SIEMENS

Operating instructions

SINAMICS

SINAMICS G120D

Distributed inverter
CU240D-2 Control Unit with encoder evaluation

Edition 10/2020

www.siemens.com/drives

SIEMENS

SINAMICS

SINAMICS G120D Converter with the control units CU240D-2

Operating Instructions

Edition 10/2020, firmware V4.7 SP13

10/2020, FW V4.7 SP13
A5E34262100B AH

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

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

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

NOTICE
indicates that property damage can result if proper precautions are not taken.

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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

Disclaimer of Liability

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

Siemens AG
Digital Industries
Postfach 48 48
90026 NÜRNBERG
GERMANY

A5E34262100B AH
Ⓟ 10/2020 Subject to change

Changes in the current edition

Essential changes with respect to Edition 04/2018

New functions

Overview of all new and modified functions in firmware V4.7 SP13:

Firmware version 4.7 SP13 (Page 343)

Revised descriptions

- Motor overload protection according to IEC/UL 61800-5-1
  How do I achieve a motor overload protection in accordance with IEC/UL 61800-5-1? (Page 267)
- Converter replacement
  Uploading the converter settings (Page 97)
  Replace Control Unit (Page 306)
  Downloading the converter settings (Page 308)
  Replacing a Power Module (Page 318)
- Acceptance tests for the safety functions
  The acceptance test for safety function "Safe Torque Off" is no longer described in the manual. Instead we recommend that you use the appropriate wizards in the "Startdrive Advanced" commissioning tool.
  Acceptance test (Page 192)

Table of contents

1 Fundamental safety instructions

1.1 General safety instructions

> ⚠ **WARNING**
>
> **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.

> ⚠ **WARNING**
>
> **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.

⚠ WARNING

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.

⚠ WARNING

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.

⚠ WARNING

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.

⚠ WARNING

Electric shock due to unconnected cable shield

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

- Attach the cable shields at least on one side to 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.

⚠ WARNING

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.

- Be sure to only use screwdrivers which exactly match the heads of the screws.
- 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.

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.

⚠ 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.

⚠ WARNING

Unexpected movement of machines caused by radio devices or mobile phones

Using radio devices or mobile telephones 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 or mobile telephones.
- 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 conductor or in the event of a ground fault in the IT system, the motor insulation can be damaged by the higher voltage to 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.

⚠ WARNING

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.

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.

WARNING

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 notices for Safety Integrated functions

If you want to use Safety Integrated functions, you must observe the safety notices in the Safety Integrated manuals.

⚠ WARNING

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

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

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

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 (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/industrialsecurity (https://new.siemens.com/global/en/products/services/cert.html#Subscriptions).

Further information is provided on the Internet:

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

⚠ WARNING

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

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 installer 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 and/or software errors in the sensors, control system, actuators, and cables 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
6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network

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

Introduction

2

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.

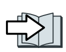
What is described in the operating instructions?

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.

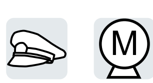
What is the meaning of the symbols in the manual?

 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

Description

3

The converter described in this manual is a device for controlling an induction motor or a synchronous 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 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 (https://www.openssl.org/)

Cryptsoft (mailto:eay@cryptsoft.com)

3.1 SINAMICS G120D CU240D-2 converter

Overview

The SINAMICS G120D is a converter for controlling the speed of three-phase motors. The converter consists of two parts, the Control Unit (CU) and the Power Module (PM).

Table 3-1 CU240D-2 Control Units

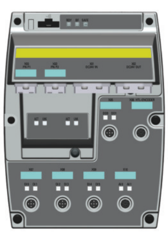
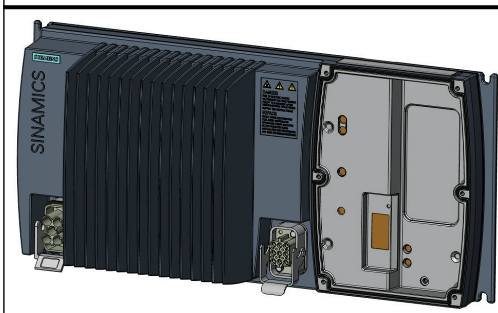
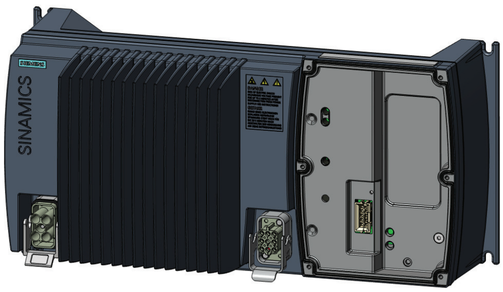
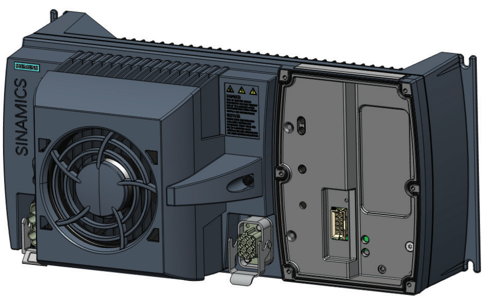
	Designation	Interface	Encoder type	Article number
	CU240D-2 DP	PROFIBUS	HTL Encoder	6SL3544-0FB20-1PA0
	CU240D-2 DP-F	PROFIBUS	HTL Encoder	6SL3544-0FB21-1PA0
	CU240D-2 PN	PROFINET, EtherNet/IP	HTL Encoder	6SL3544-0FB20-1FA0
	CU240D-2 PN-F	PROFINET, EtherNet/IP	HTL Encoder	6SL3544-0FB21-1FA0
	CU240D-2 PN-F PP	PROFINET, EtherNet/IP Push-Pull connections	HTL Encoder	6SL3544-0FB21-1FB0
	CU240D-2 PN-F FO	PROFINET, EtherNet/IP Fibre optic connections	HTL Encoder	6SL3544-0FB21-1FC0

Table 3-2 PM250D Power Modules

	Frame size	Rated output power	Rated output current	Article number
		based on High Overload (HO)		
	FSA	0.75 kW	2.2 A	6SL3525-0PE17-5AA1
		1.5 kW	4.1 A	6SL3525-0PE21-5AA1

	Frame size	Rated output power	Rated output current	Article number
		based on High Overload (HO)		
	FSB	3.0 kW	7.7 A	6SL3525-0PE23-0AA1
	FSC	4.0 kW	10.2 A	6SL3525-0PE24-0AA1
		5.5 kW	13.2 A	6SL3525-0PE25-5AA1
		7.5 kW	19.0 A	6SL3525-0PE27-5AA1

3.2 Directives and standards

Relevant directives and standards

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.

Immunity to voltage drop of semiconductor process equipment.

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

China RoHS

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

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

Quality systems

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

Certificates for download

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

Standards that are not relevant

China Compulsory Certification

The converters do not fall in the area of validity of the China Compulsory Certification (CCC).

3.3 Motors and multi-motor drives that can be operated

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 motors from 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)

Installation

4

4.1 Mechanical Installation

Fitting the Control Unit to the Power Module

The converter is delivered as two separate components - the Power Module (PM) and the Control Unit (CU). The CU must be fitted to the PM prior to any further commissioning taking place.

NOTICE
Damage due to incorrectly fitted seal If the seal is not fitted correctly, the converter will not reach IP65 rating. In this case the converter is not protected against water or dust. This may damage the converter. • Fit the seal correctly when assembling the Power Module and the Control Unit.

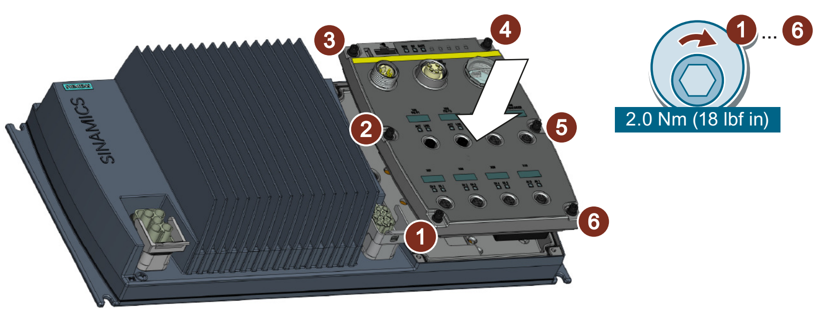


Figure 4-1 Fitting the Control Unit to the Power Module

Drill pattern and dimensions

The converter has an identical drill pattern for all frame sizes. The drill pattern, depth and tightening torques are shown in the diagram below.

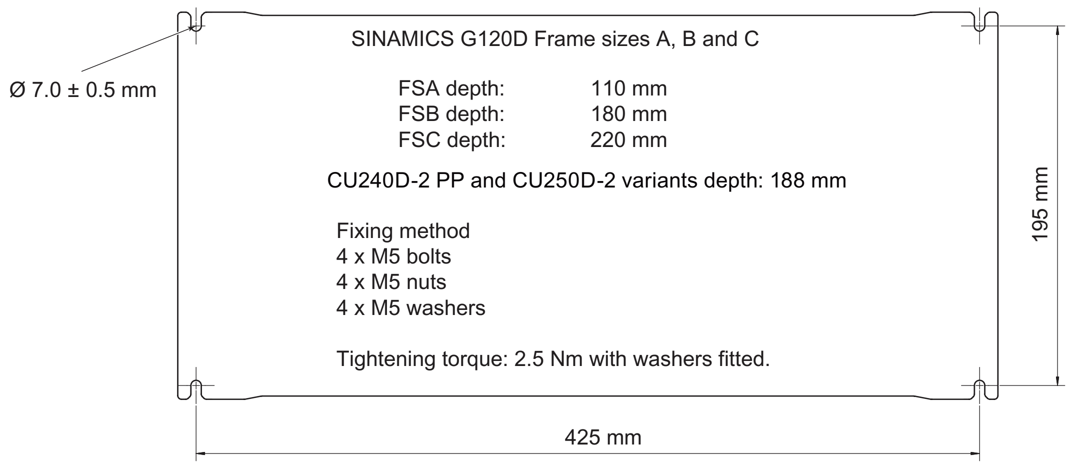


Figure 4-2 SINAMICS G120D drill pattern

Mounting orientation

Mount the converter on a table or on a wall. The minimum clearance distances are as follows:

- Side-by-side - no clearance distance is required
- Above and below the converter 150 mm (5.9 inches).

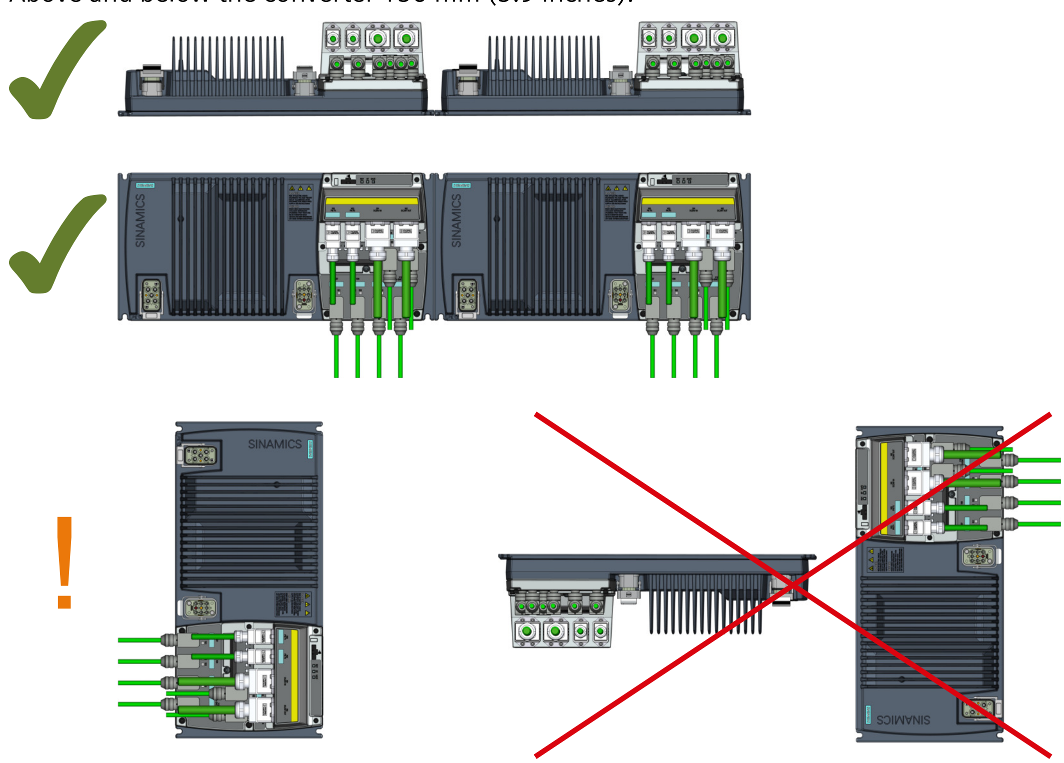


Figure 4-3 Mounting orientation: correct (✓), impermissible (X), permissible with restrictions (!)

Restrictions due to vertical mounting

If the converter is mounted in the vertical position, the maximum ambient temperature is 40°C.

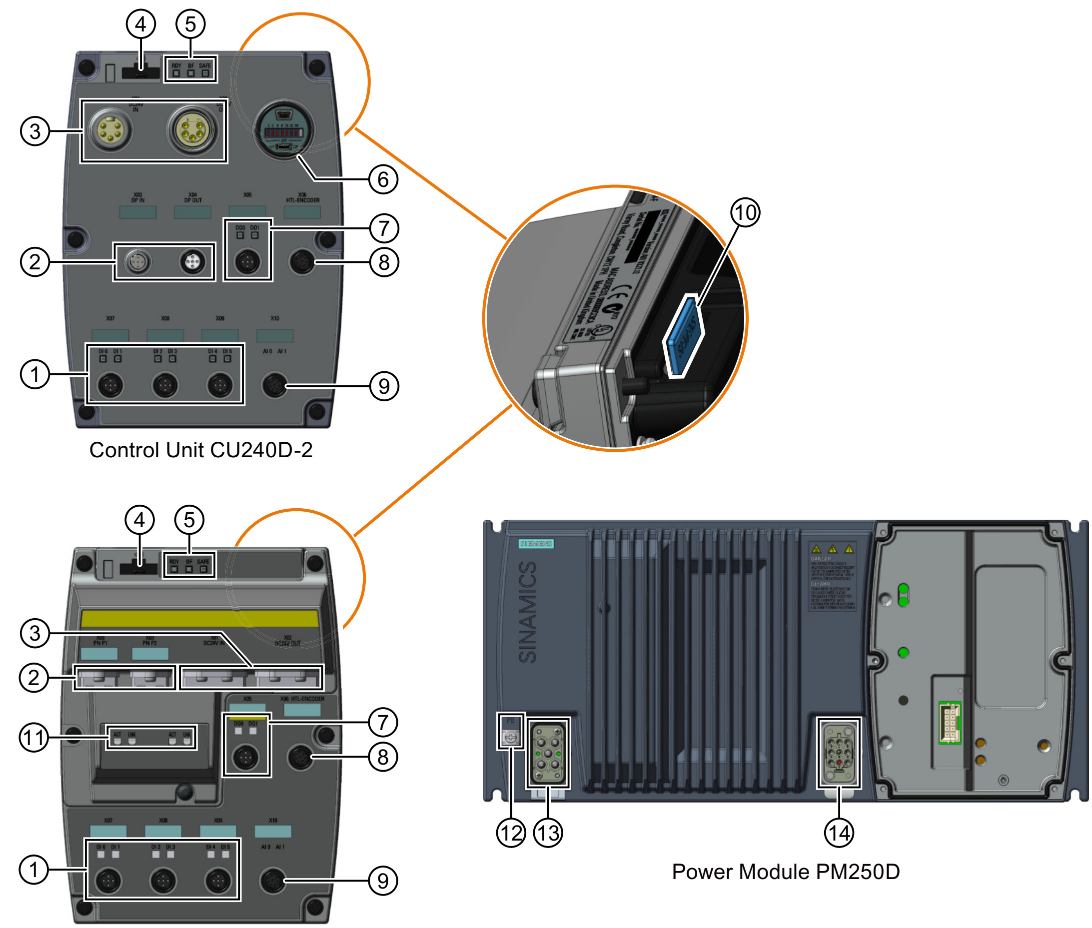
Additionally you have to reduce the converter output current to 80 % of rated converter current.

If the output current derating adversely affects the application, you have to use an converter of the next highest power rating.

4.2 Electrical Installation

4.2.1 Overview of the interfaces

Intefaces of the converter



①	Digital inputs 0 ... 5 with status LED	⑧	HTL Encoder connection
②	Fieldbus IN and OUT (PROFINET or PROFIBUS)	⑨	Analog inputs 0 and 1
③	24 V DC supply IN and OUT	⑩	Slot for a memory card at rear of the Control Unit
④	Optical interface for operator panel IOP handheld	⑪	PROFINET status LED
⑤	Converter status LED	⑫	PE grounding terminal
⑥	USB PC connection, address and bus termination switch for PROFIBUS	⑬	Mains supply connection
⑦	Digital outputs 0 and 1 with status LED	⑭	Motor, brake and temperature sensor connections

Figure 4-4 Interfaces on the converter variants

Protection against unauthorized access via the USB interface

⚠ WARNING

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.

- Secure the USB interface of the converter against unauthorized access, e.g. with a USB port lock available on the market.

NOTICE

Material damage from inappropriate supply system u_k > 1 %

Operating the converter on an inappropriate supply system can cause damage to the converter and other loads.

- Only operate the converter on supply systems with $u_k \leq 1$ %.

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.

4.2.2 Permissible line supplies

Operation on an IT line system is not permitted.

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.

Operation on IT line systems is not permitted.

Operation on TN and TT line systems

TN line system

The TN line system in accordance with IEC 60364-1 (2005) transmits the PE conductor to the installation via a conductor.

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

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

TT 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.

Operation of the converter on the TN and TT line system

The converter is designed for TN and TT line systems with a grounded neutral point

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

Current derating as a function of the installation altitude (Page 336)

Prohibited operation

- Operation on TN line systems with grounded external conductors is prohibited.
- Operation on TT line systems without grounded neutral points is prohibited.

4.2.3 Protective conductor

WARNING

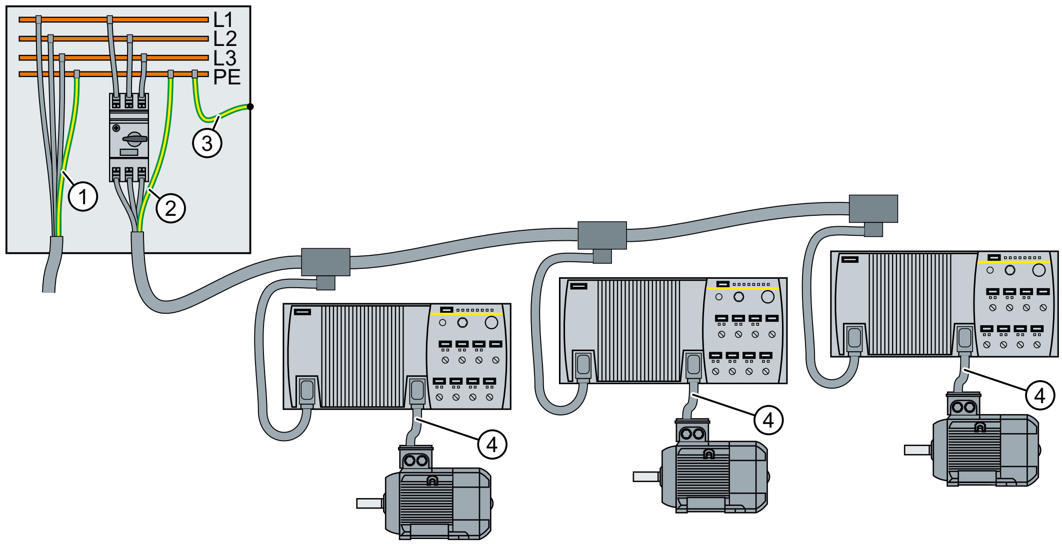
Electric shock due to interrupted protective conductor

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.

- Dimension the protective conductor as stipulated in the appropriate regulations.

Dimensioning the protective conductor

Observe the local regulations for protective conductors subject to an increased leakage current at the installation site.



① Protective conductor for line feeder cables
② Protective conductor for converter line feeder cables
③ Protective conductor between PE and the electrical cabinet
④ Protective conductor for motor feeder cables

The minimum cross-section of the protective conductor ① ... ④ depends on the cross-section of the line or motor feeder cable:

- Line or motor feeder cable ≤ 16 mm²
  ⇒ Minimum cross-section of the protective conductor = cross-section of the line or motor feeder cable
- Line feeder cable = 16 mm² ... 35 mm²
  ⇒ Minimum cross-section of the protective conductor = 16 mm²
- Line feeder cable > 35 mm²
  ⇒ 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:

- 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 electrical 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 ≥ 2.5 mm² Cu.
  - For an individual conductor, the protective conductor has a cross-section ≥ 10 mm² Cu.
  - The protective conductor consists of two conductors with the same cross-section.
- When connecting a multi-conductor cable using an industrial plug connector according to EN 60309, the protective conductor must have a cross-section of ≥ 2.5 mm² Cu.

4.2.4 Grounding converter and motor

Grounding the converter

- Ground the converter via the PE connection in the mains supply connector.
- Ground the connectors as shown in the diagram below.

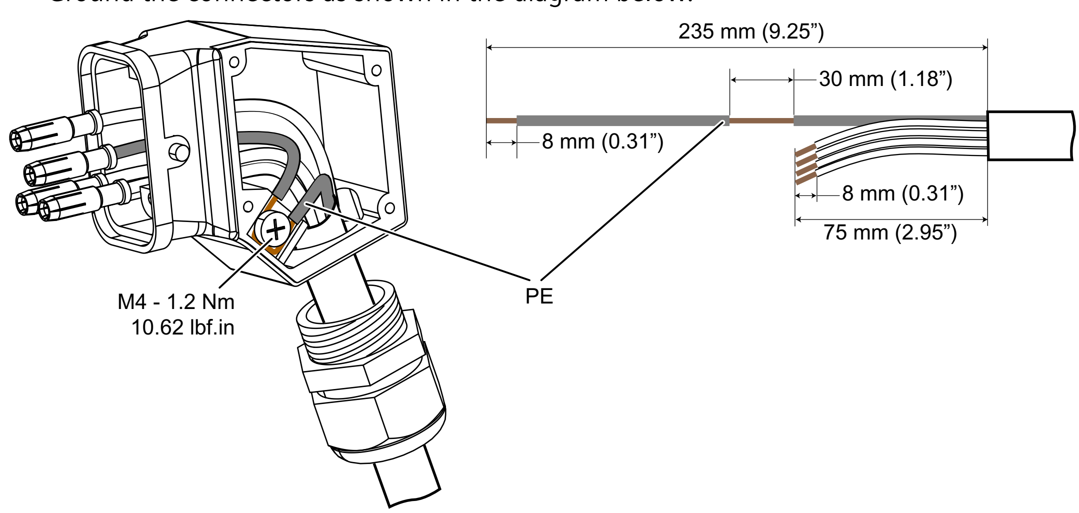
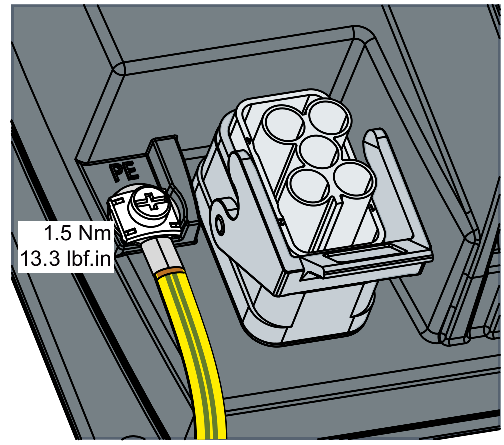


Figure 4-5 Grounding the line supply and motor connectors

- Connect the PE terminal on the left-hand side of the converter to the metal frame it is mounted on.
- Recommended cable cross section: 10 mm²
- Use a short wire connection preferably.
- Clean the connection to the steel construction from paint or dirt.
- Use a ring clamp to ensure a good physical connection which is resistant to accidental disconnection.



Grounding the motor

- Ground the motor via the PE connection in the motor connector.
- Ground the connector as shown in the diagram above (grounding the converter). Although the line and motor connectors are of a different type, the principle of grounding them is the same.
- If possible, ground the motor housing.

EMC cable glands

Where cable glands are used within the installation of the system, it is recommended that EMC glands are used.

The cable gland provides protection to the IP68 standard when fitted correctly.

Figure 4-6 Example of a Blueglobe EMC cable gland

Table 4-1 Brass-nickel plated EMC cable gland with metric thread as per EN50262.

Connection thread/length			Clamping range without inlet max/min [mm]	Clamping range max/ min [mm]	Spanner width SW * E	Article No.
A	D [mm]	C [mm]				
M16 x 1.5	6.0	29	11 ... 7	9 ... 7	20 x 22.2	bg216mstri
M20 x 1.5	6.5	29	14 ... 9	12 ... 7	24 x 26.5	bg220mstri

Connection thread/length			Clamping range without inlet max/min [mm]	Clamping range max/ min [mm]	Spanner width SW * E	Article No.
A	D [mm]	C [mm]				
M25 x 1.5	7.5	29	20 ... 13	16... 10	30 x 33	bg255mstri
M32 x 1.5	8.0	32	25 ... 20	20 ... 13	36 x 39.5	bg232mstri

4.2.5 Basic EMC Rules

Measures to limit Electromagnetic Interference (EMI)

Listed below are the necessary measures that must be taken to ensure the correct installation of the converter within a system, which will minimize the effect of EMI.

Cables

- Keep all cable lengths to the minimum possible length; avoid excessive cable lengths.
- Route always signal and data cables, as well as their associated equipotential bonding cables, in parallel and with as short a distance as possible.
- Don't route signal and data cables and line supply cables in parallel to motor cables.
- Signal and data cables and line supply cables should not cross motor cables; if crossing is necessary, they should cross at an angle of 90 °.
- Shield signal and data cables.
- Route particularly sensitive signal cables, such as setpoint and actual value cables, with optimum shield bonding at both ends and without any interruptions of the shield.
- Ground spare wires for signal and data cables at both ends.
- Route all power cables (line supply cables, as well as motor cables) separately from signal and data cables. The minimum distance should be approximately 25 cm.
  Exception: hybrid motor cables with integrated shielded temperature sensor and brake control wires are allowed.
- Shield the power cable between converter and motor. We recommend shielded cables with symmetrical three-phase conductors (L1, L2, and L3) and an integrated, 3-wire, and symmetrically arranged PE conductor.

Cable shields

- Use shielded cables with finely stranded braided shields. Foil shields are not suitable since they are much less effective.
- Connect shields to the grounded housings at both ends with excellent electrical conductivity and a large contact area.
- Bond the cable shields to the plug connectors of the converter.
- Don't interrupt cable shields by intermediate terminals.

- In the case of both, the power cables and the signal and data cables, the cable shields should be connected by means of suitable EMC shield clips or via electrically conductive PG glands. These must connect the shields to the shield bonding options for cables and the unit housing respectively with excellent electrical conductivity and a large contact area.
- Use only metallic or metallized connector housings for shielded data cables (e. g. PROFIBUS cables).

4.2.6 Connections and interference suppression

All connections should be made so that they are permanent. Screwed connections on painted or anodized metal components must be made either by means of special contact washers, which penetrate the isolating surface and establish a metallically conductive contact, or by removing the isolating surface on the contact points.

Contactor coils, relays and the solenoid valves must have interference suppressors to reduce high-frequency radiation when the contacts are opened (RC elements or varistors for AC currentoperated coils, and freewheeling diodes for DC current-operated coils). The interference suppressors must be connected directly on each coil.

No external suppression device is required for the motor holding brake.

4.2.7 Equipotential bonding

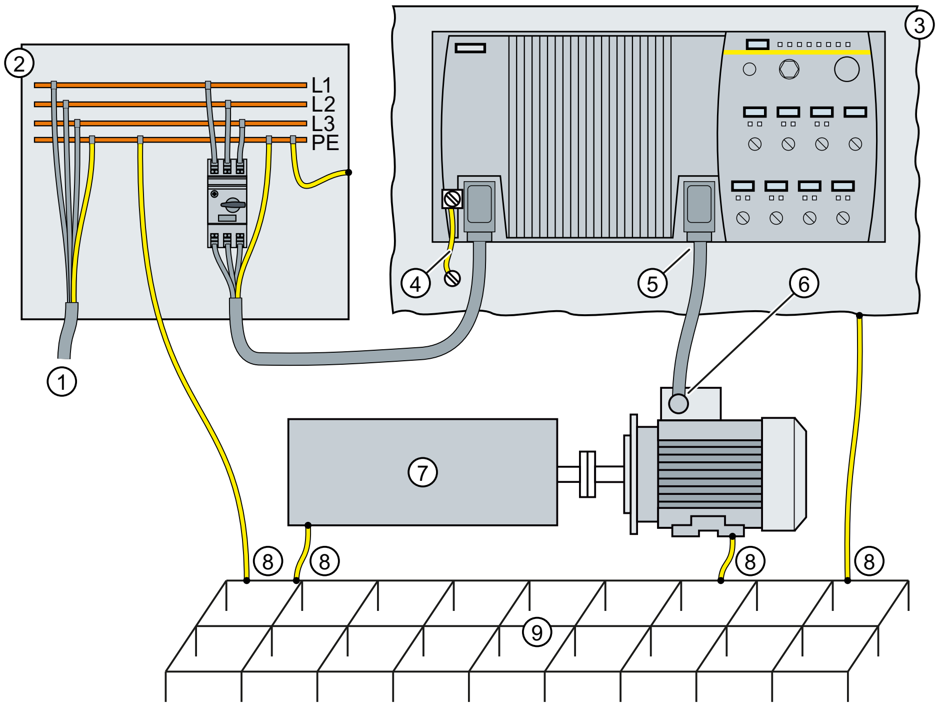
Grounding and high-frequency equipotential bonding measures

All electrical and mechanical drive components (transformer, motor and driven machine) must be connected to the grounding system. These connections are established by means of standard heavy-power PE cables, which do not need to have any special high-frequency properties.

In addition to these connections, the converter as the source of the high-frequency interference and the motor must be interconnected with respect to the high-frequency point of view:

- Use a shielded motor cable.
- Connect the cable shield both to the motor connector on the converter and to the motor terminal box.
- Use a short grounding connection from the PE terminal on the converter to the metal frame.

The following figure illustrates all grounding and high-frequency equipotential bonding measures using an example.



① From the transformer
② Second level distribution with PE equipotential bonding
③ Metal frame
④ Short connection from the PE terminal to the metal frame.
⑤ Electrical connection of motor cable shield and connector body.
⑥ Electrical connection of motor cable shield and motor terminal box via electrically conductive PG gland.
⑦ Driven machine
⑧ Conventional grounding system.

- Standard, heavy-power PE conductors without special high-frequency properties.
- Ensures low frequency equipotential bonding as well as protection against injury.

⑨ Foundation ground

Figure 4-7 Grounding and high-frequency equipotential bonding measures in the drive and in the plant

You find further information on the rules for EMC compliant installation on the Internet:

EMC design guidelines (http://support.automation.siemens.com/WW/view/en/60612658/0/en)

4.2.8 Branch circuit protection of individual converters

When you install a dedicated 400 V branch for each converter, then you must individually fuse/protect each branch.

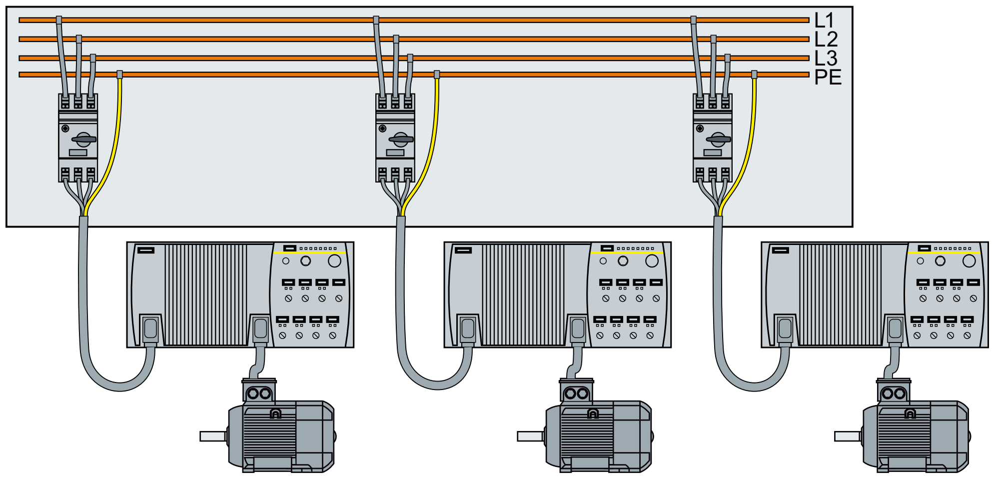


Figure 4-8 Power supply to converters through their own dedicated 400 V branch

Branch circuit protection according to the IEC standard

Table 4-2 Branch circuit protection according to the IEC standard

Rated power	Power Module	Frame size	Article No.		Max. rated current of the protection device
			Fuse	Circuit-breaker	
0.75 kW	6SL3525-0PE17-5AA1	FSA	3NA3803	3RV2011-1JA10	10 A
1.5 kW	6SL3525-0PE21-5AA1				
3 kW	6SL3525-0PE23-0AA1	FSB	3NA3805	3RV2011-4AA10	16 A
4 kW	6SL3525-0PE24-0AA1	FSC	3NA3807	3RV2021-4BA10	20 A
5.5 kW	6SL3525-0PE25-5AA1				
7.5 kW	6SL3525-0PE27-5AA1		3NA3812	3RV2021-4PA10	32 A

Branch circuit protection according to the UL standard

Use in the American market requires protection devices that meet UL standards as detailed in the following tables.

Table 4-3 Overview of the approved protection devices/fuses according to UL standards

Protection device	UL category
Fuses of any manufacturer with faster tripping characteristic than class RK5, e.g. class J, T, CC, G, or CF	JDDZ
SIEMENS circuit breaker	DIVQ
Type E combination motor controller (designation according to the UL standard - is available as SIEMENS circuit breaker)	NKJH

Table 4-4 Branch circuit protection with non-semiconductor fuses of Classes J, T, CC, G or CF (UL Category JDDZ)

Rated power	Power Module	Frame size	Max. rated current of the fuse	Short circuit current rating SCCR
0.75 kW	6SL3525-0PE17-5AA1	FSA	10 A	100 kA, 480 V 3 AC
1.5 kW	6SL3525-0PE21-5AA1		15 A	100 kA, 480 V 3 AC
3 kW	6SL3525-0PE23-0AA1	FSB	25 A	100 kA, 480 V 3 AC
4 kW	6SL3525-0PE24-0AA1	FSC	35 A	100 kA, 480 V 3 AC
5.5 kW	6SL3525-0PE25-5AA1		45 A	100 kA, 480 V 3 AC
7.5 kW	6SL3525-0PE27-5AA1		60 A	100 kA, 480 V 3 AC

Table 4-5 Branch circuit protection according to UL Categories DIVQ and NKJH

Rated power	Power Module	Frame size	Article No.	UL cat.	Max. rated current of the circuit breaker	Short circuit current rating SCCR
0.75 kW	6SL3525-0PE17-5AA1	FSA	3RV2711...	DIVQ	15 A	65 kA, 480Y/277 V AC
			3RV1742..., LGG... or CED6...	DIVQ	15 A	65 kA, 480 V 3 AC
			3RV2021-1JA...	NKJH	10 A	65 kA, 480Y/277 V AC
1.5 kW	6SL3525-0PE21-5AA1	FSA	3RV2711...	DIVQ	15 A	65 kA, 480Y/277 V AC
			3RV1742..., LGG... or CED6...	DIVQ	15 A	65 kA, 480 V 3 AC
			3RV2021-1JA...	NKJH	10 A	65 kA, 480Y/277 V AC
3 kW	6SL3525-0PE23-0AA1	FSB	3RV1742..., LGG... or CED6...	DIVQ	25 A	65 kA, 480 V 3 AC
			3RV2721...	DIVQ	22 A	50 kA, 480Y/ 277 V AC
			3RV2021-4AA...	NKJH	16 A	65 kA, 480Y/277 V AC
			3RV1031-4AA... or 3RV2031-4AA...	NKJH	16 A	65 kA, 480Y/277 V AC
4 kW	6SL3525-0PE24-0AA1	FSC	3RV1742...	DIVQ	35 A	65 kA, 480Y/277 V AC
			LGG... or CED6...	DIVQ	35 A	65 kA, 480 V 3 AC
			3RV2021-4BA...	NKJH	20 A	65 kA, 480Y/277 V AC
			3RV1031-4BA... or 3RV2031-4BA...	NKJH	20 A	65 kA, 480Y/277 V AC

Rated power	Power Module	Frame size	Article No.	UL cat.	Max. rated current of the circuit breaker	Short circuit current rating SCCR
5.5 kW	6SL3525-0PE25-5AA1	FSC	3RV1742...	DIVQ	45 A	65 kA, 480Y/277 V AC
			LGG... or CED6...	DIVQ	45 A	65 kA, 480 V 3 AC
			3RV2021-4DA...	NKJH	25 A	65 kA, 480Y/277 V AC
			3RV1031-4DA... or 3RV2031-4DA...	NKJH	25 A	65 kA, 480Y/277 V AC
7.5 kW	6SL3525-0PE27-5AA1	FSC	3RV1742...	DIVQ	60 A	65 kA, 480Y/277 V AC
			LGG... or CED6...	DIVQ	60 A	65 kA, 480 V 3 AC
			3RV1031-4EA...	NKJH	32 A	65 kA, 480Y/277 V AC
			3RV2031-4EA...	NKJH	32 A	65 kA, 480Y/277 V AC

4.2.9 Branch circuit protection of multiple converters

For installations with more than one converter, the converters are normally powered from a 400-V power bus with a T distributor.

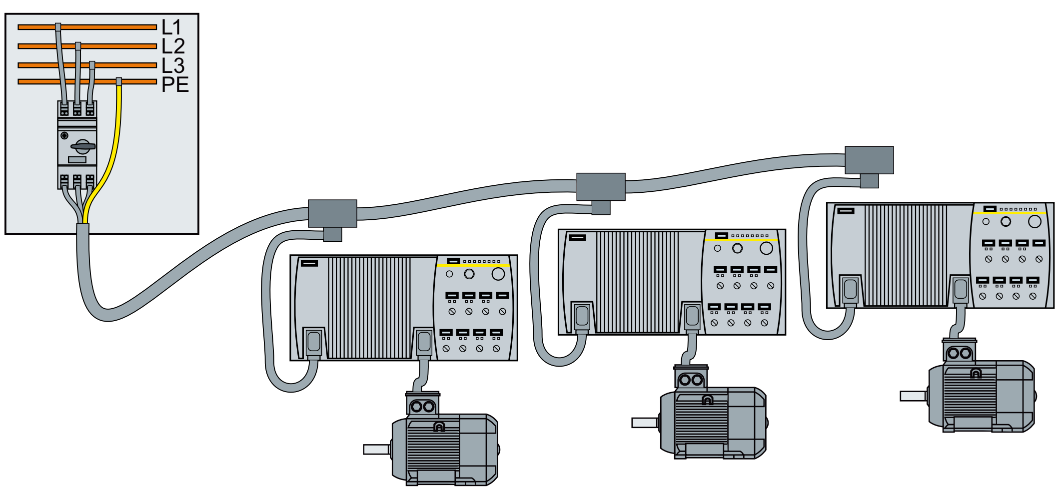


Figure 4-9 Power supply to a converter group via a shared 400-V branch circuit

Calculation of the branch circuit protection according to IEC and UL standards

Calculation of the branch circuit protection:

- Add together the rated input currents of the converter group.
- The sum of all rated input currents must be ≤ 24 A.
- Use one of the following protection devices for the converter group:
  - Fuse or circuit breaker with a rated current of 30 A
  - Intrinsically safe circuit breaker with a rated current of 25 A

The branch circuit protection also depends on the following conditions:

- Type of cable routing
- Limit values of the cables and system components, e.g. the T distributor.
- Country-specific regulations

If it is precluded that all of the converters of a group operate simultaneously, it is permissible to form larger converter groups on one 400-V branch circuit. The sum of the input currents of all converters must always be less than 24 A.

Branch circuit protection according to IEC

Table 4-6 Branch circuit protection according to IEC

Max. rated current of the protection device	Article No. of the fuse	Article No. of the circuit breaker
25 A	3NA3810	3RV2021..., 3RV1031..., 3RV2031...
30 A	-	3RV1742...

Branch circuit protection according to UL standards

Use in North America requires protection devices that meet UL standards as detailed in the following tables.

Table 4-7 Overview of the approved protection devices according to UL standards

Protection device	UL category
Fuses of any manufacturer with faster tripping characteristic than class RK5, e.g. class J, T, CC, G, or CF	JDDZ
SIEMENS circuit breaker	DIVQ
Intrinsically safe SIEMENS circuit breaker	NKJH

Table 4-8 Branch circuit protection with non-semiconductor fuses of Classes J, T, CC, G or CF (UL Category Code JDDZ)

Max. rated current of the fuse	Short circuit current rating SCCR
30 A	65 kA, 480 V 3 AC

Table 4-9 Branch circuit protection with circuit breaker, UL categories DIVQ and NKJH

Max. rated current of the circuit breaker	Article No.	UL cat.	Short circuit current rating SCCR
30 A	3RV2711...	DIVQ	65 kA, 480Y/ 277 V AC
	3RV1742..., LGG... or CED6...	DIVQ	65 kA, 480 V 3 AC
25 A	3RV2021-4DA...	NKJH	65 kA, 480Y/ 277 V AC
	3RV1031-4DA... or 3RV2031-4DA...	NKJH	65 kA, 480Y/ 277 V AC
22 A	3RV2721...	DIVQ	50 kA, 480Y/ 277 V AC

4.2.10 24-V power supply with multiple converters

Installation using 24 V bus

The following options are available for the 24 V supply of the converter:

1. A T distributor with integrated power supply unit supplies the 24 V.
   Advantage: Low installation costs.
2. An external power supply unit supplies the 24 V.
   Advantage: You can switch off the 400 V without interrupting the 24 V supply and thus the fieldbus communication of the converter.

The converter can conduct a maximum current of 8 A through its 24 V connector.

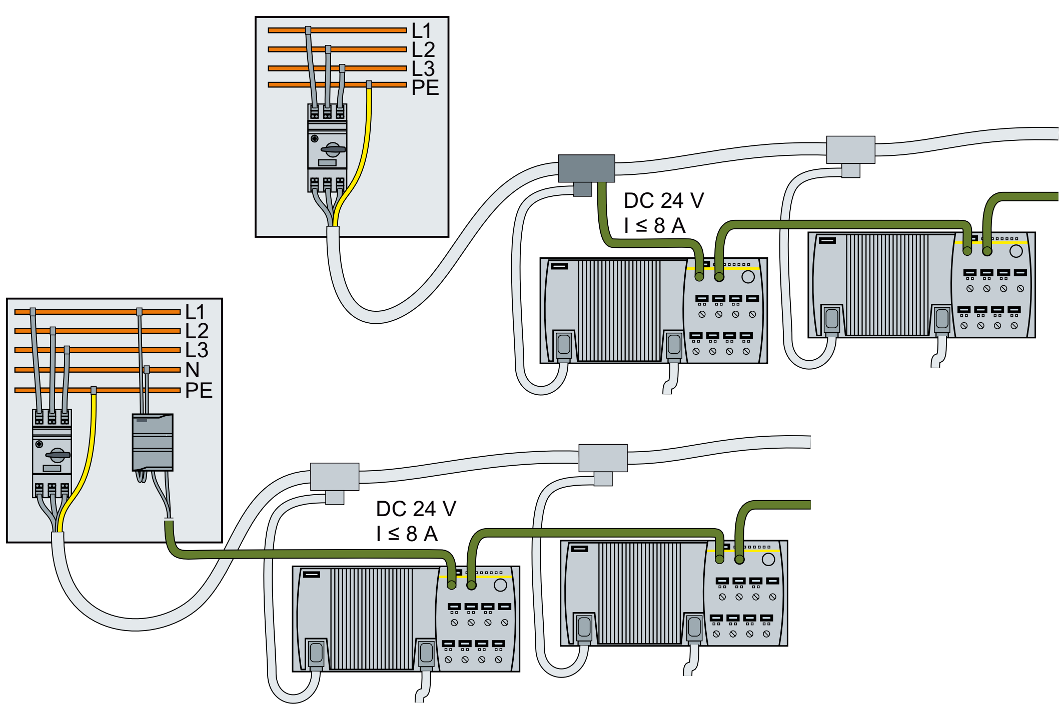


Figure 4-10 24 V bus from T distributor or with separate power supply

4.2.11 Connections and cables

Connectors

"Switched" and "unswitched" 24 V power supply

The unswitched 24 V power supply (1L+) is required for the converter to function.

- Use a power supply with PELV (Protective Extra Low Voltage).
- For applications in USA and Canada: Use a power supply NEC Class 2.
- The 0 V of the power supply must be connected with low resistance to the PE of the system.

The switched 24 V (2L+) supplies the two digital outputs. Switching off brings all of the actuators connected to the digital outputs into the no-voltage state.

If you don't need the switching of 2L+ power supply, then both the switched as well as the non-switched 24 V may come from the same supply.

