SIEMENS

EPos

Operating instructions

SINAMICS

SINAMICS G120D

Distributed converter
Control Units CU250D-2 with encoder evaluation
and basic positioner EPos

Edition 04/2018

www.siemens.com/drives

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SINAMICS

SINAMICS G120D
Converter with the control units
CU250D-2

Operating Instructions

Edition 04/2018, firmware V4.7 SP10

04/2018, FW V4.7 SP10

A5E34261542B AF

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.

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Ⓟ 04/2018 Subject to change

Changes in the current edition

Notable changes since the 09/2017 edition of the Manual

New functions

Firmware version 4.7 SP10 (Page 361)

Corrections

- Both PROFINET connectors of the Control Unit are sockets (not socket and connector).

  Connections and cables (Page 51)

- Diagrams standardized for the reduction of the output current as a function of installation altitude.

  Current derating as a function of the installation altitude (Page 356)

- SSI encoders are permissible for both speed control and position control.

  Encoder assignment (Page 77)

- PROFIdrive status word 1, bit 13 corrected.

  Control and status word 1 (Page 166)

  PROFIdrive control word 2, bit 8 corrected.

  PROFIdrive status word 2, bit 7 corrected.

  Control and status word 2 (Page 168)

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

⚠WARNING
Arcing when a plug connection is opened during operation
Opening a plug connection when a system is operation can result in arcing that may cause serious injury or death.
• Only open plug connections when the equipment is in a voltage-free state, unless it has been explicitly stated that they can be opened in operation.

⚠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
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

Spread of fire from built-in devices

In the event of fire outbreak, the enclosures of built-in devices cannot prevent the escape of fire and smoke. This can result in serious personal injury or property damage.

- Install built-in units in a suitable metal cabinet in such a way that personnel are protected against fire and smoke, or take other appropriate measures to protect personnel.
- Ensure that smoke can only escape via controlled and monitored paths.

WARNING

Active implant malfunctions due to electromagnetic fields

Inverters generate electromagnetic fields (EMF) in operation. People with active implants in the immediate vicinity of this equipment are at particular risk.

- As the operator of an EMF-emitting installation, assess the individual risks of persons with active implants. The following clearances are usually adequate:
  - No clearance to closed control cabinets and shielded MOTION-CONNECT supply cables
  - Forearm length (approx. 35 cm clearance) to distributed drive systems and open control cabinets

WARNING

Unexpected movement of machines caused by radio devices or mobile phones

When radio devices or mobile phones with a transmission power > 1 W are used in the immediate vicinity of components, they may cause the equipment to malfunction. Malfunctions may impair the functional safety of machines and can therefore put people in danger or lead to property damage.

- If you come closer than around 2 m to such components, switch off any radios or mobile phones.
- 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.

⚠WARNING
Unrecognized dangers due to missing or illegible warning labels
Dangers might not be recognized if warning labels are missing or illegible. Unrecognized dangers may cause accidents resulting in serious injury or death. • Check that the warning labels are complete based on the documentation. • Attach any missing warning labels to the components, where necessary in the national language. • Replace illegible warning labels.

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

⚠ 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 (parameter assignments) 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 Industrial security

Note

Industrial security

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:

Industrial security (http://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 at:

Industrial security (http://www.siemens.com/industrialsecurity)

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, malware 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.
- Protect the drive against unauthorized changes by activating the "know-how protection" drive function.

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 and safety-related applications.

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 inverter function symbols

2.2 Guide through the manual

Section	In this section you will find answers to the following questions:
Description (Page 27)	• How is the inverter marked? • Which components make up the inverter? • Which motors can be fed from the inverter? • Which commissioning tools are there?
Installation (Page 33)	• What are the inverter dimensions? • Which mounting and installation materials are required when installing the inverter? • To which line supplies can the inverter be connected? • How is the inverter connected to the line supply? • What does EMC-compliant installation actually mean? • Which terminals and fieldbus interfaces does the inverter have? • What are the interface functions?
Commissioning (Page 73)	• Which motor data is required for commissioning • How is the inverter set in the factory? • What is the commissioning procedure? • How do you restore the inverter factory settings?
Advanced commissioning (Page 153)	• Which functions are included in the inverter firmware? • How do the functions interoperate with one another? • How are the functions set?
Backing up data and series commissioning (Page 281)	• Why is it necessary to back up the inverter settings? • Which options are available to back up the settings? • How does the data backup function? • How do you prevent the inverter settings from being changed? • How do you prevent the inverter settings from being read out?
Corrective maintenance (Page 325)	• How are inverter components replaced? • How do you change the firmware version of the inverter?
Alarms, faults and system messages (Page 299)	• What is the meaning of the LEDs provided on the inverter? • How does the system runtime respond? • How does the inverter save alarms and faults? • What do the inverter alarms and faults mean? • How are inverter faults resolved? • Which I&M data is saved in the inverter?

Section	In this section you will find answers to the following questions:
Technical data (Page 351)	• What is the inverter technical data?
Appendix (Page 361)	• What are the new functions of the current firmware? • What are the most important inverter parameters? • How does the device trace function in STARTER? • How can signal interconnections be changed in the inverter firmware? • What does "BiCo technology" mean? • Where can you find additional manuals and information about the inverter?

Description

3

Use for the intended purpose

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

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

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

Use of third-party products

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

You can use equivalent products from other manufacturers.

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

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 CU250D-2 Inverter

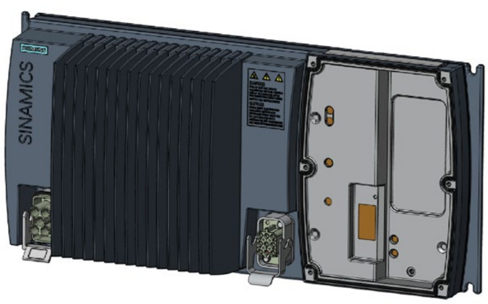
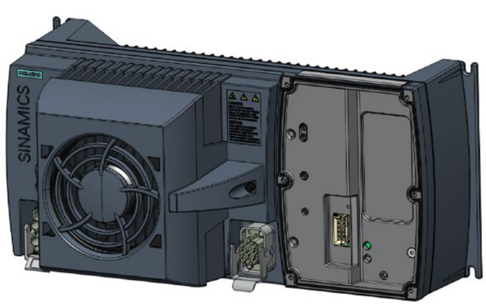
Overview

The SINAMICS G120D is a converter for controlling the position of a drive. The converter consists of two parts, the Control Unit (CU) and the Power Module (PM).

Table 3- 1 CU250D-2 Control Units

	Designation	Interface	Encoder type	Article number
	CU250D-2 DP-F	PROFIBUS	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1PA0
	CU250D-2 PN-F	PROFINET, Ether-Net/IP	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1FA0
	CU250D-2 PN-F PP	PROFINET, Ether-Net/IP Push-Pull connections	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1FB0
	CU250D-2 PN-F FO	PROFINET, Ether-Net/IP Fibre optic connections	HTL Encoder SSI Absolute Encoder	6SL3546-0FB21-1FC0

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
	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 inverters:

CE

European Low Voltage Directive

The inverters fulfil 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 inverters fulfil the requirements stipulated in the Machinery Directive 2006/42/EU, if they are covered by the application area of this directive.

However, the use of the inverters 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 inverter 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

By completely complying with IEC/EN 61800-3, it has been proven that the inverter is in compliance with directive 2004/108/EC or 2014/30/EU.

Underwriters Laboratories (North American market)

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

EMC requirements for South Korea

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

Eurasian conformity

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

Australia and New Zealand (RCM formerly C-Tick)

The inverters showing the test symbols fulfil the EMC requirements for Australia and New Zealand.

Immunity to voltage drop of semiconductor process equipment.

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

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 inverters 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 inverter.

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 inverter:

NOTICE
Insulation failure due to unsuitable third-party motor
A higher load occurs on the motor insulation in inverter mode than with line operation. Damage to the motor winding may occur as a result.
• Please observed 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 inverter. 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 inverter 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 drive 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.

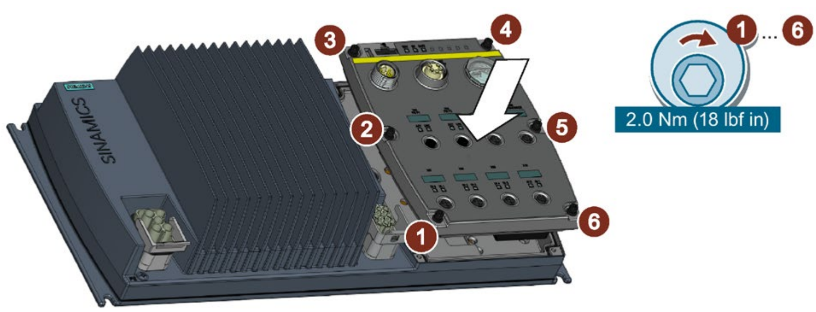


Figure 4-1 Fitting the Control Unit to the Power Module

Drill pattern and dimensions

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

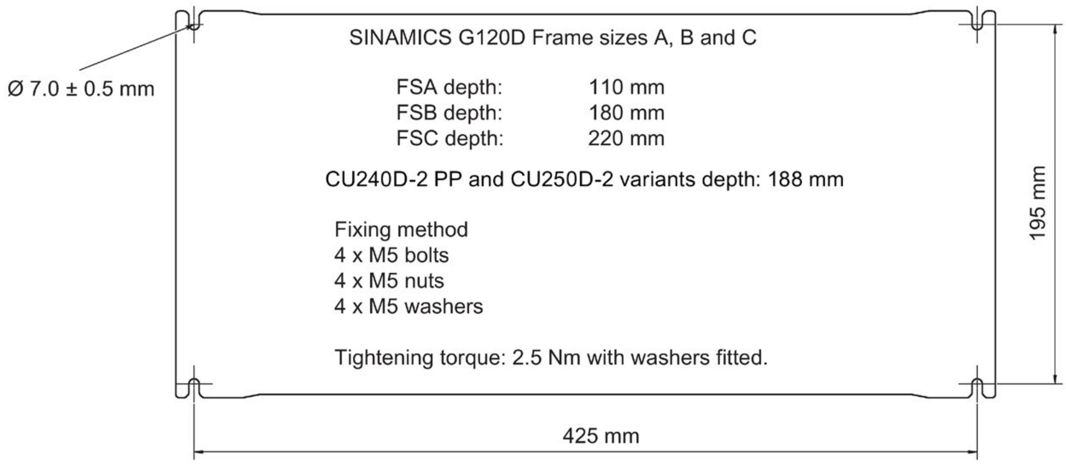


Figure 4-2 SINAMICS G120D drill pattern

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 inverter 150 mm (5.9 inches).

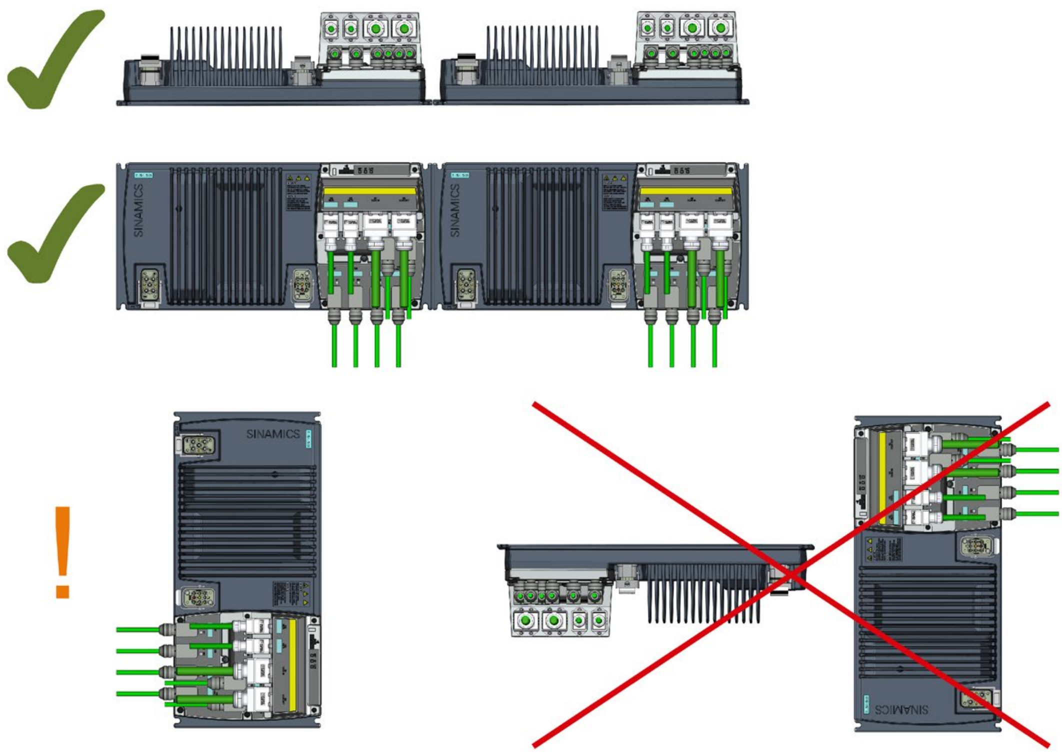


Figure 4-3 Mounting orientation: correct (✓), impermissible (X), permissible with restrictions (!)

Restrictions due to vertical mounting

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

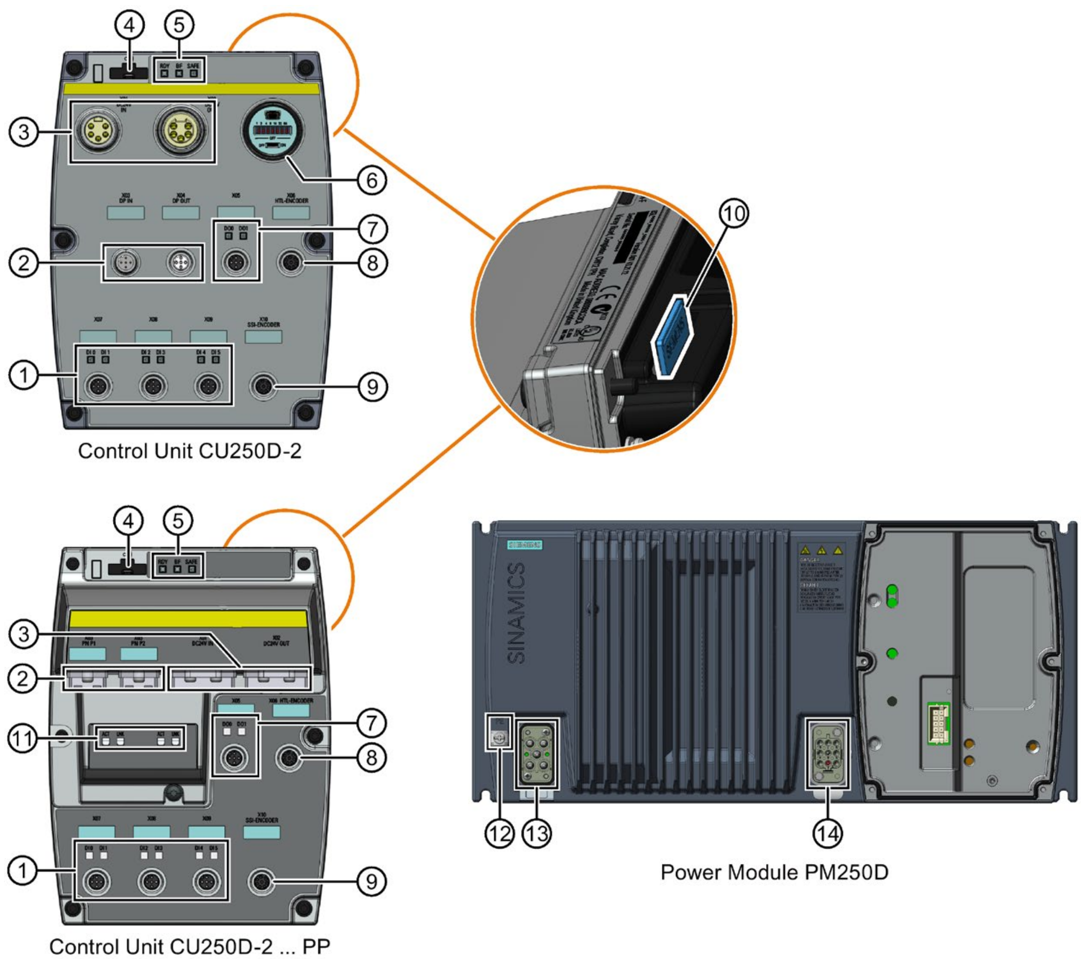
Additionally you have to reduce the converter output current to 80 % of rated converter current.

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

Interfaces of the converter



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

NOTICE
Material damage from inappropriate supply system $V_t > 1\%$
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 $V_t \leq 1\%$.

Note

Fault protection for the motor circuit

The electronic overcurrent trip complies with the requirements laid down in IEC 60364-3-2:2005/AMD1:- Section 411 for protection against electric shock.

- Observe the installation specifications provided in this manual.
- Observe the applicable installation standards.
- Ensure the continuity of the protective conductor.

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 inverter on the TN and TT line system

The inverter 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 356)

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

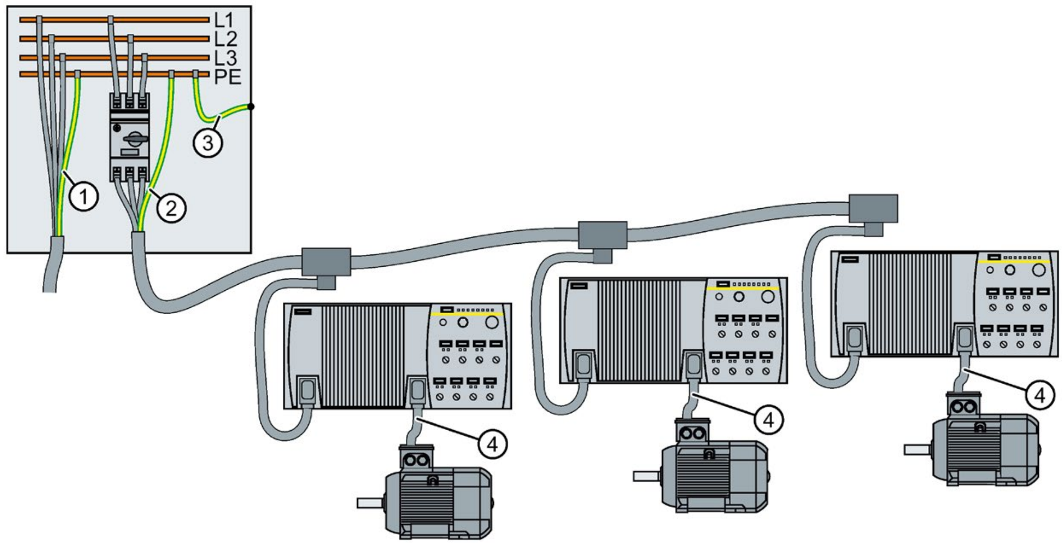
Electric shock due to interrupted protective conductor

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 inverter 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 mm^2

  ⇒ Minimum cross-section of the protective conductor = cross-section of the line or motor feeder cable

- Line feeder cable = 16 mm² … 35 mm^2

  ⇒ Minimum cross-section of the protective conductor = 16 mm^2

- Line feeder cable> 35 mm^2

  ⇒ 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.

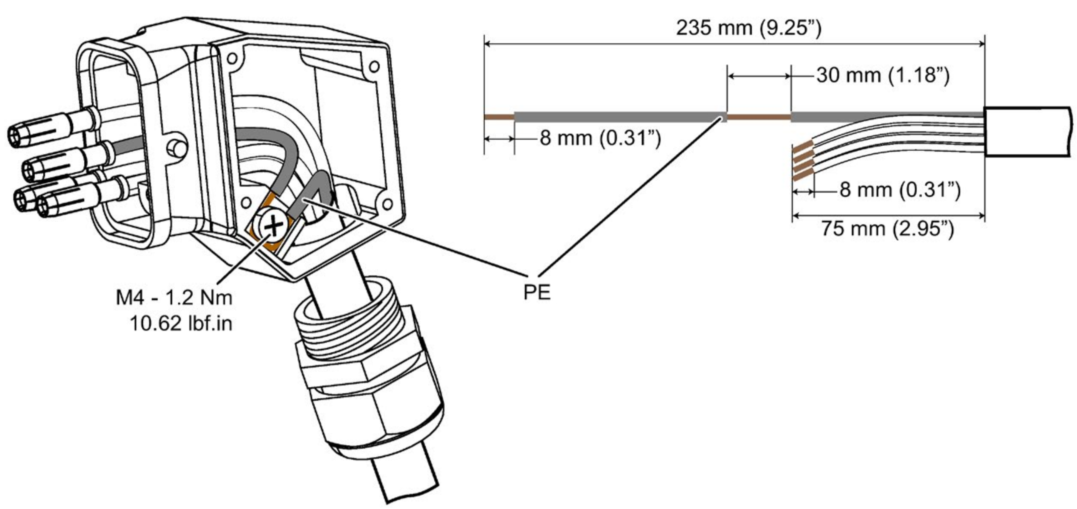
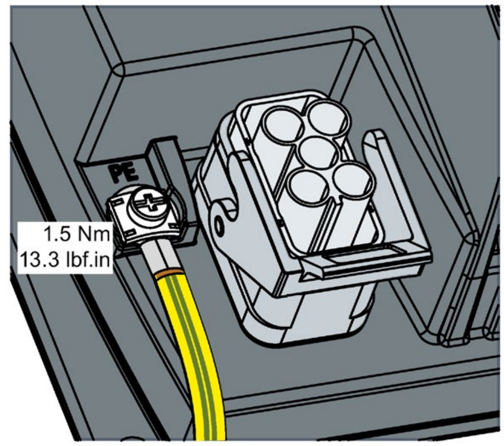


Figure 4-5 Grounding the line supply and motor connectors

- 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 Inverter 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 inverter 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 inverter.
- 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

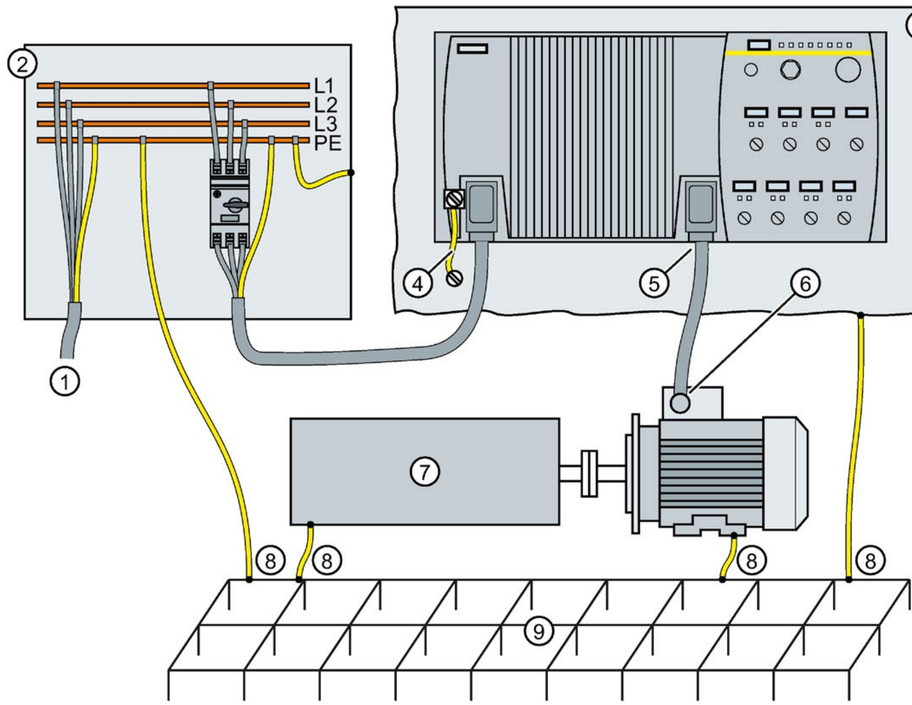
Grounding and high-frequency equipotential bonding measures

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 inverter (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 inverter and to the motor terminal box.
- Use a short grounding connection from the PE terminal on the inverter 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 system 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 inverters

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

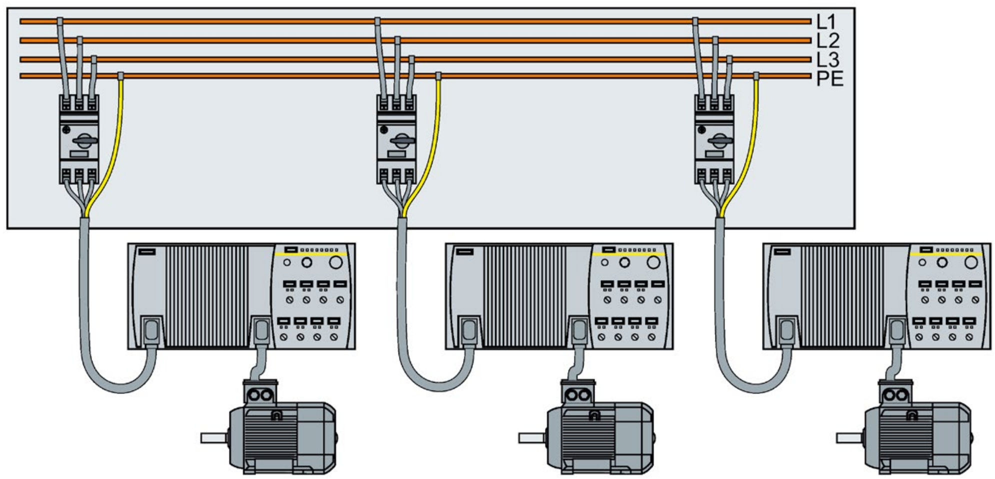


Figure 4-8 Power supply to inverters through their own dedicated 400 V branch

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

Rated power	Power Module	Frame size	Article No.	UL cat.	Max. rated current of the circuit breaker	Short circuit current rating SCCR
			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
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 3AC
			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 inverters

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

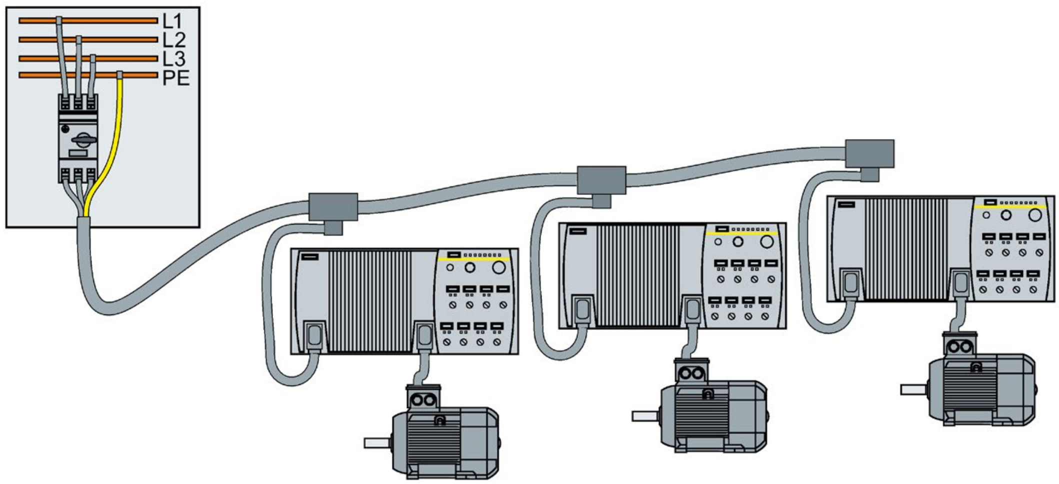


Figure 4-9 Power supply to an inverter group via a shared 400-V branch circuit

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 inverter group.
- The sum of all rated input currents must be ≤ 24 A.
- Use one of the following protection devices for the inverter 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 inverters of a group operate simultaneously, it is permissible to form larger inverter groups on one 400-V branch circuit. The sum of the input currents of all inverters 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

<table>
<tr><th>Max. rated current of the circuit breaker</th><th>Article No.</th><th>UL cat.</th><th>Short circuit current rating SCCR</th></tr>
<tr><td rowspan="2">30 A</td><td>3RV2711…</td><td>DIVQ</td><td>65 kA, 480Y/277 V AC</td></tr>
<tr><td>3RV1742…, LGG… or CED6…</td><td>DIVQ</td><td>65 kA, 480 V 3 AC</td></tr>
<tr><td rowspan="2">25 A</td><td>3RV2021-4DA…</td><td>NKJH</td><td>65 kA, 480Y/277 V AC</td></tr>
<tr><td>3RV1031-4DA… or 3RV2031-4DA…</td><td>NKJH</td><td>65 kA, 480Y/277 V AC</td></tr>
<tr><td>22 A</td><td>3RV2721…</td><td>DIVQ</td><td>50 kA, 480Y/277 V AC</td></tr>
</table>

4.2.10 24-V power supply with multiple inverters

Installation using 24 V bus

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

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 inverter.

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

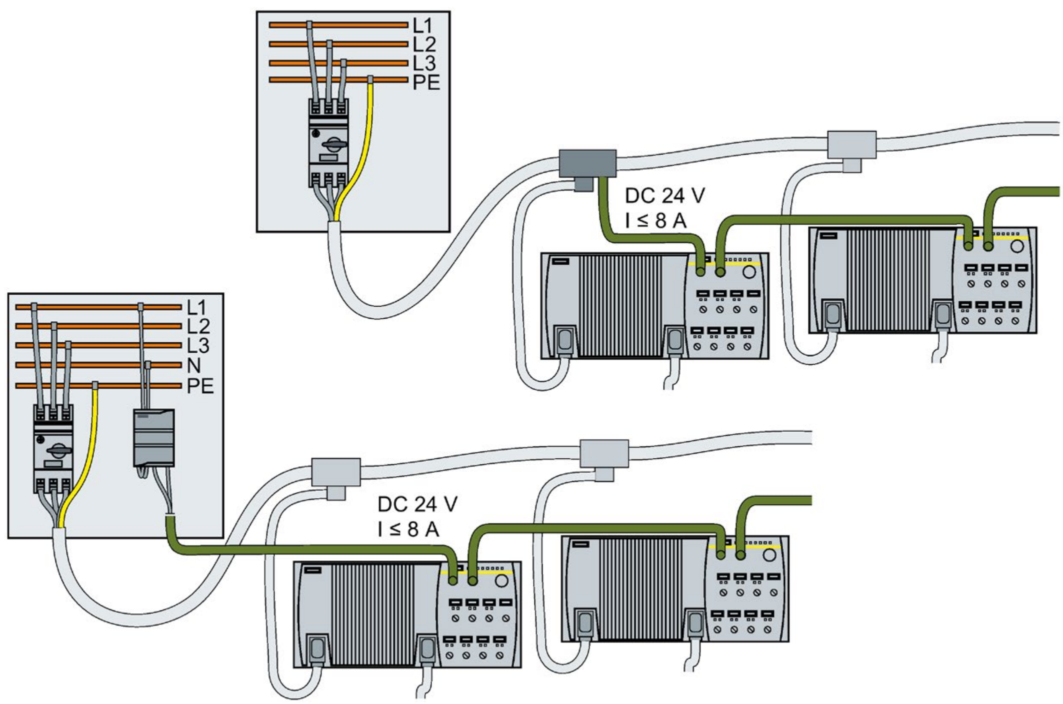


Figure 4-10 24 V bus from T distributor or with separate power supply

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 device 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 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.

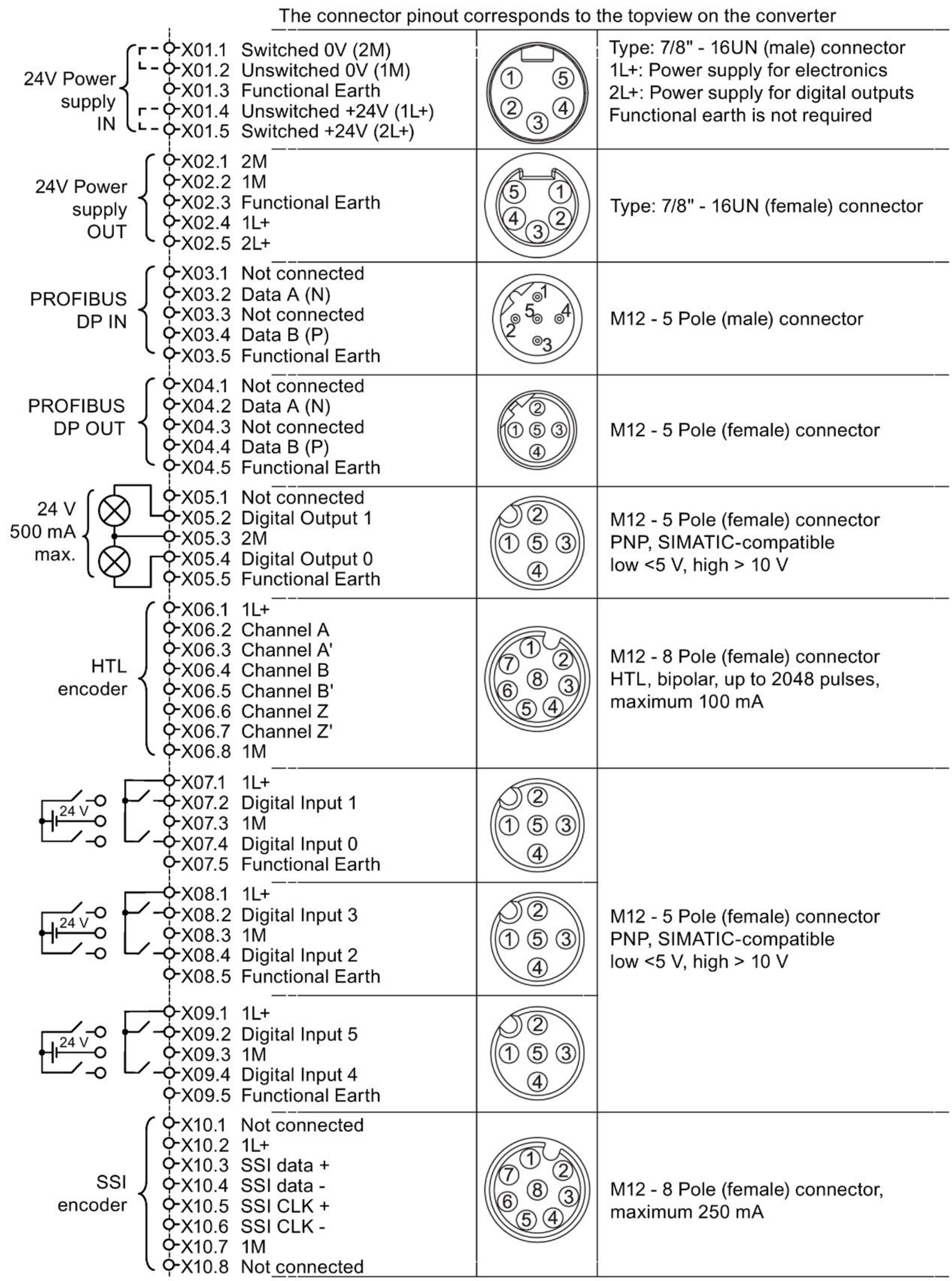


Figure 4-11 G120D CU250D-2 PROFIBUS connectors

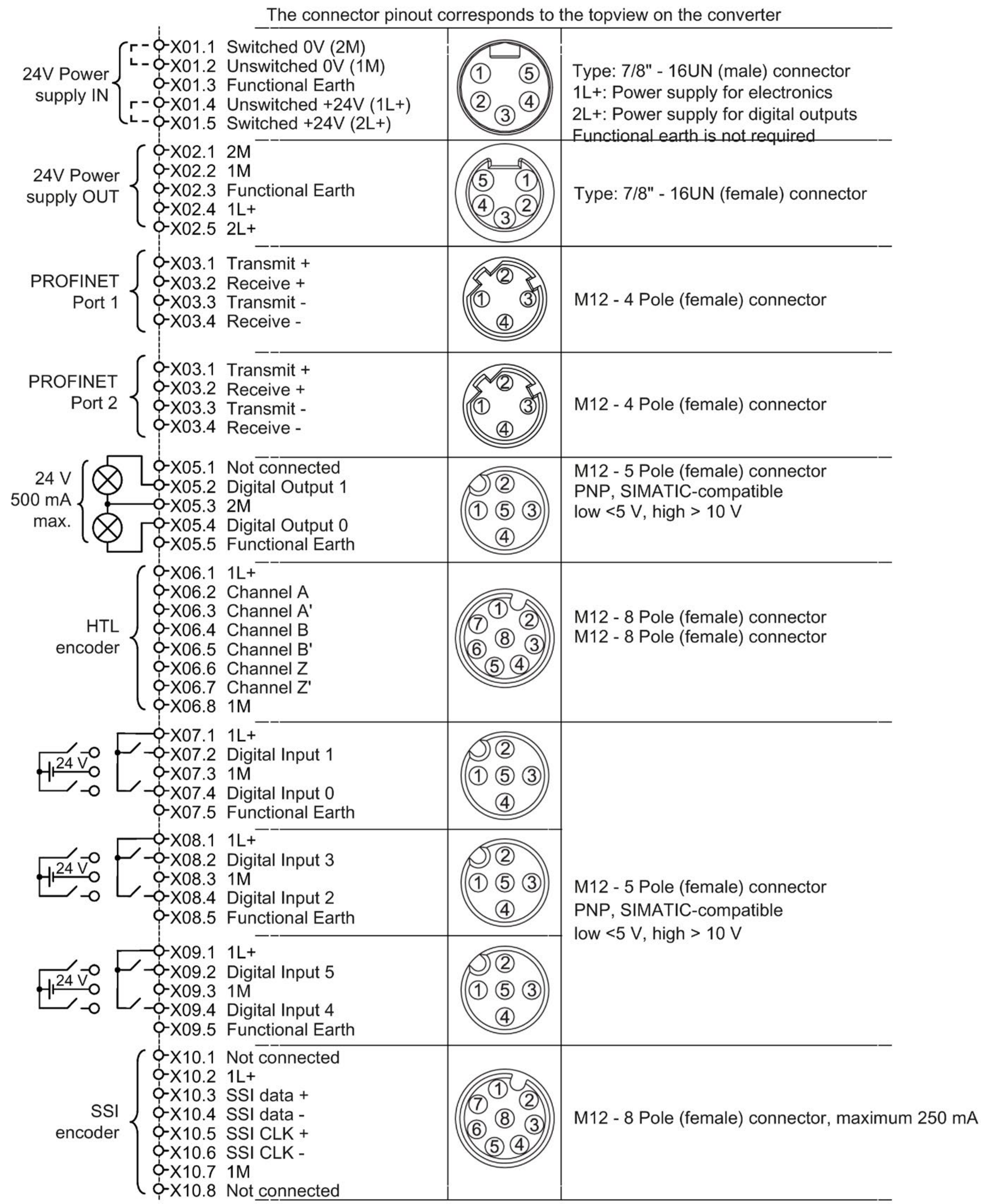


Figure 4-12 G120D CU250D-2 PROFINET connectors

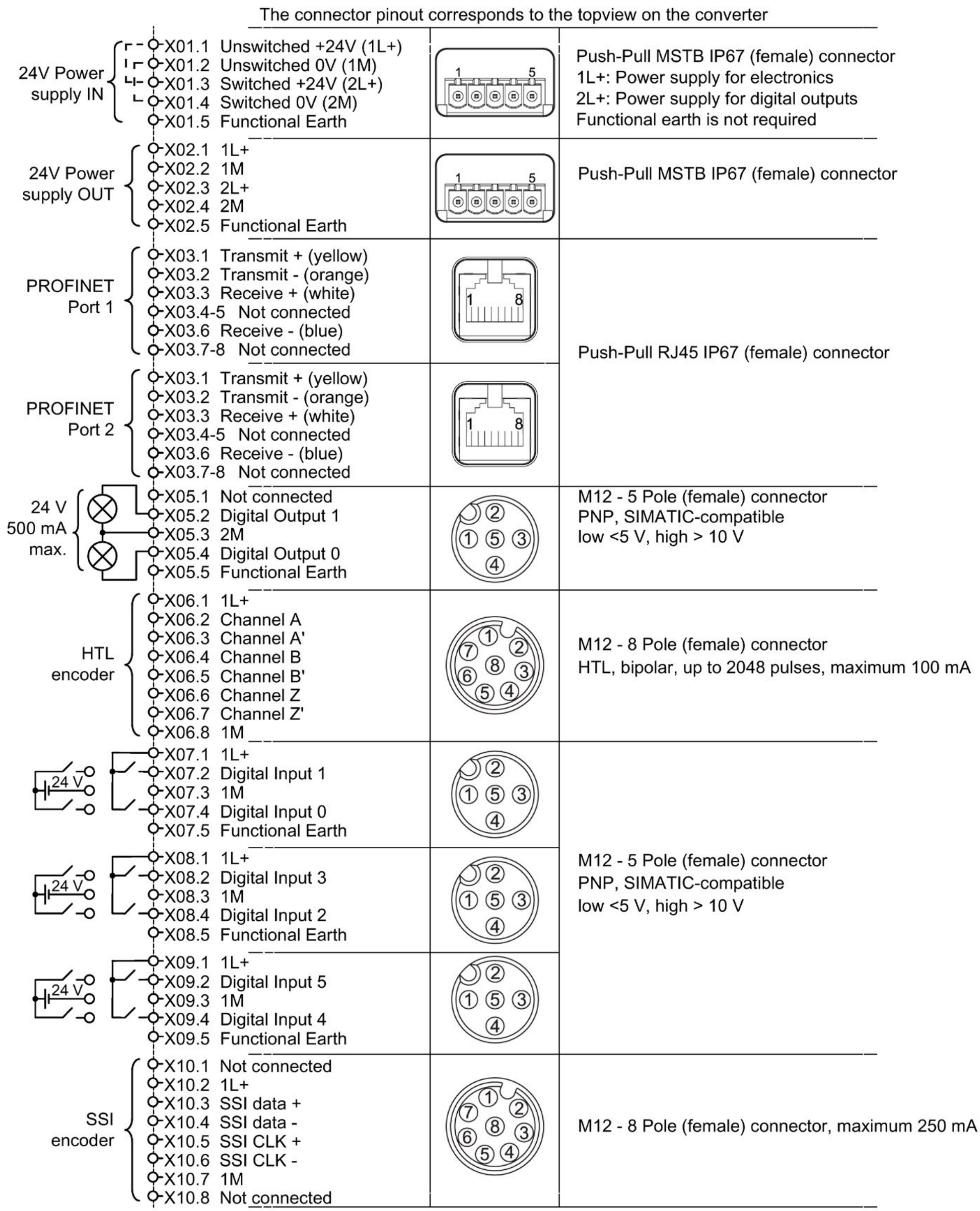


Figure 4-13 G120D CU250D-2 PROFINET Push-Pull connectors

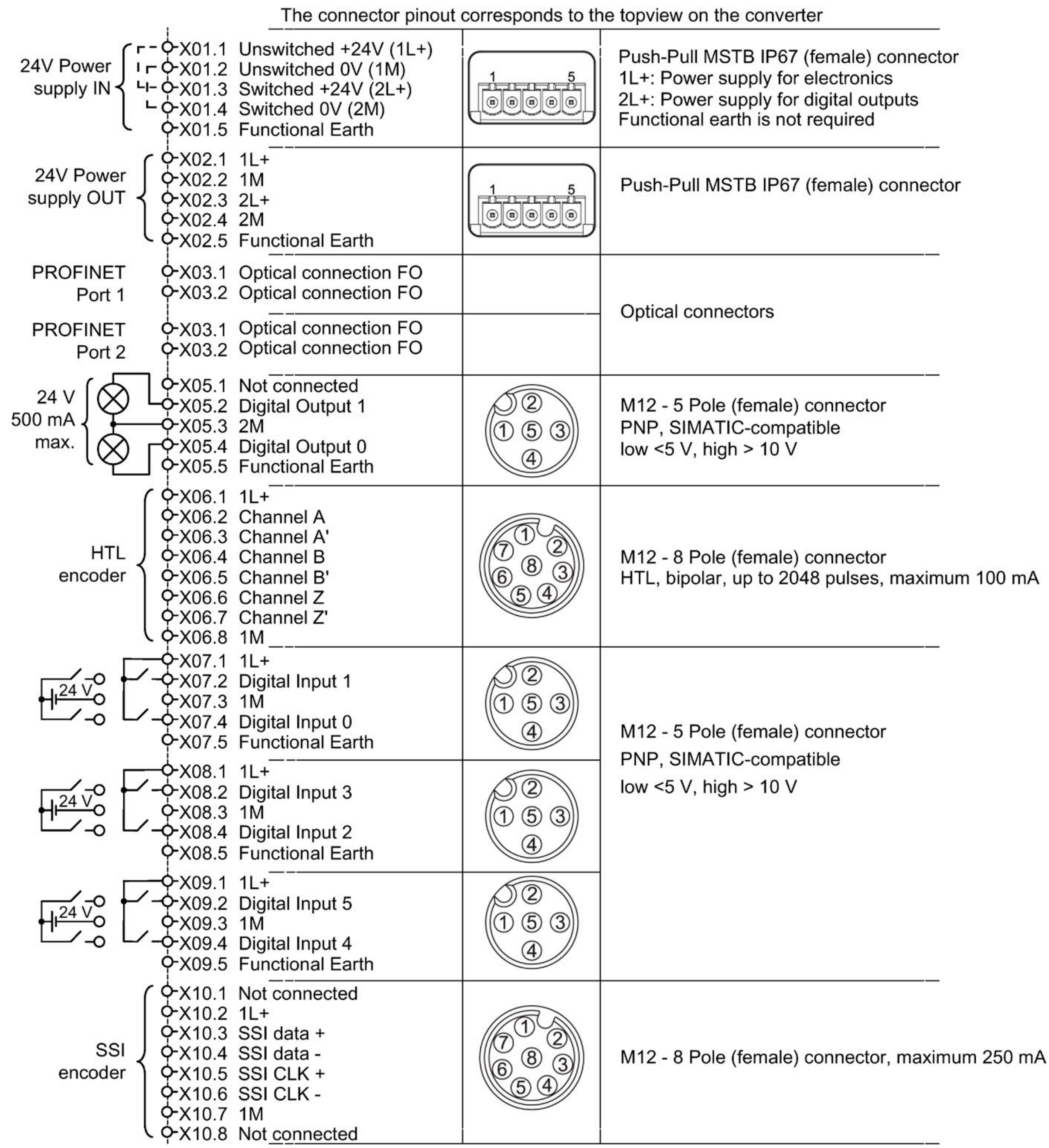


Figure 4-14 G120D CU250D-2 PROFINET FO terminal diagram

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.

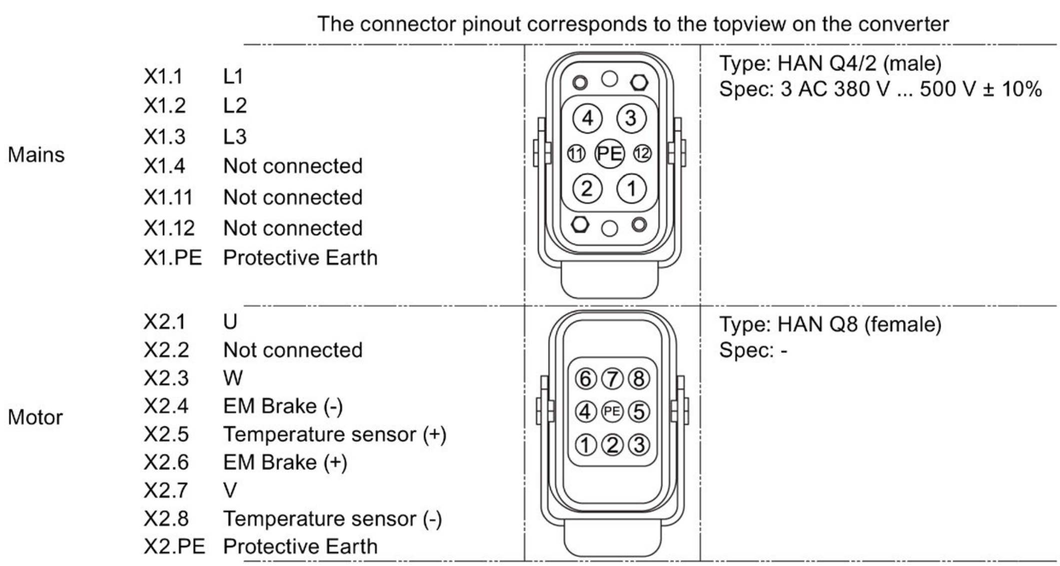


Figure 4-15 PM250D connectors

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 Inverter. 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

These devices are intended only for installation on industrial machines in accordance with the "Electrical Standard for Industrial Machinery" (NFPA79). Due to the nature of these devices they may not be suitable for installation 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
Encoder (M12)	Via KnorrTec	
Digital input and output (M12)	3RK1902-4BA00-5AA0	3RK1902-4DA00-5AA0

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 POWER 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

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)
Encoder (SSI and HTL)	Screened	30 m (98 ft)

1) The motor, temperature sensor and motor holding brake connections are all carried in a single cable which is connected to the Power Module 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 69)	✓	✓	---	✓	CU250D-2 DP-F
PROFINET (Page 65)	✓	✓	✓	✓	CU250D-2 PN-F CU250D-2 PN-F PP CU250D-2 PN-F FO
EtherNet/IP [2]	---			---	

[1] Information on PROFIsafe can be found in the "Safety Integrated" function manual.

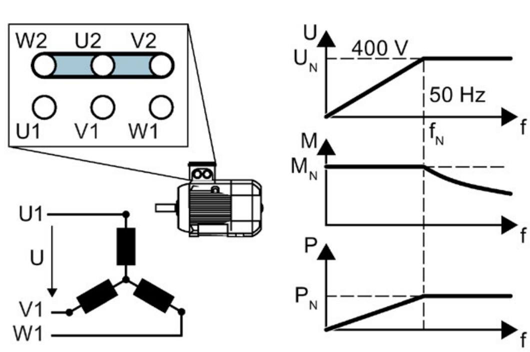
[2] Information about these fieldbuses, profiles and communication types can be found in the "Fieldbus" function manual.

Overview of the manuals (Page 389)

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

Standard induction motors with a rated power of approximately ≤ 3 kW are normally connected in a star/delta connection (Y/Δ) at 400 V/230 V. For a 400-V line supply, you can connect the motor to the inverter either in a star or in a delta connection.

Operating the motor in a star connection

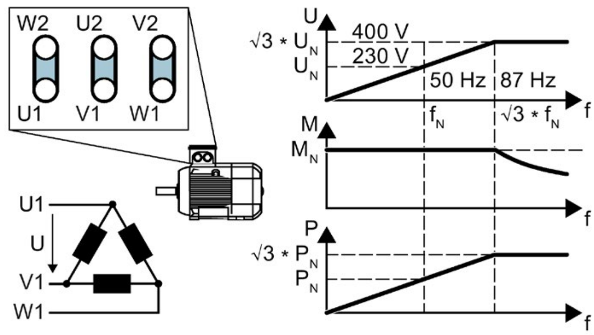


In a star connection, the motor can provide its rated torque M_N in the range 0 … rated frequency f_N.

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 linearly 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 inverter must supply approximately 1.73x current. Select an inverter 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

Device 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 device.

- 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.

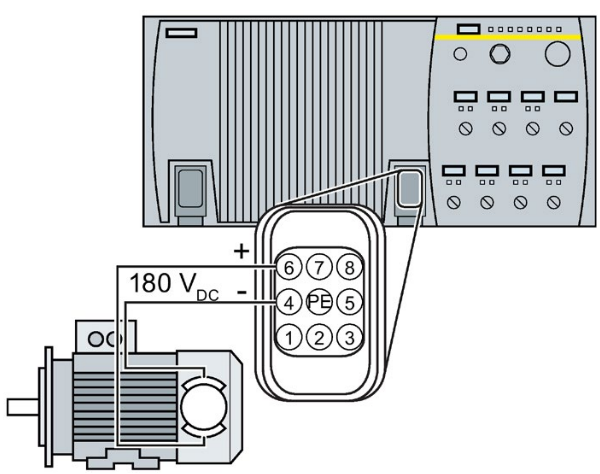


Figure 4-16 Principle of connectiong the motor holding brake to the converter

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 CU250D-2 control unit

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

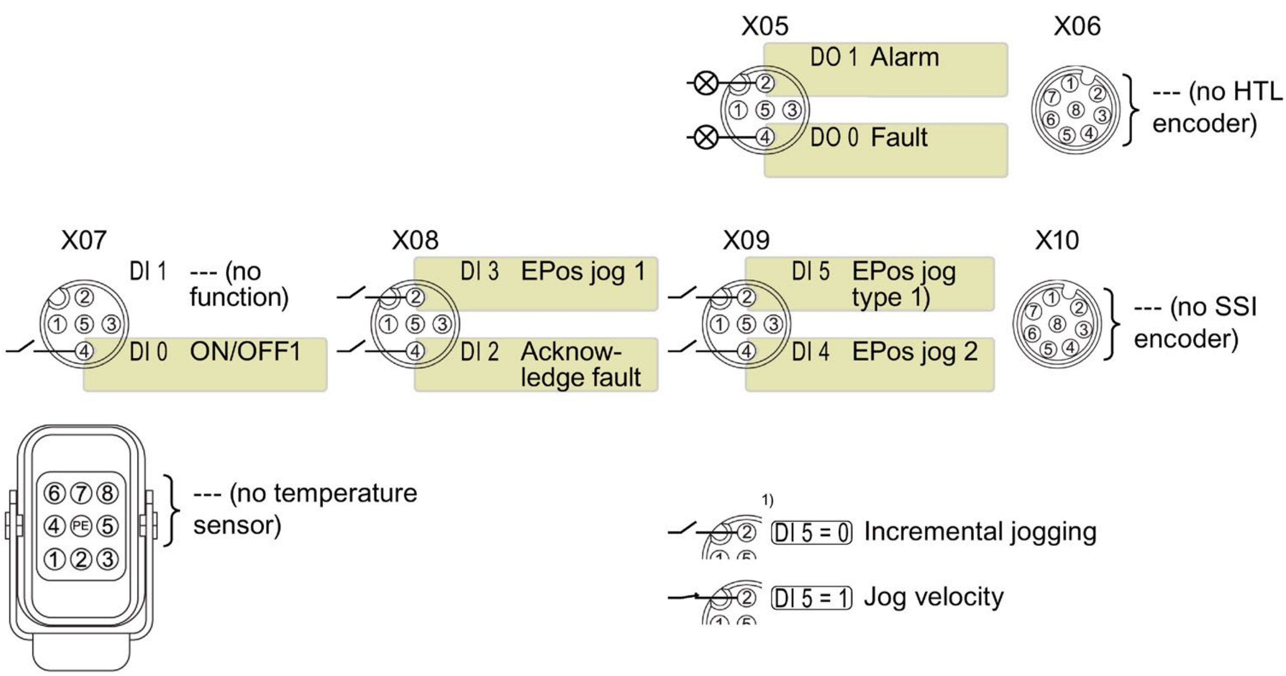


Figure 4-17 Factory settings of the CU250D-2 control units

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.

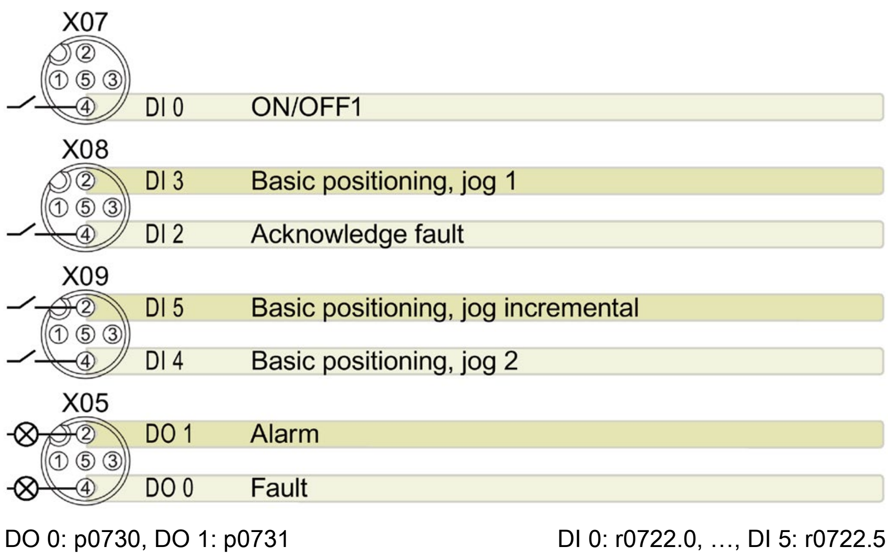
The factory setting of the inputs and outputs described above corresponds to the default setting 7 (switchover between fieldbus and a jog using DI 3).

Default settings of inputs and outputs (Page 63)

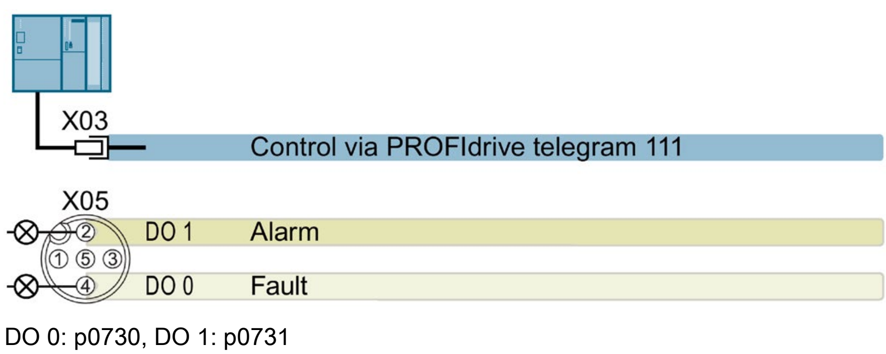
4.2.16 Default settings of inputs and outputs

Default setting 26: "EPOS without fieldbus"

Factory setting

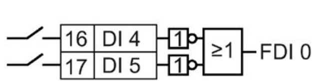


Default setting 27: "EPOS with fieldbus"



4.2.17 Fail-safe digital input

To enable a safety function via the terminal strip of the inverter, you need a fail-safe digital input.



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

Which devices are you allowed to connect?

The fail-safe digital input is designed for the following devices:

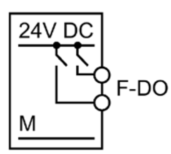
- Connection of safety sensors, e.g. emergency stop command devices or light curtains.
- Connection of pre-processing devices, e.g. fail-safe control systems and safety relays.

Signal state

The inverter expects signals with the same state at its fail-safe 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 inverter compares the two signals of the fail-safe digital input. The inverter thus detects, for example the following faults:

- Cable break
- Defective sensor

The inverter 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 reduce the risk of cable damage, you need to lay signal lines in steel pipes.

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 inverter terminals, use the shortest possible jumpers directly at the terminals themselves.

Bright and dark test

The inverter filters signal changes using bright and dark tests at the fail-safe digital input using an adjustable software filter.

Connecting a fail-safe digital input (Page 378)

4.2.18 Encoders examples

Examples

The following SSI encoders have been commissioned successfully in several applications with the CU250D-2:

Table 4- 15 SSI encoders

Manufacturer	Type / order number	Details	Setting	Note
SIEMENS	6FX2001-5xS12	Singleturn encoder	p0400 = 3081	---
SIEMENS	1XP80X4-20 / 6FX2001-5xS24	Multiturn encoder	p0400 = 3082	
T&R	CEW-58, CEV-58, CEH-58, CEW-65; CEV-65	Programmable encoder	p0400 = 9999. Set the encoder data manually.	We can not guarantee the function of these encoders in any circumstance.
SICK / Stegmann	AFM60…	Single- and multiturn		
	DME4000	Laser distance measuring unit, programmable encoder		
Heidenhain	EQN 425	Multiturn		

4.3 Connecting the inverter to PROFINET

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

The inverter in PROFINET IO operation

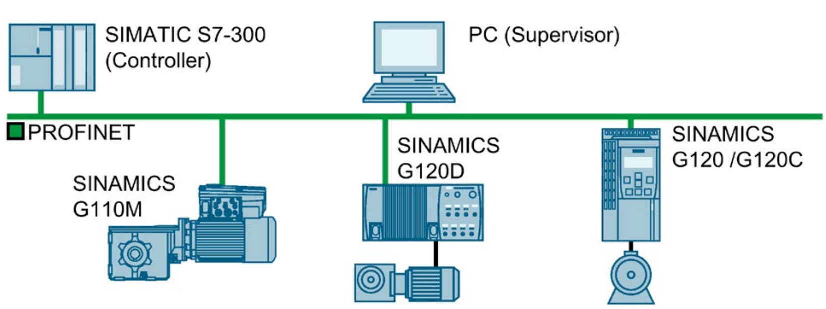


Figure 4-18 The inverter in PROFINET IO operation

The inverter supports the following functions:

- RT
- IRT: The inverter forwards the clock synchronism, but does not support clock synchronism.
- MRP: Media redundancy, impulsed with 200 ms. Requirement: Ring topology
- MRPD: Media redundancy, bumpless. Requirement: 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
- Shared Device for Control Units with fail-safe functions

The inverter as Ethernet node

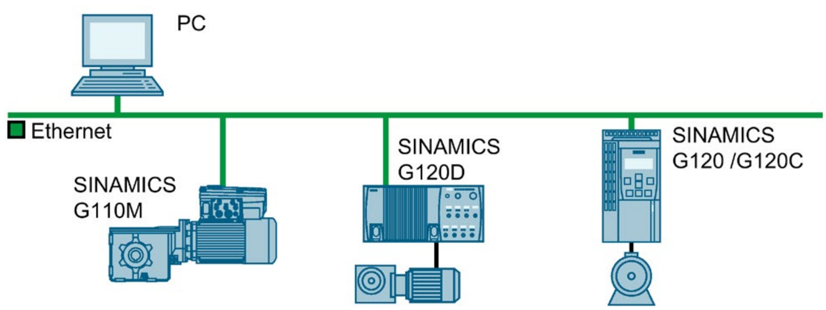


Figure 4-19 The inverter as Ethernet node

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 389)

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

Industrial Ethernet Cables and cable length

Listed in the table below are the recommended Ethernet cables.

Table 4- 16 Recommended PROFINET cables

Cable type	Max. length between devices	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

Cable screening

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.

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 inverter into the engineering system.

Installing GSDML (Page 69)

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 or STARTER.

The inverter 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 inverter:

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

Telegram

Set the same telegram in the inverter 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 162)

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)

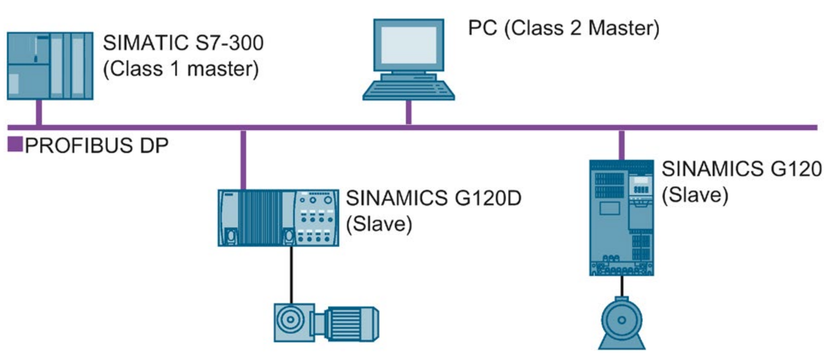
4.3.3 Installing GSDML

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 inverter.
     Set p0804 = 12.
     The inverter writes the GSDML as 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 inverter 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 inverter into the engineering system.

Installing the GSD (Page 71)

Setting the address

Set the address of the PROFIBUS slave.

Setting the address (Page 71)

Setting the telegram

Set the telegram in the inverter 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 162)

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 inverter in PROFIBUS

Procedure

1. Integrate the inverter in the bus system (e.g. line topology) of the control using PROFIBUS cables and the two PROFIBUS jacks X03 and X04. If your inverter forms the end of the line, only use jack X03 and connect the bus-terminating resistor.

   Overview of the interfaces (Page 36)

   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 inverter with 24 V DC through X01.

