  |
| 14 | Diagnostic alarms for PROFIBUS  | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        |  |

# A.1.10 Firmware version 4.5

| Table A-10 | New functions | and function | changes in | Firmware 4.5      |
|------------|---------------|--------------|------------|-------------------|
|            | New runctions | una runction | chunges m  | i iiiiiwai e ii.5 |

|    | Function  | SINAMICS |          |          |          |          |          |  |
|----|---|----------|----------|----------|----------|----------|----------|--|
|    |   |          | G120     |          |          | G120D    |          |  |
|    |   | G120C    | CU230P-2 | CU240B-2 | CU240E-2 | CU240D-2 | CU250D-2 |  |
| 1  | Support for the new Power Modules:                              | -        | 1        | 1        | 1        | -        | -        |  |
|    | • PM230 IP20 FSA FSF  |          |          |          |          |          |          |  |
|    | PM230 in a push-through FSA FSC                                 |          |          |          |          |          |          |  |
| 2  | Support for the new Power Modules:                              | -        | 1        | ✓        | 1        | -        | -        |  |
|    | • PM240-2 IP20 FSA  |          |          |          |          |          |          |  |
|    | • PM240-2 in push-through FSA                                   |          |          |          |          |          |          |  |
| 3  | New Control Units with PROFINET support                         | 1        | 1        | -        | 1        | 1        | ✓        |  |
| 4  | Support of the PROFlenergy profile                              | 1        | 1        | -        | ✓        | 1        | ✓        |  |
| 5  | Shared device support via PROFINET                              | 1        | 1        | -        | ✓        | 1        | ✓        |  |
| 6  | Write protection  | 1        | 1        | 1        | ✓        | 1        | ✓        |  |
| 7  | Know-how protection   | ✓        | 1        | ✓        | ✓        | 1        | ✓        |  |
| 8  | Adding a second command data set (CDS0 $\rightarrow$ CDS0 CDS1) | 1        | -        | -        | -        | -        | -        |  |
|    | (All other converters have four command data sets)              |          |          |          |          |          |          |  |
| 9  | Position control and basic positioner                           | -        | -        | -        | -        | -        | ✓        |  |
| 10 | Support of an HTL encoder                                       | -        | -        | -        | -        | 1        | ✓        |  |
| 11 | Support of an SSI encoder                                       | -        | -        | -        | -        | -        | ✓        |  |
| 12 | Failsafe digital output   | -        | -        | -        | -        | 1        | ✓        |  |

A.2 Interconnecting signals in the converter

# A.2 Interconnecting signals in the converter

### A.2.1 Fundamentals

The following functions are implemented in the converter:

- Open-loop and closed-loop control functions
- Communication functions
- Diagnosis and operating functions

Every function comprises one or several blocks that are interconnected with one another.



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

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.



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

### **Binectors and connectors**

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

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



Figure A-3 Symbols for binector and connector inputs and outputs

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

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

### Interconnecting signals

### When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

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

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

### Principle when connecting BICO blocks using BICO technology

When interconnecting the signal, the following principle applies: Where does the signal come from?

An interconnection between two BICO blocks consists of a connector or a binector and a BICO parameter. The input of a block must be assigned the output of a different block: In the BICO parameters, enter the parameter numbers of the connector/binector that should supply its output signal to the BICO parameter.

### How much care is required when you change the signal interconnection?

Note which changes you make. A subsequent analysis of the set signal interconnections is possible only by evaluating the parameter list.

### Where can you find additional information?

- All the binectors and connectors are located in the Parameter list.
- The function diagrams provide a complete overview of the factory setting for the signal interconnections and the setting options.

A.2 Interconnecting signals in the converter

## A.2.2 Application example

### Shift the control logic into the converter

It is only permissible that a conveyor system starts when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).



Figure A-4 Signal interconnection for control logic

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

### Setting the control logic

| Parameter         | Description   |
|-------------------|---|
| p20161 = 5        | The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)              |
| p20162 = 430      | Run sequence of the time block within runtime group 5 (processing before the AND logic block) |
| p20032 = 5        | The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)         |
| p20033 = 440      | Run sequence of the AND logic block within runtime group 5 (processing after the time block)  |
| p20159 = 5000.00  | Setting the delay time [ms] of the time module: 5 seconds                                     |
| p20158 = 722.0    | Connect the status of DI 0 to the input of the time block                                     |
|                   | r0722.0 = Parameter that displays the status of digital input 0.                              |
| p20030[0] = 20160 | Interconnecting the time block to the 1st AND input   |
| p20030[1] = 722.1 | Interconnecting the status of DI 1 to the 2nd AND input                                       |
|                   | r0722.1 = Parameter that displays the status of digital input 1.                              |
| p0840 = 20031     | Interconnect the AND output to ON/OFF1  |

### A.2 Interconnecting signals in the converter

### Explanation of the application example using the ON/OFF1 command

Parameter p0840[0] is the input of the "ON/OFF1" block of the converter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.