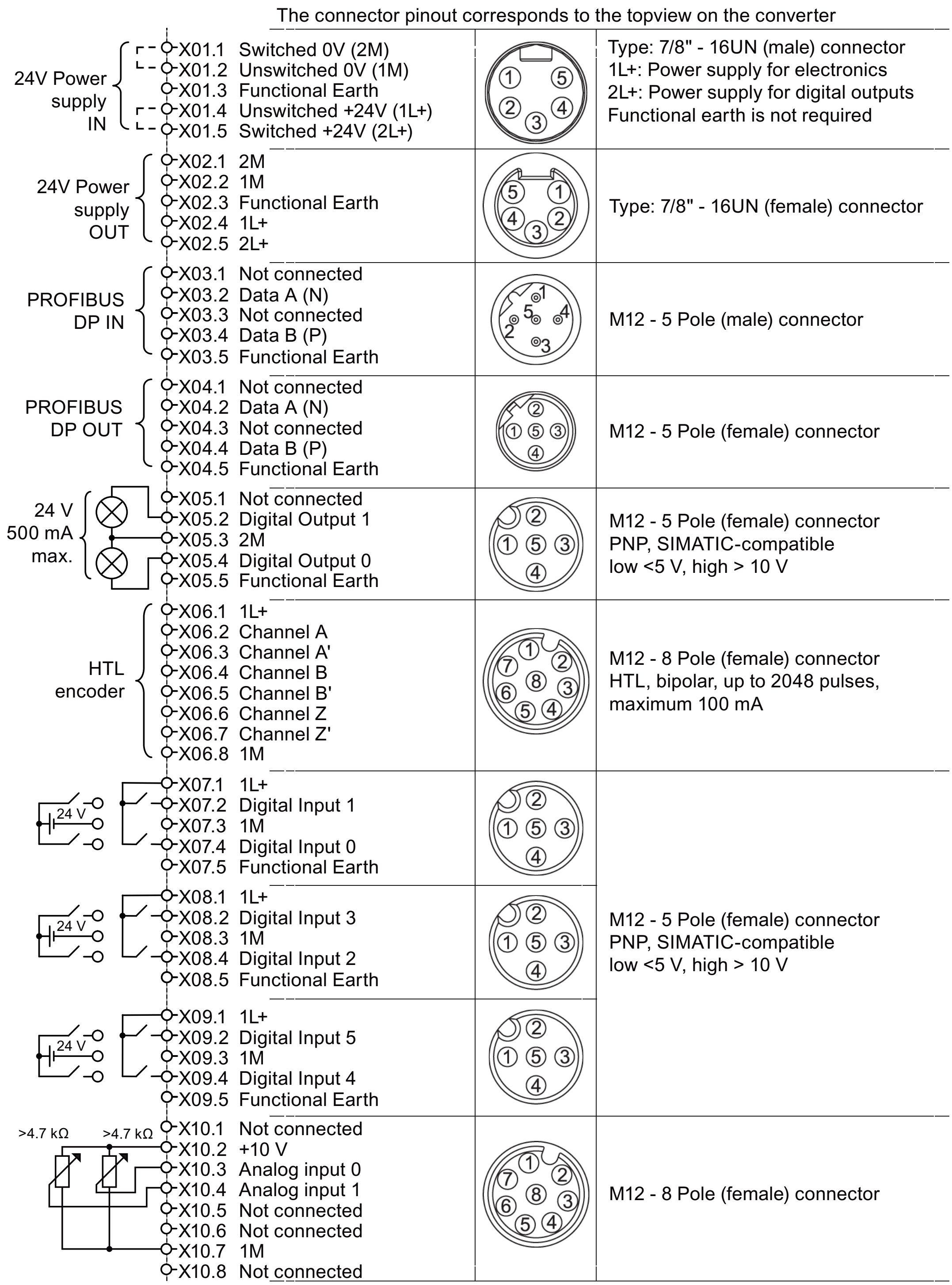


Figure 4-11 CU240D-2 PROFIBUS connectors

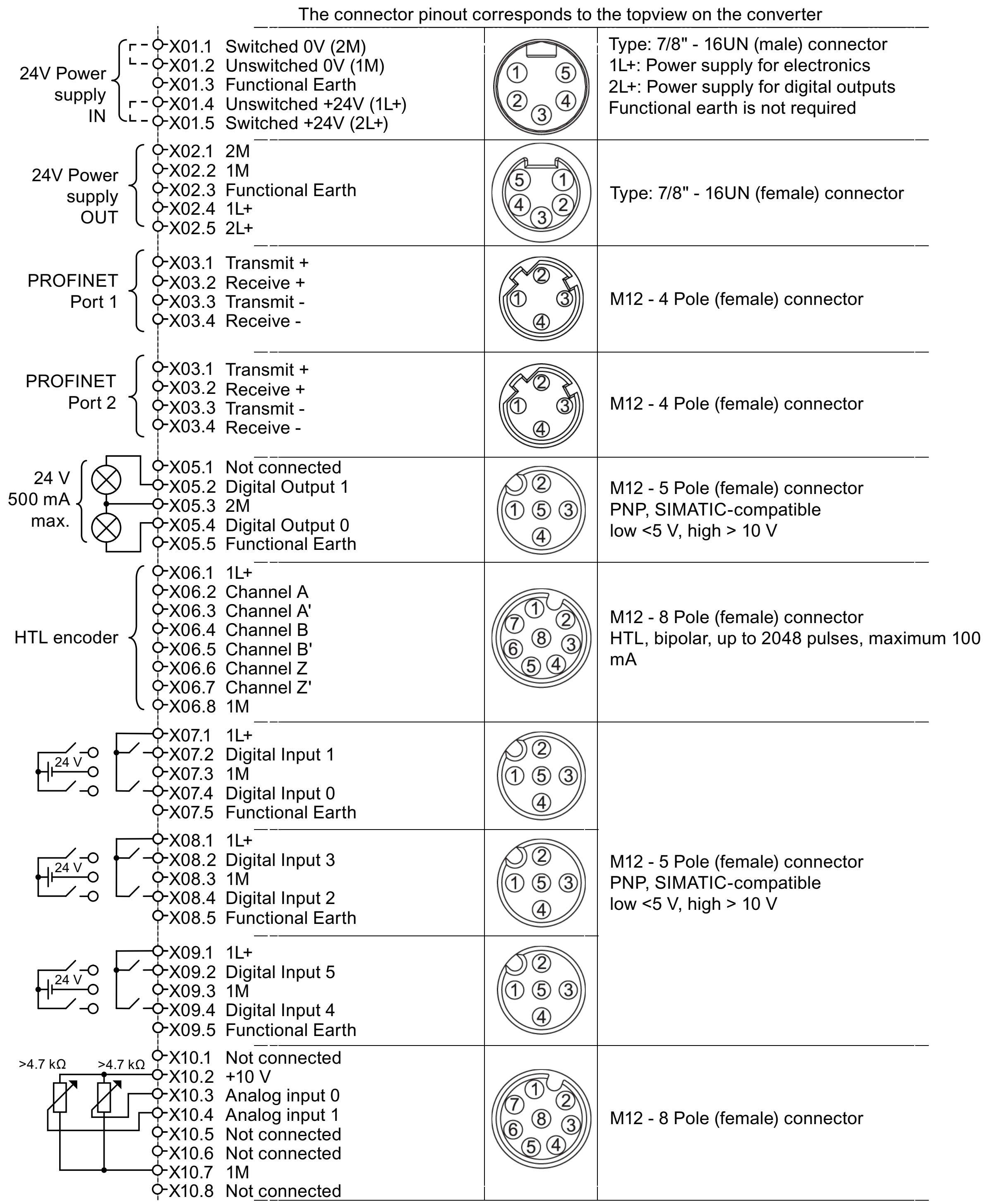


Figure 4-12 CU240D-2 PROFINET connectors

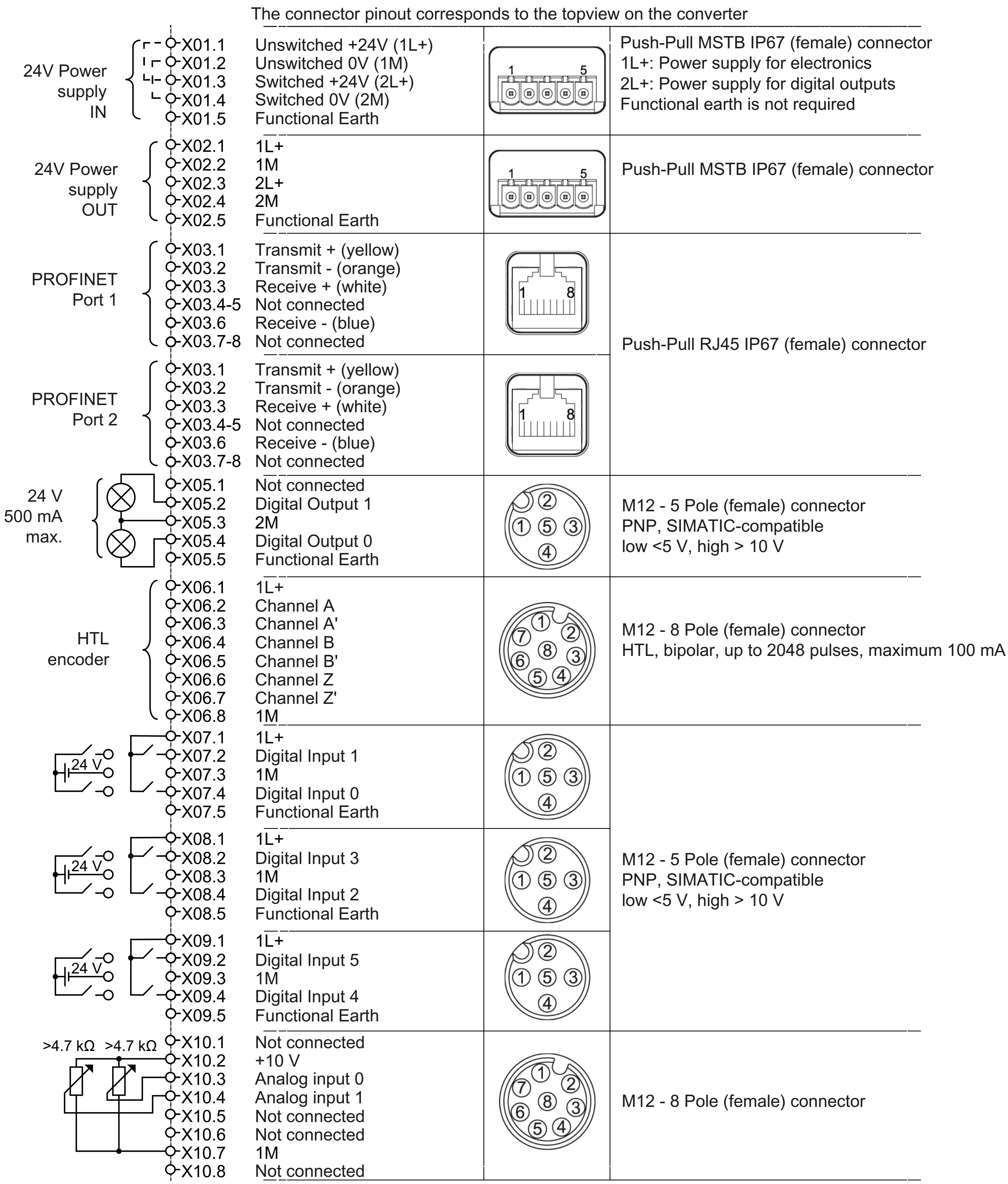


Figure 4-13 CU240D-2 PROFINET Push-Pull connectors

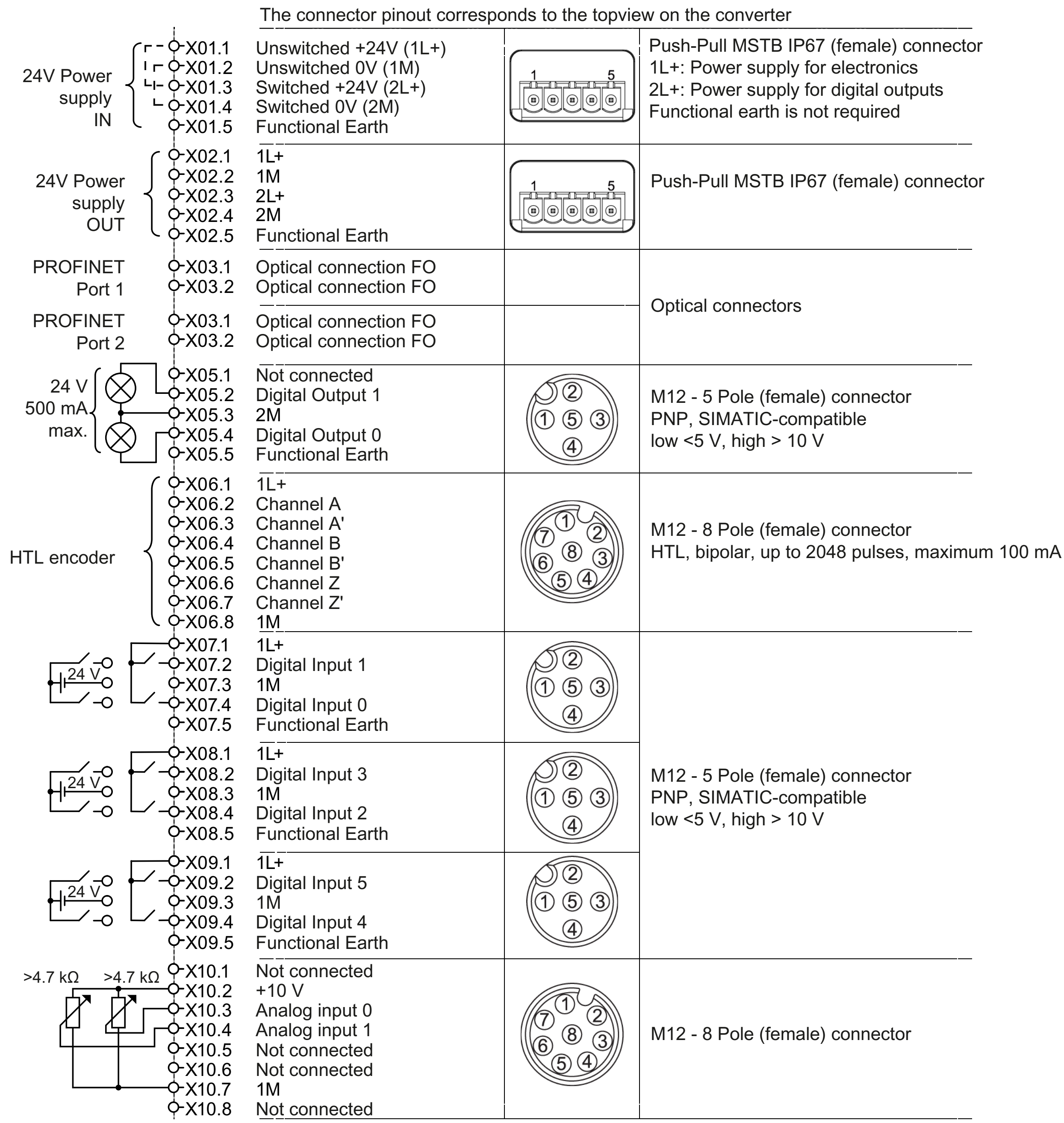


Figure 4-14 CU240D-2 PROFINET FO connectors

⚠ WARNING
Electric shock by live parts in the motor terminal box
Hazardous voltage can be present on the pins for temperature sensor and motor holding brake. Touching live parts on the motor cable and in the motor terminal box can lead to death due electrical shock. • Keep the motor terminal box closed whenever the mains is applied to the converter. • Insulate the cables that are not used. • Use appropriate insulation on the cables.

NOTICE
Damage of the converter by disconnecting the motor cable during operation
The disconnection of the motor cable by a switch or contactor during operation may damage the converter. • Disconnect converter and motor during operation only if it is necessary in terms of personal security or machine protection.

The connector pinout corresponds to the topview on the converter

Mains	X1.1	L1	Type: HAN Q4/2 (male) Spec: 3 AC 380 V ... 500 V ± 10%
	X1.2	L2	
	X1.3	L3	
	X1.4	Not connected	
	X1.11	Not connected	
	X1.12	Not connected	
	X1.PE	Protective Earth	
Motor	X2.1	U	Type: HAN Q8 (female) Spec: -
	X2.2	Not connected	
	X2.3	W	
	X2.4	EM Brake (-)	
	X2.5	Temperature sensor (+)	
	X2.6	EM Brake (+)	
	X2.7	V	
	X2.8	Temperature sensor (-)	
	X2.PE	Protective Earth	

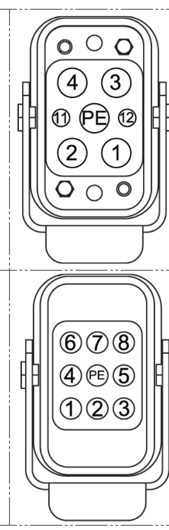


Figure 4-15 PM250D connectors

Cable, connectors and tools specifications

The detailed specifications for the cables, connectors and tools required to manufacture the necessary cables for the SINAMICS G120D are listed in the following tables. The connections that are detailed in this section relate to the physical connections that exist on the converter. Information for the preparation and construction of the individual connectors have separate detailed instructions delivered with the ordered parts, direct from the manufacturers. Use 75 °C copper wire only.

Note

NFPA compatibility

The converter is intended only for installation on industrial machines in accordance with the "Electrical Standard for Industrial Machinery" (NFPA79). The converter it not designed for installation in accordance with the "National Electrical Code" (NFPA70).

Table 4-10 Tools

	Article number
Crimp tool (Q8/0 and Q4/2)	3RK1902-0AH00
Removal tool (Q8/0)	3RK1902-0AJ00
Removal tool (Q4/2)	Harting part number 0999-000-0305
No special tools are required for the Control Unit connectors	

Table 4-11 Control unit connectors

Connector	Article number	
	Straight connector	**Right-angle connector**
24 V DC power supply In (7/8")	6GK1905-0FB00	3RK1902-3DA00
24 V DC power supply Out (7/8")	6GK1905-0FA00	3RK1902-3BA00
PROFIBUS In (M12)	6GK1905-0EB00	3RK1902-1DA00
PROFIBUS Out (M12)	6GK1905-0EA00	3RK1902-1BA00
PROFINET Port 1 and Port 2 (M12)	6GK1901-0DB20-6AA0	3RK1902-2DA00
Digital input and output	3RK1902-4BA00-5AA0	3RK1902-4DA00-5AA0
Encoder (M12), analog input (M12)	Via KnorrTec	

You find information about KnorrTec in the internet:

Knorrtec (http://www.knorrtec.de/index.php/en/company-profile/siemens-solution-partner)

Table 4-12 Push-Pull variant PROFINET and 24 V DC connectors

Connector	Article number
24 V DC power supply	6GK1907-0AB10-6AA0
RJ45 PROFINET	6GK1901-1BB10-6AA0

Table 4-13 Fibre optic connectors

Connector	Article number
IE SC RJ POF PLUG PRO	6GK1900-0MB00-6AA0
IE SC RJ PCF PLUG PRO	6GK1900-0NB00-6AA0

Table 4-14 Mains connector

Power rating	cable size	Article number
0.75 kW ... 1.50 kW	2.5 mm^2 (14 AWG)	3RK1911-2BE50
3.00 kW ... 4.00 kW	4 mm^2 (12 or 10 AWG)	3RK1911-2BE10
5.50 kW ... 7.50 kW	6 mm^2 (10 AWG)	3RK1911-2BE30

You find information about motor connectors in the internet:

Solution partner (https://www.automation.siemens.com/solutionpartner/partnerfinder/Partner-Finder.aspx?lang=en)

Cable lengths

Table 4-15 Maximum cable lengths

Cable	Screening	Max. length
Motor 1)	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Temperature sensor 1)	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Motor holding brake 1)	Screened	15 m (49 ft)
	Unscreened	30 m (98 ft)
Digital inputs	Screened	30 m (98 ft)
Digital outputs	Screened	30 m (98 ft)
Analog input	Screened	30 m (98 ft)
Encoder	Screened	30 m (98 ft)

1) The motor, temperature sensor and motor holding brake are connected through a hybrid cable to the converter using a Harting connector.

4.2.12 Fieldbus interfaces

Fieldbus interfaces of the Control Units

There are different versions of the Control Units for communication with a higher-level control system:

Fieldbus	Profiles			S7 communication [2)]	Control Unit
	PROFIdrive	PROFIsafe [1)]	PROFIenergy [2)]		
PROFIBUS (Page 72)	✓	✓	---	✓	CU240D-2 DP CU240D-2 DP-F
PROFINET (Page 68)	✓	✓	✓	✓	CU240D-2 PN CU240D-2 PN-F CU240D-2 PN-F PP CU240D-2 PN-F FO
EtherNet/IP [2)]	---			---	

[1)] Information on PROFIsafe can be found in the "Safety Integrated" Function Manual.

[2)] Information about these fieldbuses, profiles and communication types can be found in the "Fieldbus" function manual.

Overview of the manuals (Page 361)

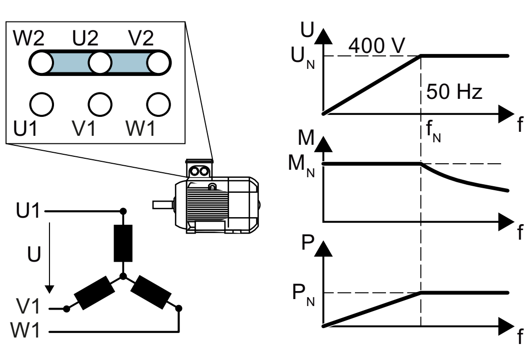
4.2.13 Connecting the motor to the converter in a star or delta connection

Overview

Standard induction motors up to a rated power of approximately 3 kW are usually connected in star/delta connection (Y/Δ) 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

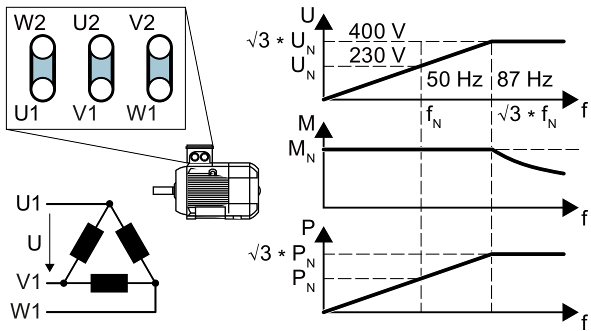


In a star connection, the motor can provide its rated torque M_N in the range 0 ... rated frequency f_N.

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 ≈ 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 ≤ 50 Hz.
- The motor must have windings that are approved for a voltage > rated voltage U_N.
- As the fan impeller rotates faster, the motor has a higher noise level than operation with f ≤ 50 Hz.

4.2.14 Connecting the motor holding brake

⚠ WARNING

Electric shock from live parts in the motor terminal box

The temperature sensor and motor holding brake connections of the converter are at DC link negative potential. Touching live parts on the motor cable and in the motor terminal box can result in death or severe injury.

- Power down the converter and disconnect all power cables from the converter before connecting or disconnecting the motor temperature sensor or the motor holding brake.
- Insulate cables in the motor terminal box that are not used.

NOTICE

Converter damage when earthing the connections for temperature sensor and motor holding brake

The temperature sensor and motor holding brake connections are at DC link negative potential. Earthing any connection of the motor cable will damage the converter.

- Insulate cables in the motor terminal box that are not used.
- Do not earth cables that are not used.

The brake is connected to the converter using Pin 4 - Brake (-) and Pin 6 - Brake (+) of the motor connector.

The converter supplies 180 V DC to the brake.

The brake supply is suitable for brakes which require 400 V AC with rectifier. If there is a rectifier module in the motor terminal box, you have to remove it and connect the brake output of the converter directly to the brake coil.

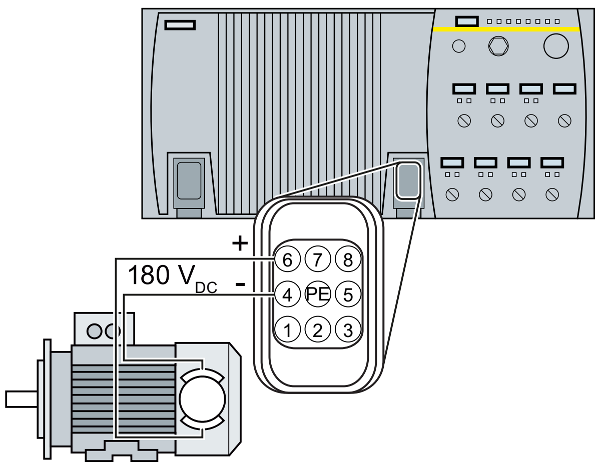


Figure 4-16 Principle of connectiong the motor holding brake to the converter

The converter reduces high-frequency radiation of the motor holding brake with an internal interference suppressor. No other RC elements, varistors or freewheeling diodes are needed.

4.2.15 Factory settings of the inputs and outputs

Factory settings of the inputs and outputs of the control unit CU240D-2

In the factory settings, the fieldbus interface of the converter is not active.

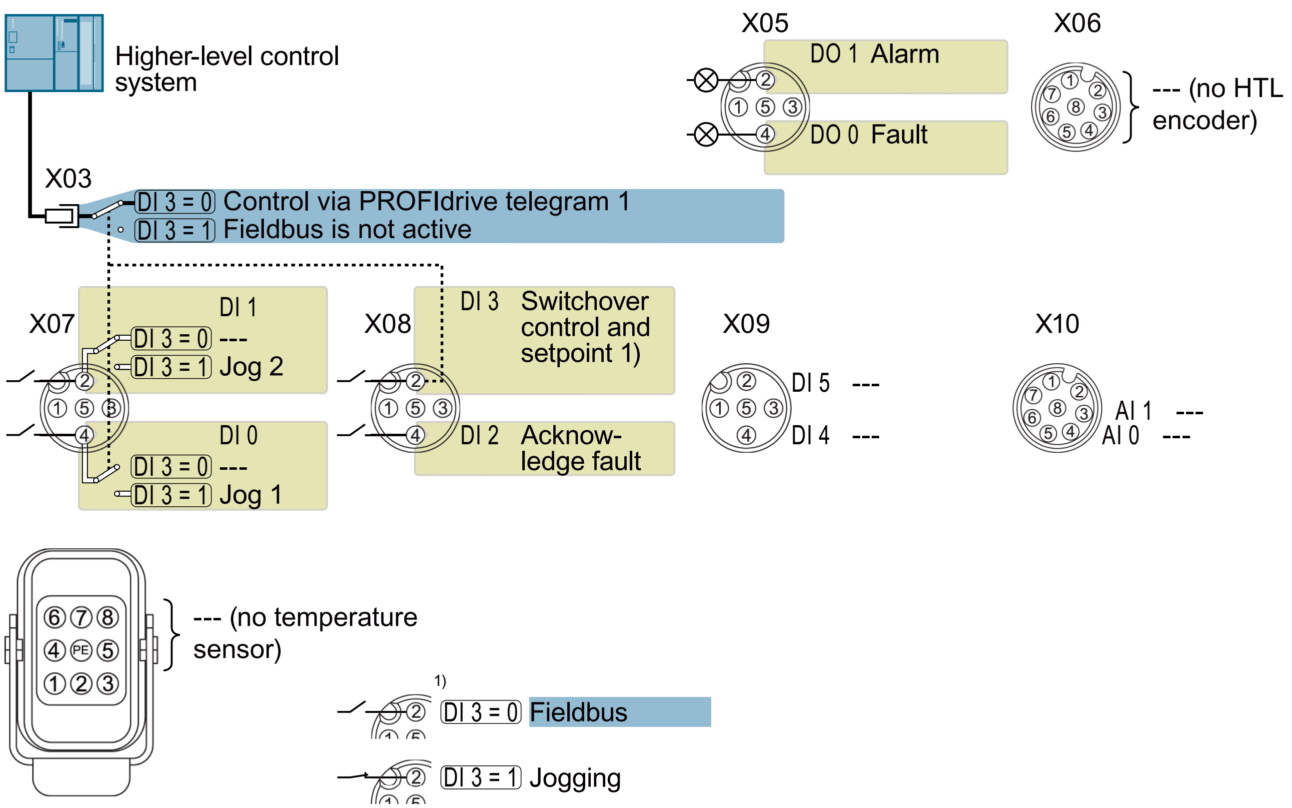


Figure 4-17 Factory settings of the control units CU240D-2

Changing the function of the inputs and outputs

The function of each color-identified input and output can be set.

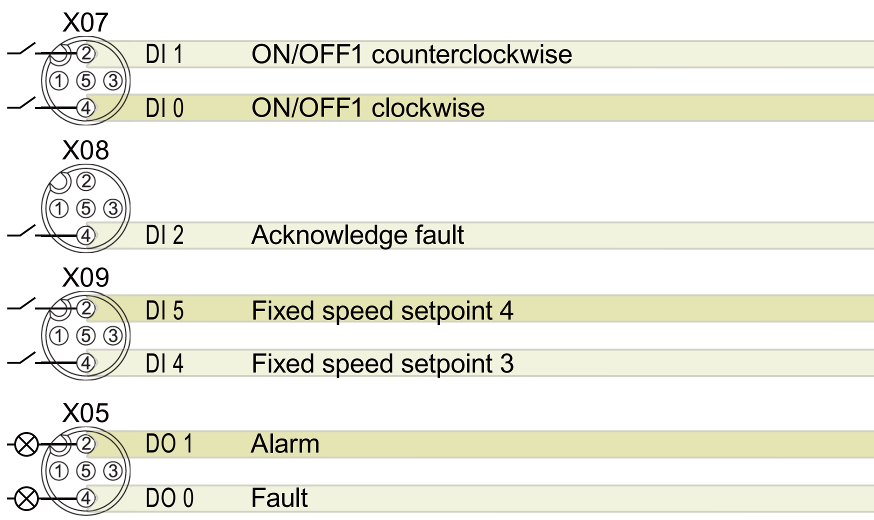
To avoid having to change each input individually, you can set multiple inputs and outputs together using default settings.

The factory setting of the inputs and outputs described above corresponds to the default setting 7 (switchover between fieldbus and a jog using DI 3).

Default settings of inputs and outputs (Page 58)

4.2.16 Default settings of inputs and outputs

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



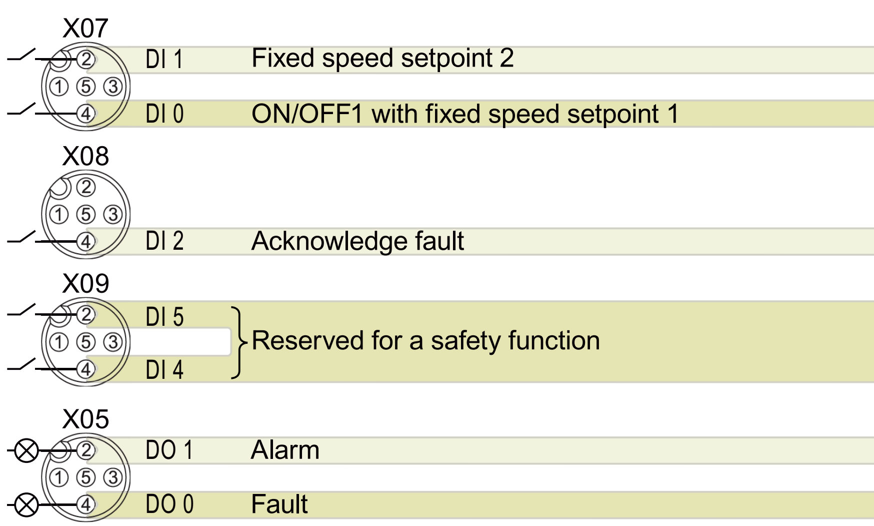
DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

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 the two fixed speed setpoints

Default setting 2: "Conveyor systems with Basic Safety"



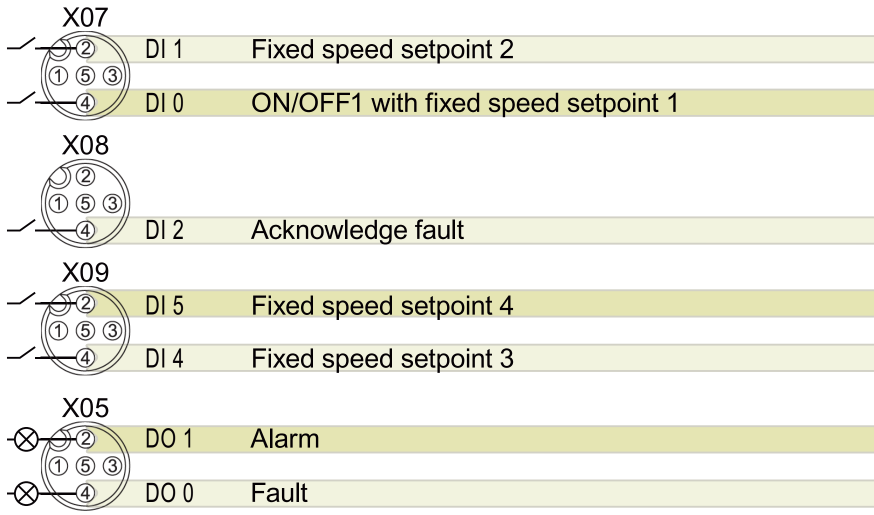
DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

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 the two fixed speed setpoints.

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



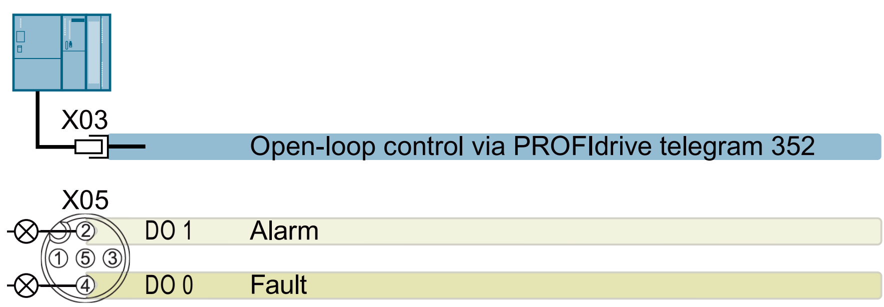
DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

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.

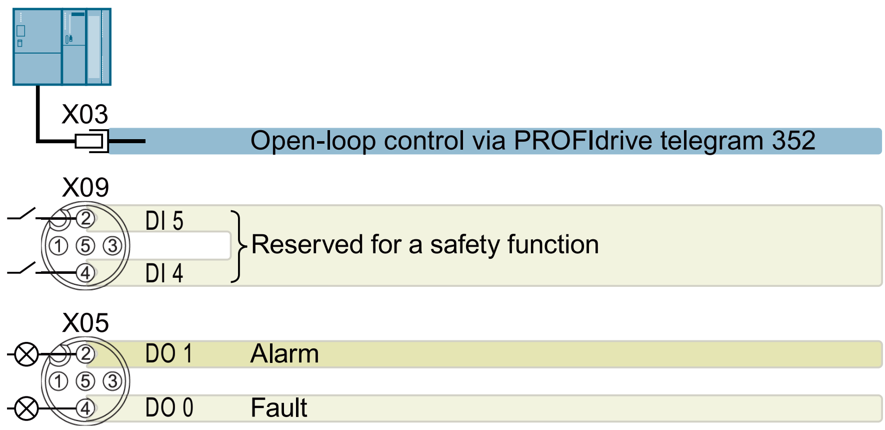
Default setting 4: "Conveyor system with fieldbus"



DO 0: p0730, DO 1: p0731

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

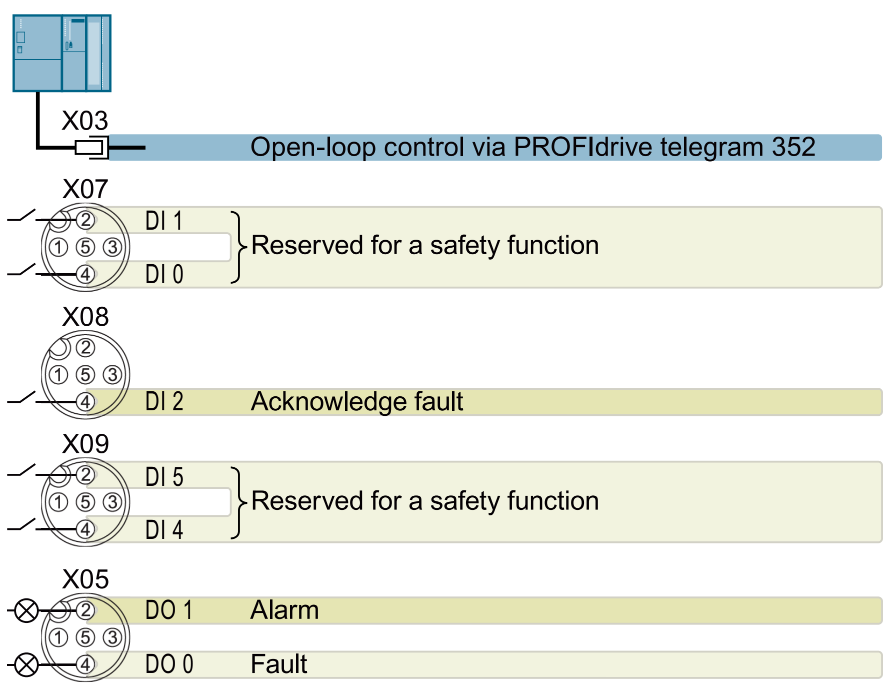
Default setting 5: "Conveyor systems with fieldbus and Basic Safety"



DO 0: p0730, DO 1: p0731 DI 4: r0722.4, DI 5: r0722.5

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

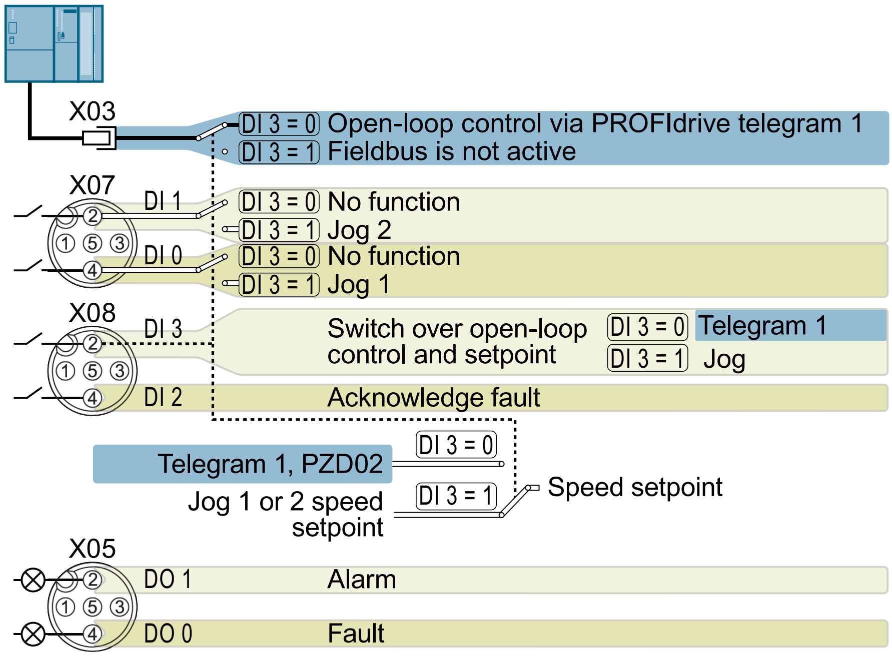
Default setting 6: "Fieldbus with Extended Safety"



DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

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

Default setting 7: "Fieldbus with data set switchover"



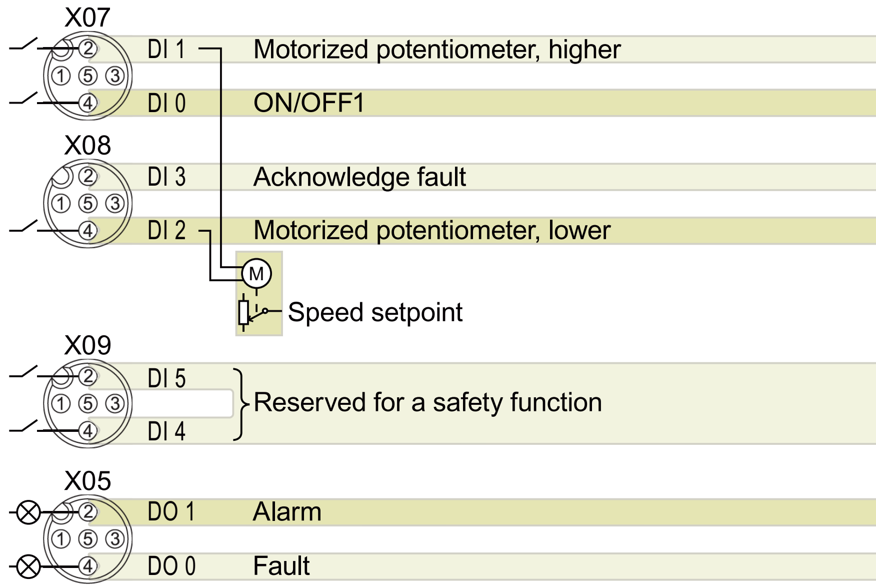
DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 3: r0722.3

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

Default setting 8: "MOP with Basic Safety"

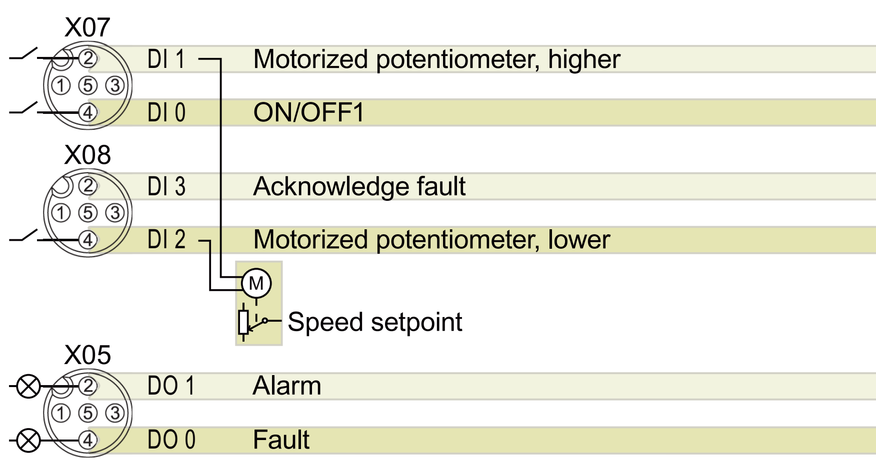


DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

Motorized potentiometer, setpoint after the ramp-function generator r1050

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

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

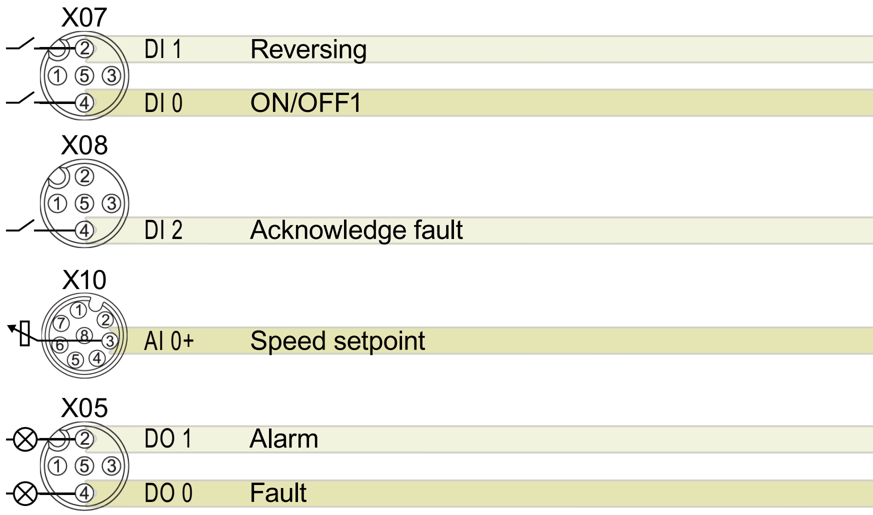


DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 3: r0722.3

Motorized potentiometer, setpoint after the ramp-function generator r1050

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

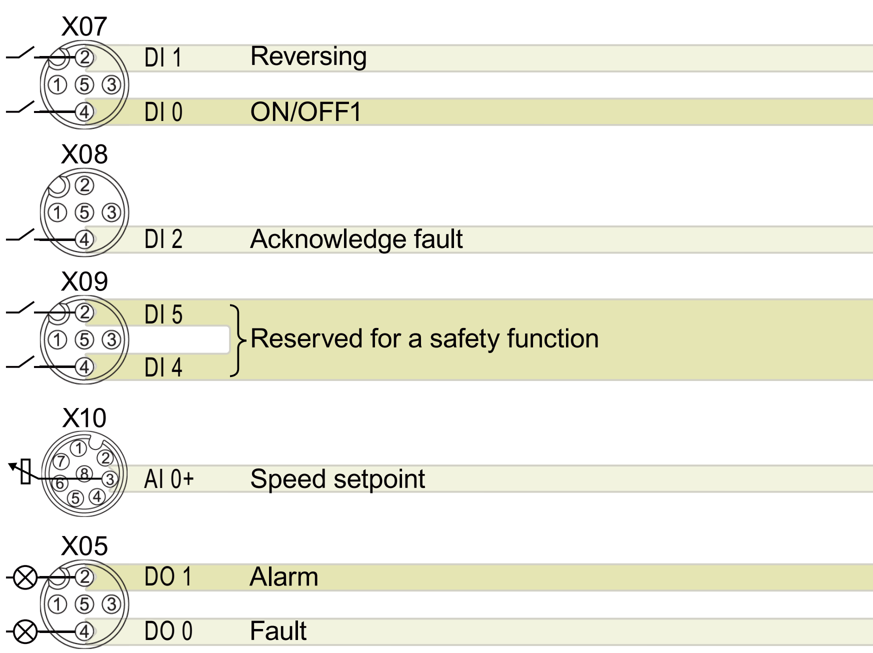
Default setting 12: "Standard I/O with analog setpoint"



DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 2: r0722.2 AI 0: r0755[0]

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

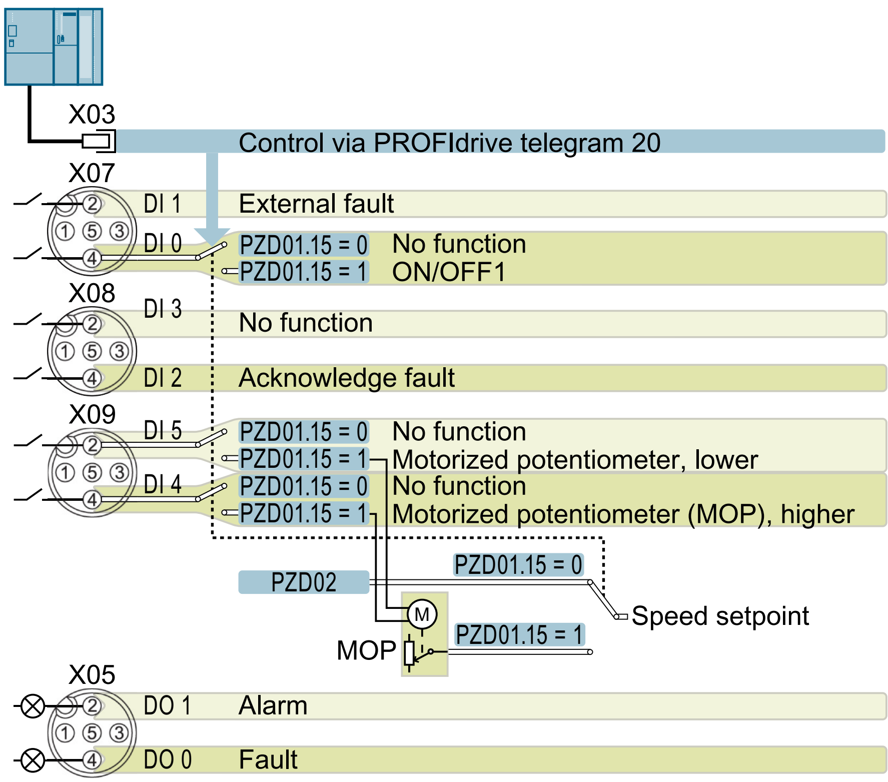
Default setting 13: "Standard I/O with analog setpoint and safety"



DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5 AI 0: r0755[0]

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

Default setting 14: "Process industry with fieldbus"



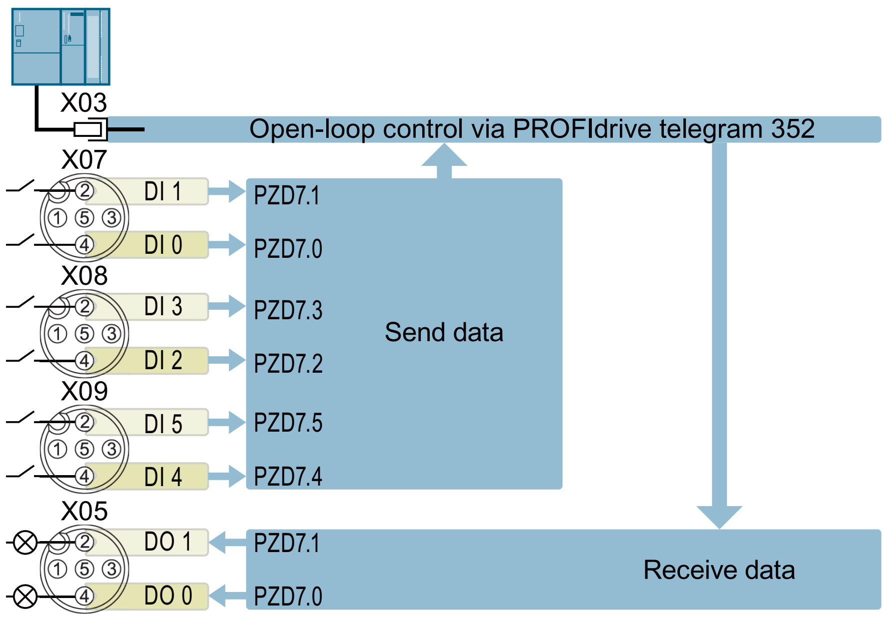
DO 0: p0730, DO 1: p0731 DI 0: r0722.0, ..., DI 5: r0722.5

Motorized potentiometer, setpoint after the ramp-function generator r1050

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

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

Default setting 24: "Distributed conveyor systems with fieldbus"



DO 0: p0730, DO 1: p0731

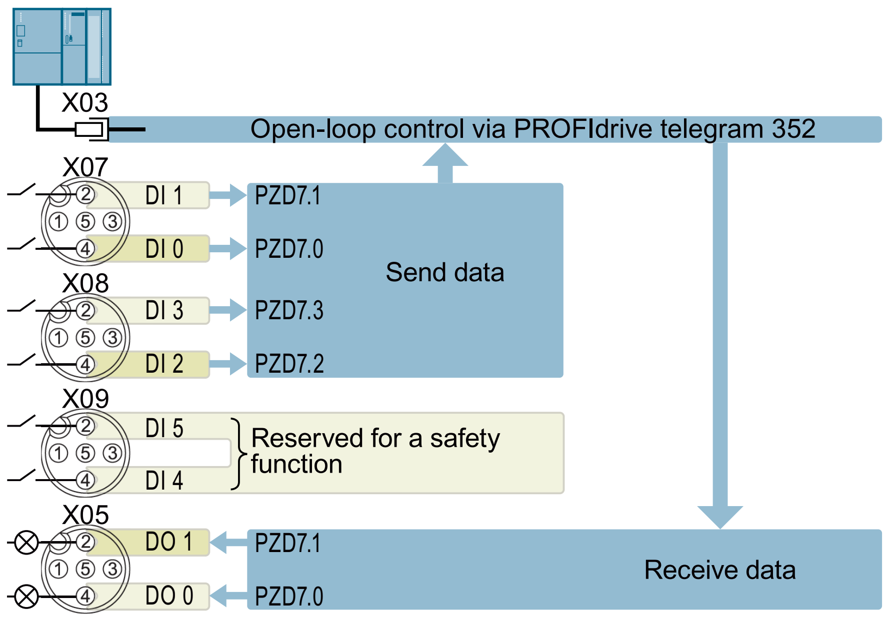
DI 0: r0722.0, ..., DI 5: r0722.5

p2081[0] = r0722.0, ..., p2081[5] = r0722.5

p0730 = r2094.0, p0731 = r2094.1

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

Default setting 25: "Distributed conveyor systems with fieldbus, safety"



DO 0: p0730, DO 1: p0731

DI 0: r0722.0, ..., DI 5: r0722.5

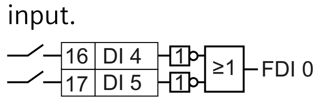
p2081[0] = r0722.0, ..., p2081[3] = r0722.3

p0730 = r2094.0, p0731 = r2094.1

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

4.2.17 Failsafe digital input

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:

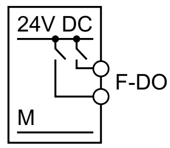
- Connection of safety sensors, e.g. emergency stop command devices or light curtains.
- Connection of pre-processing devices, e.g. failsafe control systems and safety relays.

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.

Connect safe P/P-switching outputs



PP-switching output

You may not connect safe P/P-switching outputs to a safe 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.

Connecting a failsafe digital input (Page 358)

4.3 Connecting the converter to PROFINET

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

The converter in PROFINET IO operation

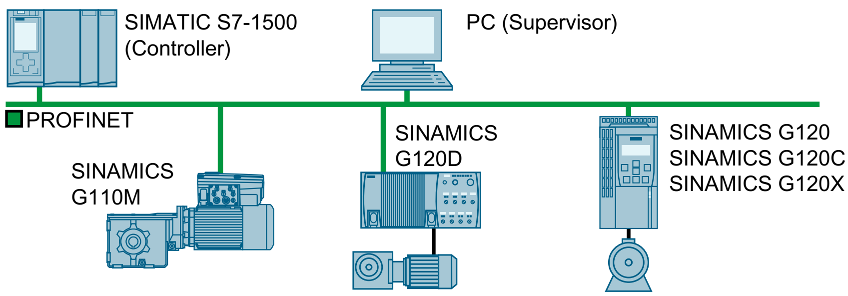


Figure 4-18 The converter in PROFINET IO operation (examples)

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

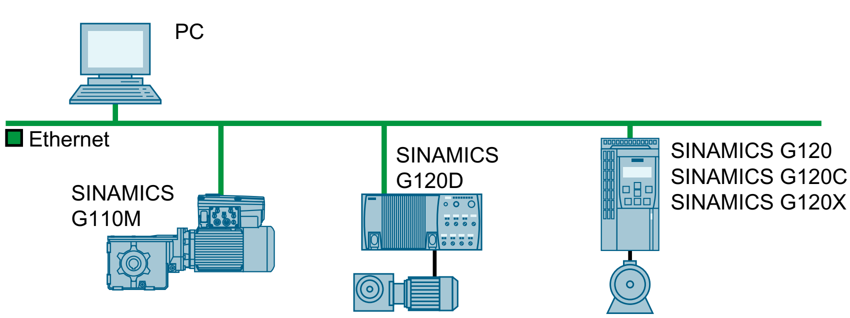


Figure 4-19 The converter as Ethernet node (examples)

See also

http://support.automation.siemens.com/WW/view/de/19292127 (http://support.automation.siemens.com/WW/view/en/19292127)

PROFINET – the Ethernet standard for automation (http://w3.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx)

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

Overview of the manuals (Page 361)

Further information on PROFINET

Further information on PROFINET can be found on the Internet:

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

4.3.1 Connecting the PROFINET interface

Condition

The screen of the PROFINET cable must be connected with the protective earth. The solid copper core must not be scored when the insulation is removed from the core ends.