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

4.4.3 Installing the GSD

Procedure

1. Save the GSD on your PC via 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 inverter.
     Set p0804 to 12.
     The inverter 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 Setting the address

Valid address area: 1 … 125

You have the following options for setting the address:

- Using the address switch on the Control Unit:

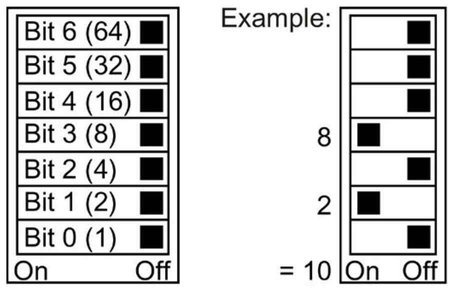


Figure 4-20 Address switch with example for bus address 10

The address switch has priority over the other settings.

- Using Startdrive or an operator panel via parameter p0918 (default setting: p0918 = 126)
  It is only possible to change p0918 if an invalid address is set in the address switch.

  If you are working with Startdrive, back up the settings so they are not lost if the power fails.

Overview of the interfaces (Page 36)

Setting the bus address

Procedure

1. Set the address using one of the subsequently listed options:
   – Via the address switch
   – On an operator panel via p0918
   – With Startdrive

     Confirm the prompt for saving your settings (copy RAM to ROM).
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter are dark.
4. Switch on the inverter power supply again.

   Your settings become effective after switching on.

The PROFIBUS address is set.
❒

5 Commissioning

5.1 Commissioning tools

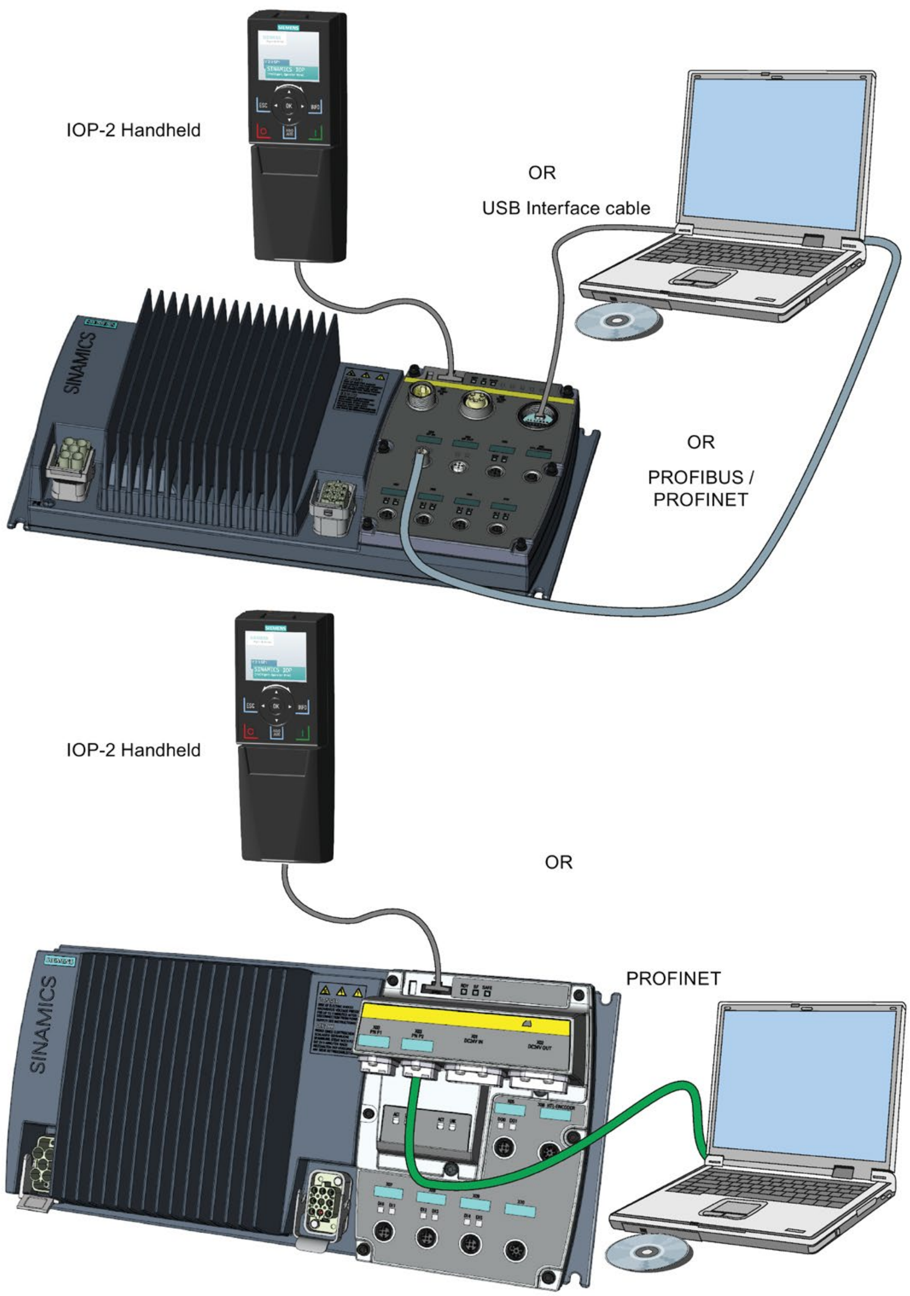


Figure 5-1 Commissioning tools - PC or IOP-2 Handheld Kit

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

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

You obtain STARTER and Startdrive on a DVD:

- STARTER: Article number 6SL3072-0AA00-0AG0
- 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)

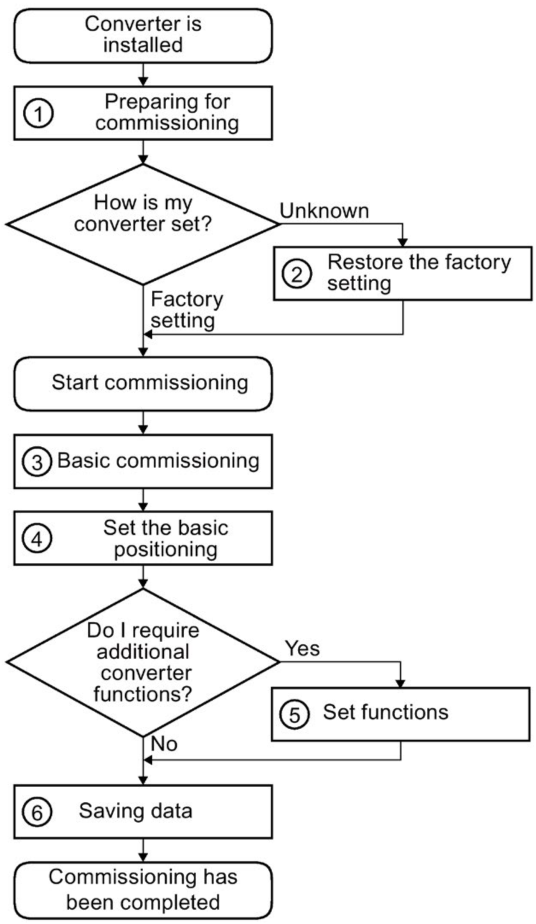
Help regarding operation:

- Startdrive tutorial (http://support.automation.siemens.com/WW/view/en/73598459)
- STARTER videos (http://www.automation.siemens.com/mcms/mc-drives/en/low-voltage-inverter/sinamics-g120/videos/Pages/videos.aspx)

5.2 Commissioning guidelines

Adapting the converter to the drive application

The converter must match the motor and the drive application to be able to optimally operate and protect the motor. We recommend a certain procedure when commissioning your converter.



Explanation of the commissioning steps:

① Preparing for commissioning (Page 75)

② Restoring the factory setting (Page 149)

③ Basic commissioning:

Basic commissioning with a PC (Page 83)

Commissioning a decentralized drive with the IOP-2 (Page 79)

④ Basic positioner and position control (Page 90)

⑤ Advanced commissioning (Page 153)

⑥ Backing up data and series commissioning (Page 281)

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 inverter?**

  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.

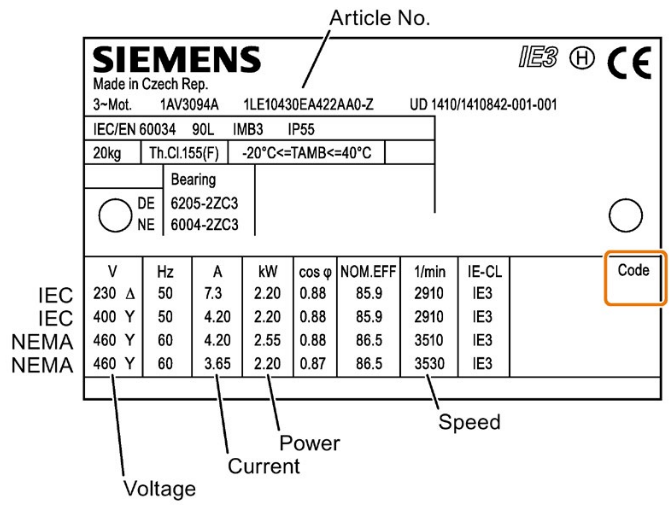


Figure 5-2 Example of the rating plate for a standard induction motor

- **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.

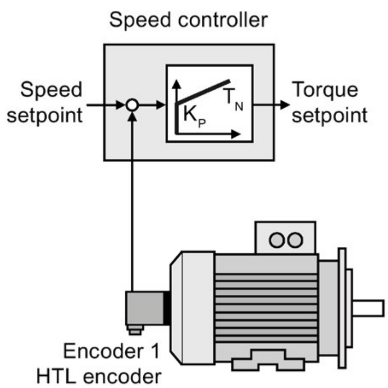
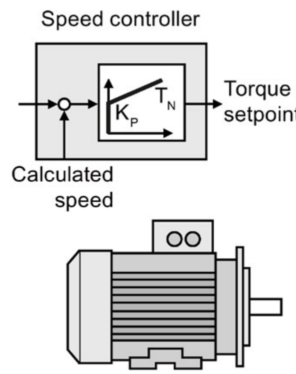
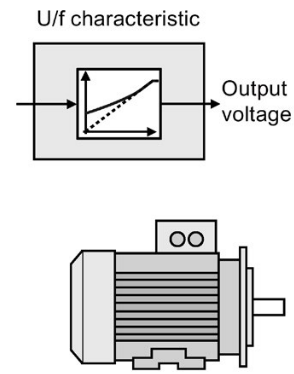
5.3.1 Introduction, V/f control, vector control

Specifying the control mode

The converter has three open-loop control and closed-loop control modes for induction motors:

- Open-loop control with U/f-characteristic (U/f control)
- Field-oriented control (sensorless vector control)
- Speed control (vector control with encoder)

The control modes have different degrees of suitability when it comes to controlling a position-controlled axis:

<table>
<tr><th>Vector control with encoder</th><th>Sensorless vector control</th><th>U/f control</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>With the position control, provides the best results</td><td>Limited functionality of the position control.
• Low accuracy
• Travel to fixed stop is not possible</td><td>Not recommended in conjunction with position control.
• Low accuracy
• Low dynamic response
• Travel to fixed stop is not possible</td></tr>
</table>

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

- If the motor is too small in comparison to the inverter (the rated motor power may not be less than one quarter of the rated inverter power)
- If several motors are connected to one inverter
- If a power contactor is used between the inverter and motor and is opened while the motor is powered up
- If the maximum motor speed exceeds the following values:

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

5.3.2 Encoder assignment

The inverter offers four options of allocating encoders to the closed-loop control on the motor and load side.

SSI encoder for the position controller, HTL for the speed controller

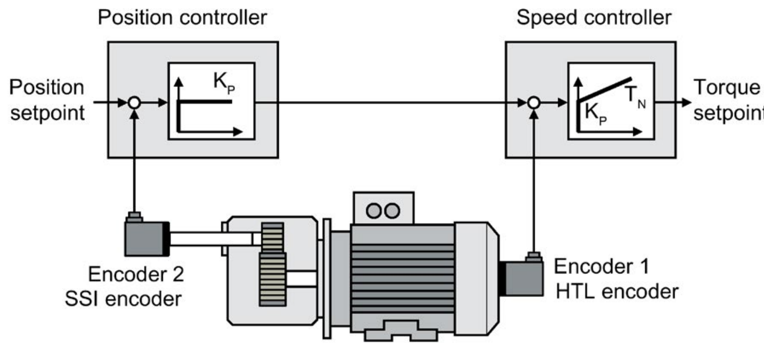
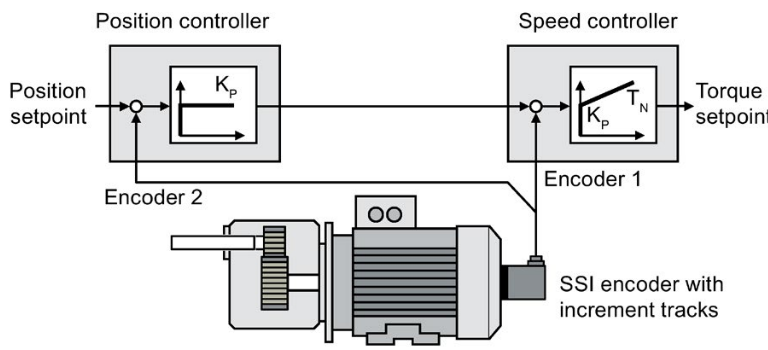


Figure 5-3 SSI encoder on the load side for the position controller, HTL encoder on the motor axis for the speed controller

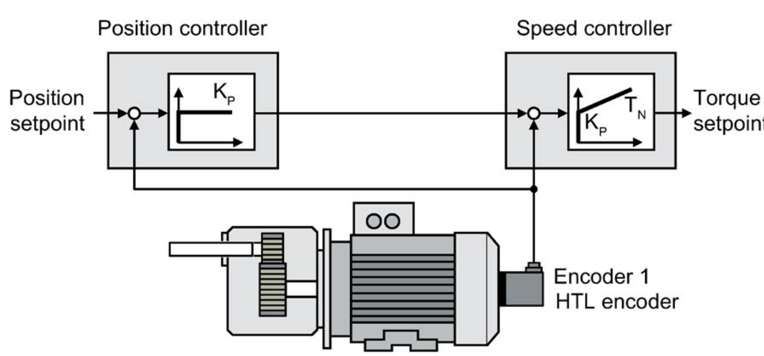


Restriction:

Reduced accuracy of the position control depending on the gearbox ratio and gearbox backlash

Figure 5-4 SSI encoder with increment tracks on motor axis

HTL encoder for position and speed controllers

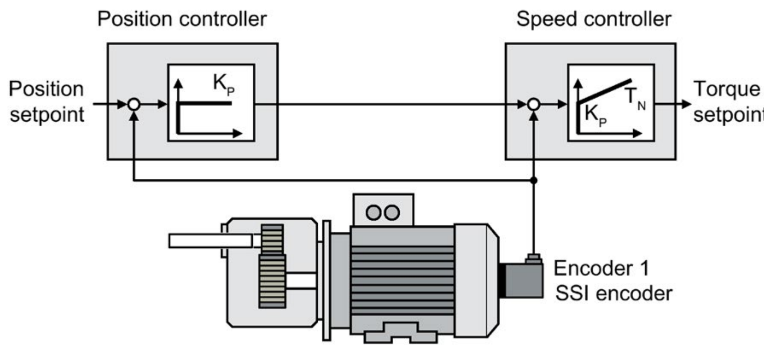


Restriction:

Reduced accuracy of the position control depending on the gearbox ratio and gearbox backlash

Figure 5-5 HTL encoder on the motor axis for position and speed controllers

SSI encoder for position and speed controllers

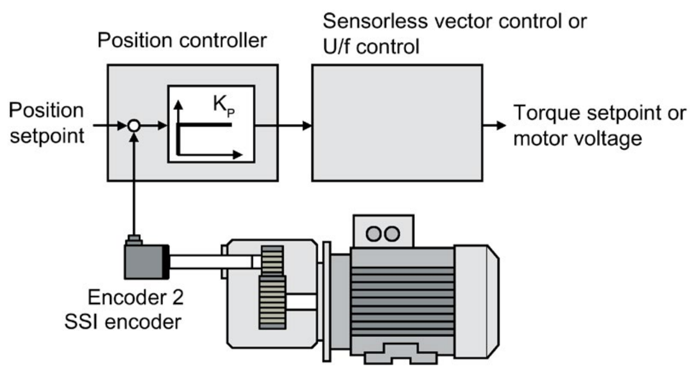


Restriction:

Reduced accuracy of the position control depending on the gearbox ratio and gearbox backlash

Figure 5-6 SSI encoder on the motor axis for position and speed controllers

SSI encoder for the position controller, speed controller has no encoder



Restrictions:

- Restrictions regarding the accuracy and dynamic performance of the position control
- Not suitable for the position control of hoisting gear
- Travel to fixed stop is not possible

Figure 5-7 SSI encoder on the load side for the position controller, speed controller without an encoder

5.4 Commissioning a decentralized drive with the IOP-2

Overview

To perform the basic commissioning of a decentralized drive it is necessary to use the IOP-2 Handheld Kit (HHK).

The details of the HHK and the associated cables are given in the Commissioning tools section of this manual.

See Commissioning tools (Page 73).

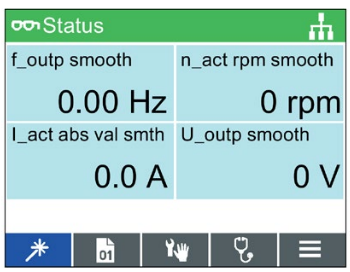
Note

Screens and sequence may vary

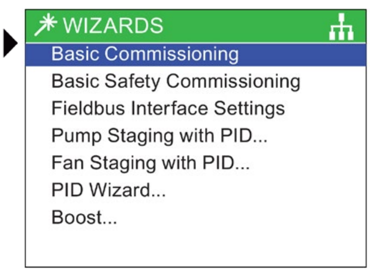
The sequence of the commissioning process and the actual screens may vary according to the following influences:

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

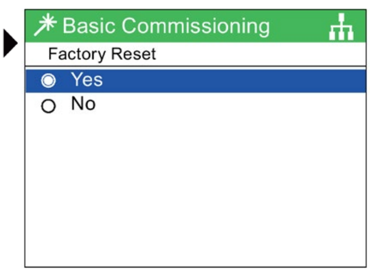
In all the scenarios, the IOP-2 will always display the appropriate commissioning screens and sequence for the device to which it is connected.



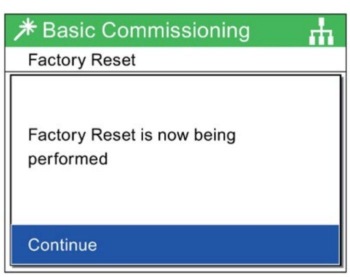
Select Wizards



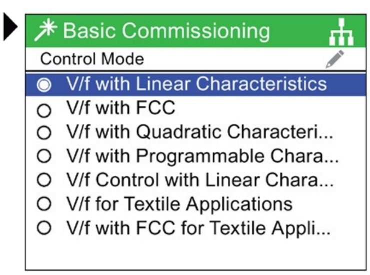
Select Basic Commissioning wizard



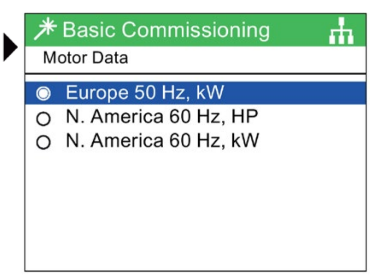
Select Factory Reset (yes or no)



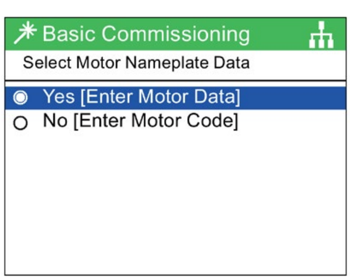
Select Continue



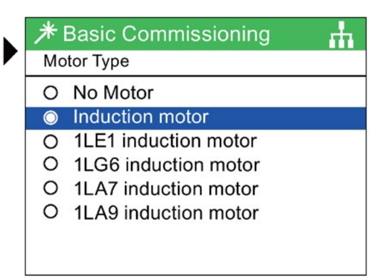
Select Control Mode



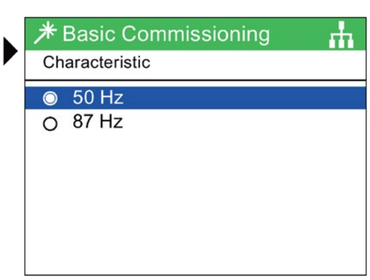
Select Motor Data



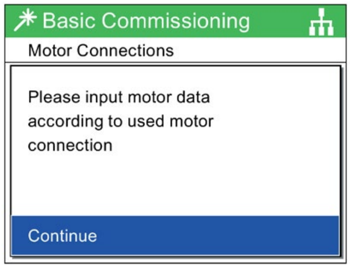
Select Enter Motor Data



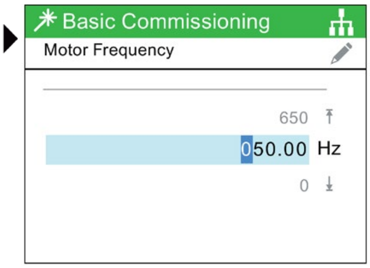
Select Motor Type



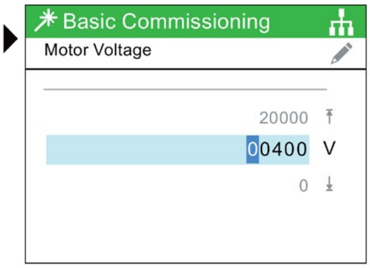
Select Characteristic



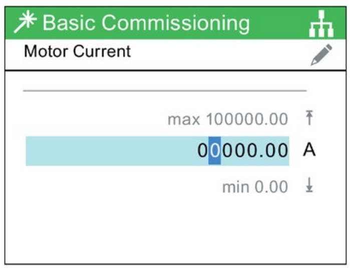
Select Continue



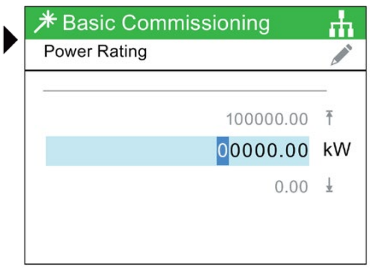
Input Motor Frequency



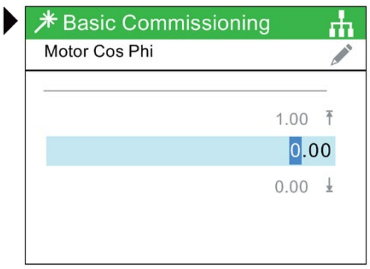
Input Motor Voltage



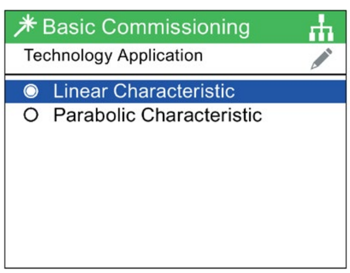
Input Motor Current



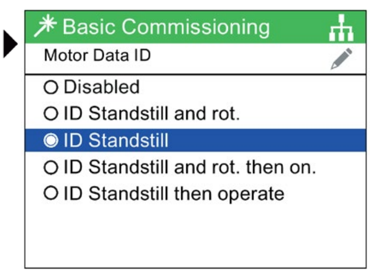
Input Power Rating



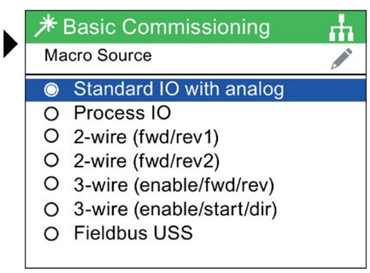
Input Motor Speed



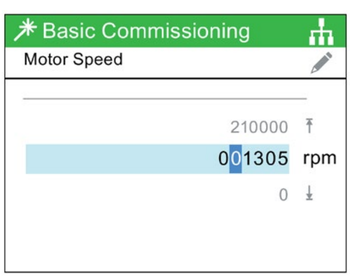
Select Technology Application



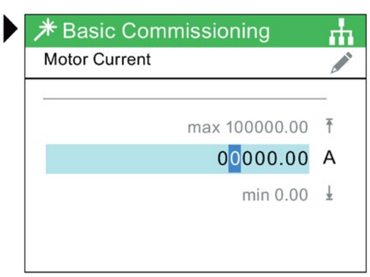
Select required Motor Data ID function



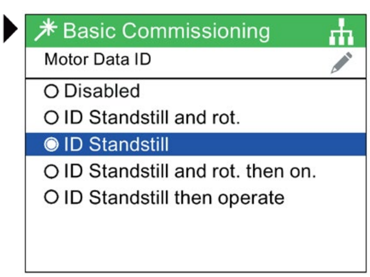
Select Macro Source



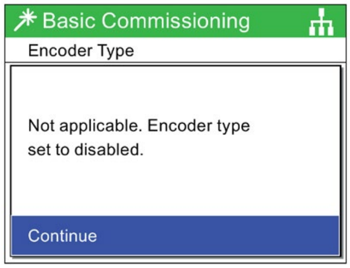
Input the Motor Speed



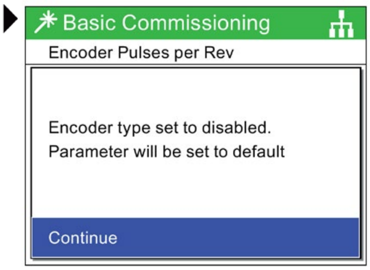
Input Current Limit



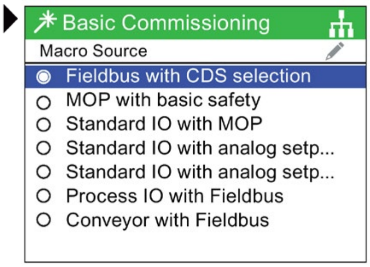
Select Motor Data ID option



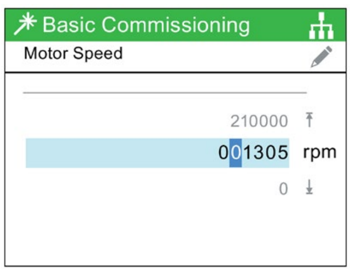
Input Encoder Type



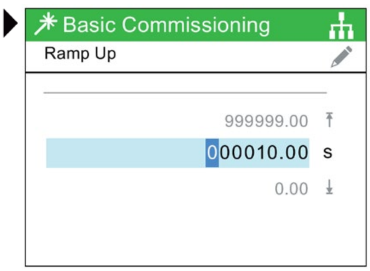
Input Encoder Pulses per rev



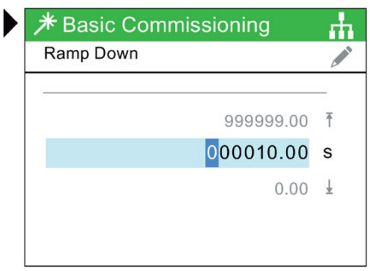
Select Macro Source



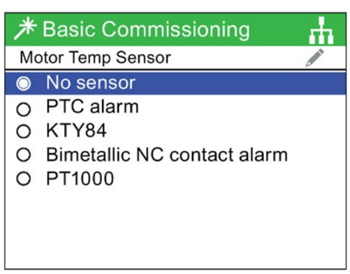
Input Maximum Speed



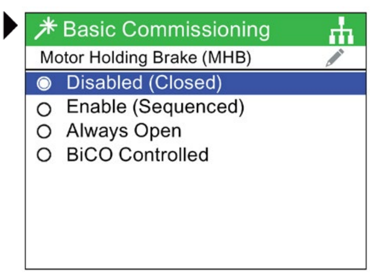
Input Ramp-up time



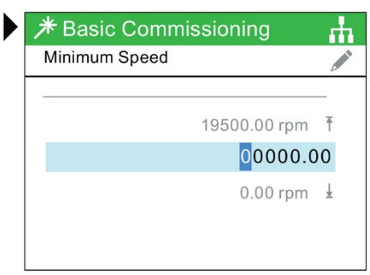
Input Ramp-down time



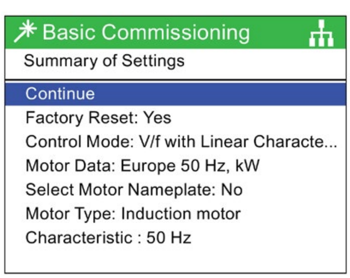
Select Motor Temperature Sensor



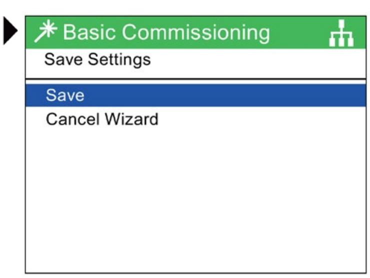
Select Motor Holding Brake option



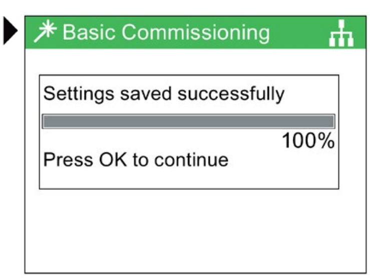
Input Minimum Motor Spped



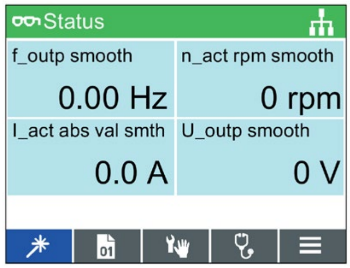
Summary of settings - Select Continue



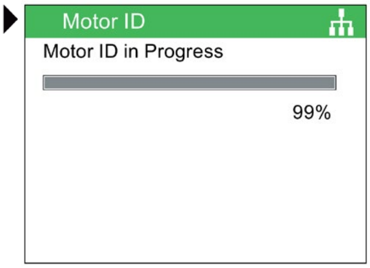
Save Settings



Settings saved



Status Screen displayed



On first ON command - Motor ID is performed

5.5 Basic 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 inverter 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.
❒

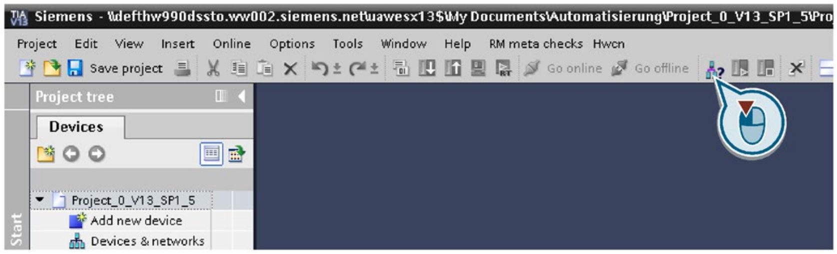
5.5.2 Transfer inverters connected via USB into the project

Integrating the inverter into the project

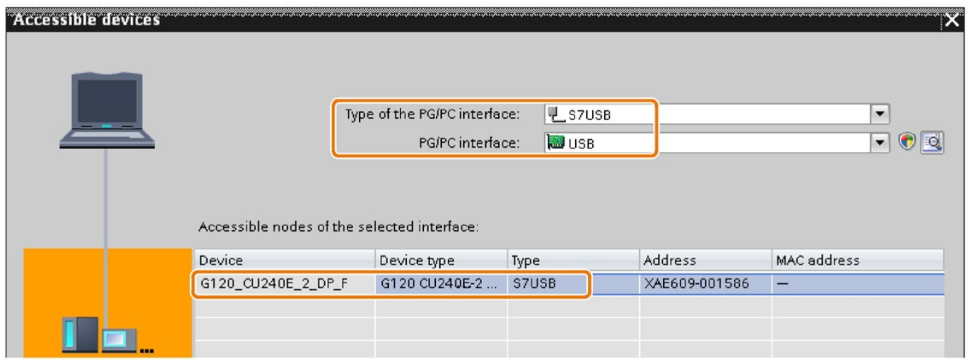
Procedure

1. Switch on the inverter power supply.
2. First insert a USB cable into your PC and then into the inverter.
3. The PC operating system installs the USB driver when you are connecting the inverter 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 inverters that can be accessed.

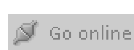


If you have not correctly set the USB interface, then the following "No additional nodes found" message is displayed. In this case, follow the description below.

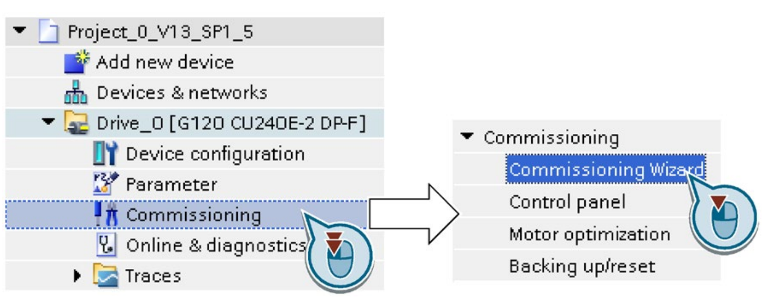
6. Transfer the inverter into the project using the menu: "Online - Upload device as new station (hardware and software)".

You have transferred an inverter accessible via the USB interface into your project.
❒

Procedure

1. Select your project and go online: 

2. In the following screen form, select the inverter with which you wish to go online.
3. Once you are online, select "Commissioning" → "Commissioning Wizard":



You have started the commissioning Wizard of the inverter.
❒

5.5.3 Performing the basic commissioning

Procedure

Setpoint specification

Select whether the inverter is connected to a higher-level control via the fieldbus.

Open-loop/closed-loop ...

Select the control mode.

Introduction, V/f control, vector control (Page 76)

Defaults of the setpoi...

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

Default settings of inputs and outputs (Page 63)

Drive setting

Set the applicable motor standard and the inverter supply voltage.

Select the application for the inverter:

- "[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] S1 duty cycle
- "[7] S6 duty cycle

Drive options

If an optional component is installed between inverter 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 inverter 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:

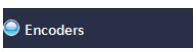
- [1]: Recommended setting. Measure the motor data at standstill and with the motor rotating. The inverter switches off the motor after the motor data identification has been completed.
- [2]: Measure the motor data at standstill. The inverter switches off the motor after the motor data identification has been completed.

  Recommended setting for the following cases:

  – You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.

  – You have set "V/f control" as control mode.
- [3]: Measure the motor data while the motor is rotating. The inverter switches off the motor after the motor data identification has been completed.

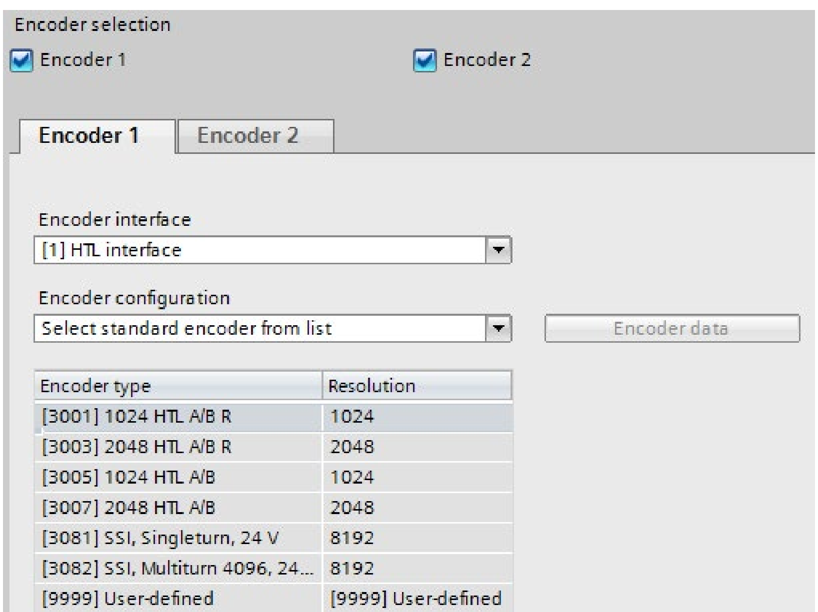
Calculating the motor parameters: Select "Complete calculation".



The inverter can evaluate up to two encoders.

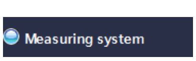
Encoder assignment (Page 77)

Either select a standard encoder from the list or enter the encoder data.

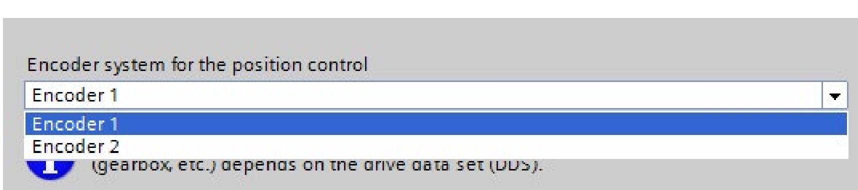


…R: Encoder with zero mark

Adapting the encoder data (Page 87)



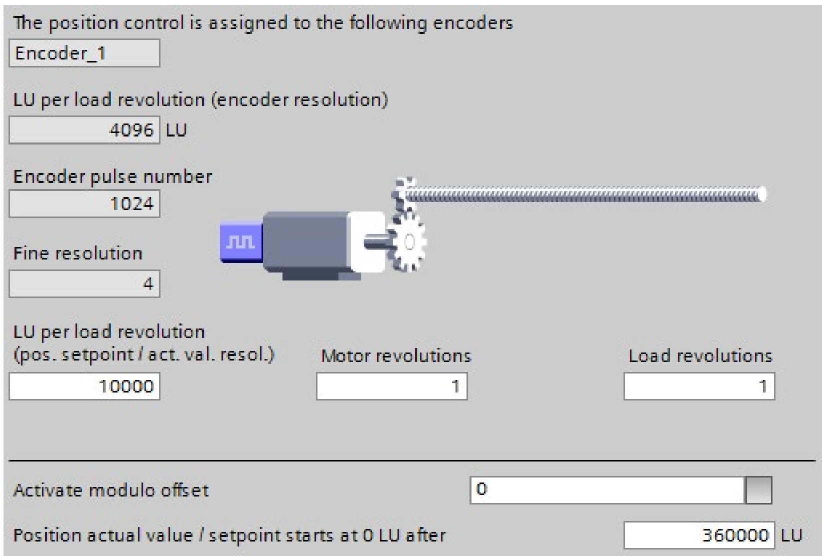
Select the encoder that you use for position sensing.



Mechanical system

You may skip this screen initially. The settings are explained when commissioning the basic positioner.

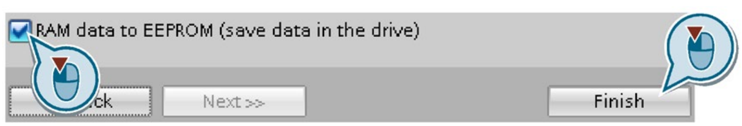
Basic positioner and position control (Page 90)



Summary

Set the check mark for "RAM data to EEPROM (save data in the drive)" to save your data in the inverter 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 basic commissioning of the inverter.

❒

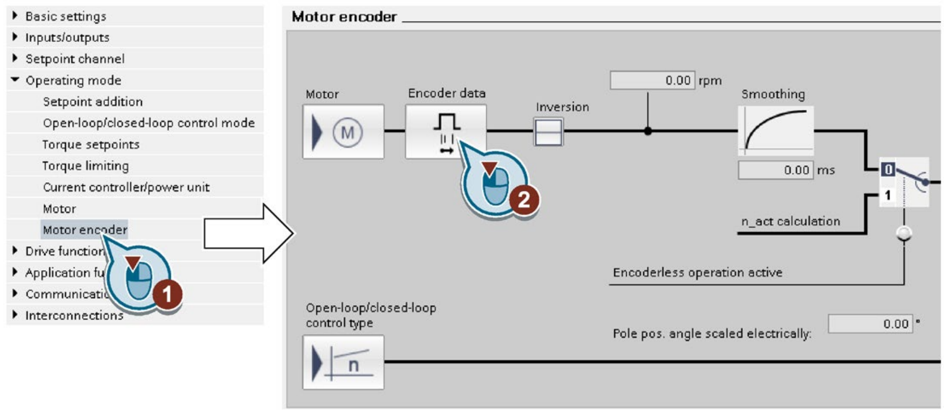
5.5.4 Adapting the encoder data

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 inverter measures the data of the stationary motor. In addition, based on the response of the rotating motor, the inverter 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

Preconditions

- 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 inverter 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 inverter are connected to each other online.

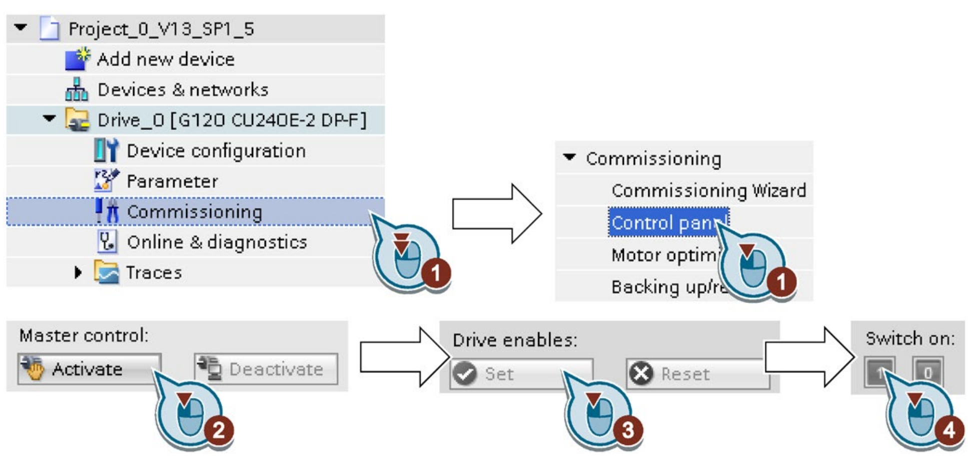
WARNING

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 inverter.
3. Set the "Drive enables"

4. Switch on the motor.

   The inverter starts the motor data identification. This measurement can take several minutes.

   Depending on the setting, after motor data identification has been completed, the inverter 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 inverter (RAM → EEPROM):

You have completed the motor data identification.
❒

Self-optimization of the speed control

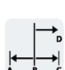
If you have not only selected motor data identification with the motor stationary, but also rotating measurement with self-optimization of the speed control, you must switch on the motor again as described above and wait for the optimization run to finish.

Quick commissioning has been completed once the motor data identification has been successfully completed.

5.6 Basic positioner and position control

5.6.1 Basic positioner and position control

Overview



Position control means controlling the position of an axis. An "axis" is a machine or system component that comprises the converter with active position control and the driven mechanical system.

The basic positioner (EPOS) calculates the traversing profile for the time-optimized traversing of the axis to the target position.

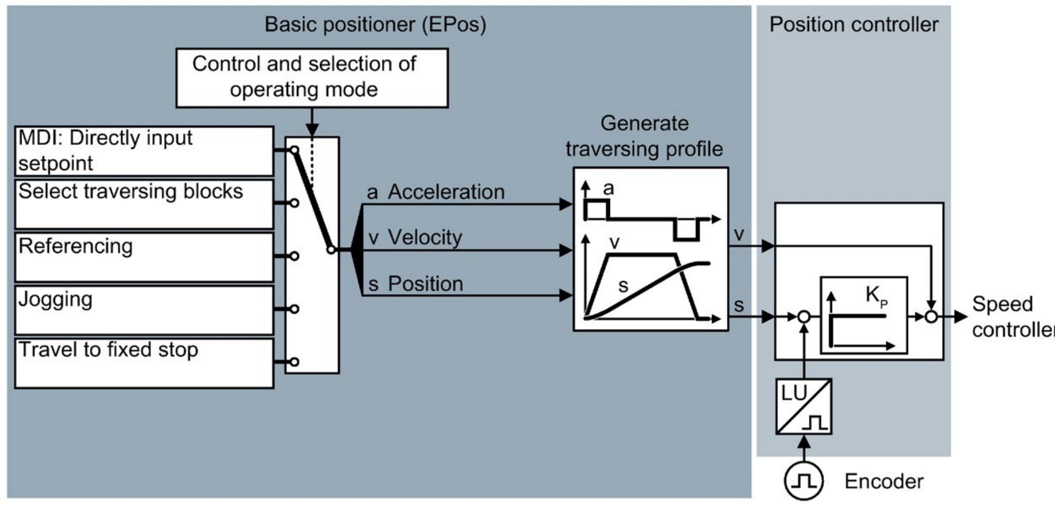


Figure 5-8 Basic positioner and position control

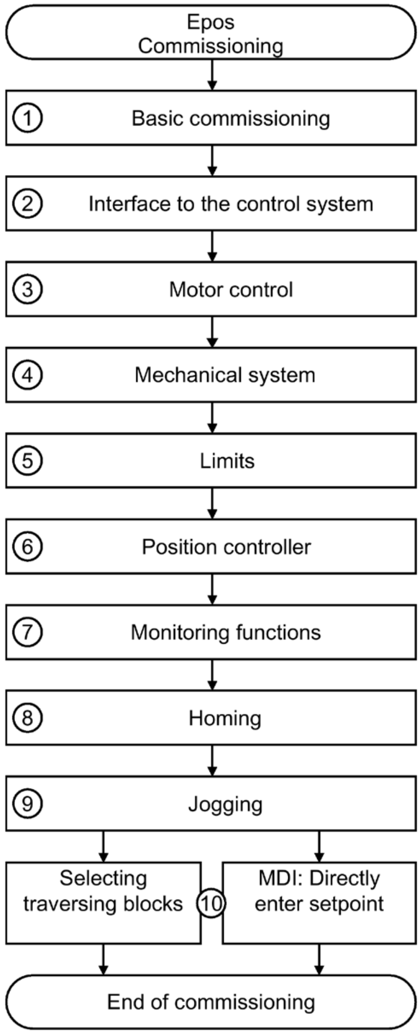
The basic positioner has the following operating modes:

- Direct setpoint input (MDI): The external control specifies the position setpoint for the axis.
- Traversing block selection: Position setpoints are saved in different traversing blocks in the converter. The external control selects a traversing block.
- Referencing: Referencing establishes the reference of the position measurement in the converter to the machine.
- Jogging: This function is used to incrementally traverse the axis (Set up).
- Travel to fixed stop: The converter positions the axis with a defined torque against a mechanical fixed stop.

5.6.2 Commissioning sequence

We recommend that you commission the basic positioner using the "STARTER" or "Startdrive" tool.

Commissioning tools (Page 73)



① Assigning encoders to the axes (Page 83)

② Setting the communication via the fieldbus (Page 162)

③ Optimizing the speed control (Page 229)

④ Normalizing the encoder signal (Page 92)

⑤ Setting the axis traversing range (Page 98)

⑥ Tuning the position controller (Page 101)

⑦ Setting the positioning accuracy (Page 106)

⑧ Establishing the reference to the machine zero point (Page 110)

⑨ Setting up the axis (Page 125)

⑩ Saving and calling the traversing blocks in the inverter (Page 128)

or

Entering a position setpoint from the external control via fieldbus (Page 143)

5.6.3 Normalizing the encoder signal

5.6.3.1 Define the resolution

Distance unit (LU): the resolution of the position actual value in the inverter

The inverter calculates the position actual value of the axis using the neutral position unit LU (Length Unit). The distance unit LU is independent of whether the inverter controls e.g. the position of an elevating platform or the angle of rotary table.

Firstly, for your application define the required resolution. In other words: Which distance or angle corresponds to the length unit (LU)?

The following rules apply when selecting the distance unit LU:

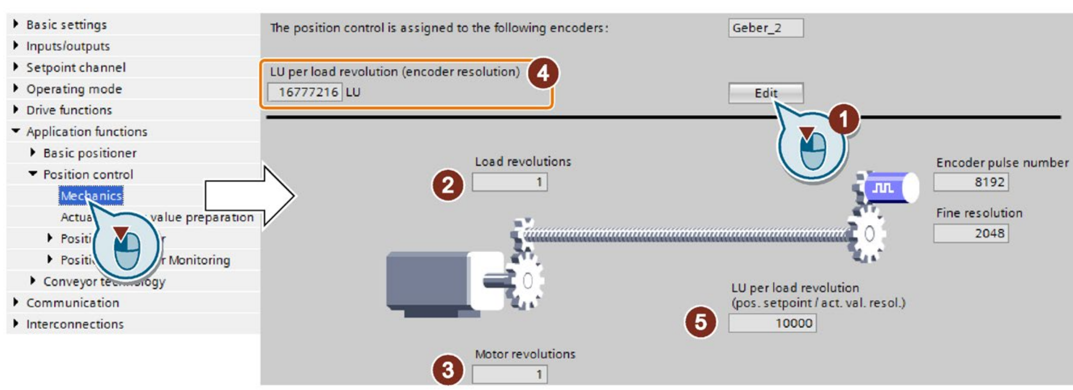
1. The higher the resolution of the distance unit LU, the higher the accuracy of the position control.
2. If you select a resolution that is too high, then the inverter cannot represent the position actual value over the complete axis traversing range. The inverter responds with a fault in the case of an overflow when representing the number.
3. The resolution of the distance unit LU should be less than the maximum resolution that is obtained from the resolution of the distance-encoder.

Normalize the encoder signal

Requirements

- You are online with the STARTER .
- You have selected the "Mechanical system" screen.
- You have defined the required resolution for your particular application, e.g. 1 LU ≙ 1 µm or 1 LU ≙ 1/1000° (1 millidegree).

Procedure



1. Enable the settings so they can be edited.
2. Enter the gear ratio of the axis: Load revolutions.
3. Motor revolutions

   Unknown gear ratio
   If you do not know the gear ratio, then you must measure the ratio, for example by manually rotating the motor and counting the load revolutions.
   Example: After 5 motor revolutions, the load has turned through 37 °. The ratio is therefore 37 ° / (5 × 360 °). You must then enter the following values into STARTER:

   – ② 37 [load revolution]

   – ③ 1800 [motor revolution]

4. Check the maximum resolution based on your encoder data.
5. Calculate:
   Value = 360 ° / required resolution, e.g. 360 °/ 0.1 ° = 3600.
   Enter this value into the STARTER.

You have normalized the encoder signal.
❒

Parameter	Meaning	
p2502	**Encoder assignment**	
	0	No encoder
	1	Encoder 1
	2	Encoder 2
p2503	**Length unit LU per 10 mm**	
p2504	**Motor/load motor revolutions**	
p2505	**Motor/load load revolutions**	
p2506	**Length unit LU per load revolution**	

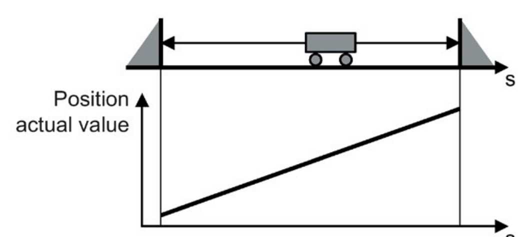
5.6.3.2 Modulo range setting

Description

Linear axis

A linear axis is an axis whose traversing range is limited in both motor directions of rotation by the mechanical system of the machine, e.g.:

- Stacker crane
- Elevating platform
- Tilting station
- Gate/door drive

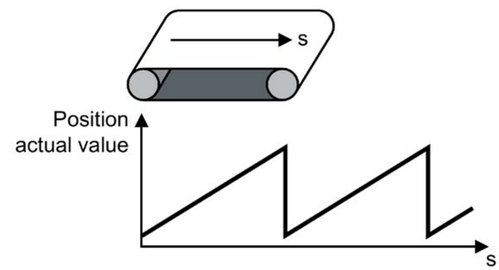


The inverter maps the complete traversing range to the position actual value.

Modulo axis

A modulo axis is an axis with an infinite traversing range, e.g.:

- Rotary table
- Conveyor belt
- Roller conveyor



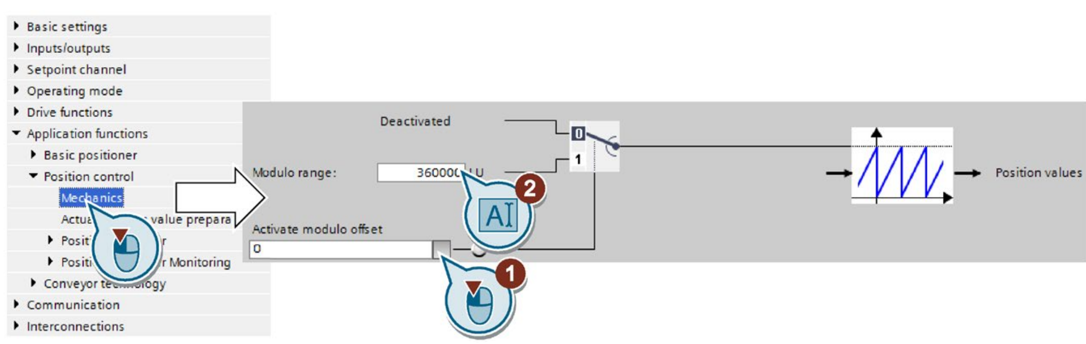
The inverter maps the modulo range on the position actual value. If the load position leaves the modulo range, then the value range of the position actual value repeats in the inverter.

Setting the modulo range

Requirements

- You are online with the STARTER .
- You have selected the "Mechanical system" screen.

Procedure



1. Enable the modulo correction.
2. Define the modulo range.

   Example 1: In the case of a rotary table, one load revolution corresponds to 3600 LU. In this case, the modulo correction is also 3600.

   Example 2: For a roller conveyor, 100 motor revolutions corresponds to one production cycle. For a resolution of 3600 LU per motor revolution, the modulo range is 360000 LU.

You have now set the modulo range.
❒

Parameter	Meaning
p2576	Modulo offset, modulo range
p2577	Modulo correction activation (signal = 1)
r2685	Offset value

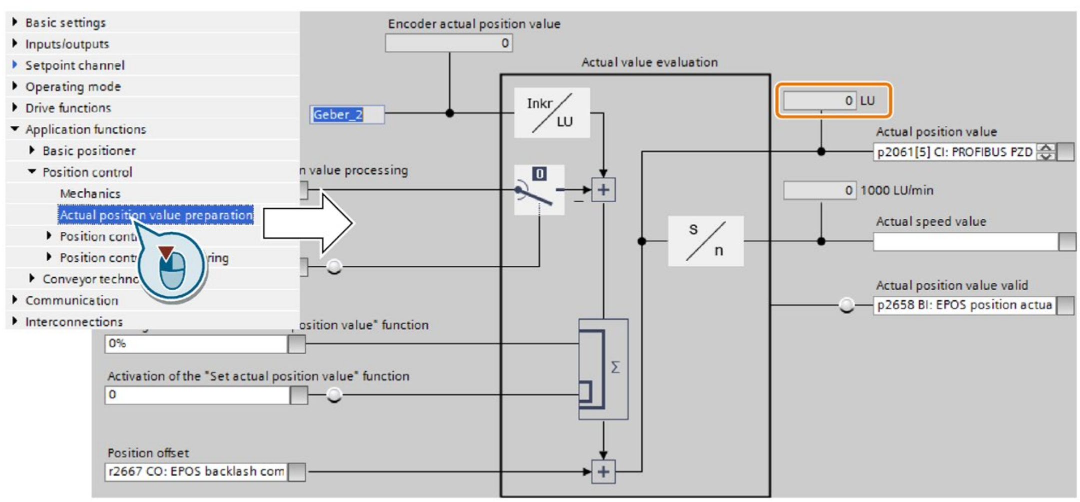
5.6.3.3 Checking the actual position value

After normalization of the encoder signal you should check the actual position value.

Requirements

- You are online with the STARTER .
- You have selected the screen for "Actual value processing".

Procedure



- There must be no overflow of the actual position value in the entire traverse range. The converter can show as a maximum the value range of -2147483648 … 2147483647. If this maximum value is exceeded, the converter reports fault F07493.
- If you have defined a modulo range, the converter resets the actual position value after passing through the range.

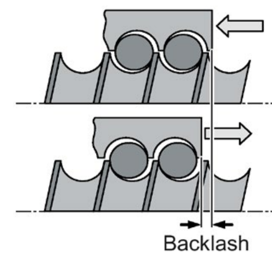
You have now checked the calculation for the actual position value.
❒

Parameter	Meaning
r2521[0]	Position actual value for position control

5.6.3.4 Setting the backlash

Description

Backlash (also called play, dead travel on reversing etc.) is the distance or the angle that a motor must travel through when the direction of rotation reverses until the axis actually moves in the other direction.



Backlash in a spindle

With the appropriate setting, the inverter corrects the positioning error caused by the backlash when reversing.

The inverter corrects the backlash under the following condition:

- For an incremental encoder, the axis must be referenced.

  Referencing (Page 110)

- For an absolute encoder, the axis must be adjusted.

  Absolute encoder adjustment (Page 123)

Measuring backlash

Procedure

1. Move the axis to position A in the machine. Mark this position in the machine and note down the actual position value in the inverter.

   Checking the actual position value (Page 96)

2. Move the axis a little bit more in the same direction.
3. Move the axis in the opposite direction until the actual position value in the inverter shows the same value as at position A. Due to the backlash when reversing, the axis is now at position B.
4. Measure the position difference Δ = A - B in the machine.

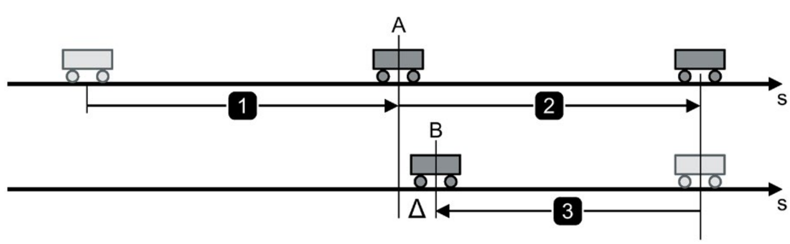


Figure 5-9 Measuring backlash

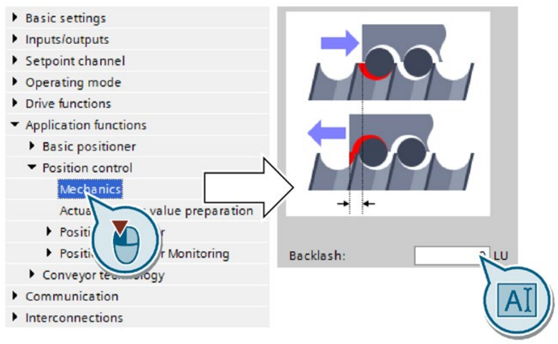
You have measured the backlash.
❒

Correcting backlash

Requirement

You have selected the "Mechanical system" screen.

Procedure



- If the axis has not traveled far enough, then set a positive backlash.
- If the axis has traveled too far, then set a negative backlash.

You have corrected the backlash.
❒

Parameter	Meaning
p2583	Backlash compensation
r2685	Offset value

5.6.4 Limiting the positioning range

Description

Positioning range for linear axes

The inverter limits the positioning range of a linear axis using a software limit switch. The inverter only accepts position setpoints that lie within the software limit switches.

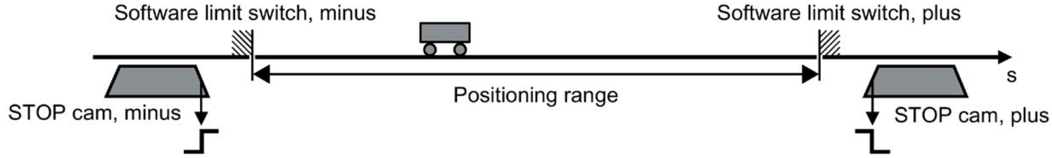


Figure 5-10 Limiting the positioning range of a linear axis

In addition, using its digital inputs, the inverter evaluates signals from stop cams. When passing a STOP cam, the inverter responds – depending on the setting – either with a fault or an alarm.

Fault when passing over a STOP cam

When passing the STOP cam, the inverter brakes the axis with the OFF3 ramp-down time, switches the motor off and outputs fault F07491 or F07492.

To switch the motor on again, you must do the following:

1. Switch the motor off (OFF1).
2. Acknowledge the fault.
3. Traverse the axis away from the STOP cam, e.g. using the jogging function.

Alarm when passing over a STOP cam

The following happens when the STOP cam is passed:

1. The inverter brakes the axis with maximum deceleration.

   Limiting the traversing profile (Page 104)
2. The inverter maintains the axis in closed-loop control and reports alarm A07491 or A07492.

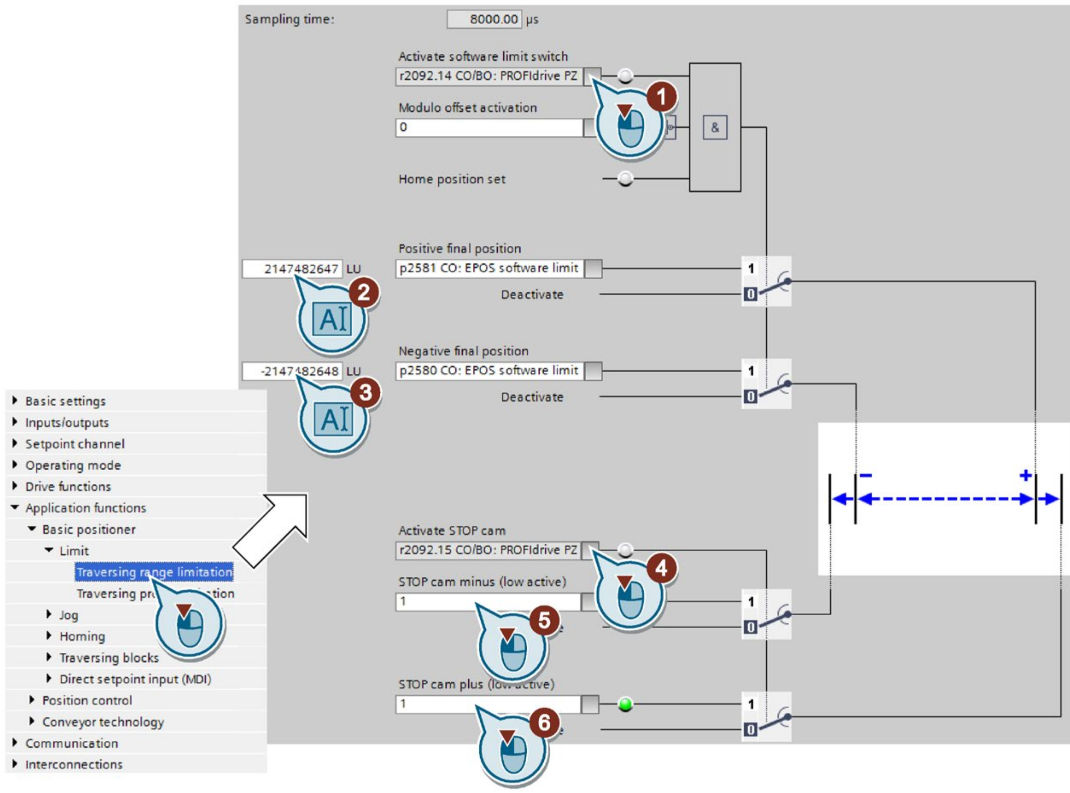
In order to bring the axis back into the valid traversing range, you must move the axis away from the STOP cam, e.g. using the jogging function.

Setting the limits of the positioning range

Requirement

You have selected the "Limit" screen.

Procedure



1. Enable the software limit switch.
2. Move the axis to the positive limit position in your machine. Set the position of the software limit switches to the actual position value.
3. Move the axis to the negative limit position in your machine. Set the position of the software limit switches to the actual position value.
4. Enable the STOP cams.
5. Interconnect the signal of the STOP cam minus with the corresponding signal of your machine.

   Signal = 0 means an active STOP cam.
6. Interconnect the signal of the STOP cam plus with the corresponding signal of your machine.

You have now set the limits of the positioning range.
❒

Parameter	Meaning
p2568	STOP cam activation
p2569	STOP cam, minus
p2570	STOP cam, plus
p2578	Software limit switch, minus signal source
p2579	Software limit switch, plus signal source

Parameter	Meaning
p2580	Software limit switch, minus
p2581	Software limit switch, plus
p2582	Software limit switch activation
r2683.6	Software limit switch, minus actuated
r2683.7	Software limit switch, plus actuated
r2684.13	STOP cam minus active
r2684.14	STOP cam plus active

5.6.5 Setting the position controller

5.6.5.1 Precontrol and gain

Preconditions and constraints

Before you optimize the position controller, the closed-loop drive speed control must be optimally set.