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

A.3 Manuals and technical support

#### Manuals and technical support A.3

#### A.3.1 Overview of the manuals

### **Converter Manuals**

CU240B/E-2 List Manual (https://support.industry.siemens.com/cs/ww/en/view/ 109782301)

Parameter list, alarms and faults. Graphic function diagrams 

CU240B/E-2 operating instructions (https://support.industry.siemens.com/cs/ww/en/ view/109782865)

Installing, commissioning and maintaining the converter. Advanced commissioning (this manual)

### Supplementary manuals for converter

Fieldbus" function manual (<u>https://support.industry.siemens.com/cs/ww/en/view/</u> 109751350) Configuring fieldbuses. 

Safety Integrated function manual (https://support.industry.siemens.com/cs/ww/en/ view/109751320)

Configuring PROFIsafe. Installing, commissioning and operating failsafe functions of the converter.

Power Module Installation Manual (https://support.industry.siemens.com/cs/ww/en/ps/ 13224/man)

Installing Power Modules, reactors and filters. Technical data, maintenance 

### **Converter accessory manuals**

BOP-2 operating instructions (<u>https://support.industry.siemens.com/cs/ww/en/view/</u> 109483379)

Using the Operator Panel. 

Operating instructions IOP-2 (https://support.industry.siemens.com/cs/ww/en/view/ 109808456)

Using the Operator Panel. Mounting the door mounting kit for IOP.

A.3 Manuals and technical support

 Application manual IOP (<u>https://support.industry.siemens.com/cs/ww/en/view/</u> <u>109483443</u>) <u>The commissioning wizards in the IOP</u>

Accessories manual (<u>https://support.industry.siemens.com/cs/ww/en/ps/13225/man</u>) Installation descriptions for converter components, e.g. line reactors and line filters. The printed installation descriptions are supplied together with the components.

### Additional information

EMC installation guideline (<u>http://support.automation.siemens.com/WW/view/en/</u>60612658)

EMC-compliant control cabinet design, equipotential bonding and cable routing

|  |  | <u></u> | *) |  |
|--|--|---------|----|--|
|  |  |         |    |  |

### Finding the most recent edition of a manual

If there a multiple editions of a manual, select the latest edition:

| <ul> <li>Manual Fieldbus systems: PROFINET, PROFIBUS, EtherNet/IP, CANopen, USS, Bacnet, Modbus, P1</li> <li>04/2014 TV Inction manual, A5E34229197B AA</li> <li>For provide statements of this manual</li> </ul> | 08/11/2014<br>ID: 99685159<br>★★★☆☆ (3) |
|---|---|
| 04/2015, FW ∨4.7.3<br>04/2015, FW ∨4.7.3<br>04/2014, FW ∨4  |   |

### **Configuring a manual**

Further information about the configurability of manuals is available in the Internet:

MyDocumentationManager (<u>https://www.industry.siemens.com/topics/global/en/</u>planning-efficiency/documentation/Pages/default.aspx).

Select "Display and configure" and add the manual to your "mySupport-documentation":



Not all manuals can be configured.

The configured manual can be exported in RTF, PDF or XML format.

A.3 Manuals and technical support

## A.3.2 Configuring support

### Catalog

Ordering data and technical information for the converters SINAMICS G.



Catalogs for download or online catalog (Industry Mall):

Everything about SINAMICS G120 (<u>www.siemens.com/sinamics-g120</u>)

### SIZER

The configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controllers and SIMATIC technology



SIZER on DVD:

Article number: 6SL3070-0AA00-0AG0

Download SIZER (<u>http://support.automation.siemens.com/WW/view/en/</u>10804987/130000)

### EMC (electromagnetic compatibility) technical overview

Standards and guidelines, EMC-compliant control cabinet design

EMC overview (<u>https://support.industry.siemens.com/cs/ww/en/view/103704610</u>)

### **EMC Guidelines configuration manual**

EMC-compliant control cabinet design, potential equalization and cable routing



EMC installation guideline (<u>http://support.automation.siemens.com/WW/view/en/</u>60612658)

See also

Safety Integrated for novices (<u>https://support.industry.siemens.com/cs/ww/en/view/</u>80561520)

## A.3.3 Product Support

Overview

You can find additional information about the product on the Internet:

Product support (<u>https://support.industry.siemens.com/cs/ww/en/</u>) This URL provides the following:

- Up-to-date product information (product announcements)
- FAQs
- Downloads
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

If you have any technical questions, use the online form in the "Support Request" menu:



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A.3 Manuals and technical support

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## **Further information**

SINAMICS converters: www.siemens.com/sinamics

Safety Integrated www.siemens.com/safety-integrated

PROFINET www.siemens.com/profinet

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