Description

Listed in the table below are the recommended Ethernet cables.

Table 4-16 Recommended Ethernet cables and cable length

Cable type	Max. length between 2 converters	Article Number
Industrial Ethernet FC TP Standard Cable GP 2 x 2	100 m (328 ft)	6XV1840-2AH10
Industrial Ethernet FC TP Flexible Cable GP 2 x 2	85 m (278 ft)	6XV1870–2B
Industrial Ethernet FC Trailing Cable GP 2 x 2	85 m (278 ft)	6XV1870–2D
Industrial Ethernet FC Trailing Cable 2 x 2	85 m (278 ft)	6XV1840–3AH10
Industrial Ethernet FC Marine Cable 2 x 2	85 m (278 ft)	6XV1840–4AH10

4.3.2 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 71)

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 131)

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 (https://support.industry.siemens.com/cs/ww/en/view/60441457)

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

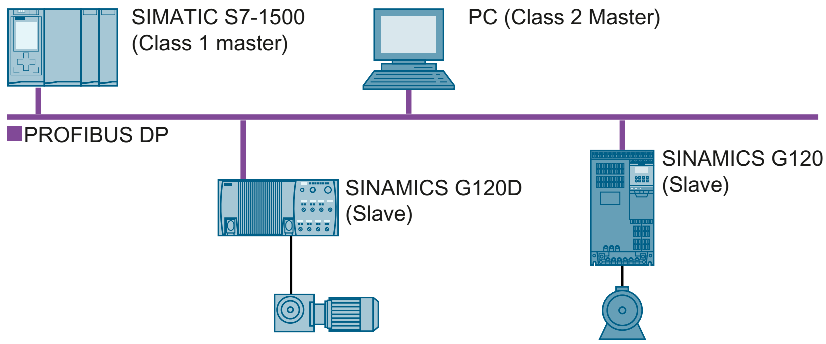
4.3.3 Installing GSDML

Procedure

1. Save the GSDML to your PC.
   - With Internet access:
     GSDML (http://support.automation.siemens.com/WW/view/en/22339653/133100)
   - 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.

4.4 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 (http://www.profibus.com/downloads/installation-guide/)
- Information about PROFIBUS DP (www.siemens.com/profibus)

4.4.1 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 73)

Setting the address

Set the address of the PROFIBUS slave.

Set the PROFIBUS address (Page 74)

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 131)

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 (https://support.industry.siemens.com/cs/ww/en/view/60441457)

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

4.4.2 Integrating the converter in PROFIBUS

Procedure

1. Integrate the converter in the bus system (e.g. line topology) of the control using PROFIBUS cables and the two PROFIBUS jacks X03 and X04. If your converter forms the end of the line, only use jack X03 and connect the bus-terminating resistor.
   Overview of the interfaces (Page 32)
   The maximum permitted cable length to the previous station and the subsequent one is 100 m at a baud rate of 1 Mbit/s.
2. Externally supply the converter with 24 V DC through X01.

You have now connected the converter to the control system using PROFIBUS DP.
❒

4.4.3 Installing the GSD

Procedure

1. Save the GSD on your PC using one of the following methods.
   – With Internet access:
   GSD (http://support.automation.siemens.com/WW/view/en/22339653/133100)
   – 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.

4.4.4 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:

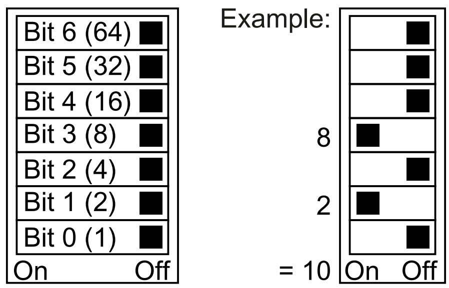


Figure 4-20 Address switch with example for bus address 10

  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 32)

Setting the bus address

Procedure

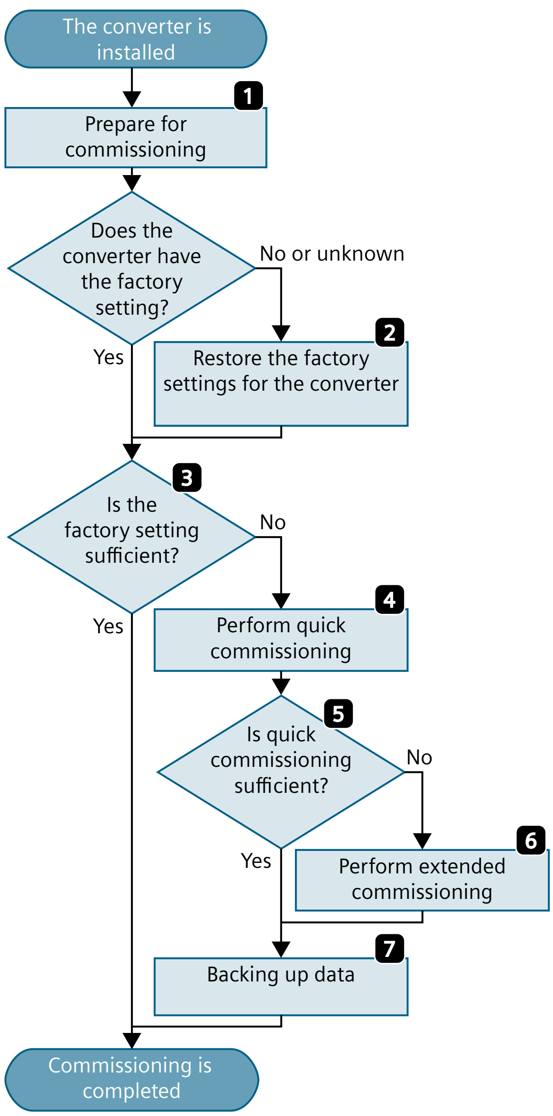
1. Set the address using one of the subsequently listed options:
   – Via the address switch
   – With a commissioning tool via p0918
2. Switch off the converter power supply.
3. Wait until all LEDs on the converter are dark.
4. Switch on the converter power supply again.
   Your settings become effective after switching on.

The PROFIBUS address is set.
❒

Commissioning 5

5.1 Commissioning guidelines

Overview



1. Define the requirements to be met by the drive for your application.
   (Page 78)
2. Restore the factory settings of the converter if necessary.
   (Page 92)
3. Check if the factory setting of the converter is sufficient for your application.
   (Page 78)
4. Set the following for quick commissioning of the drive:
   - The closed-loop motor control
   - The inputs and outputs
   - The fieldbus interface

   (Page 82)
5. Check if additional converter functions are required for the application.
   (Page 115)
6. If necessary, adapt the drive.
   (Page 115)
7. Save your settings.
   (Page 97)

5.2 Commissioning tools

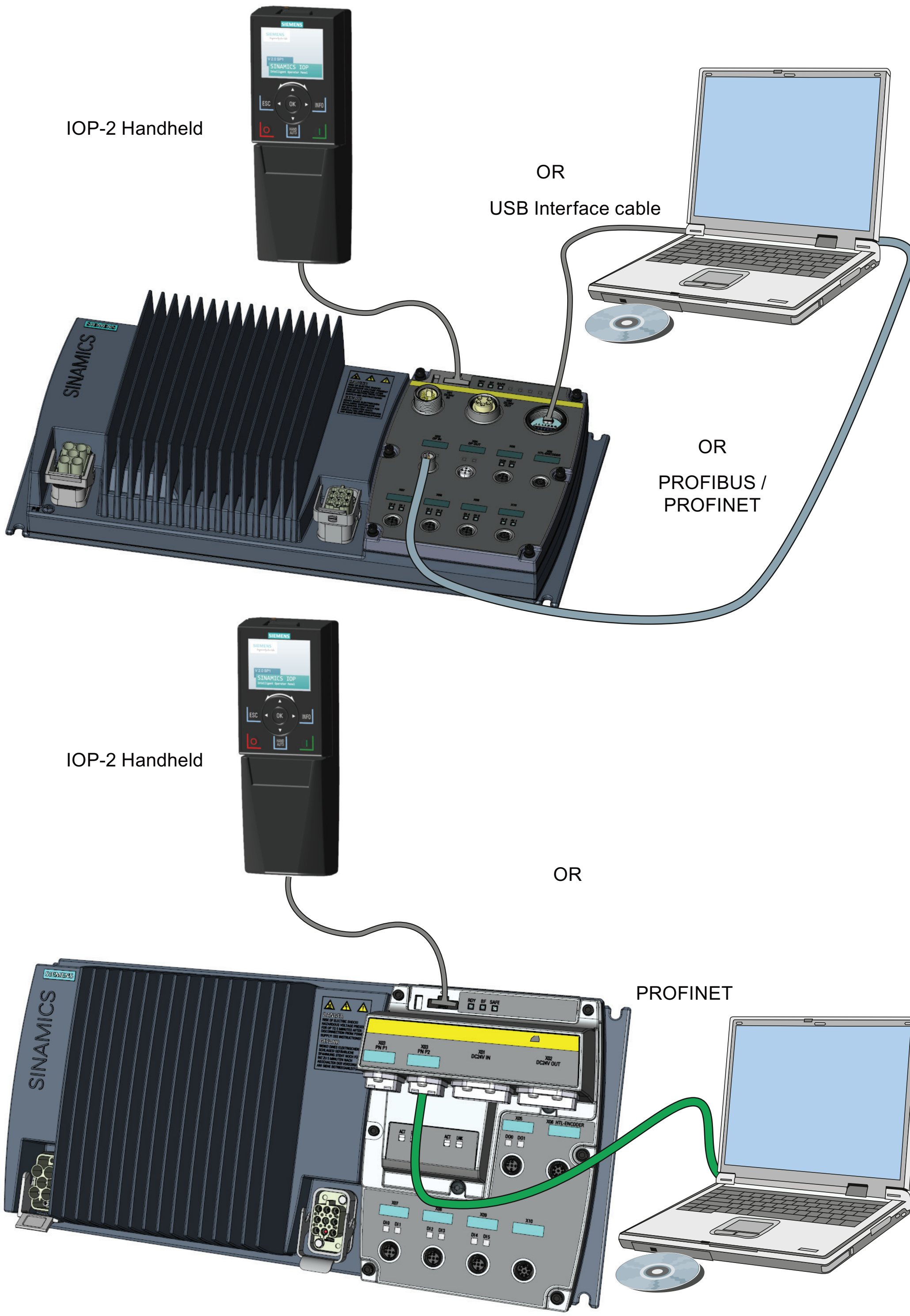


Figure 5-1 Commissioning tools - PC or IOP-2 Handheld Kit

IOP-2 Handheld: Article number 6SL3255-0AA00-4HA1

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

You obtainStartdrive on a DVD:

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

STARTER and Startdrive download:

- STARTER (http://support.automation.siemens.com/WW/view/en/10804985/133200)
- Startdrive (http://support.automation.siemens.com/WW/view/en/68034568)

Help regarding operation:

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

5.3 Preparing for commissioning

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.

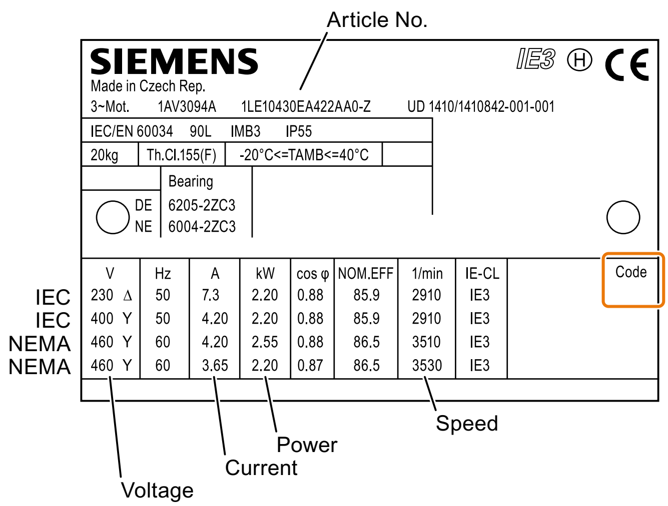


Figure 5-2 Example of the rating plate for a standard induction motor

- **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 [Δ]).
  Note the appropriate motor data for connecting.

5.3.1 Converter factory setting

Motor

With its factory settings, the converter is set up for an induction motor suitable for the power rating of the Power Module.

Converter interfaces

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

Factory settings of the inputs and outputs (Page 57)

Switching the motor on and off

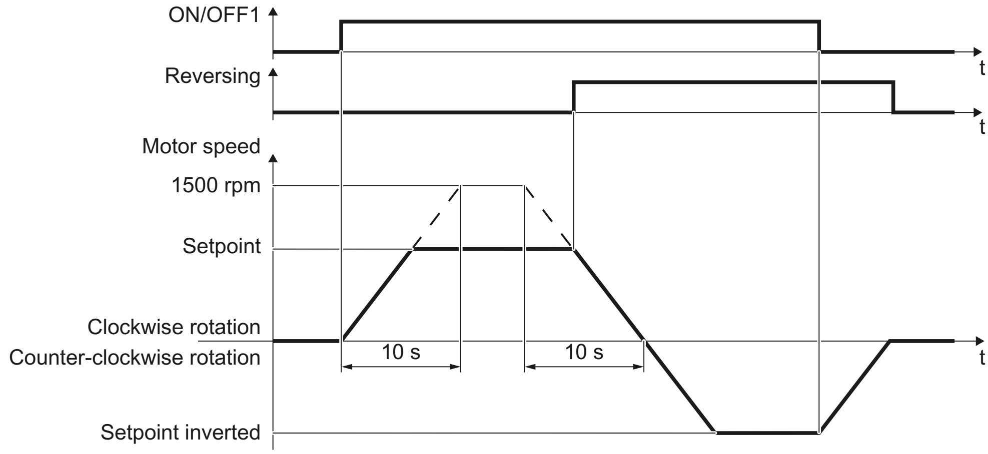


Figure 5-3 Switching on and switching off the motor and reversing in the factory setting

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 10 s 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 time is derived from the time between motor standstill and the maximum speed, or between the maximum speed and motor standstill.

Switching the motor on and off in the jog mode

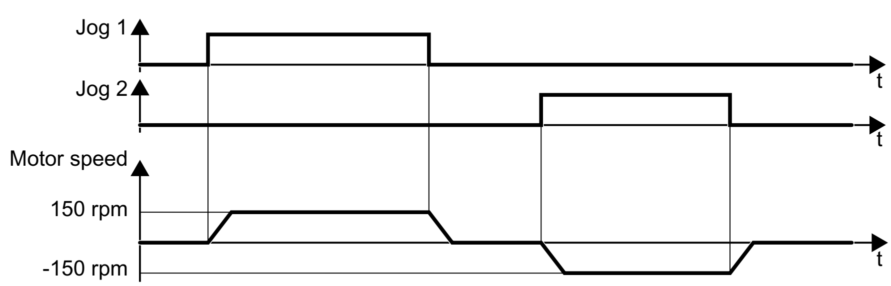


Figure 5-4 Jogging the motor with the factory settings

In the case of converters with a PROFIBUS or PROFINET interface, operation can be switched via 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.

When a control command is received at the respective digital input, the motor rotates at ±150 rpm. The same ramp-up and ramp-down times as described above apply.

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 is, for example, useful for fans or pumps.
- Maximum speed - factory setting 1500 [rpm]
  The converter limits the motor speed to this value.

Operate the converter with the factory setting

For basic applications, you can try to operate the drive without any additional commissioning steps. Check whether the control quality of the drive without commissioning is adequate for the requirements of the application.

We recommend that you configure the drive with the precise motor data.

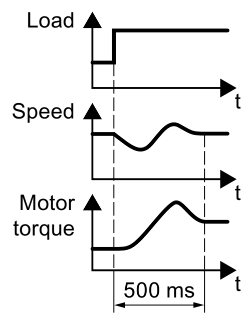
5.3.2 Selecting the control mode

Suitable applications and typical control properties

	U/f control or FCC (flux current control) without an encoder	Vector control without an encoder	Vector control with encoder
Application examples	• Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors) • Pumps, fans, and compressors with flow characteristic	• Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors) • Extruder • Centrifuges • Pumps and compressors with displacement machines	• Vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors) • Lifters/Lowerers • Stacker cranes
Motors that can be operated	Induction motors	Induction motors Encoderless 1FK7 synchronous motors Reluctance motors	Induction motors
	The rated current of the motor must lie in the range of 13 % ... 100 % of the rated current of the converter.		

<table>
<tr><th></th><th>U/f control or FCC (flux current control) without an encoder</th><th>Vector control without an encoder</th><th>Vector control with encoder</th></tr>
<tr><td rowspan="2">Properties of closed-loop motor control</td><td rowspan="2">

Responds to speed changes with a typical settling time of 100 ms ... 200 ms
Responds to load surges with a typical settling time of 500 ms



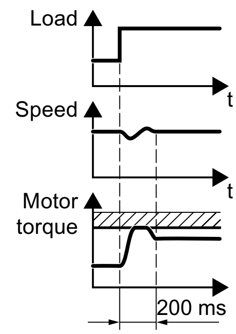
U/f and FCC are suitable for the following cases:

For power-up times 0 → rated speed > 2 s
For applications with increasing load torque without load impulses

The closed-loop control is insensitive to inaccurate motor data settings, e.g. the motor temperature

</td><td colspan="2">

The vector control responds to speed changes with a typical settling time of < 100 ms.
The vector control responds to load impulses with a typical settling time of 200 ms.



The vector control is required in the following cases:

For power-up times 0 → rated speed < 2 s
For applications with fast and high load impulses

</td></tr>
<tr><td>Typically achieves a torque accuracy of ± 5 % for 15 % ... 100 % of the rated speed</td><td>Extends the torque accuracy of ± 5 % to speeds < 15 % of the rated speed.</td></tr>
<tr><td>Max. output frequency</td><td>550 Hz</td><td colspan="2">240 Hz</td></tr>
<tr><td>Torque control</td><td>Closed-loop torque control not possible</td><td>Torque control for speeds > 15 % of the rated speed</td><td>Torque control from speeds = 0.</td></tr>
</table>

5.4 Quick commissioning with the IOP-2

Commissioning a 1FK7 encoderless synchronous motor

If you want to operate the converter using a 1FK7 encoderless synchronous motor, we recommend using the PC tools Startdrive or STARTER for commissioning.

Condition

The IOP-2 handheld is connected to the converter.

Commissioning tools (Page 76)

Description

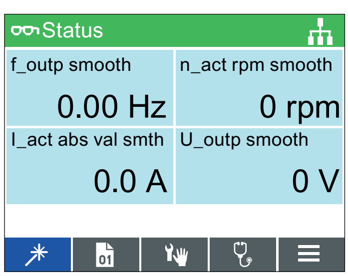
Note

Screens and sequence may vary

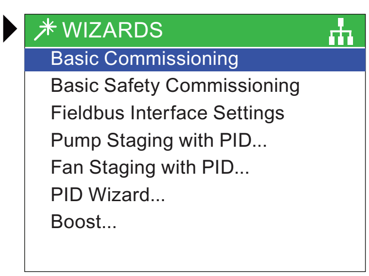
The sequence of the commissioning process and the actual screens may vary according to the following influences:

- The firmware version of the Intelligent Operator Panel 2 (IOP-2)
- The firmware version of the converter being commissioned
- The specific type of converter being commissioned.

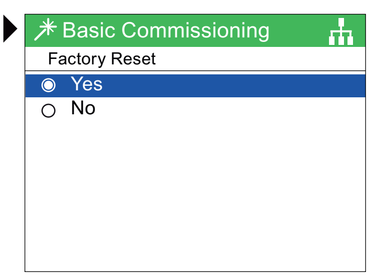
In all the scenarios, the IOP-2 will always display the appropriate commissioning screens and sequence for the converter to which it is connected.



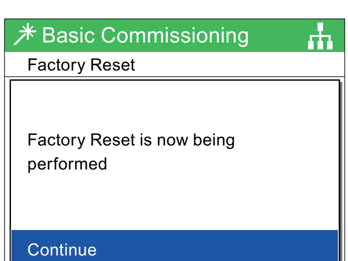
Select Wizards

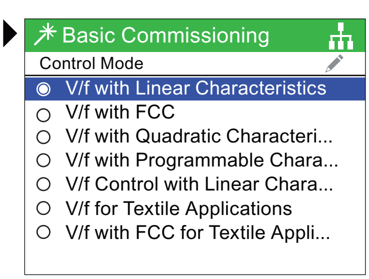


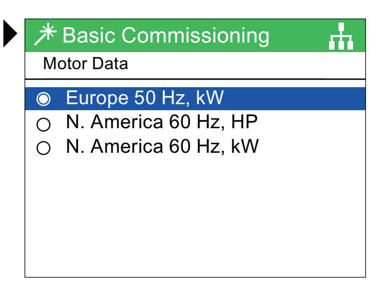
Select Basic Commissioning wizard



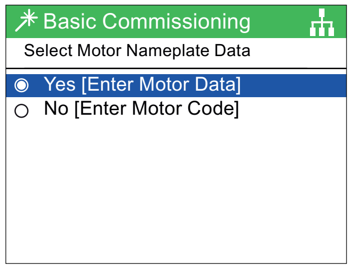
Select Factory Reset (yes or no)



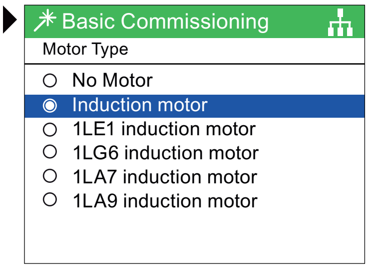




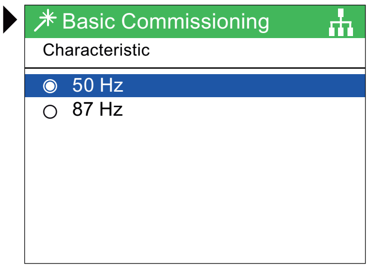
Select Continue | Select Control Mode | Select Motor Data



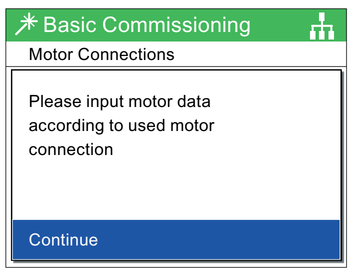
Select Enter Motor Data



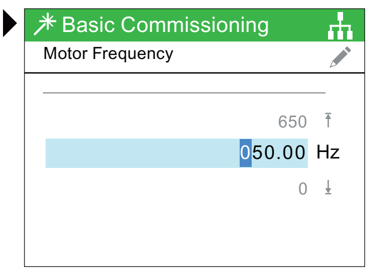
Select Motor Type



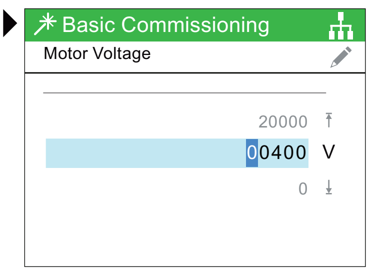
Select Characteristic



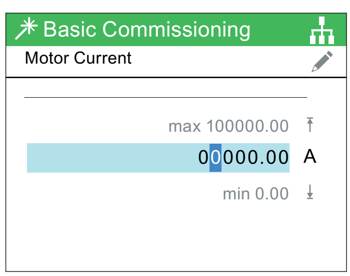
Select Continue



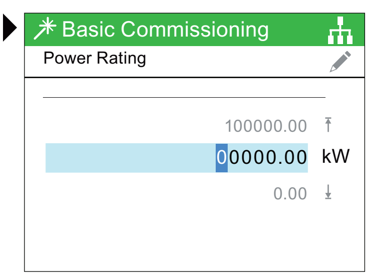
Input Motor Frequency



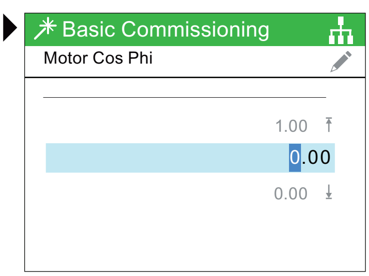
Input Motor Voltage



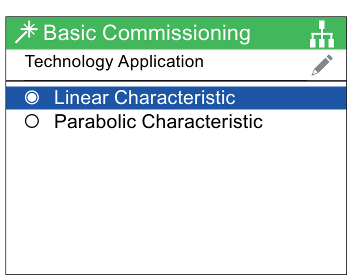
Input Motor Current



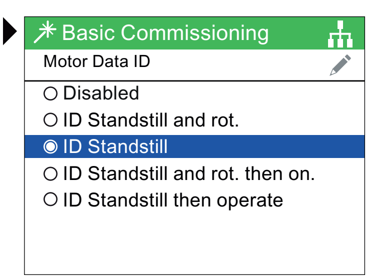
Input Power Rating



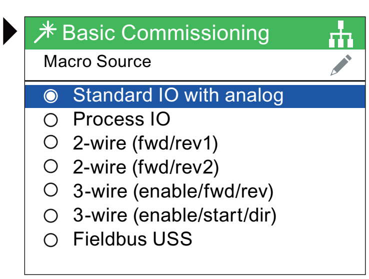
Input Motor Speed



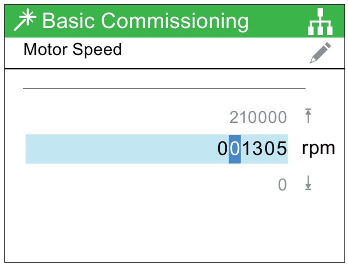
Select Technology Application



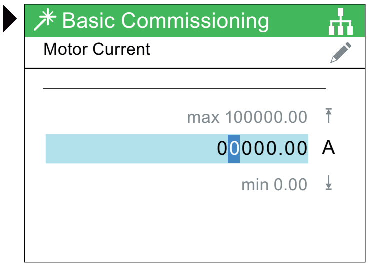
Select required Motor Data ID function



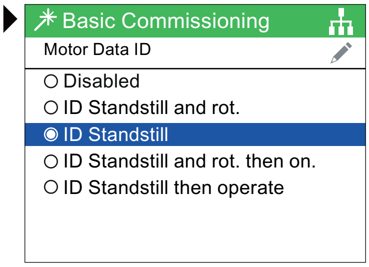
Select Macro Source



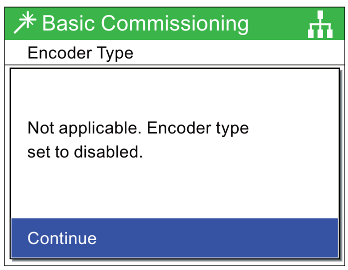
Input the Motor Speed



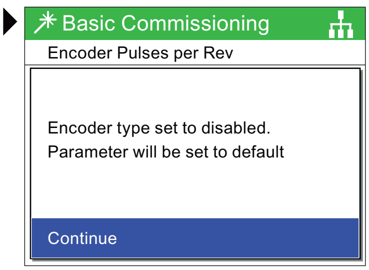
Input Current Limit



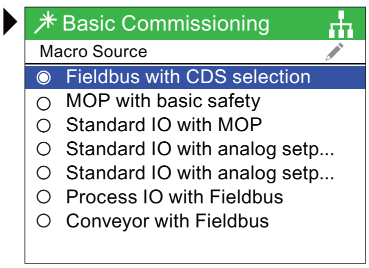
Select Motor Data ID option



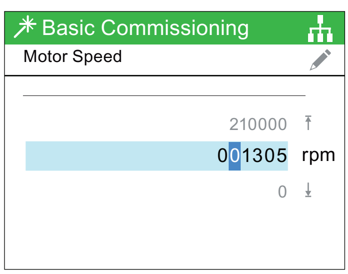
Input Encoder Type



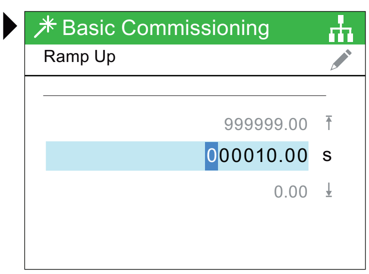
Input Encoder Pulses per rev



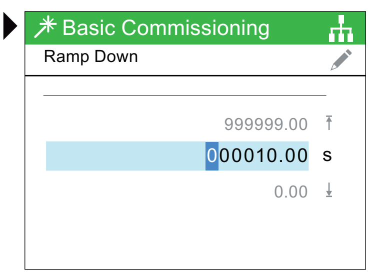
Select Macro Source



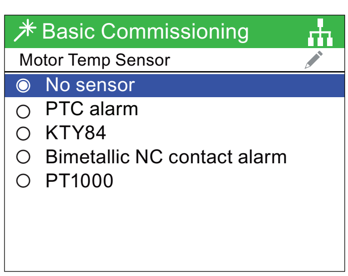
Input Maximum Speed



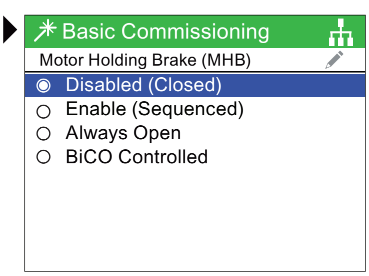
Input Ramp-up time



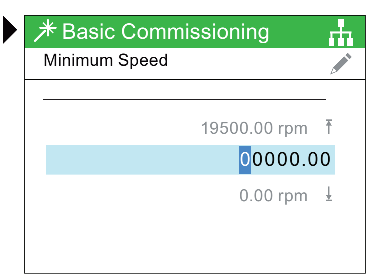
Input Ramp-down time



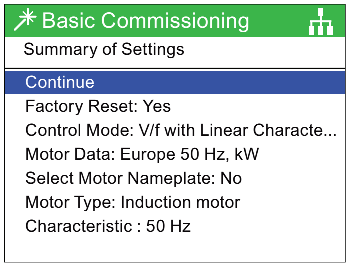
Select Motor Temperature Sensor



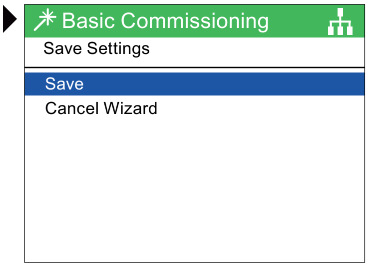
Select Motor Holding Brake option



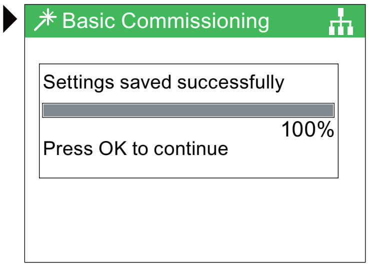
Input Minimum Motor Spped



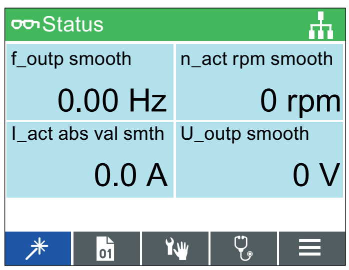
Summary of settings - Select Continue



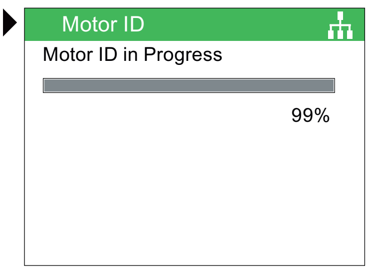
Save Settings



Settings saved



Status Screen displayed



On first ON command - Motor ID is performed

5.5 Quick commissioning with a PC.

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" → "New...".
3. Specify a name of your choice for the project.

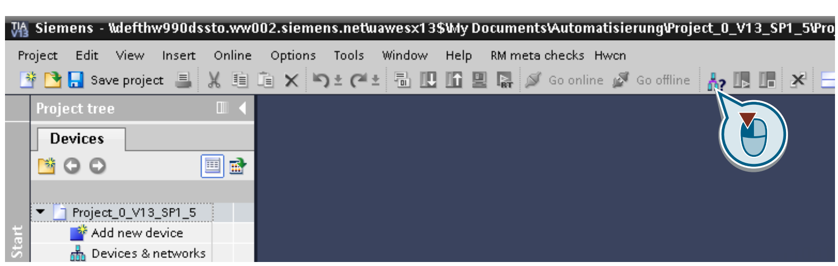
You have created a new project.
❒

5.5.2 Transfer converters connected via USB into the project

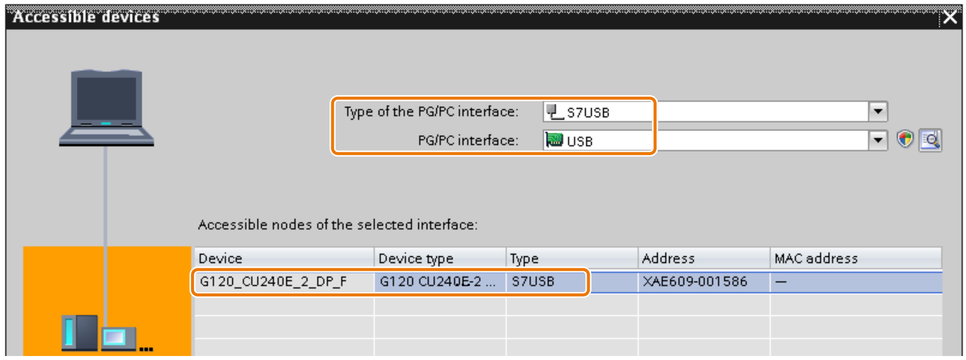
Integrating the converter into the project

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.



5. When the USB interface is appropriately set, then the "Accessible nodes" screen form shows the converters that can be accessed.



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)".

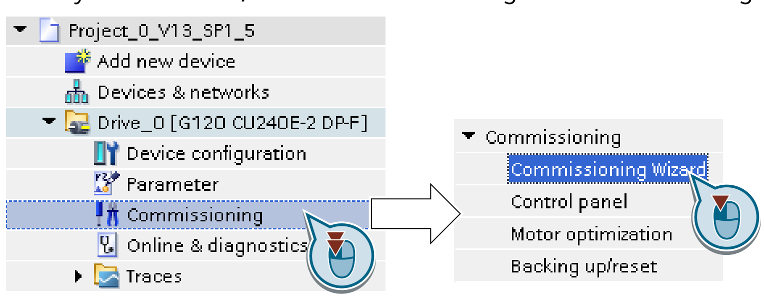
You have transferred a converter accessible via the USB interface into your project.
❒

Procedure

1. Select your project and go online: 

2. In the following screen form, select the converter with which you wish to go online.

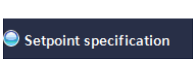
3. Once you are online, select "Commissioning" → "Commissioning Wizard":



You have started the commissioning Wizard of the converter.
❒

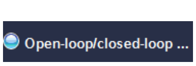
5.5.3 Carrying out quick commissioning

Procedure



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.

Selecting the control mode (Page 80)

Defaults of the setpoi...

Select the I/O configuration to preassign the converter interfaces.

Default settings of inputs and outputs (Page 58)

Drive setting

Set the applicable motor standard and the converter supply voltage.

Select the application for the converter:

- "[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.
- [6], [7]: Load cycles for applications with encoderless 1FK7 synchronous motors.

Drive options

If an optional component is installed between converter and motor, the corresponding setting must be performed.

Motor

Select your 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.

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]: In all applications that do not fall under [2]
- [2]: Encoderless control down to standstill

Motor identification:

- [2]: Measure the motor data at standstill. The converter switches off the motor after the motor data identification has been completed.

Calculating the motor parameters: Select "Complete calculation".

Encoders

If you use an HTL encoder on the motor shaft for the speed control of the converter, either select one of the standard encoders or enter the encoder data.

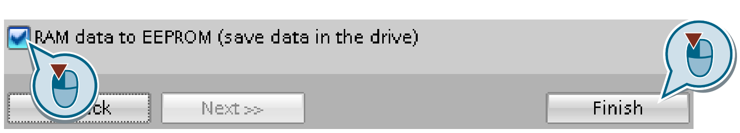
...R: Encoder with zero mark

Adapting the encoder data (Page 89)

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.



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

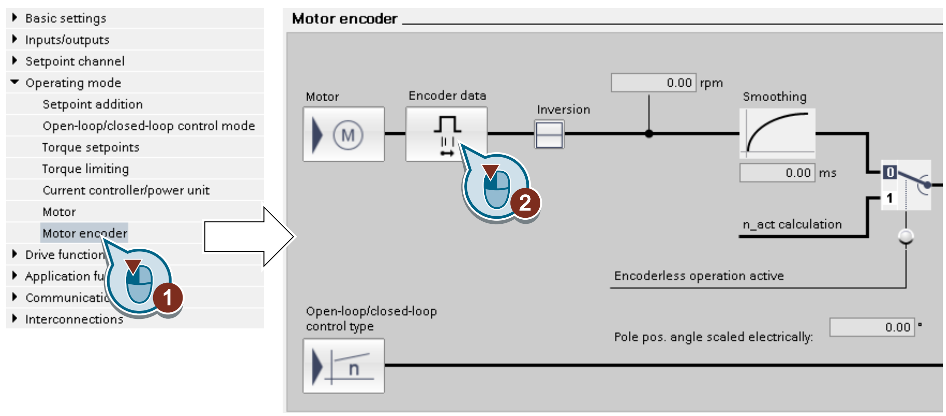
5.5.4 Adapting the encoder data

Preconditions

- You have selected an encoder type that does not precisely match your encoder, because it is not included in the list of default encoder types.
- You have completely configured the drive.

Procedure

1. Select the "Motor encoder" screen form.
2. Select the "Encoder data" button.



3. You have access to the following settings in the "Encoder data" screen form:
   - You can change all of the encoder data.
   - You can select another encoder type. Startdrive only lists the encoder types that are permitted for the configured interface.

   If you wish to set another encoder interface, you must restart the commissioning Wizard.

You have adapted the encoder data.
❒

5.5.5 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.

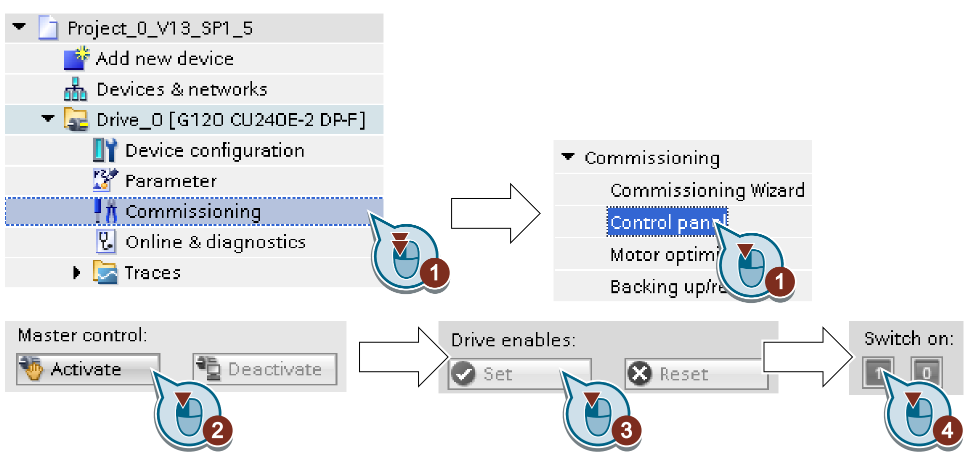
⚠ WARNING

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



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 → EEPROM):

You have completed the motor data identification.
❒

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.

5.6 Restoring the factory setting

5.6.1 Restoring the factory setting

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.

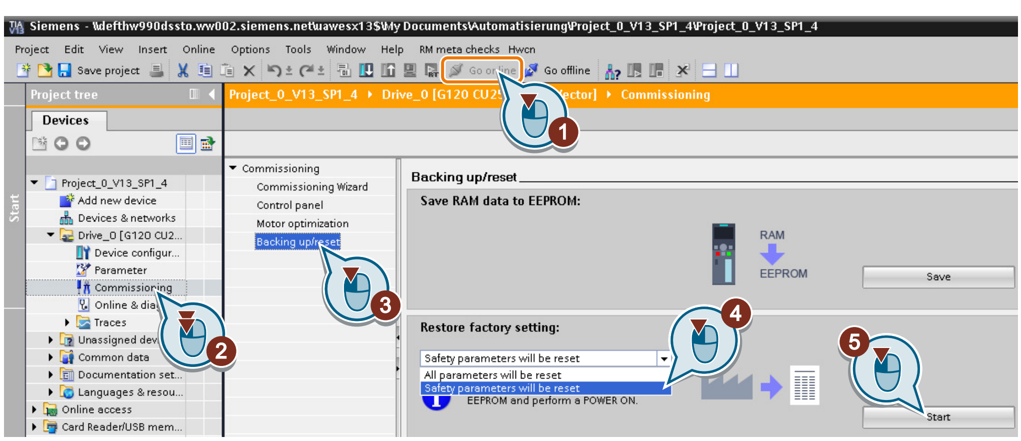
The settings of the safety functions are protected by a password.

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.

5.6.2 Resetting the safety functions to the factory setting

Procedure



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.
❒

Exception: The password for the safety functions is not reset.

Password (Page 181)

Procedure with an operator panel

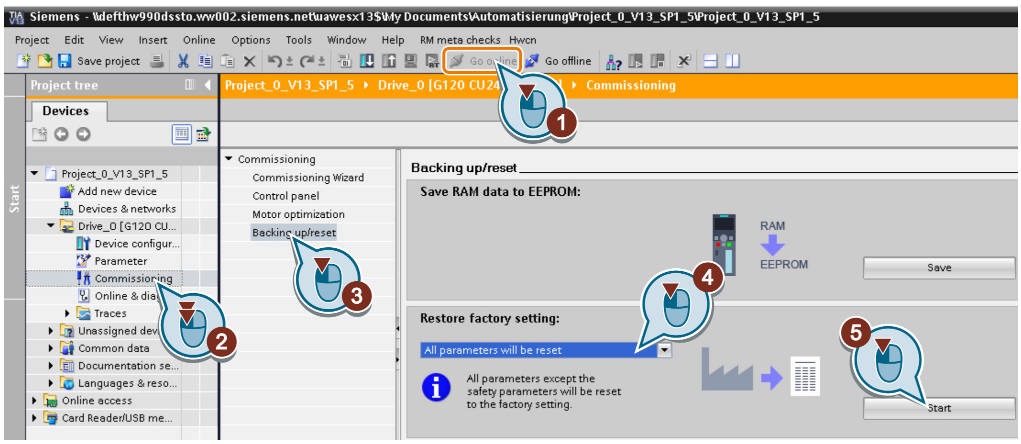
1. Set p0010 = 30
   Activate reset settings.
2. p9761 = ...
   Enter the password for the safety functions
3. Start the reset with p0970 = 5.
4. Wait until the converter sets p0970 = 0.
5. Set p0971 = 1.
6. Wait until the converter sets p0971 = 0.
7. Switch off the converter power supply.
8. Wait until 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.
❒

5.6.3 Restore the settings to the factory settings (without safety functions)

Restoring the converter to the factory setting

Procedure with Startdrive



1. Go online.
2. Select "Commissioning".
3. Select "Backing up/reset".
4. Select "All parameters are reset".
5. Press the "Start" button.
6. Wait until the converter has been reset to the factory setting.

You have reset the converter to the factory settings.
❒

Procedure with operator panel

Proceed as follows to reset the converter to factory settings:

1. Select the "Extras" menu
2. Select the "Parameter settings" menu
3. Select the entry "Restore drive to factory settings"
4. Wait until the converter has been reset to the factory setting.

You have reset the converter to the factory settings.
❒

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.
   Uploading the converter settings (Page 97)
3. Transfer the settings from the first converter to another converter via the data storage medium.
   Downloading the converter settings (Page 308)

Uploading the converter settings 6

6.1 Why does an upload make sense?

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

6.2 Uploading to the memory card

6.2.1 Recommended memory cards

Function description

Table 6-1 Memory 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 SP13	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.

6.2.2 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 319)

   ---
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.
❒

6.2.3 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.
❒

Parameter

Parameter	Explanation	Factory setting
p2118[0...19]	Change message type, message number	0
p2119[0 ... 19]	Change message type, type	0
r9401	Safely remove memory card status	-

6.2.4 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.

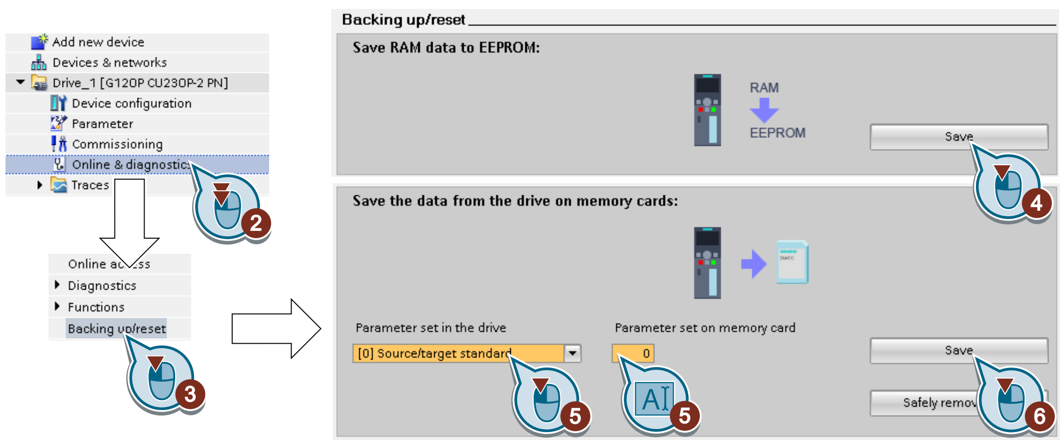
Requirement

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



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.

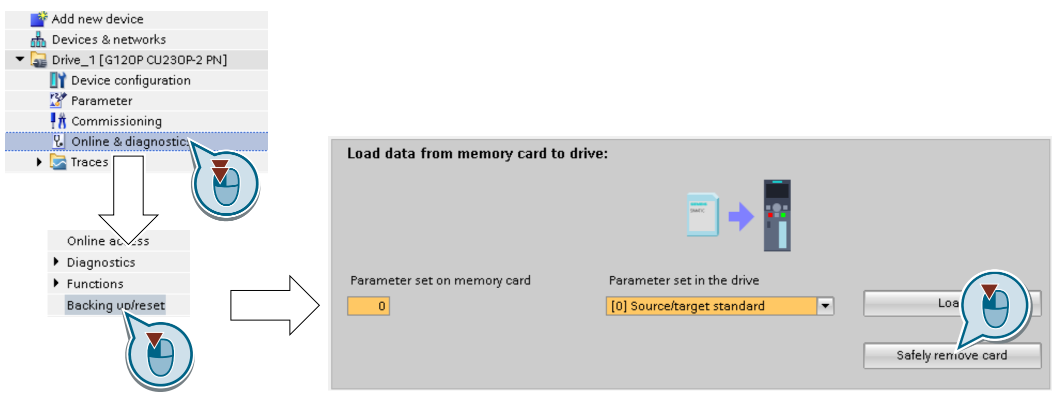
You have backed up the converter settings to a memory card.
❒

6.2.5 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



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.
❒

6.3 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 (http://support.automation.siemens.com/WW/view/en/43512514)

Protecting the converter settings 7

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 protection/know-how protection status**	
	.00	1 signal: Write protection active
p7761	**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[0...n]	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

Number	Name
p8806[0...53]	Identification and Maintenance 1 / I&M 1
p8807[0...15]	Identification and Maintenance 2 / I&M 2
p8808[0...53]	Identification and Maintenance 3 / I&M 3
p8809[0...53]	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

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 copy protection	Is a memory card necessary?	
Know-how protection without copy protection	The converter can be operated with or without memory card.	
Know-how protection with basic copy protection		The converter can only be operated with a SIEMENS memory card Recommended memory cards (Page 98)
Know-how protection with extended copy protection		

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.

- 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.
   List of exceptions (Page 111)
2. Activate the know-how protection.
   Know-how protection (Page 112)

Parameter

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[0...n]	CU detection using LED / CU detect LED
p0791[0...1]	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[0...8]	RTC daylight saving time setting / RTC DST
p8805	Identification and Maintenance 4 Configuration / I&M 4 Config
p8806[0...53]	Identification and Maintenance 1 / I&M 1
p8807[0...15]	Identification and Maintenance 2 / I&M 2
p8808[0...53]	Identification and Maintenance 3 / I&M 3
p8809[0...53]	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 be read with active know-how 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[0...n]	Motor type selection / Mot type sel
p0304[0...n]	Rated motor voltage / Mot U_rated
p0305[0...n]	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

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[0...n]	Minimum velocity / v_min
p1082[0...n]	Maximum velocity / v_max
p1520[0...n]	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[0...n]	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

Parameter	Description	Factory setting
p7763	KHP OEM exception list, number of indices for p7764	1
p7764[0...p7763]	KHP OEM exception list p7766 is the password for know-how protection	[0] 7766 [1...499] 0

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.
❒

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

Parameter	Description	Factory setting
r7758[0...19]	KHP Control Unit serial number	---
p7759[0...19]	KHP Control Unit reference serial number	---
r7760	Write protection/know-how protection status	---
p7765	KHP configuration	0000 bin
p7766[0...29]	KHP password, input	---
p7767[0...29]	KHP password, new	---
p7768[0...29]	KHP password, confirmation	---
p7769[0...20]	KHP memory card reference serial number	---
r7843[0...20]	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.