Dynamic response and accuracy of the closed-loop position control depend heavily on the lower-level closed-loop or open-loop control or the motor speed:

- Position control in connection with an optimally set vector control with speed encoder provides the best results.
- Position control with encoderless vector control (sensorless vector control, SLVC) provides satisfactory results for most applications. Hoisting/lifting applications require a speed controller.
- If you operate the position control with the U/f control of drive, then you must take into account some significant reduction in closed-loop control performance and precision.

Position controllers in hoisting gear

U/f control is not suitable for vertical axes, such as elevating platforms or hoisting gear used in high-bay racking units, as the axis generally cannot reach the target position as a result of the limited precision of the U/f control.

Description

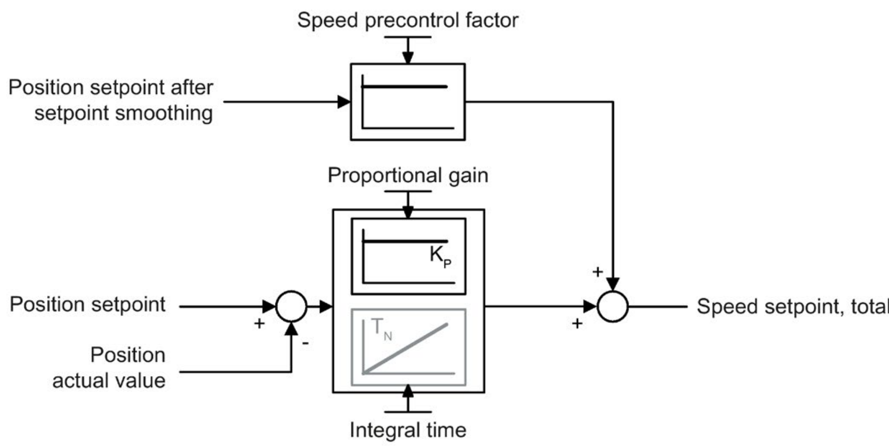


Figure 5-11 Position controller with precontrol

If the speed control of the converter has an encoder to feedback the actual speed, then deactivate the integral component T_N of the position controller.

If you use the position control together with the encoderless vector control (SLVC, SensorLess Vector Control), the positioning accuracy may be inadequate. With active integral time, positioning accuracy improves.

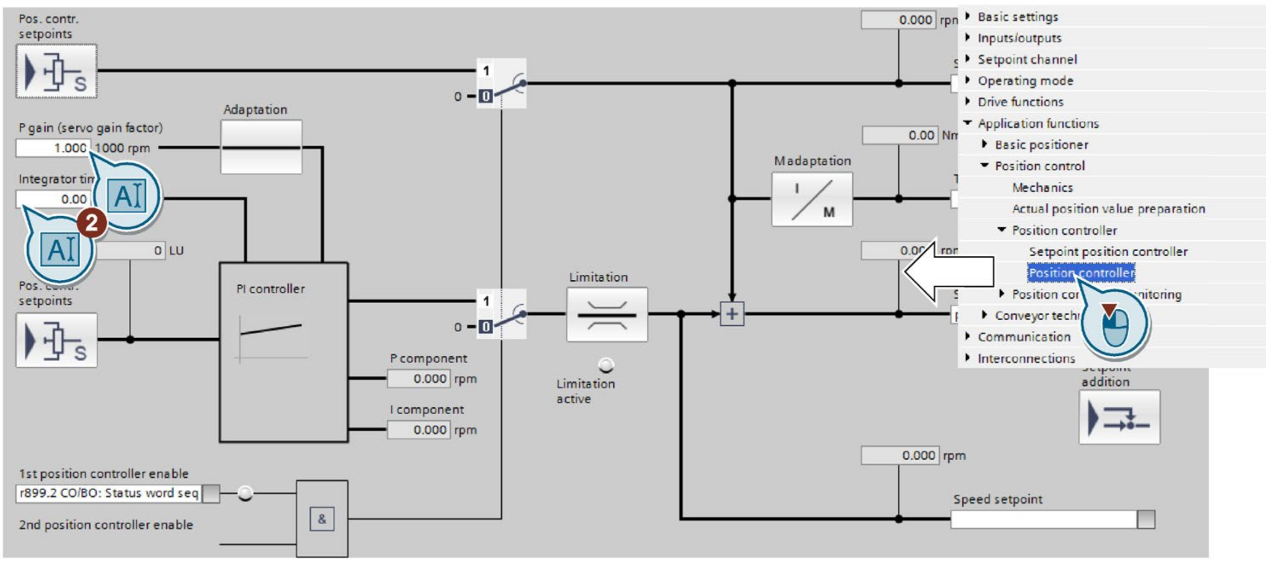
5.6.5.2 Optimizing the position controller

To assess the control performance of the position controller, you must move the axis with the position control and assess the control performance e.g. via the timing of the following error.

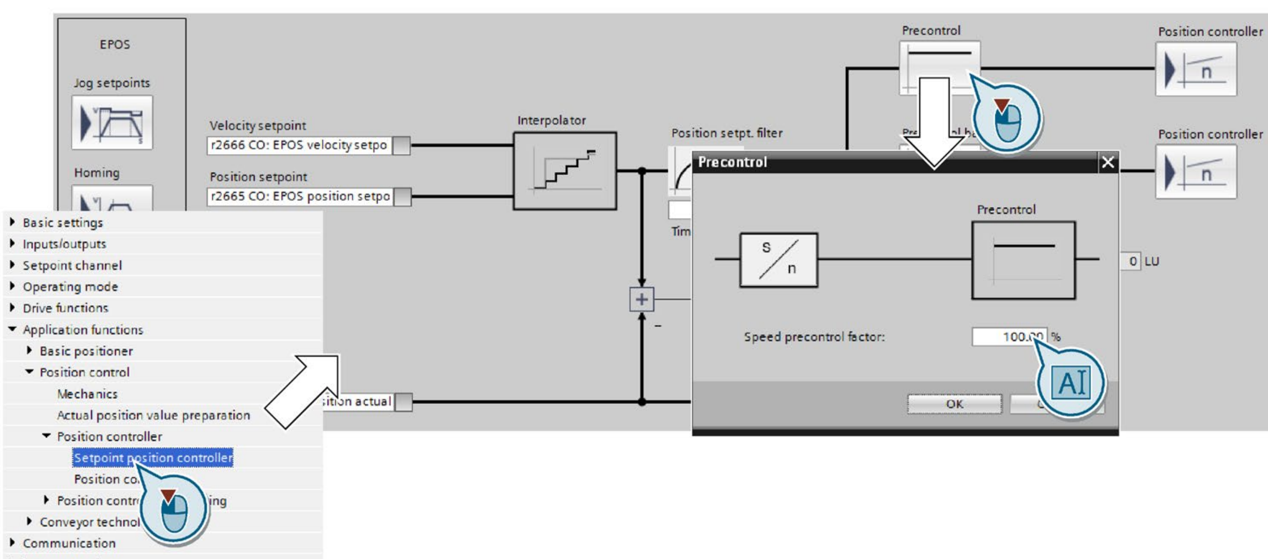
Optimizing the position controller

Procedure

1. Adjust the proportional gain.
2. Adjust the integral time.



3. Set the precontrol of the position controller to 100 %.



You have optimized the position controller.
❒

Parameter	Meaning
p2534	Speed precontrol factor
p2538	Proportional gain / Kp

Parameter	Meaning
p2539	Integral time / Tn
p2731	Signal = 0: activate position controller

Advanced settings

If you permanently activate the integral time of the position controller, the characteristics of the position control change as follows:

- The following error during positioning goes to zero.
- When positioning the axis, it tends to overshoot. This means that the axis briefly moves beyond the target position.

5.6.5.3 Limiting the traversing profile

Description

The traversing profile is the acceleration, velocity and position characteristics of an axis when being positioned.

You can influence the traversing profile by limiting velocity, acceleration or jerk (= change of the acceleration over time).

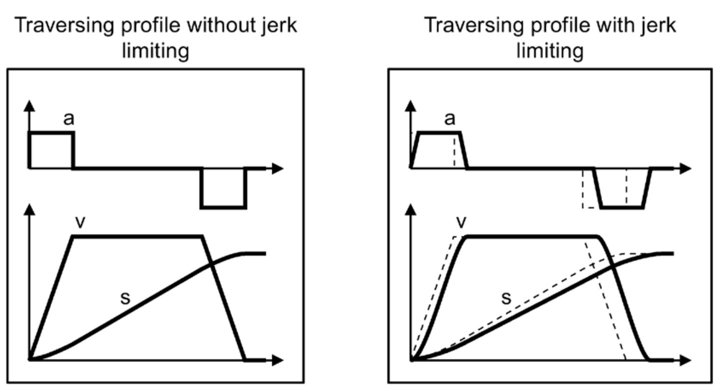


Figure 5-12 Example: Effect of jerk limiting

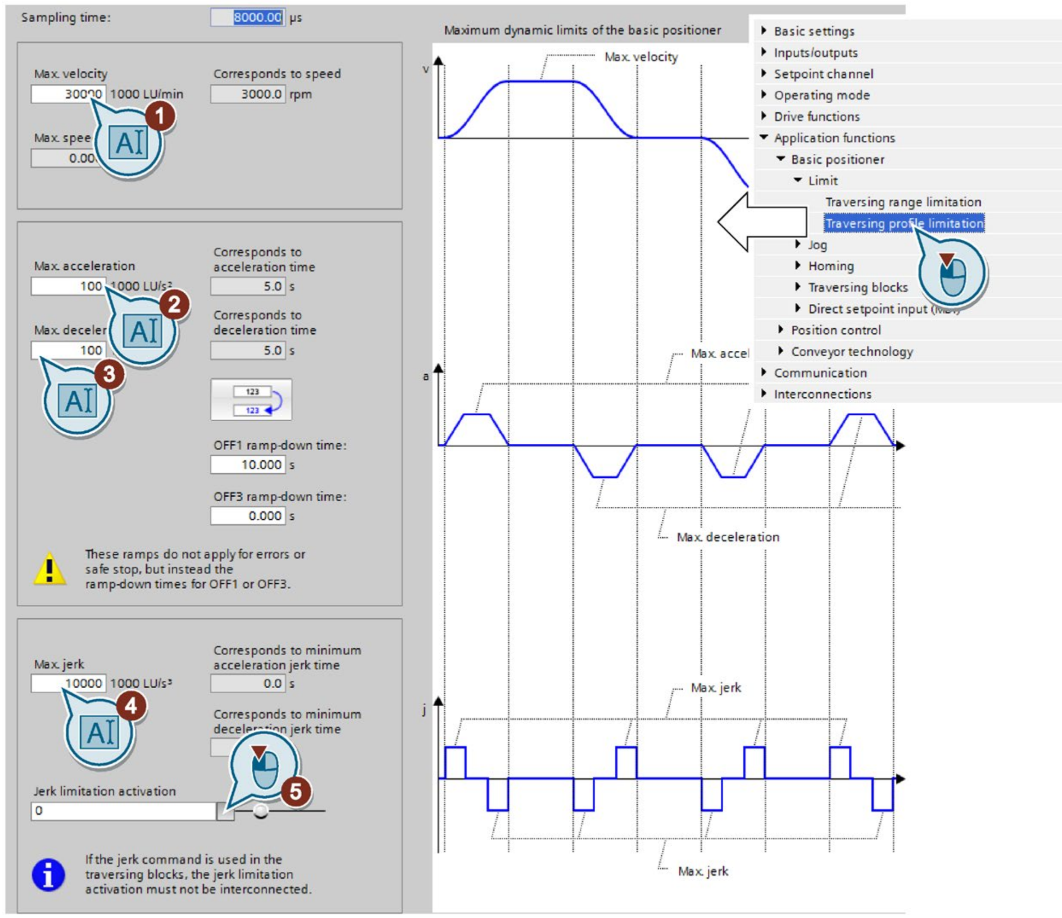
If the axis must traverse more slowly or must accelerate at a lower rate or "softly", then you must set the relevant limits to lower values. The lower that one of the limits is, the longer the inverter needs to position the axis.

Setting the traversing profile limitation

Requirement

You have selected the "Limit" screen and the "Traversing profile limitation" tab.

Procedure



1. Set the maximum velocity with which the inverter may position the axis.
2. Set the maximum acceleration.
3. Set the maximum delay.

   The "override" in the traversing blocks or for the direct setpoint input refers to the values ② and ③.
4. Reduce the maximum jerk, if you require softer acceleration and braking.
5. For permanent jerk limiting, set this signal to 1.

You have now set the limitation of the traversing profile.
❒

Parameter	Meaning
p2571	**Maximum velocity**
p2572	**Maximum acceleration**
p2573	**Maximum deceleration**
p2574	**Jerk limiting**
p2575	**Activating jerk limiting** 1 signal: Jerk limiting is active

5.6.6 Setting the monitoring functions

5.6.6.1 Standstill and positioning monitoring

Description

As soon as the setpoint for the position within a positioning operation no longer changes, then the inverter sets the "Setpoint stationary" signal to 1. With this signal, the inverter starts to monitor the position actual value:

- As soon as the axis has reached the positioning window, the inverter signals that the target has been reached, and maintains the axis in closed-loop control.
- If the axis does not come to a standstill within the standstill monitoring time, the inverter reports fault F07450.
- If the axis does not enter the positioning window within the positioning monitoring time, the inverter reports fault F07451.

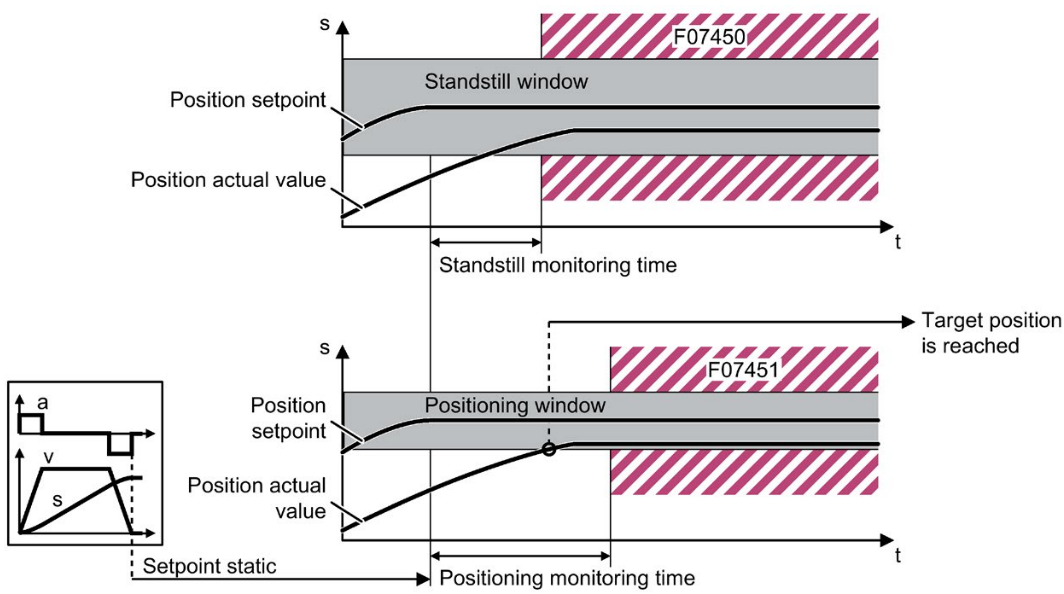


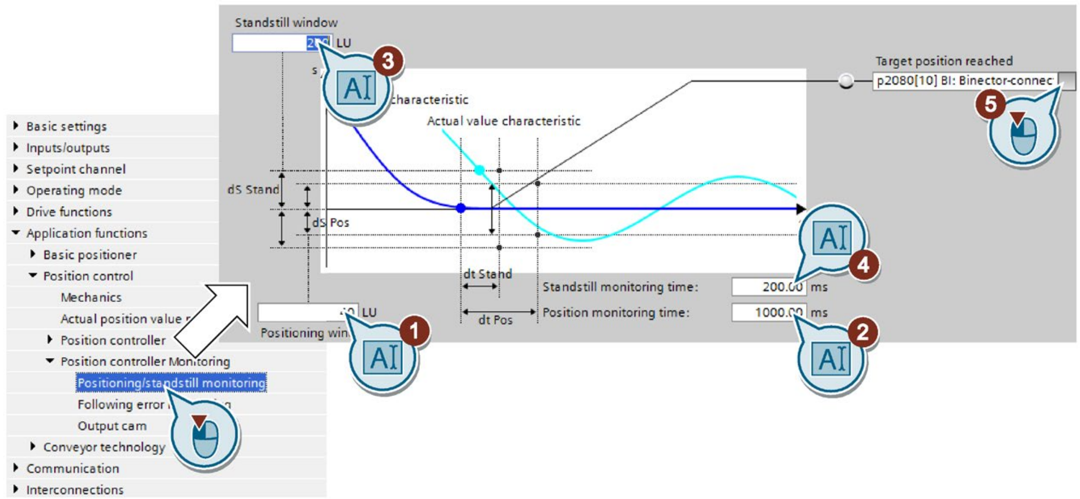
Figure 5-13 Standstill monitoring and positioning monitoring

Setting standstill monitoring and positioning monitoring

Requirement

You have selected the "Monitoring" screen and the "Position monitoring" tab.

Procedure



1. Set the required positioning accuracy.
2. Set the time within which the axis must be positioned.
3. Set the required standstill window.

   The standstill window must be larger than the positioning window.
4. Set the time within which the axis must be at standstill.
5. Define the signal "Target position reached" as a message to a higher-level control.

You have now set the standstill and position monitoring.
❒

Parameter	Meaning
p2542	Standstill window (target position ±p2542)
p2543	Standstill monitoring time
p2544	Positioning window (target position ±p2544)
p2545	Positioning monitoring time

5.6.6.2 Following error monitoring

Description

The following error is the deviation between the position setpoint and the position actual value while the converter is positioning the axis.

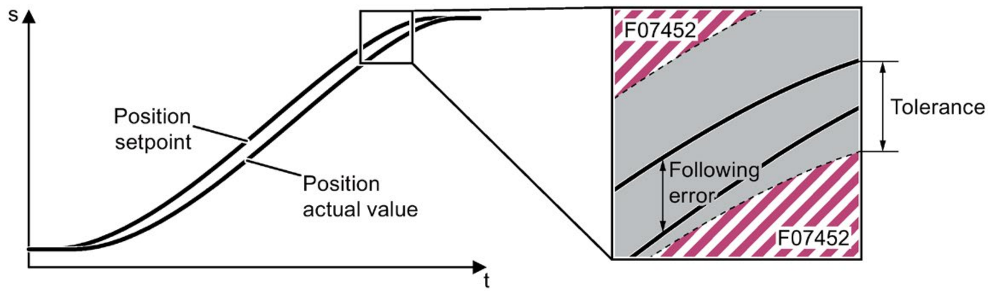


Figure 5-14 Monitoring the following error

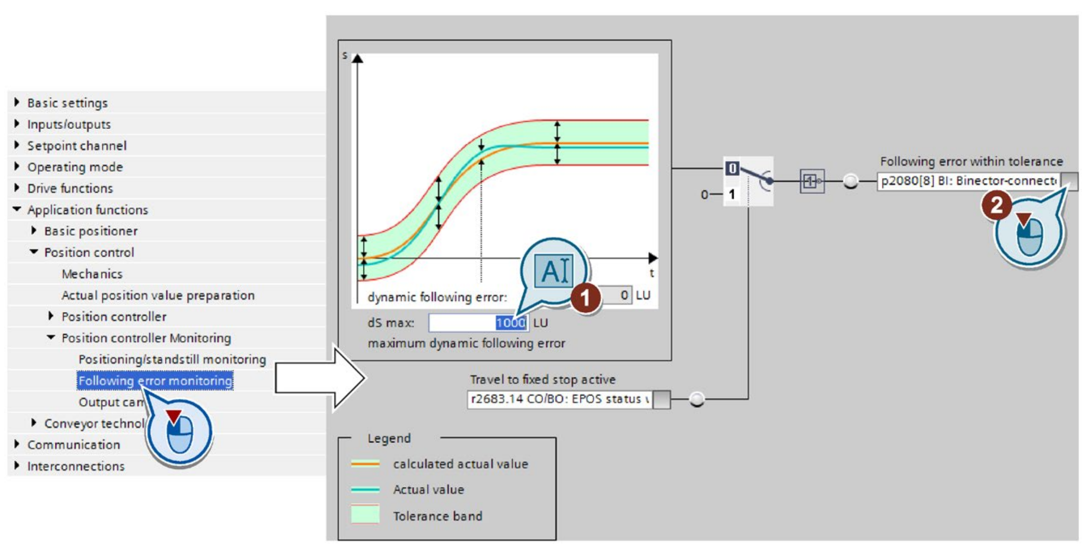
The converter reports fault F07452 if the following error is too high. If you set the tolerance to 0, monitoring is deactivated.

Setting following error monitoring

Requirement

You have selected the "Monitoring" screen and the "Following error monitoring" tab.

Procedure



1. Set the monitoring window.

   Start with the factory setting value.

   Test your setting by positioning the axis at maximum velocity, e.g. from the control panel. If the converter stops the travel with fault F07452 , you will need to either increase the monitoring window or increase the dynamics of the position controller.

2. If you want to evaluate the message in your higher-level control, interconnect this signal with, for example, a status bit in the fieldbus telegram.

You have now set the monitoring of the following error.
❒

Parameter	Meaning
p2546	Dynamic following error monitoring tolerance
r2563	Following error, dynamic model

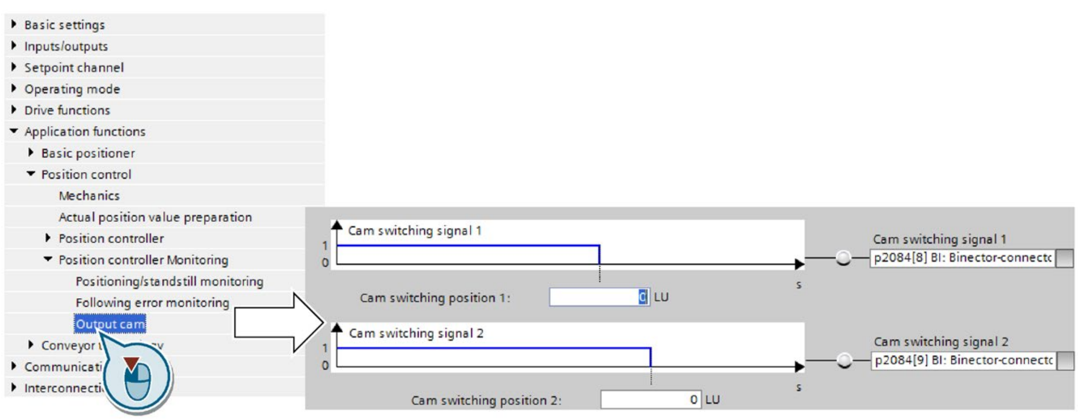
5.6.6.3 Cam sequencer

Description

The converter compares the position actual value with two different positions and therefore simulates two independent cam switching signals.

Setting the cam sequencer

Procedure



Set the cam switching position to match your particular application and interconnect the cam switching signal appropriately.

Parameter	Meaning
p2547	Cam switching position 1
p2548	Cam switching position 2
r2683.8	Position actual value <= cam switching position 1
r2683.9	Position actual value <= cam switching position 2

5.6.7 Referencing

5.6.7.1 Referencing methods

Overview

If you are using an incremental encoder for the position actual value, after the supply voltage is switched off, the inverter loses its valid position actual value. After the supply voltage is switched on again, the inverter no longer knows the reference of the axis position to the machine.

Referencing re-establishes the reference between the zero point of the position calculated in the inverter and the machine zero point.

Absolute encoders retain their position information, even after the supply has been switched off.

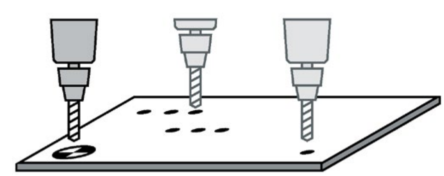
The inverter offers various ways of referencing the axis:

- Reference point approach - only with incremental encoders
- Flying referencing - with all encoder types
- Set reference point - with all encoder types
- Absolute encoder adjustment - with absolute encoders

Reference point approach

The inverter automatically traverses the axis to a defined reference point.

Example: A workpiece must be positioned at a starting point before machining starts.



Flying referencing

The inverter corrects its position actual value while traversing and reduces errors, e.g. caused by wheel slip or a gear ratio that has not been precisely set.

Example: A pallet on a roller conveyor must be stopped at a specific position. However, the exact position of the pallet on the conveyor is only known when a sensor is passed.

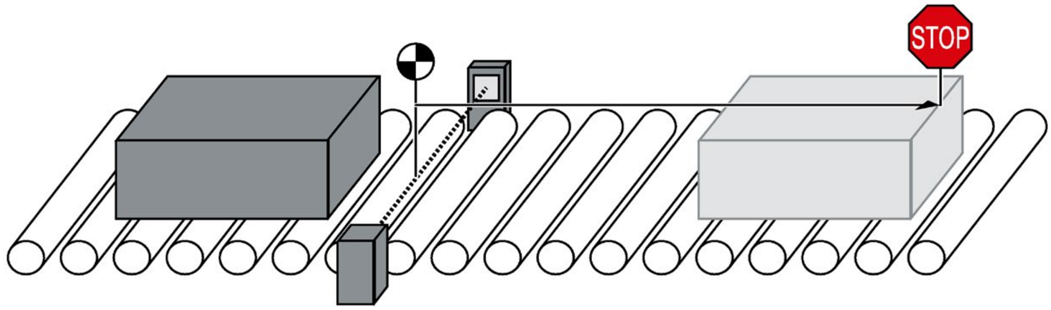


Figure 5-15 Positioning an item to be transported on a roller conveyor

Set the reference point and adjust the absolute encoder

The inverter takes the reference point coordinate as the new axis position.

5.6.7.2 Setting the reference point approach

Description

A reference point approach generally consists of the following three steps:

1. Travel to reference cam.

   When it receives a signal, the axis searches for the reference cam in a specified direction.

2. Travel to zero mark.

   Once the reference cam is reached, the axis changes the traversing direction and evaluates the zero mark of the encoder.

3. Travel to reference point.

   Once the zero mark is reached, the axis traverses to the reference point and synchronizes the actual position value in the inverter with the machine.

Step 1: Travel to reference cam

The converter accelerates the axis in the start direction to the "Approach velocity". Once the axis has reached the reference cam, in step 2, the converter switches to the reference point approach.

Reversing cams make sense if the reference cam does not extend up to the end of the traversing range. After reaching a reversing cam, the converter continues to search for the reference cam in the opposite direction.

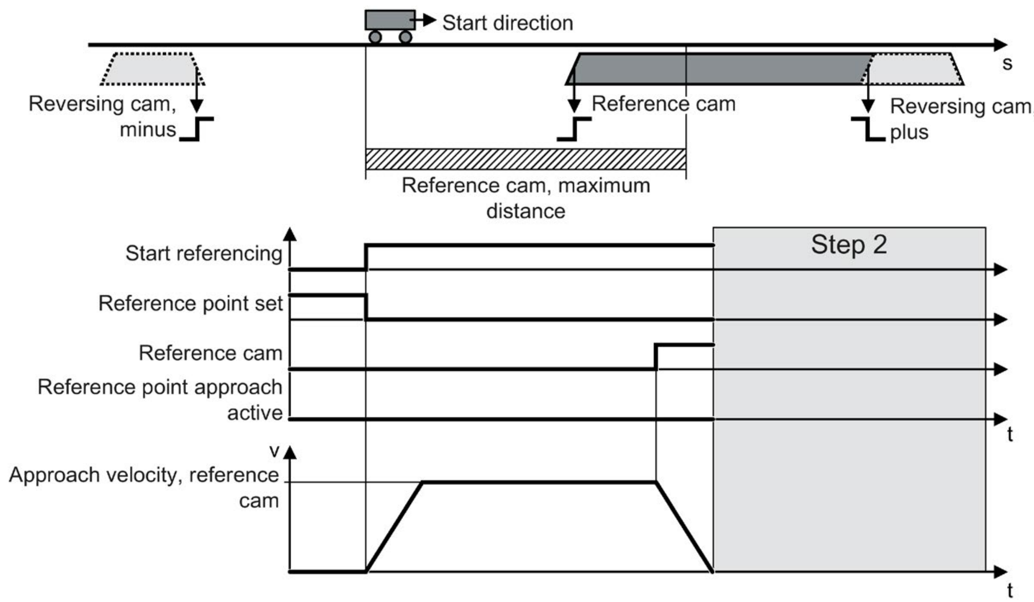


Figure 5-16 Step 1: Travel to reference cam

Under one of the following conditions, the converter skips the first step and starts with step 2:

- The axis is already at the reference cam.
- There is no reference cam available.

Step 2: Travel to zero mark

The behavior of the axis in step 2 depends on whether a reference cam is available:

• Reference cam available:	When the converter reaches the reference cam, the axis accelerates *in the opposite direction to the start direction*, to the "approach velocity zero mark".
• No reference cam is available:	The converter accelerates the axis *in the start direction* to the "approach velocity zero mark".

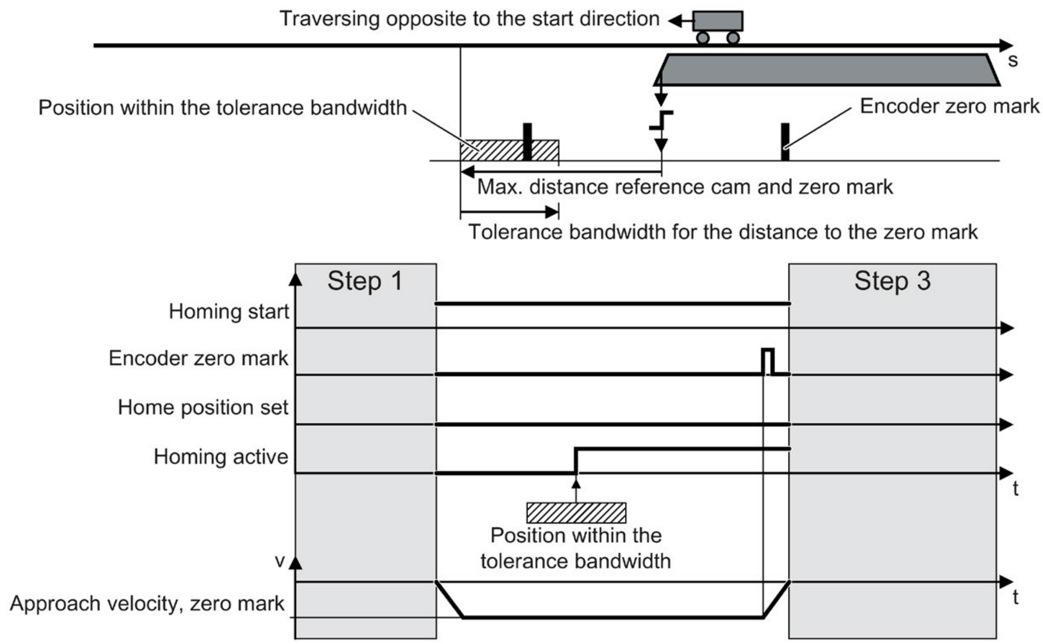


Figure 5-17 Step 2: Travel to zero mark if a reference cam is available

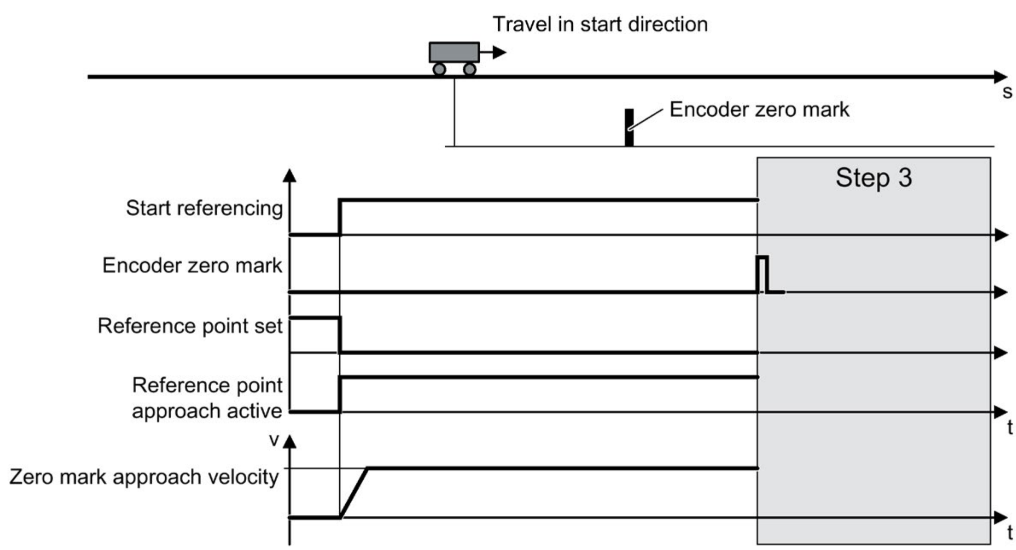


Figure 5-18 Travel to the zero mark if a reference cam is not available

Step 3: Travel to reference point

After the converter has detected a zero mark, the axis moves with the "approach velocity reference point" to the reference point coordinate.

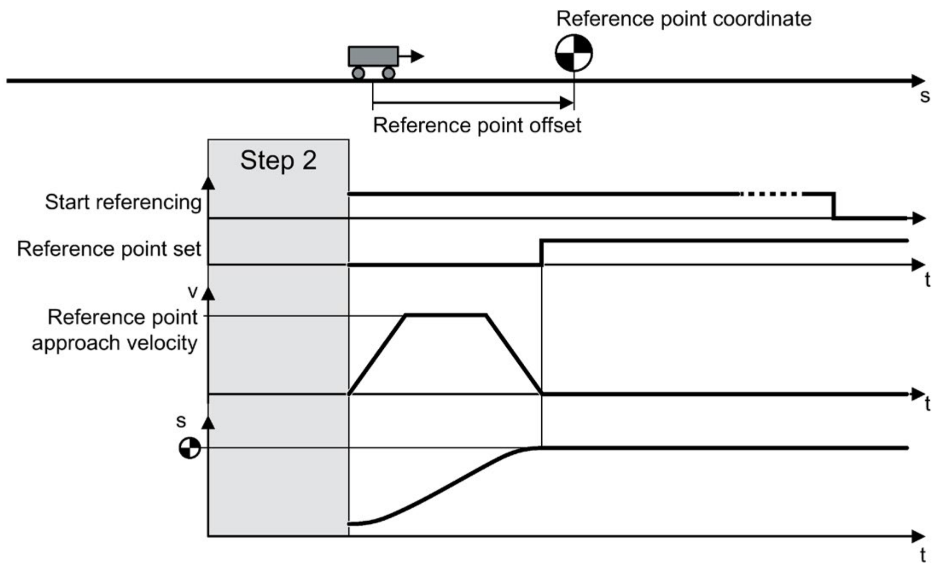


Figure 5-19 Step 3: Travel to reference point

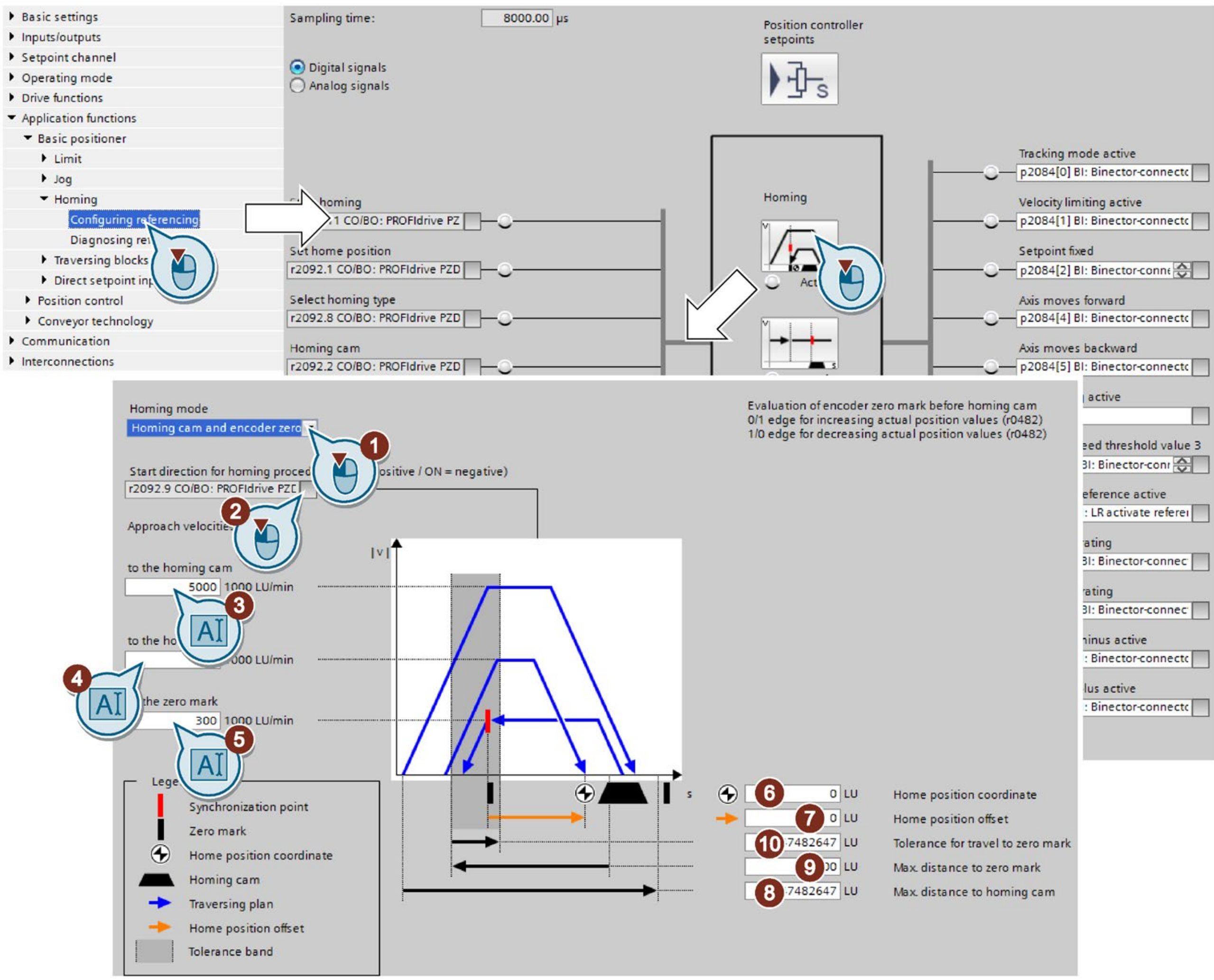
After the load has reached the reference point coordinate, the converter sets its position setpoint and actual value to this value.

Setting the reference point approach

Requirements

1. You have selected the "Homing" screen.
2. You have come to the settings via the button on the screen.
3. You have selected "Active homing".

Procedure



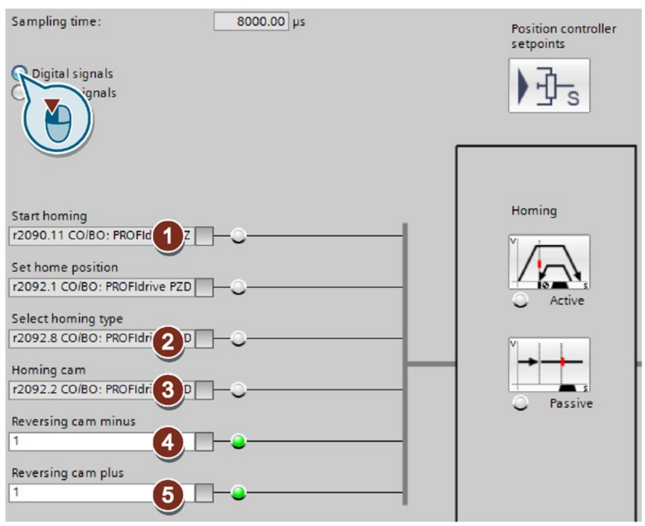
1. You specify the referencing mode:
   - Only using the encoder zero mark
   - With external zero mark
   - With reference cam and encoder zero mark
2. Specify the start direction.
3. Set the approach velocity to the reference cam.
4. Set the approach velocity to the reference point.
5. Set the approach velocity to the zero mark.
6. Specify the reference point coordinate.
7. Specify the reference point offset.
8. Specify the max. permissible distance to the reference cam in step 1 of active referencing.

9. If a reference cam is available: Define the maximum permitted distance to the zero mark.
10. If no reference cam is available: Define the tolerance for travel to the zero mark.
11. Close the screen form.

You have set the USB reference point approach.
❒

Defining the digital signals for controlling referencing

Procedure

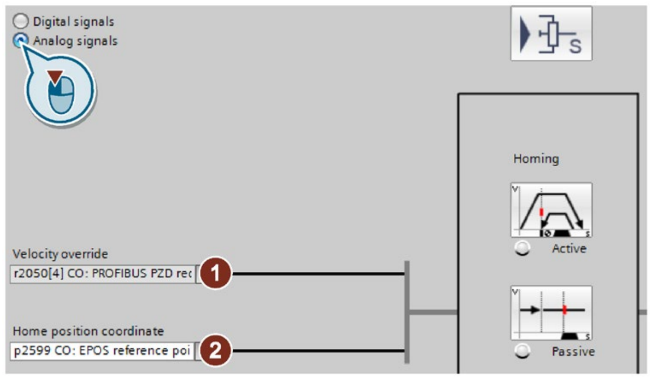


1. This signal starts the reference point approach.
2. This signal must be 0 for the reference point approach.
3. Interconnect the signal of the reference cam with the corresponding signal of your machine.
4. If you use the reversing cam minus, interconnect the reversing cam with the corresponding signal, e.g. with the fieldbus.
   0 = Reversing cams active.
5. If you use the reversing cam plus, interconnect the reversing cam with the corresponding signal, e.g. with the fieldbus.
   0 = Reversing cams active.

You have now defined the digital signals for controlling.
❒

Defining the analog signals for controlling referencing

Procedure



1. Define the signal source for the velocity override.

   Direct setpoint input (MDI) (Page 143)

2. Change the source for the reference point coordinate, if necessary.

You have now defined the analog signals for controlling.
❒

Parameter	Meaning
p2595	Start referencing
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
p2600	Reference point approach, reference point offset
p2604	Reference point approach, start direction
p2605	Reference point approach, approach velocity, reference cam
p2606	Reference point approach reference cam, maximum distance
p2607	Reference point approach reference cam available
p2608	Reference point approach, approach velocity, zero mark
p2609	Reference point approach, max distance reference cam and zero mark
p2610	Reference point approach, tolerance band for the distance to the zero mark
p2611	Reference point approach, approach velocity, reference point
p2612	Reference point approach, reference cam
p2613	Reference point approach reversing cam, minus
p2614	Reference point approach reversing cam, plus
r2684.0	Reference point approach active
r2684.11	Reference point set

5.6.7.3 Setting the flying referencing

Description

During motion, the load passes a reference cam. The converter evaluates the reference cam signal via a suitable fast digital input, and corrects its calculated position during travel. The fast digital inputs of the converter used for flying referencing are also called probe inputs.

For flying referencing, the converter corrects the position setpoint and actual value simultaneously.

If the position actual value correction means that the axis has already passed the point where it should start braking, then the axis travels beyond the target and approaches the target from the opposite direction.

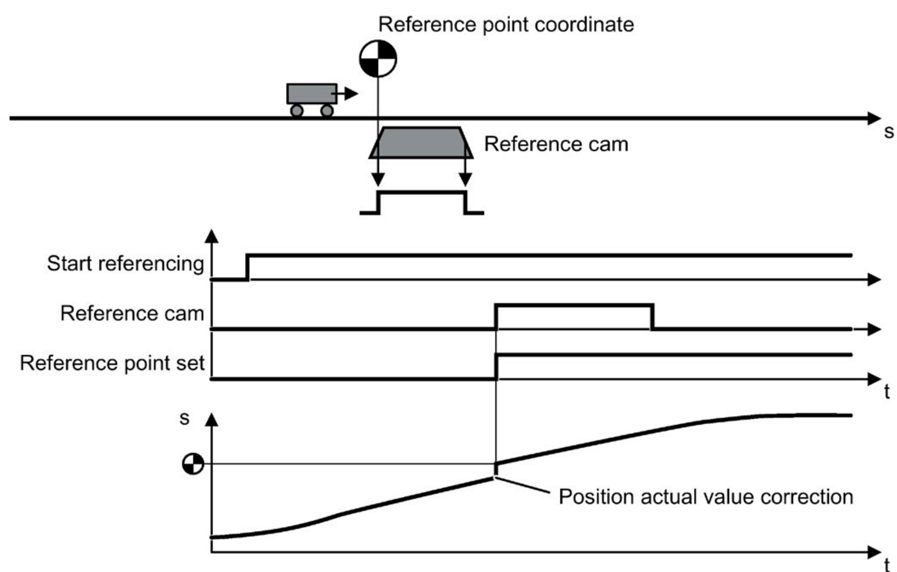


Figure 5-20 Flying referencing

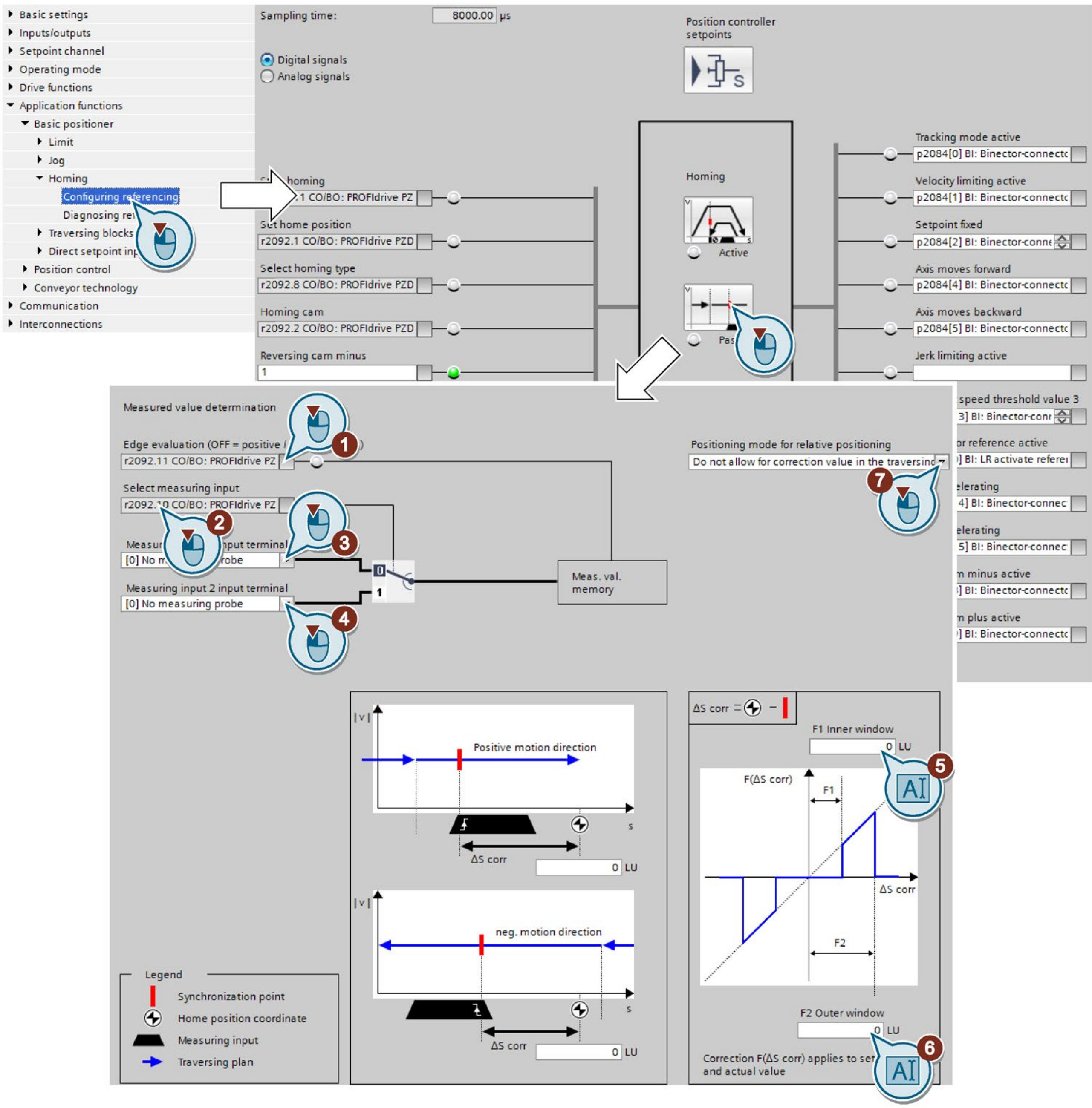
The converter sets the "Reference point set" signal back to zero after its supply voltage is switched off and switched on again. The converter only corrects its position actual value for a 1 signal from "Start referencing". In this way, you can define, for example, the direction of travel when the converter is referencing.

Setting flying referencing

Requirement

1. You have selected the "Homing" screen.
2. You have come to the settings via the button on the screen.
3. You have selected "Passive homing".

Procedure



1. Set the edge of the reference cam signal the inverter should use to reference its actual position value:

   0: Rising edge

   1: Falling edge

2. Interconnect the switchover of reference cams 1 and 2 with a signal of your choice.
3. Select the digital input with which reference cam 1 is interconnected.

4. Select the digital input with which reference cam 2 is interconnected.

   Several reference points:
   If you require several reference points for an axis, then you must do the following:

   – Assign the corresponding digital input to the respective reference point.

   – Change the reference point coordinate during operation, e.g. using the non-cyclic communication of the fieldbus.

5. Set the inner window for referencing. You deactivate the inner window with the value 0.
6. Set the outer window for referencing. You deactivate the outer window with the value 0.

   Referencing can be suppressed depending on the deviation of the actual position value:

   Inner window: For excessively small deviations, the converter does not correct its position actual value.

   Outer window: The converter signals an excessive deviation, but does not correct its position actual value.

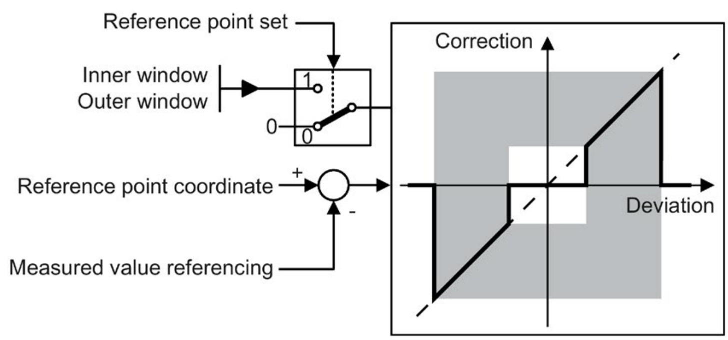


Figure 5-21 Outer and inner window for flying referencing

7. Specify the following:

   – Taking into account the offset in traversing distance: The converter corrects both the actual position as well as the setpoint. The relative traversing distance is shorter or longer by the value of the correction.
   Example: 500 LU is the axis start position. The axis should travel relatively through 1000 LU. The converter corrects the reference point during travel by 2 LU, and travels to the corrected target position 1498 LU.

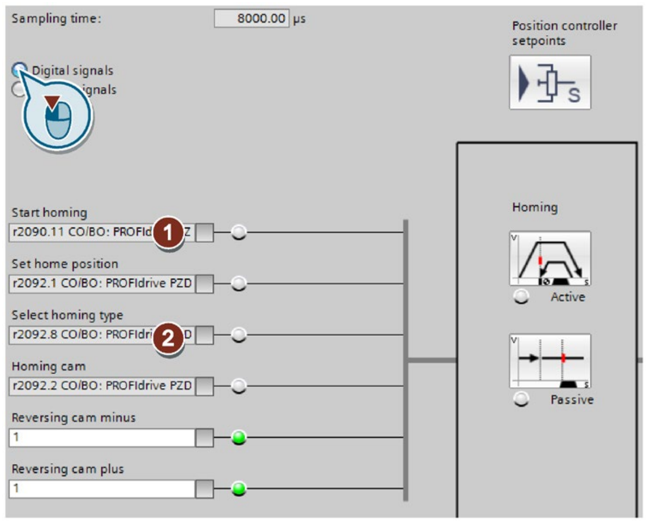
   – Not taking into account the correction in the traversing distance: The converter corrects both the actual position as well as the setpoint. The relative travel distance remains unchanged.
   Example: 500 LU is the axis start position. The axis should travel relatively through 1000 LU. The converter corrects the reference point during travel by 2 LU, however, moves to the old target position 1500 LU.

8. Set the reference point coordinate p2599 via the expert list in the STARTER.
9. Close the screen form.

You have set flying referencing.
❒

Defining the digital signals for controlling referencing

Procedure



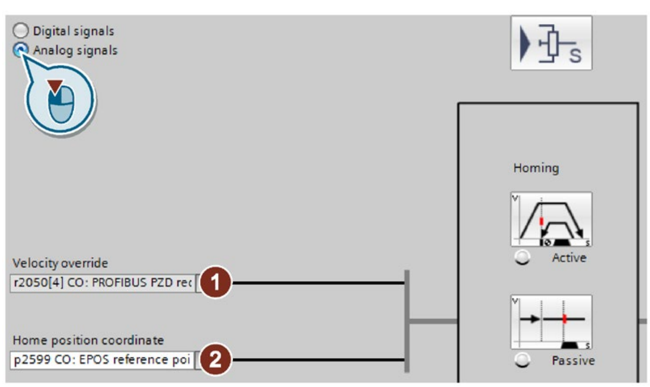
1. This signal starts flying referencing.
2. For flying referencing, this signal must be 1.

   The other signals are of no significance for flying referencing.

You have now defined the digital signals for controlling.
❒

Defining the analog signals for controlling referencing

Procedure



1. Define the signal source for the velocity override.

   Direct setpoint input (MDI) (Page 143)
2. Change the source for the reference point coordinate, if necessary.

You have now defined the analog signals for controlling.
❒

Parameter	Meaning
p2595	Start referencing
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
p2601	Flying referencing, inner window
p2602	Flying referencing, outer window
p2603	Flying referencing, relative positioning mode
p2612	Reference point approach, reference cam
r2684.11	Reference point set
p2660	Measured value referencing

5.6.7.4 Set reference point

Description

Position the load, e.g. using the "jog" function, at the reference position in the machine.

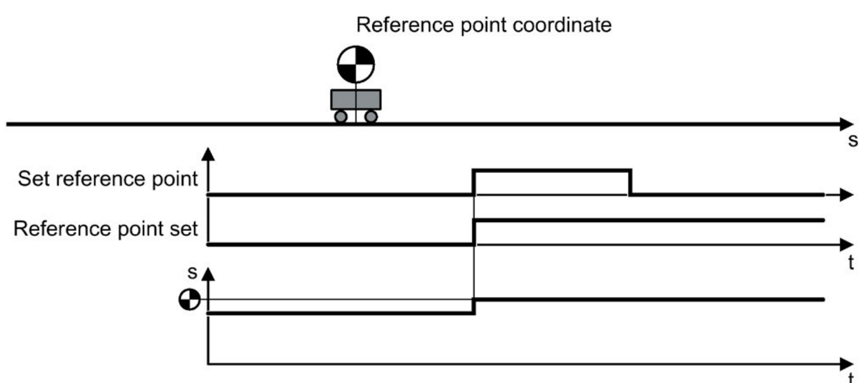


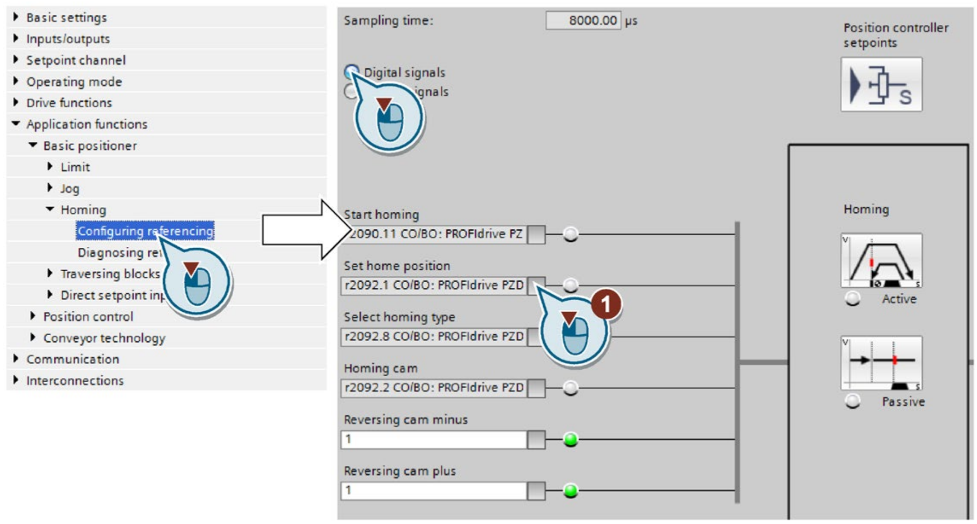
Figure 5-22 Set reference point

Activate 'set home position'

Requirement

You have selected the "Homing" screen.

Procedure



1. Interconnect this bit with the corresponding signal of your machine.
   If the axis is stationary, with the signal change 0 → 1, the inverter sets its actual position value to the reference point coordinate.
   For this function, all of the other signals are of no significance.
2. In Startdrive, proceed to the parameter view and set p2599 = reference point coordinate.

You have now activated 'set home position'.
❐

Parameter	Meaning
p2596	Set reference point
p2598	Reference point coordinate, signal source
p2599	Reference point coordinate value
r2684.11	Reference point set

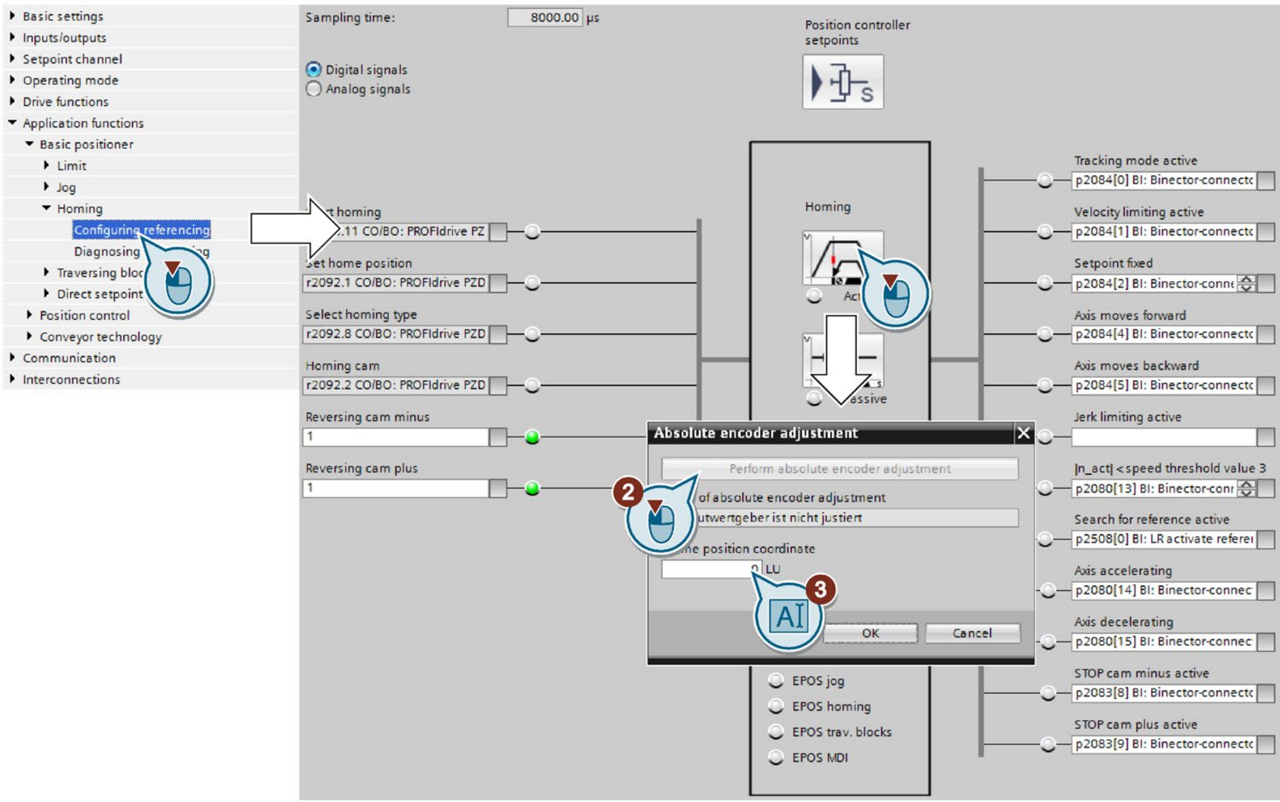
5.6.7.5 Absolute encoder adjustment

Absolute encoder adjustment

Requirement

1. You have positioned the axis (e.g. using the "jog" function) to the reference position in the machine.
2. You can use an absolute encoder for the position control.

Procedure



1. Specify the reference point coordinate.
2. Accept the reference point coordinate in the position actual value.

You have now adjusted the absolute encoder.
❒

Parameter	Meaning	
p2598	**Reference point coordinate, signal source**	
p2599	**Reference point coordinate value**	
p2507	**Absolute encoder adjustment status**	
	0	Error has occurred in the adjustment
	1	Absolute encoder was not adjusted
	2	Absolute encoder was not adjusted and encoder adjustment was initiated
	3	Absolute encoder adjusted

5.6.8 Jogging

5.6.8.1 Jog velocity

Description

Only input a setpoint velocity for the converter for velocity jog. With the signal "Jogging 1" or "Jogging 2", the converter accelerates the axis to the relevant setpoint velocity. The converter stops the axis when the respective "Jog" signal returns to zero.

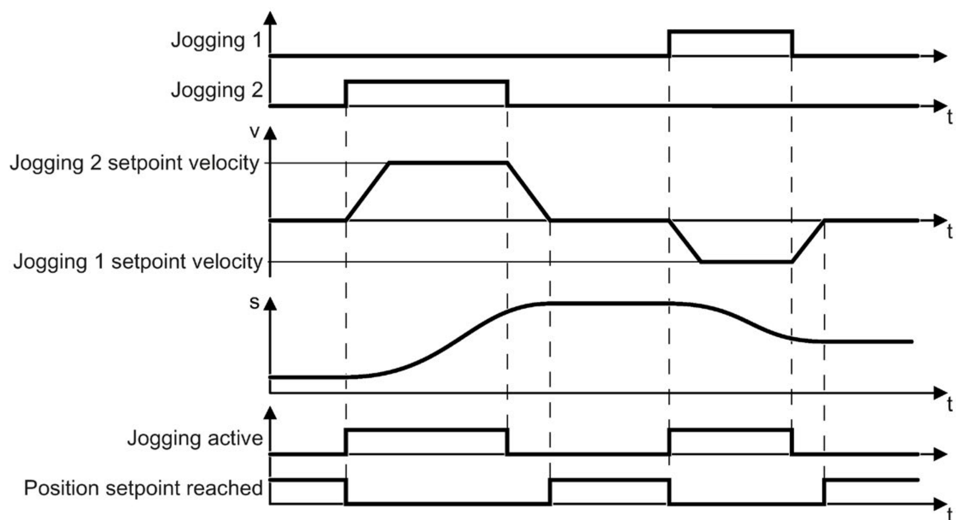


Figure 5-23 Jog velocity

5.6.8.2 Incremental jogging

Description

In the case of incremental jogging, input a relative traversing distance and a velocity setpoint into the converter. With the signals "Jogging 1" or "Jogging 2" the converter positions the axis by the respective travel path.