Advanced commissioning 8

8.1 Overview of the converter functions

Overview

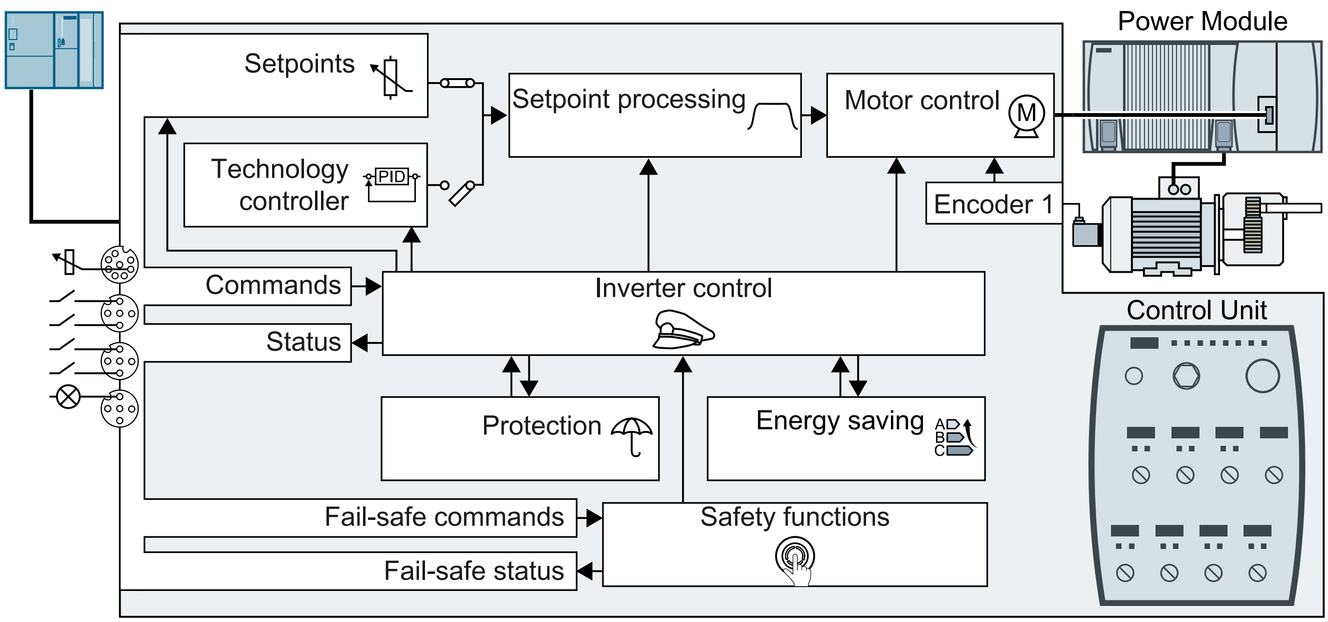


Figure 8-1 Overview of converter functions

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 119)
Adapt the default setting of the terminal strip (Page 122)
Drive control via PROFIBUS or PROFINET (Page 131)
Jogging (Page 157)
Limit position control (Page 159)

The converter can switch between different settings of the drive control.

Switching over the drive control (command data set) (Page 163)

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 166)

The free function blocks permit configurable signal processing within the converter.

Free function blocks (Page 171)

You can select in which physical units the converter represents its associated values.

Selecting physical units (Page 173)

Safety functions

The safety functions fulfill increased requirements regarding the functional safety of the drive.

Safe Torque Off (STO) safety function (Page 178)

The extended safety functions monitor the drive speed.

The extended safety functions are described in the "Safety Integrated" function manual.

Overview of the manuals (Page 361)

Setpoints and setpoint processing

The setpoint generally determines the motor speed.

Setpoints (Page 194)

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 204)

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 215)

Motor control

The closed-loop motor control ensures that the motor follows the speed setpoint. You can choose between various control modes.

Motor control (Page 222)

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 250)

Protection of the drive and the driven load

The protection functions prevent damage to the motor, converter and driven load.

Overcurrent protection (Page 257)

Converter protection using temperature monitoring (Page 258)

Motor protection with temperature sensor (Page 261)

Motor protection by calculating the temperature (Page 264)

The monitoring of the driven load prevents impermissible operating modes, e.g. dry-running of a pump.

Monitoring the driven load (Page 268)

Energy saving

For standard induction motors, the efficiency optimization reduces the motor losses in the partial load range.

Efficiency optimization (Page 277)

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.

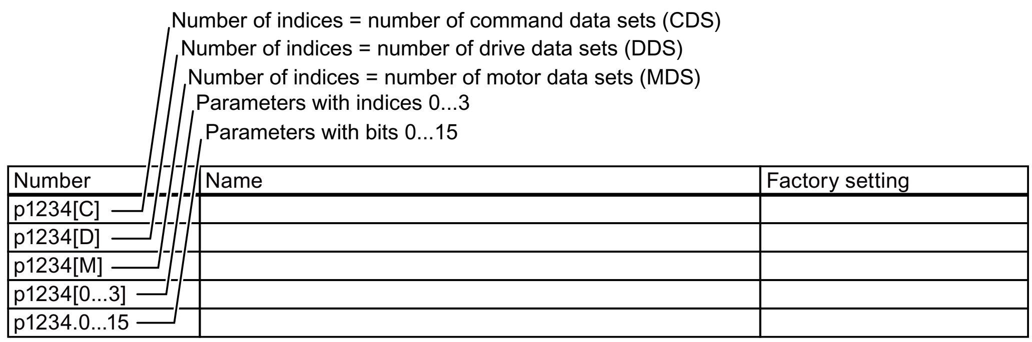


Figure 8-2 Brief parameter description

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.

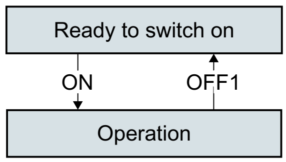


Figure 8-3 Simplified representation of the sequence control

After switching the supply voltage on, the inverter normally goes into the "ready to start" state. In this state, the inverter waits for the command to switch on the motor.

The inverter switches on the motor with the ON command. The inverter changes to the "Operation" state.

After the OFF1 command, the inverter brakes the motor down to standstill. The inverter switches off the motor once standstill has been reached. The inverter is again "ready to start".

Requirement

Functions

In order to be able to respond to external commands, you must set the command interface so that it fits your specific application.

Tools

To change the function settings, you can use an operator panel or a PC tool, for example.

Function description

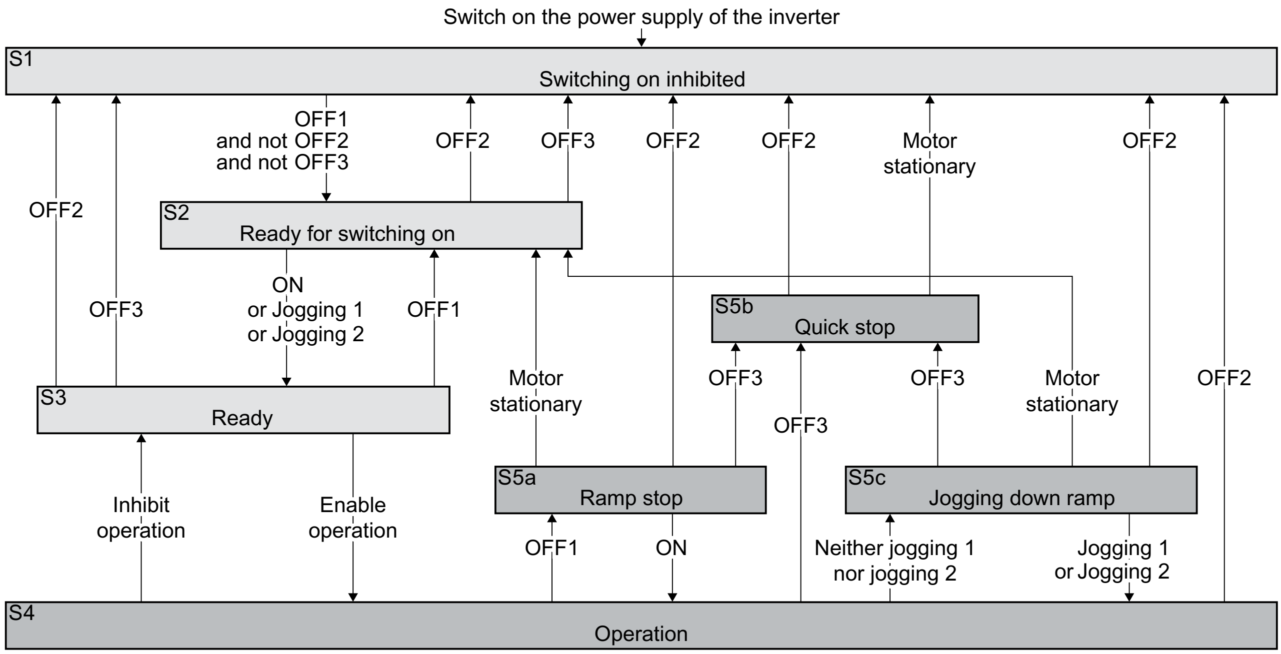


Figure 8-4 Sequence control of the inverter when the motor is switched on and off

Inverter states S1 ... S5c are defined in the PROFIdrive profile. The sequence control defines the transition from one state to another.

Table 8-1 Inverter states

The motor is switched off		**The motor 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 generates a torque	
S1	The inverter waits for a new ON command. The ON command is currently active. You must activate the ON command again in order that the inverter exits the state.	S4	The motor is switched on.
S2	The inverter waits for a new command to switch on the motor.	S5a, S5c	The motor is still switched on. The inverter brakes the motor with the ramp-down time of the ramp-function generator.
S3	The inverter waits for "Enable operation". The "Enable operation" command is always active in the inverter factory setting.	S5b	The motor is still switched on. The inverter brakes the motor with the OFF3 ramp-down time.

Table 8-2 Commands for switching the motor on and off

ON Jogging 1 Jogging 2 Enable operation	The inverter switches the motor on.
OFF1, OFF3	The inverter brakes the motor. The inverter switches off the motor once it comes to a standstill. The motor is considered to be stationary if the speed is less than a defined minimum speed.
OFF2 Inhibit operation	The inverter switches off the motor immediately without first braking it.

Parameter

<table>
<tr><th>Parameter</th><th>Description</th><th colspan="2">Setting</th></tr>
<tr><td>p1226</td><td>Standstill detection, speed threshold [rpm]</td><td>Factory setting: 20.00 rpm</td><td rowspan="3">The inverter identifies that the motor is at a standstill after OFF1 or OFF3 when at least one of the following conditions has been 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.</td></tr>
<tr><td>p1227</td><td>Standstill detection monitoring time [s]</td><td>Factory setting: 300.00 s</td></tr>
<tr><td>p1228</td><td>Pulse cancellation delay time [s]</td><td>Factory setting: 0.01 s</td></tr>
</table>

Further information

You will find additional information in function diagram 2610 of the List Manual.

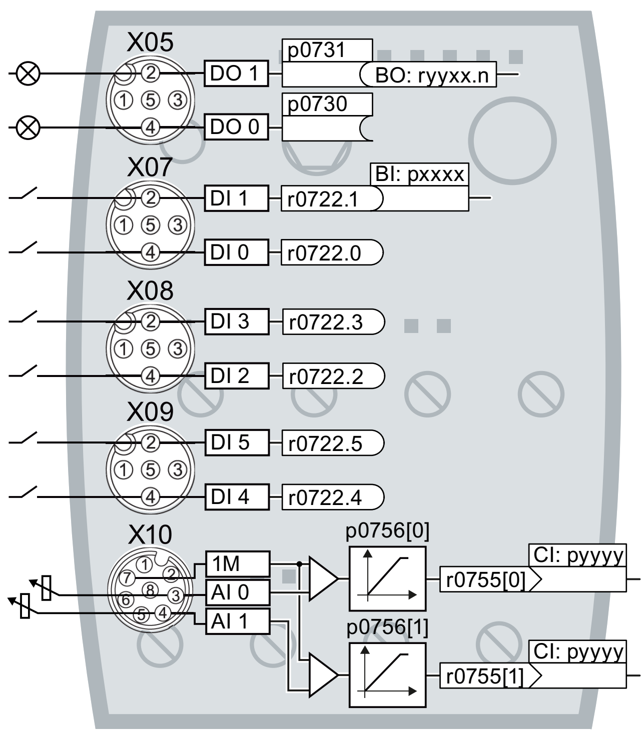
8.4 Adapt the default setting of the terminal strip

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:

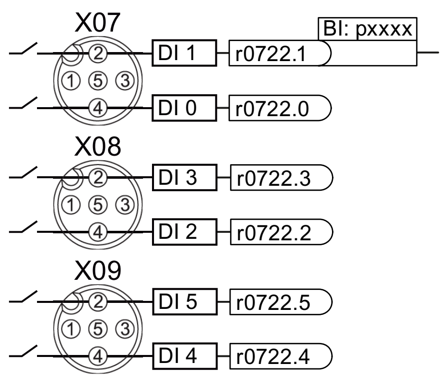
- Binectors BI and BO are parameters to interconnect binary signals.
- Connectors CI and CO are parameters to interconnect analog signals.

The following chapters describe how you adapt the function of individual converter inputs and outputs using binectors and connectors.



8.4.1 Digital inputs

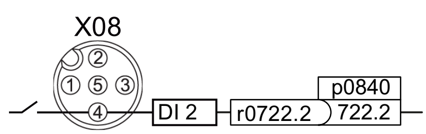
Function description



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 switch on the motor using digital input DI 2, you must connect the status parameter of DI 2 with p0840: Set p0840 = 722.2

Parameter

Table 8-3 Binector inputs (BI) of the converter (selection)

Parameter	Description	Factory setting
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 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
p0855[C]	BI: Unconditionally open holding brake	0
p0856[C]	BI: Enable speed controller	1
p0858[[C]	BI: Unconditionally close holding brake	0
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

Parameter	Description	Factory setting
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
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
p1201[C]	BI: Flying restart enable signal source	1
p2103[C]	BI: 1. Acknowledge faults	Dependent on the converter
p2106[C]	BI: External fault 1	1
p2112[C]	BI: External alarm 1	1
p2200[C]	BI: Technology controller enable	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

Additional information is provided in the parameter list and function diagrams 2210 ff in the List Manual.

Further information

You can debounce the digital input signal using parameter p0724.

A complete list of binector inputs is provided in the parameter list.

Overview of the manuals (Page 361)

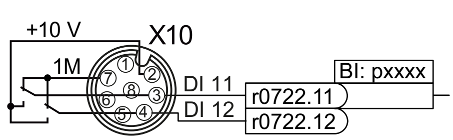
See also

Connections and cables (Page 46)

Safe Torque Off (STO) safety function (Page 178)

8.4.2 Analog inputs as digital inputs

Function description



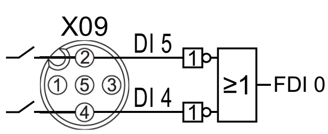
When required, you can use the analog inputs as additional digital inputs.

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 input

Function description

The converter combines digital inputs DI4 and DI5 to create a failsafe digital input.



Safe Torque Off (STO) safety function (Page 178)

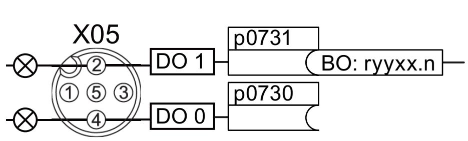
See also

Connections and cables (Page 46)

8.4.4 Digital outputs

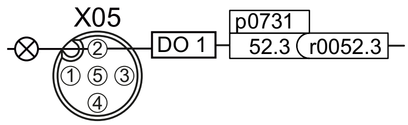
Function description

Interconnect the digital output with a binector output of your choice.



Binector outputs are designated in the parameter list with "BO".

Example



To output the fault message via digital output DO 1, you must connect DO 1 with the fault message: Set p0731 = 52.3.

Parameter

Table 8-4 Binector outputs of the converter (selection)

Parameter	Description		Factory setting
r0052[0...15]	CO/BO: Status 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: The converter inverts signal r0052.03 if it is interconnected to a digital output.	
	.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[0...11]	CO/BO: Status word 2		-
	.00	1 signal: DC braking active	
	.02	1 signal: Speed > minimum speed (p1080)	
	.06	1 signal: Speed ≥ setpoint speed (r1119)	

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

Further information

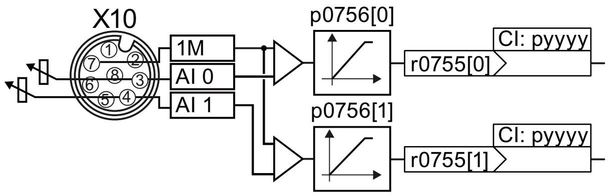
You can invert the digital output signal using parameter p0748.

Additional information is provided in the parameter list and in function diagram 2241.

Overview of the manuals (Page 361)

8.4.5 Analog inputs

Function description



Defining the analog input type

Define the analog input type using parameter p0756 for voltage input 0V ... 10V.

AI 0	Single-pole voltage input No sensor connected	0 V ... +10 V	p0756[0] =	08
AI 1	Single-pole voltage input No sensor connected	0 V ... +10 V	p0756[1] =	08

Defining the function of analog input

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

Parameter

Table 8-5 Connector inputs (CI) of the converter (selection)

Parameter	Description	Factory setting
p1070[C]	CI: Main setpoint	0
p1075[C]	CI: Supplementary setpoint	0
p1503[C]	CI: Torque setpoint	0
p1511[C]	CI: Supplementary torque 1	0
p1522[C]	CI: Torque limit, upper	1520
p2253[C]	CI: Technology controller setpoint 1	0
p2264[C]	CI: Technology controller actual value	0

A complete list of connector inputs is provided in the parameter list.

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 the function diagrams 2251 ff.

Using an analog input as a digital input

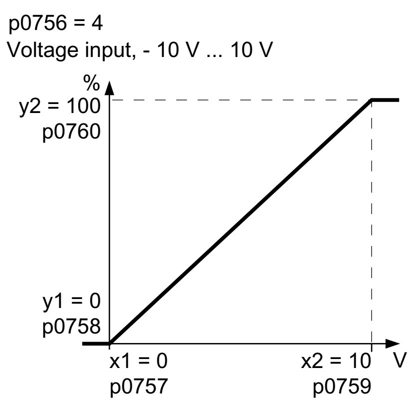
An analog input can also be used as a digital input.

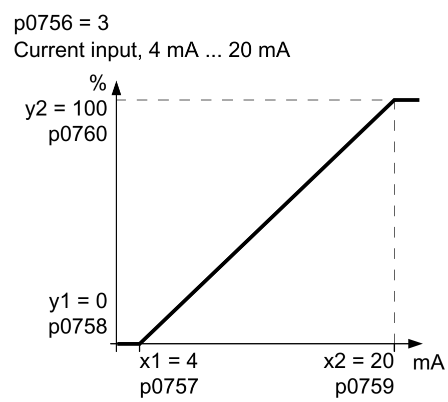
Digital inputs (Page 123)

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.

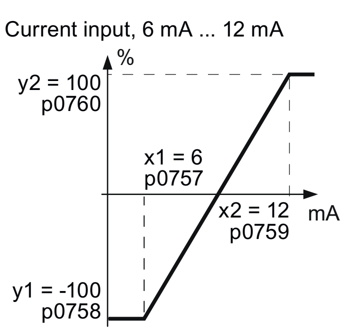




You must define your own characteristic if none of the default types match your particular application.

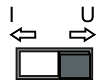
Example

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").



2. 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)
7. Set p0761[0] = 6
   An input current < 6 mA results in fault F03505.

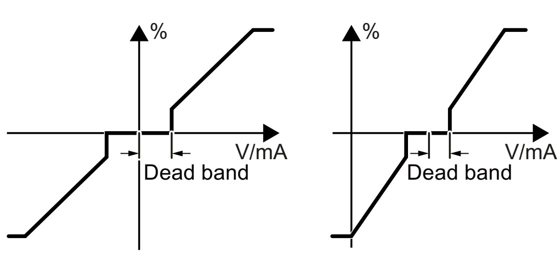
The characteristic for the application example is set.
❒

Parameters

Parameter	Description	Factory setting
p0757[0...n]	CU analog inputs characteristic value x1	0
p0758[0...n]	CU analog inputs characteristic value y1	0%
p0759[0...n]	CU analog inputs characteristic value x2	10
p0760[0...n]	CU analog inputs characteristic value y2	100%
p0761[0...n]	CU analog inputs wire-break monitoring, response threshold	2
p0762[0...n]	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.

Parameters

Parameter	Description	Factory setting
p0764[0]	Analog inputs deadband, AI 0	0
p0764[1]	Analog inputs deadband, AI 1	0

8.5 Drive control via PROFIBUS or PROFINET

8.5.1 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.

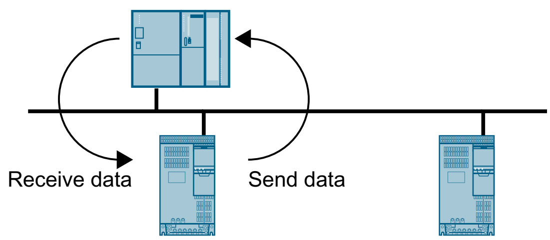


Figure 8-5 Cyclic data exchange

Converter and higher-level control system package their data in the form of telegrams.

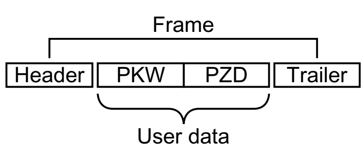


Figure 8-6 Telegram structure

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.

8.5.2 Telegrams

Overview

The user data of the telegrams that are available are described in the following.

Telegram 1

PZD01	PZD02
STW1	NSOLL_A
ZSW1	NIST_A

Receive user data

Send user data

16-bit speed setpoint

Telegram 20

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06
STW1	NSOLL_A				
ZSW1	NIST_A GLATT	IAIST_ GLATT	MIST_ GLATT	PIST_ GLATT	MELD_ NAMUR

16-bit speed setpoint for VIK-Namur

Telegram 350

PZD01	PZD02	PZD03	PZD04
STW1	NSOLL_A	M_LIM	STW3
ZSW1	NIST_A GLATT	IAIST_ GLATT	ZSW3

16-bit speed setpoint with torque limiting

Telegram 352

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06
STW1	NSOLL_A	Freely assignable			
ZSW1	NIST_A GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE

16-bit speed setpoint for PCS7

Telegram 353

	PZD01	PZD02
PKW	STW1	NSOLL_A
	ZSW1	NIST_A GLATT

16-bit speed setpoint with reading and writing to parameters

Telegram 354

	PZD01	PZD02	PZD03	PZD04	PZD05	PZD06
PKW	STW1	NSOLL_A	Freely assignable			
	ZSW1	NIST_A GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ 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	PZD13 ... PZD17
STW1	Telegram length for the receive data											
ZSW1	Telegram length for the transmit data											

Unassigned interconnection and length

Table 8-6 Abbreviations

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 limiting 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 value	MELD_NAMUR	Message according to the VIK-NAMUR definition

Function description

Control word 1 (STW1)

Bit	Significance		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The converter goes into the "ready" state. If, in addition bit 3 = 1, then the converter switches on the motor.	
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	p0844[0] = r2090.1
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Quick stop: The motor brakes to a standstill with the OFF3 ramp-down time p1135.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG		The converter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	

Bit	Significance		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates to the setpoint with the ramp-up time p1120.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the converter switches to the "switching on inhibited" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Converter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, converter accepts the process data from the fieldbus.	
11	1 = Direction reversal		Invert setpoint in the converter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

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

Status word 1 (ZSW1)

Bit	Significance		Remarks	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	1 = Ready for switching on		Power supply switched on; electronics initialized; pulses locked.	p2080[0] = 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] = r0899.1
2	1 = Operation enabled		Motor follows setpoint. See control word 1, bit 3.	p2080[2] = r0899.2
3	1 = Fault active		The converter has a fault. Acknowledge fault using STW1.7.	p2080[3] = r2139.3
4	1 = OFF2 inactive		Coast down to standstill is not active.	p2080[4] = r0899.4

Bit	Significance		Remarks	Signal interconnection in the converter
	Telegram 20	All other telegrams		
5	1 = OFF3 inactive		Quick stop is not active.	p2080[5] = 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] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint / actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the converter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	1 = current or torque limit reached	1 = torque limit reached	Comparison value for current or torque has been reached or exceeded.	p2080[11] = r0056.13 / r1407.7
12	---[1]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal converter actual value > 0.	p2080[14] = r2197.3
	0 = Motor rotates counter-clockwise		Internal converter actual value < 0.	
15	1 = CDS display	0 = Alarm, converter thermal overload		p2080[15] = r0836.0 / r2135.15

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

Control word 3 (STW3)

Bit	Significance	Explanation	Signal interconnection in the converter [1]
	Telegram 350		
0	1 = fixed setpoint bit 0	Selects up to 16 different fixed setpoints.	p1020[0] = r2093.0
1	1 = fixed setpoint bit 1		p1021[0] = r2093.1
2	1 = fixed setpoint bit 2		p1022[0] = r2093.2
3	1 = fixed setpoint bit 3		p1023[0] = r2093.3
4	1 = DDS selection bit 0	Changes over between settings for different motors (drive data sets).	p0820 = r2093.4
5	1 = DDS selection bit 1		p0821 = r2093.5
6	Not used		
7	Not used		
8	1 = technology controller enable	--	p2200[0] = r2093.8
9	1 = enable DC braking	--	p1230[0] = r2093.9
10	Not used		

Bit	Significance **Telegram 350**	Explanation	Signal interconnection in the converter [1]
11	Reserved		
12	1 = torque control active 0 = speed control active	Changes over the control mode for vector control.	p1501[0] = r2093.12
13	1 = no external fault 0 = external fault is active (F07860)	--	p2106[0] = r2093.13
14	Not used		
15	1 = CDS bit 1	Changes over between settings for different operation interfaces (command data sets).	p0811[0] = r2093.15

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

Status word 3 (ZSW3)

Bit	Significance	Description	Signal interconnection in the converter
0	1 = DC braking active	--	p2051[3] = r0053
1	1 = |n_act | > p1226	Absolute current speed > stationary state detection	
2	1 = |n_act | > p1080	Absolute actual speed > minimum speed	
3	1 = i_act ≧ p2170	Actual current ≥ current threshold value	
4	1 = |n_act | > p2155	Absolute actual speed > speed threshold value 2	
5	1 = |n_act | ≦ p2155	Absolute actual speed < speed threshold value 2	
6	1 = |n_act | ≧ r1119	Speed setpoint reached	
7	1 = DC link voltage ≦ p2172	Actual DC link voltage ≦ threshold value	
8	1 = DC link voltage > p2172	Actual DC link voltage > threshold value	
9	1 = ramp-up or ramp-down completed	Ramp-function generator is not active.	
10	1 = technology controller output at the lower limit	Technology controller output ≦ p2292	
11	1 = technology controller output at the upper limit	Technology controller output > p2291	
12	Not used		
13	Not used		
14	Not used		
15	Not used		

Fault word according to the VIK-NAMUR definition (MELD_NAMUR)

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	

See also

Expanding or freely interconnecting telegrams (Page 153)

Overview of the manuals (Page 361)

8.5.3 Control and status word 1

Control word 1 (STW1)

Bit	Meaning		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The converter goes into the "ready" state. If, in addition, bit 3 = 1, the converter switches on the motor.	
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	p0844[0] = r2090.1
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Fast stopping The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	

Bit	Meaning		Explanation	Signal interconnection in the converter
	Telegram 20	All other telegrams		
4	0 = Disable RFG		The converter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the converter switches to the "switching on inhibited" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Converter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, converter accepts the process data from the fieldbus.	
11	1 = Direction reversal		Invert setpoint in the converter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

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

Status word 1 (ZSW1)

Bit	Meaning		Remarks	Signal interconnection in the converter
	Telegram 20	All other telegrams		
0	1 = Ready for switching on		Power supply switched on; electronics initialized; pulses locked.	p2080[0] = 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] = r0899.1
2	1 = Operation enabled		Motor follows setpoint. See control word 1, bit 3.	p2080[2] = r0899.2

Bit	Meaning		Remarks	Signal interconnection in the converter
	Telegram 20	All other telegrams		
3	1 = Fault active		The converter has a fault. Acknowledge fault using STW1.7.	p2080[3] = r2139.3
4	1 = OFF2 inactive		Coast down to standstill is not active.	p2080[4] = r0899.4
5	1 = OFF3 inactive		Quick stop is not active.	p2080[5] = r0899.5
6	1 = Switching on inhibited active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint / actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the converter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	1 = current or torque limit reached	1 = torque limit reached	Comparison value for current or torque has been reached or exceeded.	p2080[11] = r0056.13 / r1407.7
12	---[1)]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal converter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counter-clockwise		Internal converter actual value < 0	
15	1 = CDS display	0 = Alarm, converter thermal overload	--	p2080[15] = r0836.0 / r2135.15

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

8.5.4 Control and status word 3

Control word 3 (STW3)

Bit	Meaning Telegram 350	Explanation	Signal interconnection in the converter [1]
0	1 = fixed setpoint bit 0	Selects up to 16 different fixed setpoints.	p1020[0] = r2093.0
1	1 = fixed setpoint bit 1		p1021[0] = r2093.1
2	1 = fixed setpoint bit 2		p1022[0] = r2093.2
3	1 = fixed setpoint bit 3		p1023[0] = r2093.3
4	1 = DDS selection bit 0	Changes over between settings for different motors (drive data sets).	p0820 = r2093.4
5	1 = DDS selection bit 1		p0821 = r2093.5
6	Not used		
7	Not used		
8	1 = technology controller enable	--	p2200[0] = r2093.8
9	1 = enable DC braking	--	p1230[0] = r2093.9
10	Not used		
11	1 = Enable droop	Enable or inhibit speed controller droop.	p1492[0] = r2093.11
12	1 = torque control active 0 = speed control active	Changes over the control mode for vector control.	p1501[0] = r2093.12
13	1 = no external fault 0 = external fault is active (F07860)	--	p2106[0] = r2093.13
14	Not used		
15	1 = CDS bit 1	Changes over between settings for different operation interfaces (command data sets).	p0811[0] = r2093.15

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

Status word 3 (ZSW3)

Bit	Meaning	Description	Signal interconnection in the converter
0	1 = DC braking active	--	p2051[3] = r0053
1	1 = |n_act | > p1226	Absolute current speed > stationary state detection	
2	1 = |n_act | > p1080	Absolute actual speed > minimum speed	
3	1 = i_act ≧ p2170	Actual current ≥ current threshold value	
4	1 = |n_act | > p2155	Absolute actual speed > speed threshold value 2	
5	1 = |n_act | ≦ p2155	Absolute actual speed < speed threshold value 2	
6	1 = |n_act | ≧ r1119	Speed setpoint reached	
7	1 = DC link voltage ≦ p2172	Actual DC link voltage ≦ threshold value	
8	1 = DC link voltage > p2172	Actual DC link voltage > threshold value	
9	1 = ramp-up or ramp-down completed	Ramp-function generator is not active.	
10	1 = technology controller output at the lower limit	Technology controller output ≦ p2292	
11	1 = technology controller output at the upper limit	Technology controller output > p2291	
12	Not used		
13	Not used		
14	Not used		
15	Not used		

8.5.5 NAMUR message word

Function description

Fault word according to the VIK-NAMUR definition (MELD_NAMUR)

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	

8.5.6 Parameter channel

Overview

The parameter channel allows parameter values to be cyclically read and written to.

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

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 8-7 Request identifiers, control → converter

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

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

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

Table 8-8 Response identifiers, converter → control

AK	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1)]
4	Transfer parameter value (field, word) [2)]
5	Transfer parameter value (field, double word) [2)]
6	Transfer number of field elements
7	Converter cannot process the request. 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

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

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

Table 8-9 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element 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	**Request cannot be executed due to the operating state** (access is not possible for tempo-rary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the converter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → converter")
6B hex	**No change access for a controller that is enabled**. (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	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (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.

Table 8-10 Parameter value or connector

<table>
<tr><th></th><th>PWE 1</th><th colspan="3">PWE 2</th></tr>
<tr><td rowspan="4">Parameter value</td><td>Bit 15 ... 0</td><td colspan="2">Bit 15 ... 8</td><td>Bit 7 ... 0</td></tr>
<tr><td>0</td><td colspan="2">0</td><td>8-bit value</td></tr>
<tr><td>0</td><td colspan="3">16-bit value</td></tr>
<tr><td colspan="4">32-bit value</td></tr>
<tr><td rowspan="2">Connector</td><td>Bit 15 ... 0</td><td>Bit 15 ... 10</td><td colspan="2">Bit 9 ... 0</td></tr>
<tr><td>Number of the connector</td><td>3F hex</td><td colspan="2">The index or bit field number of the connector</td></tr>
</table>

Examples

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

To obtain the value of indexed parameter p7841, 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 word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 8-7 Parameter channel for read request from p7841[2]

Write request: Change restart mode (p1210)

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

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

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

Figure 8-8 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	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 8-9 Parameter channel to assign digital input 2 with ON/OFF1

Function description

AK: Request and response ID

Table 8-11 Request identifiers, control → converter

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

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

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

Table 8-12 Response identifiers, converter → control

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

AK	Description
7	Converter cannot process the request. 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

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

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

Table 8-13 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element 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	**Request cannot be executed due to the operating state** (access is not possible for tempo-rary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the converter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → converter")
6B hex	**No change access for a controller that is enabled**. (The operating state of the conerter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating state of the converter pre-vents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (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
29000 ... 29999	0000 ... 1999	70 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.

Table 8-14 Parameter value or connector

<table>
<tr><th></th><th>PWE 1</th><th colspan="3">PWE 2</th></tr>
<tr><td rowspan="4">Parameter value</td><td>Bit 15 ... 0</td><td colspan="2">Bit 15 ... 8</td><td>Bit 7 ... 0</td></tr>
<tr><td>0</td><td colspan="2">0</td><td>8-bit value</td></tr>
<tr><td>0</td><td colspan="3">16-bit value</td></tr>
<tr><td colspan="4">32-bit value</td></tr>
<tr><td rowspan="2">Connector</td><td>Bit 15 ... 0</td><td>Bit 15 ... 10</td><td colspan="2">Bit 9 ... 0</td></tr>
<tr><td>Number of the connector</td><td>3F hex</td><td colspan="2">The index or bit field number of the connector</td></tr>
</table>

Examples

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

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

- **PKE, Bit 12 ... 15 (AK): = 6** (request parameter value (field))
- **PKE, Bit 0 ... 10 (PNU): = 1841** (parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 ... 15 (subindex): = 2** (index of 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 word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 8-10 Telegram for a read request from p7841[2]

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.

Table 8-15 Parameter value or connector

	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 value		
Connector	Bit 15 ... 0	Bit 15 ... 10	Bit 9 ... 0
	Number of the connector	3F hex	The index or bit field number of the connector

8.5.7 Examples

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

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

- **PKE, Bit 12 ... 15 (AK): = 6** (request parameter value (field))
- **PKE, Bit 0 ... 10 (PNU): = 1841** (parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 ... 15 (subindex): = 2** (index of 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 word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 8-11 Telegram for a read request from p7841[2]

Write request: Change restart mode (p1210)

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

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

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

Figure 8-12 Telegram, to activate the automatic restart with p1210 = 26

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

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

- **PKE, bit 12 ... 15 (AK): = 7 hex** (change parameter value (field, word))
- **PKE, bit 0 ... 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)

- **IND, bit 8 ... 15 (subindex): = 1 hex** (CDS1 = 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))

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

Figure 8-13 Telegram, to assign DI 2 with ON/OFF1

8.5.8 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

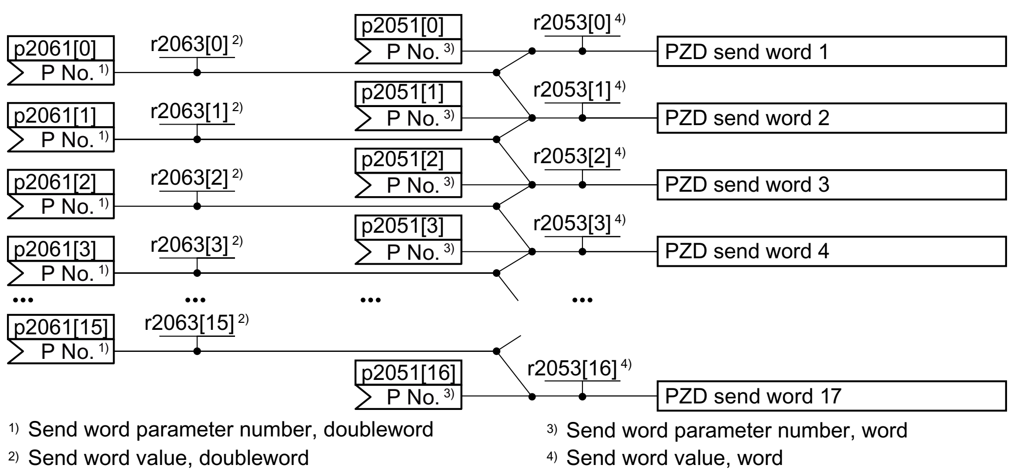


Figure 8-14 Interconnection of the send data

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.

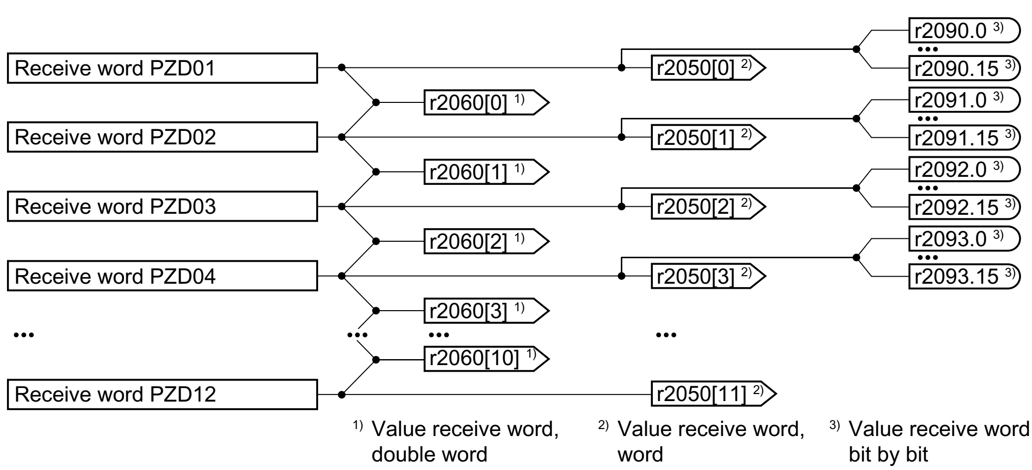


Figure 8-15 Interconnection of the receive data

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.
❒

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.
❒

Parameter

Number	Name	Factory setting
p0922	PROFIdrive PZD telegram selection	1
r2050[0...11]	CO: PROFIdrive PZD receive word	-
p2051[0...16]	CI: PROFIdrive PZD send word	0 or dependent on the converter
r2053[0...16]	PROFIdrive diagnostics send PZD word	-
r2060[0...10]	CO: PROFIdrive PZD receive double word	-
p2061[0...15]	CI: PROFIdrive PZD send double word	0
r2063[0...15]	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[0...15]	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
r2090.0...15	BO: PROFIdrive receive PZD1 bit by bit	-
r2091.0...15	BO: PROFIdrive PZD2 receive bit-serial	-
r2092.0...15	BO: PROFIdrive PZD3 receive bit-serial	-
r2093.0...15	BO: PROFIdrive PZD4 receive bit-serial	-

8.5.9 Slave-to-slave communication

Overview

"Direct data exchange" is sometimes called "slave-to-slave communication" or "data exchange broadcast". With direct data exchange, slaves 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 361)

8.5.10 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

See also

Overview of the manuals (Page 361)

Example

Application example, "Read and write to parameters"

Further information is provided on the Internet:

Application examples (https://support.industry.siemens.com/cs/ww/en/view/29157692)

Further information

Further information about acyclic communication is provided in the Fieldbus function manual.

Overview of the manuals (Page 361)

8.6 Jogging

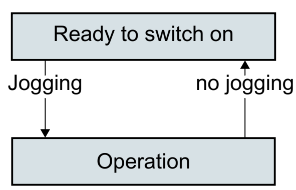
Overview

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.

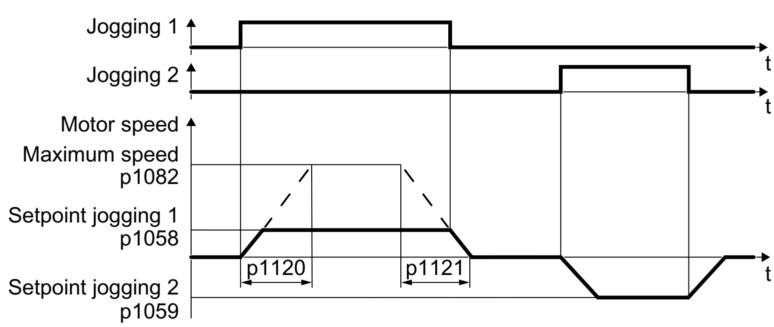


Figure 8-16 Behavior of the motor when "jogging"

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

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

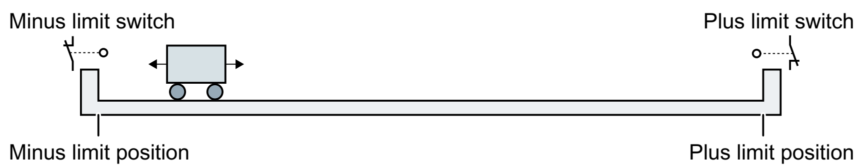
Parameter

Table 8-16 Jog settings

Parameter	Description	Factory setting
p1055[C]	BI: Jogging bit 0	0
p1056[C]	BI: Jogging bit 1	0
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	0
p1111[C]	BI: Inhibit positive direction	0
p1113[C]	BI: Setpoint inversion	0
p1120[D]	Ramp-function generator ramp-up time	10 s
p1121[D]	Ramp-function generator ramp-down time	10 s

8.7 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 one end position, the converter prevents the motor from moving the machine components further in the direction of this end position.

Function description

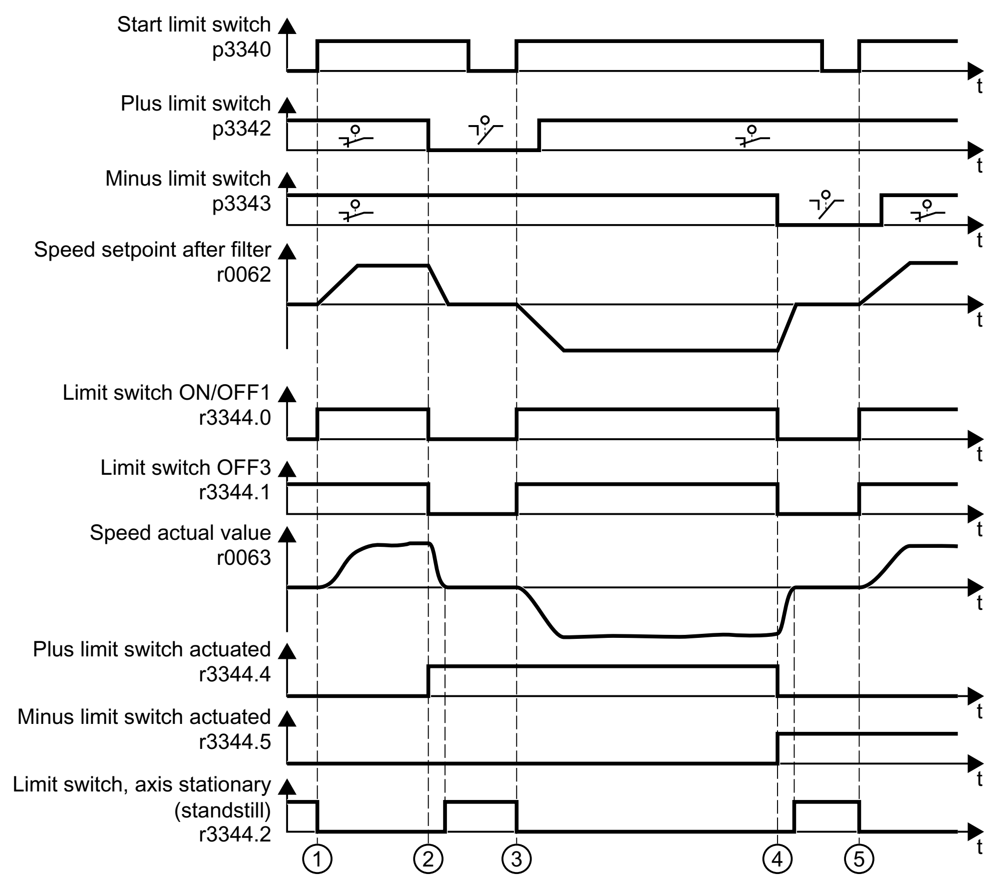


Figure 8-17 End position control of the converter

Table 8-17 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 → 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 → 1 at p3340, the motor moves the machine component in the direction of "Limit switch plus".

Example

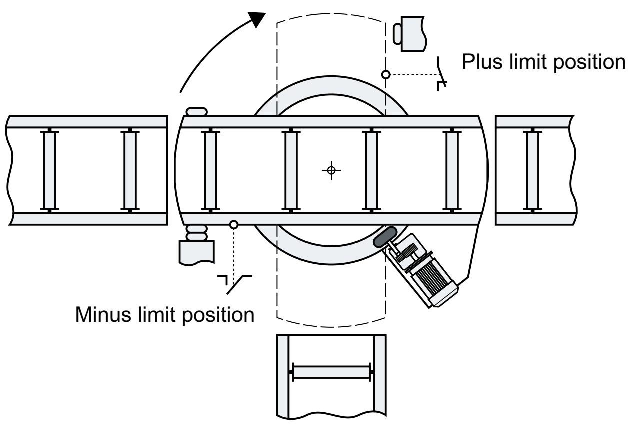


Figure 8-18 Roller conveyor with rotary table

A rotary table in a roller conveyor directs the material at the crossing of two conveyor lines. The rotary table rotates through 90 ° from one end position to the other. 2 limit switches signal the respective end position.

The signal to start the rotary table comes from the higher-level control system.

A fixed setpoint in the converter supplies the speed setpoint.

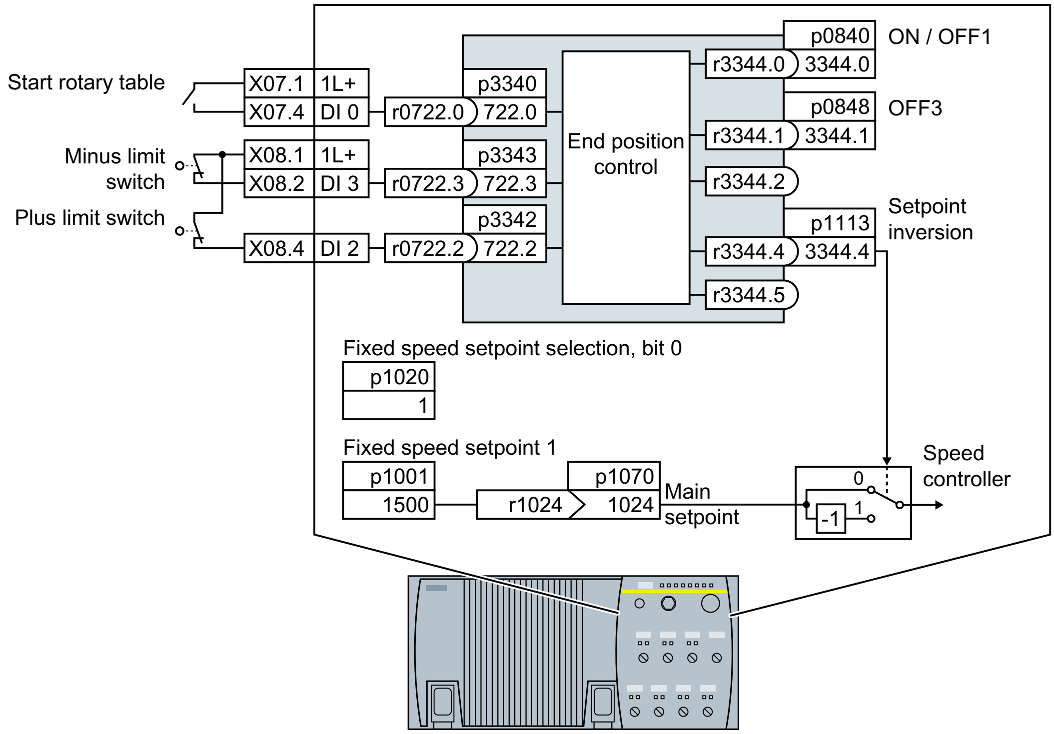


Figure 8-19 Interconnecting signals of the end position control

Procedure

1. Interconnect inputs of the end position control to digital inputs of your choice:
   – p3340 = 722.0
   – p3342 = 722.2
   – p3343 = 722.3
2. Interconnect the ON / OFF1 command. If the motor is to stop with a shorter braking time than OFF1 when the end position is reached, then interconnect both the OFF1 command as well as the OFF3 command.
   – p0840 = r3344.0
   – p0848 = r3344.1
3. When required, interconnect parameter value r3344.4, with a digital output of the converter, for example.
   r3344.4 signals to the higher-level control system that the converter is waiting for signal "Start rotary table" to change 0 → 1.
4. To switch over the sign of the speed setpoint, use parameter r3344.4:
   p1113 = r3344.4
5. Interconnect fixed speed setpoint p1001 = 1500 rpm with the main setpoint:
   – p1020 = 1
   – p1001 = 1500
   – p1070 = 1024

6. Move the rotary table to one of the two end positions or open one of the limit switches manually.
7. Specify a speed setpoint.
8. Briefly start the rotary table.
9. If the rotary table has not traversed in the direction of the opposite end position, invert the speed setpoint in the converter.
10. Set the mechanical position of the limit switch and the OFF3 ramp-down time so that the rotary table stops in good time at each end position.

You have adapted the end position control to the application.
❒

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	-

8.8 Switching over the drive control (command data set)

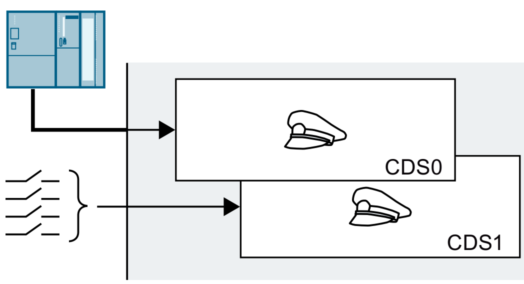
Overview

Several applications require the option of switching over the master control to operate the converter.

Example: The motor is to be operable either from a central control via the fieldbus or via the local digital inputs of the converter.

Function description

Command data set (CDS)



This means that you can set the converter control in various ways and toggle between the settings. For instance, as described above, the converter can either be operated via a fieldbus or via its digital inputs.

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 parameter p0810. To do this, you must interconnect parameter p0810 with a control command of your choice, e.g. a digital input.

Changing the number of command data sets

1. Set p0010 = 15.
2. The number of command data sets is configured with p0170.
3. Set p0010 = 0.

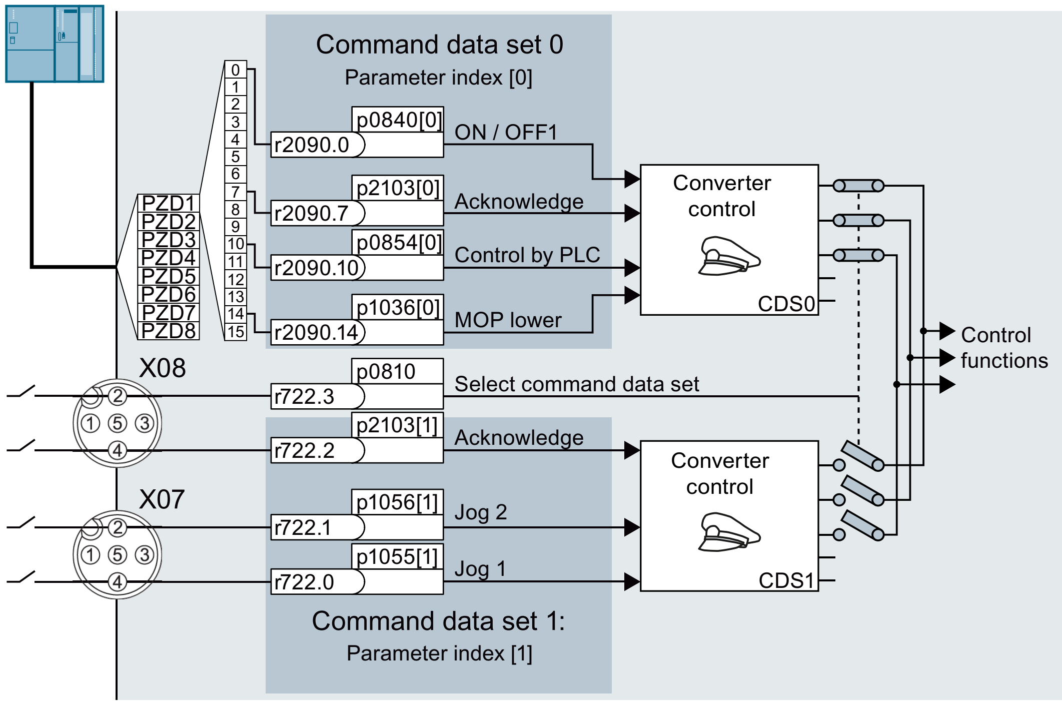
You have changed the number of command data sets.
❒

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.
❒

Example



As in the example above, you obtain the interconnection if you configured the interfaces of the converter with p0015 = 7 in the basic commissioning.

Connections and cables (Page 46)

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

Note

The converter requires approx. 4 ms to switch over the command data set.

Parameter

Parameter	Description	Factory settings
p0010	Drive commissioning parameter filter	1
r0050	CO/BO: Command data set CDS effective	-
p0170	Number of command data sets (CDS)	2
r0722	CO/BO: CU digital inputs, status	-
p0809[0 ... 2]	Copy command data set CDS	0
p0810	BI: Command data set selection CDS bit 0	0
p0811	BI: Command data set selection CDS bit 1	0
p0840[C]	BI: ON/OFF (OFF1)	Dependent on the converter

Parameter	Description	Factory settings
p0854[C]	BI: Master control by PLC/no control by PLC	Dependent on the converter
p1036[C]	BI: Motorized potentiometer setpoint lower	0
p1055[C]	BI: Jogging bit 0	0
r2090[0 ... 15]	BO: PROFIdrive receive PZD1 bit by bit	-
p2103[C]	BI: 1. Acknowledge faults	Dependent on the converter

8.9 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

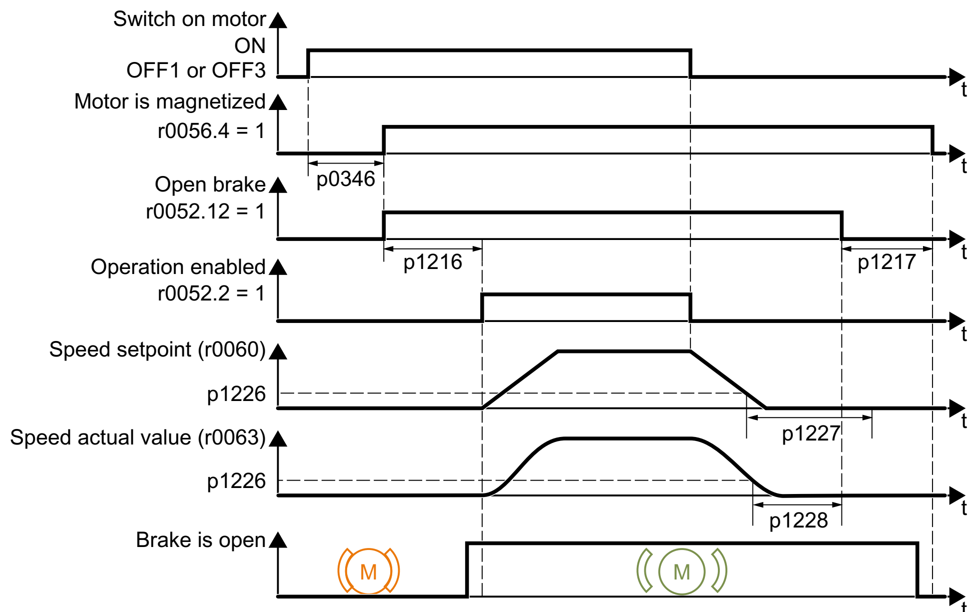


Figure 8-20 Motor holding brake function

Procedure

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.

The "Motor holding brake" function has been commissioned.
❒

After the OFF2 command

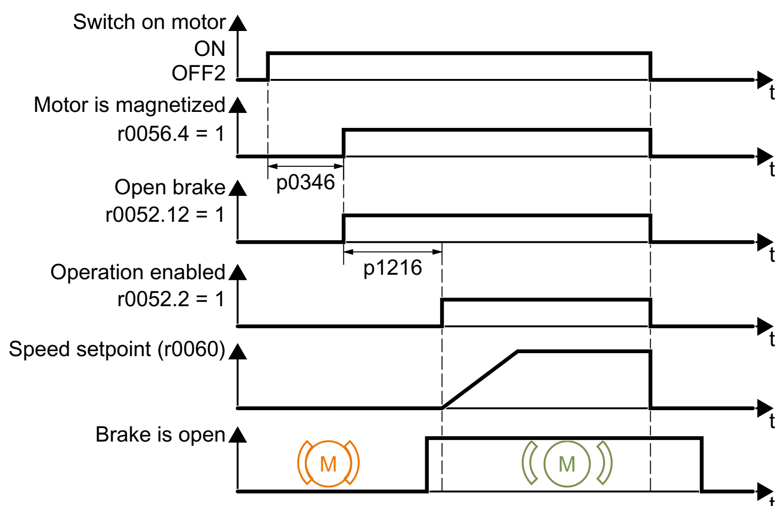


Figure 8-21 Controlling the motor holding brake after OFF2

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

1. 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 ≥ mechanical opening time of the motor holding brake
   - p1217 > mechanical closing time of the motor holding brake
5. Switch on the motor.

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 8-18 Setting the control logic of the motor holding brake

Parameter	Description	Factory setting
r0052.0...15	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 8-19 Advanced settings

Parameter	Description	Factory setting
p0346[M]	Motor excitation build-up time	0 s
p0855[C]	BI: Unconditionally open holding brake	0

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

8.10 Free function blocks

8.10.1 Overview

Overview

The free function blocks permit configurable signal processing in the converter.

Function description

The following free function blocks are available:

Table 8-20 Free function blocks

Logic blocks	AND 0 AND 1 AND 2 AND 3	OR 0 OR 1 OR 2 OR 3	XOR 0 XOR 1 XOR 2 XOR 3	NOT 0 NOT 1 NOT 2 NOT 3 NOT 4 NOT 5			
Calculation blocks	Adder	Subtractor	Multiplier	Divider	Comparator	Absolute value	Polyline
	ADD 0 ADD 1 ADD 2	SUB 0 SUB 1	MUL 0 MUL 1	DIV 0 DIV 1	NCM 0 NCM 1	AVA 0 AVA 1	PLI 0 PLI 1
Timer blocks	Pulse generator	Pulse shortening	ON delay	OFF delay	Pulse stretching		
	MFP 0 MFP 1 MFP 2 MFP 3	PCL 0 PCL 1	PDE 0 PDE 1 PDE 2 PDE 3	PDF 0 PDF 1 PDF 2 PDF 3	PST 0 PST 1		
Memory block	RS flip-flop	D flip-flop					
	RSR 0 RSR 1 RSR 2	DFR 0 DFR 1 DFR 2					
Breaker block	Analog switch	Binary switch					
	NSW 0 NSW 1	BSW 0 BSW 1					
Control block	Limiter	Smoothing	Integrator	Differentiator			
	LVM 0 LVM 1	PT1 0 PT1 1	INT 0	DIF 0			

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.

8.10.2 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)

8.11 Selecting physical units

8.11.1 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.

Table 8-21 Parameters involved when selecting the motor standard

Parameter	Designation	Motor standard IEC/NEMA, p0100 =		
		0[1)] IEC motor 50 Hz, SI units	1 NEMA motor 60 Hz, US units	2 NEMA motor 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^2	lb ft^2	kgm^2
p0344	Motor weight	kg	Lb	kg
r0394	Rated motor power	kW	hp	kW
r1493	Total moment of inertia, scaled	kgm^2	lb ft^2	kgm^2

1) Factory setting

It is only possible to change the motor standard during quick commissioning.

8.11.2 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 → fixed speed = 80 % corresponds to the speed = 1200 rpm
- Reference speed = 3000 rpm → 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.

Table 8-22 Unit group (p0100)

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 ft²	kg m²
27_1	kg	lb	kg
28_1	Nm/A	lbf ft/A	Nm/A

Table 8-23 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	A	%	A	%	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	K	K	° F	° F	-
39_1	1/s²	%	1/s²	%	p2007

See also

Overview of the manuals (Page 361)

8.11.3 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], [m³/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.

See also

Overview of the manuals (Page 361)

8.11.4 Setting the system of units and technology unit

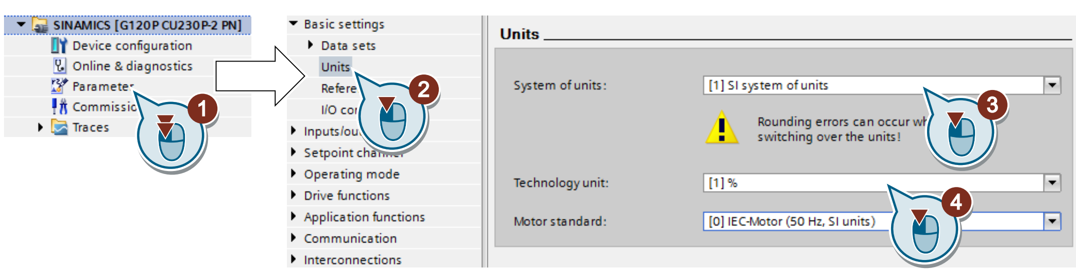
Setting using Startdrive

Requirement

You are offline with Startdrive.

Procedure

1. In the project, select "Parameter".
2. Select "Units".



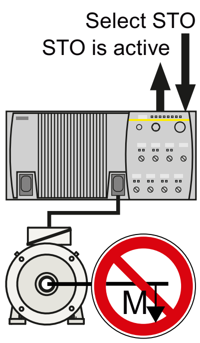
3. Select the system of units.
4. Select the technological unit of the technology controller.
5. Save your settings.
6. Go online.
   The converter signals that offline, other units and process variables are set than in the converter itself.
7. Accept these settings in the converter.

You have selected the motor standard and system of units.
❒

8.12 Safe Torque Off (STO) safety function

8.12.1 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 8-24 Principle of operation of STO

	Safe Torque Off (STO)	Standard converter functions linked with STO
1.	The converter recognizes the selection of STO via a safety-relevant input or via the PROFIsafe safe communication.	---
2.	The converter interrupts the energy supply to the motor.	If you use a motor holding brake, the converter closes the brake.
3.	The converter signals that "STO is active" via a safety-relevant output or via the PROFIsafe safe communication.	---

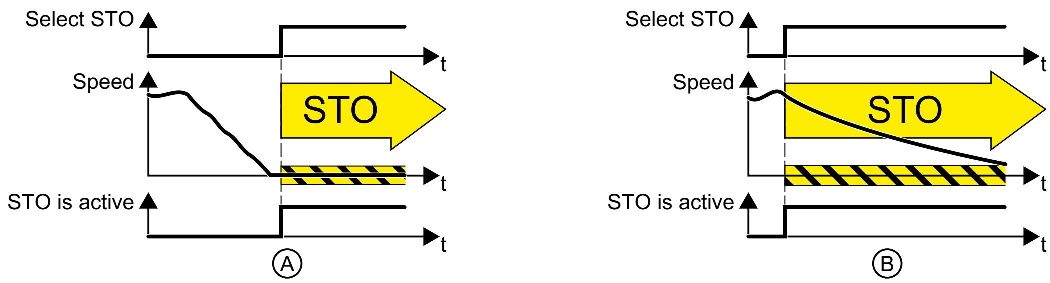


Figure 8-22 STO when the motor is at standstill (A), and rotating (B)

(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)".

⇒ 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 run-on 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.	• Connect the EMERGENCY STOP pushbutton with a failsafe converter digital input. • Select STO via the failsafe digital input.
A central EMERGENCY STOP button must prevent the unintentional acceleration of several motors that are at a standstill.	• Evaluate the EMERGENCY STOP button in a central control. • Select STO via PROFIsafe.

Further information

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 361)

8.12.2 EMERGENCY SWITCHING OFF and EMERGENCY STOP

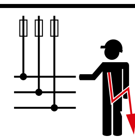
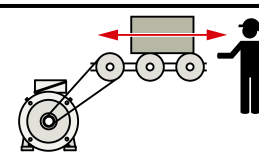
Overview

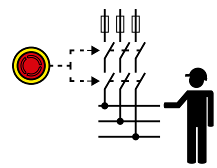
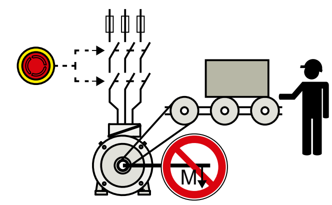
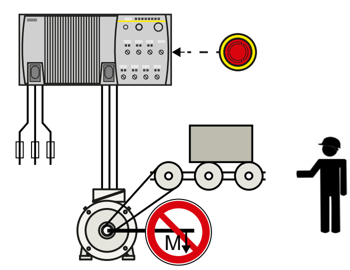
In plants, systems and machines a distinction must be made between "EMERGENCY OFF" and "EMERGENCY STOP". The STO safety function is only suitable for implementing an "EMERGENCY STOP".

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 risk:	**Switch off the power supply** Either completely or partially switch off hazardous voltages	**Prevent movement** Prevent any hazardous movement

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 safety function integrated in the drive:	STO is not suitable for switching off a voltage.	Select STO:  It is permissible that you also switch off the converter supply voltage. However, switching off the voltage is not required as a risk reduction measure.

8.12.3 Commissioning STO

8.12.3.1 Commissioning tools

Overview

We recommend that you commission the safety functions using the Startdrive PC tool.

Commissioning tools (Page 76)

8.12.3.2 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 363)

8.12.3.3 Configuring a safety function

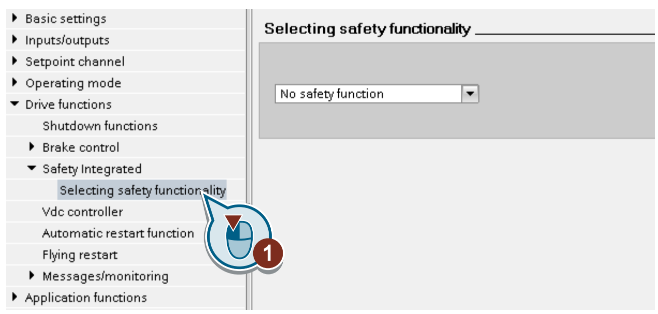
Overview

You must enable the STO safety function and define how STO is selected.

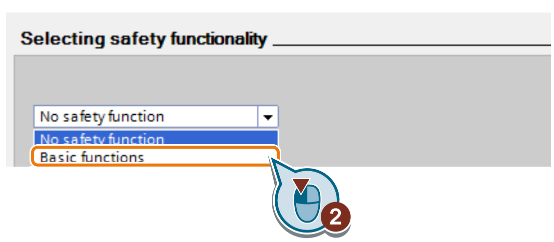
Function description

Procedure

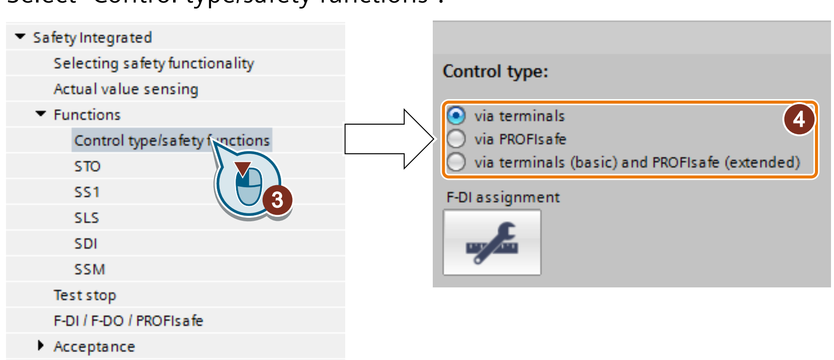
1. Select "Select safety functionality".



2. Select "Basic Functions".



3. Select "Control type/safety functions".



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 361)

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

8.12.3.4 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.

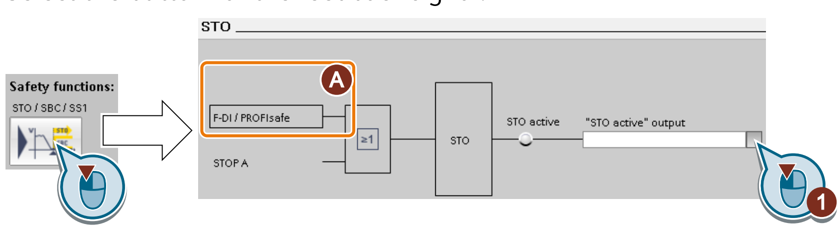
Requirement

You are online with Startdrive.

Function description

Procedure

1. Select the button for the feedback signal.



The screen form varies depending on the interface selected.

(A) Control type

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[0...31]	CO/BO: SI status (processor 1 + processor 2)		-
	.01	1 signal: STO is active in the drive	

8.12.3.5 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.

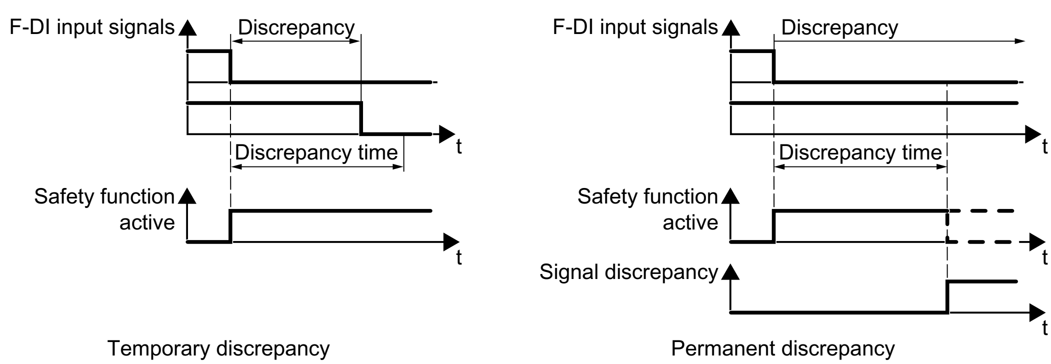


Figure 8-23 Discrepancy time

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.

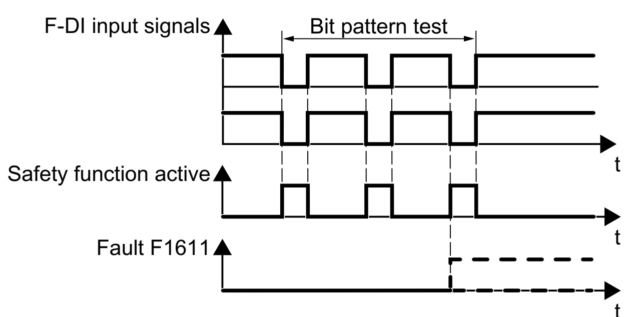


Figure 8-24 Converter response to a bit pattern test

You must set the debounce time to ignore temporary signal changes.

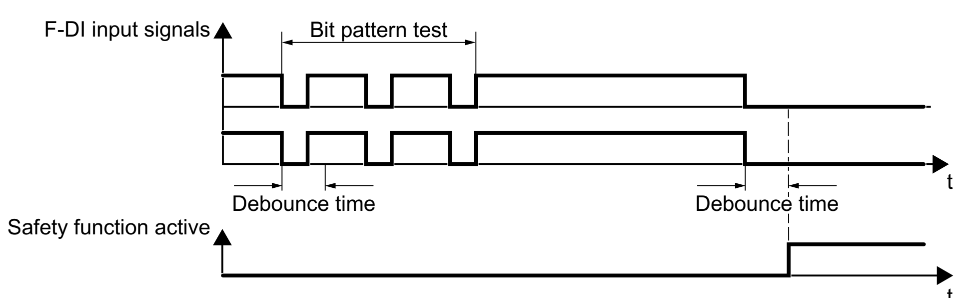


Figure 8-25 Filter to suppress brief signals

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.

8.12.3.6 Setting the signal filter for STO selection

Overview

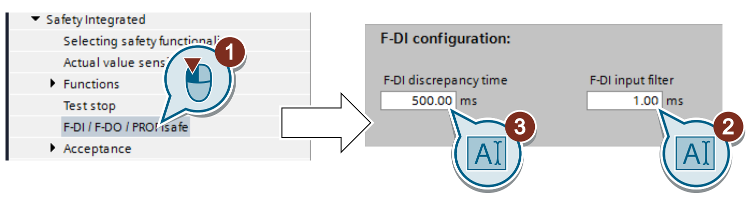
If required, you must set the signal filter for selecting the STO safety function.

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.
❒

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

8.12.3.7 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.

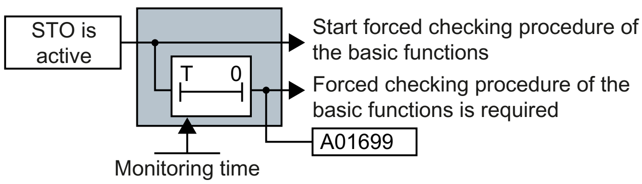


Figure 8-26 Starting and monitoring the forced checking procedure (test stop)

8.12.3.8 Setting forced checking procedure

Overview

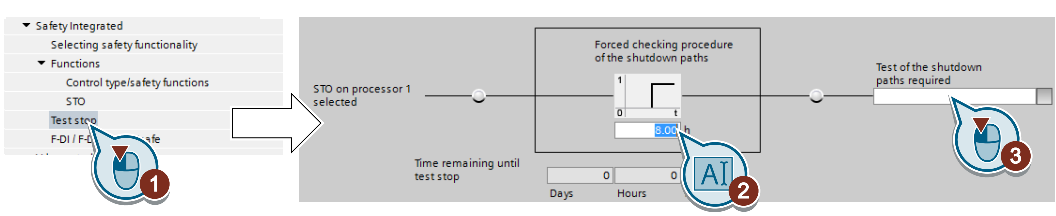
You must set the time interval in which, as a minimum, you must start the forced checking procedure at least once.

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
r9773.0...31	CO/BO: SI status (processor 1 + processor 2)	-

8.12.3.9 Complete commissioning

Overview

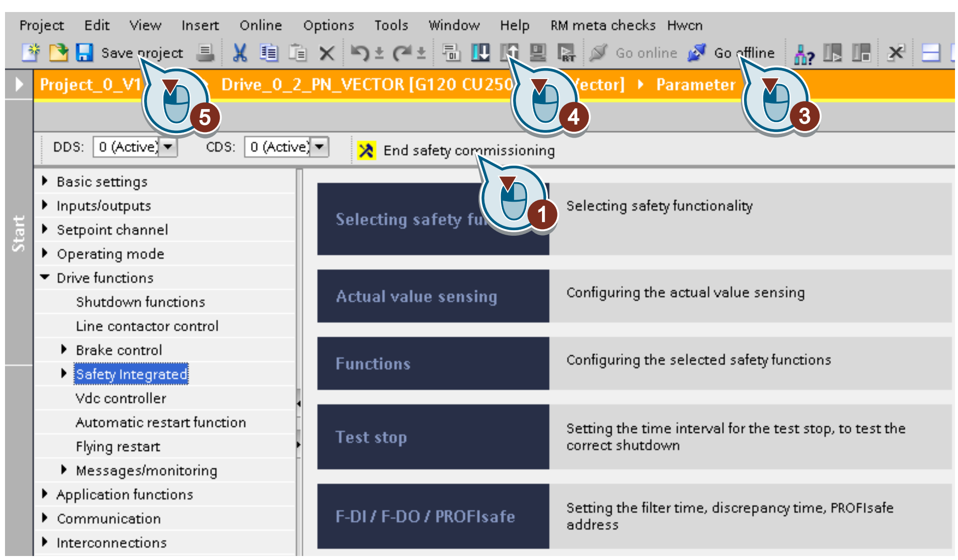
You must exit commissioning the safety functions and save the settings.

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

8.12.3.10 Checking the assignment of the digital inputs

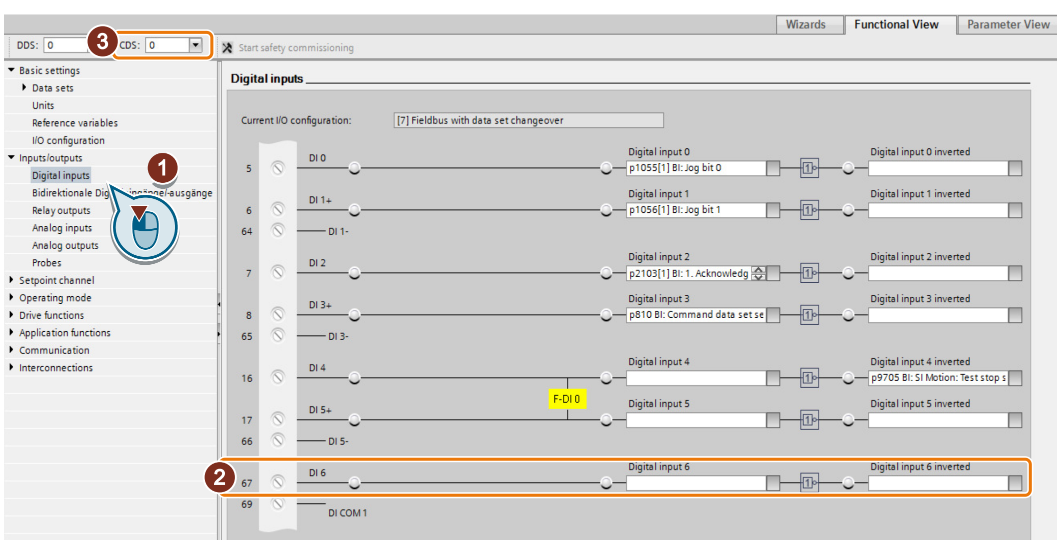
Overview

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



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.
❒

8.12.3.11 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 (https://support.industry.siemens.com/cs/ww/en/view/109752254)

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 machine (additional drive).	Yes. Only check the safety functions of the new drive.	• Supplement machine overview • Supplement converter data • Add function table • Log the new checksums • Countersignature
Transfer of converter settings to other identical machines by means of series commissioning.	No. Only check the control of all of the safety functions.	• Add machine description • Check checksums • Checking the firmware versions

8.13 Setpoints

8.13.1 Overview

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

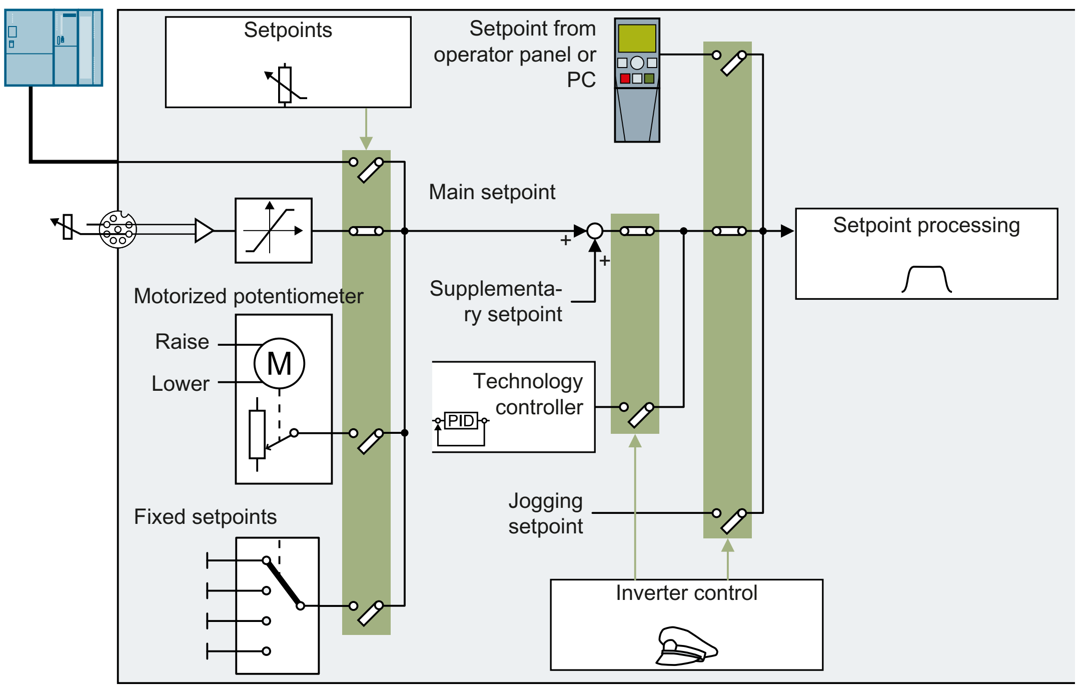


Figure 8-27 Setpoint sources for the converter

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

- Converter analog input.
- Converter fieldbus interface.
- Motorized potentiometer simulated 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.

8.13.2 Analog input as setpoint source

Function description

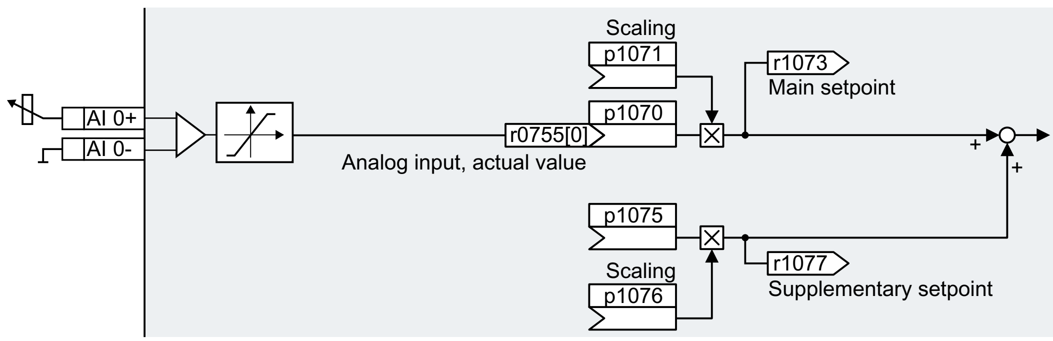


Figure 8-28 Example: Analog input 0 as setpoint source

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

8.13.3 Specifying the setpoint via the fieldbus

Function description

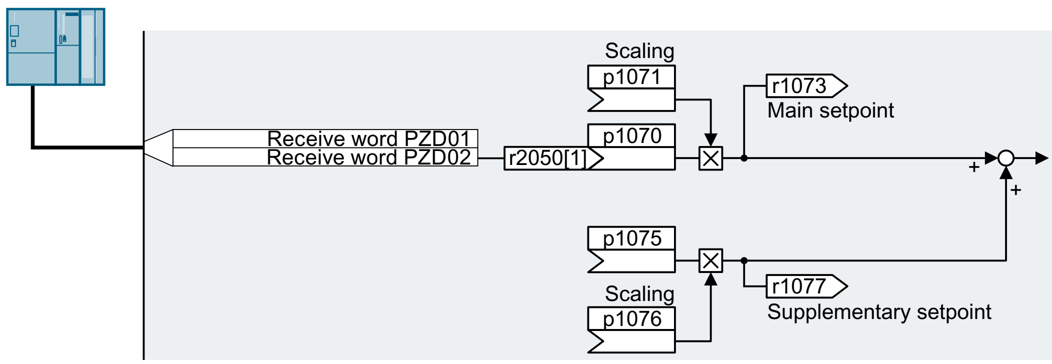


Figure 8-29 Fieldbus as setpoint source

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-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[0...11]	CO: PROFIdrive PZD receive word	-

8.13.4 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.

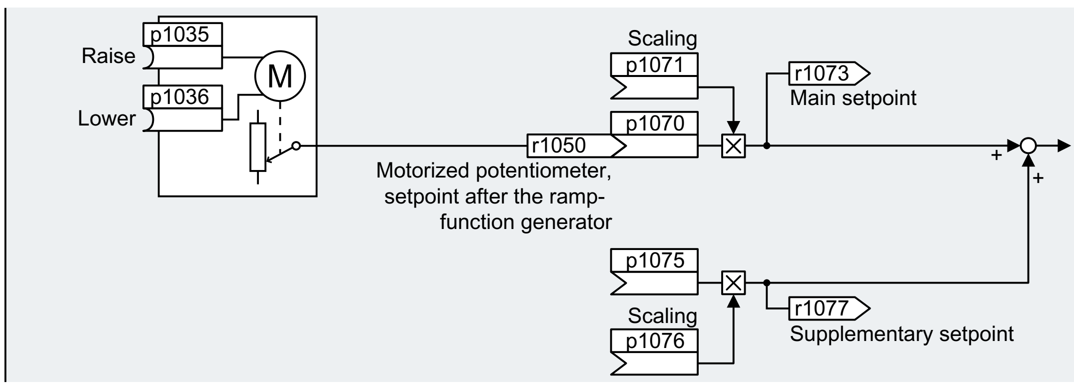


Figure 8-30 Motorized potentiometer as setpoint source

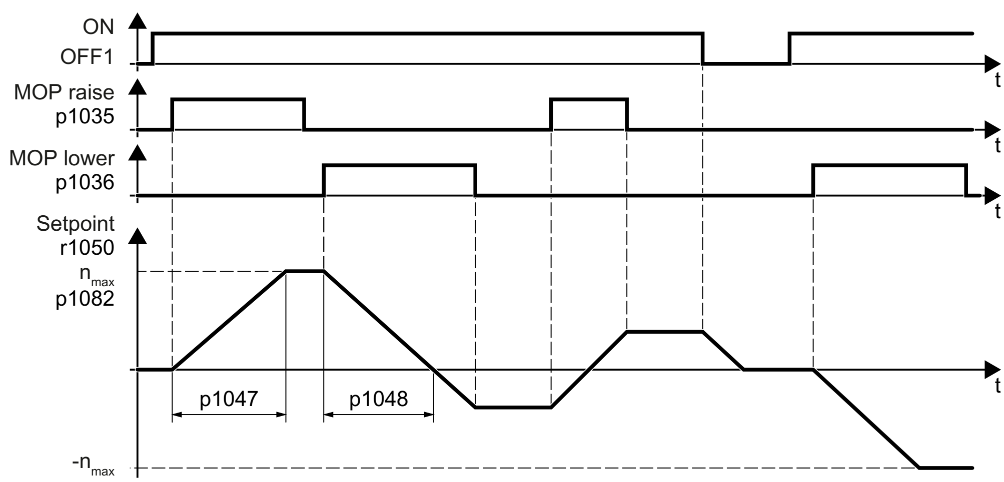


Figure 8-31 Function chart of the motorized potentiometer

Example

Setting with the motorized potentiometer as setpoint source:

Parameter	Description
p1070 = 1050	Interconnects the main setpoint with the motorized potentiometer output.

Parameter

Table 8-25 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 8-26 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

8.13.5 Fixed speed setpoint as setpoint source

Function description

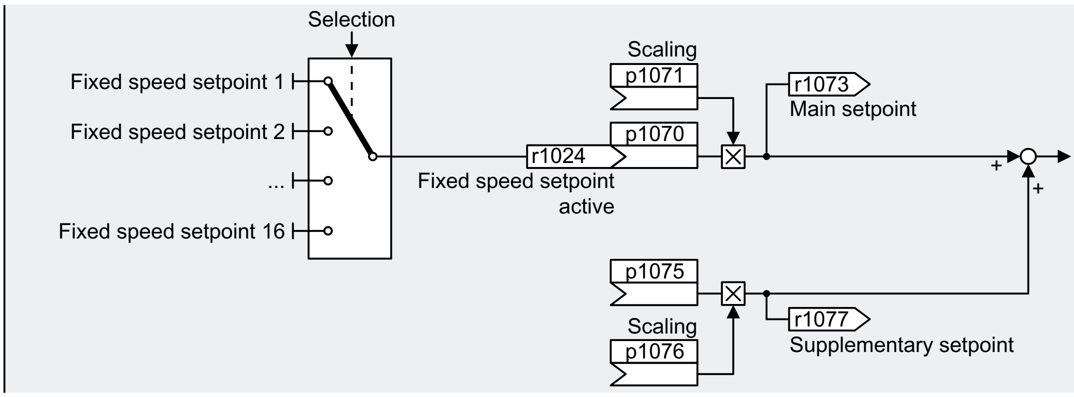


Figure 8-32 Fixed speed setpoint as setpoint source

The converter makes a distinction between two methods when selecting the fixed speed setpoints:

Directly selecting a fixed speed setpoint

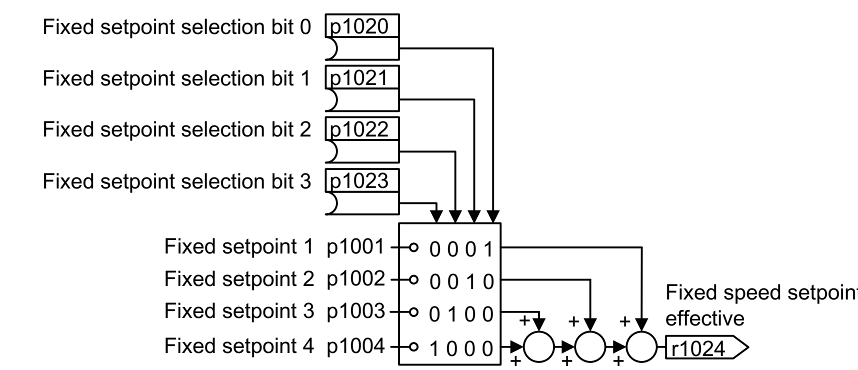


Figure 8-33 Direct selection of the fixed speed setpoint

Table 8-27 Resulting 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	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

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

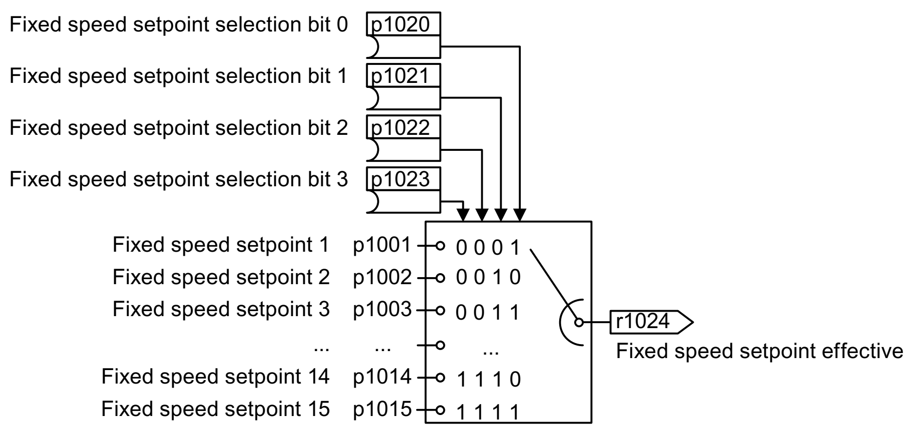


Figure 8-34 Binary selection of the fixed speed setpoint

Table 8-28 Resulting 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

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.

Table 8-29 Settings for the application example

Parameter	Description
p1001[0] = 300.000	Fixed speed setpoint 1
p1002[0] = 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 digital input 0 (DI 0).
p1021[0] = 722.1	Fixed speed setpoint selection bit 1: Interconnects fixed speed setpoint 2 with digital input 1 (DI 1).
p1016 = 1	Fixed speed setpoint mode: Directly selects fixed speed setpoints.

Table 8-30 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

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 8-31 Settings 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	**Fixed speed setpoint selection bit 0:** Interconnects fixed speed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnects fixed speed setpoint 2 with digital input 1 (DI 1).
p1016 = 1	**Fixed speed setpoint mode:** Directly selects fixed speed setpoints.

Table 8-32 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
p0840[C]	BI: ON/OFF (OFF1)	[0] 2090.0 [1] 0 [2] 0 [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

8.14 Setpoint processing

8.14.1 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.

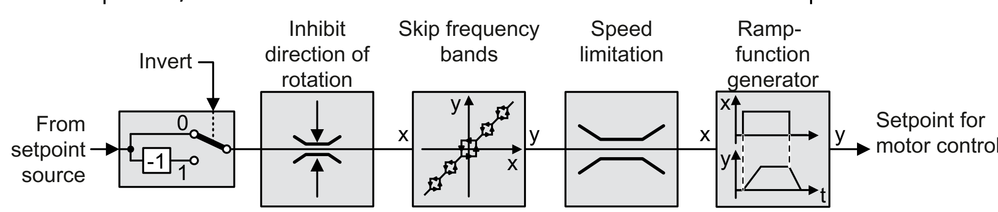
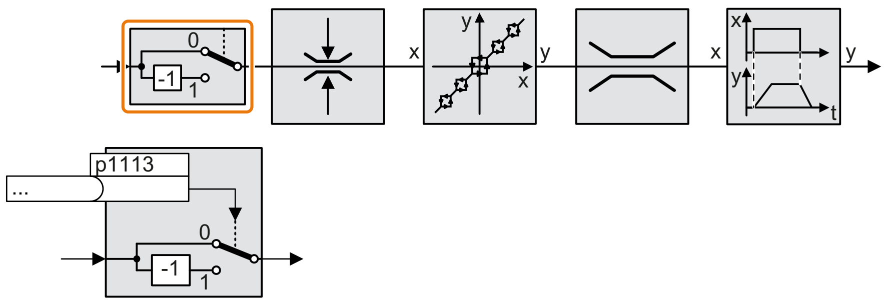


Figure 8-35 Setpoint processing in the converter

8.14.2 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 8-33 Application examples showing how a setpoint is inverted

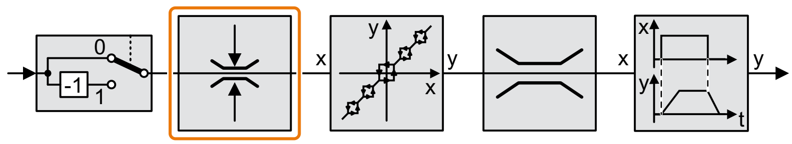
Parameter	Description
p1113 = 722.1	Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Converter inverts the setpoint.
p1113 = 2090.11	Inverts the setpoint via the fieldbus (control word 1, bit 11).

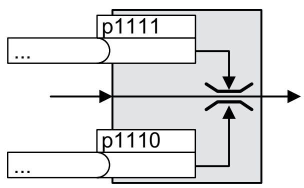
Parameter

Number	Name	Factory setting
p1113[C]	BI: Setpoint inversion	Dependent on the converter

8.14.3 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 8-34 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

8.14.4 Skip frequency bands and minimum speed

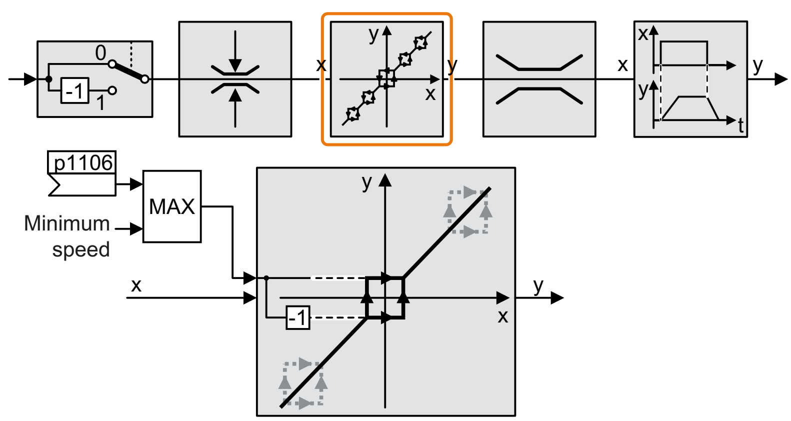
Overview

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.

Parameter

Table 8-35 Minimum speed

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

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	-
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

NOTICE

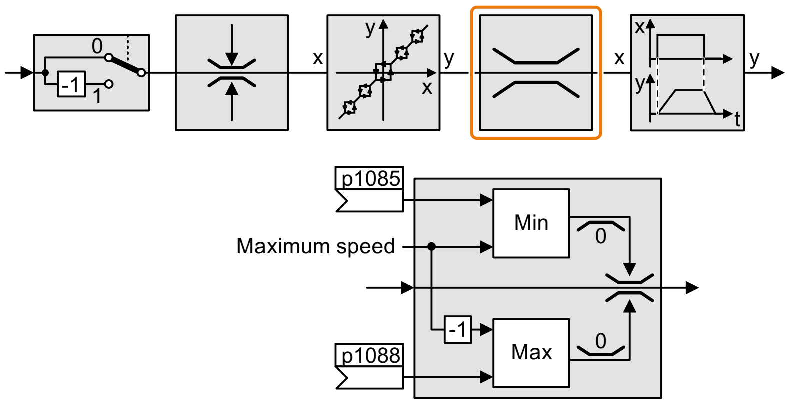
Incorrect direction of motor rotation if the parameterization is not suitable

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.

8.14.5 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 8-36 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

8.14.6 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.

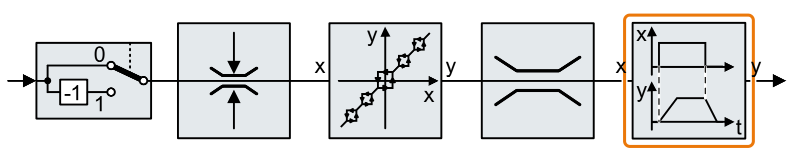
You can select between two different ramp-function generator types:

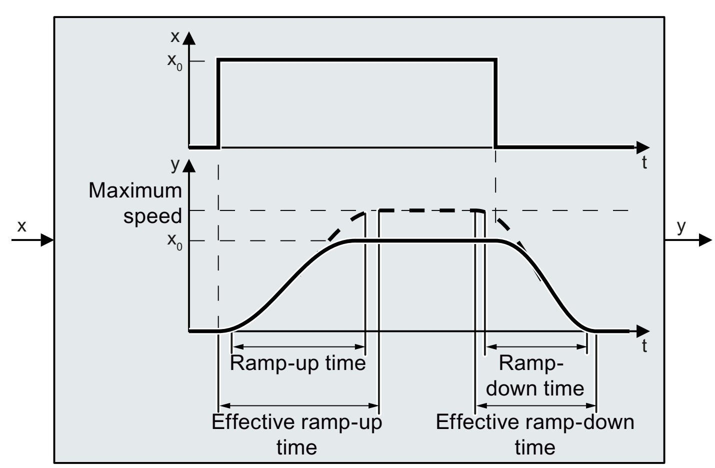
- Extended ramp-function generator
  The expanded ramp-function generator limits not only the acceleration but also the change in acceleration (jerk) by rounding the setpoint. In this case, the torque does not rise suddenly in the motor.
- Basic ramp-function generator
  The basic ramp-function generator limits the acceleration, however not the rate the acceleration changes (jerk).

If you use a 1FK7 encoderless synchronous motor, we recommend using an extended ramp-function generator with an initial rounding of at least 0.1 s.

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.





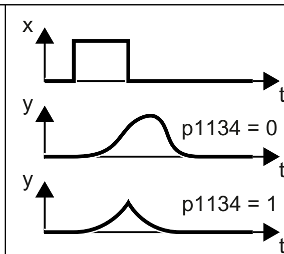
Initial and final rounding permit smooth, jerk-free acceleration and braking.

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 8-37 Additional parameters to set the extended ramp-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 rounding type 0: Continuous smoothing 1: Discontinuous smoothing 	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

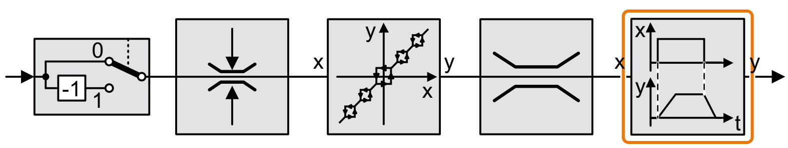
Procedure

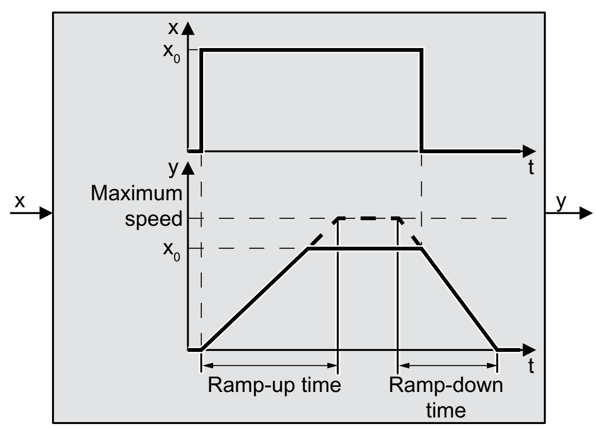
1. Enter the highest possible speed setpoint.
2. Switch on the motor.
3. Evaluate your drive response.
   – If the motor accelerates too slowly, then reduce the ramp-up time.
   An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily 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.