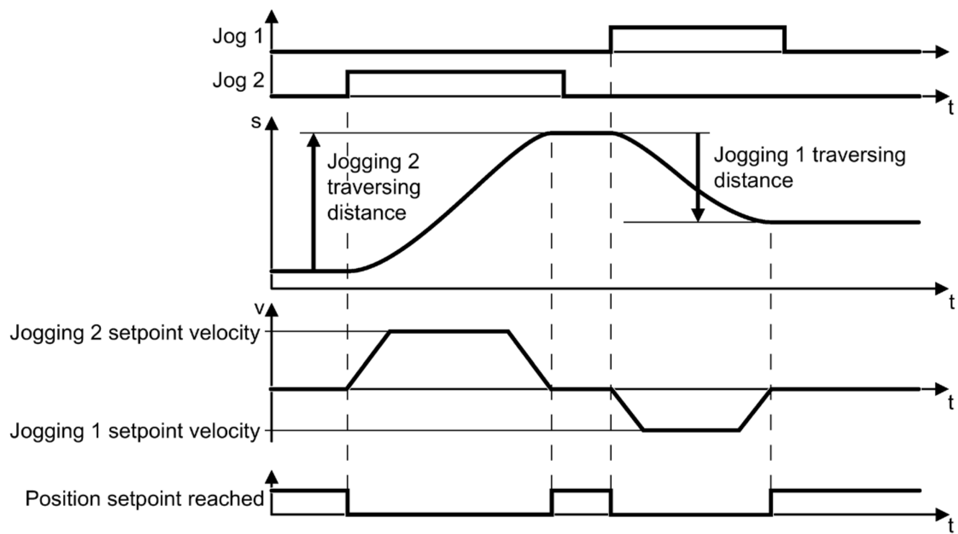


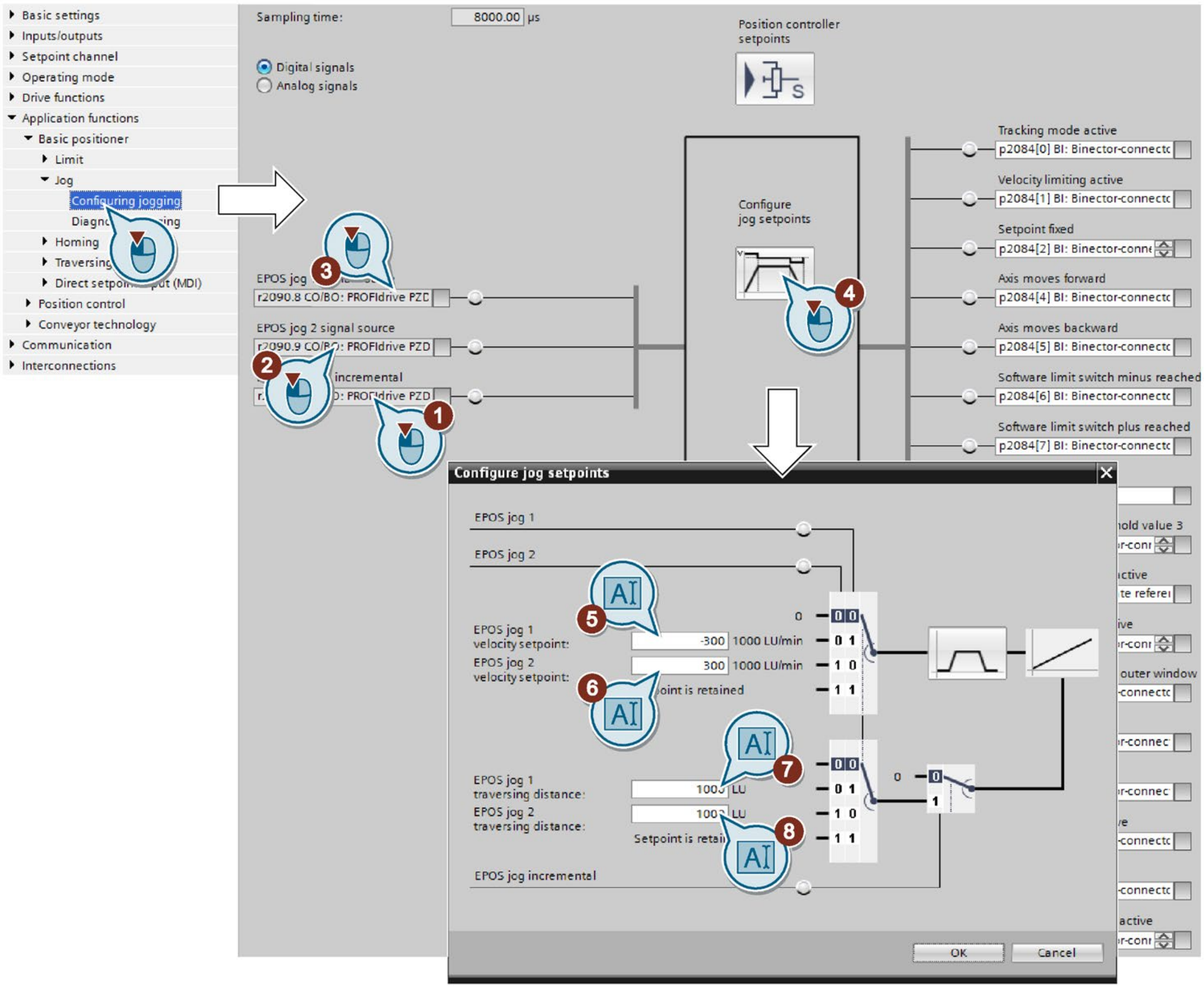
Figure 5-24 Incremental jogging

5.6.8.3 Setting jogging

Requirement

You have selected the "Jog" screen.

Procedure



1. Interconnect the signal that defines the mode for the "jog" function.

   0: Velocity jogging

   1: Incremental jogging
2. Interconnect the signal for jogging 1
3. Interconnect the signal for jogging 2.
4. Select the button for the other settings.
5. Set the velocities for the "jogging 1" function.
6. Set the velocities for the "jogging 2" function.

7. If you use the incremental jog, set the relative position setpoint for the "jogging 1" function.

   This value has no significance for velocity jogging.
8. If you use the incremental jog, set the relative position setpoint for the "jogging 2" function.

   This value has no significance for velocity jogging.

You have set the "jog" function.
❒

Parameter	Meaning
p2585	Jogging 1 setpoint velocity
p2586	Jogging 2 setpoint velocity
p2587	Jogging 1 traversing distance
p2588	Jogging 2 traversing distance
p2589	Jogging 1 signal source
p2590	Jogging 2 signal source
p2591	Incremental jogging

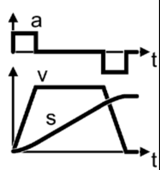
5.6.9 Traversing blocks

Description

A traversing block describes a positioning instruction for the drive.

The converter saves 16 different traversing blocks, which it normally executes one after the other. However, you can also directly select a specific traversing block or skip traversing blocks.

Table 5- 1 Components of a traversing block

<table>
<tr><th>Element</th><th colspan="3">Meaning</th></tr>
<tr><td>Number</td><td colspan="3">With this number in the range 0 to 15, every traversing block can be selected using binary-coded control signals.</td></tr>
<tr><td>Job</td><td colspan="3" rowspan="2">Positioning command: You can give the converter various commands. For some jobs, you must also specify a parameter. See the table below.</td></tr>
<tr><td>Parameter</td></tr>
<tr><td>Mode</td><td colspan="3">Positioning mode: Positioning relative to the start position or absolute to the machine zero point.</td></tr>
<tr><td>Position</td><td colspan="3">Target position</td></tr>
<tr><td>Velocity</td><td>v</td><td rowspan="3"></td><td rowspan="3">Setpoints for the traversing profile.</td></tr>
<tr><td>Acceleration</td><td>a</td></tr>
<tr><td>Braking</td><td>-a</td></tr>
<tr><td>Advance</td><td colspan="3">Jump condition to the next traversing block. See the table below.</td></tr>
</table>

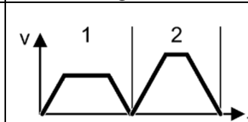
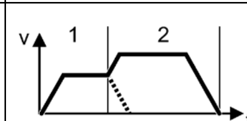
Job and parameters

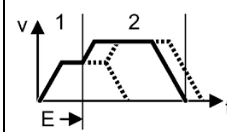
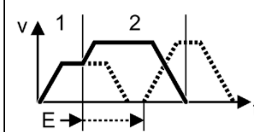
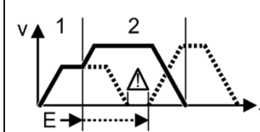
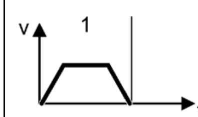
Table 5- 2 Job and parameters

Job	Parameter		Meaning
Positioning	---		• Axis absolute or relative positioning. • Rotary axis with modulo correction in a positive or negative direction, absolute positioning.
Travel to fixed stop	Force [N] or torque [0.01 Nm]		Traverse axis to a fixed stop: • Linear axis with reduced force. • Rotary axis with reduced torque. Travel to fixed stop (Page 137)
Endless travel	---		Traverse the axis at the specified velocity to the positive or negative end of the traversing range.
Wait	Time [ms]		Wait the specified time.
Go to	Number		The converter then executes the next traversing block with the specified number.
Set, reset	1	Set output 1	Set or reset internal signals in the converter: • Output 1: r2683.10 • Output 2: r2683.11 You can interconnect the signals with digital outputs of the converter or with bit 10 and 11 of the positioning status word of the fieldbus. Control and status word for the positioner (Page 169) Control and status word 2 for the positioner (Page 172)
	2	Set output 2	
	3	Set outputs 1 and 2	
Jerk	0	Inactive	Activate or deactivate jerk limiting. Limiting the traversing profile (Page 104)
	1	active	

Conditions for advance

Table 5- 3 Advance: Jump condition to the next traversing block

Condition	Meaning	Traversing block
CONTINUE WITH STOP	If the axis has reached the setpoint position and has come to a standstill, the converter executes the next traversing block.	
CONTINUE FLYING	The converter goes to next traversing block at the braking instant.	

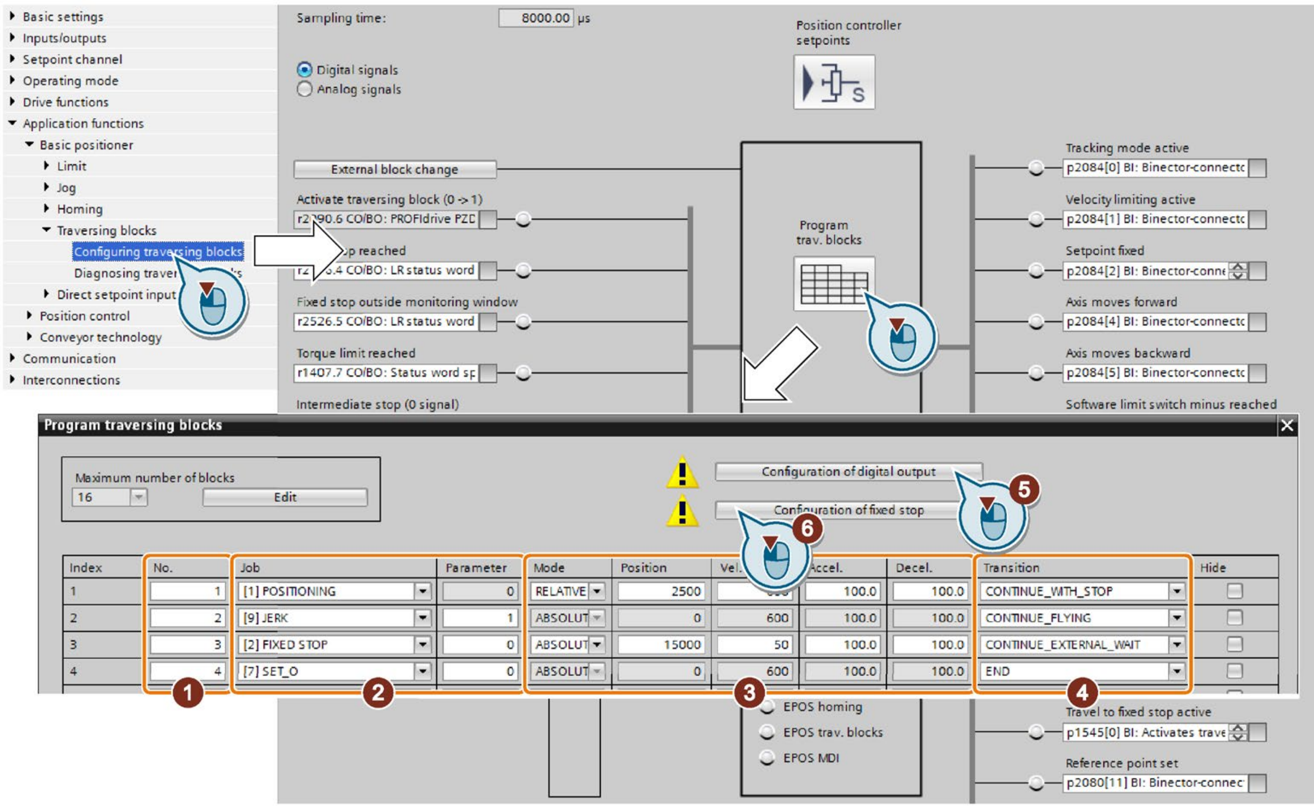
<table>
<tr><th>Condition</th><th colspan="3">Meaning</th><th>Traversing block</th></tr>
<tr><td>CONTINUE EXTERNAL</td><td rowspan="3">At the external E signal, the converter goes to the next traversing block.</td><td colspan="2">If the E signal is not present, the drive behaves just the same as for "CONTINUE FLYING".</td><td></td></tr>
<tr><td>CONTINUE EXTERNAL WAIT</td><td rowspan="2">If the E signal is not present, the converter exits the actual traversing block and continues to wait for the signal.</td><td>---</td><td></td></tr>
<tr><td>CONTINUE EXTERNAL ALARM</td><td>As long as the axis is at a standstill, the converter signals alarm A07463.</td><td></td></tr>
<tr><td>END</td><td colspan="3">The converter exits the actual traversing block if the target position has been reached. The converter does not go to the next traversing block.</td><td></td></tr>
</table>

Programming traversing blocks

Requirement

1. You have selected the "Traversing blocks" screen.
2. You select the "Program traversing blocks" button.

Procedure



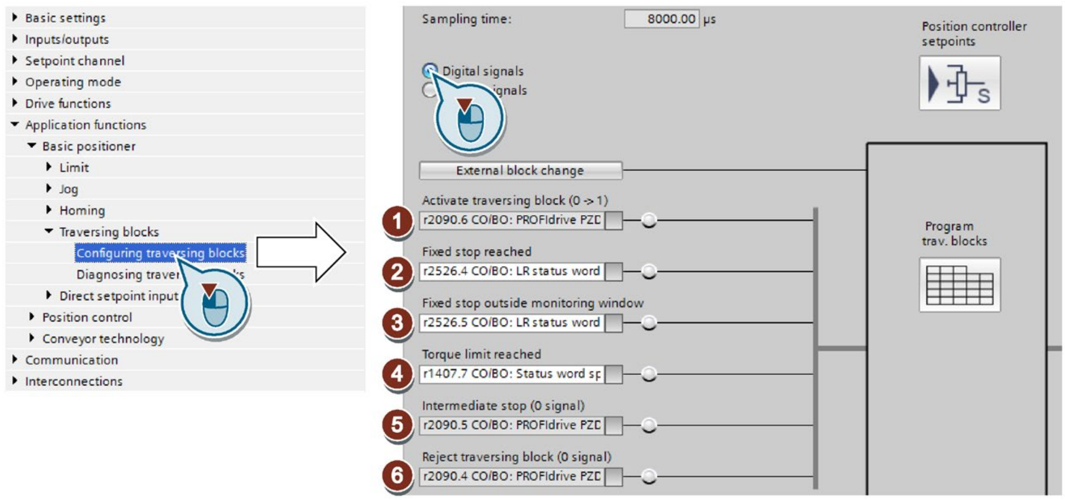
1. Assign a unique number for each traversing block.
2. Define the command and the corresponding parameters.
3. Set the job-specific values.
4. Define the step enabling condition for the next job.
5. Click this button to interconnect the status signals of the traversing blocks, for example, with bit 10 and 11 of the positioner status word with the fieldbus.
6. If you travel to a fixed stop, a button appears to make additional settings for this function.

   Travel to fixed stop (Page 137)
7. When you have programmed all traversing blocks, close the screen.

You have programmed the traversing blocks.
❒

Define digital signals for controlling

Procedure



1. Define the signal for the start of the traversing block.

   The signal change 0 → 1 starts the currently selected traversing block.
2. In the factory setting, this signal is interconnected with the appropriate internal signals of the inverter. We recommend that you do not change this setting.
3. See ②.
4. See ②.
5. Define the signal for the settings for the intermediate stop.

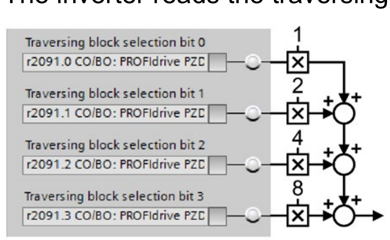
   The axis temporarily stops for the "intermediate stop" = 0 signal. The axis continues its travel with "intermediate stop" = 1. The same traversing block as before the stop is active.

   Application examples (Page 141)
6. Define the signal for "reject signaling task".

   For the signal "reject traversing task" = 0, the inverter stops the axis with the maximum deceleration (p2573). If you start the axis again with "Activate traversing request" = 0 → 1, the inverter starts again with the currently selected traversing block.

7. Interconnect the signals for selecting the traversing block number.

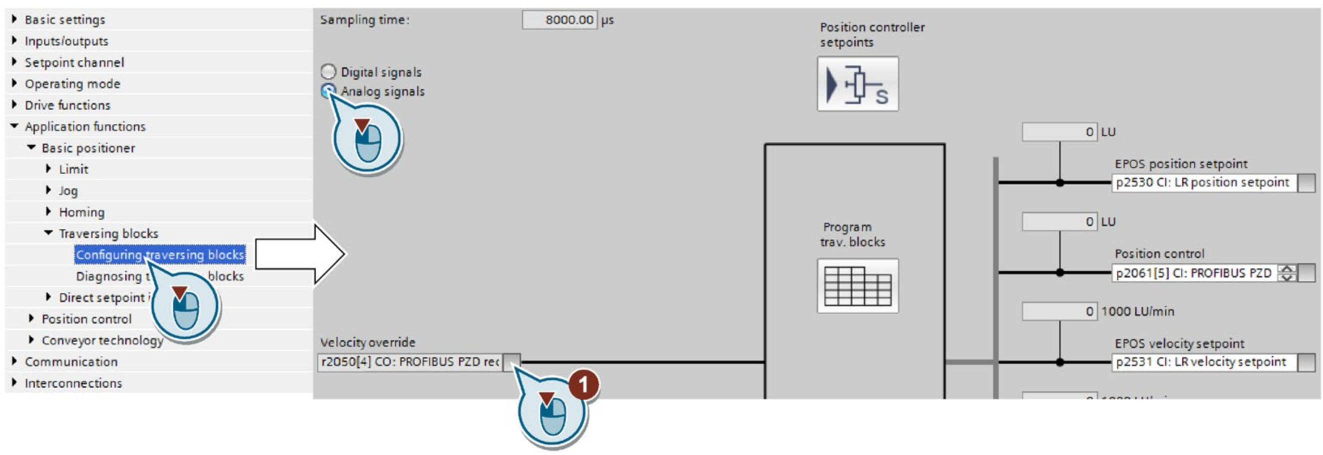
   The inverter reads the traversing block number as binary code.



You have now defined the digital signals for controlling the traversing blocks.
❒

Define analog signals for controlling

Procedure



1. Change the signal source for the velocity override, if required.
   The velocity override refers to the velocity values you have set in the screen for programming the traversing blocks.

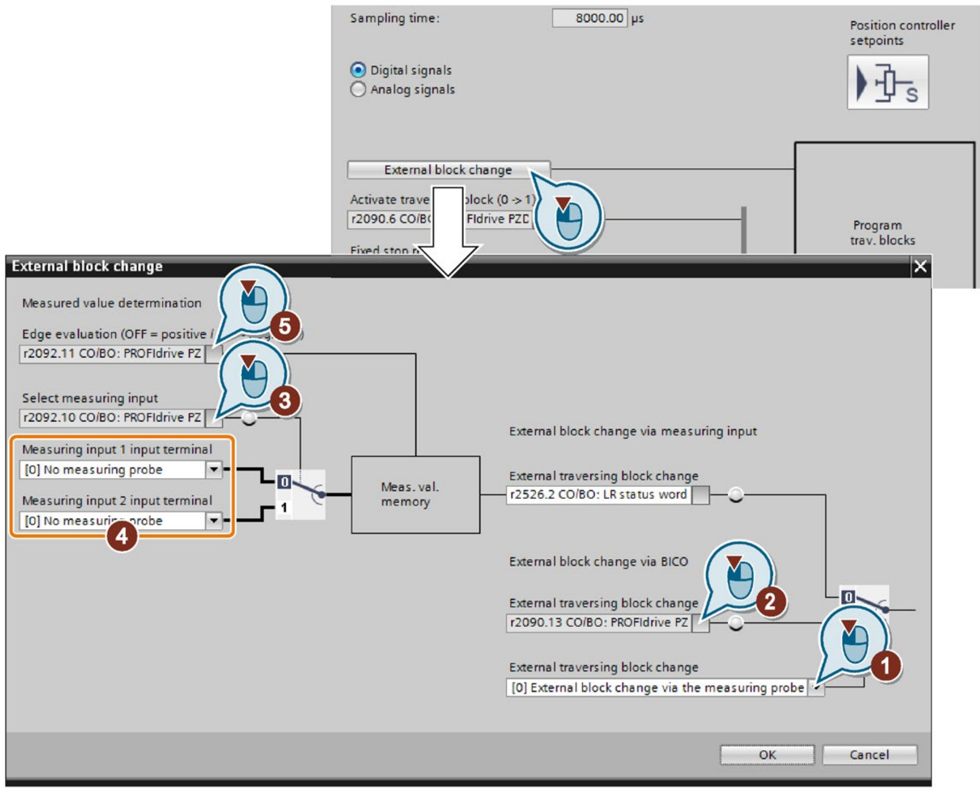
You have now defined the analog signals for controlling the traversing blocks.
❒

Define an external signal for block change

Requirement

You have selected the "External block change" button.

Procedure



1. Specify whether the external signal is received via a fast digital input (probe) or from another source, e.g. via the fieldbus.
2. To initiate a block change via the machine control system, you must interconnect this signal with a signal of your choice.
3. Select the input with which cam signal 1 is interconnected.
4. Select the input with which cam signal 2 is interconnected.
5. Specify the edge with which the inverter jumps to the next traversing block:
   0: Rising edge
   1: Falling edge

You have now defined an external signal for the block change.
❒

Parameter	Meaning	
p0488	**Probe 1, input terminal**	
p0489	**Probe 2, input terminal**	
p0581	**Probe edge**	
	0	Positive edge 0 → 1
	1	Negative edge 1 → 0
p2584	**Configuration functions**	
	.00	1 signal: activates position feedback signal (p2688 and r2689)

<table>
<tr><th>Parameter</th><th colspan="4">Meaning</th></tr>
<tr><td>p2615</td><td colspan="4">Maximum number of traversing blocks</td></tr>
<tr><td>p2616[0…n]</td><td colspan="4">Traversing block, block number</td></tr>
<tr><td>p2617[0…n]</td><td colspan="4">Traversing block, position</td></tr>
<tr><td>p2618[0…n]</td><td colspan="4">Traversing block, velocity</td></tr>
<tr><td>p2619[0…n]</td><td colspan="4">Traversing block, acceleration override</td></tr>
<tr><td>p2620[0…n]</td><td colspan="4">Traversing block, deceleration override</td></tr>
<tr><td rowspan="6">p2621[0…n]</td><td colspan="4">Traversing block, job</td></tr>
<tr><td>1</td><td>POSITIONING</td><td>6</td><td>GOTO</td></tr>
<tr><td>2</td><td>FIXED STOP</td><td>7</td><td>SET_O</td></tr>
<tr><td>3</td><td>ENDLESS_POS</td><td>8</td><td>RESET_O</td></tr>
<tr><td>4</td><td>ENDLESS_NEG</td><td>9</td><td>JERK</td></tr>
<tr><td>5</td><td colspan="3">WAIT</td></tr>
<tr><td>p2622[0…n]</td><td colspan="4">Traversing block, job parameter</td></tr>
<tr><td rowspan="12">p2623[0…n]</td><td colspan="4">Traversing block, job mode
Value = 0000 cccc bbbb aaaa</td></tr>
<tr><td>cccc = 0000</td><td rowspan="4">Positioning mode</td><td colspan="2">Absolute</td></tr>
<tr><td>cccc = 0001</td><td colspan="2">Relative</td></tr>
<tr><td>cccc = 0010</td><td colspan="2">Absolute positive (only for rotary axis with modulo correction)</td></tr>
<tr><td>cccc = 0011</td><td colspan="2">Absolute negative (only for rotary axis with modulo correction)</td></tr>
<tr><td>bbbb = 0000</td><td rowspan="7">Advance condition</td><td colspan="2">End</td></tr>
<tr><td>bbbb = 0001</td><td colspan="2">Continue with stop</td></tr>
<tr><td>bbbb = 0010</td><td colspan="2">Continue flying</td></tr>
<tr><td>bbbb = 0011</td><td colspan="2">Continue external</td></tr>
<tr><td>bbbb = 0100</td><td colspan="2">Continue external wait</td></tr>
<tr><td>bbbb = 0101</td><td colspan="2">Continue external alarm</td></tr>
<tr><td>aaaa = 0001</td><td colspan="2">Identifiers: Skip block</td></tr>
<tr><td>p2624</td><td colspan="4">Sort traversing block
To sort the traversing blocks according to their block number: p2624 = 0 → 1.</td></tr>
<tr><td>p2625</td><td colspan="4">Traversing block selection, bit 0</td></tr>
<tr><td>p2626</td><td colspan="4">Traversing block selection, bit 1</td></tr>
<tr><td>p2627</td><td colspan="4">Traversing block selection, bit 2</td></tr>
<tr><td>p2628</td><td colspan="4">Traversing block selection, bit 3</td></tr>
<tr><td>p2631</td><td colspan="4">Activate traversing block (0 → 1)</td></tr>
<tr><td rowspan="3">p2632</td><td colspan="4">External block change evaluation</td></tr>
<tr><td>0</td><td colspan="3">External block change via probe</td></tr>
<tr><td>1</td><td colspan="3">External block change via BI: p2633</td></tr>
<tr><td>p2633</td><td colspan="4">External block change (0 → 1)</td></tr>
<tr><td>p2640</td><td colspan="4">Intermediate stop (0 signal)</td></tr>
<tr><td>p2641</td><td colspan="4">Reject traversing job (0 signal)</td></tr>
<tr><td>p2646</td><td colspan="4">Velocity override</td></tr>
</table>

Parameter	Meaning	
p2688	**Position feedback signal tolerance window** The parameter is only active for p2584.0 = 1 If, for a positioning operation, the actual position (r2521) is within the tolerance window of the target position, then r2689 indicates the traversing block number.	
r2689	**Position feedback signal display** The parameter is only active for p2584.0 = 1 The block number of the traversing block, whose target position lies in the tolerance window around the actual position.	
	[0]	Bit-coded display of the traversing block numbers 0 to 31
	[1]	Bit-coded display of the traversing block numbers 32 to 63

5.6.9.1 Travel to fixed stop

Requirements

The "Travel to fixed stop" function is only possible with the control type vector control with encoder (VC):

"Travel to fixed stop" is not possible with the following types of control:

- V/f control
- Vector control without encoder (SLVC)

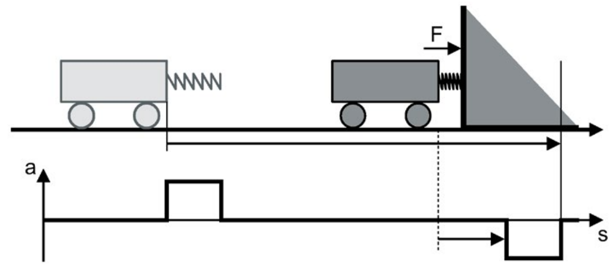
Description

With this function, the inverter positions a machine part to another machine part with force locking – and presses both machine parts together with an adjustable force.

Examples:

1. A door is pressed against a frame so that it is reliably closed.
2. A rotary table is pressed against a mechanical fixed stop, in order to secure a specific alignment.

When traveling to a fixed stop, the following applies:



- You must specify the position setpoint far enough behind the mechanical fixed stop. The load must reach the mechanical fixed stop before the inverter brakes the axis.
- If the start of braking point is located in front of the mechanical fixed stop, the inverter cancels the travel and outputs fault F07485.
- Before starting the travel, the inverter calculates the traversing profile for accelerating and braking the axis. The selected torque limit for the fixed stop has no influence on this calculation. However, the torque limit for the fixed stop reduces the available drive torque for the complete traversing distance. If the torque available for the predicted acceleration is not sufficient, then the following error is higher.
If the following error monitoring for travel to fixed stop responds, then you must reduce the acceleration override.

Fixed stop has been reached

You have two options to define when the fixed stop is reached:

1. Fixed stop via an external sensor:
At the fixed stop, the load actuates an external sensor. The sensor signals the inverter that the fixed stop has been reached. Depending on the advance condition, the inverter maintains the axis at the position with the set torque or goes to the next traversing block.
2. Fixed stop using maximum following error:
If the axis comes into contact with the mechanical fixed stop, then the actual position value remains stationary. However, the inverter still increases its position setpoint. The inverter detects the fixed stop from a settable difference between the position setpoint and position actual value. Depending on the advance condition, the inverter maintains the axis at the position with the set torque or goes to the next traversing block.

Application example: Fixed stop using maximum following error

Table 5- 4 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	TRAVEL TO FIXED STOP	5	RELATIVE	10000	10	100	100	CONTINUE WITH STOP
2	2	POSITIONING	0	ABSOLUTE	0	500	100	100	END

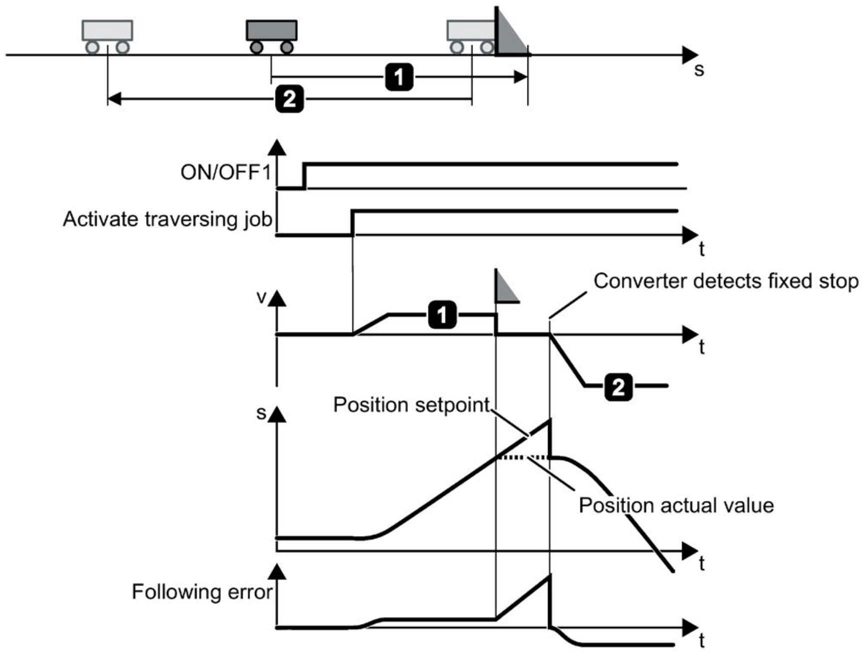
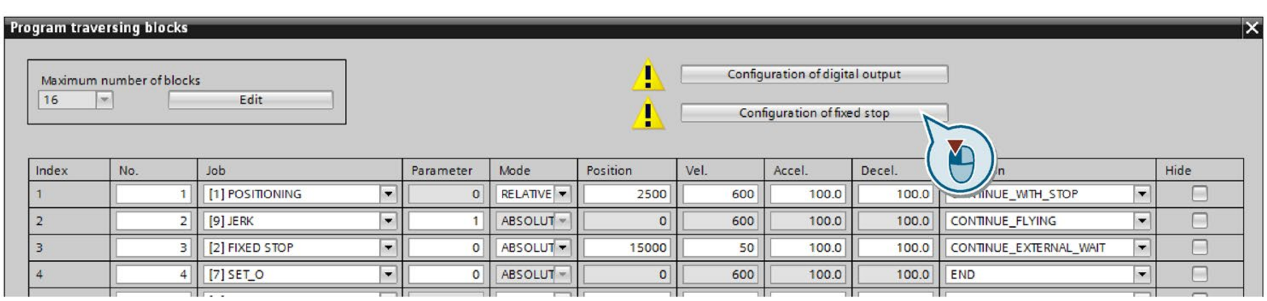


Figure 5-25 Inverter detects the fixed stop using the following error

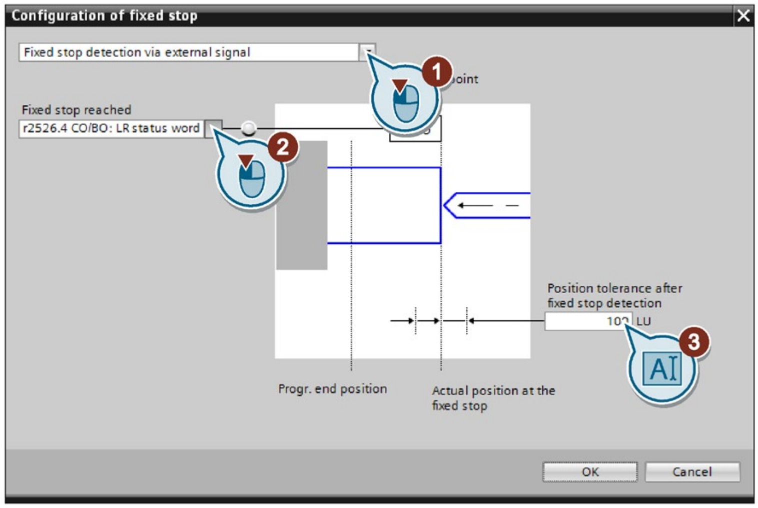
Set travel to fixed stop

Requirement

1. You have programmed "Travel to fixed stop" as the traversing block.
   Traversing blocks (Page 128)
2. If you select the "Programming traversing blocks" button, the "Configuration of fixed stop" button appears.



Procedure: Fixed stop using an external signal

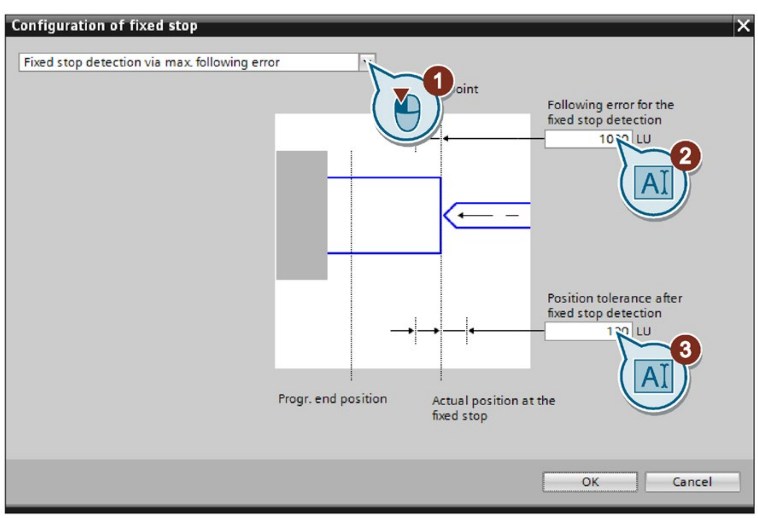


1. Select "Fixed stop using an external signal".
2. Interconnect the sensor that signals when the fixed stop is reached with this signal.
3. Set the tolerance.

   After the fixed stop is detected, the inverter monitors the actual position of the axis. If the position actual value changes by more than this distance, then the inverter stops the axis and outputs fault F07484. Therefore, the inverter detects that the fixed stop has "broken away".

You have now set "Travel to fixed stop" using an external signal.
❐

Procedure: Fixed stop using maximum following error



1. Select "Fixed stop using maximum following error":
2. Set the following error that the inverter uses to detect the fixed stop.
3. Set the tolerance.

   After the fixed stop is detected, the inverter monitors the actual position of the axis. If the position actual value changes by more than this distance, then the inverter stops the axis and outputs fault F07484. Therefore, the inverter detects that the fixed stop has "broken away".

You have now set "Travel to fixed stop" using maximum following error.
❒

Parameter	Meaning	
p2634	**Fixed stop, maximum following error**	
p2635	**Fixed stop, monitoring window**	
p2637	**Fixed stop reached**	
	0	Fixed stop has not been reached.
	1	Fixed stop has been reached.
p2638	**Fixed stop outside the monitoring window**	
p2639	**Torque limit reached**	
	0	Torque limit has not been reached.
	1	Torque limit has been reached.

5.6.9.2 Application examples

1st example

Table 5- 5 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	POSITIONING	0	RELATIVE	10000	5000	100	100	CONTINUE WITH STOP
2	2	POSITIONING	0	ABSOLUTE	0	5000	100	100	END

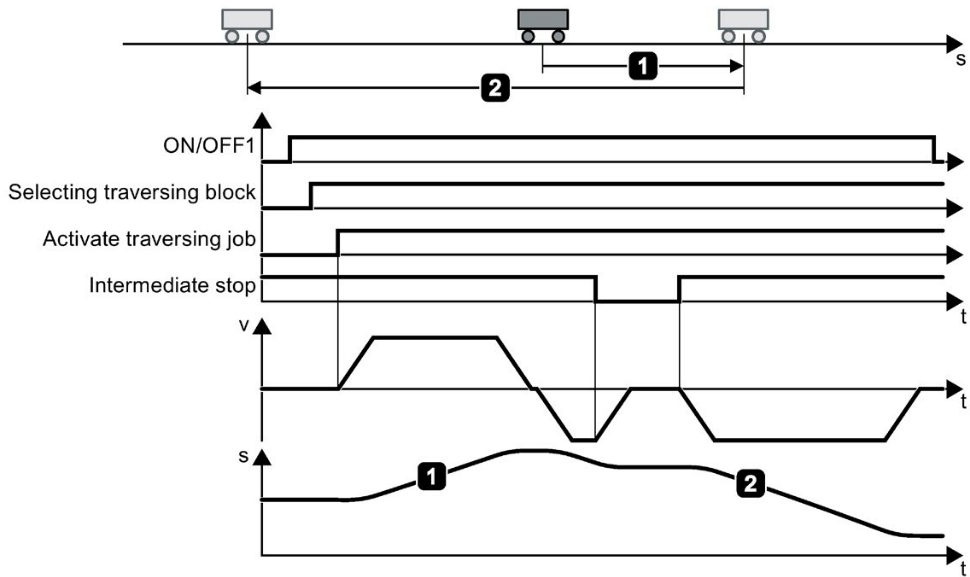


Figure 5-26 Positioning an axis using traversing blocks

2nd example

Table 5- 6 Traversing blocks

Ind.	No.	Job	Par.	Mode	s	v	a	-a	Advance
1	1	POSITIONING	0	RELATIVE	10000	2000	100	100	CONTINUE EXTERNAL ALARM
2	2	POSITIONING	0	RELATIVE	10000	5000	100	100	CONTINUE EXTERNAL ALARM
3	3	POSITIONING	0	ABSOLUTE	0	5000	100	100	END

The inverter only goes to the next traversing block for the 0 → 1 change of the "External block selection" signal.

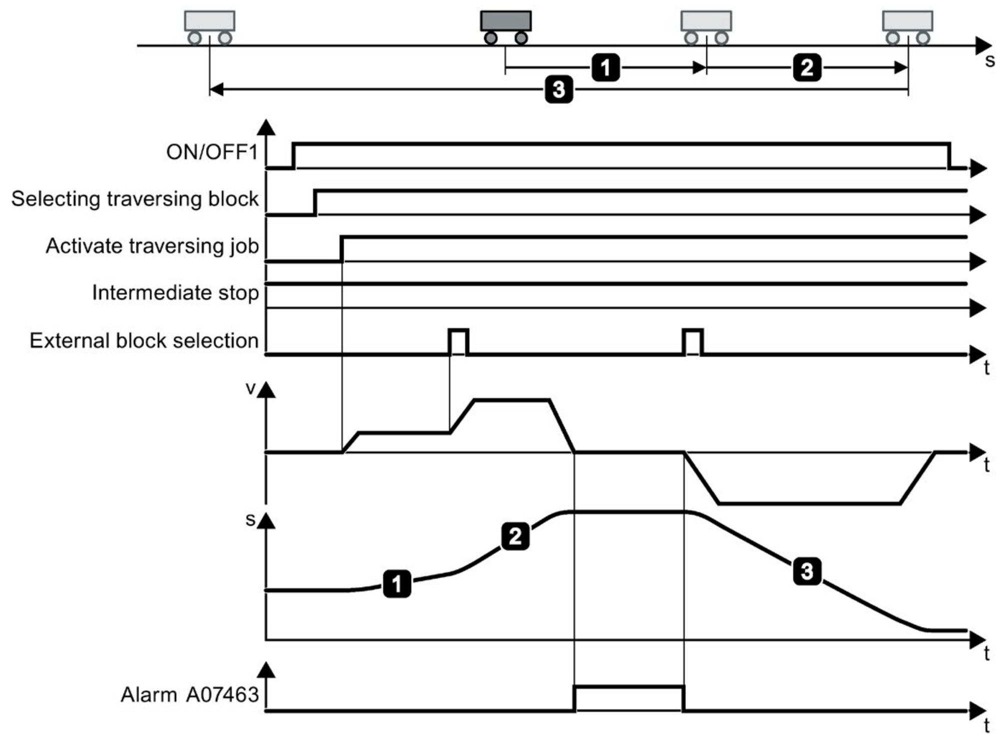


Figure 5-27 Positioning an axis using traversing blocks

5.6.10 Direct setpoint input (MDI)

Description

For direct setpoint input (MDI, Manual Data Input), a higher-level control provides the inverter with the position setpoint and traversing profile.

Example 1

The higher-level control specifies the value of the setpoint either as a relative or an absolute position setpoint:

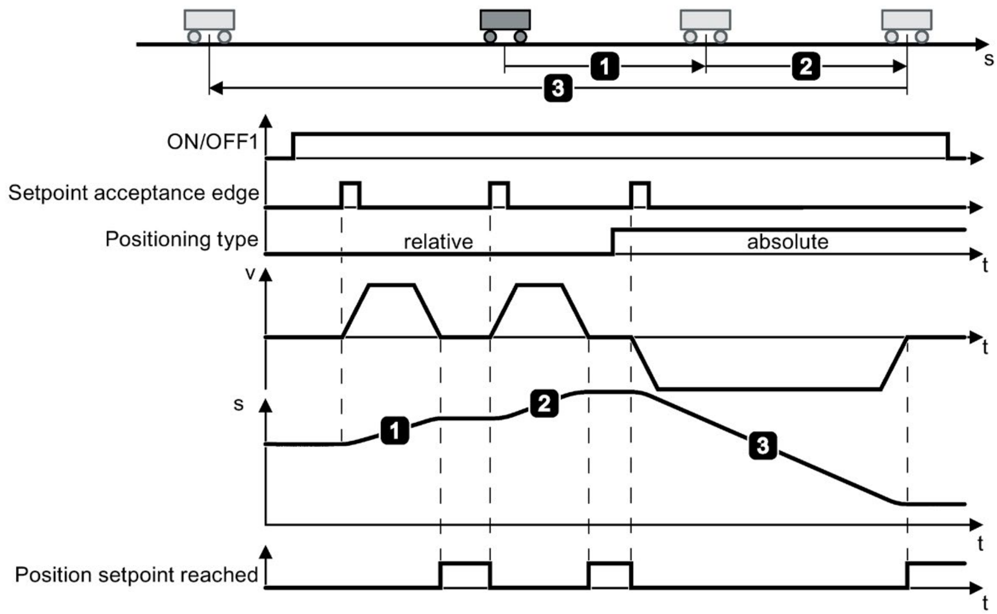


Figure 5-28 Position axis with direct setpoint input (MDI)

Example 2

The higher-level control selects the mode "Set-up":

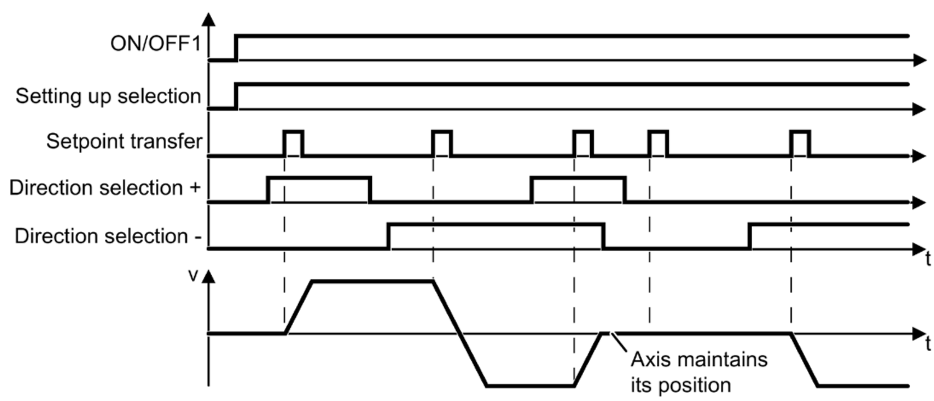


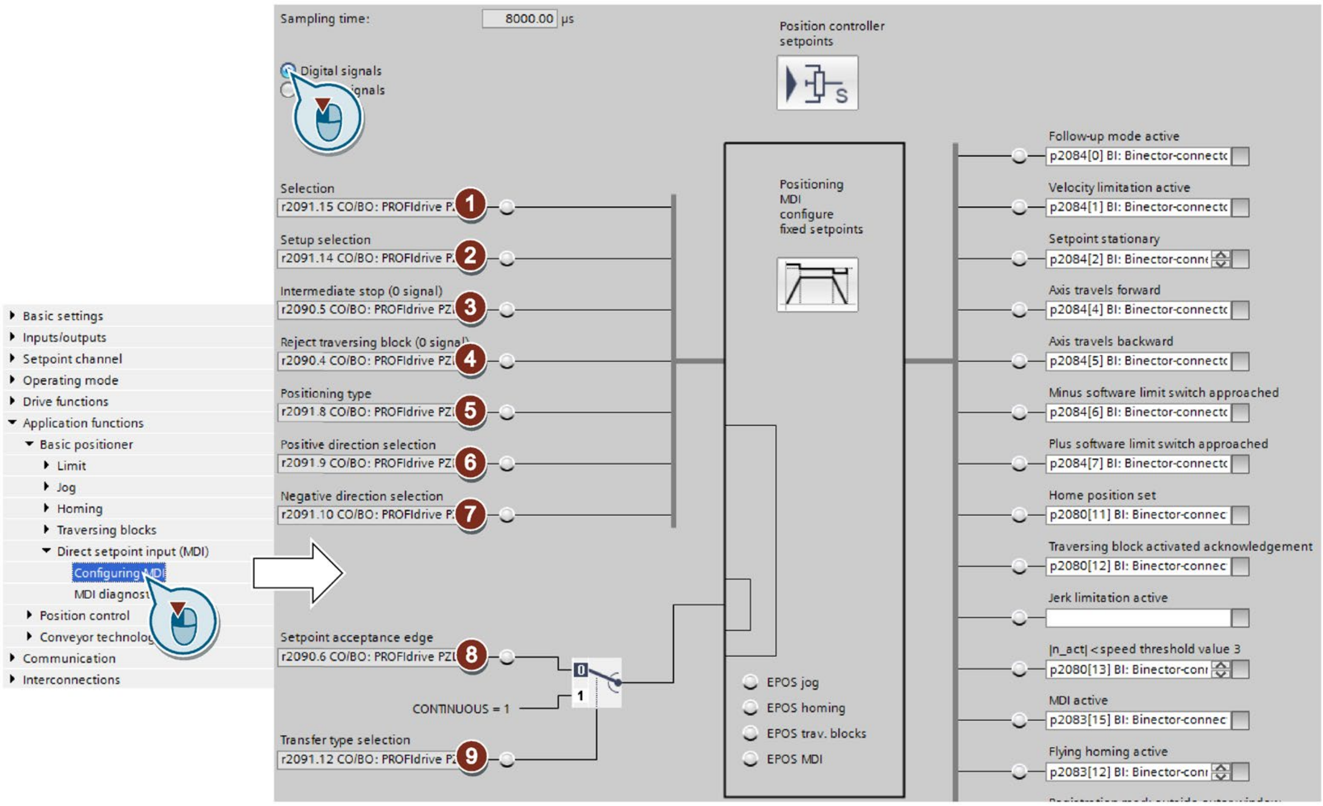
Figure 5-29 Set up axis with direct setpoint input (MDI)

Defining digital signals to control the direct setpoint input

Requirement

You have selected the "Direct setpoint input (MDI)" screen.

Procedure



Interconnect the signals to control the direct setpoint input using the appropriate signals from your machine control.

① The signal enables MDI. The signal must be = 1 if you control the inverter using MDI.

② Specifies the MDI mode:

0: Positioning: Traverse the axis with position control over the target position.

1: Set up: Traverse the axis position-controlled using velocity input

While operational, the axis operating mode can be switched over from "Set up" to "Positioning".

If "Set up" is active, then the two bits ⑥ and ⑦ define the direction of travel.

③ Intermediate stop:

0: The inverter stops the axis and maintains the axis in position after standstill. The current traversing block remains valid.

1: The axis continues the interrupted traversing block.

④ Discard traversing block:

0: The inverter stops the axis and maintains the axis in position after standstill. The inverter can no longer continue the current traversing block, however.

1: Axis waits for a new start command.

⑤ Positioning mode:

0: Relative (see also Bit ⑨).

1: Absolute (the axis must be referenced).

⑥ Direction selection for "Set up" (Bit ② = 1):

⑦ Bit ⑥ = 1: Positive direction.

Bit ⑦ = 1: Negative direction.

If both bits are the same, the axis stops.

These signals are only effective if, in the interface for analog signals, the value ⑥ is not interconnected. See also the table below.

⑧ Accept setpoint:
0 → 1: Start axis
Is only active, if bit ⑨ = 0.

⑨ 1: Continuous mode:

The inverter continually accepts changes to the position setpoint. In this mode, relative positioning is not permitted (see bit ⑤).

0: The inverter starts using bit ⑧.

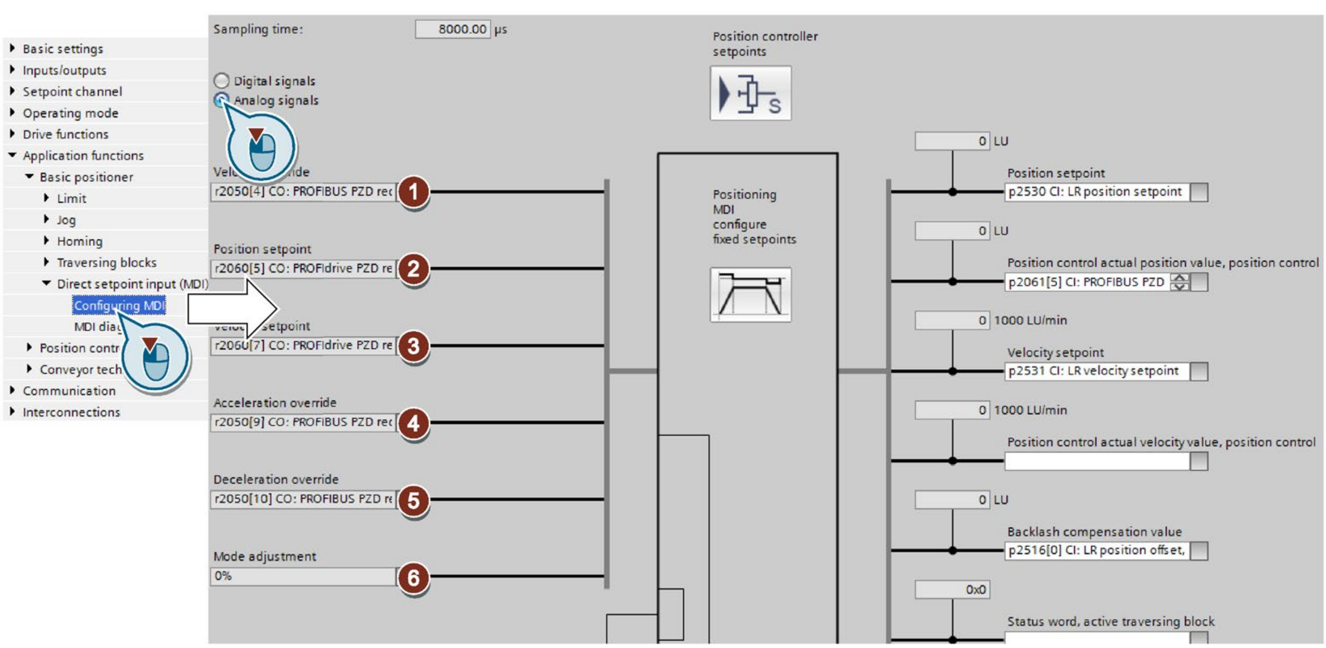
You have now interconnected the digital signals for controlling the direct setpoint input.
❒

Defining the signals to control the direct setpoint input

Requirement

You have selected the "Direct setpoint input (MDI)" screen.

Procedure



Interconnect the signals to control the direct setpoint input using the appropriate signals from your machine control:

① Override velocity, referred to ③

② Position setpoint

③ Velocity setpoint for the traversing profile.

④ Acceleration override and deceleration, referred to the values of the traversing profile
⑤ limitation.

Limiting the traversing profile (Page 104)

⑥ **"Mode adaptation" is interconnected with a signal:**

xx0x hex	Absolute positioning.
xx1x hex	Relative positioning.
xx2x hex	Position the rotary axis in the positive direction.
xx3x hex	Position the rotary axis in the negative direction.

"Mode adaptation" is not interconnected (=0):

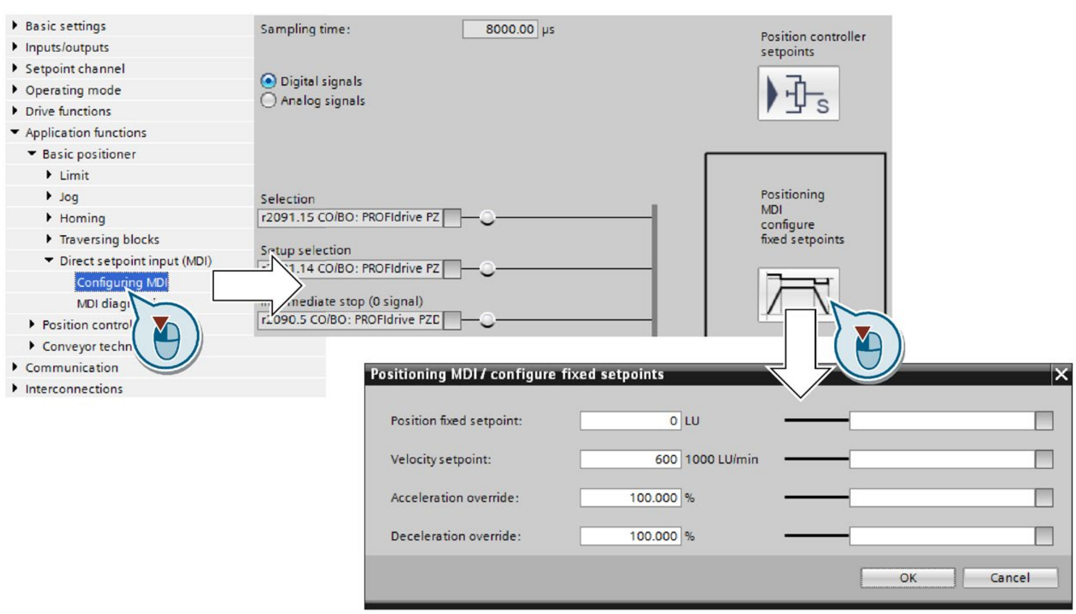
The signals ⑤, ⑥ and ⑦ of the upper table are effective.

You have now interconnected the analog signals for controlling the direct setpoint input.
❒

Set fixed setpoint

In some applications it is sufficient if the inverter moves the axis for each task in the same way, absolute or relative to the position setpoint. This approach can be achieved with fixed setpoints.

Procedure



1. Select the button for configuring the fixed setpoint:
2. Set the values suitable to your application:

You have set the fixed setpoints.
❒

Parameter	Meaning	
p2640	**Intermediate stop (0 signal)**	
p2641	**Reject traversing job (0 signal)**	
p2642	**Direct setpoint input/MDI, position setpoint**	
p2643	**Direct setpoint input/MDI, velocity setpoint**	
p2644	**Direct setpoint input/MDI, acceleration override**	
p2645	**Direct setpoint input/MDI, deceleration override**	
p2646	**Velocity override**	
p2647	**Direct setpoint input/MDI selection**	
p2648	**Direct setpoint input/MDI, positioning type**	
	0	Absolute positioning is selected
	1	Relative positioning is selected
p2649	**Direct setpoint input/MDI, acceptance method selection**	
	0	Values are accepted when p2650 = 0 → 1
	1	Continuous acceptance of values
p2650	**Direct setpoint input/MDI, setpoint acceptance, signal edge** p2650 = 0 → 1 and p2649 = 0 signal	
p2651	**Direct setpoint input/MDI, positive direction selection**	
p2652	**Direct setpoint input/MDI, negative direction selection**	
p2653	**Direct setpoint input/MDI, set up selection** Signal = 1: Set up is selected.	
p2654	**Direct setpoint input/MDI, mode adaptation**	
p2690	**Position fixed setpoint** Interconnect fixed setpoint: p2642 = 2690	
p2691	**Velocity fixed setpoint** Interconnect fixed setpoint: p2643 = 2691	
p2692	**Acceleration override fixed setpoint** Interconnect fixed setpoint: p2644 = 2692	
p2693	**Deceleration override fixed setpoint** Interconnect fixed setpoint: p2645 = 2693	

5.7 Restoring the factory setting

5.7.1 Restoring the factory setting

When must you reset the inverter to the factory settings?

Reset the inverter 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 inverter was already operational.

Restoring the factory settings when the safety functions are enabled

If you are using the integrated safety functions of the inverter, e.g. "Safe Torque Off", you must reset the safety functions separately from the remaining inverter 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.

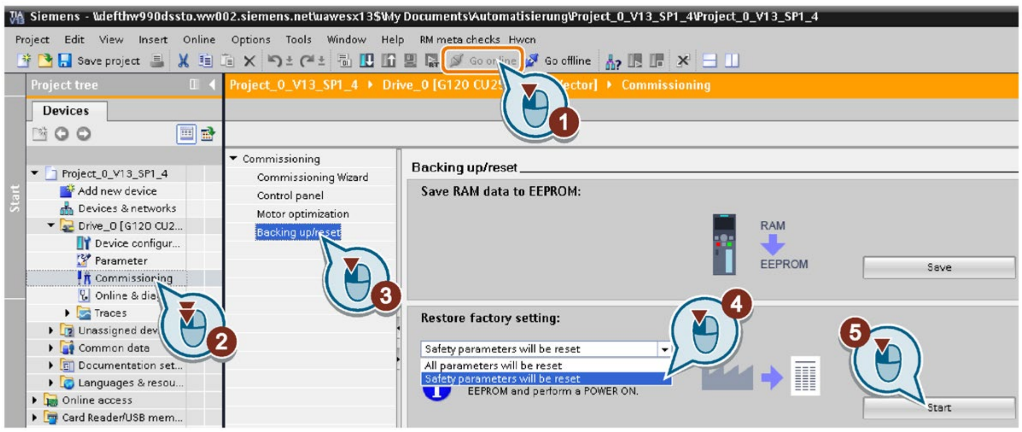
Procedure with an operator panel

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 inverter sets p0970 = 0.
5. Set p0971 = 1.
6. Wait until the inverter sets p0971 = 0.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark.
9. Switch on the inverter power supply again.

You have restored the safety function settings of your inverter to the factory settings.
❒

5.7.2 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 inverter power supply.
10. Wait until all LEDs on the inverter are dark.
11. Switch on the inverter power supply again.

You have restored the safety functions in the inverter to the factory settings.
❒

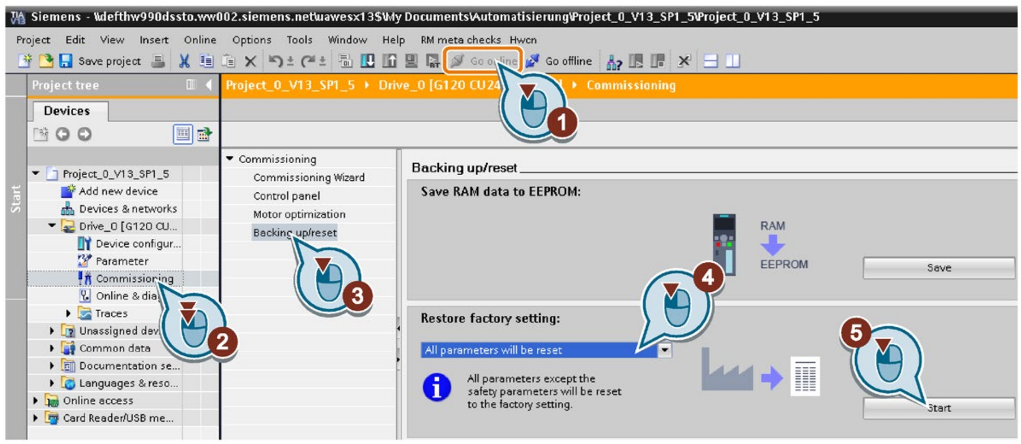
Exception: The password for the safety functions is not reset.

Safety functions password (Page 198)

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

Restoring the inverter 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 inverter has been reset to the factory setting.

You have reset the inverter to the factory settings.
❒

Procedure with operator panel

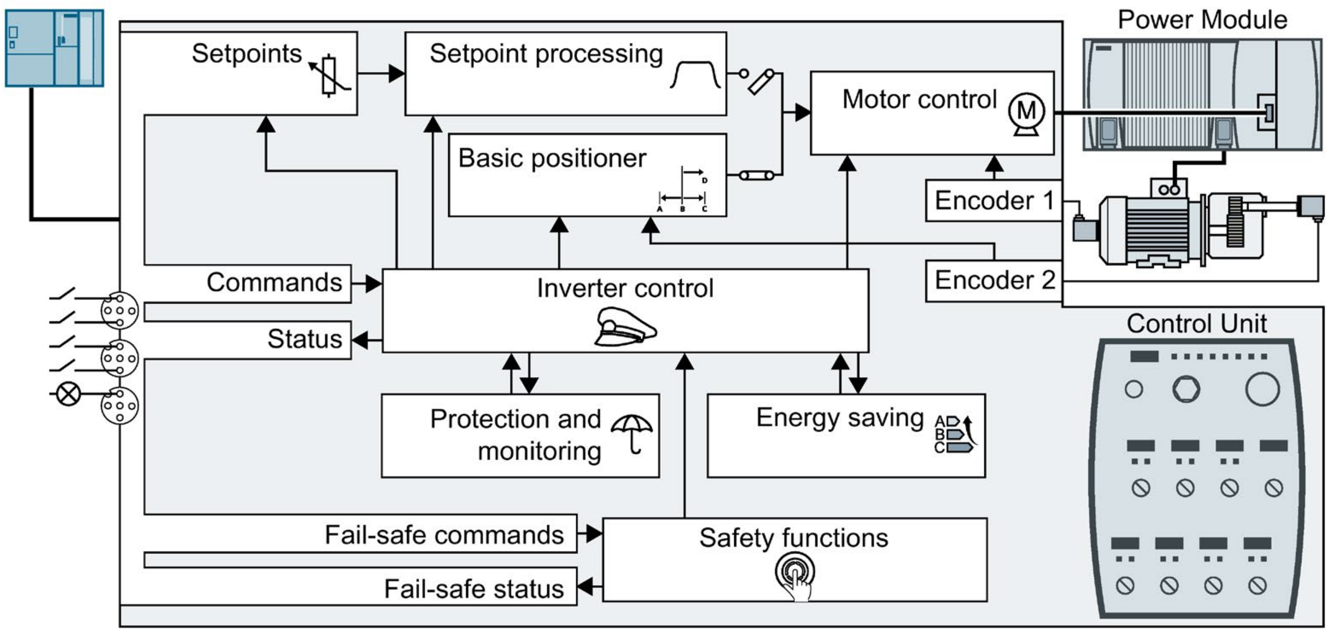
Proceed as follows to reset the inverter to factory settings:

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

You have reset the inverter to the factory settings.
❒

6 Advanced commissioning

6.1 Overview of the converter functions



Drive control

The inverter 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 inverter responds to the commands.