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.

Parameter

Table 8-38 Parameters for setting the ramp-function generator

Parameter	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 153)
- The control sends the scaling value to the converter in PZD 3.

Procedure

1. 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.

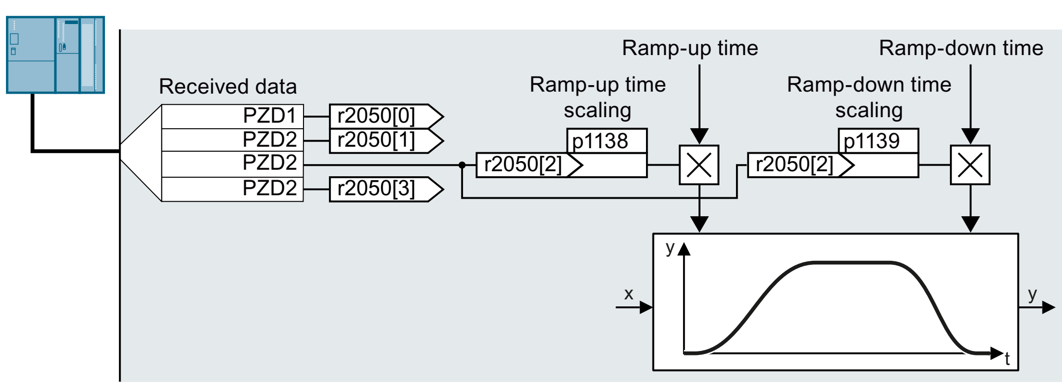


Figure 8-36 Application example for changing the ramp-function generator times in operation

Parameter

Table 8-39 Parameters for setting the scaling

Parameter	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	-

8.15 PID technology controller

Overview

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

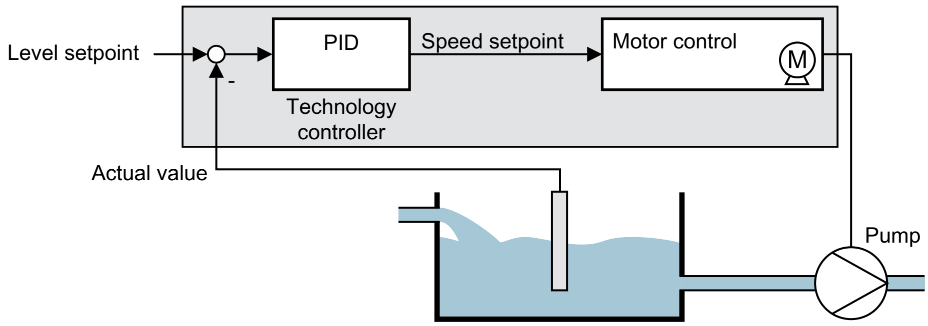


Figure 8-37 Example: Technology controller as a level controller

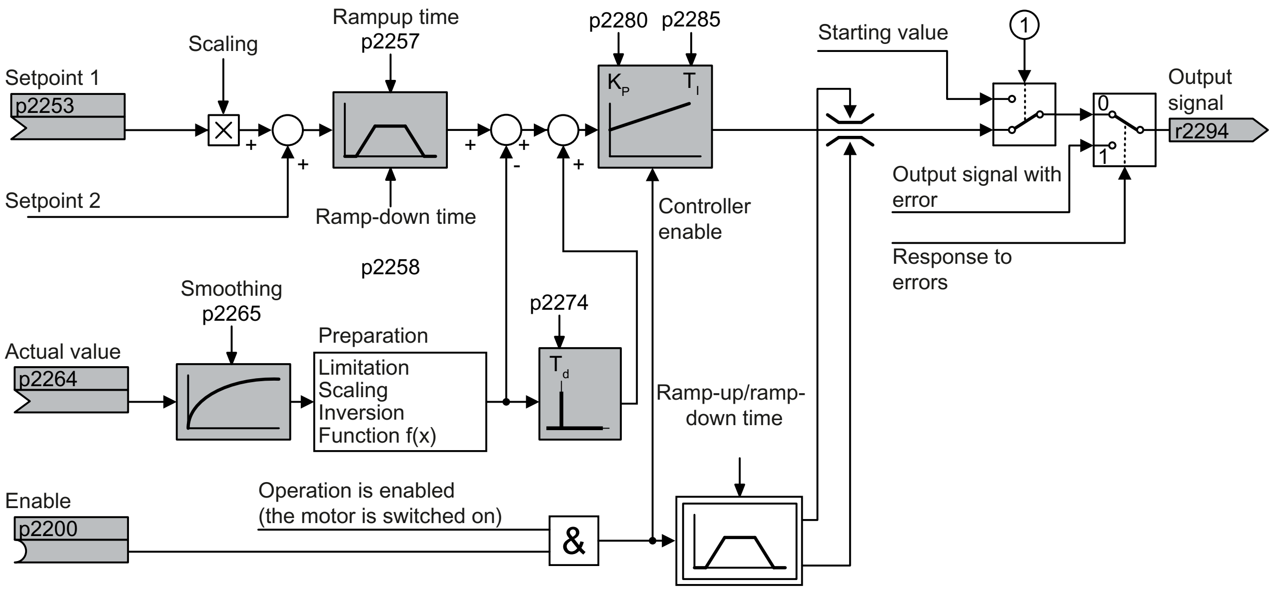
Requirement

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

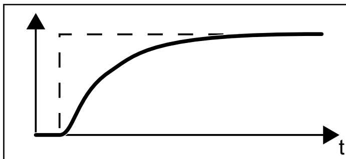
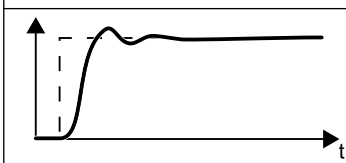
The settings required as a minimum are marked in gray in the function diagram:

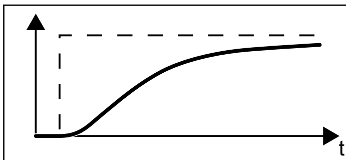
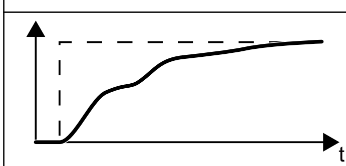
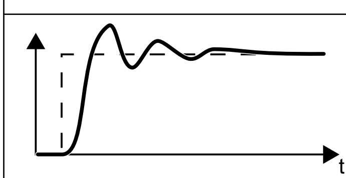
- Interconnect setpoint and actual values with signals of your choice
- Set ramp-function generator and controller parameters K_P, T_I and T_d.

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.

	Optimum controller response for applications that do not permit any overshoot. The actual value approaches the setpoint without any significant overshoot.
	Optimum controller behavior for fast correction and quick compensation of disturbance components. The actual value approaches the setpoint and slightly overshoots, maximum 10 % of the setpoint step.

	The actual value only slowly approaches the setpoint. • Increase the proportional component K_P (p2280) and reduce the integration time T_I (p2285).
	The actual value only slowly approaches the setpoint with slight oscillation. • Increase the proportional component K_P (p2280) and reduce the rate time T_d (p2274)
	The actual value quickly approaches the setpoint, but overshoots too much. • Decrease the proportional component K_P (p2280) and increase the integration time T_I (p2285).

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.
❒

Limiting the output of the technology controller

In the factory setting, the output of the technology controller is limited to ± maximum speed. You must change this limit, depending on your particular application.
Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.

Parameter

Table 8-40 Basic settings

Number	Name	Factory setting
r0046[0...31]	CO/BO: Missing enable signals	-
r0052[0...15]	CO/BO: Status word 1	-
r0056[0...15]	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 generator	- %
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[0...13]	CO/BO: Technology controller status word	-
r3889[0...10]	CO/BO: ESM status word	-

Table 8-41 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 8-42 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 8-43 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 8-44 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 8-45 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)

8.16 Motor control

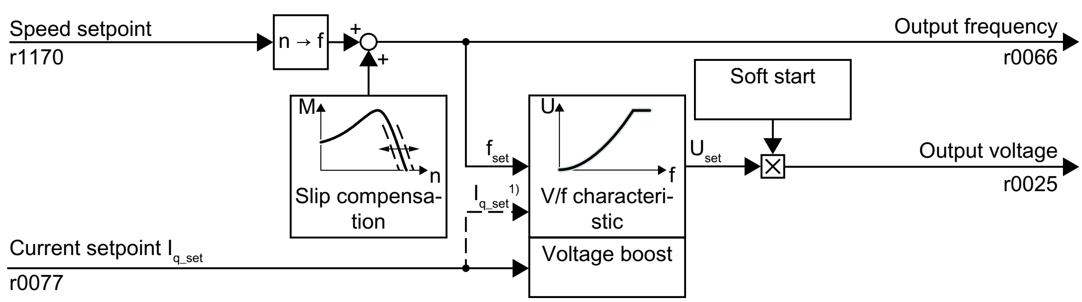
Overview

The converter has two alternative methods to ensure the motor speed follows the configured speed setpoint:

- U/f control
- Vector control

8.16.1 U/f control

Overview



1) In the "Flux Current Control (FCC)" U/f version, the converter controls the motor current (starting current) at low speeds.

Figure 8-39 Simplified function diagram of the U/f control

The U/f control is a speed feedforward control with the following properties:

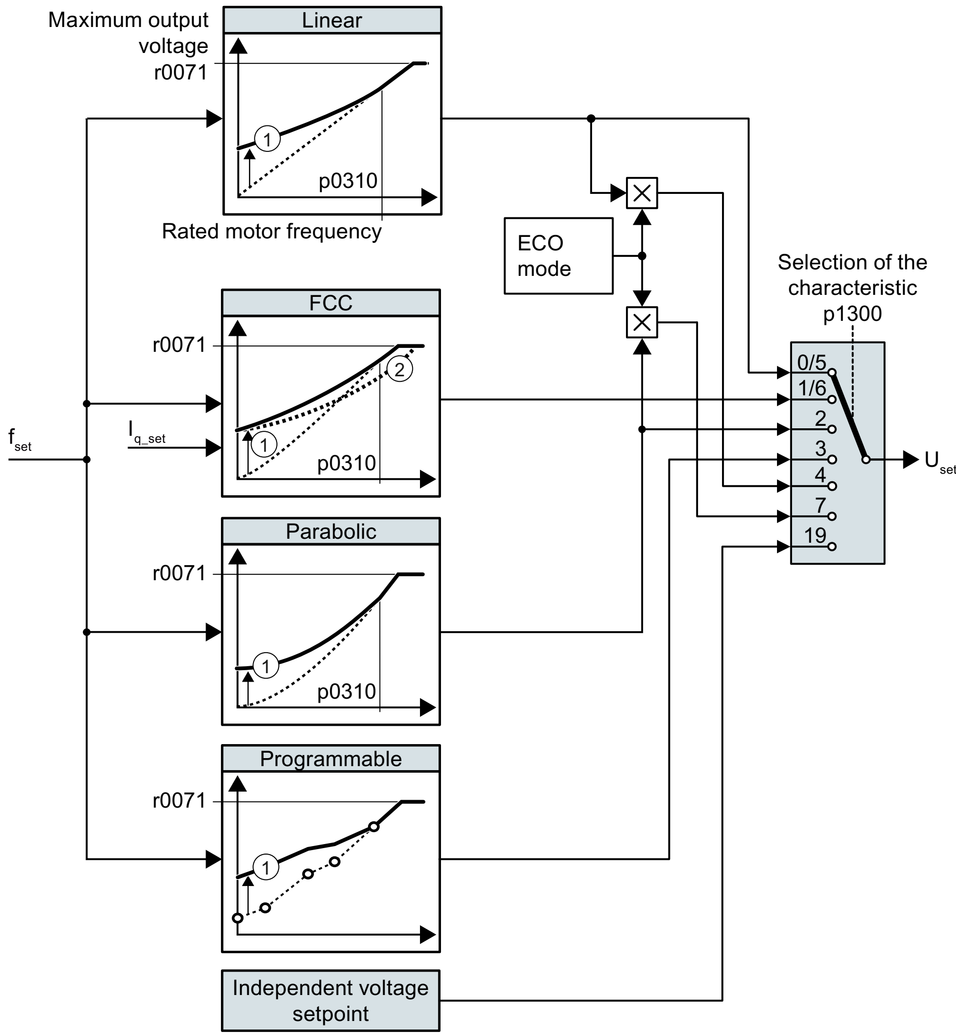
- The converter sets the output voltage on the basis of the U/f characteristic.
- The output frequency is essentially calculated from the speed setpoint and the number of pole pairs of the motor.
- The slip compensation corrects the output frequency depending on the load and thus increases the speed 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 8-40 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.

Performance ratings Power Module (Page 331)

Table 8-46 The characteristic that matches the application

Requirement	**Application examples**	**Remark**	**Characteristic**	**Parameter**
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The converter compensates for the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after quick commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and converter than for a linear characteristic.	Parabolic	p1300 = 2

Table 8-47 Characteristics for special applications

Requirement	**Application examples**	**Remark**	**Characteristic**	**Parameter**
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	If the speed setpoint is reached and remains unchanged for 5 seconds, then the converter reduces its output voltage. As a consequence, the ECO mode saves energy with respect to the parabolic characteristic.	ECO mode	p1300 = 4 or p1300 = 7
The converter must maintain the motor speed constant for the longest possible time.	Drives in the textile sector	When reaching the maximum current limit, the converter only reduces the output voltage, but not the frequency.	Precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	-	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the converter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

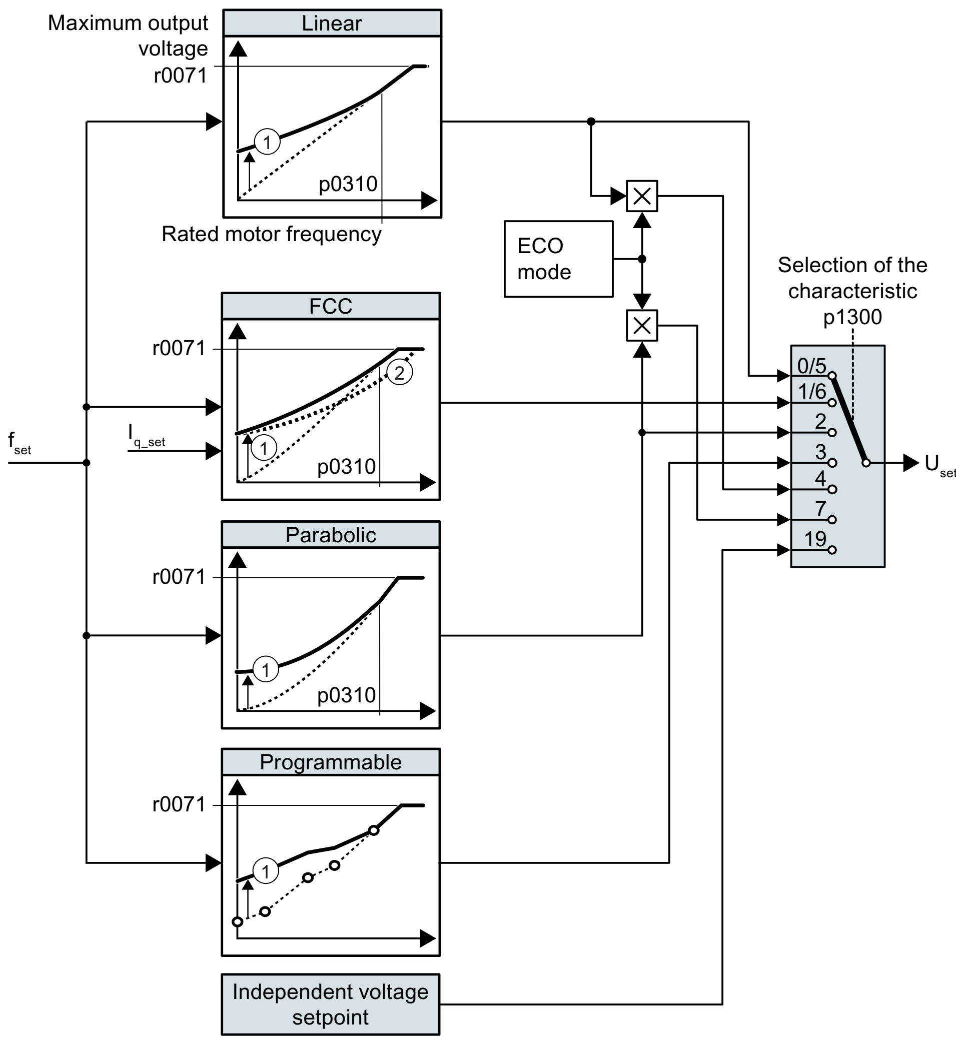
Parameter

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

8.16.1.1 Characteristics of U/f control

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 8-41 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 329)

Table 8-48 The characteristic that matches the application

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The converter compensates for the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after quick commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and converter than for a linear characteristic.	Parabolic	p1300 = 2

Table 8-49 Characteristics for special applications

Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	If the speed setpoint is reached and remains unchanged for 5 seconds, then the converter reduces its output voltage. As a consequence, the ECO mode saves energy with respect to the parabolic characteristic.	ECO mode	p1300 = 4 or p1300 = 7
The converter must maintain the motor speed constant for the longest possible time.	Drives in the textile sector	When reaching the maximum current limit, the converter only reduces the output voltage, but not the frequency.	Precise frequency characteristic	p1300 = 5 or p1300 = 6

Requirement	Application examples	Remark	Characteristic	Parameter
Freely adjustable U/f characteristic	-	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the converter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

8.16.1.2 Selecting the U/f characteristic

Parameter

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

8.16.1.3 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.

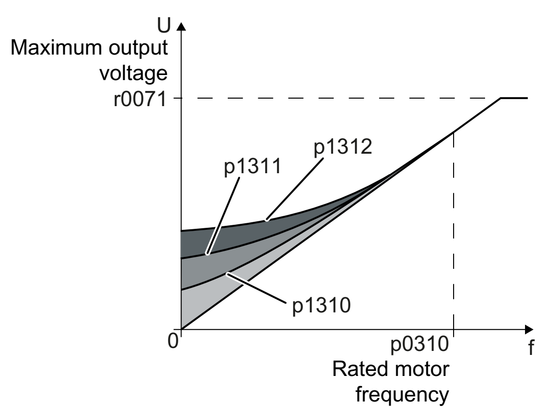


Figure 8-42 The resulting voltage boost using a linear characteristic as example

Increase parameter values p1310 ... p1312 in steps of ≤ 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.
❒

Parameter

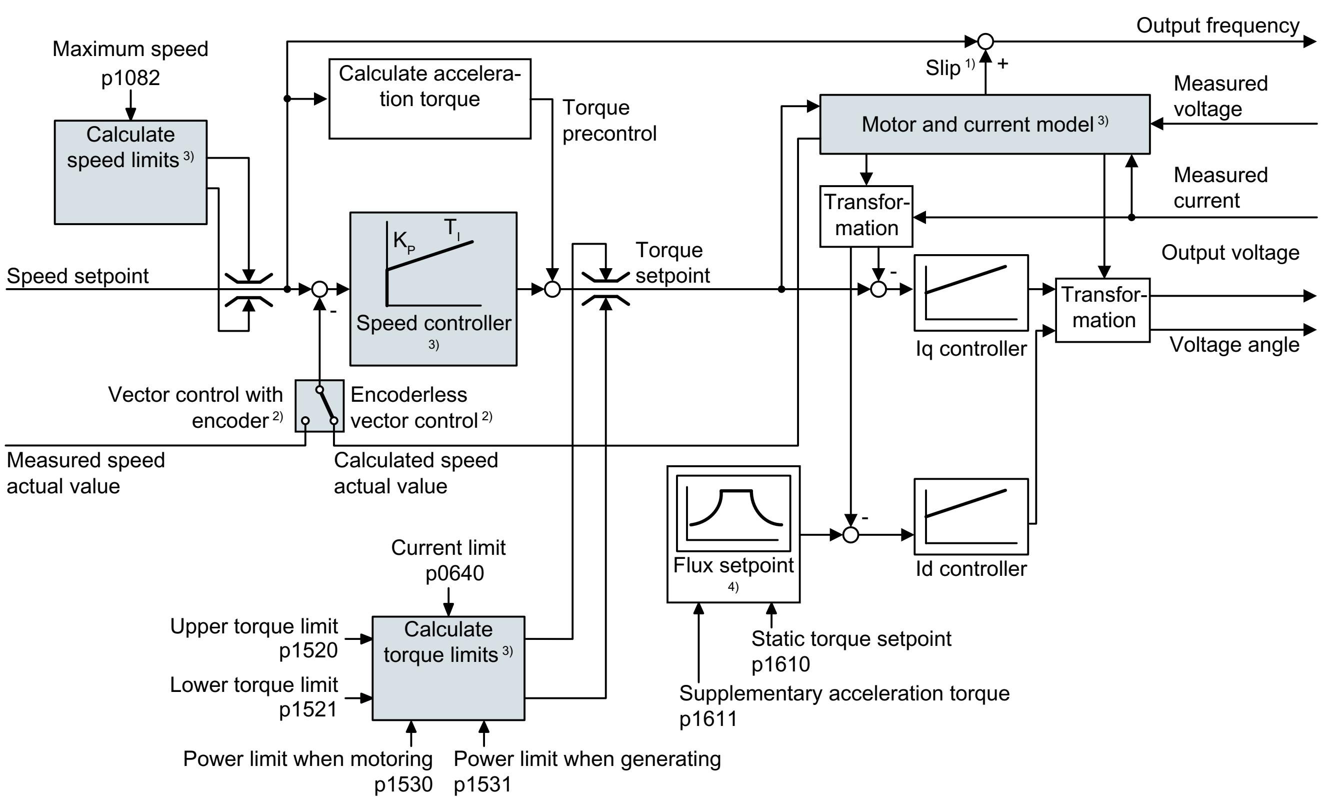
Number	Name	Factory setting
r0071	Output voltage, maximum	Vrms
p0310[M]	Rated motor frequency	0 Hz
p1310[D]	Starting current (voltage boost) permanent	50%
p1311[D]	Starting current (voltage boost) when accelerating	0%
p1312[D]	Starting current (voltage boost) when starting	0%

8.16.2 Vector control with speed controller

8.16.2.1 Structure of the vector control

Overview

The vector control comprises closed-loop current control and a higher-level closed-loop speed control.



1) for induction motors

2) Selecting the control mode

3) Settings that are required

Figure 8-43 Simplified function diagram for 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_q
- Current component I_q
- Speed actual value for encoderless vector control

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.

The complete function diagrams 6020 ff. for vector control are provided in the List Manual.

Settings that are required

Restart quick commissioning and select the vector control in quick commissioning.

Commissioning (Page 75)

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/Δ), 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.

Vector control with encoder

Instead of the calculated speed from the motor model, the vector control with encoder evaluates an encoder.

WARNING

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 166)
- For pulling loads, carefully comply with the recommended settings for vector control.
  Advanced settings (Page 236)

8.16.2.2 Checking the encoder signal

If you use an encoder to measure the speed, you should check the encoder signal before the encoder feedback is active.

Procedure

1. Set the control mode "encoderless vector control": p1300 = 20.
2. Switch-on the motor with an average speed.
3. Compare parameters r0061 (speed encoder signal in rpm) and r0021 (calculated speed in rpm) regarding the sign and absolute value.
4. If the signs do not match, invert the speed encoder signal: Set p0410 = 1.
5. If the absolute values of the two values do not match, check the setting of p0408 and the encoder wiring.

You have ensured that the scaling and polarity of the encoder signal are correct.
❒

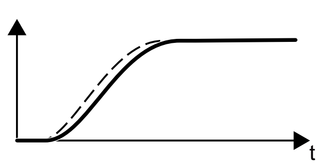
8.16.2.3 Optimizing the speed controller

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:

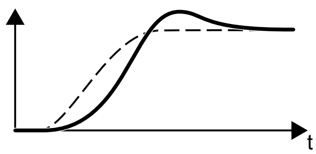


The speed setpoint (broken line) increases with the set ramp-up time and rounding.

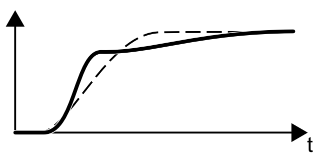
The speed actual value follows the setpoint without any overshoot.

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.

The most important parameters

Table 8-50 Encoderless speed control

Parameter	Description
p0342	**Moment of inertia ratio, total to motor** (factory setting: 1.0)
p1496	**Acceleration precontrol scaling** (factory setting: 0 %) For the rotating measurement of the motor data identification the converter sets the parameters to 100 %.
p1452	**Speed controller speed actual value smoothing time (without encoder)** (factory setting: 10 ms)
p1470	**Speed controller operation without encoder P gain** (factory setting: 0.3)
p1472	**Speed controller operation without encoder integral action time** (factory setting: 20 ms)

Table 8-51 Speed control with encoder

Parameter	Description
p0342	**Moment of inertia ratio, total to motor** (factory setting: 1.0)
p1496	**Acceleration precontrol scaling** (factory setting: 0 %) For the rotating measurement of the motor data identification the converter sets the parameters to 100 %.
p1441	**Speed controller smoothing time** (factory setting: 0 ms)
p1442	**Speed controller speed actual value smoothing time** (factory setting: 4 ms)
p1460	**Speed controller operation without encoder P gain** (factory setting: 0.3)
p1462	**Speed controller operation without encoder integral action time** (factory setting: 20 ms)

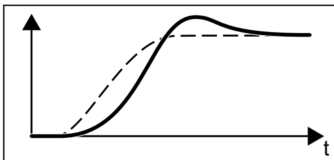
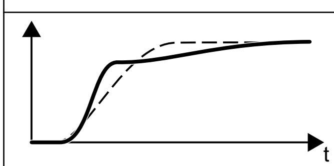
Optimizing the speed controller

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):

	Initially, the speed actual value follows the speed setpoint with some delay, and then overshoots the speed setpoint. • Increase p0342
	Initially, the speed actual value increases faster than the speed setpoint. The setpoint passes the actual value before reaching its final value. Finally, the actual value approaches the setpoint without any overshoot. • Reduce 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): $T_I \geq 4 \cdot$ p1452
- If, after these measures, the speed controller does not operate with an adequate dynamic performance, then increase p1470 (gain K_P) step-by-step.

Parameters

Table 8-52 Encoderless speed control

Number	Name	Factory setting
p0342[M]	Ratio between the total and motor moments of inertia	1
p1452	Speed controller actual speed value smoothing time (encoderless)	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%

8.16.2.4 Advanced settings

K_p- and T_n adaptation

The K_p- and T_n adaptation suppresses possible speed controller oscillations. During basic commissioning, the inverter optimizes the speed controller using the "rotating measurement" function. If you have performed the rotating measurement, then the K_p- and $T_n$adaptation has been set.

You can find additional information in the List Manual, function block diagram 6050.

Droop

The droop function reduces the speed setpoint as a function of the torque setpoint.

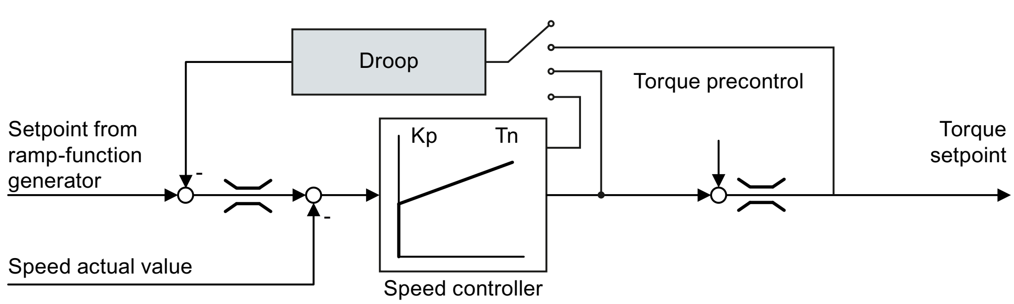


Figure 8-44 Effect of droop in the speed controller

The droop function ensures even torque distribution between two or more mechanically coupled drives. Load distribution using the droop function also masters soft mechanical couplings or a permanent speed difference as a result of slip.

Preconditions for using the droop function

- All coupled drives must be operated in vector control, with or without an encoder.
- Only a one common ramp-function generator may be used for mechanically coupled drives.

Par.	Explanation
r1482	**Speed controller I torque output**
p1488	**Droop input source** (factory setting: 0) 0: Droop feedback not connected 1: Droop from the torque setpoint 2: Droop from the speed control output 3: Droop from the integral output, speed controller
p1489	**Droop feedback scaling** (factory setting: 0,05) A value of 0.05 means: At the rated motor torque, the inverter reduces the speed by 5% of the rated motor speed.
r1490	**Droop feedback speed reduction**
p1492	**Droop feedback enable** (factory setting: 0)

You can find additional information in the List Manual, function block 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 ≤ 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 1100 bin

8.16.2.5 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.

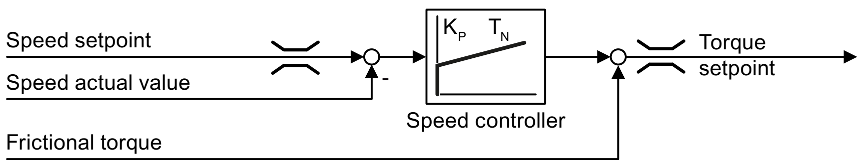


Figure 8-45 Precontrol of the speed controller with frictional torque

The converter calculates the current frictional torque from a friction characteristic with 10 intermediate points.

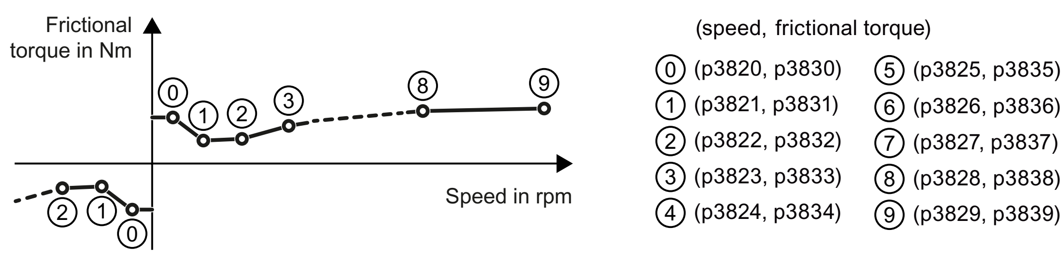


Figure 8-46 Friction characteristic

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).
3. 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.
❒

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
r3840.0...8	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.

8.16.2.6 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).

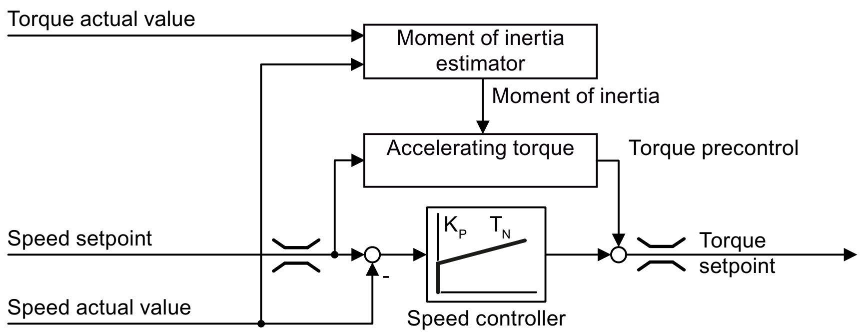


Figure 8-47 Influence of the moment of inertia estimator on the speed control

The more precise the value of the moment of inertia in the converter, the lower the overshoot after speed changes.

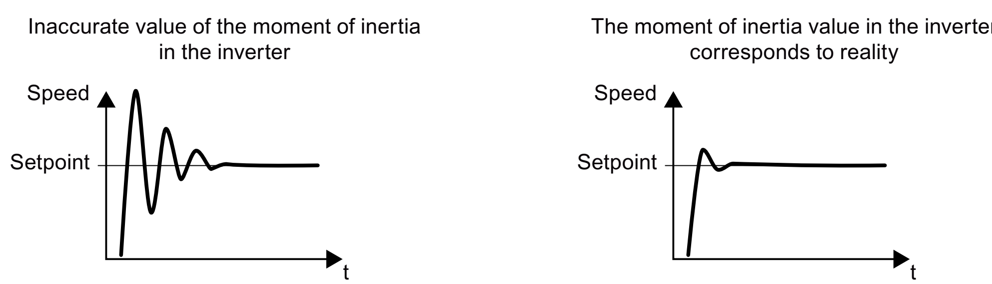


Figure 8-48 Influence of the moment of inertia on the speed

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

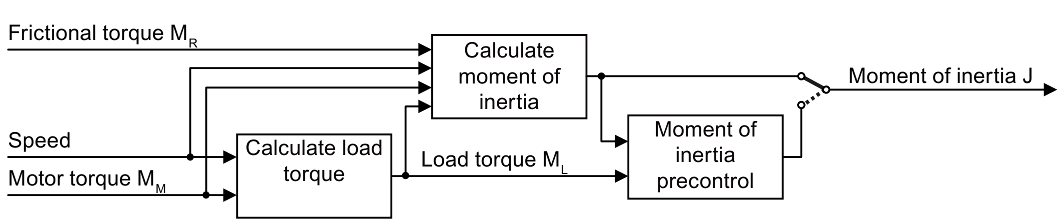


Figure 8-49 Overview of the function of the moment of inertia estimator

When using the moment of inertia estimator, we recommend that you also activate the friction characteristic.

Friction characteristic (Page 239)

How does the converter calculate the load torque?

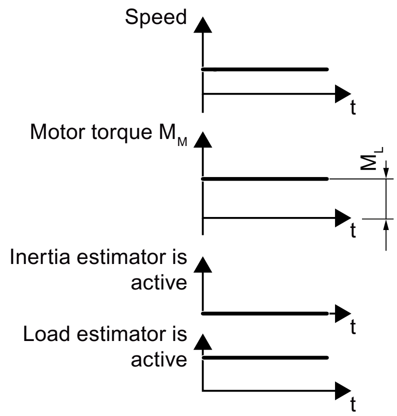


Figure 8-50 Calculating the load torque

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 ≥ p1226
- Acceleration setpoint < 8 1/s² (≙ speed change 480 rpm per s)
- Acceleration × moment of inertia (r1493) < 0.9 × p1560

How does the converter calculate the moment of inertia?

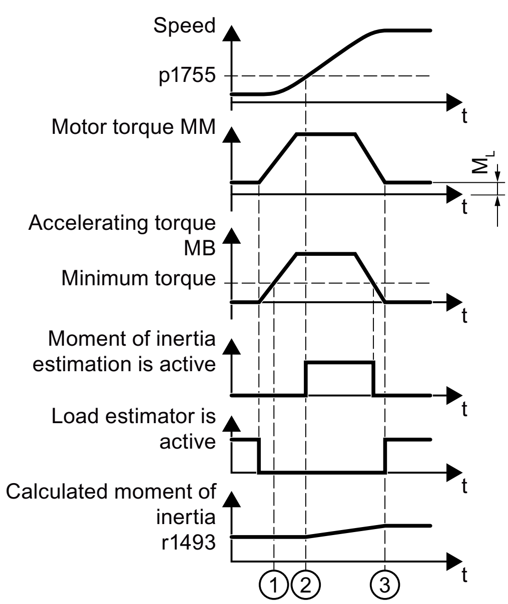


Figure 8-51 Calculating the moment of inertia

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:

$M_B = M_M - M_L - M_R$

Moment of inertia J of the motor and load is obtained from the accelerating torque M_B and angular acceleration α (α = 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 × rated motor torque (r0333)
- ② speed > p1755
- The converter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 $1/s^2$ (≙ 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.

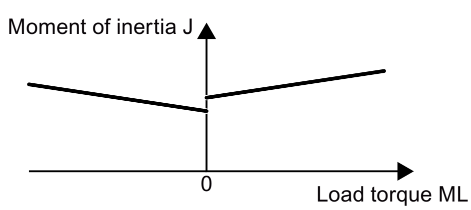


Figure 8-52 Moment of inertia precontrol

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 × load torque M_L + p5313
- In a negative direction of rotation:
  Moment of inertia J = p5314 × load torque M_L + 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 0000 1000 0000 0010 0001 bin
r1407.0...27	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

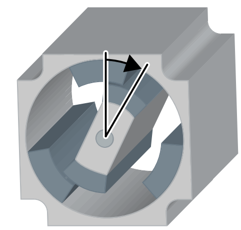
Parameter	Description	Factory setting
p1226[D]	Speed threshold for standstill detection	20 rpm
p1560[D]	Moment of inertia estimator accelerating torque threshold value	10%
p1561[D]	Moment of inertia estimator change time moment of inertia	500 ms
p1562[D]	Inertia estimator, change time, load	10 ms
p1563[D]	CO: Moment of inertia estimator load torque positive direction of rotation	0 Nm
p1564[D]	CO: Moment of inertia estimator load torque negative direction 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^2
p5313[D]	Moment of inertia precontrol constant positive	0 kgm^2
p5314[D]	Moment of inertia precontrol linear negative	0 s^2
p5315[D]	Moment of inertia precontrol constant negative	0 kgm2

8.16.2.7 Pole position identification

The pole position of a synchronous motor

The pole position of a synchronous motor is the deviation between the magnetic axis in the rotor and the magnetic axis in the stator.

The image below shows you the pole position of a synchronous motor in a simplified cross-section.



The converter must know the pole position of the rotor in the motor in order to be able to control the torque and speed of a synchronous motor.

Pole position identification

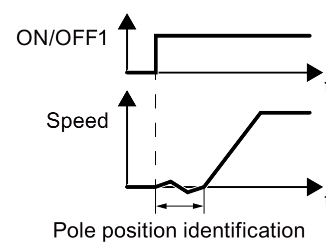
The converter must measure the pole position for motors not equipped with an encoder, or for encoders, which do not supply the information regarding the pole position.

If you are using a Siemens motor, then the converter automatically selects the appropriate technique to determine the pole position, and when required starts the pole position identification.

Motor without an encoder

Each time the motor is switched on (ON/OFF1 command), the converter measures the pole position.

As a result of the measurement, the motor responds to an ON command with a delay of up to 1 second. The motor shaft can rotate slightly during the measurement.



Identifying the pole position using a measurement

8.16.3 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.

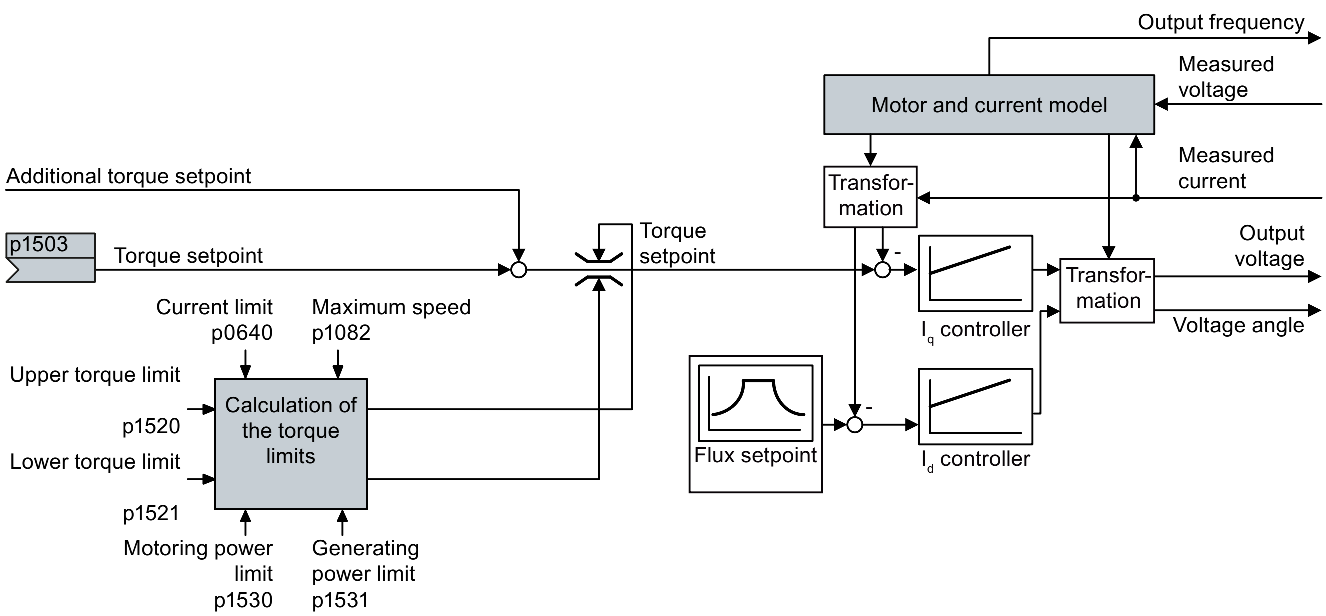


Figure 8-53 Simplified function diagram of the closed-loop torque control

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 slave drives:
  The master drive is speed controlled, the slave 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
  Quick commissioning with a PC. (Page 86)
- You have performed a motor data identification on the cold motor

Parameter

Parameter	Description	Factory setting
p0300 ... p0360	**Motor data** 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.

8.17 Electrically braking the motor

8.17.1 Electrical braking

Overview

Braking with the motor in generator operation

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.

8.17.2 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.

⚠ WARNING

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

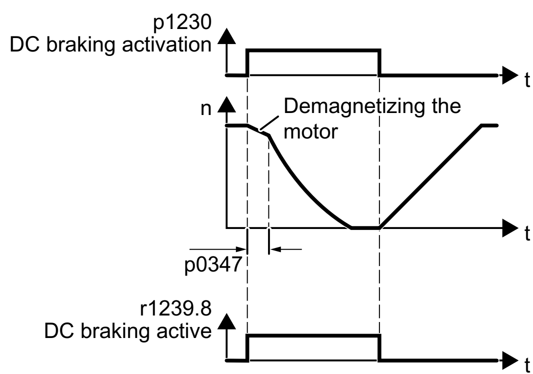


Figure 8-54 Activating DC braking via a control command

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

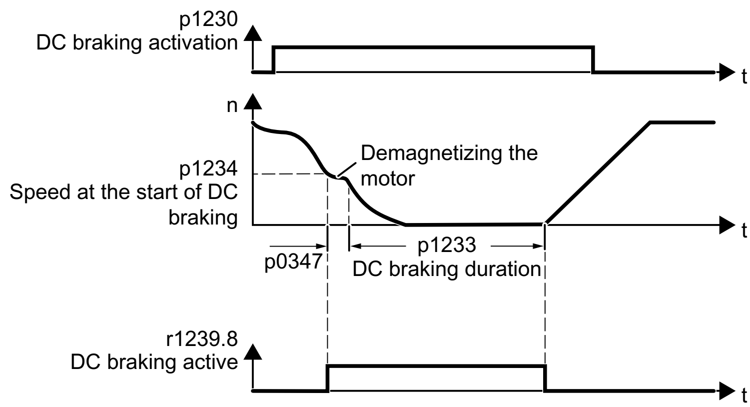


Figure 8-55 DC braking when falling below a starting speed

Set p1231 = 14 and p1230 = control command.

With an active DC braking command (p1230 = 1 signal), the following occurs:

1. 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

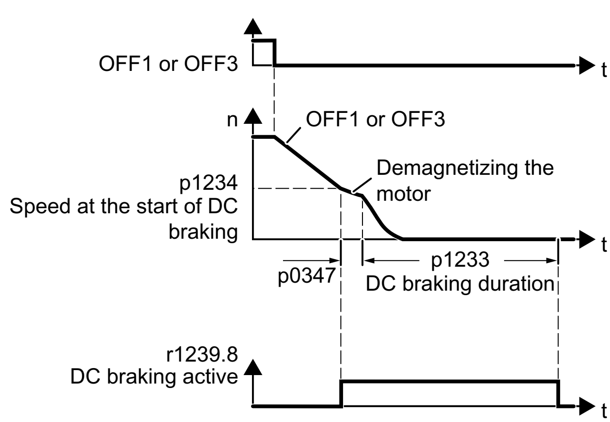


Figure 8-56 DC braking when the motor is switched off

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

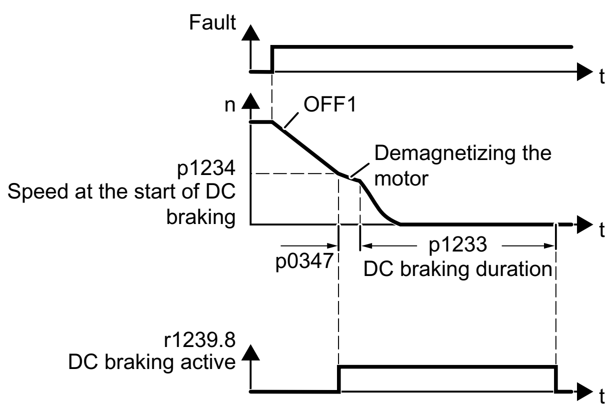


Figure 8-57 DC braking as a fault reaction

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[8...13]	CO/BO: DC braking status word	-

Table 8-53 Configuring DC braking as a response to faults

Parameter	Description	Factory setting
p2100[0...19]	Changing the fault reaction, fault code	0
p2101[0...19]	Changing the fault reaction, reaction	0

8.17.3 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).

Performance ratings Power Module (Page 331)

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

8.18 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

8.19 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^2t 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.

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.

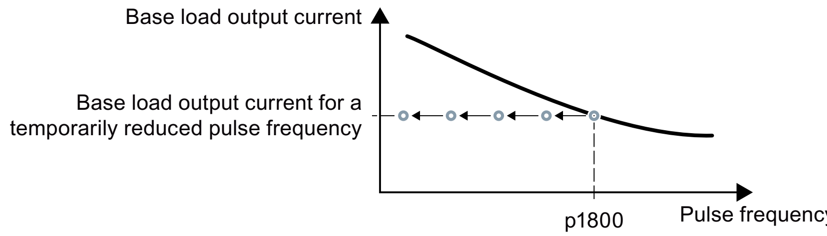


Figure 8-58 Derating characteristic and base load output current for overload

   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.

Overload response for p0290 = 12

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.
   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[0...19]	Power unit temperatures	°C
p0290	Power unit overload response	2
p0292[0...1]	Power unit temperature alarm threshold	[0] 5 °C, [1] 15 °C
p0294	Power Module alarm for I2t overload	95%

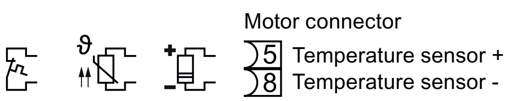
8.20 Motor protection with temperature sensor

Overview

The converter can evaluate one of the following sensors to protect the motor against overtemperature:

- Temperature switch (e.g. bimetallic switch)
- PTC sensor
- KTY 84 sensor
- Pt1000 sensor

Connect the motor temperature sensor to the Power Module via the motor cable.



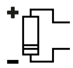
WARNING
Electric shock as a result of the temperature sensor connector
The temperature sensor represents a potential risk. Contact with live parts at the motor cable and in the motor terminal box can result in death or serious injury. • Switch off the converter and withdraw all power cables from the converter before you connect or disconnect the motor temperature sensor or the motor holding brake. • Isolate cables that are not used in the motor terminal box.

NOTICE
Risk of damage to equipment due to grounding of the motor cable
The temperature sensor represents a negative potential. The device will be damaged if these connections are grounded. • Isolate cables that are not used in the motor terminal box. • It is not permissible that unused cables are grounded.

Function description

KTY84 sensor

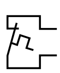
NOTICE
Overheating of the motor due to KTY sensor connected with the incorrect polarity
If a KTY sensor is connected with incorrect polarity, the motor can become damaged due to overheating, as the converter cannot detect a motor overtemperature condition. • Connect the KTY sensor with the correct polarity.



Using a KTY sensor, the converter monitors the motor temperature and the sensor itself for wire-break or short-circuit:

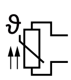
- Temperature monitoring:
  The converter uses a KTY sensor to evaluate the motor temperature in the range from -48 °C ... +248 °C.
  Set the temperature for the alarm and fault thresholds with parameter p0604 or p0605.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - 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 Ω 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 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

Temperature switch



The converter interprets a resistance ≥ 100 Ω as an opened bimetallic switch and responds according to the setting for p0610.

PTC sensor



The converter interprets a resistance > 1650 Ω as being an overtemperature condition and responds according to the setting of p0610.

For motors generally equipped with 3 PTC, a minimum resistance value of 20 Ω is required for short-circuit monitoring for each PTC. If fewer PTC are used in the motors, the total resistance must be at least 50 Ω.

If the total resistance is below these values, the converter responds with alarm A07015.

If the alarm is present for longer than 100 milliseconds, the converter responds with fault F07016.

The p4621 parameter can be used enable or disable short-circuit monitoring.

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 Ω 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 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the converter changes to the fault state with F07016.

Parameter

Parameter	Description	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
p4621[M]	Motor temperature sensor configuration	0000 bin

8.21 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.

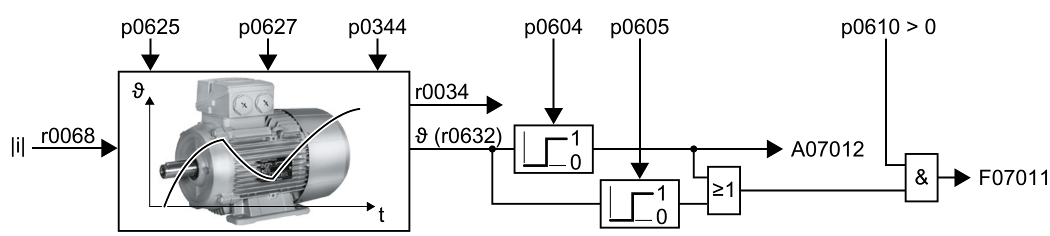


Figure 8-59 Thermal motor model 2 for induction motors

Parameter

Table 8-54 Thermal motor model 2 for induction motors

Number	Name	Factory setting
r0034	CO: Thermal motor load	- %
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 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

Thermal motor model 3 for encoderless synchronous motors

The thermal motor model 3 for encoderless synchronous motors 1FK7 or 1FG1 is a thermal 3-mass model, consisting of stator core, stator winding and rotor. Thermal motor model 3 calculates the temperatures - both in the rotor as well as in the stator winding.

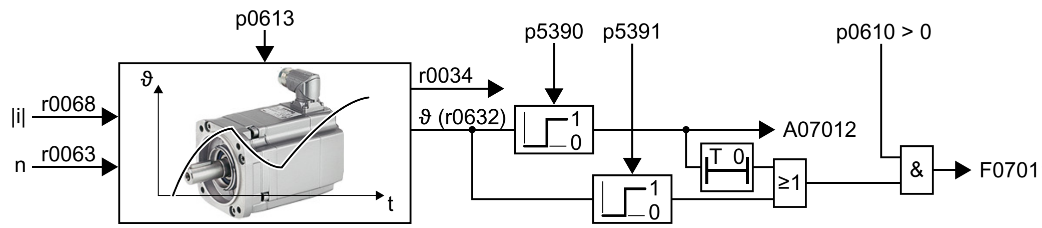


Figure 8-60 Thermal motor model 3 for 1FK7 encoderless synchronous motors

Table 8-55 Thermal motor model 3 for 1FK7 encoderless synchronous motors

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td>r0034</td><td colspan="3">CO: Thermal motor load [%]</td></tr>
<tr><td>r0063</td><td colspan="3">CO: Actual speed value [rpm]</td></tr>
<tr><td>r0068</td><td colspan="3">CO: Actual current value [A]</td></tr>
<tr><td rowspan="5">p0610</td><td colspan="3">Motor overtemperature response (factory setting: 12)</td></tr>
<tr><td>0:</td><td colspan="2">Alarm A07012
The converter does not reduce the current limit.</td></tr>
<tr><td>1:</td><td colspan="2">Alarm A07012 and fault F07011
The converter does not reduce the current limit.</td></tr>
<tr><td>2:</td><td colspan="2">Alarm A07012 and fault F07011
The converter does not reduce the current limit.</td></tr>
<tr><td>12:</td><td colspan="2">Alarm A07012 and fault F07011
The converter does not reduce the current limit.
After switching off the supply voltage, the converter saves the most-recently calculated difference to the ambient air temperature. After switching the supply voltage on again, the thermal motor model starts with 90 % of the previously saved difference temperature.</td></tr>
<tr><td rowspan="2">p0612</td><td colspan="2">Mot_temp_mod activation</td><td rowspan="4">After selecting an encoderless synchronous motor 1FK7 or 1FG1 (p0300) or a listed induction motor (p0301) during the commissioning, the converter sets thermal motor model 3 and the parameters to values appropriate for the motor type.
The parameters are write-protected for listed motors (p0301 ≥ 0).</td></tr>
<tr><td>.02</td><td>1 signal: Activate motor temperature model 3 for 1FK7 or 1FG1 encoderless synchronous motors</td></tr>
<tr><td>p5390</td><td colspan="2">Mot_temp_mod 1/3 alarm threshold (factory setting: 110.0° C)
Motor temperature > p5390 ⇒ alarm A07012.</td></tr>
<tr><td>p5391</td><td colspan="2">Mot_temp_mod 1/3 fault threshold (factory setting: 120.0° C)
Motor temperature > p5391
or
motor temperature > p5390, longer than a motor-dependent time calculated by the converter
⇒ fault F07011.</td></tr>
</table>

Parameter	Description
p0613	**Mot_temp_mod 1/3 ambient air temperature** (factory setting: 20° C) Expected motor ambient temperature in °C for motor operation.
p0625	**Motor ambient temperature during commissioning** (factory setting: 20° C) Motor ambient temperature in °C at the instant of the motor data identification.
r0632	**Mot_temp_mod stator winding temperature** [°C]
p0640	**Current limit** [A]

Further information is provided in the function charts 8016 and 8017 of the List Manual.

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.

8.22 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.

8.23 Monitoring the driven load

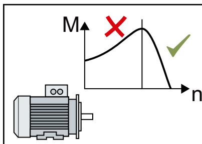
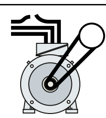
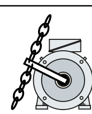
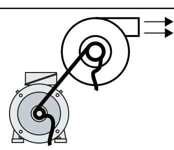
In many applications, the speed and the torque of the motor can be used to determine whether the driven load is in an impermissible operating state. The use of an appropriate monitoring function in the converter prevents failures and damage to the machine or plant.

Examples:

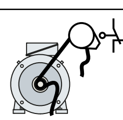
- For fans or conveyor belts, an excessively low torque can mean a broken drive belt.
- For pumps, insufficient torque can indicate a leakage or dry-running.
- For extruders and mixers, an excessive torque together with low speed can indicate machine blockage.

Functions for monitoring the driven load

The converter provides the following means to monitor the driven load via the torque of the motor:

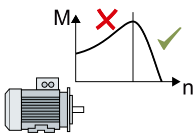
	The stall protection prevents an induction motor from stalling.
	The no-load monitoring evaluates the motor current. Insufficient current indicates that the motor and the load are no longer mechanically connected with each other.
	The blocking protection triggers for a motor current that corresponds 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.

Monitoring the driven load with a binary signal:

	The speed monitoring evaluates a periodic binary signal. A signal failure indicates that the motor and the load are no longer mechanically connected with each other.

8.23.1 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

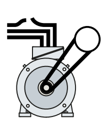
Number	Name	Factory setting
r1408[0 ... 14]	CO/BO: Status word, current controller	-
p1745[D]	Motor model error threshold stall detection	5%
r1746	Motor model fault signal stall detection	- %
p2178[D]	Motor stalled delay time	0.01 s
r2198	CO/BO: Status word monitoring functions 2	-

See also

Blocking protection (Page 270)

8.23.2 No-load monitoring

Function description



An insufficient motor current indicates that the motor cable is disconnected.

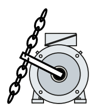
If the motor current for the time p2180 lies below the current level p2179, the converter signals the alarm A07929.

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	-

8.23.3 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	-

8.23.4 Load monitoring

The load monitoring comprises the following components:

- Load failure monitoring
- Monitoring for torque deviation
- Speed deviation monitoring

If the load monitoring detects load failure, the converter issues fault F07936. For a torque and speed deviation, as response, you can either set an alarm or a fault. Details are provided in the following descriptions.

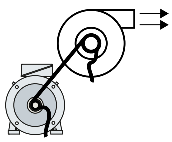
Settings

Table 8-56 Setting options for load monitoring

Parameters	Description
p2193	**Load monitoring configuration** (factory setting: 1) 0: Monitoring deactivated 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring

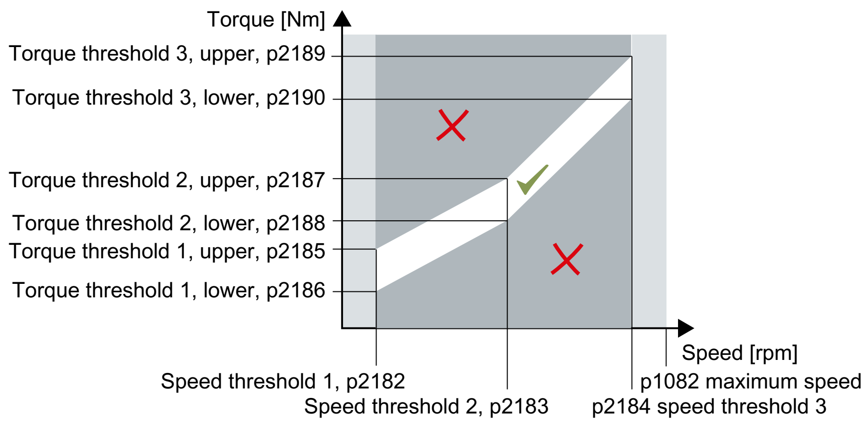
8.23.5 Torque monitoring

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.
❒

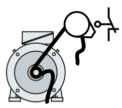
Parameter

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

8.23.6 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.

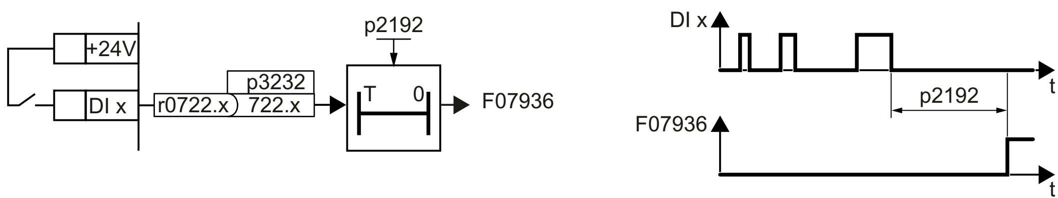


Figure 8-61 Function plan and time response of the speed monitoring

Parameter

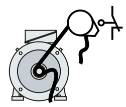
Parameter	Description	Factory setting
r0722	CO/BO: CU digital inputs, status	-
p2192[D]	Load monitoring, delay time	10 s
p2193[D]	Load monitoring configuration	1
p3232[C]	BI: Load monitoring, failure detection	1

Additional information is provided in the List Manual (the parameter list and function diagram 8013).

Function diagrams

Torque monitoring (Page 272)

8.23.7 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.

To use the function, you must connect the encoder to one of the digital inputs DI 1 or DI 2 and connect the relevant digital input with the function in the converter.

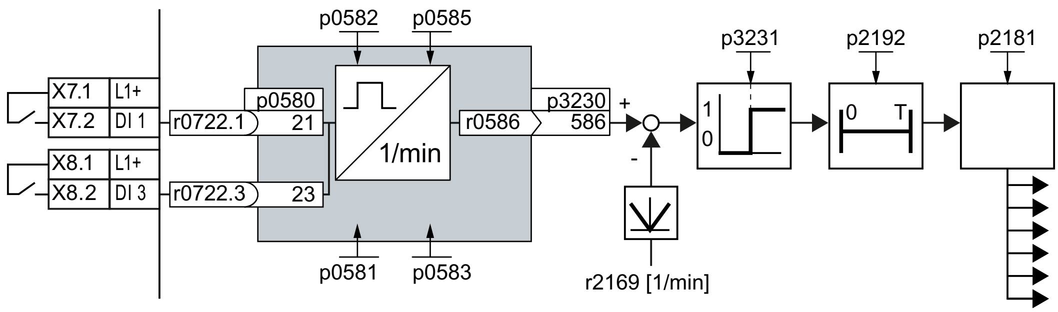


Figure 8-62 Speed deviation monitoring

Function description

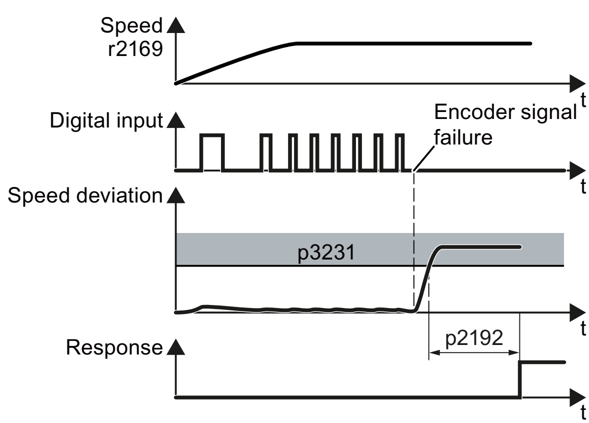


Figure 8-63 Time response of the speed monitoring

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.

1) 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	Invertmeasuring probe [1)]	0000 bin
p0580	Measuring probe input terminal [1)]	0
p0581	Measuring probe signal edge [1)]	0
p0582	Measuring probe pulses per revolution [1)]	1
p0583	Maximum measuring probe measurement time [1)]	10 s
p0585	Measuring probe gear ratio [1)]	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

8.24 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

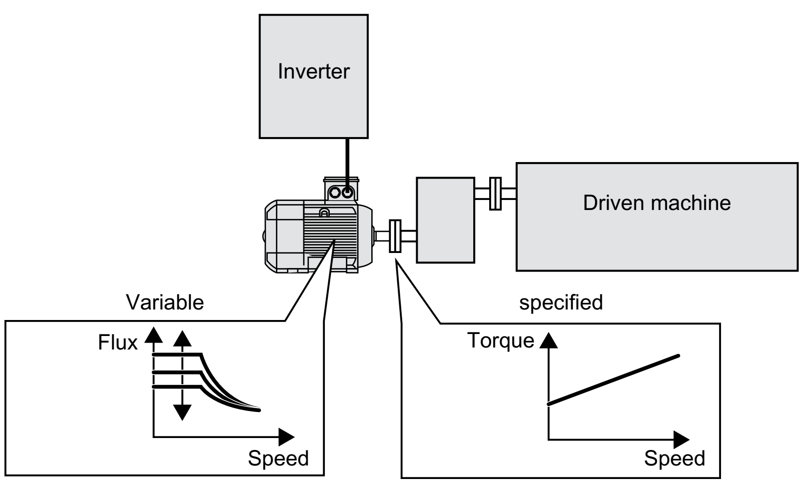


Figure 8-64 Efficiency optimization by changing the motor flux

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.

Efficiency optimization, method 2

Generally, energy efficiency optimization method 2 achieves a better efficiency than method 1.

We recommend that you set method 2.

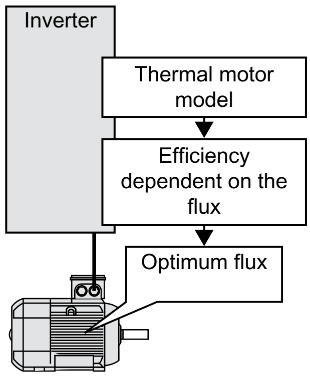
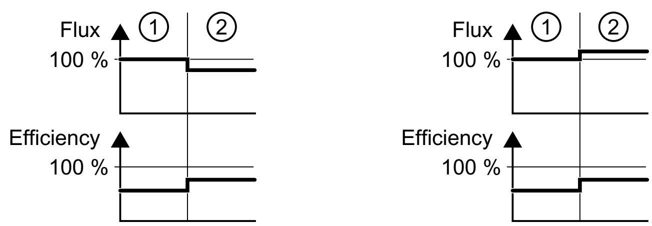


Figure 8-65 Determining the optimum flux from the motor thermal model

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 8-66 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

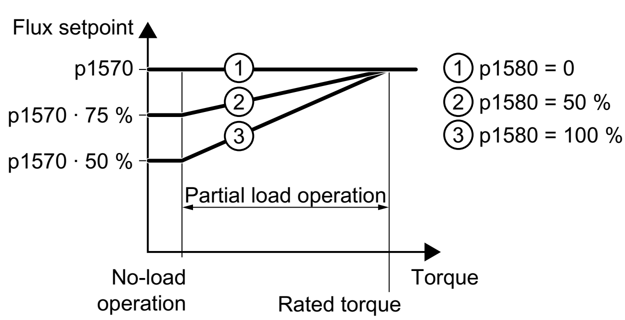


Figure 8-67 Reduce the flux setpoint in the partial load range of the motor

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.

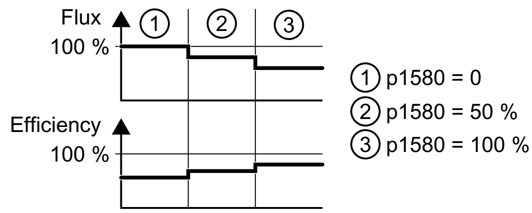


Figure 8-68 Qualitative result of efficiency optimization, method 1

The reduced flux in the motor partial load range results in higher efficiency.

Parameters

Table 8-57 Efficiency optimization, method 2

Number	Name	Factory setting
p1401[D]	Flux control configuration	0000 0000 0000 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 8-58 Efficiency optimization, method 1

Number	Name	Factory setting
p1570[D]	CO: Flux setpoint	100%
p1580[D]	Efficiency optimization	80%

8.25 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.

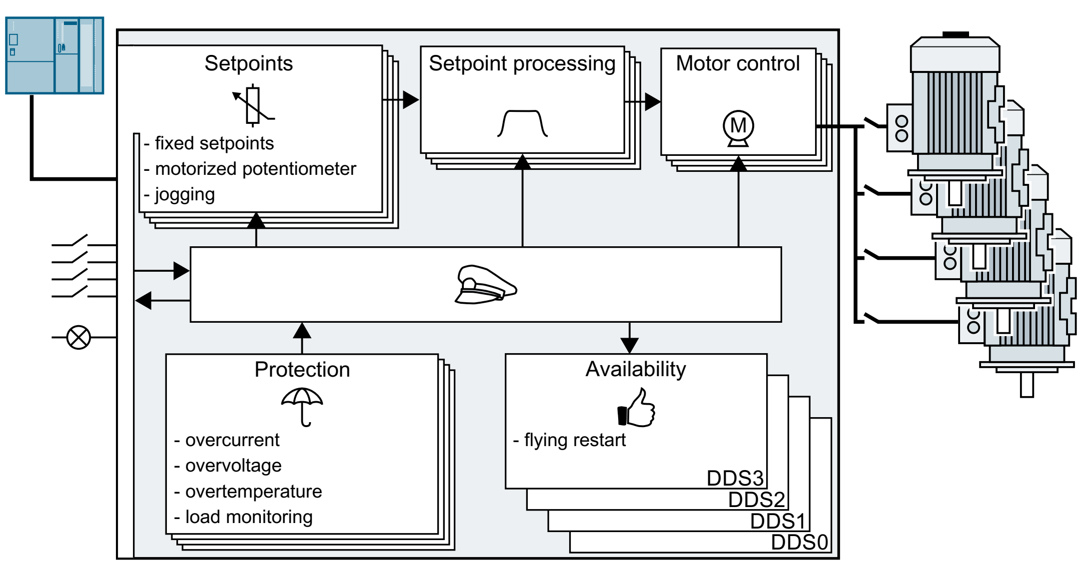
Note

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.



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).

9 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 Operating states indicated on LED

LED status indicators

The Control Unit has number of dual-colour LEDs which are designed to indicate the operational state of the converter. The LEDs are used to indicate the status of the following states:

- General fault conditions
- Communication status
- Input and Output status
- Safety-Integrated status

The location of the various LEDs on the Control Unit are shown in the figure below.

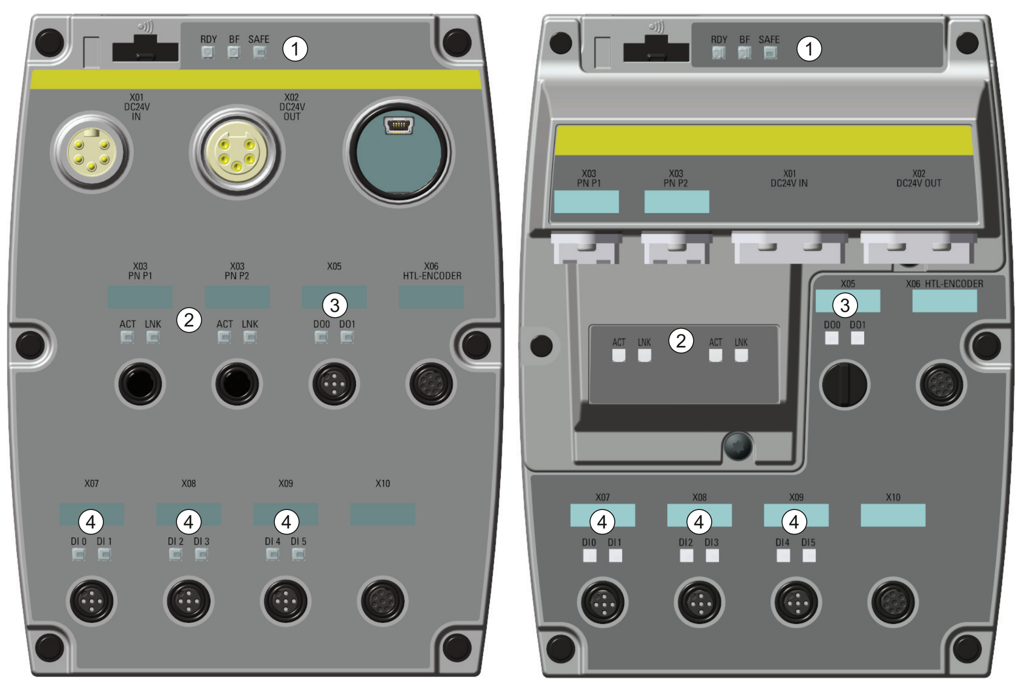
Status LEDs

① General

② PROFINET

③ Digital Output

④ Digital Inputs



CU240D-2 (PROFINET) CU250D-2 (PROFINET)

Figure 9-1 Status LED locations

Table 9-1 Explanation of symbols for the following tables

	LED is ON
	LED is OFF
2 s	LED flashes slowly

2 s	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
	Temporary state after the supply voltage is switched on.
	The converter is free of faults
	Commissioning or reset to factory settings
	A fault is active
	Firmware update is active
	Converter waits until the power supply is switched off and switched on again after a firmware update

Table 9-3 Digital input and digital output

DI/DO	Explanation
	The associated digital input or digital output has the "high" state.
	The associated digital input or digital output has the "low" state.

Table 9-4 Integrated safety functions

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 9-5 PROFINET fieldbus

ACT	LNK	Explanation
		Communication via PROFINET is error-free. Converter and open-loop control exchange actual data.
		Communication via PROFINET has been set up.
		Communication via PROFINET is not active.

Table 9-6 PROFINET fieldbus

FO	ACT / LNK	Explanation
		Communication via PROFINET is error-free. Converter and open-loop control exchange actual data.
		Communication via PROFINET has been set up.
		Communication via PROFINET is not active.
		Converter does not receive a light wave signal. Possible causes: • Fiber optical cable or connector damaged. • Excessive attenuation of the fiber optic line.

Table 9-7 PROFINET fieldbus

BF	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: Incorrect memory card
	Firmware update failed	
	Firmware update is active	

Table 9-8 PROFIBUS fieldbus

BF	Explanation	
	Data exchange between the converter and control system is active	
	Fieldbus interface is not being used	
	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: 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)

I&M data

The converter supports the following identification and maintenance (I&M) data.

I&M data	Format	Explanation	Associated parameters	Example for the content
I&M0	u8[64] PROFIBUS u8[54] PROFINET	Converter-specific data, read only	-	See below
I&M1	Visible String [32]	Plant/system identifier	p8806[0 ... 31]	"ak12-ne.bo2=fu1"
	Visible String [22]	Location code	p8806[32 ... 53]	"sc2+or45"
I&M2	Visible String [16]	Date	p8807[0 ... 15]	"2013-01-21 16:15"
I&M3	Visible String [54]	Any comment	p8808[0 ... 53]	-
I&M4	Octet String[54]	Check signature to track changes for Safety Integrated. 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.	p8809[0 ... 53]	Values of r9781[0] and r9782[0]

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 content	Valid for PROFINET	Valid for PROFIBUS
Manufacturer-specific	u8[10]	00 ... 00 hex	---	✓
MANUFACTURER_ID	u16	42d hex (=Siemens)	✓	✓
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	✓	✓
REVISION_COUNTER	u16	0000 hex	✓	✓
PROFILE_ID	u16	3A00 hex	✓	✓
PROFILE_SPECIFIC_TYPE	u16	0000 hex	✓	✓
IM_VERSION	u8[2]	01.02	✓	✓
IM_SUPPORTED	bit[16]	001E hex	✓	✓

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		Alarm time received			Alarm time removed	
	I32	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 9-2 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 288)

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].

Alarm history

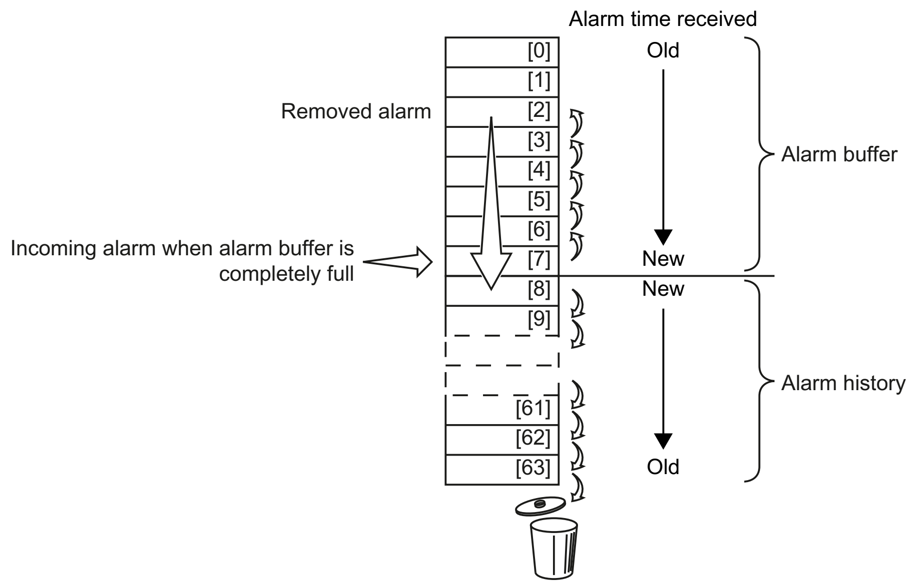


Figure 9-3 Shifting removed alarms into the alarm history

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 received". The latest alarm has Index [8].

Parameter

Table 9-9 Parameters of the alarm buffer and the alarm history

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

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 9-10 Extended settings for alarms

Parameter	Description	Factory setting
You can change up to 20 different alarms into a fault or suppress alarms:		
p2118[0...19]	Change message type, message number	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

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		Fault time received			Fault time removed	
	I32	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 9-4 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 288)

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].

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

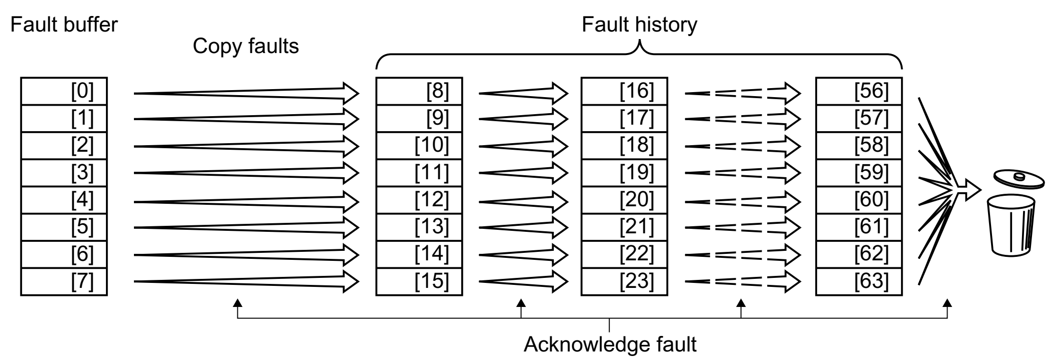


Figure 9-5 Fault history after acknowledging the faults

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.

Parameter

Table 9-11 Parameters 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[0...63]	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[0...19]	Changing the fault reaction, fault number	0
p2101[0...19]	Changing the fault reaction, reaction	0
p2118[0...19]	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.

9.6 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 9-12 The most important alarms and faults

Number	Cause	Remedy
F01000	Software error in the CU	Replace CU.
F01001	Floating point exception	Switch off CU and switch 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 booted with the factory settings. 3. Recommission the converter.
A01028	Configuration error	Explanation: The parameter assignments on the memory card were created with a different type of module (Article no.). Check the module parameters and recommission if necessary.
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01034	Unit switchover: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Error loading data from memory card	Replace memory card or CU.
A01101	Memory card not available	Insert a memory card or deactivate the warning A01101. Message for a memory card that is not inserted (Page 100)
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	Replace CU.
F01512	An attempt has been made to establish a conversion factor for scaling which does not exist	Create scaling or check transfer value.
A01590	Motor maintenance interval expired	Carry out maintenance and reset the maintenance interval (p0651).
F01600	STOP A initiated	Select the STO safety function and then deselect again.
F01650	Acceptance test required	Carry out an acceptance test and create test certificate. Switch off the Control Unit and switch on again.

<table>
<tr><th>Number</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>F01659</td><td>Write task for parameter rejected</td><td>Cause: The converter should be reset to the factory setting. However, it is not permissible to reset the safety functions as the safety functions are currently enabled.
Remedy with operator panel:<table><tr><td>p0010 = 30</td><td>Parameter reset</td></tr><tr><td>p9761 = ...</td><td>Enter password for the safety functions.</td></tr><tr><td>p0970 = 5</td><td>Reset start safety parameter.
The converter sets p0970 = 5 once it has reset the parameters.</td></tr></table>Then reset the converter to the factory setting again.</td></tr>
<tr><td>F01662</td><td>CU hardware fault</td><td>Switch CU off and on again, upgrade firmware or contact technical support.</td></tr>
<tr><td>A01666</td><td>Static 1 signal at the F-DI for safe acknowledgment</td><td>Set failsafe digital input F-DI to a logical 0 signal.</td></tr>
<tr><td>A01698</td><td>Commissioning mode active for safety functions</td><td>This message is withdrawn after the Safety commissioning has ended.</td></tr>
<tr><td>A01699</td><td>Switch-off signal path test required</td><td>After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.</td></tr>
<tr><td>A01900</td><td>PROFIBUS: Configuration telegram faulty</td><td>Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram.
Check the bus configuration on the master and slave side.</td></tr>
<tr><td>A01910
F01910</td><td>Setpoint timeout</td><td>The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present:
• The bus connection is interrupted
• The MODBUS master is switched off
• Communications error (CRC, parity bit, logical error)
• An excessively low value for the fieldbus monitoring time (p2040)</td></tr>
<tr><td>A01920</td><td>PROFIBUS: Cyclic connection interrupt</td><td>Explanation: The cyclic connection to PROFIBUS master is interrupted.
Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.</td></tr>
<tr><td>F03505</td><td>Analog input, wire break</td><td>Check the connection to the signal source for interrupts.
Check the level of the signal supplied.
The input current measured by the analog input can be read out in r0752.</td></tr>
<tr><td>A03520</td><td>Temperature sensor fault</td><td>Check that the sensor is connected correctly.</td></tr>
<tr><td>A05000
A05001
A05002
A05004
A05006</td><td>Power Module overtemperature</td><td>Check the following:
- Is the ambient temperature within the defined limit values?
- Are the load conditions and duty cycle configured accordingly?
- Has the cooling failed?</td></tr>
<tr><td>F06310</td><td>Supply voltage (p0210) incorrectly parameterized</td><td>Check the parameterized supply voltage and if required change (p0210).
Check the line voltage.</td></tr>
<tr><td>F07011</td><td>Motor overtemperature</td><td>Reduce the motor load.
Check ambient temperature.
Check the wiring and connection of the sensor.</td></tr>
</table>

Number	Cause	Remedy
A07012	I2t motor model overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the temperature sensor fault (p0607 = 0).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	V_{DC_max} controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the ramp up to the setpoint speed.
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).
F07801	Motor overcurrent	Check current limits (p0640). Vector control: Check current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 ... p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short circuit and ground fault. Check motor for star-delta connection and rating plate parameterization. Check power unit / motor combination. Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.

Number	Cause	Remedy
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short circuit detected	• Check the converter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850 A07851 A07852	External alarm 1 ... 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1... 3. Remedy: Remove the causes of these alarms.
F07860 F07861 F07862	External fault 1 ... 3	Remove the external causes for this fault.
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).
F07901	Motor overspeed	Activate precontrol of the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 or PT1000 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor data identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller to RUN mode. • If the error occurs repeatedly, check the set monitoring time p2044.

Number	Cause	Remedy
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.
F08700	Communications faulty	A CAN communications error has occurred. Check the following: • Bus cable • Baud rate (p8622) • Bit timing (p8623) • Masters Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred during checking of 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 protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC-link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.

Number	Cause	Remedy
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Converter overtemperature	Check whether the converter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the converter's input fuses. Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30022	Power Module: Monitoring U_{CE}	Check or replace Power Module.
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	• Check whether the fan is running. • Check the fan filter elements. • Check whether the ambient temperature is in the permissible range.
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: • Check the motor load. • Check the line phases
A30049	Internal fan defective	Check the internal fan and if required replace.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU 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 Control Unit and Power Module	There is a communications fault between the Control Unit and the Power 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 unit supply voltage (p0210). • Check the dimensioning of the line reactor.
F30600	STOP A initiated	Select the STO safety function and then deselect again.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware or contact technical support.
F30850	Software fault in the Power Module	Replace Power Module or contact technical support.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.

<table>
<tr><th>Number</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>F31118</td><td>Speed difference outside tolerance</td><td rowspan="2">For an HTL/TTL encoder, the speed difference has exceeded the value in p0492 over several sampling cycles.
• Check tachometer feeder cable for interruptions.
• Check grounding of the tachometer shielding.
• Increase the maximum speed difference per sampling cycle (p0492).</td></tr>
<tr><td>A31418</td><td>Speed difference per sampling rate exceeded</td></tr>
<tr><td>F31905</td><td>Parameterization error</td><td>Check whether the connected encoder type matches the encoder that has been parameterized.</td></tr>
</table>

Further information on this topic is provided in the List Manual.

Overview of the manuals (Page 361)

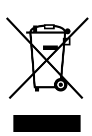
Corrective maintenance 10

> ⚠ **WARNING**
>
> **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

> ⚠ **WARNING**
>
> **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 Replacing the exteral fan

External fan for Frame Size C

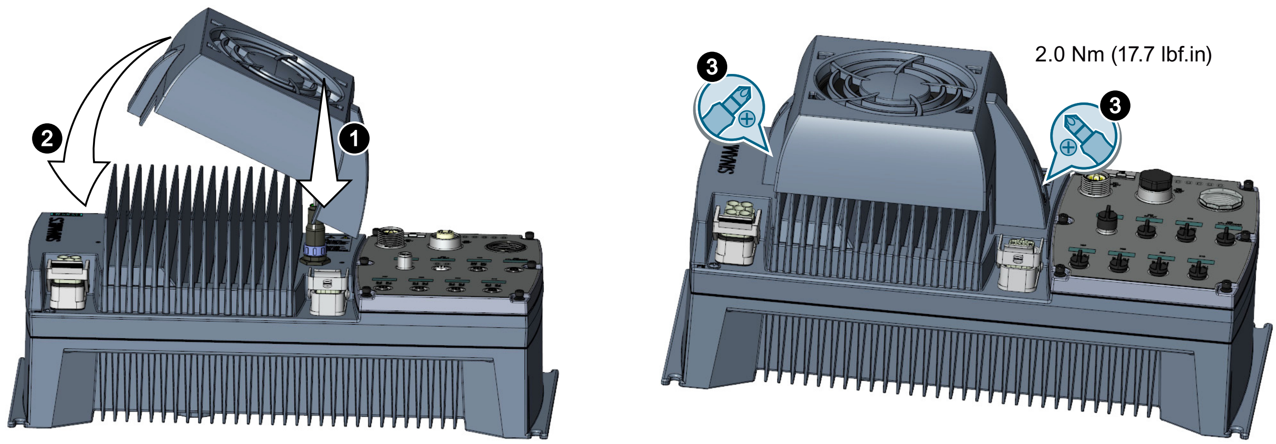


Figure 10-1 Fitting the external fan

Article number: 6SL3500-0SF01-0AA0

Replacement kit

The replacement kit comprises seals, cover caps, fieldbus address window and screws.

Article number: 6SL3500-0SK01-0AA0

More information

You will find more information in the Internet:

Spares on Web (https://www.automation.siemens.com/sow?sap-language=EN)

10.2 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

⚠ **WARNING**

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.

⚠ **WARNING**

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.

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 308)
    - If there is no data backup of the replaced Control Unit, commission the converter as new converter.

You have replaced the Control Unit.
❒

10.3 Downloading the converter settings

10.3.1 Converter without enabled safety functions

10.3.1.1 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 316)

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.
❒

10.3.1.2 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.

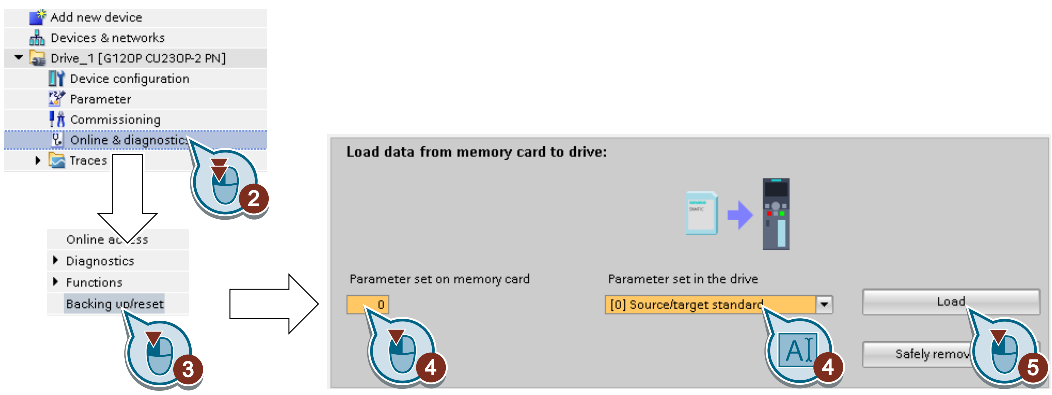
Requirement

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 316)

Function description

Procedure



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.
❒

10.3.1.3 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

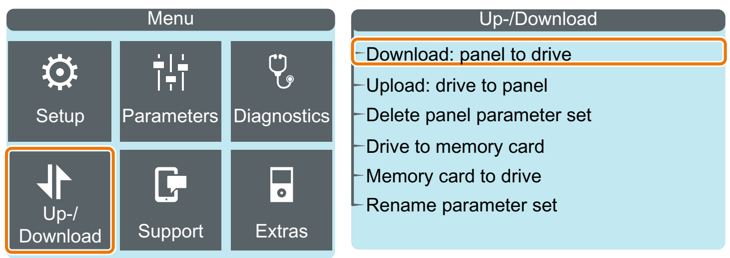
The following requirements apply:

- 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 316)

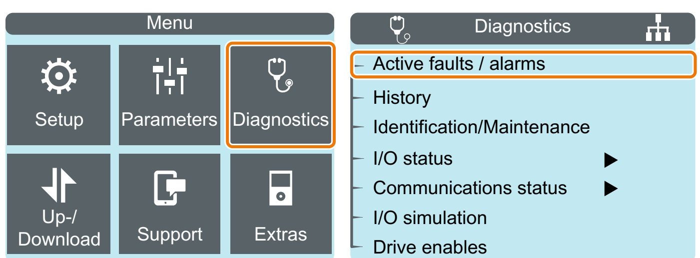
Function description

Procedure

1. Connect the operator panel to the converter.
2. Start the download.



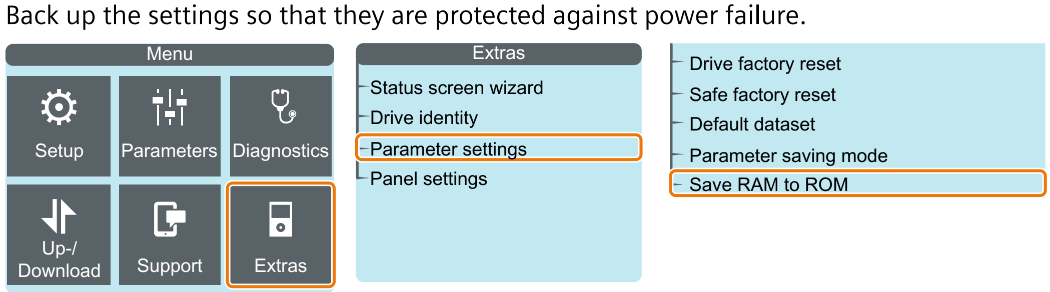
3. Wait until the download is completed.
4. After loading, check whether the converter outputs Alarm A01028.



   – 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.
❒

10.3.1.4 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 316)

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.
❒

10.3.2 Converter with enabled safety functions

10.3.2.1 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 316)

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 326)

You have transferred the settings to the converter.
❒

10.3.2.2 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

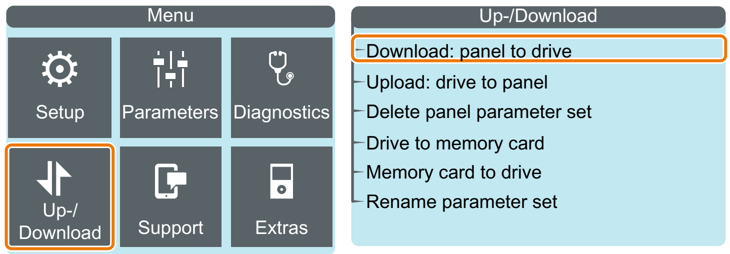
The following preconditions apply:

- 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 316)

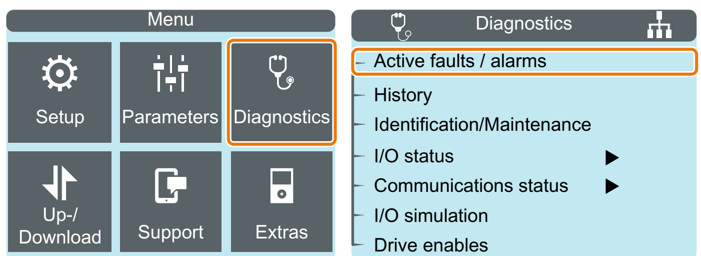
Function description

Procedure

1. Attach the Operator Panel to the converter.
2. Start the download.



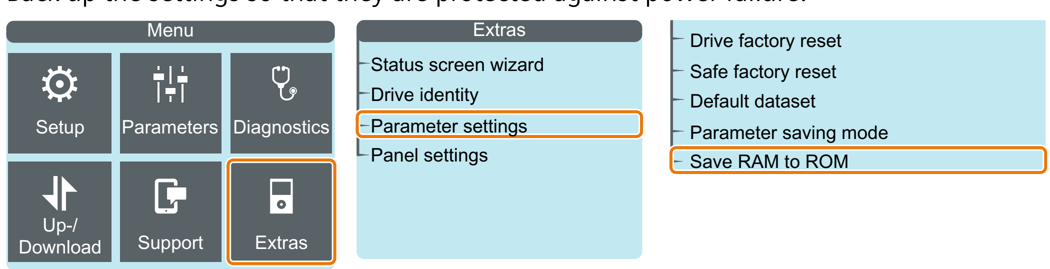
3. Wait until the transfer is complete.
4. After loading, check whether the converter outputs Alarm A01028.



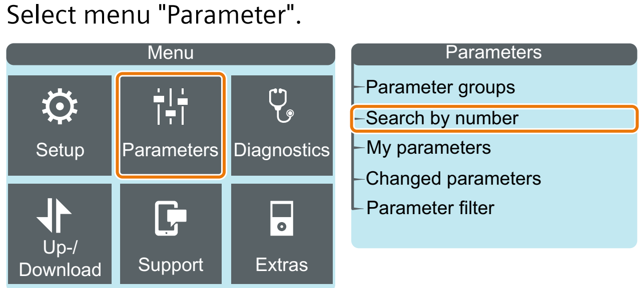
   – Alarm A01028:
   The loaded settings are not compatible with the converter.
   Delete the alarm with p0971 = 1.
   Recommission the drive.

   – No alarm A01028: Proceed with the next step.

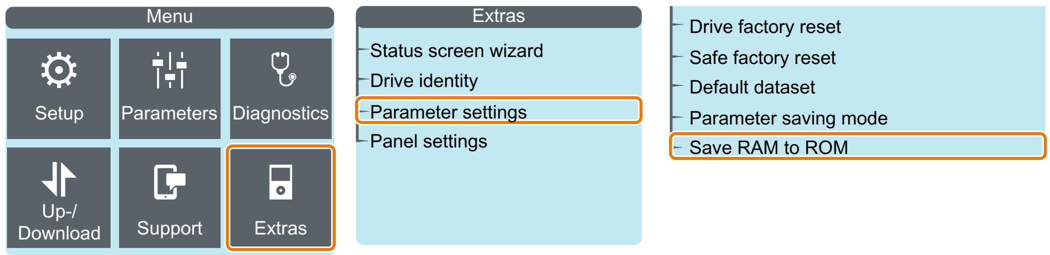
5. Back up the settings so that they are protected against power failure.



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 326)

You have replaced the converter and transferred the safety function settings from the operator panel to the new converter.
❒

10.3.2.3 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:

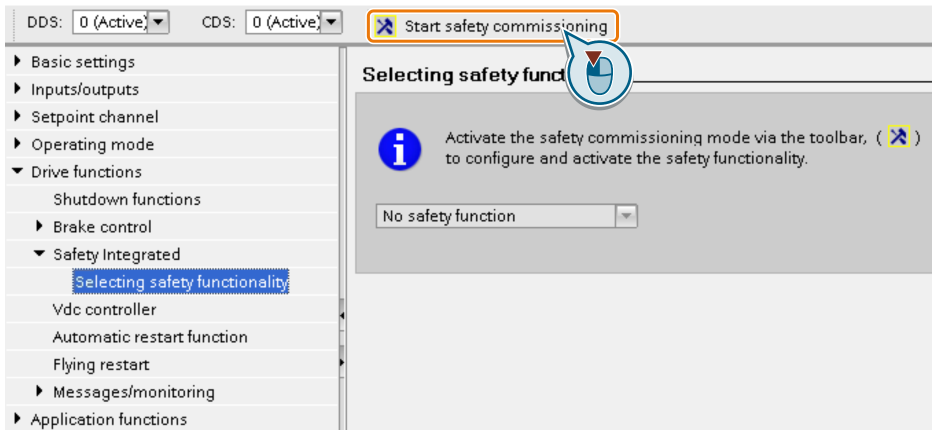
- The converter power supply has been switched on.
- The PC and converter are connected with one another via a USB cable or via the fieldbus.
- The converter settings are not protected against copying.
Download with active know-how protection with copy protection (Page 316)

Function description

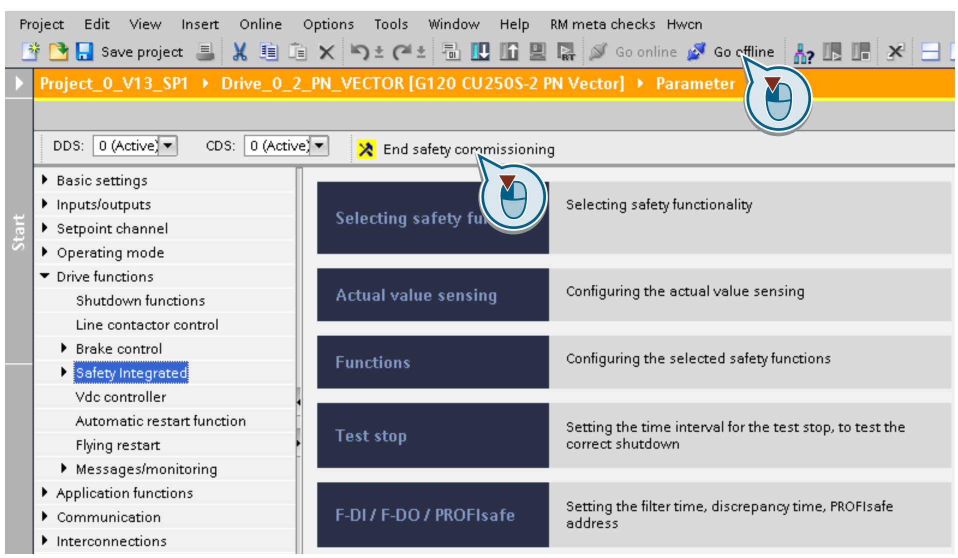
Procedure

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.



5. Enter the password for the safety functions.
6. Press the "End safety commissioning" button.



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 326)

You transferred the settings from the PC to the new converter.
❒

10.3.3 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 112)
   - 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.
❒

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 112)
   - 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.
❒

10.4 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.
  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): 0.25 ... 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.
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 326)

You have successfully replaced the Power Module.
❒

10.5 Firmware upgrade and downgrade

10.5.1 Overview

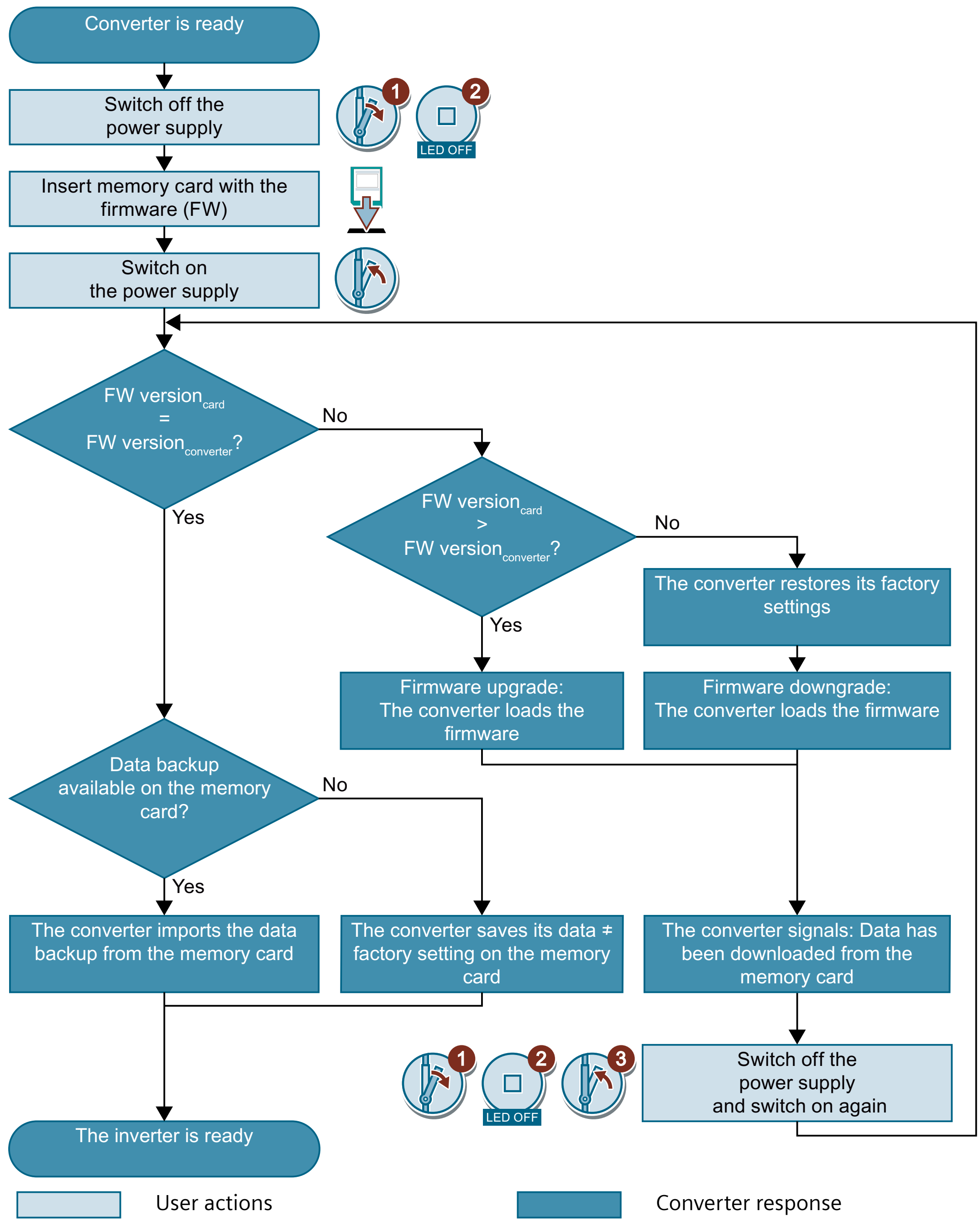


Figure 10-2 Overview of the firmware upgrade and firmware downgrade

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 98)

Function description

Procedure

1. Download the required firmware to your PC from the Internet.
   Download (https://support.industry.siemens.com/cs/ww/en/view/67364620)
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.