Efficiency optimization (Page 274)

Adapt the default setting of the terminal strip (Page 158)

Drive control via PROFIBUS or PROFINET (Page 162)

Jogging (Page 179)

Limit position control (Page 181)

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

Switching over the drive control (command data set) (Page 185)

The inverter provides a motor holding brake control. The motor holding brake holds the motor in position when it is switched off.

Motor holding brake (Page 188)

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

Selecting physical units (Page 192)

Basic positioner

The basic positioner traverses an axis with position control to a target position.

Basic positioner and position control (Page 90)

Safety functions

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

Safe Torque Off (STO) safety function (Page 195)

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 389)

Setpoints and setpoint conditioning

The setpoint generally determines the motor speed.

Setpoints (Page 209)

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

Setpoint calculation (Page 219)

Motor control

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

Motor control (Page 229)

The inverter has various methods to electrically brake the motor. When electrically braking, the motor develops a torque, which reduces the speed down to standstill.

Electrically braking the motor (Page 252)

Protection of the drive and the driven load

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

Overcurrent protection (Page 257)

Inverter protection using temperature monitoring (Page 258)

Motor temperature monitoring using a temperature sensor (Page 261)

Motor protection by calculating the temperature (Page 265)

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

Monitoring the driven load (Page 266)

Energy saving

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

Efficiency optimization (Page 274)

See also

Sequence control when switching the motor on and off (Page 156)

6.2 Sequence control when switching the motor on and off

Overview

The sequence control defines the rules for switching the motor on and off.

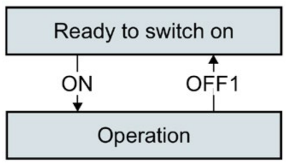


Figure 6-1 Simplified representation of the sequence control

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

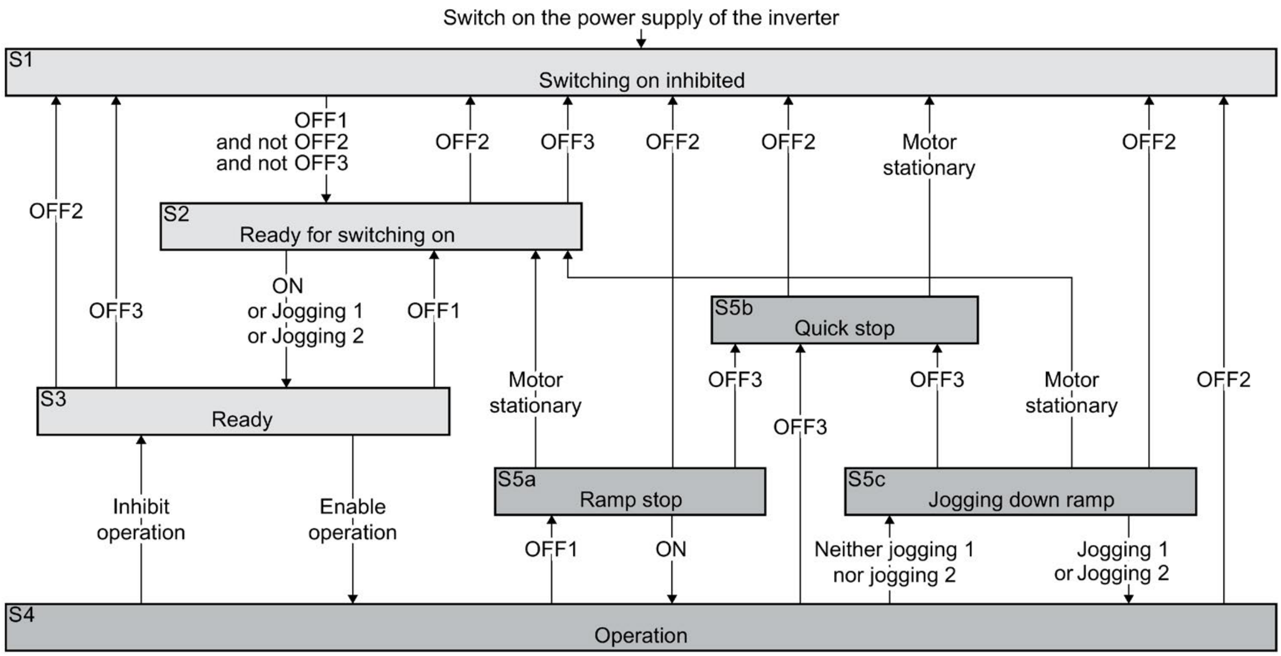


Figure 6-2 Sequence control of the inverter when the motor is switched on and off

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

Table 6- 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 6- 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.

6.3 Adapt the default setting of the terminal strip

This chapter describes how you adapt the function of individual digital and analog inputs and outputs of the inverter.

If you adapt the function of an input or output, you overwrite the settings made during the basic commissioning.

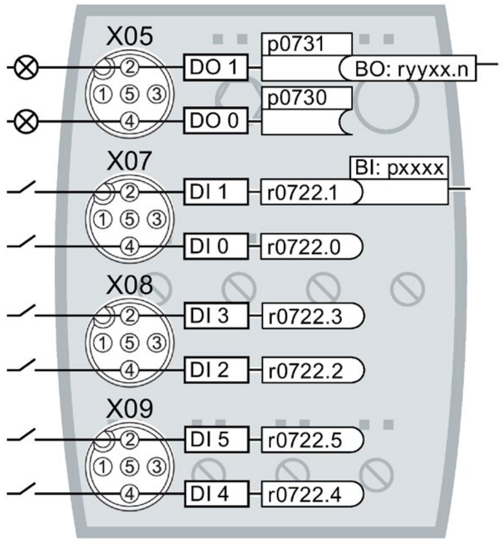
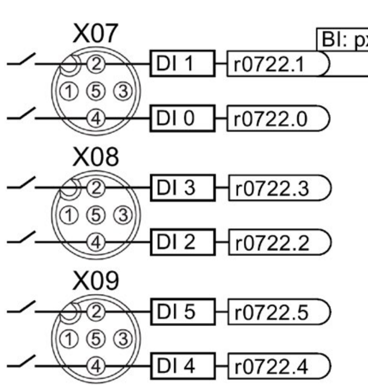


Figure 6-3 Internal interconnection of the inputs and outputs

6.3.1 Digital inputs

Changing the function of a digital input



Interconnect the status parameter of the digital input with a binector input of your choice.

Binector inputs are marked with "BI" in the parameter list of the List Manual.

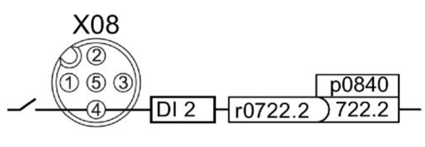
Table 6- 3 Binector inputs (BI) of the inverter (selection)

BI	Significance	BI	Significance
p0810	Command data set selection CDS bit 0	p1036	Motorized potentiometer, setpoint, lower
p0840	ON/OFF1	p1055	Jog bit 0
p0844	OFF2	p1056	Jog bit 1
p0848	OFF3	p1113	Setpoint inversion
p0852	Enable operation	p1201	Flying restart enable signal source

BI	Significance	BI	Significance
p0855	Unconditionally release holding brake	p2103	1. Acknowledge faults
p0856	Enable speed controller	p2106	External fault 1
p0858	Unconditionally close holding brake	p2112	External alarm 1
p1020	Fixed speed setpoint selection bit 0	p2200	Technology controller enable
p1021	Fixed speed setpoint selection bit 1	p3330	Two-wire/three-wire control, control command 1
p1022	Fixed speed setpoint selection bit 2	p3331	Two-wire/three-wire control, control command 2
p1023	Fixed speed setpoint selection bit 3	p3332	Two-wire/three-wire control, control command 3
p1035	Motorized potentiometer, setpoint, raise		

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

Changing the function of a digital input - example



In order to switch on the motor with digital input DI 2, you have to connect the status parameter of DI 2 to p0840: Set p0840 = 722.2.

Advanced settings

You can debounce the digital input signal using parameter p0724.

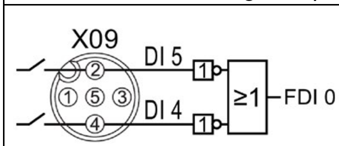
For more information, see the parameter list and the function block diagrams 2210 ff of the List Manual.

6.3.2 Fail-safe digital input

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

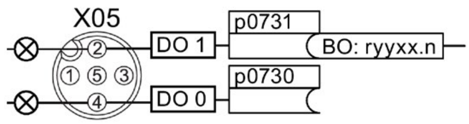
Defining a fail-safe digital input

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

Pins of the fail-safe digital input	Function
	You must enable STO to select the STO safety function (Basic Safety) via FDI 0. Further information can be found in section Safe Torque Off (STO) safety function (Page 195).

6.3.3 Digital outputs

Changing the function of a digital output



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

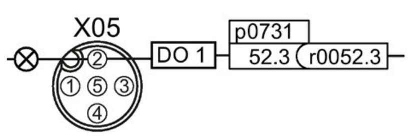
Binector outputs are marked with "BO" in the parameter list of the List Manual.

Table 6- 4 Binector outputs of the inverter (selection)

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

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

Changing the function of a digital output - example



In order to output the fault message over the digital output DO 1, you have to connect the DO 1 with the fault message: Set p0731 = 52.3.

Advanced settings

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

For more information, see the parameter list and the function block diagram 2241 of the List Manual.

6.4 Drive control via PROFIBUS or PROFINET

6.4.1 Receive data and send data

Cyclic data exchange

The inverter receives cyclic data from the higher-level control - and returns cyclic data to the control.

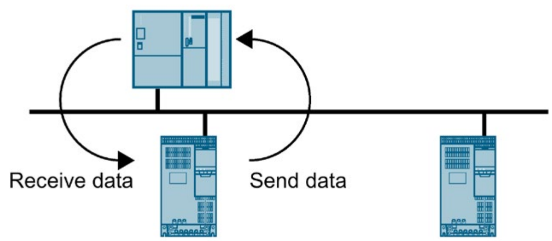


Figure 6-4 Cyclic data exchange

Inverter and control system pack their data in telegrams.

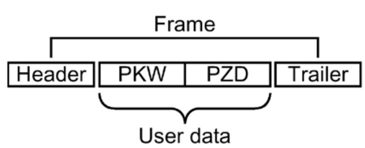


Figure 6-5 Telegram structure

Every telegram for cyclic data exchange has the following basic structure:

- Header and trailer form the protocol frame.
- User data is located within the frame:
  - PKW: The control can read or change every parameter in the inverter via "PKW data".

    Not every telegram has a "PKW range".
  - PZD: The inverter 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.

6.4.2 Positioner: Cyclic communication

The send and receive telegrams of the inverter for cyclic communication are structured as follows:

Telegram 7, positioning operation with block selection

PZD01	PZD02
STW1	SATZ ANW
ZSW1	AKT SATZ

Telegram 9, positioning operation with direct input

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10
STW1	SATZ ANW	STW2	MDI_TARPOS		MDI_VELOCITY		MDI_ ACC	MDI_ DEC	MDI_ MOD
ZSW1	AKT SATZ	ZSW2	XIST_A						

Telegram 110, positioning operation with extended control and status functions

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10	PZD11	PZD12
STW1	SATZ ANW	POS_ STW	STW2	OVER RIDE	MDI_TARPOS		MDI_VELOCITY		MDI_ ACC	MDI_ DEC	MDI_ MOD
ZSW1	AKT SATZ	POS_ ZSW	ZSW2	MELDW	XIST_A						

Telegram 111, positioning operation with extended functions

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10	PZD11	PZD12
STW1	POS_ STW1	POS_ STW2	STW2	OVER RIDE	MDI_TARPOS		MDI_VELOCITY		MDI_ ACC	MDI_ DEC	Free
ZSW1	POS_ ZSW1	POS_ ZSW2	ZSW2	MELDW	XIST_A		NIST_B		FAULT_ CODE	WARN_ CODE	Free

Telegram 999, open interconnection

PZD01	PZD02 ...
STW1	Telegram length is configurable for receive data
ZSW1	Telegram length is configurable for send data

Figure 6-6 Telegrams for cyclic communication - Position control

Table 6- 5 Explanation of the abbreviations

Abbreviation	Explanation	
STW	Control word	Control and status word 1 (Page 166) Control and status word 2 (Page 168)
ZSW	Status word	
SATZANW	Selects the traversing block	Control word block selection (Page 174)
AKTSATZ	Currently selected traversing block	
MDI_TARPOS	Position setpoint for direct setpoint input (MDI)	
XIST_A	Actual position value (32 bits)	
OVERRIDE	Speed setpoint	
MSGW	Status word for messages	Status word messages (Page 176)
NIST_B	Actual speed value (32 bits)	
Not assigned	Freely interconnectable	
MDI_VELOCITY	MDI velocity	
MDI_ACC	MDI acceleration	
MDI_DEC	MDI deceleration	
MDI_MOD	Selects the positioning mode in the case of direct setpoint input (MDI)	Control word MDI mode (Page 175)
POS_STW	Control word for basic positioner	Control and status word for the positioner (Page 169)
POS_ZSW	Status word for basic positioner	
POS_STW1	Control word 1 for basic positioner	Control and status word 1 for the positioner (Page 171)
POS_ZSW1	Status word 1 for basic positioner	
POS_STW2	Control word 2 for basic positioner	Control and status word 2 for the positioner (Page 172)
POS_ZSW2	Status word 2 for basic positioner	
WARN_CODE	Number of the actual alarm	
FAULT_CODE	Number of the actual fault	

Interconnection of the process data

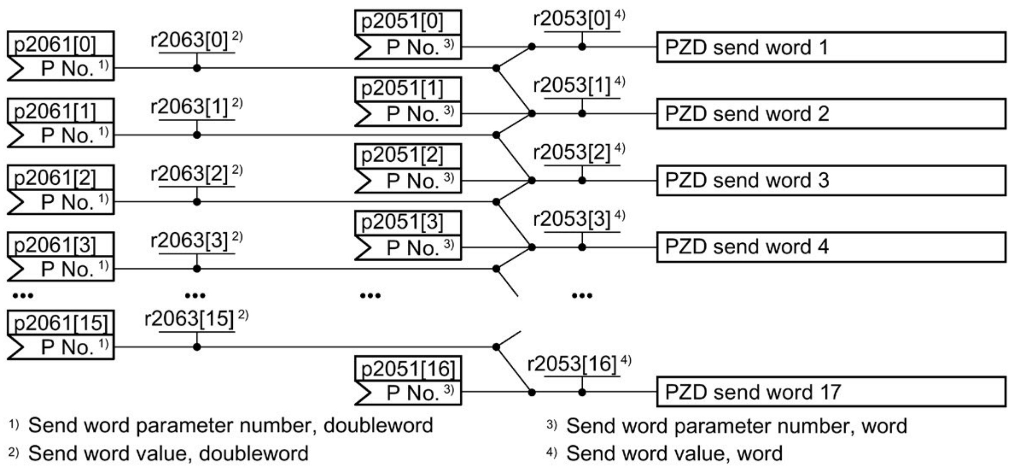


Figure 6-7 Interconnection of the send words

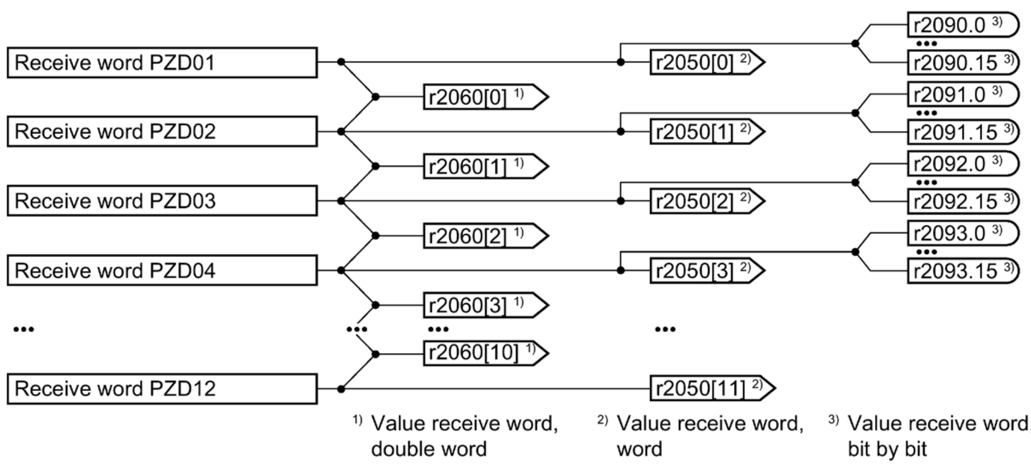


Figure 6-8 Interconnection of the receive words

If you require an individual telegram for your application, you can adapt one of the predefined telegrams using the parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

6.4.3 Control and status word 1

Control word 1 (STW1)

Table 6- 6 Control word 1 for active basic positioner

Bit	Meaning	Comments	P No.
0	0 = OFF1	The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON	The inverter goes into the "ready" state. If, in addition, bit 3 = 1, the inverter switches on the motor.	
1	0 = OFF2	Switch off motor immediately, then the motor coasts to a standstill.	p0844[0] = r2090.1
	1 = No OFF2	It is possible to switch on the motor (ON command).	
2	0 = Quick stop (OFF3)	Quick stop: the motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)	It is possible to switch on the motor (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 = Reject traversing job	Axis brakes down to standstill with the maximum deceleration. Inverter rejects the actual traversing block.	p2641 = r2090.4
	1 = Do not reject traversing task	Axis can be started or travel to position setpoint.	
5	0 = Intermediate stop	Axis brakes down to standstill with the specified deceleration override. Inverter remains in the actual traversing block.	p2640 = r2090.5
	1 = No intermediate stop	Axis can be started or continue to travel to position setpoint.	
6	0 → 1: Activate traversing job	The inverter starts axis travel to the setpoint position.	p2631 = r2090.6
	0 → 1: Setpoint transfer MDI		p2650 = r2090.6
7	0 → 1: = Acknowledge faults	Acknowledge fault in the inverter. If the ON command is still active, the inverter switches to "closing lockout" state.	p2103[0] = r2090.7
8	1 = jogging bit 0	Jogging 1	p2589 = r2090.8
9	1 = jogging bit 1	Jogging 2	p2590 = r2090.9
10	0 = No control via PLC	Inverter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC	Control via fieldbus, inverter accepts the process data from the fieldbus.	
11	0 = Stop referencing	---	p2595 = r2090.11
	1 = Start referencing	The inverter does not start referencing.	
12	Reserved		
13	0 → 1: External block change	The axis goes to the next traversing block.	p2633 = r2090.13
14, 15	Reserved		

Status word 1 (ZSW1)

Table 6- 7 Status word 1 when the basic positioner is active

Bit	Meaning		Comments	P No.
	Telegram 110	Telegram 111		
0	1 = Ready to start		Power supply is switched on; electronics initialized; pulses are inhibited.	p2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON command = 1); no fault is active. With the command "Enable operation" (STW1.3) the inverter 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 present		The inverter 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 = Closing lockout active		It is only possible to switch on the motor after an OFF1 command and an additional ON command.	p2080[6] = r0899.6
7	1 = Alarm present		Motor remains switched on; no acknowledgment necessary.	p2080[7] = r2139.7
8	1 = Following error in tolerance		The actual difference between the actual position and the position setpoint is within the permissible tolerance p2546.	p2080[8] = r2684.8
9	1 = Control requested		The automation system is requested to accept the control from the inverter.	p2080[9] = r0899.9
10	1 = Target position reached		The axis has reached the target position.	p2080[10] = r2684.10
11	1 = Reference point set		The axis is referenced.	p2080[11] = r2684.11
12	0 → 1 = Acknowledgement, traversing block active			p2080[12] = r2684.12
13	1 = Setpoint is stationary			p2080[13] = r2683.2
14	Reserved	1 = Axis accelerates		p2080[14] = r2684.4
15	Reserved	1 = Axis brakes		p2080[15] = r2684.5

6.4.4 Control and status word 2

Control word 2 (STW2)

Bit	Meaning	Signal interconnection in the inverter
0	1 = drive data set selection DDS bit 0	p0820[0] = r2093.0
1	1 = drive data set selection DDS bit 1	p0821[0] = r2093.1
2…6	Reserved	
7	1 = parking axis is selected	p0897 = r2093.7
8	Reserved	p1545[0] = r2093.8
9…11	Reserved	
12	1 = master sign-of-life bit 0	p2045 = r2050[3]
13	1 = master sign-of-life bit 1	
14	1 = master sign-of-life bit 3	
15	1 = master sign-of-life bit 4	

Status word 2 (ZSW2)

Bit	Meaning	Signal interconnection in the inverter
0	1 = Drive data set DDS effective, bit 0	p2081[0] = r0051.0
1	1 = Drive data set DDS effective, bit 1	p2081[1] = r0051.1
2…4	Reserved	
5	1 = Alarm class bit 0	p2081[5] = r2139.11
6	1 = alarm class bit 1	p2081[6] = r2139.12
7	Reserved	
8	1 = travel to fixed stop active	p2081[6] = r2139.12
9	Reserved	
10	1 = pulses enabled	p2081[10] = r0899.11
11	Reserved	
12	Slave sign-of-life bit 0	Internally interconnected
13	Slave sign of life bit 1	
14	Slave sign of life bit 2	
15	Slave sign of life bit 3	

6.4.5 Control and status word for the positioner

Positioning control word (POS_STW)

Table 6- 8 POS_STW and interconnection with parameters in the inverter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode	The inverter continuously corrects the position setpoint to follow the position actual value.	p2655[0] = r2092.0
1	1 = Set reference point	The inverter accepts the reference point coordinate in its position actual value and setpoint.	p2596 = r2092.1
2	1 = Reference cam active	The load is currently on the reference cam.	p2612 = r2092.2
3	Reserved	---	---
4			
5	1 = Incremental jogging active	If the jogging command is active, the inverter positions the load by the specified traversing path in a positive or negative direction.	p2591 = r2092.5
	0 = Jogging velocity active	If the jogging command is active, the inverter positions the load with the jog velocity in the direction of the beginning or end of the traversing range.	
6…15	Reserved	---	---

Positioning status word (POS_ZSW)

Table 6- 9 POS_ZSW and interconnection with parameters in the inverter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode active	The inverter is in the follow-up mode.	p2084[0] = r2683.0
1	1 = Velocity limiting is active	The inverter limits the velocity of the axis.	p2084[1] = r2683.1
2	1 = Setpoint is stationary	During a positioning operation, the setpoint no longer changes.	p2084[2] = r2683.2
3	1 = Position setpoint reached	The axis has reached the specified target position.	p2084[3] = r2684.3
4	1 = Axis traverses forwards	The axis traverses in the positive direction.	p2084[4] = r2683.4
	0 = Axis is stationary or traverses backwards	---	
5	1 = Axis traverses backwards	The axis traverses in the negative direction.	p2084[5] = r2683.5
	0 = Axis is stationary or traverses forwards	---	
6	1 = Software limit switch, minus actuated	The load is outside the permitted traversing range.	p2084[6] = r2683.6
7	1 = Software limit switch, plus actuated		p2084[7] = r2683.7
8	1 = Position actual value ≤ cam switching position 1	Feedback of the software cams in the inverter.	p2084[8] = r2683.8
	0 = Cam switching position 1 passed		
9	1 = Position actual value ≤ cam switching position 2		p2084[9] = r2683.9
	0 = Cam switching position 2 passed		
10	1 = Direct output 1 active	The inverter sets these signals in the actual traversing block.	p2084[10] = r2683.10
11	1 = Direct output 2 active	Traversing blocks (Page 128)	p2084[11] = r2683.11
12	1 = Fixed stop reached	The axis is at the fixed stop	p2084[12] = r2683.12
13	1 = Fixed stop clamping torque reached	The axis is at the fixed stop and has reached the clamping torque.	p2084[13] = r2683.13
14	1 = Travel to fixed stop active	The inverter moves the axis to a fixed stop.	p2084[14] = r2683.14
15	Reserved	---	---

6.4.6 Control and status word 1 for the positioner

Positioning control word 1 (POS_STW1)

Table 6- 10 POS_STW1 and interconnection in the converter

Bit	Meaning	Comments	P No.
0	Traversing block selection, bit 0	Selecting the traversing block	p2625 = r2091.0
1	Traversing block selection, bit 1		p2626 = r2091.1
2	Traversing block selection, bit 2		p2627 = r2091.2
3	Traversing block selection, bit 3		p2628 = r2091.3
4 to 7	Reserved	---	---
8	0 = Relative positioning is selected	The converter interprets the position setpoint as the position setpoint relative to the start position.	p2648 = r2091.8
	1 = Absolute positioning is selected	The converter interprets the position setpoint as absolute position setpoint relative to machine zero point.	
9	01 = Absolute positioning for rotary axis in the positive direction	Selection of the positioning type for a rotary axis.	p2651 = r2091.9
10	10 = Absolute positioning for rotary axes in negative direction		p2652 = r2091.10
	00, 11 = Absolute positioning for a rotary axis through the shortest distance		
11	Reserved	---	---
12	1 = Continuous acceptance	The converter accepts position setpoint changes immediately.	p2649 = r2091.12
	0 = MDI block change with control word 1, bit 6	The inverter accepts a changed position setpoint with the signal change 0 → 1 of control word 1, bit 6. Control and status word 1 (Page 166)	
13	Reserved	---	---
14	1 = Select Set up	Toggling the axis operating mode between "Set up" and "Positioning". Direct setpoint input (MDI) (Page 143)	p2653 = r2091.14
	0 = Select positioning		
15	1 = Activate MDI	The converter receives its position setpoint from an external control.	p2647 = r2091.15
	0 = Deactivate MDI		

Positioning status word 1 (POS_ZSW1)

Table 6- 11 POS_ZSW1 and interconnection in the converter

Bit	Meaning	Comments	P No.
0	Active traversing block bit 0 (2^0)	Number of the currently selected traversing block.	p2083[0] = r2670[0]

Bit	Meaning	Comments	P No.
1	Active traversing block bit 1 (2^1)		p2083[1] = r2670[1]
2	Active traversing block bit 2 (2^2)		p2083[2] = r2670[2]
3	Active traversing block bit 3 (2^3)		p2083[3] = r2670[3]
4	Active traversing block bit 4 (2^4)		p2083[4] = r2670[4]
5	Active traversing block bit 5 (2^5)		p2083[5] = r2670[5]
6	Reserved	---	---
7			
8	1 = STOP cam minus active	The axis is currently located at a STOP cam.	p2083[08] = r2684[13]
9	1 = STOP cam plus active		p2083[09] = r2684[14]
10	1 = Jogging active	The converter is in the jogging mode.	p2083[10] = r2094[0]
11	1 = Reference point approach active	The converter is presently executing a reference point approach.	p2083[11] = r2094[1]
12	1 = Flying referencing active	The converter references when passing the reference cam.	p2083[12] = r2684[1]
13	1 = Traversing block active	The converter receives its position setpoint from a traversing block.	p2083[13] = r2094[2]
14	1 = Set up active	The axis is in the "Set up" operating mode.	p2083[14] = r2094[4]
15	1 = MDI active	The converter receives its position setpoint from an external control.	p2083[15] = r2670[15]
	0 = MDI inactive		

6.4.7 Control and status word 2 for the positioner

Positioning control word 2 (POS_STW2)

Table 6- 12 POS_STW2 and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Activate follow-up mode	The converter continuously corrects the position setpoint to follow the position actual value.	p2655[0] = r2092.0
1	1 = Set reference point	The converter accepts the reference point coordinate in its position actual value and setpoint.	p2596 = r2092.1
2	1 = Reference cam active	The axes is currently located at the reference cam.	p2612 = r2092.2
3	Reserved	---	---
4			

Bit	Meaning	Comments	P No.
5	1 = Incremental jogging active	If the jogging command is active, the converter positions the axis by the specified traversing path in a positive or negative direction.	p2591 = r2092.5
	0 = Jogging velocity active	If the jogging command is active, the converter positions the axis with the jog velocity in the direction of the beginning or end of the traversing range.	
6	Reserved	---	---
7			
8	1 = Selects referencing using flying referencing	Select the referencing type.	p2597 = r2092.8
	0 = Selects referencing via the reference point approach		
9	1 = Starts reference point approach in negative direction	Select the start direction for automatic referencing.	p2604 = r2092.9
	0 = Starts reference point approach in positive direction		
10	1 = Selects probe 2	Edge of the probe input, with which the converter references its actual position value.	p2510[0] = r2092.10
	0 = Selects probe 1		
11	1 = Probe falling edge	Select the edge of the probe input, with which the converter references its actual position value.	p2511[0] = r2092.11
	0 = Probe, rising edge		
12	Reserved	---	---
13			
14	1 = Software limit switch active	The converter evaluates its software limit switch.	p2582 = r2092.14
15	1 = STOP cams active	Converter evaluates the stop cams.	p2568 = r2092.15

Positioning status word 2 (POS_ZSW2)

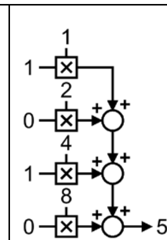
Table 6- 13 POS_ZSW2 and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	1 = Follow-up mode active	The converter is in the follow-up mode.	p2084[0] = r2683.0
1	1 = Velocity limiting is active	The converter limits the velocity of the axis.	p2084[1] = r2683.1
2	1 = Setpoint is stationary	During a positioning operation, the setpoint no longer changes.	p2084[2] = r2683.2
3	1 = Print index outside outer window	The discrepancy between the actual position and the reference point was greater than permitted during flying referencing.	p2084[3] = r2684.3
4	1 = Axis traverses forwards	The axis traverses in the positive direction.	p2084[4] = r2683.4
	0 = Axis is stationary or traverses back-wards	---	
5	1 = Axis traverses backwards	The axis traverses in the negative direction.	p2084[5] = r2683.5
	0 = Axis is stationary or traverses forwards	---	
6	1 = Software limit switch, minus actuated	The axis is outside the permitted traversing range.	p2084[6] = r2683.6
7	1 = Software limit switch, plus actuated		p2084[7] = r2683.7
8	1 = Position actual value ≤ cam switching position 1	Feedback of the cam sequencer in the converter.	p2084[8] = r2683.8
	0 = Cam switching position 1 passed		
9	1 = Position actual value ≤ cam switching position 2		p2084[9] = r2683.9
	0 = Cam switching position 2 passed		
10	1 = Direct output 1 active	The converter sets these signals in the actual traversing block.	p2084[10] = r2683.10
11	1 = Direct output 2 active	Traversing blocks (Page 128)	p2084[11] = r2683.11
12	1 = Fixed stop reached	The axis is at the fixed stop	p2084[12] = r2683.12
13	1 = Fixed stop clamping torque reached	The axis is at the fixed stop and has reached the clamp-ing torque.	p2084[13] = r2683.13
14	1 = Travel to fixed stop active	The converter moves the axis to a fixed stop.	p2084[14] = r2683.14
15	1 = Traversing command active	Feedback signal indicating as to whether the converter is currently moving the axis.	p2084[15] = r2684.15
	0 = Axis stationary		

6.4.8 Control word block selection

Block selection

Table 6- 14 Block selection and interconnection in the converter

Bit	Meaning	Comments	P No.
0	Block selection, bit 0	Example for selecting traversing block number 5: 	p2625 = r2091.0
1	Block selection, bit 1		p2626 = r2091.1
2	Block selection, bit 2		p2627 = r2091.2
3	Block selection, bit 3		p2628 = r2091.3
4…14	Reserved		
15	0 = Deactivate MDI	Switching from traversing blocks to direct setpoint input.	p2647 = r2091.15
	1 = Activate MDI		

Actual traversing block

Table 6- 15 Feedback signal of the actual traversing block

Bit	Meaning	Comments	P No.
0	Actual traversing block, bit 0	---	p2081[0] = r2670.0
1	Actual traversing block, bit 1		p2081[1] = r2670.1
2	Actual traversing block, bit 2		p2081[2] = r2670.2
3	Actual traversing block, bit 3		p2081[3] = r2670.3
4…14	Reserved		
15	0 = MDI active	---	p2081[15] = r2670.15
	1 = MDI not active		

6.4.9 Control word MDI mode

MDI mode

Table 6- 16 Selection of the MDI mode and interconnection with parameters in the converter

Bit	Meaning	Comments	P No.
0	0 = Relative positioning is selected	The converter interprets the position setpoint as the position setpoint relative to the start position.	p2648 = r2094.0
	1 = Absolute positioning is selected	The converter interprets the position setpoint as absolute position setpoint relative to machine zero point.	

Bit	Meaning	Comments	P No.
1	01 = Absolute positioning for rotary axis in the positive direction	Selection of the positioning type for a rotary axis.	p2651 = r2094.1
2	10 = Absolute positioning for rotary axes in negative direction		p2652 = r2094.2
	00, 11 = Absolute positioning for a rotary axis through the shortest distance		
3…15	Reserved		

6.4.10 Status word messages

Status word messages (MELDW)

Table 6- 17 Status word for messages and interconnection with parameters in the converter

Bit	Meaning	Description	P No.
0	0 = Ramp-function generator active	The motor is presently accelerating or braking	p2082[0] = r2199.5
	1 = Ramp-up/ramp-down completed	Speed setpoint and actual speed are the same.	
1	1 = Torque utilization [%] < torque threshold value 2 (p2194)	---	p2082[1] = r2199.11
2	1 = |n_act| < speed threshold value 3 (p2161)	---	p2082[2] = r2199.0
3	1 = |n_act| speed threshold value 2 (p2155)	---	p2082[3] = r2197.1
4, 5	Reserved		
6	1 = No motor overtemperature alarm	The motor temperature is within the permissible range.	p2082[6] = r2135.14
7	1 = No alarm, thermal power unit overload	The converter temperature is within the permissible range.	p2082[7] = r2135.15
8	1 = Speed setpoint - actual value deviation within tolerance t_on	Speed setpoint and actual speed are within the permissible tolerance range p2163.	p2082[8] = r2199.4
9, 10	Reserved		
11	1 = Controller enable	The speed controller is enabled.	p2082[11] = r0899.8
12	1 = Drive ready	The converter is ready to be switched on.	p2082[12] = r0899.7
13	1 = Pulses enabled	The motor is switched on.	p2082[13] = r0899.11
14, 15	Reserved		

6.4.11 Function block FB283

Overview

The function block FB283 is an interface block that connects an inverter with basic positioner to a SIMATIC S7 controller via PROFIBUS/PROFINET.

The block FB283 transfers all of the required process data to and from the drive. It is suitable for both controlling the basic positioner and for a pure speed-controlled drive.

The FB283 additionally provides the following functions:

- Reading and writing parameters in the inverter.
- Reading out the fault buffer of the inverter.
- Transferring up to 16 traversing blocks when a function is initiated.
- Reading or writing a maximum of any 10 parameters with one job, e.g. for product adaptation.

You can find additional information about FB283 in the Internet:

FB283 (http://support.automation.siemens.com/WW/view/en/25166781)

6.4.12 Extend telegrams and change signal interconnection

Following selection of a telegram, the inverter interconnects the corresponding signals with the fieldbus interface. The inverter protects this interconnection against changes.

Extend telegram

If you want to extend a telegram, you have to do the following:

Table 6- 18 Procedure

Parameter	Description	
p0922 = 999	**PROFIdrive telegram selection**	
	999:	Free telegram configuration with BICO
p2079	**PROFIdrive PZD telegram selection extended** Set the suitable telegram:	
	7: 9: 110: 111:	Standard telegram 7, PZD-2/2 Standard telegram 9, PZD-10/5 SIEMENS telegram 110, PZD-12/7 SIEMENS telegram 111, PZD-12/12
Now you can extend the telegram by interconnecting the PZD send words and PZD receive words with signals of your choice.		

For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

Change the signal interconnection of the telegram

If you want to change the signal interconnection or extend telegrams, you have to do the following:

Table 6- 19 Procedure

Parameter	Description	
p0922 = 999	**PROFIdrive telegram selection**	
	999:	Free telegram configuration with BICO
p2079 = 999	**PROFIdrive PZD telegram selection extended**	
	999:	Free telegram configuration with BICO
Now you can freely interconnect all signals of the fieldbus interface.		

For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

6.4.13 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.

Further information about the "Direct data exchange" function is provided in the Fieldbus function manual.

Overview of the manuals (Page 389)

6.4.14 Acyclically reading and writing inverter parameters

Overview

The inverter 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

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

Overview of the manuals (Page 389)

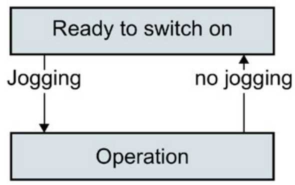
Application example, "Read and write to parameters"

Further information is provided on the Internet:

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

6.5 Jogging

The "Jog" function is typically used to temporarily move a machine part using local control commands, e.g. a transport conveyor belt.



Commands "Jog 1" or "Jog: 2" switch the motor on and off.

The commands are only active when the inverter is in the "Ready for switching on" state.

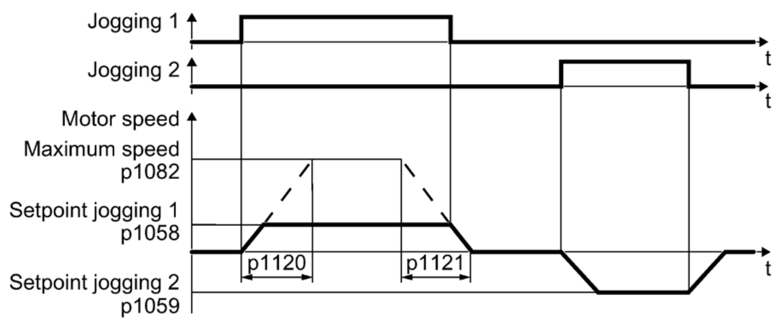


Figure 6-9 Behavior of the motor when "jogging"

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.

Jog settings

Parameter	Description	
p1058	**Jogging 1 speed setpoint** (factory setting 150 rpm)	
p1059	**Jogging 2 speed setpoint** (factory setting -150 rpm)	
p1082	**Maximum speed** (factory setting 1500 rpm)	
p1110	**Inhibit negative direction**	
	=0: Negative direction of rotation is enabled	=1: Negative direction of rotation is inhibited
p1111	**Inhibit positive direction**	
	=0: Positive direction of rotation is enabled	=1: Positive direction of rotation is inhibited
p1113	**Setpoint inversion**	
	=0: Setpoint is not inverted	=1: Setpoint is inverted
p1120	**Ramp-function generator ramp-up time** (factory setting 10 s)	
p1121	**Ramp-function generator ramp-down time** (factory setting 10 s)	

Parameter	Description
p1055 = 722.0	**Jog bit 0:** Select jogging 1 via digital input 0
p1056 = 722.1	**Jog bit 1:** Select jogging 2 via digital input 1

6.6 Limit position control

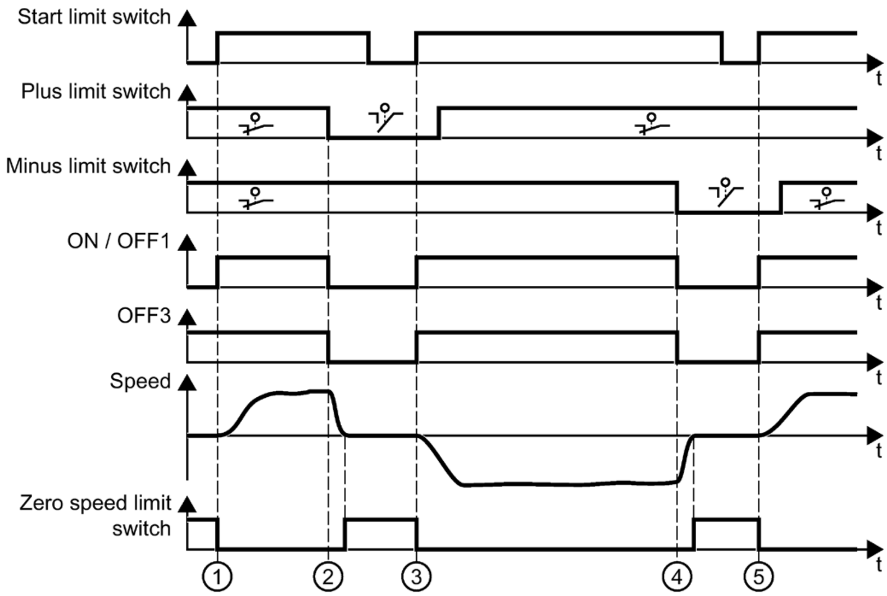
Limit position and limit switch

A limit position is a position in the direction of motion of a machine component at which the motion stops due to the construction. A limit switch is a sensor that signals that the limit position has been reached.

Function

The limit position control moves the motor depending on two limit switch signals:

- When a limit position is reached, the inverter stops the motor.
- At a limit position, the inverter starts the motor with a new motion command in the direction of the opposite limit position.
- If neither of the limit positions has been reached when the power is switched on, the polarity of the speed setpoint decides in which direction the motor is to start with the first motion command.

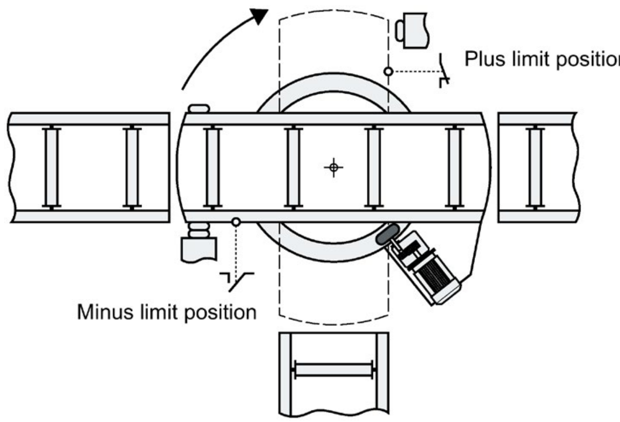


① The motor moves the machine component in the direction of the positive limit position.
② The positive limit position has been reached. The motor stops with the OFF3 ramp-down time.
③ The motor moves the machine component in the opposite direction at a 0 → 1 signal change.
④ The negative limit position has been reached. The motor stops with the OFF3 ramp-down time.
⑤ The motor moves the machine component in the opposite direction at a 0 → 1 signal change.

Figure 6-10 Limit position control of the inverter

Parameter	Explanation	
p3340[0 … n]	Start limit switch	1 signal: Start is active 0 signal: Start is inactive
p3342[0 … n]	Minus limit switch	1 signal: Limit switch is inactive 0 signal: Limit switch is active
p3343[0 … n]	Plus limit switch	
r3344	Limit switch ON/OFF	
	.00	1 signal: Limit switch ON 0 signal: Limit switch OFF1
	.01	1 signal: Limit switch no OFF3 0 signal: Limit switch OFF3
	.02	1 signal: Limit switch, axis stationary (standstill)
	.04	1 signal: Plus limit switch actuated
	.05	1 signal: Minus limit switch actuated

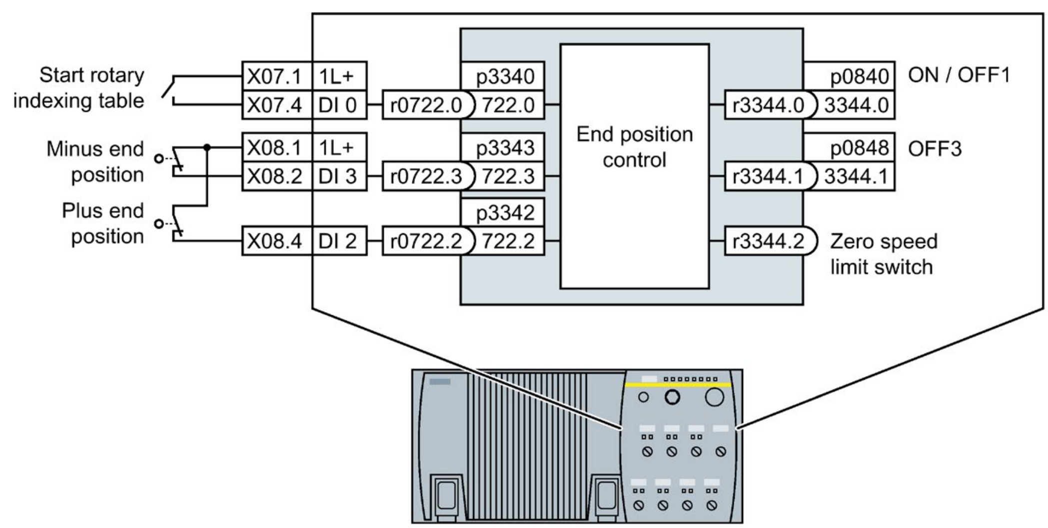
Application example: Roller conveyor with rotary table



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 limit position to the other. Two limit switches signal the respective limit position. The signal to start the rotary table comes from the higher-level controller.

Procedure

1. Connect the inverter to a commissioning tool, e.g. to an Operator Panel.
2. Interconnect the limit position control of the inverter to the signals of the limit switches and the higher-level controller.



p3340 = 722.0 p3342 = 722.2 p3343 = 722.3	Interconnect inputs of the limit position control to digital inputs of your choice
p0840 = r3344.0 p0848 = r3344.1	Interconnect ON / OFF1 command. If the motor is to stop with a shorter braking time than OFF1 when the limit position is reached, then interconnect both the OFF1 command as well as the OFF3 command.
r3344.2	Interconnect this signal, e.g. to a digital output of the inverter, to signal the higher-level controller that the inverter is waiting for a 0 → 1 change of the "Start rotary table" signal.

3. Move the rotary table to one of the two end positions or open one of the limit switches manually.

4. Specify a speed setpoint. We recommended that you use a fixed setpoint for the limit position control.

   Fixed speed setpoint as setpoint source (Page 216).
5. Start the rotary table briefly.
6. If the rotary table has not traversed in the direction of the opposite limit position, invert the speed setpoint in the inverter.
7. 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 limit position.

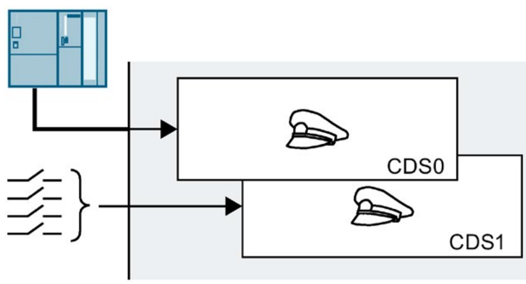
You have adapted the limit position control to the application.
❒

6.7 Switching over the drive control (command data set)

Several applications require the option of switching over the control authority to operate the inverter.

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

Command data set (CDS)



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

The settings in the inverter, which are assigned to a specific master control, are termed 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.

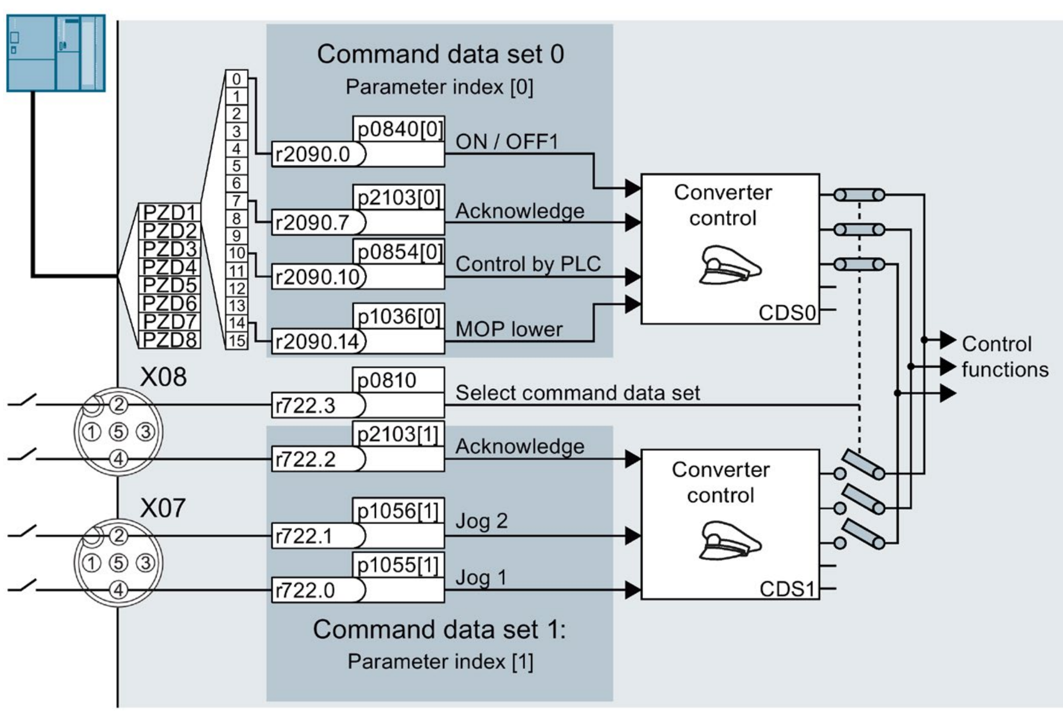


Figure 6-11 Example for the various command data sets

In the above example, use digital input 3 to switch from one control system of the converter via digital inputs to a control system via the fieldbus.

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.

Changing the number of command data sets

Procedure

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

Procedure

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 in which you wish to copy the settings.
3. Set p0809[2] = 1
4. The inverter sets p0809[2] = 0.

You have copied the settings of a command data set into another command data set.
❒

Parameter

Parameter	Description
p0010	**Drive commissioning parameter filter**
r0050	**Command data set CDS active** Displays the number of the currently active command data set
p0170	**Number of command data sets (CDS)** (factory setting: 2) p0170 = 2, 3 or 4
p0809[0]	**Copying the command data set CDS** (factory setting: 0) [0] Source command data set [1] Target command data set [2] 0→1: Starts the copy operation

Parameter	Description
p0810	Command data set selection CDS bit 0
p0811	Command data set selection CDS bit 1

6.8 Motor holding brake

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 inverter only switches the motor off when the motor holding brake is closed.

Function

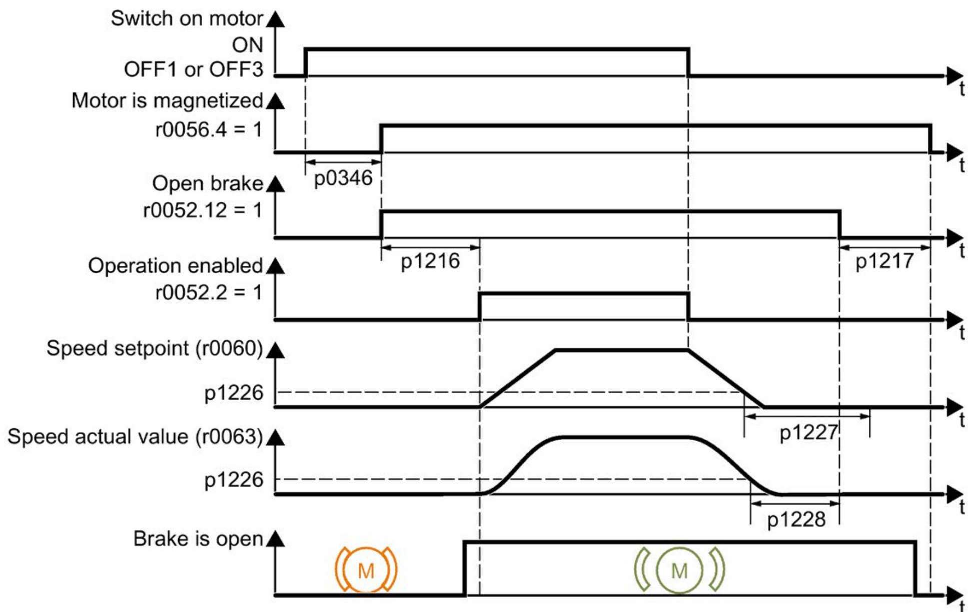


Figure 6-12 Motor holding brake function

After the ON command

1. With the ON command, the inverter switches the motor on.
2. At the end of the "motor excitation build-up time" (p0346), the inverter issues the command to open the brake.
3. The inverter 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 inverter accelerates the motor to the speed setpoint.

After the OFF1 or OFF3 command

1. The inverter brakes the motor down to a standstill using the OFF1 or OFF3 command.
2. When braking, the inverter 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 inverter issues the command to close the brake.
4. After the "motor holding brake closing time" p1217, the inverter switches off the motor.

   The motor holding brake must close within the time p1217.

After the OFF2 command

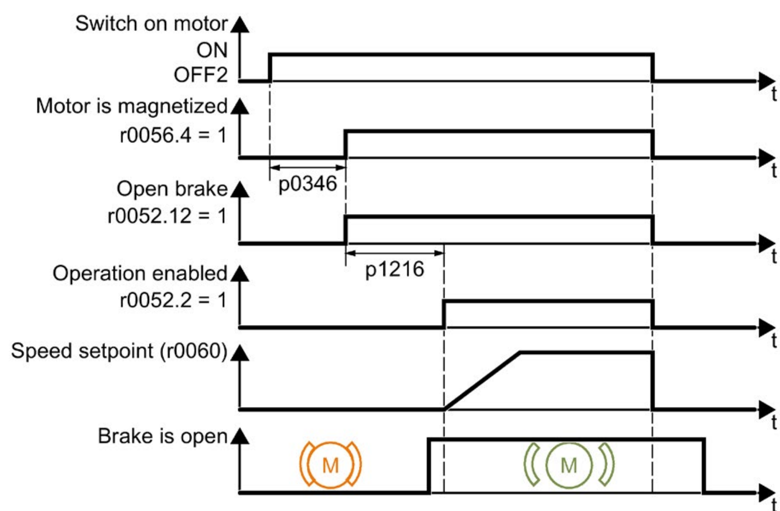


Figure 6-13 Controlling the motor holding brake after OFF2

After the OFF2 command, the inverter issues the signal to immediately close the motor holding brake, irrespective of the motor speed.

Commissioning a motor holding brake

Precondition

The motor holding brake is connected to the inverter.

⚠ 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 together with an encoder.

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 inverter 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 inverter 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 inverter 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.
❒

Table 6- 20 Setting the control logic of the motor holding brake

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

Table 6- 21 Advanced settings

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

6.9 Selecting physical units

6.9.1 Motor standard

Selection options and parameters involved

The inverter represents the motor data corresponding to motor standard IEC or NEMA in different system units: SI units or US units.

Table 6- 22 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

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
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.

6.9.2 System of units

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 ≙ p0505 = 2 and p0505 = 3 ≙ 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 ≙ p0505 = 3 and p0505 = 2 ≙ 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 % ≙ 1200 rpm
- Reference speed = 3000 rpm → fixed speed = 80 % ≙ 2400 rpm

For each parameter you can find the associated reference variable for scaling in the List Manual. Example: r0065 is scaled with reference variable p2000.

If scaling is not specified in the List Manual, then the converter always represents/displays the parameter unscaled (not normalized).

Groups of units

The parameters associated with the selection of a physical unit, belong to different groups of units.

You can find the associated group of units in the List Manual for each parameter. Example: r0333 belongs to unit group 7_4.

An overview of the unit groups and the possible physical units can also be found in the List Manual.

See also

Overview of the manuals (Page 389)

6.9.3 Setting the system of units and technology unit

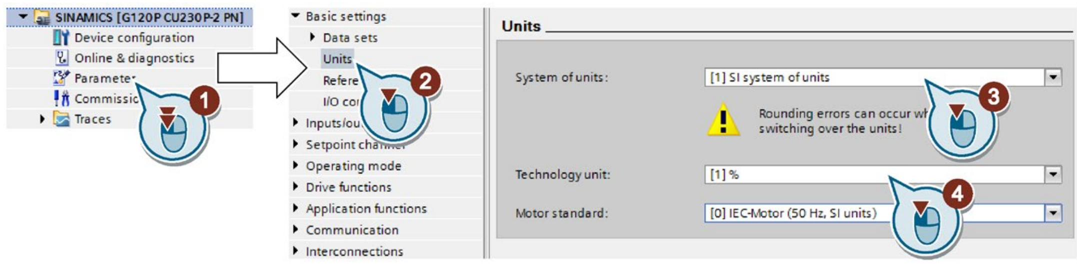
Setting using Startdrive

Precondition

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 inverter signals that offline, other units and process variables are set than in the inverter itself.
7. Accept these settings in the inverter.

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

6.10 Safe Torque Off (STO) safety function

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

Commissioning tools (Page 73)

The operating instructions describe how to commission the STO safety function as basic function for control via a fail-safe 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 389)

6.10.1 Function description

What does the STO safety function do?

An inverter with active STO function prevents energy supply to the motor. The motor can no longer generate torque at the motor shaft.

Consequently, the STO function prevents the starting of an electrically-driven machine component.

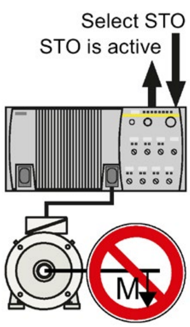


Table 6- 23 The principle of operation of STO

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

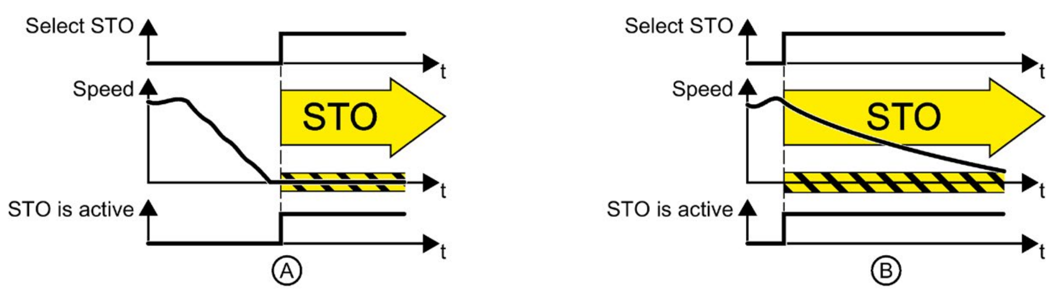


Figure 6-14 Functionality of STO when the motor is at standstill (A) and rotating (B)

If the motor is still rotating (B) when STO is selected, then it coasts down to standstill.

The STO safety function is standardized

The STO function is defined in IEC/EN 61800-5-2:

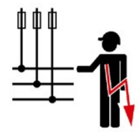
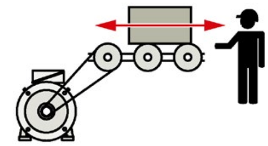
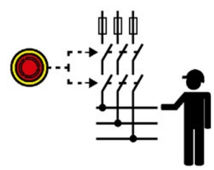
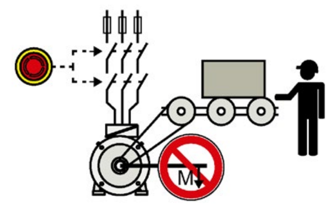
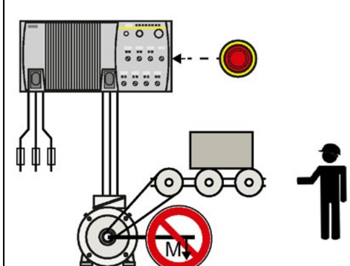
"[…] [The inverter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)."

⇒ The STO inverter function is in conformance to IEC/EN 61800-5-2.

The distinction between Emergency Off and Emergency Stop

"Emergency Off" and "Emergency Stop" are commands that minimize different risks in the machine or plant.

The STO function is suitable for achieving an emergency stop but not an emergency off.

Risk:	Risk of electric shock: 	Risk of unexpected motion: 
Measure to minimize risk:	**Safe switch off** Switching off the electric power supply for the installation, either completely or partially.	**Safely stop and safely prevent restarting** Stopping or preventing the dangerous movement
Command:	**Emergency Off**	**Emergency Stop**
Classic solution:	Switch of the power supply: 	Switch-of the drive power supply: 
Solution with the STO safety function integrated in the drive:	STO is not suitable for safely switching of an electric voltage.	Select STO:  It is permissible that you switch of the inverter supply voltage as well. However, switching off the voltage is not required as a risk-reduction measurement.

Application examples for the STO function

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 of machine components with high inertia.

Examples	Possible solution
When the Emergency Stop button is pressed, a stationary motor should not unintentionally start.	• Wire the Emergency Stop button to a fail-safe input of the inverter. • Select STO via the fail-safe 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.

6.10.2 ((Precondition for using STO))

Prerequisite for STO use

In order to use the STO safety function, the machine manufacturer should have 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 the inverter is permitted for use in accordance with SIL 2 or PL d.

6.10.3 Commissioning STO

6.10.3.1 ((Commissioning tools))

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

Commissioning tools (Page 73)

6.10.3.2 Safety functions password

What is the purpose of the password?

The password protects the settings of the safety function from being changed by unauthorized persons.

Do you have to assign a password?

You do not have to assign a password.

The machine manufacturer decides whether or not a password is required.

The probabilities of failure (PFH) and certification of the safety functions also apply without password.

What do I do if I lose the password?

Requirement

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 inverter using Startdrive.

   Leave all the factory setting in the project.
2. Load the project in the inverter.

   After loading, the inverter has the factory settings.
3. If a memory card inserted in the inverter, remove it.
4. Recommission the inverter.

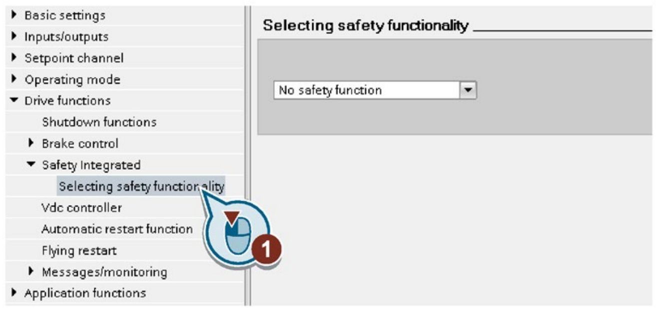
You can obtain more information or learn about alternative procedures from Technical Support.

No.	Description	
p9761	**Entering a password** (factory setting 0000 hex)	
	0:	No password set
	1 … FFFF FFFF:	Password is set
p9762	**New password**	
p9763	**Password confirmation**	

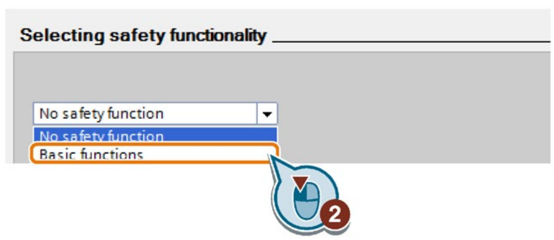
6.10.3.3 Configuring a safety function

Procedure

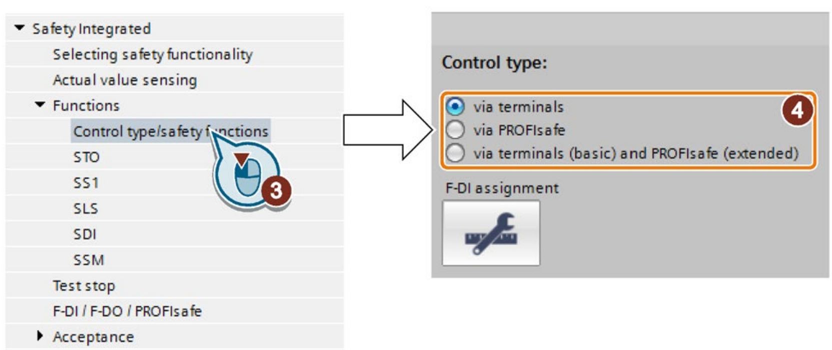
1. Select "Select safety functionality".



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 configurations of the safety functions are described in the "Safety Integrated" Function Manual.

Overview of the manuals (Page 389)

Parameter	Description	
p0010 = 95	**Drive commissioning parameter filter** Safety Integrated commissioning	
p9601	**Enable functions integrated in the drive** (factory setting: 0000 bin)	
	0 hex	None of the safety functions has been released

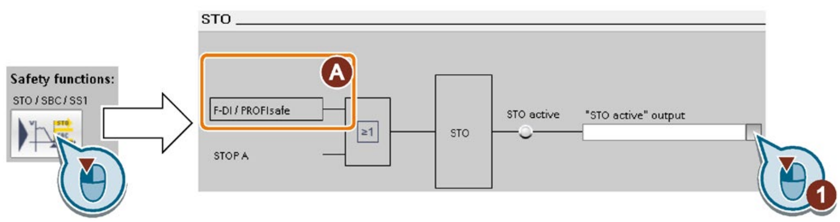
Parameter	Description	
	1 hex	Basic functions via onboard terminals has been enabled
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Password confirmation**	

6.10.3.4 Interconnecting the "STO active" signal

If you require the feedback signal "STO active" of the inverter in your higher-level control system, then you must appropriately interconnect the signal.

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 inverter signals "STO active" to the higher-level control.

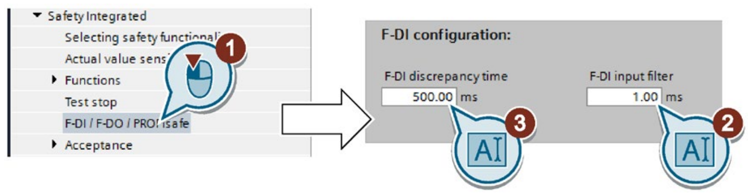
Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

6.10.3.5 Setting the filter for fail-safe digital inputs

Requirement

You are online with Startdrive.

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 input filter and the simultaneity monitoring of the failsafe digital input.
❒

Description of the signal filter

The following filters are available for the fail-safe digital inputs:

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

Set the discrepancy time for the simultaneity monitoring.

The inverter checks that the two input signals of the fail-safe 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 never switch at exactly the same time and are therefore temporarily inconsistent (discrepancy). A permanent discrepancy signifies a fault in the fail-safe digital input circuit, e.g. wire breakage.

When appropriately set, the inverter tolerates brief discrepancies.

The discrepancy time does not extend the inverter response time. The inverter selects its safety function as soon as one of the two F-DI signals changes its state from high to low.

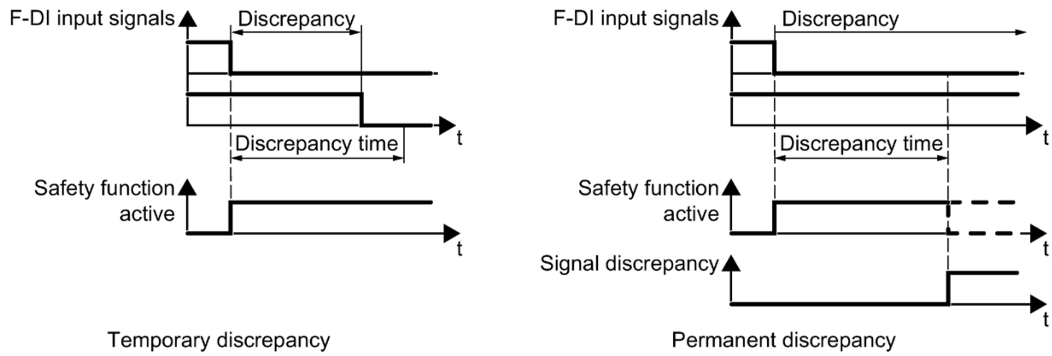


Figure 6-15 Simultaneity monitoring with discrepancy time

Filter to suppress short signals

In the following cases, an immediate inverter response to signal changes of the fail-safe digital inputs is not desirable:

- If a fail-safe digital input of the inverter is interconnected with an electromechanical sensor, 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 fail-safe digital outputs with "bit pattern tests" (bright/dark test). If a fail-safe digital input of the inverter is interconnected with a fail-safe digital output of an open-loop control module, then the inverter 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

If the fail-safe digital input responds to many signal changes within a certain time, then the inverter responds with a fault.

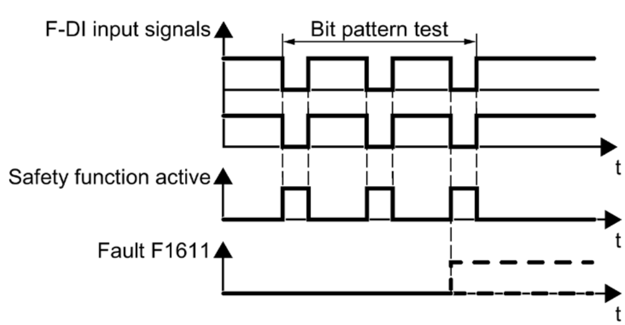


Figure 6-16 Inverter response to a bit pattern test

A filter in the inverter suppresses brief signals as a result of the bit pattern test or contact bounce.

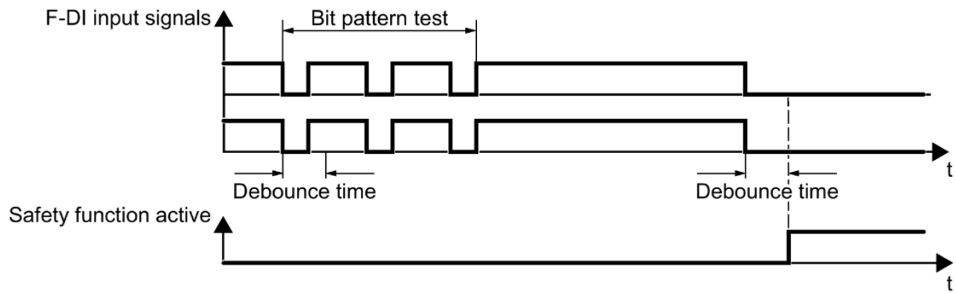


Figure 6-17 Filter to suppress brief signals

The filter extends the response time of the safety function by the debounce time.

Parameter	Description
p9650	**F-DI changeover tolerance time** (factory setting: 500 ms) Tolerance time to change over the fail-safe digital input for the basic functions.
p9651	**STO debounce time** (factory setting: 1 ms) Debounce time of the fail-safe digital input for the basic functions.

Debounce times for standard and safety functions

The debounce time p0724 for "standard" digital inputs has no influence on the fail-safe input signals. Conversely, the same applies: The F-DI debounce time does not affect the signals of the "standard" inputs.

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

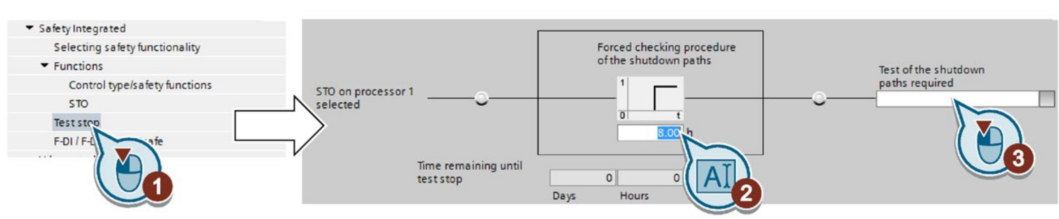
If you use an input as a fail-safe input, set the debounce time as described above.

6.10.3.6 Setting the forced checking procedure (test stop)

Requirement

You are online with Startdrive.

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 inverter signals that a forced checking procedure (test stop) is required.

   Interconnect this signal with an inverter signal of your choice.

You have set the forced checking procedure (test stop) for the Basic Functions.
❒

Description

The forced checking procedure (test stop) of the basic functions is an inverter self test. The inverter checks its circuits to switch off the torque. If you are using the Safe Brake Relay, for a forced checking procedure, the inverter also checks the circuits of this component.

You start the forced checking procedure each time that the STO function is selected.

Using a timer block, the inverter monitors as to whether the forced checking procedure is regularly performed.

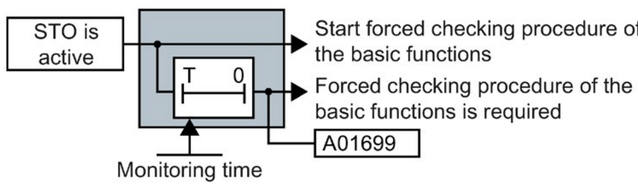


Figure 6-18 Starting and monitoring the forced checking procedure (test stop)

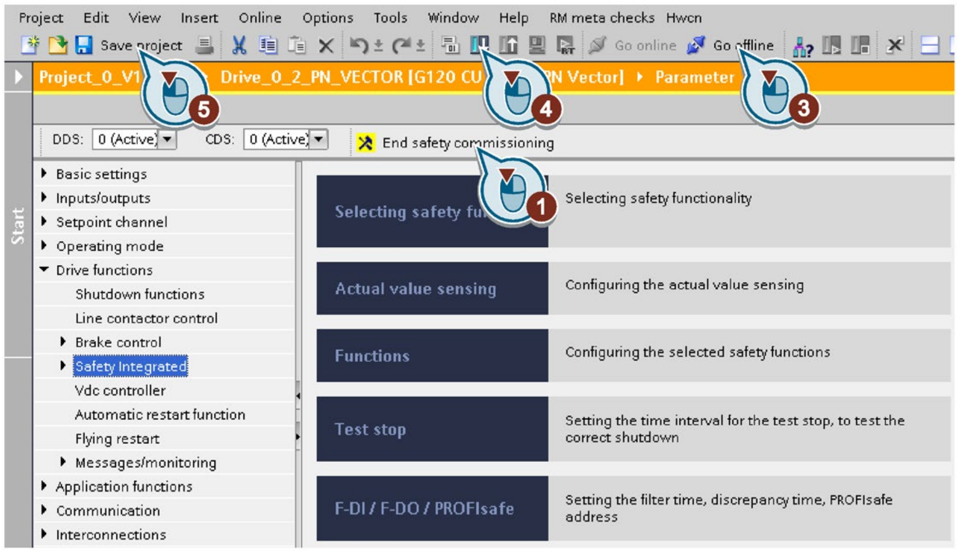
Parameter	Description
p9659	**Forced dormant error detection timer** (Factory setting: 8 h) Monitoring time for the forced dormant error detection.
r9660	**Forced dormant error detection remaining time** Displays the remaining time until the forced dormant error detection and testing the safety switch-off signal paths.
r9773.31	**1 signal: Forced dormant error detection is required** Signals for the higher-level control system.

Activate settings

Requirement

You are online with Startdrive.

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 inverter power supply.
7. Wait until all LEDs on the inverter go dark (no voltage condition).
8. Switch the inverter power supply on again.

Your settings are now active.
❒

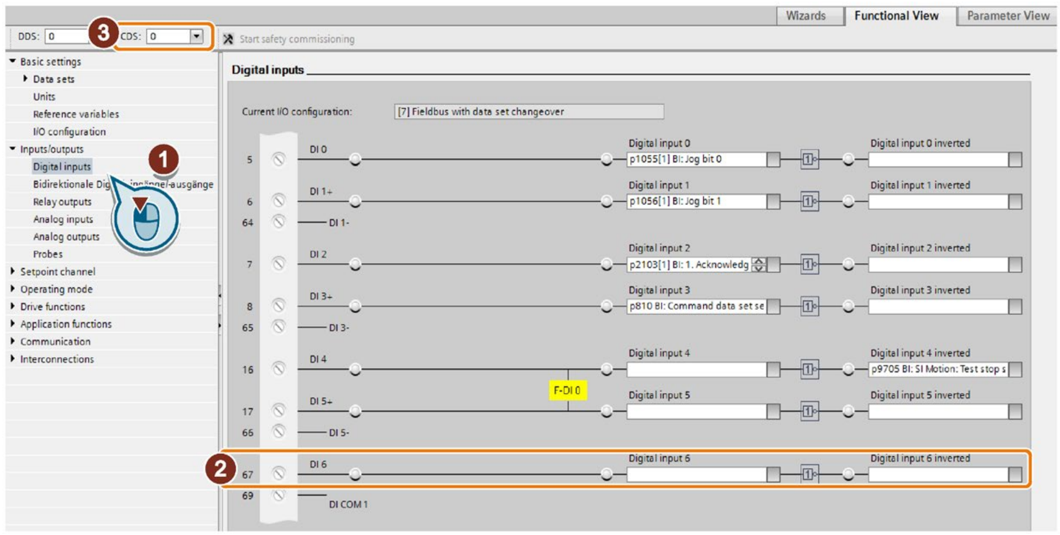
Parameter	Description
p9700 = D0 hex	**SI copy function** (factory setting: 0) Start the SI parameter copy function.
p9701 = DC hex	**Confirm data change** (factory setting: 0) Confirm SI Basic parameter change
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

Checking the interconnection of digital inputs

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 inverter via failsafe digital inputs, then you must check as to whether the failsafe digital inputs are in some instances interconnected with a "standard" function.

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 inverter.
❒

6.10.3.7 Acceptance - completion of commissioning

What is an acceptance?

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.

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 inverter?
- Do the inverter settings match the configured safety-relevant function in the machine?

Acceptance test of the inverter

The acceptance test of the inverter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the inverter checks whether the integrated drive safety functions are set up correctly for the planned safety function of the machine.

Recommended acceptance test (Page 384)

Documentation of the inverter

The following must be documented for the inverter:

- 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 inverter?

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 manner are authorized to perform the acceptance testing of the inverter.

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)

6.10.3.8 Reduced acceptance after functions have been expanded

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 inverter data • Add function table • Log the new checksums • Countersignature
Transfer of inverter 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 • Check firmware versions

6.11 Setpoints

6.11.1 Overview

You only have to set the setpoint source if you operate the converter without basic positioner, i.e. you only operate it in the speed-controlled mode.

If you operate the converter in the speed-controlled mode, you must set the source for the main setpoint of the motor speed.

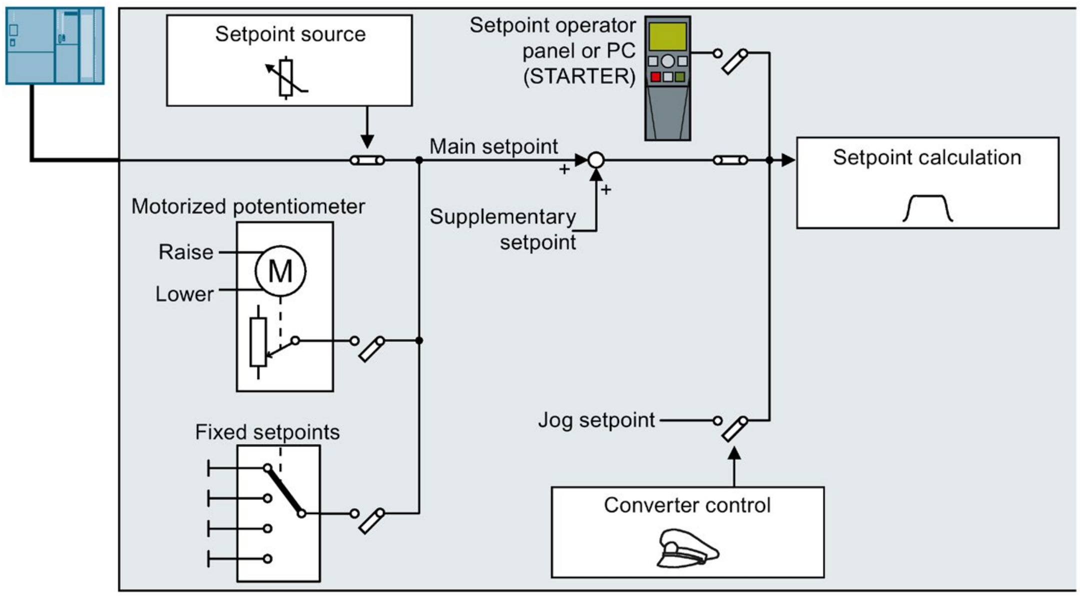


Figure 6-19 Setpoint sources for the converter

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

- 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 jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

In the basic commissioning, you have already selected a setpoint source.

Commissioning (Page 73)

However, you can change this setting. The setpoint sources will be described in more detail on the following pages.

6.11.2 Specifying the setpoint via the fieldbus

Function description

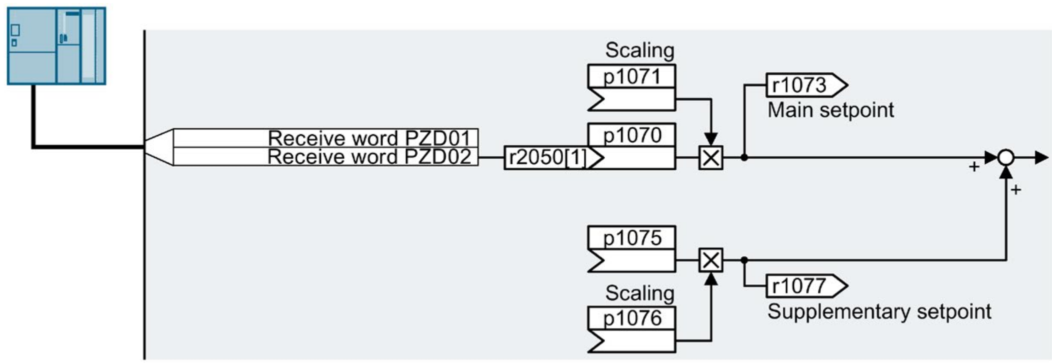


Figure 6-20 Fieldbus as setpoint source

In the quick commissioning, you define the preassignment for the inverter 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 fieldbus.

Parameter

Parameter	Description	Setting
p1070[0…n]	CI: Main setpoint	Signal source for the main setpoint The factory setting depends on the Control Unit. With PROFIBUS or PROFINET interface: [0] 2050[1] Without PROFIBUS or PROFINET interface: [0] 755[0]
p1071[0…n]	CI: Main setpoint scaling	Signal source for scaling the main setpoint Factory setting: 1
r1073	CO: Main setpoint active	Displays the active main setpoint
p1075[0…n]	CI: Supplementary setpoint	Signal source for the supplementary setpoint Factory setting: 0

Parameter	Description	Setting
p1076[0…n]	CI: Supplementary setpoint scaling	Signal source for scaling the supplementary setpoint Factory setting: 0
r2050[0…11]	CO: PROFIdrive PZD receive word	Connector output to interconnect the PZD received from the fieldbus controller in the word format. [1] Most standard telegrams receive the speed setpoint as receive word PZD02.

Further information

For further information refer to the function diagrams 2468, 9360 and 3030 of the List Manual.

6.11.3 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.

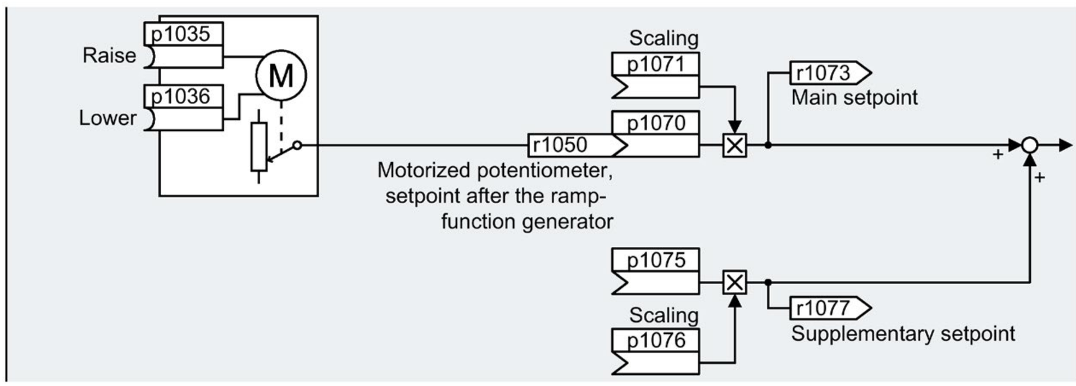


Figure 6-21 Motorized potentiometer as setpoint source

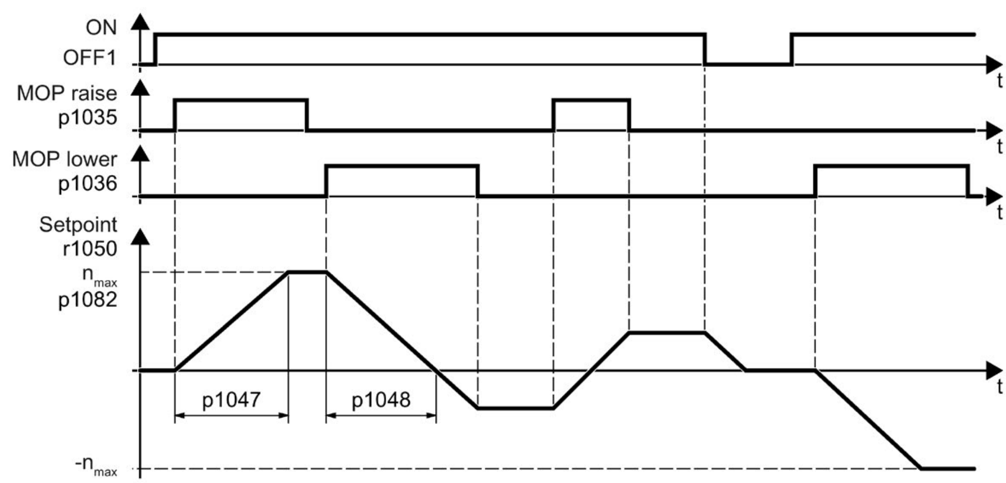


Figure 6-22 Function chart of the motorized potentiometer

Example

Setting with the motorized potentiometer as setpoint source:

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

Parameter

Table 6- 24 Basic setup of motorized potentiometer

Parameter	Description	Setting
p1035[0…n]	BI: Motorized potentiometer setpoint higher	Signal source to continuously increase the setpoint The factory setting depends on the inverter. Inverters with PROFIBUS or PROFINET interface: [0] 2090.13 [1] 0 Inverters without PROFIBUS or PROFINET interface: 0
p1036[0…n]	BI: Motorized potentiometer setpoint lower	Signal source to continuously decrease the setpoint The factory setting depends on the inverter. Inverters with PROFIBUS or PROFINET interface: [0] 2090.14 [1] 0 Inverters without PROFIBUS or PROFINET interface: 0
p1040[0…n]	Motorized potentiometer start value [rpm]	Start value that is effective when the motor is switched on. Factory setting: 0 rpm
p1047	MOP ramp-up time [s]	MOP ramp-up time Factory setting: 10 s
p1048	MOP ramp-down time [s]	MOP ramp-down time: Factory setting: 10 s
r1050	Motorized potentiometer, setpoint after the ramp-function generator	Motorized potentiometer, setpoint after the ramp-function generator
p1070[0…n]	CI: Main setpoint	Signal source for the main setpoint The factory setting depends on the Control Unit. With PROFIBUS or PROFINET interface: [0] 2050[1] Without PROFIBUS or PROFINET interface: [0] 755[0]
p1071[0…n]	CI: Main setpoint scaling	Signal source for scaling the main setpoint Factory setting: 1
r1073	CO: Main setpoint active	Displays the active main setpoint
p1075[0…n]	CI: Supplementary setpoint	Signal source for the supplementary setpoint Factory setting: 0
p1076[0…n]	CI: Supplementary setpoint scaling	Signal source for scaling the supplementary setpoint Factory setting: 0

Table 6- 25 Extended setup of motorized potentiometer

Parameter	Description	Setting
p1030[0…n]	Motorized potentiometer configuration	Configuration for the motorized potentiometer Factory setting: 00110 bin .00 Storage active = 0: After the motor has been switched on, the setpoint = p1040 = 1: After the motor has switched off, the inverter saves the setpoint. After the motor has switched on, the setpoint = the stored value .01 Automatic mode, ramp-function generator active (1-signal via BI: p1041) = 0: Ramp-up/ramp-down time = 0 = 1: With ramp-function generator In manual mode (p1041 = 0), the ramp-function generator is always active. .02 Initial rounding active 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes .03 Storage in NVRAM active 1: If bit 00 = 1, the setpoint is retained during a power failure .04 Ramp-function generator always active 1: The inverter also calculates the ramp-function generator when the motor is switched off
p1037[0…n]	Motorized potentiometer maximum speed [rpm]	The inverter limits the motorized potentiometer output to p1037. Factory setting: 0 rpm After quick commissioning, the inverter sets the parameter to the appropriate value.
p1038[0…n]	Motorized potentiometer minimum speed [rpm]	The inverter limits the motorized potentiometer output to p1038. Factory setting: 0 rpm After quick commissioning, the inverter sets the parameter to the appropriate value.
p1043[0…n]	BI: Motorized potentiometer, accept setting value	Signal source for accepting the setting value. The motorized potentiometer accepts the setting value p1044 on signal change p1043 = 0 → 1. Factory setting: 0
p1044[0…n]	CI: Motorized potentiometer, setting value	Signal source for the setting value Factory setting: 0

Further information

For more information about the motorized potentiometer, refer to function diagram 3020 in the List Manual.

6.11.4 Fixed speed setpoint as setpoint source

Function description

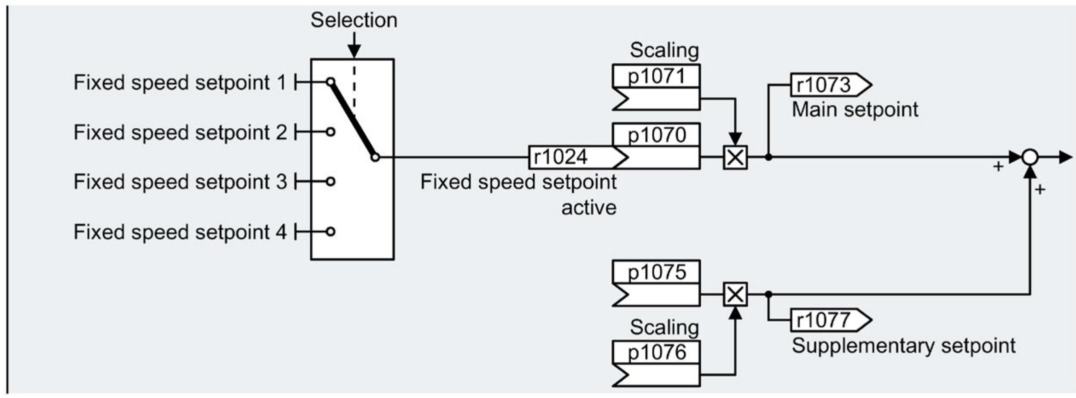


Figure 6-23 Fixed speed setpoint as setpoint source

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

Directly selecting a fixed speed setpoint

You set 4 different fixed speed setpoints. Up to 16 different setpoints are obtained by adding one or several of the four fixed speed setpoints.

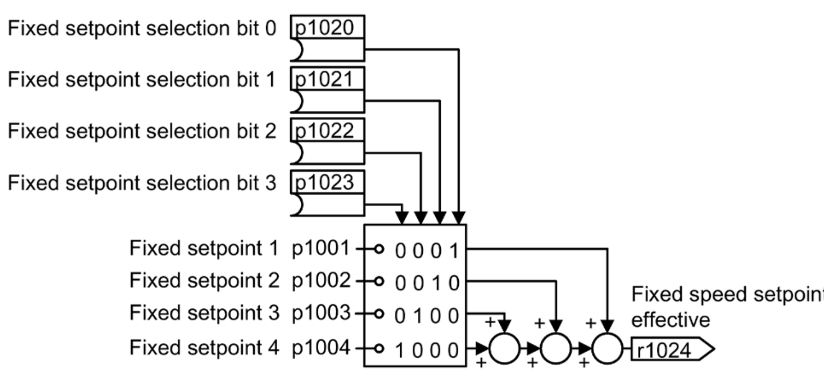


Figure 6-24 Direct selection of the fixed speed setpoint

Selecting the fixed speed setpoint, binary

You set 16 different fixed speed setpoints. You precisely select one of these 16 fixed speed setpoints by combining four selection bits.

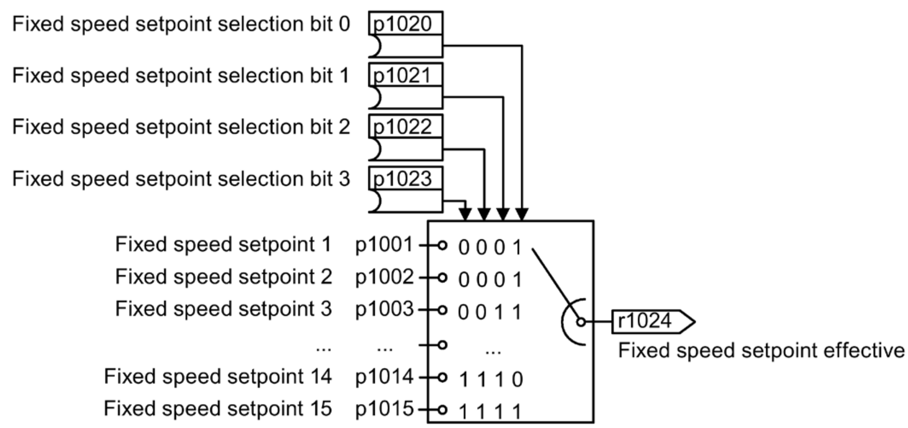


Figure 6-25 Binary selection of the fixed speed setpoint

Example

After it has been switched on, a conveyor belt only runs with two different velocities. The motor should now operate with the following corresponding speeds:

- The signal at digital input 0 switches the motor on and accelerates it up to 300 rpm.
- The signal at digital input 1 accelerates the motor up to 2000 rpm.
- With signals at both digital inputs, the motor accelerates up to 2300 rpm.

Table 6- 26 Settings for the application example

Parameter	Description
p1001[0] = 300.000	Fixed speed setpoint 1 [rpm]
p1002[0] = 2000.000	Fixed speed setpoint 2 [rpm]
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 6- 27 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	Setting
p1001[0...n]	Fixed speed setpoint 1 [rpm]	Fixed speed setpoint 1 Factory setting: 0 rpm
p1002[0...n]	Fixed speed setpoint 2 [rpm]	Fixed speed setpoint 2 Factory setting: 0 rpm
...	...	...
p1015[0...n]	Fixed speed setpoint 15 [rpm]	Fixed speed setpoint 15 Factory setting: 0 rpm
p1016	Fixed speed setpoint mode	Fixed speed setpoint mode Factory setting: 1 1: Direct 2: Binary
p1020[0...n]	Fixed speed setpoint selection, bit 0	Fixed speed setpoint selection, bit 0 Factory setting: 0
p1021[0...n]	Fixed speed setpoint selection, bit 1	Fixed speed setpoint selection, bit 1 Factory setting: 0
p1022[0...n]	Fixed speed setpoint selection, bit 2	Fixed speed setpoint selection, bit 2 Factory setting: 0
p1023[0...n]	Fixed speed setpoint selection, bit 3	Fixed speed setpoint selection, bit 3 Factory setting: 0
r1024	Fixed speed setpoint active	Fixed speed setpoint active
r1025.0	Fixed speed setpoint status	Fixed speed setpoint status 1 signal: Fixed speed setpoint is selected

Further information

Additional information about binary selection can be found in function diagram 3010 in the List Manual.

Additional information about direct selection can be found in function diagram 3011 in the List Manual.

Application 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.
- The signals at the two digital inputs accelerate the motor to 2300 rpm.

Table 6- 28 Settings for the application example

Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** [rpm]
p0840 = 722.0	**ON/OFF1:** Switches on the motor with digital input 0
p1070 = 1024	**Main setpoint:** Interconnects the main setpoint with 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 6- 29 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

6.12 Setpoint calculation

6.12.1 Overview of setpoint preparation

You only have to set the setpoint processing if you operate the converter without basic positioner, i.e. you only operate it in the speed-controlled mode.

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.

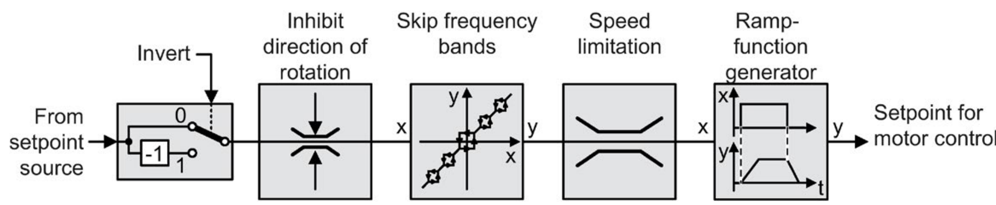
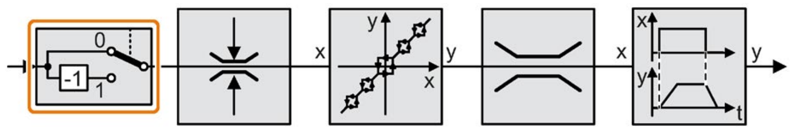
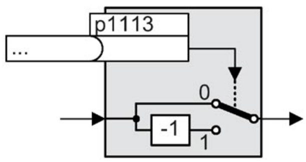


Figure 6-26 Setpoint processing in the inverter

6.12.2 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 6- 30 Application examples showing how a setpoint is inverted

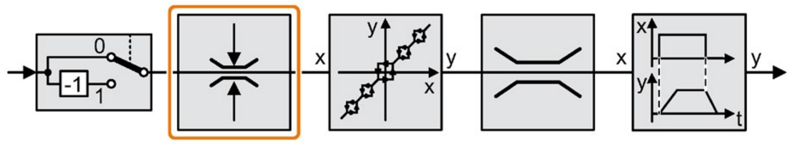
Parameter	Description
p1113 = 722.1	Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Inverter inverts the setpoint.
p1113 = 2090.11	Inverts the setpoint via the fieldbus (control word 1, bit 11).

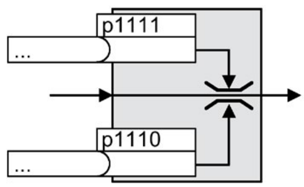
Parameter

Parameter	Description	Setting
p1113[0…n]	BI: Setpoint inversion	Signal source for inverting the setpoint 1 signal: Invert setpoint The factory setting depends on the fieldbus interface.

6.12.3 Inhibit direction of rotation

Function description





In the factory setting of the inverter, both motor directions of rotation are enabled.

Set the corresponding parameter to a value = 1 to permanently block directions of rotation.

Example

Table 6- 31 Application examples showing how a setpoint is inverted

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	Setting
p1110[0…n]	BI: Inhibit negative direction	Signal source to inhibit the negative direction 0 signal: Direction of rotation is enabled 1 signal: Direction of rotation is inhibited Factory setting: 0
p1111[0…n]	BI: Inhibit positive direction	Signal source to inhibit the positive direction 0 signal: Direction of rotation is enabled 1 signal: Direction of rotation is inhibited Factory setting: 0

6.12.4 Skip frequency bands and minimum speed

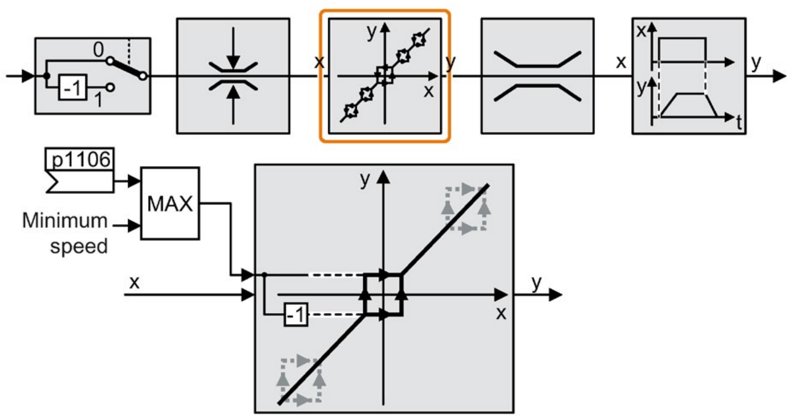
Skip frequency bands

The inverter has four skip frequency bands that prevent continuous motor operation within a specific speed range. Further information is provided in function diagram 3050 of the List Manual.

Overview of the manuals (Page 389)

Minimum speed

The inverter prevents continuous motor operation at speeds < minimum speed.



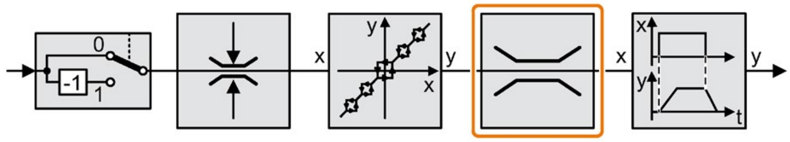
Speeds where the absolute value is less than the minimum speed are only possible during motor operation when accelerating or braking.

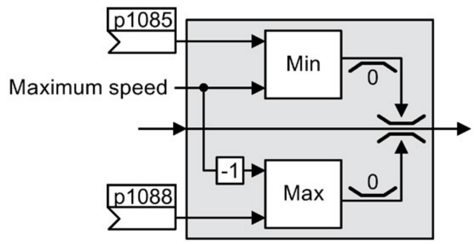
Table 6- 32 Setting the minimum speed

Parameter	Description
p1080	**Minimum speed** (factory setting: 0 rpm)
p1106	**CI: Minimum speed signal source** (factory setting: 0) Dynamic specification of the minimum speed

6.12.5 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.

Table 6- 33 Parameters for the speed limitation

Parameter	Description
p1082	**Maximum speed** (factory setting: 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting: 210,000 rpm)
p1085	**CI: Speed limit, positive direction of rotation** (factory setting: 1083)
p1086	**Speed limit, negative direction of rotation** (factory setting: -210,000 rpm)
p1088	**CI: Speed limit, negative direction of rotation** (factory setting: 1086)

6.12.6 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate change of the speed setpoint (acceleration). A reduced acceleration reduces the accelerating torque of the motor. In this case, the motor reduces the load on the mechanical system of the driven machine.

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

- Extended ramp-function generator

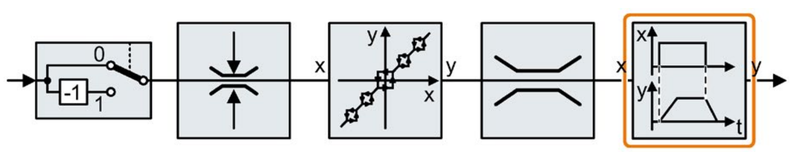
  The expanded ramp-function generator limits not only the acceleration but also the change in acceleration (jerk) by rounding the setpoint. In this case, the torque does not rise suddenly in the motor.

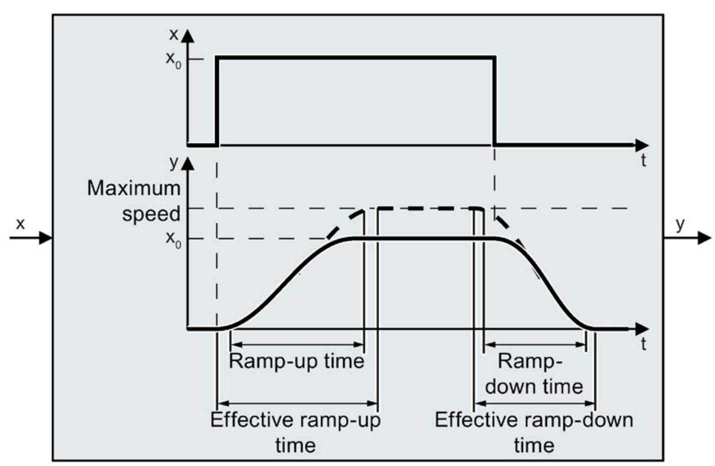
- Basic ramp-function generator

  The basic ramp-function generator limits the acceleration, however not the rate the acceleration changes (jerk).

Extended ramp-function generator

The ramp-up and ramp-down times of the extended ramp-function generator can be set independently of each other. The optimum times that you select depend on your particular application in question and can range from just a few 100 ms (e.g. for belt conveyor drives) to several minutes (e.g. for centrifuges).



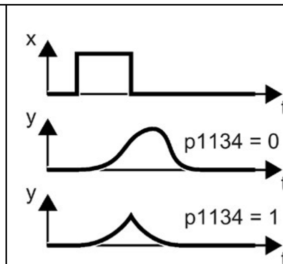


Initial and final rounding permit smooth, jerk-free acceleration and braking.

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).

Table 6- 34 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting: 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting: 10 s) Braking time in seconds from the maximum speed down to standstill
p1130	**Ramp-function generator initial rounding time** (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1131	**Ramp-function generator final rounding time** (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1134	**Ramp-function rounding type** (factory setting: 0) 0: Continuous smoothing 1: Discontinuous smoothing 
p1135	**OFF3 ramp-down time** (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.
p1136	**OFF3 initial rounding time** (factory setting: 0 s) Initial rounding for OFF3 for the extended ramp-function generator.
p1137	**OFF3 final rounding time** (factory setting: 0 s) Final rounding for OFF3 for the extended ramp-function generator.

You can find more information in function diagram 3070 and 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.

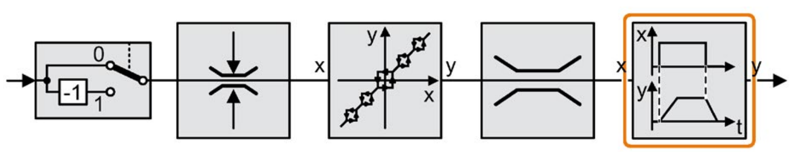
3. Evaluate your drive response.
   – If the motor accelerates too slowly, then reduce the ramp-up time.

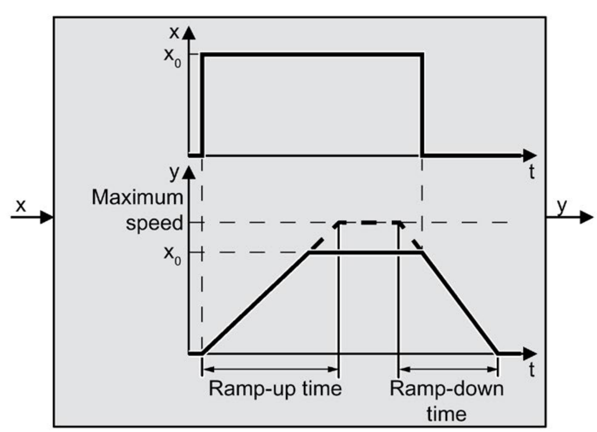
     An excessively short ramp-up time means that the motor will reach its current limiting when accelerating, and will temporarily not be able to follow the speed setpoint. In this case, the drive exceeds the set time.
   – If the motor accelerates too fast, then extend the ramp-up time.
   – Increase the 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 inverter either reaches the motor current, or the DC link voltage in the inverter becomes too high.
   – Extend the ramp-down time if the motor is braked too quickly or the inverter goes into a fault condition when braking.
6. Repeat steps 1 … 5 until the drive behavior meets the requirements of the machine or plant.

You have set the extended ramp-function generator.
❒

Basic ramp-function generator





When compared to the extended ramp-function generator, the basic ramp-function generator has no rounding times.

Table 6- 35 Parameters for setting the ramp-function generator

Parameter	Description
p1115 = 0	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting: 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting: 10 s) Braking time in seconds from the maximum speed down to standstill
p1135	**OFF3 ramp-down time** (factory setting: 0 s) The quick stop (OFF3) has its own ramp-down time.

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.

Table 6- 36 Parameters for setting the scaling

Parameter	Description
p1138	**Up ramp scaling** (factory setting: 1) Signal source for scaling the acceleration ramp.
p1139	**Deceleration ramp scaling** (factory setting: 1) Signal source for scaling the deceleration ramp.

Application example

In the following application example, the higher-level control sets the ramp-up and ramp-down times of the inverter via PROFIBUS.

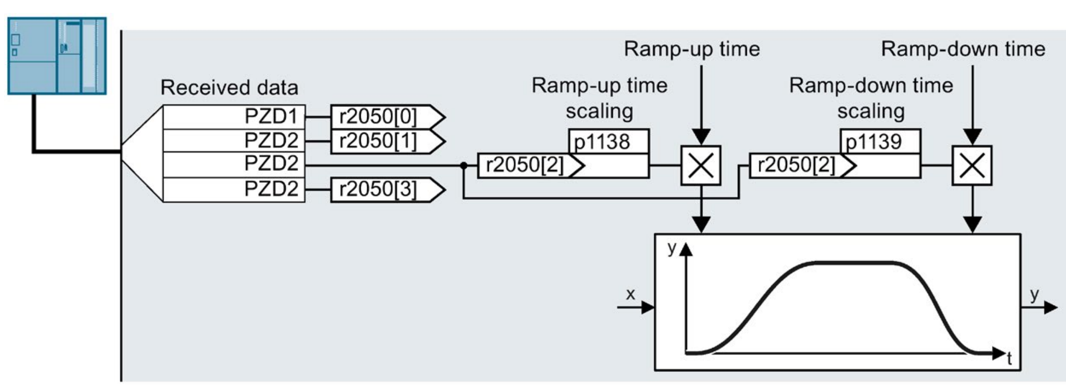


Figure 6-27 Application example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system.

  Extend telegrams and change signal interconnection (Page 177)
- The control sends the scaling value to the inverter 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 inverter 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)

6.13 Motor control

We recommend that you use vector control with encoder for a position-controlled axis.

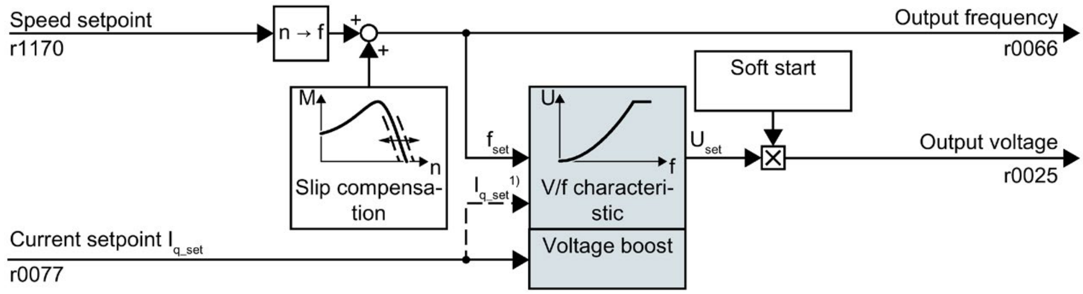
Introduction, V/f control, vector control (Page 76)

6.13.1 V/f control

Overview of the U/f control

The U/f control is a closed-loop speed control with the following characteristics:

- The inverter controls the output voltage using the V/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
- Not using a PI controller prevents the speed control from becoming unstable
- In applications in which greater speed accuracy is required, a closed-loop control with load-dependent voltage boost can be selected (flux current control, FCC)



1) In the U/f control variant, "flux current control (FCC)," the inverter controls the motor current (starting current) at low speeds

Figure 6-28 Simplified function diagram of the U/f control

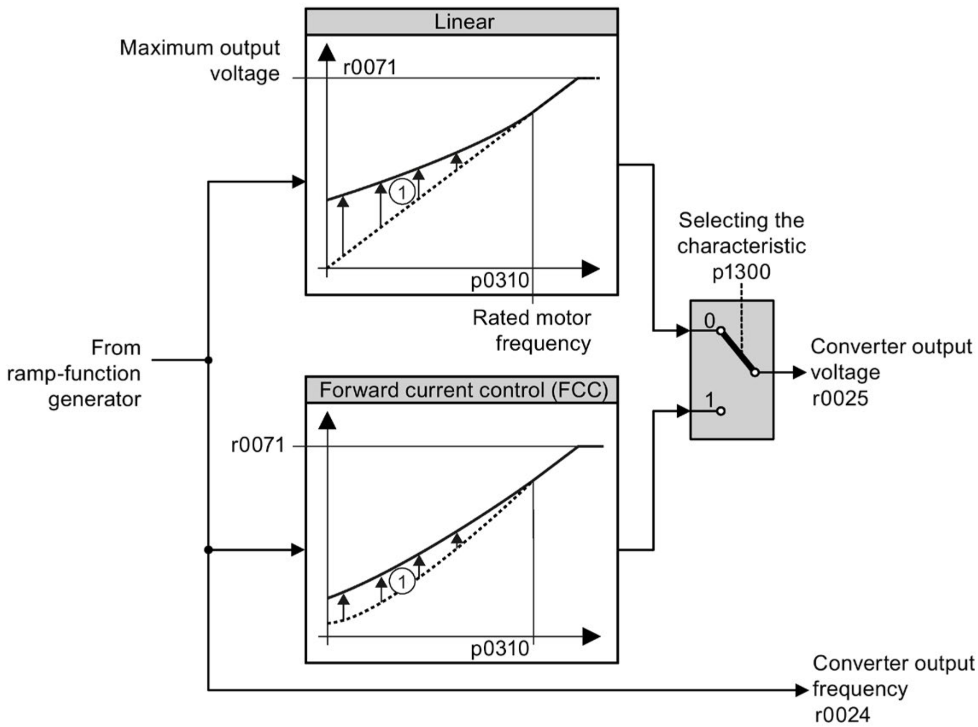
One function not shown in the simplified function diagram is the resonance damping for damping mechanical oscillations. You will find the complete function diagrams 6300 et seq. in the List Manual.

For operation of the motor with U/f control, you must set at least the subfunctions shown with a gray background in the figure to adapt them to your application:

- V/f characteristic
- Voltage boost

6.13.1.1 Characteristics of U/f control

The inverter has several U/f characteristics. Based on the characteristic, as the inverter increases in frequency the motor voltage rises.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective when frequencies < rated frequency

Figure 6-29 U/f characteristics of the inverter

The inverter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum inverter output voltage.

If the inverter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the output voltage at the rated motor frequency also depends on the following variables:

- Ratio between the sizes of the inverter and motor
- Line voltage
- Line impedance
- Current motor torque

The maximum possible output voltage relative to the input voltage is provided in the technical specifications.

Technical data (Page 351)

6.13.1.2 Selecting the U/f characteristic

Table 6- 37 U/f characteristics

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 inverter equalizes the voltage drops across the stator resistance. Recommended for motors with a low power rating. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1

Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

6.13.1.3 Optimizing motor starting

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.

Setting the voltage boost for U/f control

The inverter boosts the voltage corresponding to the starting currents p1310 … p1312.

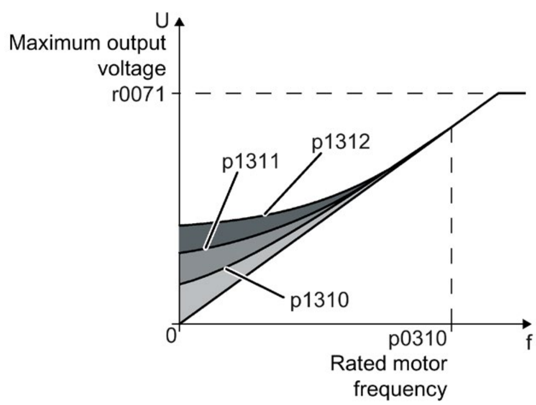


Figure 6-30 The resulting voltage boost using a linear characteristic as example

Preconditions

- Set the ramp-up time of the ramp-function generator to a value 1 s (< 1 kW) … 10 s (> 10 kW), depending on the power rating of the motor.
- Increase the starting current in steps of ≤ 5%. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter 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	Description
p1310	**Starting current (voltage boost) permanent** (factory setting 50%) Compensates for voltage drops caused by long motor cables and the ohmic losses in the motor.
p1311	**Starting current (voltage boost) when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Starting current (voltage boost) when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

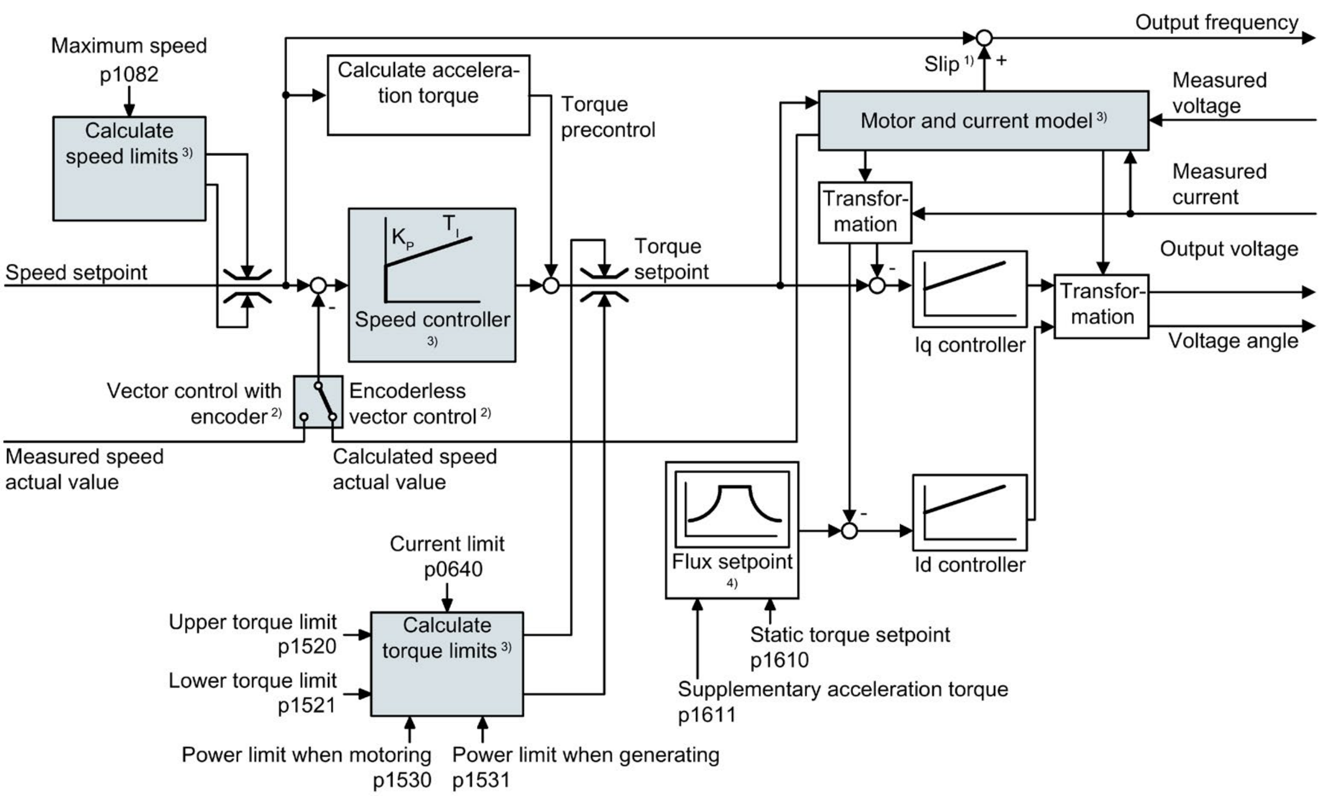
You will find more information on this function in the parameter list and in function diagram 6301 in the List Manual.

6.13.2 Vector control with speed controller

6.13.2.1 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 6-31 Simplified function diagram for vector control with speed controller

Using the motor model, the inverter 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 inverter 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.

Performing the basic commissioning (Page 85)

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 inverter 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 inverter 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 188)
- For pulling loads, carefully comply with the recommended settings for vector control.

  Advanced settings (Page 240)

6.13.2.2 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.
❒

6.13.2.3 Select motor control

Vector control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected vector control as control mode in the basic commissioning, you will have already set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement). If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Set p1300 = 20.

Select vector control with encoder

Set p1300 = 21.

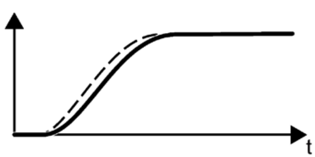
6.13.2.4 Optimizing the speed controller

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 inverter 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:

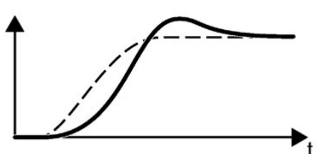


The speed setpoint (broken line) increases with the set ramp-up time and rounding.

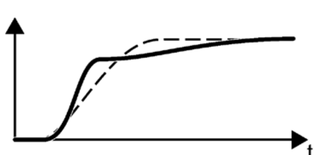
The speed actual value follows the setpoint without any overshoot.

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 6- 38 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 inverter sets the parameters to 100 %.

Parameter	Description
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 6- 39 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 inverter 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

Preconditions

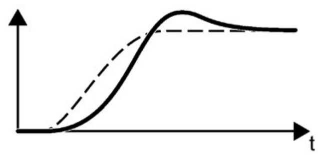
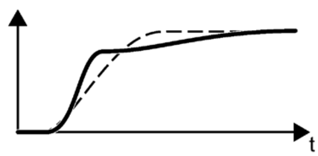
- Torque precontrol is active: p1496 = 100 %.
- The load moment of inertia is constant and independent of the speed.
- The inverter requires 10 % … 50 % of the rated torque to accelerate.

  When necessary, adapt the ramp-up and ramp-down times of the ramp-function generator (p1120 and p1121).
- STARTER and Startdrive have trace functions that allow the speed setpoint and actual value to be recorded.

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 inverter 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.

6.13.2.5 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.

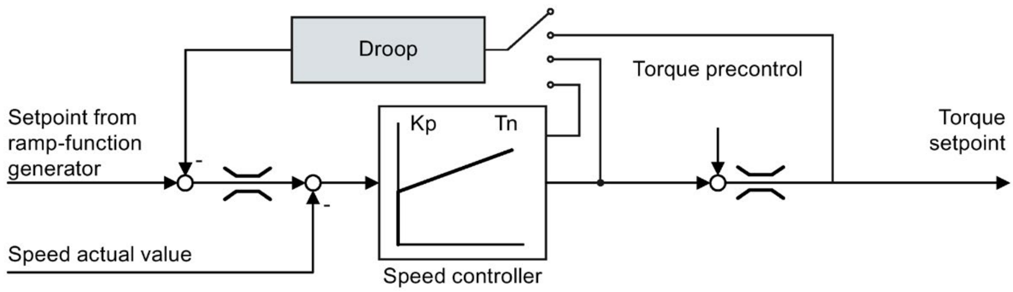


Figure 6-32 Effect of droop in the speed controller

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.

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.

If you use encoderless vector control with a pulling load, then the following settings are required:

- Set the following parameters:

Par.	Explanation	
p1750	**Motor model configuration**	
	Bit 07 = 1	Use speed switchover limits that are less sensitive to external effects
p1610	**Static torque setpoint (encoderless)** (Factory setting: 50 %) Set a value which is higher than the maximum load torque that occurs.	

- 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).

6.13.2.6 Friction characteristic

Function

In many applications, e.g. applications with geared motors or belt conveyors, the frictional torque of the load is not negligible.

The inverter provides the possibility of precontrolling the torque setpoint, bypassing the speed controller. The precontrol reduces overshooting of the speed after speed changes.

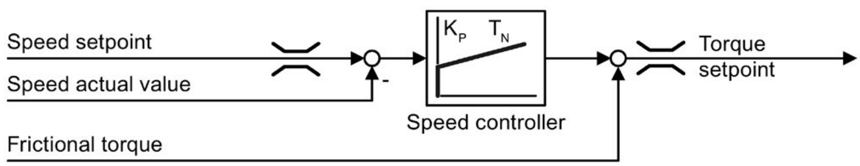


Figure 6-33 Precontrol of the speed controller with frictional torque

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

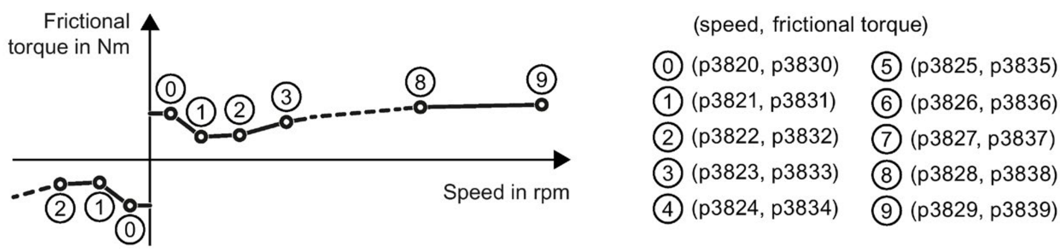


Figure 6-34 Friction characteristic

The intermediate points of the friction characteristic are defined for positive speeds. In the negative direction of rotation, the inverter uses the intermediate points with a negative sign.

Recording a friction characteristic

After quick commissioning, the inverter 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 inverter records the friction characteristic: The inverter accelerates the motor step by step up to the rated speed, measures the frictional torque und writes the frictional torque into the intermediate points of the friction characteristic.

Precondition

The motor is permitted to accelerate up to the rated speed without endangering persons or property.

Procedure

1. Set P3845 = 1: The inverter 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 inverter accelerates the motor.

   During measurement, the inverter signals the alarm A07961.

   When the inverter has determined all the intermediate points of the friction characteristic without fault code F07963, the inverter 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 inverter adds the output of the friction characteristic r3841 to the torque setpoint.

Parameter

Parameter	Explanation	
p3820 … p2839	Intermediate points of the friction characteristic [rpm; Nm]	
r3840	**Friction characteristic status word**	
	.00	1 signal: Friction characteristic OK
	.01	1 signal: Determination of the friction characteristic is active
	.02	1 signal: Determination of the friction characteristic is complete
	.03	1 signal: Determination of the friction characteristic has been aborted
	.08	1 signal: Friction characteristic positive direction
r3841	**Friction characteristic, output** [Nm]	
p3842	**Activate friction characteristic** 0: Friction characteristic deactivated 1: Friction characteristic activated	
p3845	**Activate friction characteristic plot** (factory setting: 0) 0: Friction characteristic plot deactivated 1: Friction characteristic plot activated, both directions 2: Friction characteristic plot activated, positive direction 3: Friction characteristic plot activated, negative direction	
p3846	**Friction characteristic plot ramp-up/ramp-down time** (factory setting: 10 s) Ramp-up/ramp-down time for automatic plotting of the friction characteristic.	
p3847	**Friction characteristic plot warm-up period** (factory setting: 0 s) At the start of automatic plotting, the inverter accelerates the motor up to the speed = p3829 und keeps the speed constant for this time.	

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

6.13.2.7 Moment of inertia estimator

Background

From the load moment of inertia and the speed setpoint change, the inverter 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).

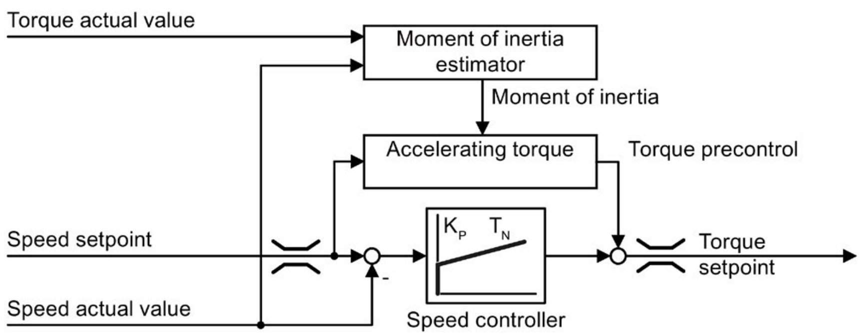


Figure 6-35 Influence of the moment of inertia estimator on the speed control

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

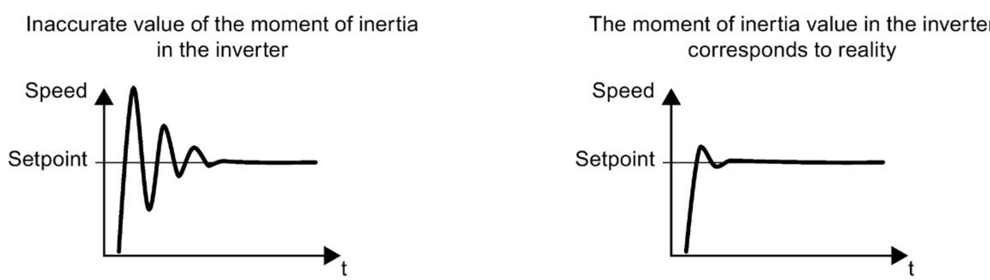


Figure 6-36 Influence of the moment of inertia on the speed

Function

From the actual speed, the actual motor torque and the frictional torque of the load, the inverter calculates the total moment of inertia of the load and motor.

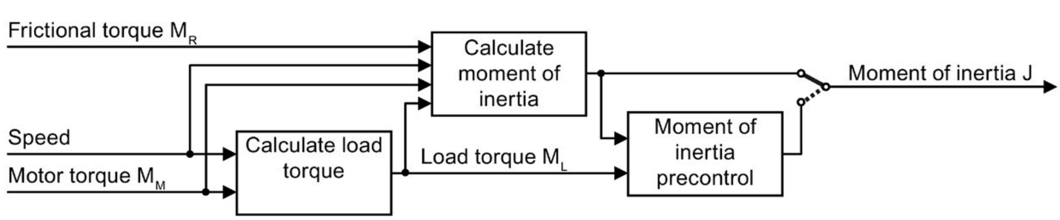


Figure 6-37 Overview of the function of the moment of inertia estimator

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

Friction characteristic (Page 243)

How does the inverter calculate the load torque?