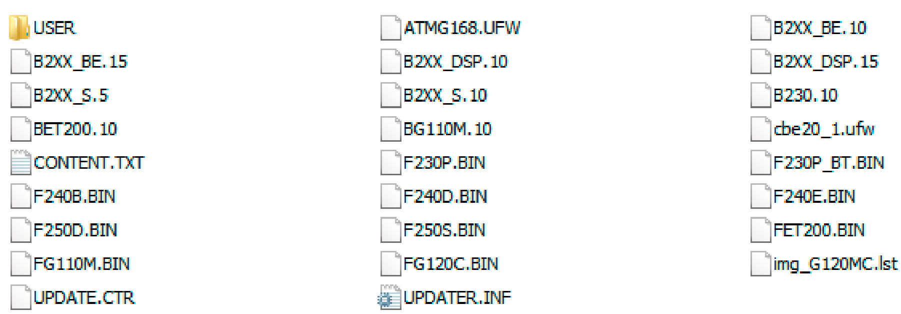


Figure 10-3 Example of memory card contents after the file transfer

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.
❒

10.5.3 Upgrading firmware

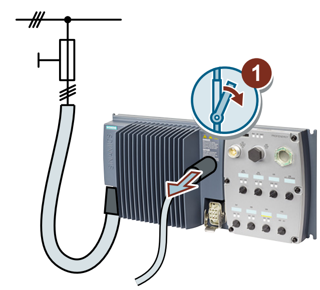
When upgrading firmware you replace the converter's firmware with a newer version. Only update the firmware to a newer version if you require the expanded range of functions of that newer version.

Requirements

- Your converter's firmware is at least version V4.5.
- Converter and memory card have different firmware versions.

Procedure

1. Remove the connector for the 24 V power supply of the Control Unit.



2. Remove the Control Unit from the Power Module.
3. All Control Unit LEDs are dark.

4. Insert the card with the matching firmware into the slot on the rear side of the Control Unit until you can feel it lock in place.

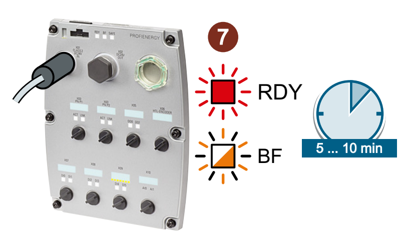
5. Insert the connectors for the Control Unit 24 V power supply.
6. Switch on the 24 V power supply for the Control Unit.

7. The Control Unit transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   During the transfer, the BF LED will flash orange at a variable frequency.

   Because the Control Unit is separated from the Power Module, the RDY LED will additionally shine red.

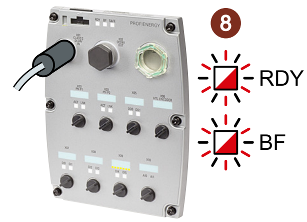


8. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during the transfer

   The converter firmware will be incomplete if the power supply fails during the transfer.

   - Start again with Step 1 of these instructions.



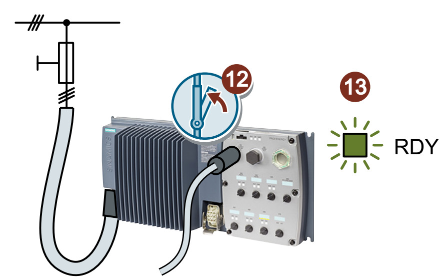
9. Switch off the 24 V supply or remove the connector for the 24 V supply from the Control Unit.
10. Wait until the LEDs on the Control Unit have gone out.

   Decide whether to remove the memory card from the converter:

   - You leave the memory card in place:
     – There was no data back up on the memory card: ⇒ In step 13, the converter writes its settings to the memory card.
     – The memory card contains a data backup: ⇒ In step 13, the converter takes the settings from the memory card.
   - Remove the memory card: The converter keeps its settings.

11. Mount the Control Unit on the Power Module

12. Reconnect all plugs and switch on the 24 V supply.
13. If the firmware upgrade was successful, the Control Unit responds after a few seconds with the RDY LED lighting up 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 contained a data backup: ⇒ The converter has taken over the settings from the memory card.
   - There was no data backup on the memory card: ⇒ The converter has written its settings to the memory card.

You have upgraded the converter firmware to a newer version.
❒

10.5.4 Firmware downgrade

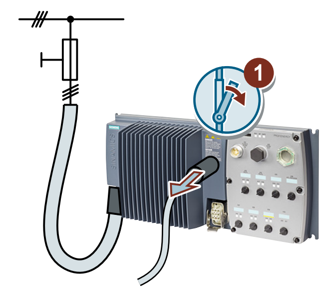
When downgrading firmware you replace the converter's firmware with an older version. Only update the firmware to an older level if, after replacing a converter, you require the same firmware in all converters.

Requirement

- Your converter's firmware is at least version V4.6.
- You have saved your settings onto a memory card, in an operator panel or on a PC.

Procedure

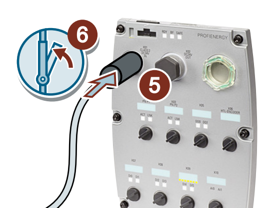
1. Remove the connector for the 24 V power supply of the Control Unit.



2. Remove the Control Unit from the Power Module.
3. All Control Unit LEDs are dark.

4. Insert the card with the matching firmware into the slot on the rear side of the Control Unit until you can feel it lock in place.

5. Insert the connectors for the Control Unit 24 V power supply.
6. Switch on the 24 V power supply.

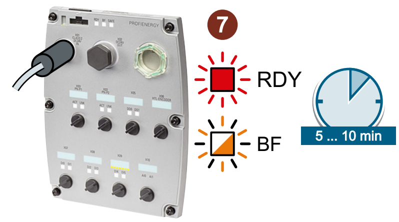


7. The Control Unit transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   During the transfer, the BF LED will flash orange at a variable frequency.

   Because the Control Unit is separated from the Power Module, the RDY LED will additionally shine red.

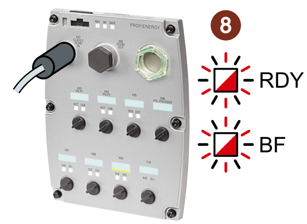


8. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during the transfer

   The converter firmware will be incomplete if the power supply fails during the transfer.

   - Start again with Step 1 of these instructions.



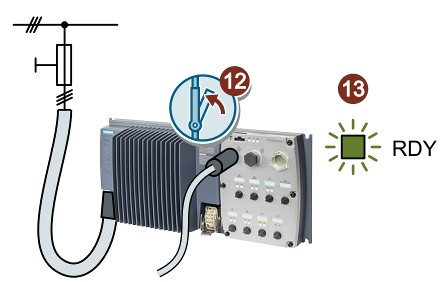
9. Switch off the 24 V supply or remove the connector for the 24 V supply from the Control Unit.
10. Wait until the LEDs on the Control Unit have gone out.

Decide whether to remove the memory card from the converter:

- You leave the memory card inserted: ⇒ If the memory card already includes a data backup, the converter imports the settings from the memory card in step 13.
- You remove the memory card or the memory card does not contain any data backup: ⇒ In the step 13, the converter restores the factory settings.

11. Mount the Control Unit on the Power Module

12. Reconnect all plugs and switch on the 24 V supply.
13. If the firmware downgrade was successful, the Control Unit responds after a few seconds with the RDY LED lighting up 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 contained a data backup: ⇒ The converter has taken over the settings from the memory card.
- There was no data backup on the memory card: ⇒ The converter has the factory settings.

14. 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.

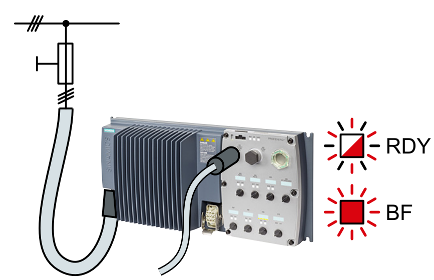
Downloading the converter settings (Page 308).

You have downgraded the converter firmware to an older version.
❒

10.5.5 Correcting a failed firmware upgrade or downgrade

How does the converter report a failed upgrade or downgrade?

The converter signals a failed firmware upgrade or downgrade with a quickly flashing RDY LED and a lit up BF LED.



Correcting a failed upgrade or downgrade

To correct a failed firmware upgrade or downgrade you can check the following:

- Does the firmware version fulfill the requirements of your converter?
  - For an upgrade at least V4.5.
  - For a downgrade at least V4.6.
- Have you inserted the card properly?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

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. Only check the direction of rotation of the motor.	• Supplement the converter data • Log the new checksums • Countersignature
Replacing the Power Module.		Supplement the hardware version in the converter data
Replacing the motor with an identical pole pair number		No change.
Replace the gearbox with an identical ratio		
Replacing safety-related I/O devices (e.g. Emergency Stop switch).	No. Only check the control of the safety functions that are influenced by the components that have been replaced.	No change.
Converter firmware update.	No.	• Supplement firmware version in the converter data • Log the new checksums • Countersignature.

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.
❒

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?

Technical data 11

11.1 Performance ratings Control Unit

Performance ratings

Table 11-1 Control Unit performance ratings

Feature	Specification	
24 V power supply IN	External supply 24 V DC (20.4 V ... 28.8 V) via X01 connector.	
	Maximum current consumption of unswitched power supply 1L+ (supplies control unit, encoder and fan)	1.2 A
	Maximum current consumption of switched power supply 2L+ (supplies the two digital outputs)	1 A
	Maximum load of the X01 connector (due to daisy chaining)	8 A
	The converter is fully protected against reverse voltage	
24 V power supply OUT	The converter is fully protected against short circuit	
Setpoint resolution	0.01 Hz digital; 0.01 Hz serial	
Digital inputs	6 programmable digital inputs • Voltage: ≤ 30 V • Voltage for "low" state: < 7,4 V • Voltage for "high" state: > 15 V • Current for 24 V input voltage: 3.5 mA ... 6.3 mA • Minimum current for the "high" state: 1.6 mA ... 3.0 mA • Compatible to SIMATIC outputs	
Pulse inputs	DI 1 (X07.2) DI 3 (X08.2)	≤ 32 kHz
Digital outputs	2 programmable digital outputs • 24 V DC / 0 A ...0.5 A (resistive) • Current output ≤ 0.5 A in total when using both or a single digital output • Update time: 2 ms	
Analog inputs	2 programmable inputs 0 V ... 10 V with 12 bit resolution. Max. 10 mA	
Encoder interface	• HTL bipolar, ≤ 2048 pulses, ≤ 100 mA, e. g. SIEMENS encoders 1XP8001-1, 1XP80X2-1X. • Max. cable length: 30 m shielded	

Feature	Specification
Temperature sensor	• PTC: Short-circuit monitoring < 22 Ω, switching threshold: 1650 Ω • KTY84: Short-circuit monitoring < 50 Ω, Short-circuit monitoring: > 2120 Ω • Pt1000: Short-circuit monitoring < 603 Ω, Short-circuit monitoring: > 2120 Ω • Temperature sensor with dry contact
Fail-safe input	• DI 4 and DI 5 form the fail-safe digital input. • Maximum input voltage 30 V, 5.5 mA • Response time: – Typical: 5 ms + debounce time p9651 – Typical, if debounce time = 0: 6 ms – Worst-case scenario: 15 ms + debounce time – Worst case, if debounce time = 0: 16 ms • You will find the extended function data in the "Safety Integrated" Function Manual.
PFH	5 × 10E-8 Probability of failure of the fail-safe functions (Probability of Failure per Hour)
USB interface	Mini-B (not available on the push-pull variants of the control unit)

11.2 Performance ratings Power Module

Performance ratings

Table 11-2 Power Module performance ratings

Feature	Specification
Line voltage & power ranges	3 AC 380 V ... 500 V ± 10 % High Overload: 0.75 kW ... 7.5 kW (1.0 hp ... 10.0 hp)
Line specification	Relative short-circuit voltage of a transformer $u_k \leq 1\%$ The specification only refers to the total instantaneous regenerative feed-back, however not to the total connected power of all of the power modules connected to the same transformer.
Output voltage	3 AC 0 V ... line volage × 0.87 (max.)
Input frequency	47 Hz ... 63 Hz
Output frequency	0 Hz ... 240 Hz
cos φ	1.05
Converter efficiency	95 % ... 97 %
Overload capability (HO)	2 x Nominal output current for 3 seconds followed by 1.5 x Nominal output current for 57 seconds every 300 seconds
Inrush current	Less than rated input current
Pulse frequency	4 kHz (standard); 4 kHz ... 16 kHz (in 2 kHz steps)
Electromagnetic compatibility	Internal Class A filters according to EN 55011
Protection level	IP65 (when Power Module and Control Unit is fully assembled)
Temperature range	Standard CU: -10 °C ... +40 °C (14 °F ... 104 °F) - High Overload (HO) Fail-Safe CU: 0 °C ... +40 °C (32 °F ... 104 °F) - High Overload (HO)
Storage temperature	-40 °C ... +70 °C (-40 °F ... 158 °F)
Humidity	< 95% RH - non-condensing
Operational altitude	Up to 1000 m (3280 ft) above sea level without derating
Protection features	Undervoltage, Overvoltage, Overload, Ground faults, Short circuit, Stall prevention, Motor blocking protection, Motor overtemperature, Power Module overtemperature, Parameter interlock
Standards	UL, cUL, CE, C-tick
CE mark	Conformity with EC Low Voltage Directive 73/23/EEC and filtered versions also Electromagnetic Compatibility Directive 89/336/EEC
Brake voltage	180 V DC (400 V half-wave rectified) 1 A maximum The UL approved current rating for the brake output is 600 mA.
Standby current	If the converter is powered-up, but the motor is still switched off, the converter requires a standby current. You have to consider the standby current when calculating the size of the conductors and selecting the correct protective devices on the line supply.

Further information in the internet:

- FAQ (http://support.automation.siemens.com/WW/view/en/34189181)
- Standby currents for PM250D (http://support.automation.siemens.com/WW/view/en/31764702)

11.3 SINAMICS G120D specifications

Power Module Specifications

Table 11-3 Power Module Frame Sizes A and B, 3 AC 380 V ... 500 V, ± 10 %

Article No.	6SL3525 -	0PE17-5AA1	0PE21-5AA1	0PE23-0AA1
Output Rating (HO)	[kW]	0.75	1.5	3
Output Power	[kVA]			
Rated Input Current	[A]	2.1	3.8	7.2
HO Output Current	[A]	2.2	4.1	7.7
Weight (nett)	[kg]	5.5	5.5	8.5
	[lbs]	12.1	12.1	18.7
Weight (packed)	[kg]	6.5	6.5	9.5
	[lbs]	14.3	14.3	20.9

Table 11-4 Power Module Frame Sizes C, 3 AC 380 V ... 500 V, ± 10 %

Article No.	6SL3525 -	0PE24-0AA1	0PE25-5AA1	0PE27-5AA1
Output Rating (HO)	[kW]	4	5.5	7.5
Output Power	[kVA]			
Rated Input Current	[A]	9.5	12.2	17.7
HO Output Current	[A]	10.2	13.2	19
Weight (nett)	[kg]	9.5	9.5	9.5
	[lbs]	20.9	20.9	20.9
Weight (packed)	[kg]	10.5	10.5	10.5
	[lbs]	23.1	23.1	23.1

11.4 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 (http://support.automation.siemens.com/WW/view/en/94059311)

11.5 Ambient operating conditions

Temperature

The operating temperature range is shown diagramatically in the figure below:

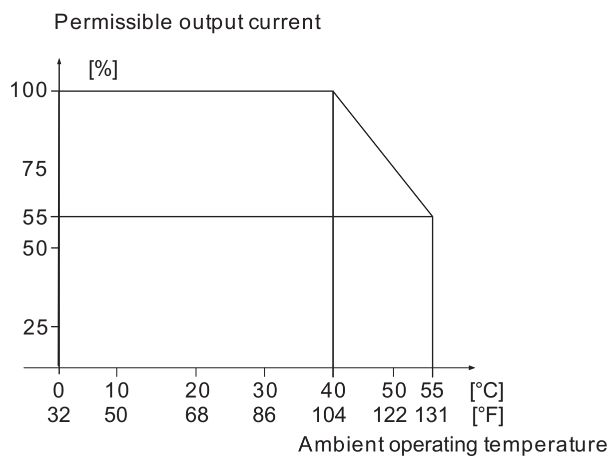


Figure 11-1 Power derating for temperature

Humidity range

Relative air humidity for the converter is ≤ 95 % non-condensing.

Shock and vibration

Do not drop the converter or expose to sudden shock. Do not install the converter in an area where it is likely to be exposed to constant vibration.

Electromagnetic radiation

Do not install the converter near sources of electromagnetic radiation.

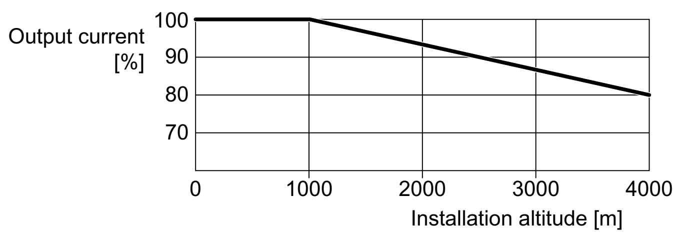
Atmospheric pollution and water

When fully assembled the converter has an IP65 rating. This means that the converter is totally protected against dust and low pressure jets of water. Any unused connections should be covered with the correct sealing caps to ensure the IP65 rating.

11.6 Current derating as a function of the installation altitude

Current derating depending on the installation altitude

The permissible converter output current is reduced above an installation altitude of 1000 m.



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.

11.7 Pulse frequency and current reduction

Pulse frequency and current reduction

Table 11-5 Current reduction depending on pulse frequency

Power rating at 400 V	Frame size	Converter current rating	Output current at pulse frequency of					
		at 4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
kW		A	A	A	A	A	A	A
0.75	A	2.2	1.9	1.5	1.3	1.1	1.0	0.9
1.5	A	4.1	3.5	2.9	2.5	2.1	1.8	1.6
3	B	7.7	6.5	5.4	4.6	3.9	3.5	3.1
4	C	10.2	8.7	7.1	6.1	5.1	4.6	4.1
5.5	C	13.2	11.2	9.2	7.9	6.6	5.9	5.3
7.5	C	19	19	19	17.6	16.3	14.9	13.5

11.8 Electromagnetic Compatibility

The SINAMICS G120 drives have been tested in accordance with the EMC Product Standard EN 61800-3:2004.

Details see declaration of conformity

Precondition

Install the converter in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Use screened cable type CY.

Maximal cable length is 15 m.

Description

Table 11-6 Compliance Table

Category C2 - First Environment - Professional Use	
Article number	Remark
6SL3525-0PE17- . **A** . 0 6SL3525-0PE21- . **A** . 0 6SL3525-0PE23- . **A** . 0 6SL3525-0PE24- . **A** . 0 6SL3525-0PE25- . **A** . 0 6SL3525-0PE27- . **A** . 0	Converter with integrated Class A filter. The converter meets the requirements for category C2 for conducted emissions. In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.

Caution

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

Precondition

Install the drive in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Use screened cable type CY. The maximal cable length is 15 m.

Do not exceed the default switching frequency 4 kHz.

EMC Emissions

Table 11-7 Conducted disturbance voltage and radiated emissions

EMC Phenomenon	Converter type Remark	Level acc. to IEC 61800-3
Conducted emissions (disturbance voltage)	All converters with integrated class A filters. Article number: 6SL3525-0PE . . - . **A** . .	**Category C2** First Environment - Professional Use
Radiated emissions	Converter frame sizes A, B and C with integrated class A filter. Article number: 6SL3525-0PE17- . **A** . . 6SL3525-0PE21- . **A** . . 6SL3525-0PE23- . **A** . . 6SL3525-0PE24- . **A** . . 6SL3525-0PE25- . **A** . . 6SL3525-0PE27- . **A** . . In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.	**Category C2** First Environment - Professional Use

Caution

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

Harmonic Currents

Units installed within the category C2 (domestic) environment require supply authority acceptance for connection to the public low-voltage power supply network. Please contact your local supply network provider.

Units installed within the category C3 (industrial) environment do not require connection approval.

To determine the harmonics currents, use the PC tool SIZER:

Download SIZER (http://support.automation.siemens.com/WW/view/en/10804987/130000)

EMC Immunity

The converter has been tested in accordance with the immunity requirements of category C3 (industrial) environment.

The immunity requirements apply equally to both filtered and unfiltered converters.

Table 11-8 EMC Immunity

EMC Phenomenon	Standard	Level	Performance Criterion
Electrostatic Discharge (ESD)	EN 61000-4-2	4 kV Contact discharge	A
		8 kV Air discharge	
Radio-frequency Electromagnetic Field	EN 61000-4-3	80 MHz ... 1000 MHz 10 V/m	A
Amplitude modulated		80 % AM at 1 kHz	
Fast Transient Bursts	EN 61000-4-4	2 kV @ 5 kHz	A
Surge Voltage	EN 61000-4-5	1 kV differential (L-L)	A
1.2/50 µs		2 kV common (L-E)	
Conducted	EN 61000-4-6	0.15 MHz ... 80 MHz 10 V/rms	A
Radio-frequency Common Mode		80 % AM at 1 kHz	
Mains Interruptions & Voltage Dips	EN 61000-4-11	95 % dip for 3 ms	A
		30 % dip for 10 ms	C
		60 % dip for 100 ms	C
		95 % dip for 5000 ms	D
Voltage Distortion	EN 61000-2-4	10 % THD	A
Voltage Unbalance	EN 61000-2-4	3 % Negative Phase Sequence	A
Frequency Variation	EN 61000-2-4	Nominal 50 Hz or 60 Hz (± 4 %)	A
Commutation Notches	EN 60146-1-1	Depth = 40 %	A
		Area = 250 % x degrees	

11.9 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.

Requirement

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 μT (RMS) for the assessment of active implants.
   According to Directive 2013/35/EU, 500 μT (RMS) at 50 Hz is applicable here.
4. 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
5. The routing of power cables has a significant impact on the electromagnetic fields that occur. Install and operate the components in compliance with what is specified in the documentation and use shielded motor cables.
   Basic EMC Rules (Page 38)

Description

The following information regarding electromagnetic fields relates solely to converters supplied by Siemens.

The converters are normally used in machines. The assessment and testing is based on DIN EN 12198.

The indicated minimum distances apply to the head and complete torso of the human body. Shorter distances are possible for extremities.

Table 11-9 Minimum distances to the converter

Individuals without active implants	Individuals with active implants
Forearm length (approx. 35 cm)	Must be separately assessed depending on the active implant.

Appendix

A

A.1 New and extended functions

A.1.1 Firmware version 4.7 SP13

Table A-1 New functions and function changes in firmware 4.7 SP13

	Function	SINAMICS								
					G120				G120D	
		G115D	G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	SIMOTICS 1FP1 and 1FP3 synchronous-reluctance motors have also been approved for operation with SINAMICS G120C.	-	✓	✓	✓	✓	✓	-	✓	-
2	The extended safety functions SS1, SLS, SSM and SDI are approved when using synchronous-reluctance motors from Siemens and third-party manufacturers.	-	-	-	-	-	✓	-	✓	-
3	The converter transmits the state of the fail-safe digital input F-DI 0 via PROFIsafe when using the basic functions. You can find more information in the "Safety Integrated" Function Manual. "Safety Integrated" function manual (https://support.industry.siemens.com/cs/ww/en/view/109751320)	✓	✓	✓	-	-	✓	✓	✓	✓
4	Modbus RTU: The converter supports the combination "1 stop bit" and "no parity".	-	-	✓	✓	✓	✓	✓	-	-
5	EtherNet/IP: When selecting the ODVA AC/DC drive profile, although telegram 1 is predefined, 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 (https://support.industry.siemens.com/cs/ww/en/view/109751350) EDS (https://support.industry.siemens.com/cs/ww/de/view/78026217)	✓	✓	✓	✓	-	✓	✓	✓	✓

A.1.2 Firmware version 4.7 SP10

Table A-2 New functions and function changes in firmware 4.7 SP10

	Function	SINAMICS								
				G120				G120D		
		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. "04070901" is equivalent to firmware version V4.7 SP9 HF1, for example	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Modbus RTU: • 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: • New factory setting for more robust converter operation: – Baud rate p2020 = 38.4 kBd – Monitoring time for data failure at the BACnet interface was increased: p2040 = 10 s – Factory setting for the maximum number of info frames p2025 [1] = 5 – Factory setting for the maximum number of master addresses p2025 [3] = 32 • r2057 indicates how the address switch on the converter is set	-	-	✓	-	-	-	-	-	-
4	Further technological unit kg/cm² for unit switchover	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Further technological unit kg/cm² for additional technology controllers	-	-	✓	-	-	-	-	-	-

	Function	SINAMICS								
				G120				G120D		
6	Commissioning with predefined motor data for SIMOTICS GP/SD synchronous-reluctance motors: • Second generation: 1FP1 . 04 → 1FP1 . 14 • Further frame sizes: – 1.1 kW ... 3 kW, 1500 1/min, 1800 1/min, 2810 1/min – 0.75 kW ... 4 kW, 3000 1/min, 3600 1/min • In planning: – 37 kW ... 45 kW, 1500 1/min, 1800 1/min, 2810 1/min – 5.5 kW ... 18.5 kW, 3000 1/min, 3600 1/min – 45 kW, 3000 1/min, 3600 1/min – The predefined motor data is already included in the firmware	✓	-	✓	-	✓ 1)	-	✓	-	-
7	Extended setting option for evaluating the STOP cam in the "basic positioner" function 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 (https://support.industry.siemens.com/cs/ww/en/view/109477922) Operating instructions SINAMICS G120D with CU250D-2 (https://support.industry.siemens.com/cs/ww/en/view/109477365)	-	-	-	-	-	✓	-	✓	-

1) Installation with PM240-2 or PM240P-2 Power Modules

A.1.3 Firmware version 4.7 SP9

Table A-3 New functions and function changes in firmware 4.7 SP9

	Function	SINAMICS								
				G120				G120D		
		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	-	-	✓	✓	✓	✓	-	-	-
2	Support of PM240-2 Power Modules in push-through technology, frame sizes FSD ... FSF, for the following voltages: • 3 AC 200 V ... 240 V • 3 AC 380 V ... 480 V • 3 AC 500 V ... 690 V	-	-	✓	✓	✓	✓	-	-	-
3	Shortened switch-on time for PM330 Power Modules	-	-	✓	-	-	-	-	-	-
4	Expansion of the support for 1FP1 synchronous-reluctance motor with the following converters: • SINAMICS G110M • SINAMICS G120D • SINAMICS G120 with CU240B-2 or CU240E-2 Control Unit A PM240-2 Power Module is required to operate a 1FP1 synchronous-reluctance motor with SINAMICS G120	✓	-	✓	✓	✓	-	✓	-	-
5	Support of 1FP3 synchronous-reluctance motors A PM240-2 Power Module is required to operate a 1FP3 synchronous-reluctance motor along with a selective release from SIEMENS	-	-	✓	-	-	-	-	-	-
6	Support of 1LE5 induction motors	-	✓	✓	✓	✓	✓	-	-	-
7	The converter supports forming of the PM330 Power Module DC link capacitors	-	-	✓	-	-	-	-	-	-
8	Setting option for two output reactors using parameter p0235 at the SINAMICS G120C and SINAMICS G120 with PM240-2 FSD ... FSF Power Module	-	✓	✓	✓	✓	✓	-	-	-
9	Efficiency-optimized operation of induction motors Improved method "Efficiency optimization 2"	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	New setting option for the "Technology application" p0500 = 5 during quick commissioning	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	Expansion of the available PROFIdrive telegrams in the SINAMICS G120C to include telegram 350	-	✓	✓	✓	✓	✓	-	-	-
12	An SSI encoder can be parameterized as motor encoder	-	-	-	-	-	✓	-	✓	-
13	Expansion of the "Basic positioner" function to include the feedback signal from traversing blocks to the higher-level control system	-	-	-	-	-	✓	-	✓	-
14	Feedback signal supplemented to indicate that a memory card is not inserted in the converter: • Parameter r9401 as BiCo parameter for the optional feedback signal to the higher-level control system. • New alarm A01101	✓	✓	✓	✓	✓	✓	✓	✓	✓

	Function	SINAMICS								
				G120				G120D		
15	Expansion of the "End stop control" function on the following converters: • SINAMICS G120 • SINAMICS G120C • SINAMICS G120D	✓	✓	✓	✓	✓	✓	✓	✓	-
16	Expansion of the technology controller to include the following functions: • 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	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	The converter displays the state "PROFIenergy pause" as follows: • LED RDY "green on": 0.5 s • LED RDY off: 3 s	✓	✓	✓	✓	✓	✓	✓	✓	✓

See also

Changes in the current edition (Page 3)

A.1.4 Firmware version 4.7 SP6

Table A-4 New functions and function changes in firmware 4.7 SP6

	Function	SINAMICS								
				G120				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	-	-	✓	✓	✓	✓	-	-	-
	Support of PM240P-2 Power Modules frame sizes FSD ... FSF	-	-	✓	✓	✓	-	-	-	-
	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	-	-	-	-	✓	✓	-	-	-
2	Support for Power Module PM330 JX frame size	-	-	✓	-	-	-	-	-	-
3	Support for 1PC1 induction motors	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	The control of synchronous reluctance takes into account the inductance of the output reactor.	-	-	✓	-	-	-	-	-	-
5	Support of motor temperature sensor Pt1000	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	New p4621 parameter for disabling PTC short-circuit monitoring	-	-	-	-	-	-	✓	✓	✓
7	Revision of the thermal motor model for protecting the motor against damage due to overheating in the stator or rotor	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Changing the quick commissioning in the "Standard Drive Control" application class: 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.	✓	✓	✓	✓	✓	✓	✓	-	-

See also

Changes in the current edition (Page 3)

Overview of the manuals (Page 361)

A.1.5 Firmware version 4.7 SP3

Table A-5 New functions and function changes in firmware 4.7 SP3

	Function	SINAMICS								
				G120				G120D		
		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	-	-	✓	✓	✓	✓	-	-	-
	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	-	-	-	-	✓	✓	-	-	-
2	Revised PM230 Power Module with new article numbers supported: • IP55 degree of protection: 6SL3223-0DE . . - . . **G** . • IP20 degree of protection and Push Through: 6SL321 . -1NE . . - . . **G** .	-	-	✓	✓	✓	-	-	-	-
	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	-	-	✓	-	-	-	-	-	-
4	Support of 1FP1 synchronous-reluctance motors	-	-	✓	-	-	-	-	-	-
5	Encoderless 1FG1 geared synchronous motors are supported	-	-	-	-	-	-	✓	-	-
6	Selection list for 1PH8 induction motors in the STARTER and Startdrive commissioning wizard	-	✓	✓	✓	✓	✓	-	-	-
7	Updated selection list for 1LE1 induction motors in the STARTER and Startdrive commissioning wizard	✓	✓	✓	✓	✓	✓	✓	✓	✓
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.	-	-	-	-	-	✓	-	✓	-
10	Power Module with temperature-controlled fan	✓	-	-	-	-	-	-	-	-
11	SINAMICS "Standard Drive Control" and "Dynamic Drive Control" application classes to simplify commissioning and increase the degree of ruggedness of the closed-loop motor control. The SINAMICS application classes are available with the following converters: • 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	✓	✓	-	✓	✓	✓	✓	✓	✓
13	Friction torque characteristic with automatic plotting to optimize the speed controller	✓	✓	-	✓	✓	✓	✓	✓	✓
14	Automatic optimization of the technology controller	-	-	✓	✓	✓	-	-	-	-
15	The sign of the system deviation for the additional, free technology controller 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								
				G120				G120D		
16	The technology controller output can be enabled and disabled during operation	-	✓	✓	✓	✓	✓	-	-	-
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	✓	✓	✓	✓	✓	✓	✓	✓	-
19	Fast flying restart for PM330 Power Modules: The "Flying restart" function does not have to wait for the motor demagnetization time, and identifies the motor speed without requiring a search operation.	-	-	✓	-	-	-	-	-	-
20	Load torque monitoring extended to include the following functions: • 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. Default setting of the communication via AS-i: p0015 macros 30, 31, 32 and 34	✓	-	-	-	-	-	-	-	-
25	Communication expansion via Modbus: 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	✓	✓	✓	✓	✓	✓	-	-	-
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.	✓	✓	✓	✓	✓	✓	✓	✓	✓
30	The result of the energy savings calculation for flow machines is available as a connector	✓	✓	✓	✓	✓	✓	✓	✓	✓
31	New "ppm" unit (parts per million) for unit switching	✓	✓	✓	✓	✓	✓	✓	✓	✓
32	Displaying speeds during commissioning via operator panel in units of Hz instead of rpm. Conversion from Hz to rpm via p8552	-	-	✓	-	-	-	-	-	-
33	Voltage-dependent current limit for 600V devices of Power Module PM330 and PM240-2	-	-	✓	✓	✓	✓	-	-	-

See also

Overview of the manuals (Page 361)

A.1.6 Firmware version 4.7

Table A-6 New functions and function changes in Firmware 4.7

	Function	SINAMICS							
				G120				G120D	
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Supporting the identification & maintenance datasets (I&M1 ... 4)	✓	✓	✓	✓	✓	✓	✓	✓
2	Fall in pulse rate with increased drive power required by the motor • The converter temporarily lowers the pulse frequency if required when the motor is started up, and simultaneously increases the current limit.	✓	✓	✓	✓	✓	✓	✓	✓
3	S7 communication • Direct data exchange between the converter and human-machine interface (HMI). • Increase in communication performance with the engineering tools and support of the S7 routing	✓	✓	✓	✓	✓	✓	✓	✓
4	The basic functions of Safety Integrated are unrestrictedly available in all control types with 1FK7 encoderless permanent-field synchronous motors	-	-	-	-	-	-	✓	-
5	Encoderless 1FK7 synchronous motors are supported • 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 • 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 PROFINET	✓	✓	✓	-	✓	✓	✓	✓
8	PROFIenergy Slave profile 2 and 3	✓	✓	✓	-	✓	✓	✓	✓
9	Uniform behavior for component replacement • 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.1.7 Firmware version 4.6 SP6

Table A-7 New functions and function changes in firmware 4.6 SP6

	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.1.8 Firmware version 4.6

Table A-8 New functions and function changes in Firmware 4.6

	Function	SINAMICS						
			G120				G120D	
		G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2
1	Support for the new Power Modules • PM240-2 IP20 FSB ... FSC • PM240-2 in through-hole technology FSB ... FSC	-	✓	✓	✓	✓	-	-
2	Support for the new Power Modules • PM230 in through-hole technology FSD ... FSF	-	✓	✓	✓	-	-	-
3	Motor data preassignment for the 1LA/1LE motors via code number • During quick commissioning with the operator panel, set the motor data using a code number	✓	✓	✓	✓	✓	✓	✓
4	Extension to communication via CANopen • CAN velocity, ProfilTorque, SDO channel for each axis, system test with CodeSys, suppression of ErrorPassiv alarm	✓	✓	-	-	✓	-	-
5	Extension to communication via BACnet • Multistate value objects for alarms, commandable AO objects, objects for configuring the PID controller	-	✓	-	-	-	-	-
6	Communication via EtherNet/IP	✓	✓	-	✓	✓	✓	✓
7	Skip frequency band for analog input • 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) • 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 • 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 r9734.0...14 for the status bits of the extended safety functions	-	-	-	✓	✓	✓	✓
14	Diagnostic alarms for PROFIBUS	✓	✓	✓	✓	✓	✓	✓

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.

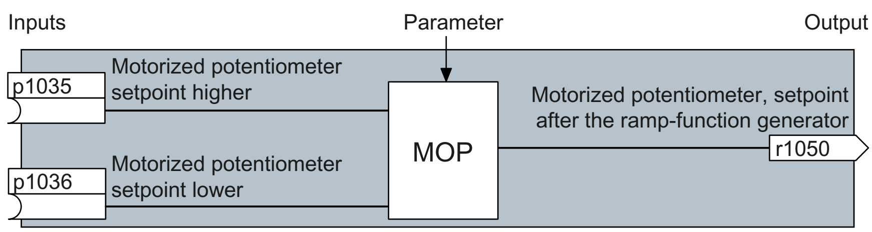


Figure A-1 Example of a block: Motorized potentiometer (MOP)

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.

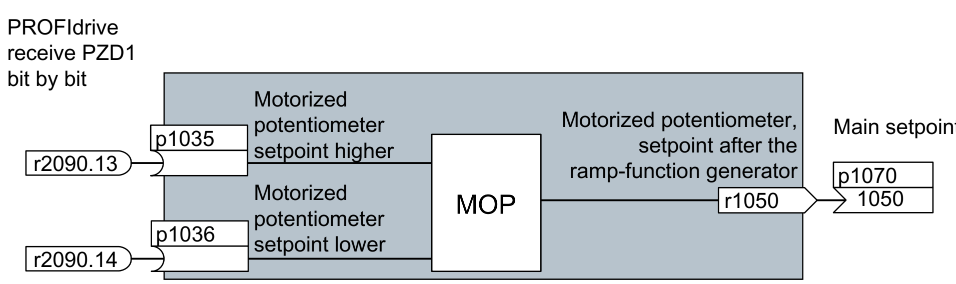


Figure A-2 Example: Signal interconnection of two blocks for digital input 0

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)

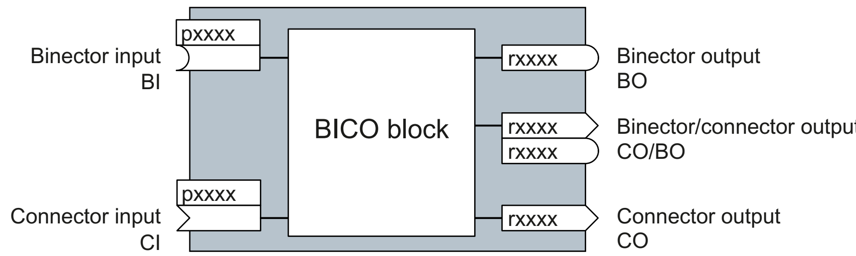


Figure A-3 Symbols for binector and connector inputs and outputs

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.2.2 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).

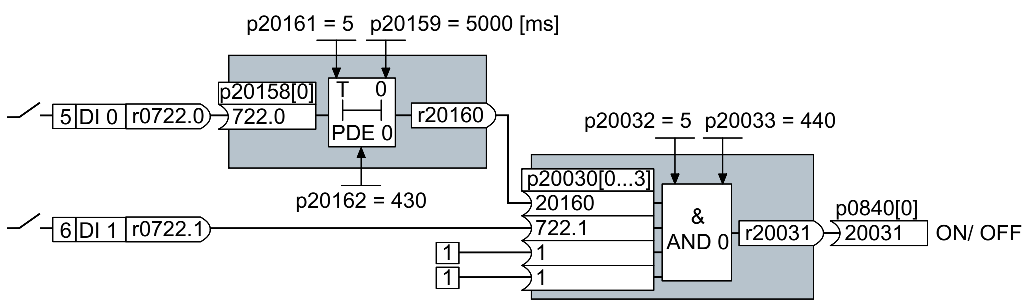


Figure A-4 Signal interconnection for control logic

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

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.

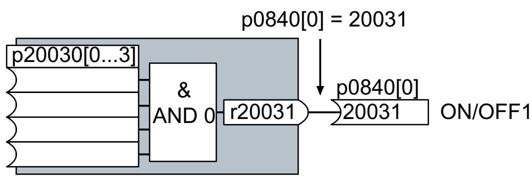


Figure A-5 Interconnecting blocks by setting p0840[0] = 20031

A.3 Connecting a failsafe digital input

The following examples show the interconnection of a failsafe digital input corresponding to PL d according to EN 13849-1 and SIL2 according to IEC61508. You can find additional examples and information in the "Safety Integrated" function manual.

Special requirements placed on EMC-compliant installation

Use shielded signal cables. Connect the shield at both conductor ends.

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

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

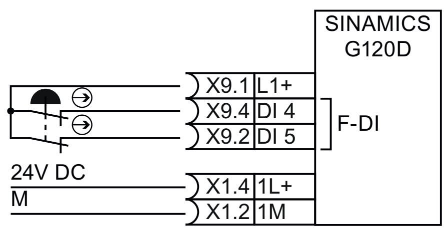


Figure A-6 Connecting a sensor, e.g. Emergency Stop mushroom push-button or limit switch

You may connect emergency stop control devices in series because it is not possible for these devices to fail and be actuated at the same time.

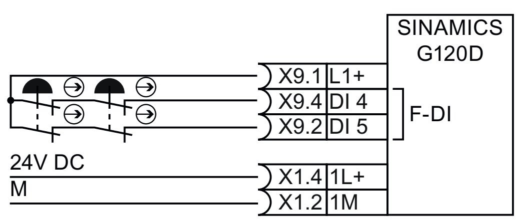


Figure A-7 Connecting electromechanical sensors in series

According to IEC 62061 (SIL) and ISO 13849-1 (PL), position switches of protective doors may also connected in series.

Exception: If several protective doors are regularly opened at the same time, it is not possible for faults to be detected, which means that the position switches must not be connected in series.

You can find additional connection options in the "Safety Integrated" Function Manual:

Overview of the manuals (Page 361)

A.4 Setting a non standard HTL encoder

Proceeding: manually configuring the encoder

1. Set p0010 = 4.
   This allows the encoder parameters to be accessed.
2. Configure the encoder using the table below.
3. Set p0010 = 0.

Parameter	Description			
p0400[0]	**Encoder type selection** (Factory setting: 0) Selects the encoder from the list of encoder types supported by the firmware of the Control Unit.			
	0	No encoder	3005	1024 HTL A/B without zero mark
	3001	1024 HTL A/B with zero mark	3007	2048 HTL A/B without zero mark
	3003	2048 HTL A/B with zero mark	9999	User-defined
p0408[0]	**Rotary encoder pulse No.** (Factory setting: 2048) Sets the number of encoder pulses.			
p0410[0]	Encoder inversion actual value (Factory setting: 0000 bin)			
	Bit 00	1 signal: Invert speed actual value		
	Bit 01	Not relevant for the CU240D-2		
p0425[0]	**Encoder, rotary zero mark distance** (Factory setting: 2048) Sets the distance in pulses between two zero marks. This information is used for zero mark monitoring.			
p0430[0]	**Sensor Module configuration** (Factory setting: 0000 0000 0000 0000 0000 0000 0000 0000 bin)			
	Bit	**Signal name**	**1 signal**	**0 signal**
	21	A one-off zero mark distance error is tolerated. In the event of a defect, the fault F3x100/F3x101 does not appear, but alarm A3x400/A3x401 does.	Yes	No
	25	Switch-off encoder voltage supply during parking	Yes	No
	A bit-wise configuration is only possible if the corresponding property is also present in r0458.			
p0437[0]	**Sensor Module configuration extended** (Factory setting: 0000 0000 0000 0000 0000 1000 0000 0000 bin)			
	Bit	**Signal name**	**1 signal**	**0 signal**
	00	Data logger	Yes	No
	01	Zero mark edge detection	Yes	No
	04	Edge evaluation bit 0	Yes	No
	05	Edge evaluation bit 1	Yes	No
	06	Freeze the speed actual value for dn/dt errors	Yes	No
	11	Fault handling after PROFIdrive	Yes	No
	12	Activate additional messages	Yes	No
	26	Deselect track monitoring	Yes	No
p0438[0]	**Squarewave encoder filter time** (Factory setting: 0.64 [μs])			
	0	No filtering		
p0439[0]	**Encoder ramp-up time** (Factory setting: 0 [ms])			
p0453[0]	**Pulse encoder evaluation zero speed measuring time** (Factory setting: 1000 [ms]) If no pulses are detected from track A/B during this time, a speed actual value of zero is output. This function is required for slow-running motors so that actual speeds close to zero can be output correctly.			

For further information, please refer to the List Manual.

A.5 Manuals and technical support

A.5.1 Overview of the manuals

Converter Manuals

- List manual SINAMICS G120D (https://support.industry.siemens.com/cs/ww/en/view/109477255)
  Parameter list, alarms and faults. Graphic function diagrams.
- Operating instructions SINAMICS G120D with CU240D-2 (https://support.industry.siemens.com/cs/ww/en/view/109477366)
  Installing, commissioning and maintaining the converter. Extended commissioning (this manual).

Supplementary manuals for converter

- "Fieldbus" function manual (https://support.industry.siemens.com/cs/ww/en/view/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.

Converter accessory manuals

- Operating instructions IOP (https://support.industry.siemens.com/cs/ww/en/view/109478559)
  Using the operator panel, mounting the door mounting kit for IOP.
- Accessories manual (https://support.industry.siemens.com/cs/ww/en/ps/13225/man)
  Descriptions of how to install converter components, e.g. line reactors and line filters. The printed installation descriptions are supplied together with the components.

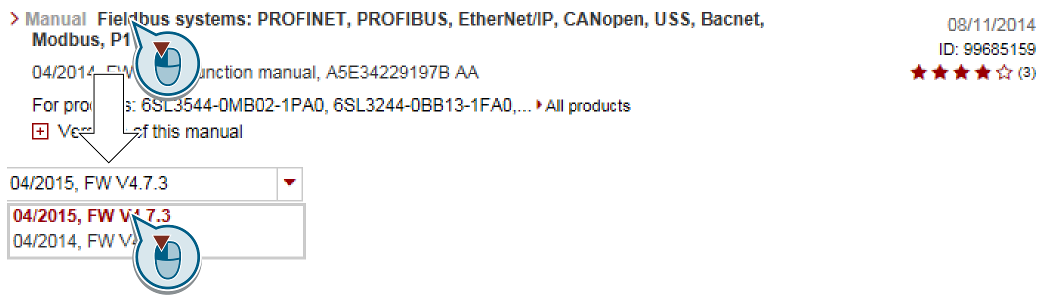
Additional information

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

EMC-compliant control cabinet design, potential equalization and cable routing.

Finding the most recent edition of a manual

If there a multiple editions of a manual, select the latest edition:

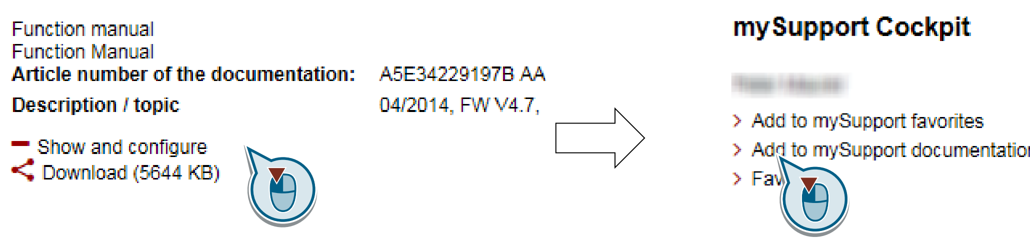


Configuring a manual

Further information about the configurability of manuals is available in the Internet:

MyDocumentationManager (https://www.industry.siemens.com/topics/global/en/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.5.2 Configuring support

Catalog

Ordering data and technical information for the converters SINAMICS G.

Catalogs for download or online catalog (Industry Mall):

Everything about SINAMICS G120D (www.siemens.com/sinamics-g120d)

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 (http://support.automation.siemens.com/WW/view/en/10804987/130000)

EMC (electromagnetic compatibility) technical overview

Standards and guidelines, EMC-compliant control cabinet design

EMC overview (https://support.industry.siemens.com/cs/ww/en/view/103704610)

EMC Guidelines configuration manual

EMC-compliant control cabinet design, potential equalization and cable routing

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

Safety Integrated for novices technical overview

Application examples for SINAMICS G drives with Safety Integrated

Safety Integrated for novices (https://support.industry.siemens.com/cs/ww/en/view/80561520)

A.5.3 Product Support

Overview

You can find additional information about the product on the Internet:

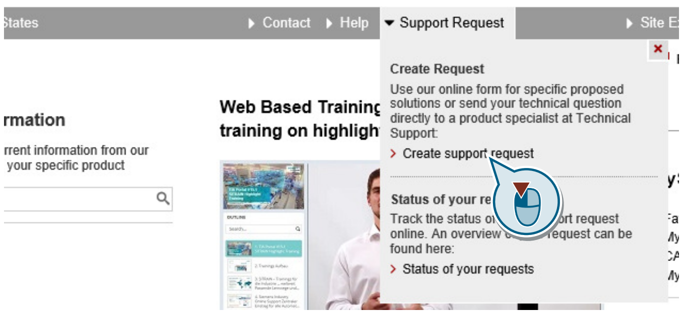
Product support (https://support.industry.siemens.com/cs/ww/en/)

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:



Index

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

Further information

SINAMICS converters:
www.siemens.com/sinamics

Safety Integrated:
www.siemens.com/safety-integrated

PROFINET:
www.siemens.com/profinet

Siemens AG
Digital Factory
Motion Control
Postfach 3180
91050 ERLANGEN
Germany

For additional information on SINAMICS G120D, scan the QR code.