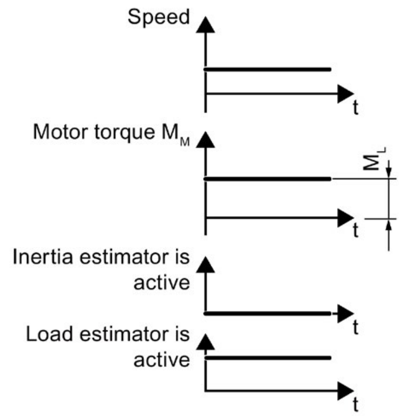


Figure 6-38 Calculating the load torque

At low speeds, the inverter calculates the load torque M_L from the actual motor torque.

The calculation takes place under the following conditions:

- Speed ≥ p1226
- Acceleration setpoint < 8 $1/s^2$ (≙ speed change 480 rpm per s)
- Acceleration × moment of inertia (r1493) < 0.9 × p1560

How does the inverter calculate the moment of inertia?

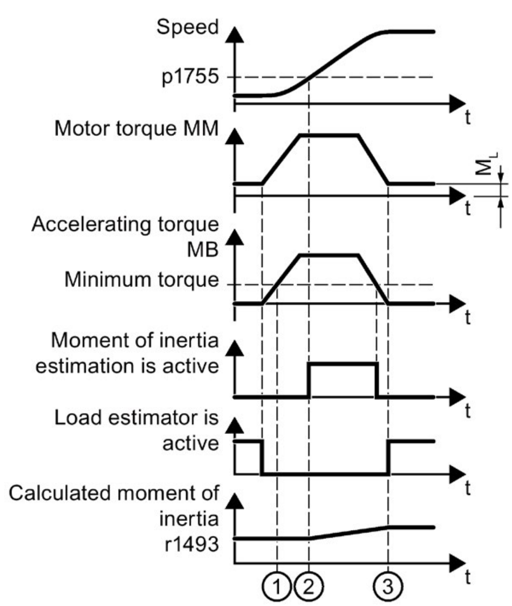


Figure 6-39 Calculating the moment of inertia

For higher speed changes, the inverter 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 inverter 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 inverter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 1/s² (≙ speed change 480 rpm per s)

③ The inverter calculates the load torque again after acceleration.

Moment of inertia precontrol

In applications where the motor predominantly operates with a constant speed, the inverter 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.

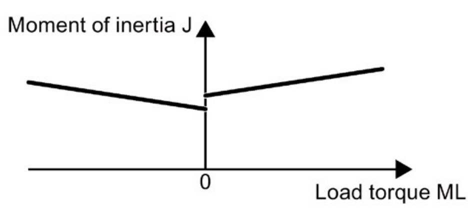


Figure 6-40 Moment of inertia precontrol

The relationship between load torque and torque is saved in the inverter 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 inverter 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.

Preconditions

- You have selected encoderless 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 conditions 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.
❒

The most important settings

Parameter	Explanation
r0333	**Rated motor torque** [Nm]
p0341	**Motor moment of inertia** (factory setting: 0 kgm²) The inverter sets the parameter when selecting a listed motor. The parameter is then write-protected.
p0342	**Moment of inertia ratio, total to motor** (factory setting: 1) Ratio of moment of inertia load + motor to moment of inertia of motor without load
p1400	**Speed control configuration**

Parameter	Explanation		
	.18	1 signal: Moment of inertia estimator active	
	.20	1 signal: Acceleration model on	
	.22	1 signal	Moment of inertia estimator retain value when motor switched off
		0 signal	Moment of inertia estimator reset value to initial value J_0 when motor switched off: J_0 = p0341 × p0342 + p1498 If the load torque can change when the motor is switched off, set p1400.22 = 0.
	.24	1 signal	Shortened moment of inertia estimation is active. p1400.24 = 1 reduces the duration of the moment of inertia estimation. Disadvantage: If the accelerating torque is not constant while calculating the moment of inertia, the calculation of the moment of inertia using p1400.24 = 1 is less precise.
r1407	**Status word, speed controller**		
	.24	1 signal: Moment of inertia estimator is active	
	.25	1 signal: Load estimator is active	
	.26	1 signal: Moment of inertia estimator is engaged	
	.27	1 signal: Shortened moment of inertia estimation is active.	
r1493	**Total moment of inertia, scaled** r1493 = p0341 × p0342 × p1496		
p1496	**Acceleration precontrol scaling** (factory setting: 0 %) According to rotating measurement of the motor data identification is p1496 = 100%.		
p1498	**Load moment of inertia** (factory setting: 0 kgm^2)		
p1502	**Freeze moment of inertia estimator** (factory setting: 0) If the load torque changes when accelerating the motor, set this signal to 0.		
	0 signal	Moment of inertia estimator is active	
	1 signal	Determined moment of inertia is frozen	
p1755	**Motor model changeover speed encoderless operation** Defines the switchover between open-loop and closed-loop controlled operation of the encoderless vector control. When selecting the closed-loop speed control, the inverter sets p1755 = 13.3% × rated speed.		

Advanced settings

Parameter	Explanation	
p1226	**Standstill detection, speed threshold** (factory setting: 20 rpm) The moment of inertia estimator only measures the load torque for speeds ≥ p1226. p1226 also defines from which speed the inverter switches-off the motor for OFF1 and OFF3.	
p1560	**Moment of inertia estimator accelerating torque threshold value** (factory setting: 10%)	
p1561	**Moment of inertia estimator change time inertia** (factory setting: 500 ms)	The lower that p1561 or p1562 is, the shorter the moment of inertia estimator

Parameter	Explanation		
p1562	**Moment of inertia estimator change time load** (factory setting: 10 ms)	measurements. The larger p1561 or p1562 is, the more accurate the results provided by the moment of inertia estimator.	
p1563	**Moment of inertia estimator load torque positive direction of rotation** (factory setting: 0 Nm)		
p1564	**Moment of inertia estimator load torque negative direction of rotation** (factory setting: 0 Nm)		
p5310	**Moment of inertia precontrol configuration** (factory setting: 0000 bin)		
	.00	1 signal: Activates calculation of the characteristic (p5312 … p5315)	
	.01	1 signal: Activates moment of inertia precontrol	
		p5310.00 = 0, p5310.01 = 0	Deactivating moment of inertia precontrol
		p5310.00 = 1, p5310.01 = 0	Adapting the moment of inertia precontrol
		p5310.00 = 0, p5310.01 = 1	Activating the moment of inertia precontrol. The characteristic of the moment of inertia precontrol remains unchanged.
		p5310.00 = 1, p5310.01 = 1	Activating the moment of inertia precontrol. The inverter adapts the characteristic in parallel.
r5311	**Moment of inertia precontrol status word**		
	.00	1 signal: New measuring points for the characteristic of the moment of inertia precontrol are available	
	.01	1 signal: New parameters are been calculated	
	.02	1 signal: Moment of inertia precontrol active	
	.03	1 signal: The characteristic in the positive direction of rotation has been calculated and is ready	
	.04	1 signal: The characteristic in the negative direction of rotation has been calculated and is ready	
	.05	1 signal: The inverter writes actual results to the parameter	
p5312	**Moment of inertia precontrol linear positive** (factory setting: 0 1/s^2)	In a positive direction of rotation: Moment of inertia = p5312 × load torque + p5313	
p5313	**Moment of inertia precontrol constant positive** (factory setting: 0 kgm^2)		
p5314	**Moment of inertia precontrol linear negative** (factory setting: 0 1/s^2)	In a negative direction of rotation: Moment of inertia = p5314 × load torque + p5315	
p5315	**Moment of inertia precontrol constant negative** (factory setting: 0 kgm^2)		

6.13.3 Operating the converter without position controller

Converter factory setting

In the factory setting of the converter, the basic positioner supplies the setpoint for the speed controller. Although other sources for the setpoint are available in the converter, they are however locked.

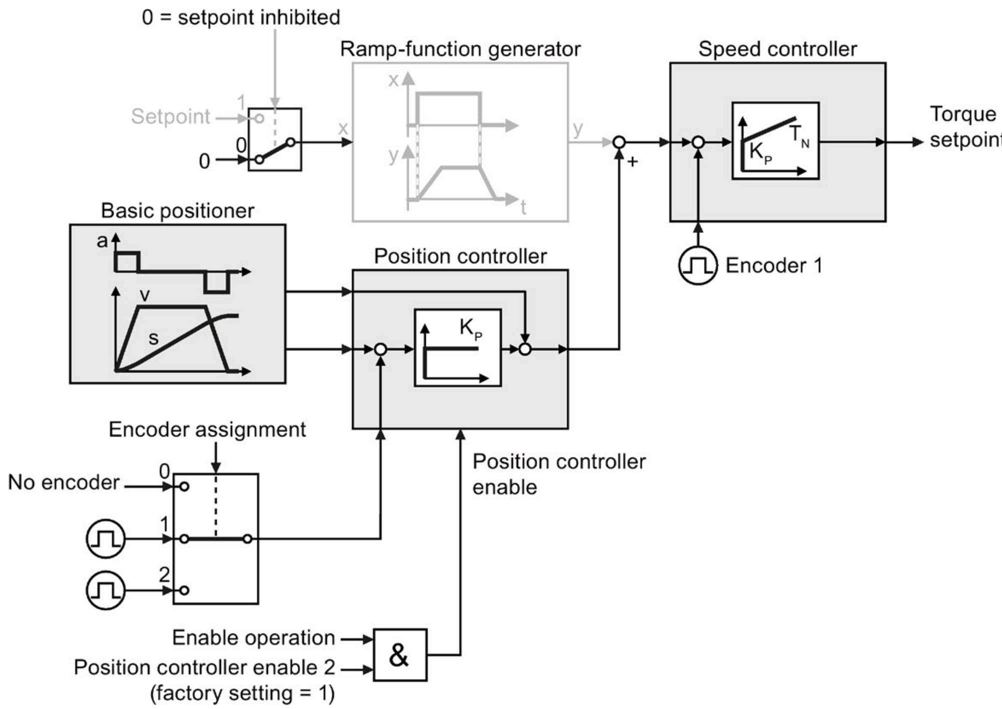


Figure 6-41 Setpoint input for the speed controller in the factory setting of the converter

Operating the converter without position controller

If you want to always operate the converter without the position control, you must inhibit the position controller and enable another source for the setpoint.

Procedure:

- Inhibit the position controller.
  Set parameter p2550 = 0, e.g. using the STARTER "Position controller" screen.
- Enable the setpoint.
  Set parameter p1142 = 1, e.g. using the STARTER "Ramp-function generator" screen.
- Delete the encoder assignment of the position controller.
  Set parameter p2502 = 0, e.g. using the expert list in STARTER.
- If disturbing alarms occur in operation, which refer to the encoder, then you can suppress these.

  Alarms, faults and system messages (Page 299)

Table 6- 40 Parameters to changeover from position controller to speed controller

Parameter	Meaning
p1142	**Enable setpoint/inhibit setpoint** (factory setting: 0)
p2502	**Encoder assignment** (factory setting: 1)
p2550	**Position controller enable 2** (factory setting: 1)

6.14 Electrically braking the motor

Braking with the motor in generating mode

If the motor brakes the connected load electrically, it will convert the kinetic energy of the motor to electrical energy. The electrical energy E released on 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 pass the energy on to the inverter.

6.14.1 DC braking

DC braking is used for applications where the motor must be actively stopped; however, neither an inverter capable of energy recovery nor a braking resistor is available.

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.

Function

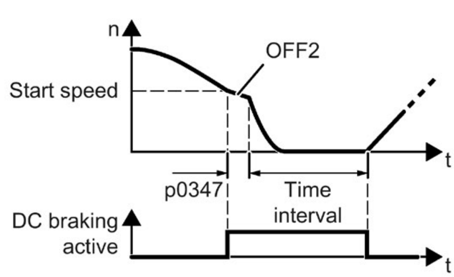
NOTICE
Motor overheating as a result of DC braking
The motor will overheat if you use DC braking too frequently or use it for too long. This may damage the motor. • Monitor the motor temperature. • Allow the motor to adequately cool down between braking operations. • If necessary, select another motor braking method.

With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

The DC-braking function is possible only for induction motors.

4 different events initiate DC braking

DC braking when falling below a starting speed



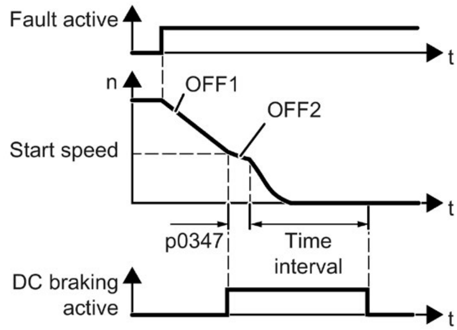
Requirement:

p1230 = 1 and p1231 = 14

Function:

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

DC braking when a fault occurs



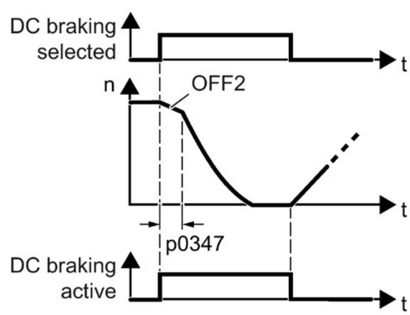
Requirement:

Fault number and fault response are assigned via p2100 and p2101.

Function:

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

DC braking initiated by a control command



Requirement:

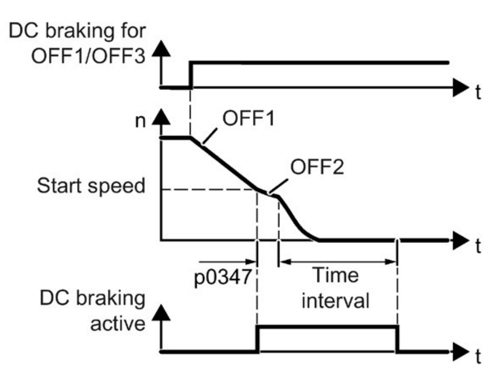
p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)

Function:

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

DC braking when the motor is switched off



Requirement:

p1231 = 5 or p1230 = 1 and p1231 = 14

Function:

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

Settings for DC braking

Parameter	Description
p0347	**Motor de-excitation time** (calculated after quick commissioning) The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.
p1230	**DC braking activation** (factory setting: 0) Signal source to activate DC braking • 0 signal: Deactivated • 1 signal: Active
p1231	**Configuring DC braking** (factory setting: 0) 0 — No DC braking 4 — General release for DC braking 5 — DC braking for OFF1/OFF3 14 — DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)
p1233	**DC braking duration** (factory setting 1 s)
p1234	**DC braking start speed** (factory setting 210000 rpm)
r1239	**DC braking status word** .08 — DC braking active .10 — DC braking ready .11 — DC braking selected .12 — DC braking selection internally locked .13 — DC braking for OFF1/OFF3

Table 6- 41 Configuring DC braking as a response to faults

Parameter	Description
p2100	**Set fault number for fault response** (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	**Fault response setting** (factory setting 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response. The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. Entry "DCBRK" means that you may set DC braking as response for this fault.	

6.14.2 Braking with regenerative feedback to the line

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 inverter 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 352)

Setting the braking with regenerative feedback to the line

Parameter	Description
Limiting the regenerative feedback for V/f control (p1300 < 20)	
p0640	**Motor series overload factor** (factory setting: 0.00 A, default for quick commissioning) It is only possible to limit the regenerative power with V/f control by limiting the motor current. If the current exceeds this value for longer than 10 s, the inverter shuts down the motor with fault F07806.
Limiting feedback with vector control (p1300 ≥ 20)	
p1531	**Power limit generative** (factory setting: -0.01 kW) The inverter calculates the parameter based on the quick commissioning or with p0340 = 5.

6.15 Overcurrent protection

The vector control ensures that the motor current remains within the set torque limits.

If you use U/f control, you cannot set any torque limits. The U/f control prevents too high a motor current by influencing the output frequency and the motor voltage (I-max controller).

I_max controller

Requirements

The torque of the motor must decrease at lower speeds, which is the case, for example, with fans.

The load must not drive the motor continuously, e.g. when lowering hoisting gear.

Function

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 load of the motor is so large during stationary operation that the motor current reaches the current limit, the I-max controller reduces the speed and the motor voltage until the motor current is in the permissible range again.

If the motor current reaches the current limit during deceleration, the I-max controller extends the deceleration operation.

Settings

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

Table 6- 42 I-max controller parameters

Parameter	Description
p0305	**Rated motor current**
p0640	**Motor current limit**
p1340	**Proportional gain of the I-max controller for speed reduction**
p1341	**Integral time of the I-max controller for speed reduction**
r0056.13	**Status: I-max controller active**
r1343	**Speed output of the I-max controller** Shows the amount to which the I-max controller reduces the speed.

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

6.16 Inverter protection using temperature monitoring

The inverter 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 inverter 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)

Inverter response to thermal overload

Parameter	Description
r0036	**Power unit overload I^2t** [%] The I^2t monitoring calculates the inverter utilization based on a current reference value defined in the factory. • Actual current > reference value: r0036 becomes higher. • Actual current < reference value: r0036 becomes lower or remains = 0.
r0037	**Power unit temperatures** [°C]
p0290	**Power unit overload response** Factory setting and the ability to be changed depends on the hardware. The dependency is described in the List Manual. A thermal overload is present if the inverter temperature is greater than that specified in p0292. You define how the inverter responds if there is a risk of thermal overload using this parameter. The details are described below.
p0292	**Power unit temperature warning threshold** (factory setting: Heat sink [0] 5 °C, power semiconductor [1] 15 °C) The value is set as a difference to the shutdown temperature.
p0294	**Power unit warning at I2t overload** (factory setting: 95 %)

Overload response for p0290 = 0

The inverter responds depending on the control mode that has been set:

- In vector control, the inverter reduces the output current.
- In U/f control, the inverter reduces the speed.

Once the overload condition has been removed, the inverter re-enables the output current or speed.

If the measure cannot prevent an inverter thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 1

The inverter 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 inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter 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 p1800.

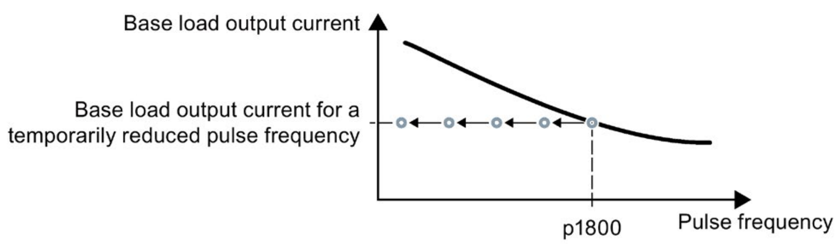
   

   Figure 6-42 Derating characteristic and base load output current for overload

   Once the overload condition has been removed, the inverter 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 inverter reduces its output current.

   – In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 3

If you operate the inverter with increased pulse frequency, then the inverter 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 inverter 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 inverter switches off the motor with fault F30024.

Overload response for p0290 = 12

The inverter responds in two stages:

1. If you operate the inverter with increased pulse frequency setpoint p1800, then the inverter 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 inverter 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 inverter thermal overload cannot be prevented, then stage 2 follows:
   – In vector control, the inverter reduces the output current.
   – In U/f control, the inverter reduces the speed.

   Once the overload condition has been removed, the inverter re-enables the output current or speed.

If both measures cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

Overload response for p0290 = 13

We recommend this setting for drives with high starting torque, e.g. horizontal conveyors or extruders.

If you operate the inverter with increased pulse frequency, then the inverter 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 inverter increases the pulse frequency back to the pulse frequency setpoint p1800.

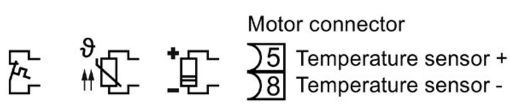
If it is not possible to temporarily reduce the pulse frequency, or the measure cannot prevent a power unit thermal overload, then the inverter switches off the motor with fault F30024.

6.17 Motor temperature monitoring using a temperature sensor

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

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

Connect the motor's temperature sensor through the motor output cable on the Power Module.



⚠ WARNING

Electrical shock from temperature sensor connectors

The temperature sensor are at dangerous 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

Device damage by earthing the motor cable

The temperature sensor are at negative potential. Earthing these connections will damage the device.

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

Temperature switch

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

PTC sensor

The inverter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for 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 inverter responds with alarm A07015.

If the alarm lasts more than 100 ms, the inverter responds with fault F07016.

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

KTY84 sensor

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

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

- Temperature monitoring:
  The inverter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The inverter 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 inverter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the inverter responds with fault F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and responds with alarm A07015. After 100 milliseconds, the inverter responds with fault F07016.

PT1000 sensor

Using a PT1000 sensor, the inverter monitors the motor temperature and the sensor itself for wire-break or short-circuit:

- Temperature monitoring:
  The inverter uses a PT1000 sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The inverter 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 inverter interprets a resistance > 2120 Ω as a wire-break and responds with the alarm A07015. After 100 milliseconds, the inverter responds with fault F07016.
  - Short-circuit:
    The inverter interprets a resistance < 603 Ω as a short-circuit and responds with alarm A07015. After 100 milliseconds, the inverter responds with a fault.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Motor-cooling method** (factory setting: 0) 0: Natural cooling - with fan on the motor shaft 1: Forced ventilation - with a separately driven fan 2: Liquid cooling 128: No fan
p0601	**Motor temperature sensor type** 0: No sensor (factory setting) 1: PTC 2: KTY84 4: Temperature switch 6: PT1000
p0604	**Mot_temp_mod 2 / sensor alarm threshold** (factory setting 130° C) For monitoring the motor temperature with KTY84/PT1000.
p0605	**Mot_temp_mod 1/2 / sensor threshold and temperature value** (factory setting: 145° C) For monitoring the motor temperature with KTY84/PT1000.

Parameter	Description	
p0610	**Motor overtemperature response** (factory setting: 12) Determines the inverter behavior when the motor temperature reaches the alarm threshold p0604. 0: Alarm A07910, no fault. 1: Alarm A07910 and fault F07011. The inverter reduces its current limit. 2: Alarm A07910 and fault F07011. 12: Alarm A07910 and fault F07011. For use of the thermal motor model in parallel to the temperature sensor: After switching off the supply voltage, the inverter 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.	
p0640	**Current limit** [A]	
p4621	**Motor temperature sensor configuration**	
	.00	0 signal: Enable PTC short-circuit monitoring 1 signal: Disable PTC short-circuit monitoring

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

6.18 Motor protection by calculating the temperature

The inverter calculates the motor temperature based on a thermal motor model.

The thermal motor model responds far faster to temperature increases than a temperature sensor.

If you are using the thermal motor model together with a temperature sensor, e.g. a Pt1000, then the inverter corrects the model based on the measured temperature.

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.

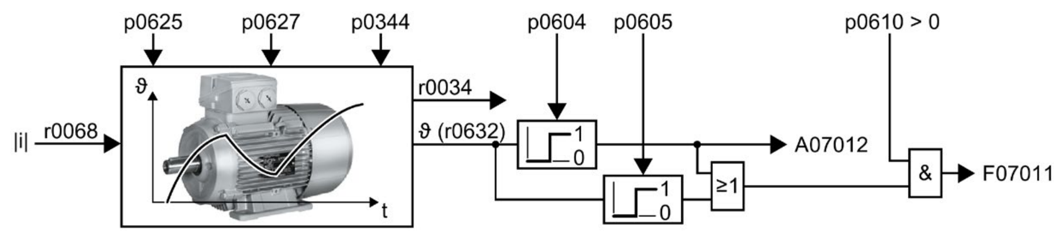


Figure 6-43 Thermal motor model 2 for induction motors

Table 6- 43 Thermal motor model 2 for induction motors

Parameter	Description	
r0068	**CO: Absolute actual current value**	
p0610	**Motor overtemperature response** (factory setting: 12)	
	0:	Alarm A07012 The inverter does not reduce the current limit.
	1:	Alarm A07012 and fault F07011 The inverter reduces the current limit.
	2:	Alarm A07012 and fault F07011 The inverter does not reduce the current limit.
	12:	Alarm A07012 and fault F07011 The inverter does not reduce the current limit. After switching off the supply voltage, the inverter 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.

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td>p0344</td><td colspan="2">Motor weight (for thermal motor type) (factory setting: 0.0 kg)</td><td rowspan="7">After selecting an induction motor (p0300) or a listed induction motor (p0301) during the commissioning, the inverter sets the parameters to values appropriate for the motor.
The parameters are write-protected for listed motors (p0301 ≥ 0).</td></tr>
<tr><td>p0604</td><td colspan="2">Mot_temp_mod 2/KTY alarm threshold (factory setting: 130.0° C)
Motor temperature > p0604 ⇒ fault F07011.</td></tr>
<tr><td>p0605</td><td colspan="2">Mot_temp_mod 1/2 threshold (factory setting: 145.0° C)
Motor temperature > p0605 ⇒ alarm A07012.</td></tr>
<tr><td rowspan="3">p0612</td><td colspan="2">Mot_temp_mod activation</td></tr>
<tr><td>.01</td><td>1 signal: Activate motor temperature model 2 for induction motors</td></tr>
<tr><td>.09</td><td>1 signal: Activate motor temperature model 2 expansions
The inverter sets bit 09 = 1 after commissioning. If you load the parameter settings for firmware version ≤ V4.6 into the inverter, bit 09 = 0 remains.</td></tr>
<tr><td>p0627</td><td colspan="2">Motor overtemperature, stator winding (factory setting: 80 K)</td></tr>
<tr><td>p0625</td><td colspan="3">Motor ambient temperature during commissioning (factory setting: 20° C)
Specification of the motor ambient temperature in °C at the instant of the motor data identification.</td></tr>
<tr><td>r0632</td><td colspan="3">Mot_temp_mod stator winding temperature [°C]</td></tr>
<tr><td>p0640</td><td colspan="3">Current limit [A]</td></tr>
</table>

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

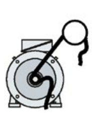
6.19 Monitoring the driven load

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 inverter 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.

6.19.1 No-load monitoring



In applications with fans, compressors or conveyor belts, an insufficient motor current indicates that the power transmission from the motor to the load is interrupted.

If the motor current for the time p2180 lies below the current level p2179, the inverter signals "output load not available" and alarm A07929.

Parameters	Description
r0068	**Actual current value** [A] [0] = Unsmoothed [1] = Smoothed with p0045
p2179	**Output load detection current limit** (Factory setting: 0 A) p2179 = 0: No load detection deactivated
p2180	**Output load detection delay time** (factory setting: 2000 ms)
r2197	**Status word, monitoring functions 1** r2197.11 = 1: Output load not available

6.19.2 Load monitoring

The load monitoring comprises the following components:

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

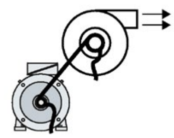
If the load monitoring detects load failure, the inverter issues fault F07936. For a torque and speed deviation, as response, you can either set an alarm or a fault. Details are provided in the following descriptions.

Settings

Table 6- 44 Setting options for load monitoring

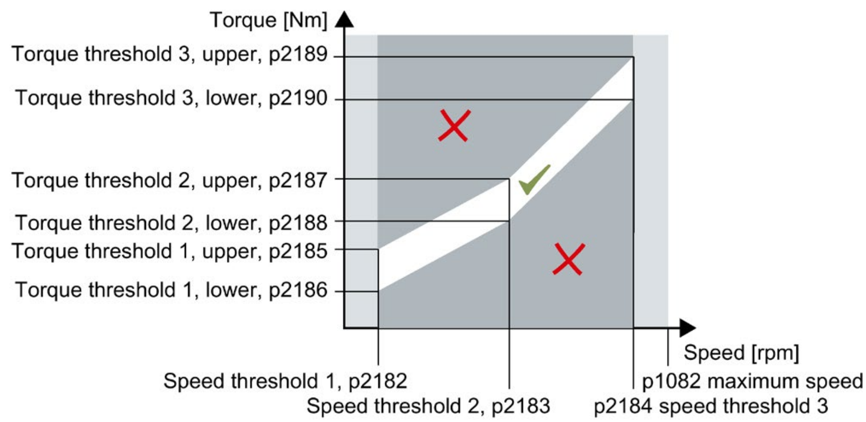
Parameters	Description
p2193	**Load monitoring configuration** (factory setting: 1) 0: Monitoring deactivated 1: Torque and load failure monitoring 2: Speed and load failure monitoring 3: Load failure monitoring

6.19.3 Torque monitoring



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 inverter 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 inverter reacts as specified in p2181.

The monitoring is not active below speed threshold 1 and above speed threshold 3.

Parameters	Description	
p2181	**Load monitoring response** 1: A07920 for torque too low 2: A07921 for torque too high 3: A07922 for torque outside tolerance 4: F07923 for torque too low 5: F07924 for torque too high 6: F07925 for torque outside tolerance	
p2182	**Load monitoring speed threshold 1**	The inverter interpolates linearly between characteristic points.
p2183	**Load monitoring speed threshold 2**	
p2184	**Load monitoring speed threshold 3**	
p2185	**Load monitoring torque threshold 1, upper**	
p2186	**Load monitoring torque threshold 1, lower**	
p2187	**Load monitoring torque threshold 2, upper**	
p2188	**Load monitoring torque threshold 2, lower**	
p2189	**Load monitoring torque threshold 3, upper**	
p2190	**Load monitoring torque threshold 3, lower**	
p2192	**Load monitoring delay time** Delay time for the message "Leave torque monitoring tolerance band"	
p2193 = 1	**Load monitoring configuration** (factory setting: 1) 1: Monitoring torque and load drop	

6.19.4 Rotation monitoring

The inverter 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 inverter checks whether the encoder consistently supplies a 24 V signal during motor operation. If the encoder signal fails for time p2192, the inverter signals fault F07936.

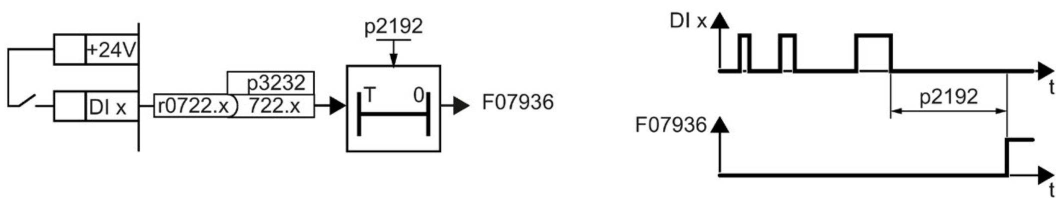


Figure 6-44 Function plan and time response of the speed monitoring

Parameter	Description
p2192	**Load monitoring delay time** (factory setting 10 s) After the motor is switched on, if the "LOW" signal is present at the associated digital input for longer than this time, the inverter signals a load failure (F07936).
p2193 = 3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring switched off 1: Monitoring torque and load drop 2: Monitoring speed and load drop 3: Load failure monitoring
p3232	**Load monitoring failure detection** (factory setting: 1) Connect the load monitoring to a DI x digital input of your choice. p3232 = 722.x

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

6.19.5 Speed deviation monitoring

The inverter 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 require an electronic encoder for the "Speed monitoring" function, e.g. a proximity switch. The inverter 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 inverter.

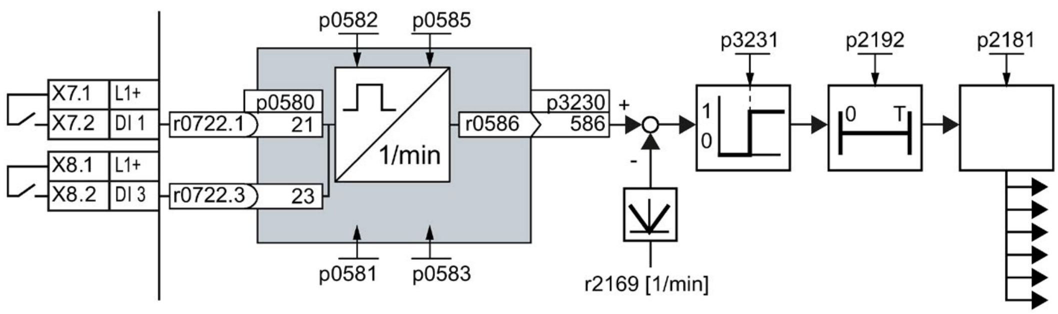


Figure 6-45 Speed deviation monitoring

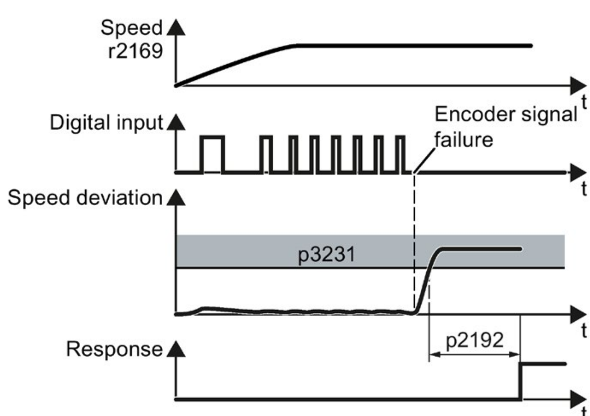


Figure 6-46 Time response of the speed monitoring

The inverter 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 inverter response for an excessive deviation.

Parameter	Description
p0490	**Probe** [1] **invert** (factory setting 0000bin) The 3rd bit of the parameter value inverts the input signal of digital input 3 for the probe.
p0580	**Probe** [1] **Input terminal** (factory setting 0) Connect input of probe with a digital input.
p0581	**Probe** [1] **Edge** (factory setting 0) Edge for analyzing the probe signal for measuring the actual speed value 0: 0/1 edge 1: 1/0 edge
p0582	**Probe** [1] **Pulse per revolution** (factory setting 1) Number of pulses per revolution
p0583	**Probe** [1] **Maximum measurement time** (factory setting 10 s) Maximum measurement time for the probe If there is no new pulse before the maximum measuring time elapses, the inverter sets the actual speed value in r0586 to zero. The time is restarted with the next pulse.
p0585	**Probe** [1] **Gear ratio** (factory setting 1) The inverter multiplies the measured speed by the gear ratio before displaying it in r0586.
r0586	**Probe** [1] **Actual speed value** Result of the speed calculation
p2181	**Load monitoring response** 1: A07920 for torque too low 2: A07921 for torque too high 3: A07922 for torque outside tolerance 4: F07923 for torque too low 5: F07924 for torque too high 6: F07925 for torque outside tolerance
p2192	**Load monitoring delay time** (factory setting 10 s) Delay time for evaluating load monitoring.
p2193 = 2	**Load monitoring configuration** (factory setting: 1) 0: Monitoring switched off 1: Monitoring torque and load drop 2: Monitoring speed and load drop 3: Load failure monitoring
p3230 = 586	**Load monitoring actual speed value** (factory setting 0) Result of the speed calculation with the evaluation of the speed monitoring.
p3231	**Load monitoring speed deviation** (factory setting 150 rpm) Permissible speed deviation of load monitoring.

[1] The "Probe" subfunction calculates the speed from the pulse signal of the digital input.

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

Table 6- 45 Response options for load monitoring

p2181 = 0	Load monitoring deactivated (factory setting)
p2181 = 1	A07920 for torque/speed too low
p2181 = 2	A07921 for torque/speed too high
p2181 = 3	A07922 for torque/speed out of tolerance
p2181 = 4	F07923 for torque/speed too low
p2181 = 5	F07924 for torque/speed too high
p2181 = 6	F07925 for torque/speed out of tolerance

6.20 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 inverter closed-loop motor control prevents the motor from stalling.

Precondition

Efficiency optimization functions under the following preconditions:

- Operation with an induction motor
- Vector control is set in the inverter.

Function description

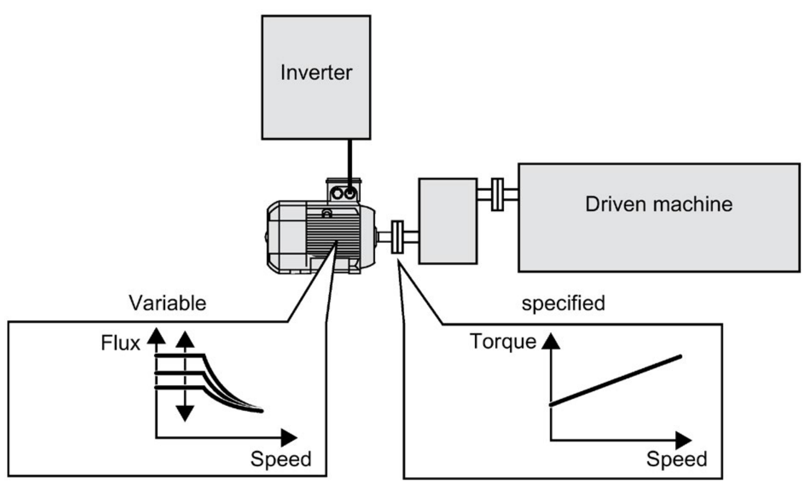


Figure 6-47 Efficiency optimization by changing the motor flux

The three variables that the inverter 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 inverter 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.

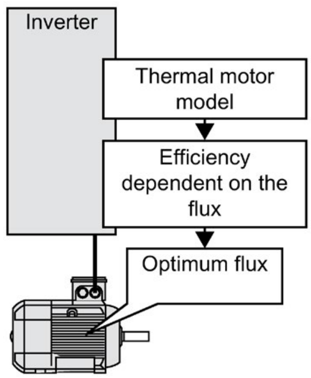


Figure 6-48 Determining the optimum flux from the motor thermal model

Based on its thermal motor model, the inverter continually determines - for the actual operating point of the motor - the interdependency between efficiency and flux. The inverter then sets the flux to achieve the optimum efficiency.

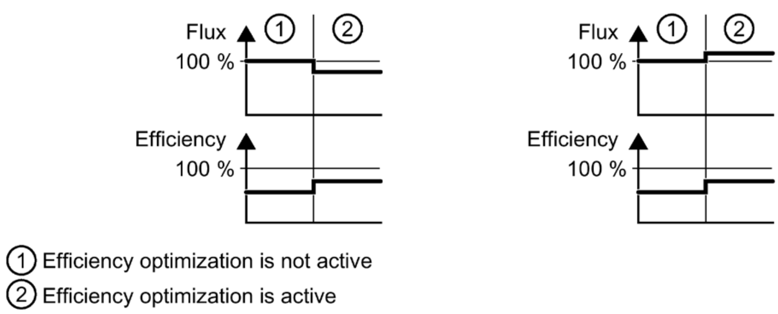


Figure 6-49 Qualitative result of efficiency optimization, method 2

Depending on the motor operating point, the inverter either decreases or increases the flux in partial load operation of the motor.

Efficiency optimization, method 1

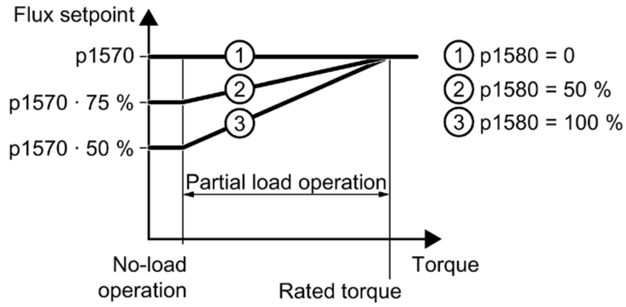


Figure 6-50 Reduce the flux setpoint in the partial load range of the motor

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 inverter reduces the flux setpoint linearly with the torque.

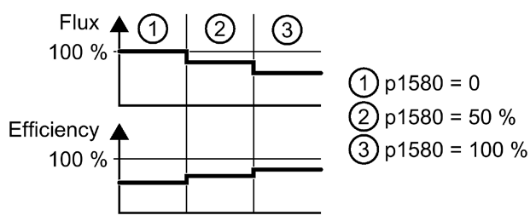


Figure 6-51 Qualitative result of efficiency optimization, method 1

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

Parameter

The inverter calculates the parameters for the thermal motor model based on the motor data that has been set – and the motor data identification.

Table 6- 46 Efficiency optimization, method 2

Parameter	Description	Setting
p1401.14	Flux control configuration	1 signal: Efficiency optimization 2 active Factory setting: 0
p1570	Flux setpoint [%]	Factory setting: 100 %
p3315	Efficiency optimization 2 flux minimum limit value [%]	Minimum limit value for the calculated optimal flux Factory setting: 50 %
p3316	Efficiency optimization 2 maximum flux limit value [%]	Maximum limit value for the calculated optimal flux Factory setting: 110 %

Table 6- 47 Efficiency optimization, method 1

Parameter	Description	Setting
p1570	Flux setpoint [%]	Factory setting: 100 %
p1580	Efficiency optimization [%]	0 %: Efficiency optimization is deactivated. 100 %: In no-load operation, the inverter reduces the flux setpoint to 50% of the rated motor flux. The factory setting depends on the inverter.

6.21 Switchover between different settings

There are applications that require different inverter settings.

Example:

You connect different motors to one inverter. Depending on the particular motor, the inverter must operate with the associated motor data and the appropriate ramp-function generator.

Drive data sets (DDS)

Your can set several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0, 1, 2, or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the inverter with the same index are called the drive data set.

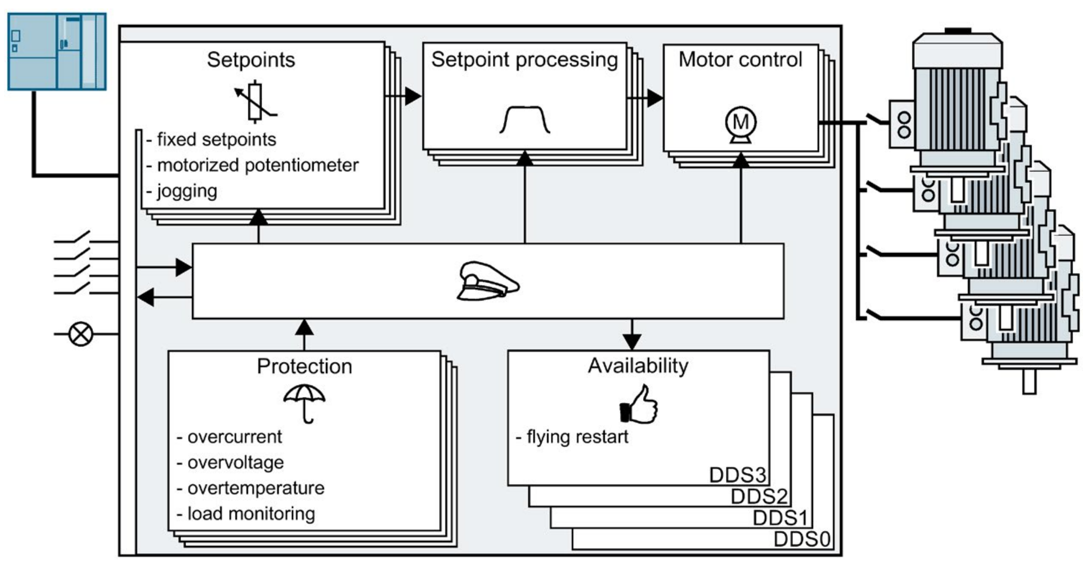


Figure 6-52 Switching over between different settings using drive data sets (DDS)

Using parameter p0180 you can define the number of drive data sets (1 ... 4).

Table 6- 48 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0180	**Drive data sets (DDS) number**(factory setting: 1)
p0010 = 0	**Drive commissioning:** Ready

Table 6- 49 Parameters for switching the drive data sets:

Parameter	Description	
p0820[0…n]	**Drive data set selection DDS bit 0**	If you use several command data sets CDS, then you must set this parameter for each CDS. The parameters are assigned to a CDS through their index: CDS0: p0820[0], p0821[0] CDS1: p0820[1], p0821[1] …
p0821[0…n]	**Drive data set selection DDS bit 1**	
p0826	**Motor changeover, motor number** Each drive data set is assigned a motor number: p0826[0] = motor number for drive data set 0. … p0826[3] = motor number for drive data set 3. If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation. If you operate different motors on one inverter, then you must number the motors in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.	
r0051	**Displaying the number of the DDS that is currently effective**	

For an overview of all the parameters that belong to the drive data sets and can be switched, see the List Manual.

Table 6- 50 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	**Source drive data set**
p0819[1]	**Target drive data set**
p0819[2] = 1	**Start copy operation**

For more information, see the List Manual (the parameter list and function diagram 8565).

Backing up data and series commissioning 7

Saving settings outside the inverter

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

We recommend that you additionally back up the settings on a storage medium outside the inverter. Without backup, your settings could be lost if the inverter develops a defect.

Replacing the Control Unit without data backup (Page 333)

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

Note

Data backup using Operator Panels with USB connection with the PG/PC is not possible

If the inverter is connected with a PG/PC via a USB cable, you cannot backup data to a memory card via an operator panel.

- Disconnect the USB connection between the PG/PC and inverter before you backup data to the memory card via an operator panel.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Precondition

The Control Unit to which the settings are transferred has the same article number and the same or a higher firmware version as the source Control Unit.

Overview of the procedure

1. Commission the first inverter.
2. Back up the settings of the first inverter to an external storage medium.
3. Transfer the settings from the first inverter to an additional inverter via the data storage medium.

7.1 Saving settings on a memory card

7.1.1 Memory cards

Recommended memory cards

Table 7- 1 Memory cards to back up inverter 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

Using memory cards from other manufacturers

The inverter 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 other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 16 or FAT 32
  - 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

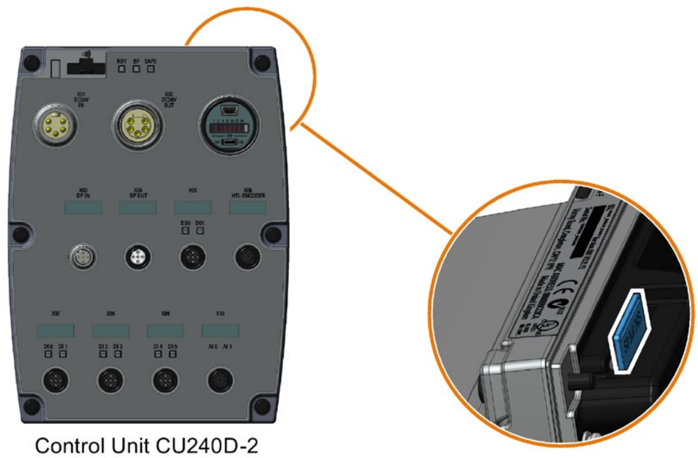
The following functions are either not possible – or only with some restrictions – when using memory cards from other manufacturers:

- Licensing functions is only possible using the recommended memory cards.
- Know-how protection is only possible with one of the recommended memory cards.
- Under certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the inverter.

7.1.2 Saving settings to the memory card

We recommend that you insert the memory card before switching on the converter for the first time. If a memory card is inserted, the converter saves every modified parameter value on the card.

The memory card reader is located at the rear of the Control Unit. You have to insert the card before the Control Unit is fitted to the Power Module.



Control Unit CU240D-2

Figure 7-1 Memory card in Control Unit

Upload

Procedure

1. Switch off the converter power supply.
2. Remove the Control Unit from the Power Module.
3. Insert an empty memory card into the Control Unit.

Note

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

---

4. Fit the Control Unit to the Power Module - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the converter.
5. Connect the external 24 V supply to the Control Unit.

After the Control Unit has been powered-up, the converter copies all modified parameters to the memory card.
❒

7.1.3 Transferring the settings from the memory card

Download

Procedure

1. Switch off the converter power supply.
2. Remove the Control Unit from the Power Module
3. Insert the memory card containing parameter settings into the Control Unit.
4. Fit the Control Unit to the Power Module - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
5. Connect the external 24 V supply to the Control Unit.

If the parameter data on the memory card is valid, then the inverter automatically downloads the parameter data to it's internal memory.
❒

7.1.4 Safely remove the memory card

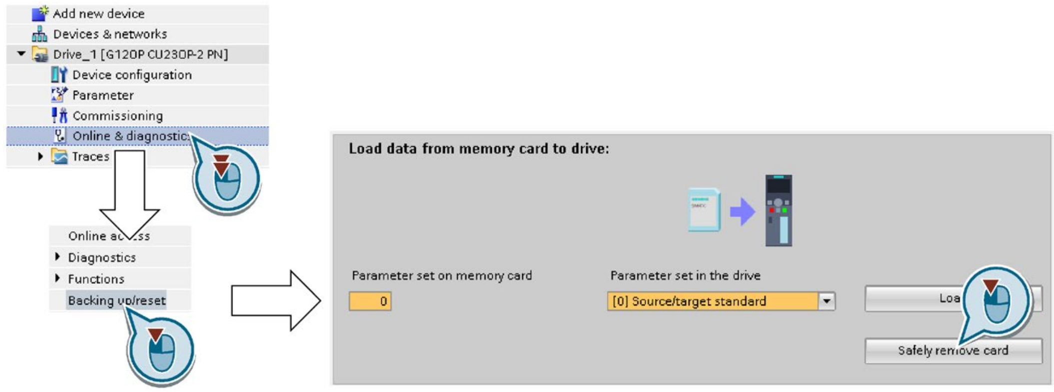
NOTICE
Data loss from improper handling of the memory card
If you remove the memory card when the converter is switched on without implementing the "safe removal" function you may destroy the file system on the memory card. The data on the memory card are lost. The memory card will only function again after formatting. • Only remove the memory card using the "safe removal" function.

To remove the memory card safely from the control unit, proceed as follows using the IOP:

1. Set P9400 to 2.
2. Check the value of parameter P9400.
3. If P9400 = 3, you can safely remove the memory card.
4. Remove the Control Unit from the Power Module.
5. Remove the memory card.
6. Reattach the Control Unit to the Power Module.

You have now safely removed the memory card from the Control Unit.

Procedure with Startdrive



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 inverter.

You have now safely removed the memory card from the inverter.
❒

7.1.5 Activate message for a memory card that is not inserted

Function

The inverter identifies that a memory card is not inserted, and signals this state. The message is deactivated in the inverter 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 a higher-level control that a memory card is not inserted, interconnect parameter r9401 to the send data of a PROFIdrive telegram of your choice.

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

<table>
<tr><th>Parameter</th><th colspan="2">Explanation</th></tr>
<tr><td>p2118[0 … 19]</td><td colspan="2">Change message type message number (factory setting: 0)</td></tr>
<tr><td>p2119[0 … 19]</td><td colspan="2">Change message type (factory setting: 0)
1: Fault
2: Alarm
3: No message</td></tr>
<tr><td rowspan="5">r9401</td><td colspan="2">Safely remove memory card status</td></tr>
<tr><td>.00</td><td>1 signal: Memory card inserted</td></tr>
<tr><td>.01</td><td>1 signal: Memory card activated</td></tr>
<tr><td>.02</td><td>1 signal: SIEMENS memory card</td></tr>
<tr><td>.03</td><td>1 signal: Memory card used as USB data storage medium from the PC</td></tr>
</table>

7.2 Backup the settings to a PC

With the supply voltage switched on, you can transfer the converter settings from the converter to a PG/PC, or the data from a PG/PC to the converter.

The precondition is that you have a commissioning tool on your PG/PC.

Commissioning tools (Page 73)

Inverter → PC/PG

Procedure with Startdrive

1. Go online.
2. Select "Online" > "Upload device to PG/PC."
3. Back up the project with "Project" > "Save."
4. Wait until Startdrive reports that data backup has been completed.
5. Go offline.

You have backed up the settings with Startdrive.
❒

PC/PG → inverter

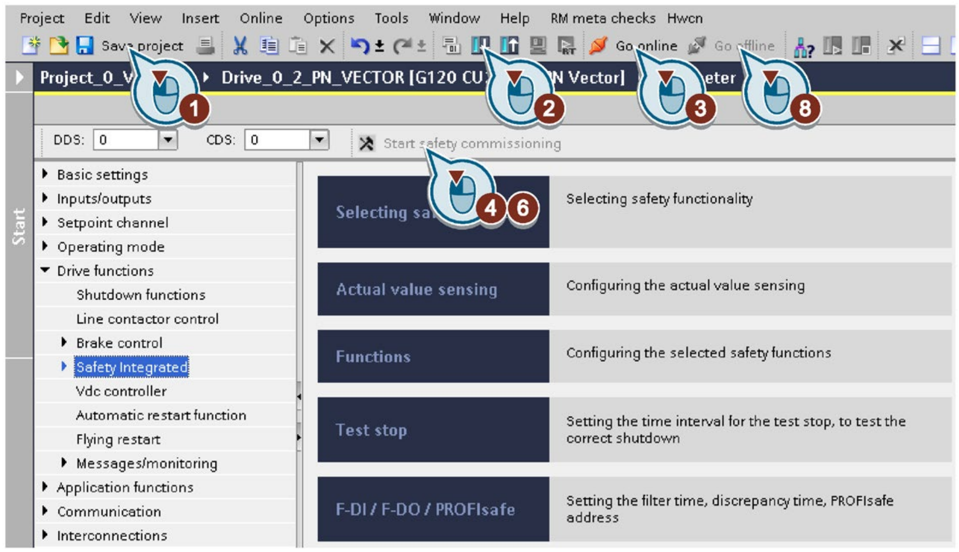
The procedure depends on whether you also transfer settings of safety functions or not.

Procedure with Startdrive without enabled safety functions

1. Go online.
2. Select "Load to device" > "Hardware and software" from the shortcut menu.
3. Wait until Startdrive reports that loading has been completed.
4. Go offline.
5. Confirm the dialog box that then opens by clicking "Yes" to save the data to the non-volatile memory of the inverter (Copy from RAM to ROM).

You have transferred the settings from the PG to the inverter with Startdrive.
❒

Procedure with Startdrive when the safety functions are enabled



1. Save the project.
2. Select "Load to device".
3. Connect Startdrive online with the drive.
4. Press the "Start safety commissioning" button.
5. Enter the password for the safety functions.

   If the password is the factory default, you are prompted to change the password.
   If you try to set a password that is not permissible, the old password will not be changed.
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 inverter power supply.
10. Wait until all LEDs on the inverter go dark (no voltage condition).
11. Switch on the inverter power supply again.

You have transferred the settings from the PG to the inverter with Startdrive and have activated the safety functions.
❒

7.3 Saving settings and transferring them using an operator panel

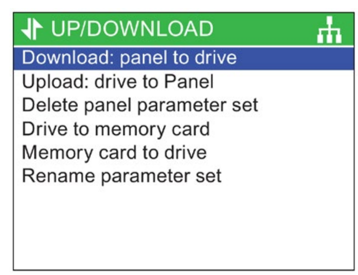
Requirement

When the power supply is switched on, you can transfer the inverter settings to the IOP or vice versa, transfer the IOP data to the inverter.

Inverter → IOP-2

Procedure

1. Connect the operator panel to the inverter.
2. Start data transfer in the menu "UP/DOWNLOAD" - "Drive to panel".

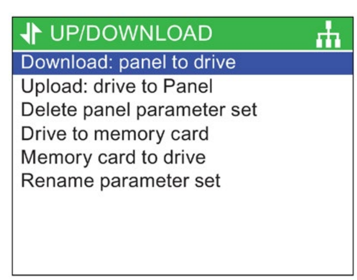


You have backed up the settings to the IOP-2.
❒

IOP-2 → Inverter

Procedure

1. Connect the operator panel to the inverter.
2. Start data transfer in the menu "UP/DOWNLOAD" - "Panel to drive".
3. Switch off the inverter power supply.
4. Wait until all LEDs on the inverter are dark. Now switch on the inverter power supply again. Your settings only become effective after this power-on reset.



You have transferred the settings to the inverter.
❒

7.4 Other ways to back up settings

In addition to the default setting, the inverter 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.

Additional information is available on the Internet: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

7.5 Write protection

The write protection prevents unauthorized changing of the inverter settings. If you are working with a PC tool, such as STARTER, then write protection is only effective online. The offline project is not write-protected.

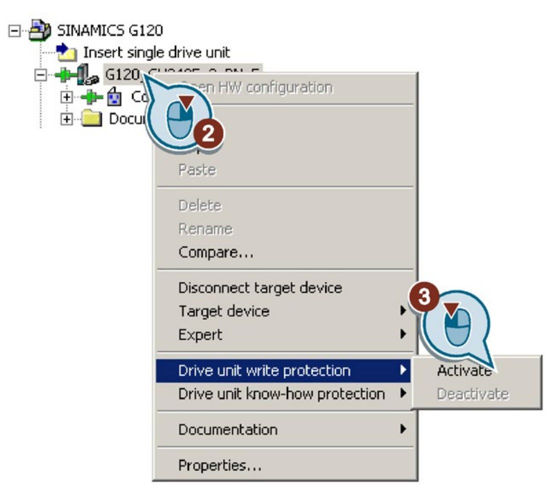
Write protection is applicable for all user interfaces:

- Operator Panel BOP-2 and IOP-2
- STARTER or Startdrive PC tool
- Parameter changes via fieldbus

No password is required for write protection.

Activate and deactivate write protection

Procedure with STARTER



1. Go online.
2. Open the shortcut menu of the required inverter.
3. Activate or deactivate write protection.
4. Press the "Copy RAM to ROM" button to retentively save the settings .

You have activated or deactivated write protection.
❒

Active write protection can be identified as in the expert list the input fields of adjustable parameters p … are shaded gray.

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

Exceptions to write protection

Some functions are excluded from write protection, e.g.:

- Activating/deactivating write protection
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Restoring the factory setting
- Transfer the settings from an external data backup, e.g. upload into the inverter from a memory card.

The parameters that are not write protected are in the List Manual in Section "Parameters for write protection and know-how protection".

7.6 Know-how protection

Overview

Know-how protection prevents unauthorized reading of the inverter settings.

To protect your inverter settings against unauthorized copying, in addition to know-how protection, you can also activate copy protection.

Precondition

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 inverter can be operated with or without memory card.	
Know-how protection with basic copy protection		The inverter can only be operated with a SIEMENS memory card Memory cards (Page 282)
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. In STARTER, instead of the parameter values, the text "Know-how protection" is displayed.
  - Several adjustable parameters can be read and changed when know-how protection is active. You can find a list of the adjustable parameters that can be read and changed in the List Manual under "KHP_WRITE_NO_LOCK".

    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. You can find a list of the adjustable parameters that can be read in the List Manual under "KHP_ACTIVE_READ".

  You can hide know-how protected parameters in the expert list of STARTER using the "Without know-how protection" display filter.
- The values of monitoring parameters r … remain visible.
- STARTER does not display any screen forms.
- Adjustable parameters cannot be changed using commissioning tools, e.g. an operator panel or Startdrive.

- Locked functions:
  - Downloading inverter settings using STARTER or Startdrive
  - 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 the inverter via the control panel in STARTER or Startdrive
  - Uploading adjustable parameters that can be changed or read when know-how protection is active.
  - Displaying acceptance documents for safety functions
  - Depending on the know-how protection settings, the trace function in STARTER can also be active when know-how protection is active.

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 inverter settings to other inverters using a memory card, an operator panel, STARTER or Startdrive.

Know-how protection with basic copy protection

After replacing an inverter, to be able to operate the new inverter with the settings of the replaced inverter without knowing the password, the memory card must be inserted in the new inverter.

Know-how protection with extended copy protection

It is not possible to insert and use the memory card in another inverter without knowing the password.

Commissioning know-how protection

1. Check as to whether you must extend the exception list.

   List of exceptions (Page 297)

2. Activate the know-how protection.

   Know-how protection (Page 294)

7.6.1 Activating and deactivating know-how protection

Activating know-how protection

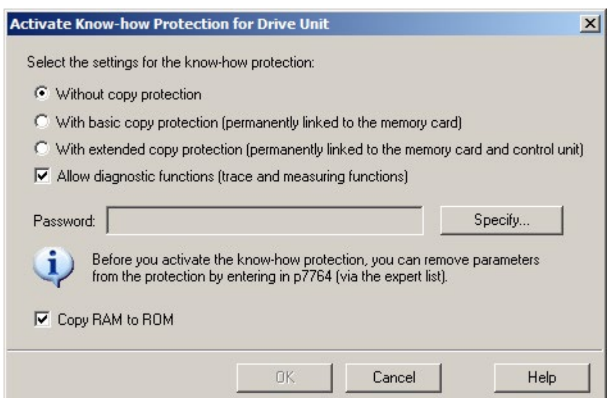
Preconditions

- The inverter 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.

Procedure with STARTER

1. Go online with STARTER.

   If you have generated a project offline on your computer, you must load the project into the inverter and go online.
2. Select the required inverter in the project.
3. In the shortcut menu, select "Know-how protection drive unit/activating ....".

4. The "Without copy protection" option is active by default. If an appropriate memory card is inserted in the Control Unit, you can select one of two copy protection options:
   – With basic copy protection (permanently linked to the memory card)
   – With extended copy protection (permanently linked to the memory card and Control Unit)

   Select the required copy protection option.
5. If, in spite of active know-how protection, you wish to permit diagnostic functions, activate option "Allow diagnostic functions (trace and measuring functions)".
6. Click on "Define"

7. Enter your password. Length of the password: 1 … 30 characters.

   Recommendation for assigning a password:

   – Only use characters from the ASCII set of characters.

     If you use arbitrary characters for the password, changing the windows language settings after activating know-how protection can result in problems when subsequently checking a password.

   – For an adequately secure password, the password must have a minimum length of 8 characters, and must include uppercase and lowercase letters as well as a combination of letters, numbers and special characters.

8. The "Copy RAM to ROM" option is active as standard.

   The option must be active in order that the inverter keeps the know-how protection settings after switching off and switching on the power supply.

9. Click on "OK".

You have activated know-how protection.
❒

Preventing data reconstruction from the memory card

As soon as know-how protection has been activated, the inverter 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.

Changing the password

Procedure with STARTER

Select the inverter in the project and open the dialog screen form using the shortcut menu "Know-how protection drive unit → Change password ...".

Deactivating know-how protection, deleting a password

Procedure with STARTER

1. Go online with STARTER.
2. Select the required inverter in the project.

3. Using the right-hand mouse key, open the dialog window "Know-how protection drive unit → Deactivate…".

4. Select the required option:
   – Temporary status: Know-how protection is again active after switching off the power supply and switching on again.
   – Final status: Also select "Copy RAM to ROM".

     The inverter deletes the password. However, after switching off and switching on the power supply, the password remains deleted.
5. Enter the password for know-how protection.
6. Exit the screen form with OK.

You have deactivated know-how protection.
❒

Parameter

Parameter	Description	
r7758[0...19]	**KHP Control Unit serial number**	
p7759[0...19]	**KHP Control Unit reference serial number**	
r7760	**Write protection/know-how protection status**	
	.01	1 signal: Know-how protection active
	.02	1 signal: Know-how protection temporarily unlocked
	.03	1 signal: Know-how protection cannot be deactivated
	.04	1 signal: Extended copy protection active
	.05	1 signal: Basic copy protection active
	.06	1 signal: Trace and measurement functions for diagnostic purposes active
p7765	**KHP configuration**	
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**	

See also

Write protection (Page 290)

7.6.2 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 inverter to the factory settings in order to be able to gain access to the inverter adjustable parameters. When restoring the factory settings, you lose what you have configured in the inverter, and you must recommission the inverter.

Extending the exception list

Procedure with STARTER

1. Backup the inverter settings using the button on the PC.
2. Go offline ()
3. Using p7763, in the expert list, define the required number of parameters n (n = 1 … 500) of the exception list.
4. Save the project.
5. Go online.
6. Load the project using the button in the inverter.
7. In p7764[0 … n-1], assign the required parameter numbers to the indices of p7763.

You have extended the exception list for know-how protection.
❒

Parameter

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

Alarms, faults and system messages

8

8.1 Operating states indicated on LEDs

LED status indicators

The Control Unit has number of dual-colour LEDs which are designed to indicate the operational state of the Inverter. 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

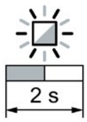
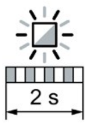
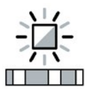
③ Digital Output

④ Digital Inputs

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

Figure 8-1 Status LED locations

Table 8- 1 Explanation of symbols for the following tables

	LED is ON
	LED is OFF
	LED flashes slowly
	LED flashes quickly
	LED flashes with variable frequency

Please contact Technical Support for LED states that are not described in the following.

Table 8- 2 Basic states

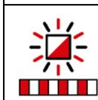
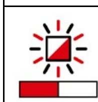
RDY	Explanation
	Temporary state after the supply voltage is switched on.
	The inverter is free of faults
	Commissioning or reset to factory settings
	A fault is active
	Firmware update is active
	Inverter waits until the power supply is switched off and switched on again after a firmware update

Table 8- 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 8- 4 Integrated safety functions

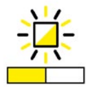
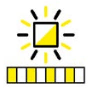
SAFE	Explanation
	One or more safety functions are enabled, but not active.
	One or more safety functions are active and error-free.
	The inverter has detected a safety function fault and initiated a stop response.

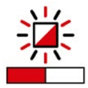
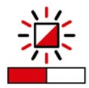
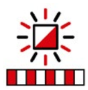
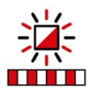
Table 8- 5 PROFINET fieldbus

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

Table 8- 6 PROFINET fieldbus

<table>
<tr><th>FO</th><th>ACT / LNK</th><th>Explanation</th></tr>
<tr><td></td><td></td><td>Communication via PROFINET is error-free. Inverter and open-loop control exchange actual data.</td></tr>
<tr><td></td><td></td><td>Communication via PROFINET has been set up.</td></tr>
<tr><td></td><td></td><td>Communication via PROFINET is not active.</td></tr>
<tr><td></td><td colspan="2">Inverter does not receive a light wave signal. Possible causes:
• Fiber optical cable or connector damaged.
• Excessive attenuation of the fiber optic line.</td></tr>
</table>

Table 8- 7 PROFINET and PROFIBUS fieldbuses

BF	Explanation	
	Data exchange between the inverter 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: Inverter 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	

8.2 Alarms, alarm buffer, and alarm history

Alarms

Alarms have the following properties:

- Incoming alarms have no direct influence on the inverter.
- Alarms disappear again when the cause is eliminated.
- Alarms do not have to be acknowledged.
- Alarms are displayed as follows:
  - Display via bit 7 in status word 1 (r0052)
  - Display on the operator panel with Axxxxx
  - Display in Startdrive or STARTER

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 8-2 Alarm buffer

The inverter 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 inverter takes its internal time calculation to save the alarm times.

System runtime (Page 310)

Up to 8 alarms can be saved in the alarm buffer.

In the alarm buffer, the warnings are sorted according to "Warning time received". If the alarm buffer is completely filled and an additional alarm occurs, then the inverter overwrites the values with Index [7].

Alarm history

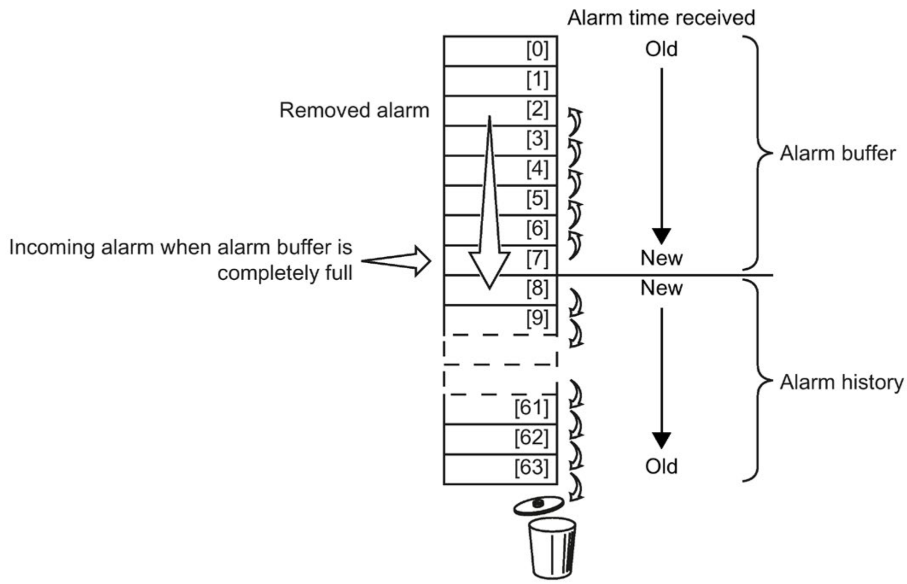


Figure 8-3 Shifting removed alarms into the alarm history

If the alarm buffer is completely filled and an additional alarm occurs, the inverter 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 inverter shifts the alarms already stored in the alarm history "down" by one or more positions.

   If the alarm history is completely full, the inverter will delete the oldest alarms.
2. The inverter 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 inverter 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 inverter 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].

Parameters of the alarm buffer and the alarm history

Parameter	Description
p2111	**Alarm counter** Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2122	**Alarm code** Displays the numbers of the alarms that have occurred

Parameter	Description
r2123	**Alarm time received in milliseconds** Displays the time in milliseconds when the alarm occurred
r2124	**Alarm value** Displays additional information about the alarm
r2125	**Alarm time removed in milliseconds** Displays the time in milliseconds when the alarm was removed
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118[0 … 19]	**Setting the message number for the message type** Selection of the alarms for which the message type should be changed
p2119[0 … 19]	**Setting the message type** Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

8.3 Faults, alarm buffer and alarm history

Faults

Faults have the following properties:

- In general, a fault leads to the motor being switched off.
- A fault must be acknowledged.
- Faults are displayed as follows:
  - Display in bit 3 of status word 1 (r0052)
  - Display on the operator panel with Fxxxxx
  - Display on the inverter via the LED RDY
  - Display in Startdrive or STARTER

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 8-4 Fault buffer

The inverter 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 inverter takes its internal time calculation to save the fault times.

System runtime (Page 310)

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 filled and an additional fault occurs, then the inverter 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)
- Acknowledging via a digital input
- Acknowledge via the Operator Panel
- Switch off the inverter power supply and switch on again

Faults detected during the inverter-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

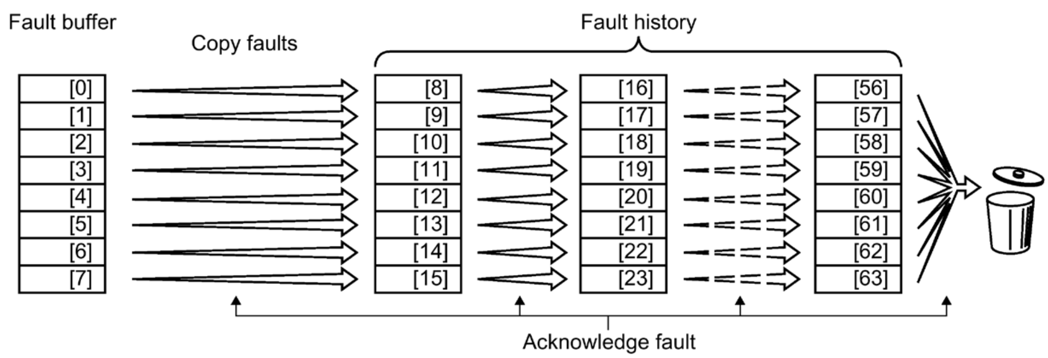


Figure 8-5 Fault history after acknowledging the faults

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 inverter shifts the values previously saved in the fault history by eight indexes.

   The inverter deletes the faults that were saved in the indexes [56 … 63] before the acknowledgement.
2. The inverter copies the contents of the fault buffer to the memory locations [8 … 15] in the fault history.
3. The inverter 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 inverter 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 to zero.

Parameters of the fault buffer and the fault history

Parameter	Description
r0945	**Fault code** Displays the numbers of the faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** A fault case can contain one or several faults. Number of fault cases that have occurred since the last acknowledgement. With p0952 = 0 you delete the fault buffer and the fault history.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

Extended settings for faults

Parameter	Description
p2100[0 … 19]	**Setting the fault number for fault response** Selecting the faults for which the fault response should be changed. You can modify the motor fault response for up to 20 different fault codes.
p2101[0 … 19]	**Setting, fault response** Setting the fault response for the selected fault
p2118[0 … 19]	**Setting the message number for the message type** Selection of the message for which the message type should be changed. You can change up to 20 different faults into an alarm, or suppress faults:
p2119[0 … 19]	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

Parameter	Description
p2126[0 … 19]	**Setting the fault number for the acknowledgement mode** Selection of the faults for which the acknowledgement type should be changed. You can modify the acknowledgement type for up to 20 different fault codes.
p2127[0 … 19]	**Setting, acknowledgement mode** Setting the acknowledgement type for the selected fault 1: Acknowledgement only using POWER ON 2: IMMEDIATE acknowledgement after removing the fault cause

You will find details in function diagram 8075 and in the parameter description of the List Manual.

8.4 Identification & maintenance data (I&M)

I&M data

The inverter 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	Inverter-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 is p8805 = 0 is used.	p8809[0 … 53]	Values of r9781[0] and r9782[0]

When requested, the inverter 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)	✓	✓

Designation	Format	Example for the content	Valid for PROFINET	Valid for PROFIBUS
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	✓	✓

8.5 System runtime

By evaluating the system runtime of the inverter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

Principle of operation

The inverter starts the system runtime as soon as the inverter is supplied with power. The system runtime stops when the inverter 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 inverter 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 inverter transfers the parameter values r2114 to the corresponding parameters of the alarm or fault buffer.

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

You cannot reset the system runtime.

8.6 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 8- 8 The most important alarms and faults

<table>
<tr><th>Number</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>F01000</td><td>Software error in the CU</td><td>Replace CU.</td></tr>
<tr><td>F01001</td><td>Floating point exception</td><td>Switch off CU and switch on again.</td></tr>
<tr><td>F01015</td><td>Software error in the CU</td><td>Upgrade firmware or contact technical support.</td></tr>
<tr><td>F01018</td><td>Power-up aborted more than once</td><td>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 inverter.</td></tr>
<tr><td>A01028</td><td>Configuration error</td><td>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.</td></tr>
<tr><td>F01033</td><td>Unit switchover: Reference parameter value invalid</td><td>Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).</td></tr>
<tr><td>F01034</td><td>Unit switchover: Calculation of the parameter values after reference value change unsuccessful</td><td>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).</td></tr>
<tr><td>F01040</td><td>Parameters must be saved</td><td>Save parameters (p0971).
Switch CU off and on again.</td></tr>
<tr><td>F01044</td><td>Error loading data from memory card</td><td>Replace memory card or CU.</td></tr>
<tr><td>A01101</td><td>Memory card not available</td><td>Insert a memory card or deactivate the warning A01101.
Activate message for a memory card that is not inserted (Page 286)</td></tr>
<tr><td>F01105</td><td>CU: Insufficient memory</td><td>Reduce number of data sets.</td></tr>
<tr><td>F01122</td><td>Frequency at the probe input too high</td><td>Reduce the frequency of the pulses at the probe input.</td></tr>
<tr><td>F01205</td><td>CU: Time slice overflow</td><td>Contact technical support.</td></tr>
<tr><td>F01250</td><td>CU hardware fault</td><td>Replace CU.</td></tr>
<tr><td>F01512</td><td>An attempt has been made to establish a conversion factor for scaling which does not exist</td><td>Create scaling or check transfer value.</td></tr>
<tr><td>A01590</td><td>Motor maintenance interval lapsed</td><td>Carry out maintenance and reset the maintenance interval (p0651).</td></tr>
<tr><td>F01600</td><td>STOP A initiated</td><td>Select the STO safety function and then deselect again.</td></tr>
<tr><td>F01650</td><td>Acceptance test required</td><td>Carry out an acceptance test and create test certificate.
Switch off the Control Unit and switch on again.</td></tr>
<tr><td>F01659</td><td>Write task for parameter rejected</td><td>Cause: The inverter 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 inverter sets p0970 = 5 once it has reset the parameters.</td></tr>
</table>
Then reset the inverter to the factory setting again.</td></tr>
</table>

Number	Cause	Remedy
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware or contact technical support.
A01666	Static 1 signal at the F-DI for safe acknowledgment	Set fail-safe digital input F-DI to a logical 0 signal.
A01698	Commissioning mode active for safety functions	This message is withdrawn after the Safety commissioning has ended.
A01699	Switch-off signal path test required	After the next time that the "STO" function is deselected, the message is withdrawn and the monitoring time is reset.
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The MODBUS master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly parameterized	Check the parameterized supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the temperature sensor fault (p0607 = 0).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.

Number	Cause	Remedy
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	V_{DC_max} controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the up ramp for the setpoint speed.
A07441	Backup the position offset of the absolute encoder adjustment	This alarm automatically disappears after the offset has been saved.
F07443	Reference point coordinate not in the permissible range	Set the reference point coordinate to a lower value than specified in the fault value r0949 (interpret decimal).
F07450	Standstill monitoring has responded	After the standstill monitoring time (p2543) has expired, the drive has left the standstill window (p2542). Check whether the following is set correctly: • Position actual value inversion (p0410) • Standstill window too small (p2542)? • Standstill monitoring time too short (p2543)? • Position loop gain too low (p2538)? • Position loop gain too high (instability/oscillatory behavior, p2538)? • Mechanical overload? Other possible causes: • Connecting cable, motor/drive inverter incorrect (phase missing, interchanged). • When selecting motor identification, select tracking mode (BI: p2655[0] = 1 signal).

Number	Cause	Remedy
F07451	Position monitoring has responded	When the positioning monitoring time expired (p2545), the drive had still not reached the positioning window (p2544). Check whether the following is set correctly: • Positioning window too small (p2544)? • Positioning monitoring time too short (p2545)? • Position loop gain too low (p2538)? • Position loop gain too high (instability/oscillatory behavior, p2538)? Another possible cause: Mechanical clamping.
F07452	Following error too high	The difference between the position setpoint and the actual position value (following error dynamic model, r2563) is higher than the tolerance (p2546). Possible causes: • The drive torque or accelerating capacity has been exceeded. • Position measuring system fault. • Position control sense is not correct. • Mechanical system locked. • Excessively high traversing velocity or excessively high position set-point differences.
F07453	Position actual value processing error	Check the encoder for the actual position value processing.
A07454	Position actual value processing does not have a valid encoder	Check whether one of the following causes exists: • An encoder is not assigned for the position actual value processing (p2502 = 0). • An encoder is assigned, but no encoder data set has been assigned (p0187 = 99 or p0188 = 99 or p0189 = 99). • An encoder and an encoder data set have been assigned, however, the encoder data set does not contain any encoder data (p0400 = 0) or invalid data (e.g. p0408 = 0).
A07455	Maximum velocity limited	The maximum velocity (p2571) is too high to correctly calculate the modulo correction. Remedy: • Reduce the maximum velocity (p2571). • Increase the sampling time for positioning (p0115[5]).
A07456	Setpoint velocity limited	The actual setpoint velocity is greater than the parameterized maximum velocity (p2571), and is therefore limited. Remedy: • Check the entered setpoint velocity. • Reduce the velocity override (CI: p2646). • Increase the maximum velocity (p2571).

Number	Cause	Remedy
A07457	Combination of input signals is not permissible	An illegal combination of input signals, which are simultaneously set was detected, e.g.: • Jog 1 and jog 2 (p2589, p2590). • Jog 1 or jog 2 and direct setpoint input/MDI (p2589, p2590, p2647). • Jog 1 or jog 2 and start referencing (p2589, p2590, p2595). • Jog 1 or jog 2 and activate traversing task (p2589, p2590, p2631). • Direct setpoint input/MDI and start referencing (p2647, p2595). • Direct setpoint input/MDI and activate traversing task (p2647, p2631). • Start referencing and activate traversing task (p2595, p2631).
F07458	Reference cam not found	After starting the reference point approach, the axis has traversed through the maximum permissible distance to search for the reference cam without finding the reference cam. Remedy: • Check the "reference cam" binector input (BI: p2612). • Check the maximum permissible distance to the reference cam (p2606). • If axis does not have a reference cam, then set p2607 to 0.
F07459	No zero mark available	After leaving the reference cam, the axis traversed through the maximum permissible distance between the reference cam and zero mark without finding the zero mark. Remedy: • Check the encoder regarding the zero mark. • Check the maximum permissible distance between the reference cam and zero mark (p2609). • Use an external encoder zero mark (p0494).
F07460	End of reference cam not found	During the reference point approach, the axis, when approaching the zero mark, has reached the end of the traversing range without identifying an edge at the binector input "Reference cam" (BI: p2612). Remedy: • Check the "reference cam" binector input (BI: p2612).
A07461	Reference point not set	Reference the system
A07462	Selected traversing block number does not exist	Correct the traversing program.
A07463	External block change not requested in the traversing block	Resolve the reason why the edge is missing at binector input (BI: p2632).
F07464	Traversing block is inconsistent	Check the traversing block and, if necessary, take into consideration any alarms that are present.
A07465	Traversing block does not have a subsequent block	• Parameterize this traversing block with the step enabling condition END. • Parameterize additional traversing blocks with a higher block number and for the last block, parameterize the step enabling condition END.
A07466	Traversing block number assigned a multiple number of times	Correct the traversing blocks.
A07467	Traversing block has illegal task parameters	Correct the task parameter in the traversing block.
A07468	Traversing block jump target does not exist	• Correct the traversing block. • Add the missing traversing block.

Number	Cause	Remedy
A07469	Traversing block target position < software limit switch minus	• Correct the traversing block. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07470	Traversing block target position > software limit switch plus	
A07471	Traversing block target position outside the modulo range	• Correct the target position in the traversing block. • Change the modulo range (p2576).
A07472	Traversing block ABS_POS/ABS_NEG not possible	Correct the traversing block.
A07473	Beginning of traversing range reached	Move away in the positive direction.
A07474	End of traversing range reached	Move away in the negative direction.
F07475	Target position < start of traversing range	Correct the target position.
F07476	Target position > end of traversing range	
A07477	Target position < software limit switch minus	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07478	Target position > software limit switch plus	
A07479	Software limit switch, minus actu-ated	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
A07480	Software limit switch, plus actuated	
F07481	Axis position < software limit switch minus	• Correct the target position. • Change the software limit switch minus (CI: p2578, p2580). • Change the software limit switch plus (CI: p2579, p2581).
F07482	Axis position > software limit switch plus	
A07483	Travel to fixed stop, clamping torque not reached	• Check the maximum torque-generating current (r1533). • Check the torque limits (p1520, p1521). • Check the power limits (p1530, p1531).
F07484	Fixed stop outside the monitoring window	In the "Fixed stop reached" state, the axis has moved outside the defined monitoring window (p2635). Remedy: • Check the monitoring window (p2635). • Check the mechanical system.
F07485	Fixed stop is not reached	In a traversing block with the FIXED STOP task the end position was reached without detecting a fixed stop. Remedy: • Check the traversing block and locate the target position further into the workpiece. • Check the "fixed stop reached" control signal (p2637). • Reduce the maximum following error window to detect the fixed stop (p2634).
A07486	Intermediate stop missing	Connect a "1" signal at the binector input "no intermediate stop/intermediate stop" (BI: p2640) and re-start motion.
A07487	Reject traversing task missing	Connect a "1" signal at the binector input "do not reject traversing task/reject traversing task" (BI: p2641) and re-start motion.

Number	Cause	Remedy
F07488	Relative positioning not possible	In the mode "direct setpoint input/MDI", for the continuous transfer (p2649 = 1), relative positioning was selected (BI: p2648 = 0 signal). Correct the selection.
A07489	Reference point offset outside window	For the function "flying referencing", the difference between the measured position at the measuring probe and the reference point coordinate is outside the parameterized window. Remedy: • Check the mechanical system. • Check the parameterization of the window (p2602).
F07490	Enable signal withdrawn while traversing	Set the enable signals.
F07491	STOP cam, minus actuated	Leave the STOP cam minus in the positive traversing direction and retract the axis to the valid traversing range.
F07492	STOP cam, plus actuated	Leave the STOP cam plus in the negative traversing direction and retract the axis to the valid traversing range.
F07493	Overflow of the value range for the position actual value	The value range (-2147483648 ... 2147483647) for representing the position actual value was exceeded. Remedy: If necessary reduce the traversing range or position resolution (p2506).
A07495	Reference function interrupted	An activated reference function (reference mark search or measuring probe evaluation) was interrupted. Possible causes: • Encoder fault • Reference mark search and measuring probe evaluation simultaneously activated (BI: p2508 and BI: p2509 = 1 signal). • Activated reference function (reference mark search or measuring probe evaluation) was de-activated (BI: p2508 and BI: p2509 = 0 signal).
A07496	Enable is not possible	It is not possible to enable the basic positioner as at least one signal is missing. Causes: • EPOS enable missing (BI: p2656). • Position actual value, valid feedback signal missing (BI: p2658).
F07499	Reversing cam approached with the incorrect traversing direction	Check the wiring of the reversing cam (BI: p2613, BI: p2614).
F07503	STOP cam approached with the incorrect traversing direction	Check the wiring of the STOP cam (BI: p2569, BI: p2570).
A07505	Fixed stop task for U/f/SLVC operation not possible	Change the open-loop/closed-loop control mode (p1300).
A07557 A07558	Reference point coordinate not in the permissible range	The received reference point coordinate when adjusting the encoder via connector input CI: p2599 lies outside half of the encoder range and cannot be set as actual axis position. Remedy: Correct reference point coordinate.
A07577 A07578	Measuring probe evaluation not possible	• Set the input terminal for the measuring probe (p0488, p0489 or p2517, p2518). • Reduce the frequency of the measuring pulses at the measuring probe.
A07581 A07582	Position actual value processing error	Check the encoder for the actual position value processing.

Number	Cause	Remedy
A07584 A07585	Position setting value activated	The alarm automatically disappears with BI: p2514 = 0 signal.
A07587 A07588	Position actual value processing does not have a valid encoder	An encoder data set has been assigned, however, the encoder data set does not contain any encoder data (p0400 = 0) or invalid data (e.g. p0408 = 0). Remedy: Check the drive data sets and encoder data sets.
A07593 A07594	Value range for position actual value exceeded	The value range (-2147483648 ... 2147483647) for representing the position actual value was exceeded. Remedy: Reduce the traversing range or position resolution. If necessary reduce the traversing range or position resolution.
A07596 A07597	Reference function interrupted	An activated reference function (reference mark search or measuring probe evaluation) was interrupted. Possible causes: • Encoder fault • Reference mark search and measuring probe evaluation simultaneously activated (BI: p2508 and BI: p2509 = 1 signal). • Activated reference function (reference mark search or measuring probe evaluation) was de-activated (BI: p2508 and BI: p2509 = 0 signal).
F07599 F07600	Adjustment not possible	The maximum encoder value times the factor to convert the absolute position (r0483 and/or r2723) from increments to length units (LU) has exceeded the value range (-2147483648 ... 2147483647) for representing the position actual value.
F07801	Motor overcurrent	Check current limits (p0640). Vector control: Check current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 … p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short circuit and ground fault. Check motor for star-delta connection and rating plate parameterization. Check power unit / motor combination. Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short circuit detected	• Check the inverter 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: Rectify the cause of these alarms.

Number	Cause	Remedy
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for these faults.
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
A07975	Traverse to the zero mark - setpoint input expected	The alarm disappears when the zero mark is detected.
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 monitoring time set (p2044).
F08502	Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).

Number	Cause	Remedy
A08565	Consistency error for 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 error	A CAN communications error has occurred. Check the following: • Bus cable. • Baud rate (p8622). • Bit timing (p8623). • Master Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. • Insert a suitable memory card and switch the inverter 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.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).

Number	Cause	Remedy
F30004	Inverter overtemperature	Check whether the inverter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t inverter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the inverter's input fuses. Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
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.

Number	Cause	Remedy
A30920	Temperature sensor fault	Check that the sensor is connected correctly.
F31100	Zero mark distance error	The measured zero mark distance does not correspond to the parameterized zero mark distance. Remedy: • Check that the encoder cables are routed in compliance with EMC. • Check the cable connections. • Check the encoder type (encoder with equidistant zero marks). • Adapt the parameters for the distance between zero marks (p0424, p0425). • For a signal output above a speed threshold, reduce the filter time (p0438).
F31101	Zero mark failed	
F31118	Speed difference outside tolerance	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 the grounding of the tachometer shielding. • Increase the maximum speed difference per sampling cycle (p0492).
A31418	Speed difference per sampling rate exceeded	
F31905	Parameterizing error	Check whether the connected encoder type matches the encoder that has been parameterized.
A31915	Configuration error	When the fine resolution Gx_XIST2 is configured, the encoder identifies a maximum possible absolute position actual value (r0483) that can no longer be represented within 32 bits. Remedy: Check the encoder data.
F32110	Serial communications error	The transfer of the serial communication protocol between the encoder and inverter is faulty. Remedy: Check the hardware and the associated settings in the inverter.
F32111 F32112	Absolute encoder internal error	• Check the power supply of the encoder. • Replace the encoder.
A32410	Serial communication	• Check that the encoder cables are routed in compliance with EMC. • Check the cable connections. • Replace the encoder.
A32411	Absolute encoder outputs alarms	Replace the encoder.
A32412	Error bit set in the serial protocol	• Carry out a power on reset (power off/on) for all components. • Check that the encoder cables are routed in compliance with EMC. • Check the plug connections. • Replace the encoder
A32442	Battery voltage pre-alarm	Replace the battery in the encoder.
F32905	Parameterizing error	• Check whether the connected encoder type matches the encoder that has been parameterized. • Correct the parameter specified by the fault value (r0949) and p0187.
A32915	Configuration error	When the fine resolution Gx_XIST2 is configured, the encoder identifies a maximum possible absolute position actual value (r0483) that can no longer be represented within 32 bits. Remedy: Check the encoder data.

For further information, please refer to the List Manual.

Overview of the manuals (Page 389)

Corrective maintenance 9

9.1 Spare parts compatibility

Continuous development within the scope of product maintenance

Inverter 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).

9.2 Replacing inverter components

⚠WARNING
Fire or electric shock due to defective components
If an overcurrent protection device is triggered, the inverter may be defective. A defective inverter can cause a fire or electric shock.
• Have the inverter and the overcurrent protection device checked by a specialist.

Repair

> ⚠ **WARNING**
>
> **Fire or electric shock due to improper repair**
>
> Improper repair of the inverter may cause malfunctions or result in consequential damage such as fire or electric shock.
>
> - Only commission the following persons to repair the inverter:
>   - 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.

9.2.1 Spare parts

External fan for Frame Size C

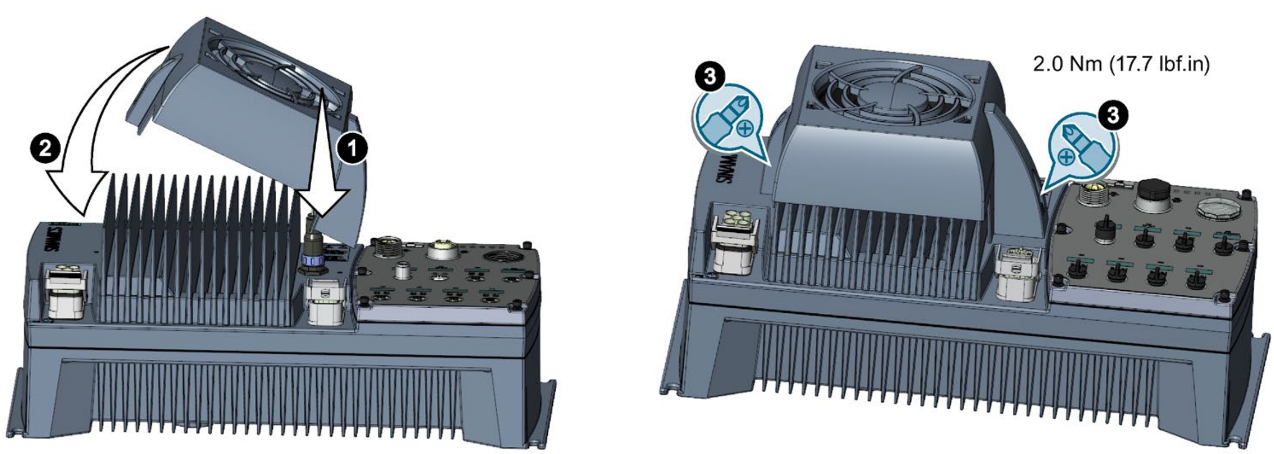


Figure 9-1 Fitting the external fan

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

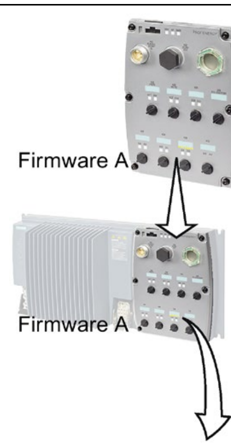
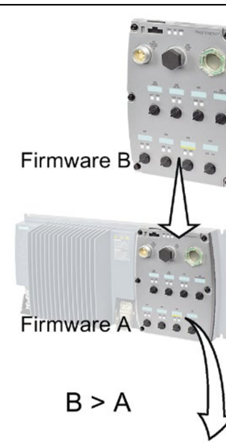
You will find more information in the Internet at:

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

9.2.2 Overview of replacing converter components

Permissible replacement of components

In the event of a long-term function fault, you must replace the Power Module or Control Unit. The converter's Power Module and Control Unit can be replaced independently of each other.

Replacing the Power Module		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
			
	Power Module and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	After replacing the Control Unit, you must restore the converter's settings.	

⚠WARNING

Unexpected machine motion caused by inappropriate/incorrect inverter settings

Replacing inverters of different types can result in incomplete or inappropriate/incorrect inverter 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 that are not permitted according to the table above, recommission the drive after replacing an converter.

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, you can use environment detection to replace a defective converter with a new device of the same type and with the same software release. Recommissioning is not required in this case.

You can either load the converter settings into the converter using the memory card or – if you are using a SIMATIC S7 controller with DriveES – using DriveES.

Additional information about replacing devices without removable storage medium can be found in the Internet:

Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127)

9.2.3 Replacing a Control Unit with enabled safety function

Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

Requirement

You have a memory card with the actual settings of the Control unit to be replaced.

Procedure

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Remove the memory card from the old Control Unit and insert it in the new Control Unit.
5. Mount the new Control Unit on the Power Module. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.

6. Reconnect the signal cables of the Control Unit.
7. Switch on the line voltage again.
8. The inverter loads the settings from the memory card.
9. Check what the inverter reports after loading.
   - Alarm A01028:

     The loaded settings are not compatible with the inverter.

     Set p0971 = 1 to delete the alarm. Check the inverter settings. We recommend that you recommission the drive.
   - Fault F01641:

     Acknowledge the message.

     Perform a **reduced** acceptance test.

     Reduced acceptance after component replacement and firmware change (Page 347)

You have replaced the Control Unit and transferred the safety function settings from the memory card to the new Control Unit.
❐

Replacing a Control Unit with data backup in Startdrive

Requirement

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

Procedure

1. Switch off the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Switch on the line voltage again.
7. Open the right project for the drive in the PC.
8. Select "Load to device".
9. Connect Startdrive online with the drive.

   The inverter signals faults after the download. Ignore these faults, as they will be automatically acknowledged by the following steps.
10. Press the "Start safety commissioning" button.
11. Enter the password for the safety functions.

12. Confirm the prompt for saving your settings (copy RAM to ROM).
13. Disconnect the online connection.
14. Switch off the inverter power supply.
15. Wait until all LEDs on the inverter are dark.
16. Switch the inverter power supply on again.
17. Perform a **reduced** acceptance test.

    Reduced acceptance after component replacement and firmware change (Page 347)

You have replaced the Control Unit and transferred the safety function settings from the PC to the new Control Unit.
❒

Replacing the Control Unit with data backup in the operator panel

Requirement

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

Procedure

1. Switch off the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Switch on the line voltage again.
7. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
8. Transfer the settings from the operator panel to the inverter.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs Alarm A01028.
    – Alarm A01028:

      The loaded settings are not compatible with the inverter.

      Set p0971 = 1 to delete the alarm. Check the inverter settings. We recommend that you recommission the drive.
    – No alarm A01028: Proceed with the next step.
11. Switch off the inverter power supply.
12. Wait until all LEDs on the inverter are dark.

13. Switch the inverter power supply on again.

    The inverter reports the faults F01641, F01650, F01680 and F30680. Ignore these faults, as they will be automatically acknowledged by the following steps.
14. Set p0010 to 95.
15. Set p9761 to the safety password.
16. Set p9701 to AC hex.
17. Set p0010 = 0.
18. Back up the settings so they are not lost when the power fails:
    – For BOP-2 in the menu "EXTRAS" - "RAM-ROM".
    – IOP in the menu "SAVE RAM TO ROM".
19. Switch off the inverter power supply.
20. Wait until all LEDs on the inverter are dark.
21. Switch the inverter power supply on again.
22. Perform a **reduced** acceptance test

    Reduced acceptance after component replacement and firmware change (Page 347)

You have replaced the Control Unit and transferred the safety function settings from the operator panel to the new Control Unit.
❐

9.2.4 Replacing the Control Unit without the safety functions enabled

Replacing a Control Unit with data backup on a memory card

If you use a memory card with firmware, after the replacement, you obtain a precise copy (firmware and settings) of the replaced Control Unit.

Precondition

You have a memory card with the actual settings of the Control unit to be replaced.

Procedure

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables from the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module. The new Control Unit must have the same article number and the same or higher firmware version as the Control Unit that was replaced.
5. Remove the memory card from the old Control Unit and insert it in the new Control Unit.

6. Reconnect the signal cables of the Control Unit.
7. Switch on the line voltage again.
8. The inverter loads the settings from the memory card.
9. After loading, check whether the inverter outputs Alarm A01028.
   – Alarm A01028:
     The loaded settings are not compatible with the inverter.
     Clear the alarm with p0971 = 1 and recommission the drive.
   – No alarm A01028:
     The inverter accepts the settings that have been loaded.

You have successfully replaced the Control Unit.
❒

Replacing a Control Unit with data backup in Startdrive

Precondition

You have backed up the actual settings of the Control Unit to be replaced to a PC using Startdrive.

Procedure

1. Switch off the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Switch on the line voltage again.
7. Open the right project for the drive in the PC.
8. Select "Load to device".
9. Connect Startdrive online with the drive.
10. Confirm the prompt for saving your settings (copy RAM to ROM).
11. Disconnect the online connection.

You have replaced the Control Unit and transferred the settings from the PC to the new Control Unit.
❒

Replacing the Control Unit with data backup in the operator panel

Precondition

You have backed up the actual settings of the Control Unit to be replaced to an operator panel.

Procedure

1. Disconnect the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.
3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Switch on the line voltage again.
7. Plug the Operator Panel into the Control Unit or connect the Operator Panel handheld device with the inverter.
8. Transfer the settings from the operator panel to the inverter.
9. Wait until the transfer is complete.
10. After loading, check whether the inverter outputs Alarm A01028.
    – Alarm A01028:

      The loaded settings are not compatible with the inverter.

      Clear the alarm with p0971 = 1 and recommission the drive.
    – No alarm A01028: Proceed with the next step.
11. Back up the settings so they are not lost when the power fails:
    – For BOP-2 in the menu "EXTRAS" - "RAM-ROM".
    – For IOP-2 in the menu "SAVE RAM TO ROM".

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

9.2.5 Replacing the Control Unit without data backup

If you do not backup the settings, then you must recommission the drive after replacing the Control Unit.

Procedure

1. Switch off the line voltage to the Power Module and (if installed) the external 24 V supply or the voltage for the digital outputs of the Control Unit.
2. Remove the signal cables of the Control Unit.

3. Remove the defective Control Unit.
4. Mount the new Control Unit on the Power Module.
5. Reconnect the signal cables of the Control Unit.
6. Switch on the line voltage again.
7. Recommission the drive.

The Control Unit replacement has been completed once the drive has been successfully commissioned.
❐

9.2.6 Replacing a Control Unit with active know-how protection

Replacing devices with know-how protection without copy protection

In the case of know-how protection without copy protection, the inverter settings can be transferred to another inverter using a memory card.

Saving settings to the memory card (Page 283)

Transferring the settings from the memory card (Page 284)

Replacing devices with know-how protection with copy protection

The know-how protection with copy protection hides the inverter settings and also prevents the duplication of the inverter settings.

If the inverter settings can neither be copied nor forwarded, a recommissioning is required after inverter replacement.

To avoid the recommissioning, you must use a Siemens memory card, and the machine manufacturer must have an identical prototype machine that it uses as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

1. The end customer provides the machine manufacturer with the following information:
   - For which machine must the inverter be replaced?
   - What is the serial number (r7758) of the new inverter?
2. The machine manufacturer performs the following steps online on the prototype machine:
   - Deactivating know-how protection

     Activating and deactivating know-how protection (Page 294)
   - Enter the serial number of the new inverter 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.

     Activating and deactivating know-how protection (Page 294)
   - Write the configuration with p0971 = 1 to the memory card.
   - Send the memory card to the end customer.
3. The end customer inserts the memory card and switches on the power supply for the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

Option 2: The machine manufacturer knows the serial number of the new inverter 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 inverter be replaced?
   – What is the serial number (r7758) of the new inverter?
   – 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 294)
   – Enter the serial number of the new inverter 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.

     Activating and deactivating know-how protection (Page 294)
   – 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 customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the power supply for the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

9.2.7 Replacing a Power Module with enabled safety function

WARNING
Electric shock due to residual charge in the Power Module
After switching off the line voltage, it will take up to 5 minutes until the capacitors in the Power Module are sufficiently discharged for the residual voltage to be safe. Death or serious injury will result if energized parts are touched.
• Check the safe isolation of the Power Module connections before carrying out installation work.

NOTICE
Motor damage due to interchanged motor connecting cables
The direction in which the motor rotates switches if you exchange the two phases of the motor line. A motor with an incorrect direction of rotation can damage the machine or installation. Driven loads with only one permissible direction of rotation include certain saws.
• Connect the three phases of the motor lines in the right order.
• After replacing the Power Module, check the direction of motor rotation.

Procedure

1. Switch off the line voltage of the Power Module.
   You can leave any external 24 V supply to the Control Unit switched on.
2. Remove the connecting cables of the Power module.
3. Remove the Control Unit from the Power Module.
4. Replace the 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. The inverter reports F01641.
9. Perform a reduced acceptance test

   Reduced acceptance after component replacement and firmware change (Page 347)

You have successfully replaced the Power Module.
❒

9.2.8 Replacing a Power Module without the safety function being enabled

Procedure

1. Switch off the supply 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 old Power Module with the new Power Module.
5. Mount the Control Unit onto the new Power Module.
6. Connect up the new Power Module using the connecting cables.

NOTICE
Motor damage due to interchanged motor connecting cables
The direction in which the motor rotates switches if you exchange the two phases of the motor line. A motor with an incorrect direction of rotation can damage the machine or installation. Work machines with only one permissible direction of rotation include certain compressors, saws and pumps. • Connect the three phases of the motor lines in the right order. • After replacing the Power Module, check the direction of motor rotation.

7. Switch on the line supply and, if necessary, the 24 V supply of the Control Unit.

You have successfully replaced the Power Module.
❒

9.3 Firmware upgrade and downgrade

Preparing a memory card for a firmware upgrade or downgrade

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.

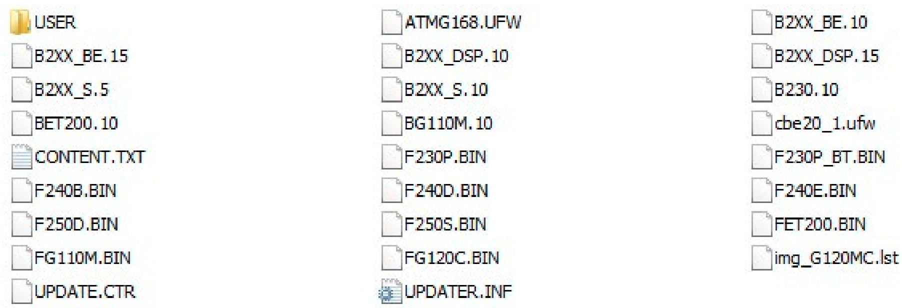


Figure 9-2 Example of memory card contents after the file transfer

Depending on the firmware, the filenames and the number of files may differ from the display above.

The "USER" directory does not exist on unused memory cards. After the memory card is plugged in for the first time, the inverter creates a new "USER" directory.

You have prepared the memory card for the firmware upgrade or downgrade.
❒

Memory cards that can be ordered:

Memory cards (Page 282)

Overview of firmware upgrades and downgrades

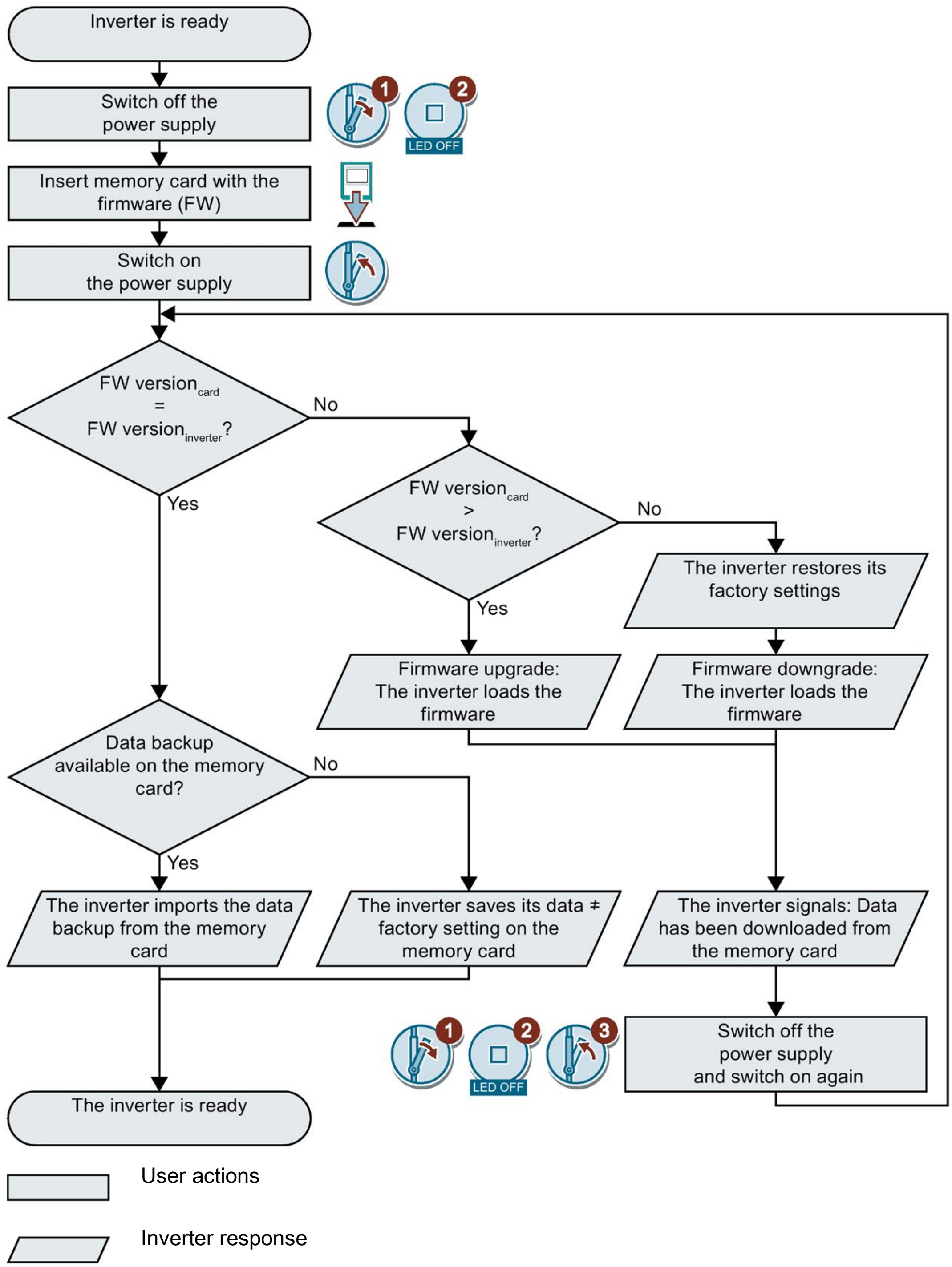


Figure 9-3 Overview of the firmware upgrade and firmware downgrade

9.3.1 Upgrading firmware

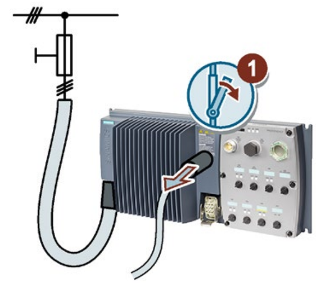
When upgrading firmware you replace the inverter's firmware with a newer version. Only update the firmware to a newer version if you require the expanded range of functions of that newer version.

Requirements

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

Procedure

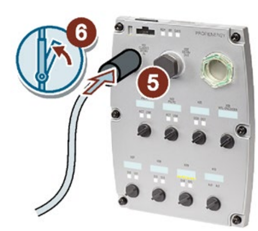
1. Remove the connector for the 24 V power supply of the Control Unit.



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.

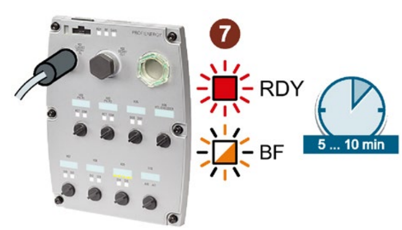


7. The Control Unit transfers the firmware from the memory card into its memory.

   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.

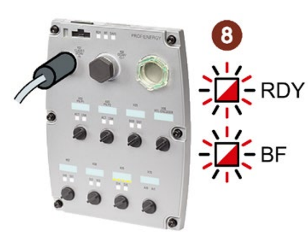


8. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during the transfer

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

   - Start again with Step 1 of these instructions.



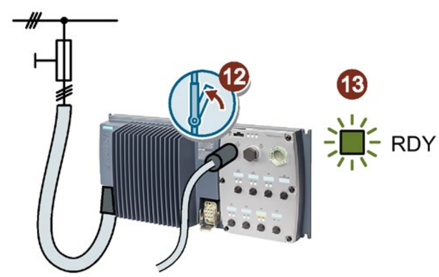
9. Switch off the 24 V supply or remove the connector for the 24 V supply from the Control Unit.
10. Wait until the LEDs on the Control Unit have gone out.

Decide whether to remove the memory card from the inverter:

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

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

9.3.2 Firmware downgrade

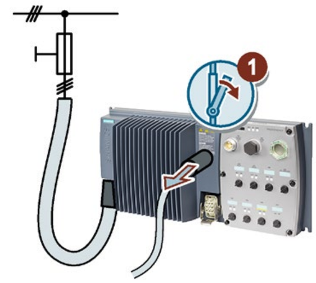
When downgrading firmware you replace the inverter's firmware with an older version. Only update the firmware to an older level if, after replacing an inverter, you require the same firmware in all inverters.

Requirement

- Your inverter'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

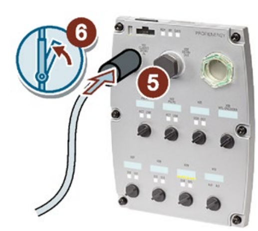
1. Remove the connector for the 24 V power supply of the Control Unit.



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.

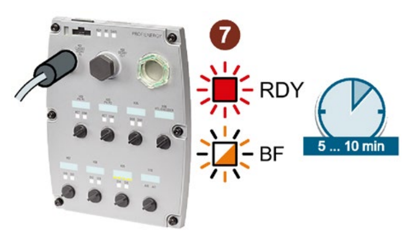


7. The Control Unit transfers the firmware from the memory card into its memory.

   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.

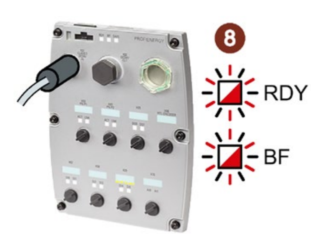


8. At the end of the transfer, the LED RDY and BF slowly flash red (0.5 Hz).

   Power supply failure during the transfer

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

   - Start again with Step 1 of these instructions.



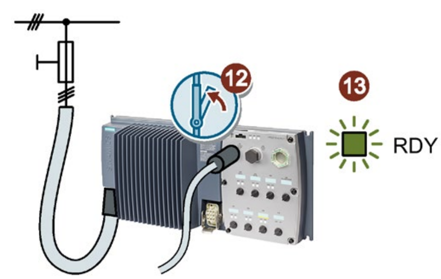
9. Switch off the 24 V supply or remove the connector for the 24 V supply from the Control Unit.
10. Wait until the LEDs on the Control Unit have gone out.

Decide whether to remove the memory card from the inverter:

- You leave the memory card inserted: ⇒ If the memory card already includes a data backup, the inverter 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 inverter 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 inverter has taken over the settings from the memory card.
- There was no data backup on the memory card: ⇒ The inverter has the factory settings.

14. If the memory card did not contain a data backup of the inverter settings, then you must transfer your settings to the inverter from another data backup.

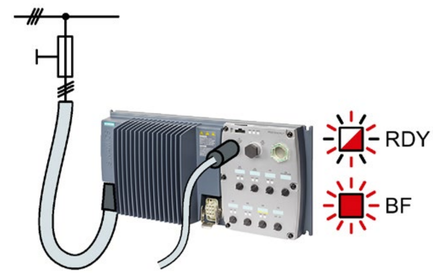
Backing up data and series commissioning (Page 281).

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

9.3.3 Correcting a failed firmware upgrade or downgrade

How does the inverter report a failed upgrade or downgrade?

The inverter 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 inverter?
  - 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.

9.4 Reduced acceptance 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 inverter data • Log the new checksums • Countersignature
Replacing the Power Module.		Supplement the hardware version in the inverter 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.
Inverter firmware update.	No.	• Supplement firmware version in the inverter data • Log the new checksums • Countersignature.

9.5 If the converter no longer responds

If the inverter no longer responds

For example, when loading an incorrect file from the memory card, the inverter 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 inverter to its factory setting and recommission it. This inverter state is manifested in two different ways:

Case 1

- The motor is switched off.
- You cannot communicate with the inverter, either via the operator panel or other interfaces.
- The LEDs flicker and after 3 minutes the inverter has still not powered up.

Procedure

1. Remove the memory card if one is inserted in the inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter are dark. Then switch on the inverter power supply again.
4. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
5. Set p0971 = 1.
6. Switch off the inverter power supply.
7. Wait until all LEDs on the inverter are dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
8. Recommission the inverter.

You have restored the inverter factory settings.
❒

Case 2

- The motor is switched off.
- You cannot communicate with the inverter, 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 inverter.
2. Switch off the inverter power supply.
3. Wait until all LEDs on the inverter are dark. Then switch on the inverter power supply again.
4. Wait until the LEDs flash orange.
5. Repeat steps 2 and 3 as often as required until the inverter outputs fault F01018.
6. Now set p0971 = 1.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark. Then switch on the inverter power supply again.

   The inverter now powers up with the factory settings.
9. Recommission the inverter.

You have restored the inverter 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 inverter been completely commissioned p0010 = 0?
  If not, the inverter is e.g. still in a commissioning state.
- Is the inverter reporting the "ready to start" status (r0052.0 = 1)?
- Is the inverter missing some enable signals (r0046)?
- How does the inverter receive its setpoint and commands?

  Digital inputs, analog inputs or fieldbus?

Technical data 10

10.1 Performance ratings Control Unit

Performance ratings

Table 10- 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	
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	
Encoder interfaces	• HTL bipolar, ≤ 2048 pulses, ≤ 100 mA, e. g. SIEMENS encoders 1XP8001-1, 1XP80X2-1X. • SSI interface, ≤ 250 mA. See also Encoders examples (Page 65). • 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)

Note

Short-term voltage dips in the external 24 V supply (≤ 3 ms and ≤ 95% of the rated voltage)

When the mains voltage of the inverter is switched off, the inverter responds to short-term voltage dips in the external 24 V supply with fault F30074. Communication via fieldbus, however, remains in effect in this case.

10.2 Performance ratings Power Module

SINAMICS G120 D performance ratings

Table 10- 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 ≤ 1% The specification only refers to the total instantaneous regenerative feed-back, however not to the total connected power of all of the power mod-ules connected to the same transformer.

Feature	Specification
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)

10.3 SINAMICS G120D specifications

Power Module Specifications

Table 10- 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 10- 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

10.4 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)

10.5 Ambient operating conditions

Temperature

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

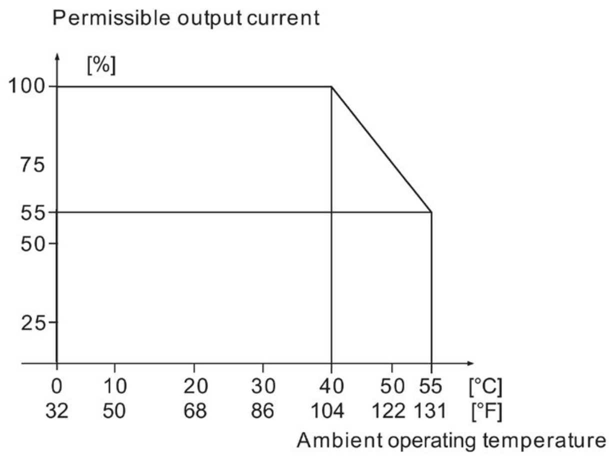


Figure 10-1 Power derating for temperature

Humidity range

Relative air humidity for the SINAMICS G120D is ≤ 95 % non-condensing.

Shock and vibration

Do not drop the SINAMICS G120D or expose to sudden shock. Do not install the SINAMICS G120D in an area where it is likely to be exposed to constant vibration.

Electromagnetic radiation

Do not install the SINAMICS G120D near sources of electromagnetic radiation.

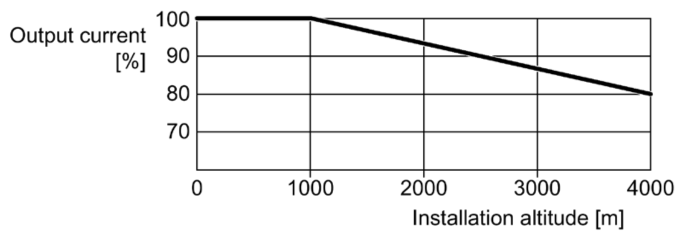
Atmospheric pollution and water

When fully assembled the inverter has an IP65 rating. This means that the inverter 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.

10.6 Current derating as a function of the installation altitude

Current derating depending on the installation altitude

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



Permissible line supplies depending on the installation altitude

- Installation altitude up to 2000 m above sea level
  – Connection to every supply system permitted for the inverter.
- Installation altitudes between 2000 m and 4000 m above sea level
  – Connection to a TN system with grounded neutral point.
  – TN systems with grounded line conductor are not permitted.
  – The TN line system with grounded neutral point can also be supplied using an isolation transformer.
  – The phase-to-phase voltage does not have to be reduced.

Note

690 V Power Modules

For 690 V Power Modules, the TN line system must be established with grounded neutral point through an isolating transformer.

10.7 Pulse frequency and current reduction

Pulse frequency and current reduction

Table 10- 5 Current reduction depending on pulse frequency

Power rating at 400 V	Frame size	Inverter 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

10.8 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

Note

Install all drives 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.

Table 10- 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	All inverters with integrated Class A filters. The inverter 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.

EMC Emissions

Note

Install all drives 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.

Table 10- 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

Harmonic Currents

Table 10- 8 Harmonic Currents

Typical Harmonic Current (% of rated input current) at U_K 1 %							
5th	**7th**	**11th**	**13th**	**17th**	**19th**	**23rd**	**25th**
54	39	11	5	5	3	2	2

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.

EMC Immunity

The SINAMICS G120D drives have been tested in accordance with the immunity requirements of category C3 (industrial) environment.

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

Table 10- 9 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	

Appendix

A

A.1 New and extended functions

A.1.1 Firmware version 4.7 SP10

Table A- 1 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 inverter operation. Monitoring time for data failure at the Modbus interface: p2040 = 10 s • r2057 indicates how the address switch on the inverter is set	✓	✓	✓	✓	✓	✓	-	-	-
3	BACnet MS/TP: • New factory setting for more robust inverter 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 inverter 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)	-	✓	-	-

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

A.1.2 Firmware version 4.7 SP9

Table A- 2 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 inverters: • 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 inverter 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	-	-	-	-	-	✓	-	✓	-

	Function	SINAMICS								
				G120				G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC-2
14	Expansion to include a feedback signal if a memory card is not inserted in the inverter: • Parameter r9401 as BiCo parameter for the optional feedback signal to the higher-level control system. • New alarm A01101	✓	✓	✓	✓	✓	✓	✓	✓	✓
15	Expansion of the "End stop control" function on the following inverters: • 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 inverters with CU230P-2 Control Unit	✓	✓	✓	✓	✓	✓	✓	✓	✓
18	The inverter displays the state "PROFIenergy pause" as follows: • LED RDY "green on": 0.5 s • LED RDY off: 3 s	✓	✓	✓	✓	✓	✓	✓	✓	✓

Changes in the current edition (Page 3)

A.1.3 Firmware version 4.7 SP6

Table A- 3 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 You can find additional information in the "Safety Integrated" function manual. Overview of the manuals (Page 389)	-	-	-	-	✓	✓	-	-	-
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.	✓	✓	✓	✓	✓	✓	✓	-	-

Changes in the current edition (Page 3)

A.1.4 Firmware version 4.7 SP3

Table A- 4 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** . You can find additional information in the "Safety Integrated" function manual. Overview of the manuals (Page 389)	-	-	✓	✓	✓	-	-	-	-
	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	✓	-	-	-	-	-	-	-	-

	Function	SINAMICS								
				G120				G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC-2
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 inverters: • 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.	-	-	✓	-	-	-	-	-	-
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 inverter 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	-	-	✓	-	-	-	-	-	-

	Function	SINAMICS								
				G120				G120D		
		G110M	G120C	CU230P-2	CU240B-2	CU240E-2	CU250S-2	CU240D-2	CU250D-2	ET 200pro FC-2
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 inverter 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	-	-	✓	✓	✓	✓	-	-	-

A.1.5 Firmware version 4.7

Table A- 5 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 inverter 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 inverter 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 inverter 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, an inverter 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.1.6 Firmware version 4.6 SP6

Table A- 6 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.1.7 Firmware version 4.6

Table A- 7 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 inverter

A.2.1 Fundamentals

The following functions are implemented in the inverter:

- 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.

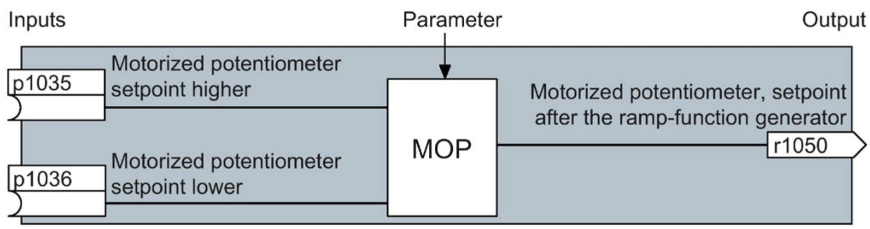


Figure A-1 Example of a block: Motorized potentiometer (MOP)

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.

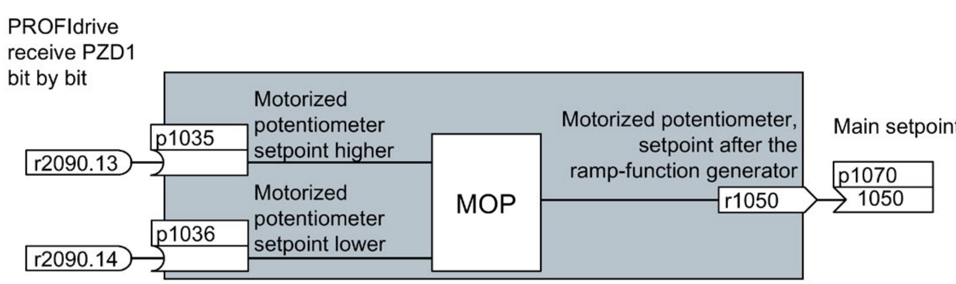


Figure A-2 Example: Signal interconnection of two blocks for digital input 0

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)

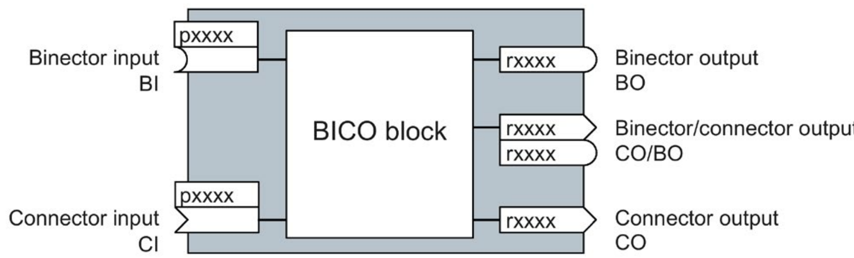


Figure A-3 Symbols for binector and connector inputs and outputs

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 inverter?

If you change the signal interconnection in the inverter, you can adapt the inverter 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.

We recommend that you use the STARTER and Startdrive commissioning tools for setting the signal interconnections.

Where can you find additional information?

- This manual suffices for assigning a different meaning to the digital inputs.
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- The function diagrams in the List Manual 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 inverter

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).

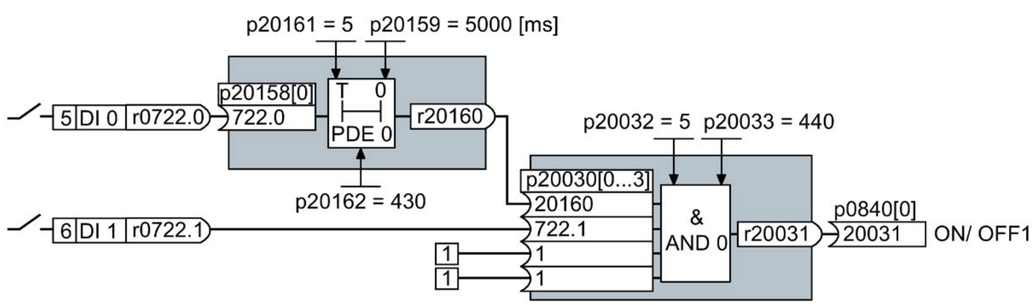


Figure A-4 Signal interconnection for control logic

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)

Parameter	Description
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 inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

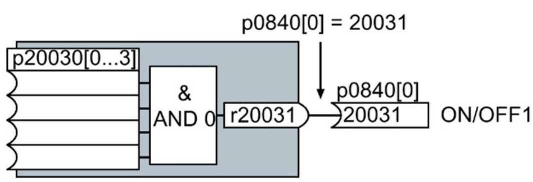


Figure A-5 Interconnecting blocks by setting p0840[0] = 20031

A.3 Application Examples

A.3.1 Setting an absolute encoder

Example for encoder data

In the following example, the inverter must evaluate an SSI encoder. The encoder data sheet also includes the following encoder data:

Table A- 8 Excerpt from the data sheet of the absolute encoder

Property	Value
Principle of operation	Multiturn
Operating voltage	10 V … 30 V
Clock frequency of the SSI interface	100 kHz … 1 MHz
Digital resolution	25 bit (8192 steps x 4096 revolutions)
SSI telegram	25 bit, without parity
Code type	Gray

Configuring an encoder with Startdrive

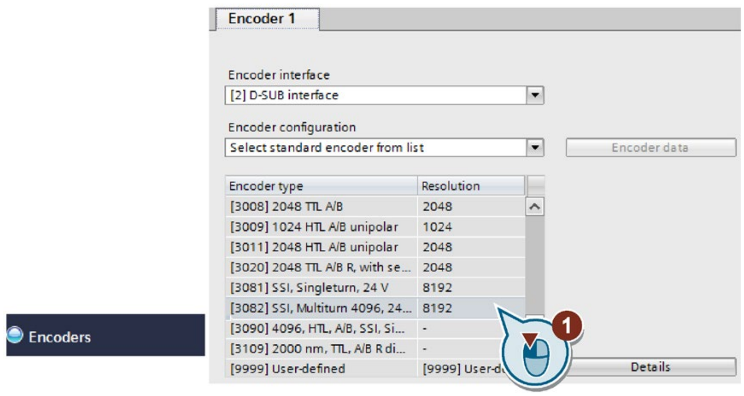
When configuring the encoder, you must select an encoder type that has the best possible fit to the real encoder.

Precondition

You have started the commissioning Wizard of the inverter.

Procedure

1. In the "Encoder" commissioning step, select the multiturn encoder with SSI interface.



Property	Value	Parameter
Principle of operation	Multiturn	p0404.2 = 1

2. Complete the commissioning Wizard.

You have now configured the absolute encoder.
❒

Adapting the encoder data

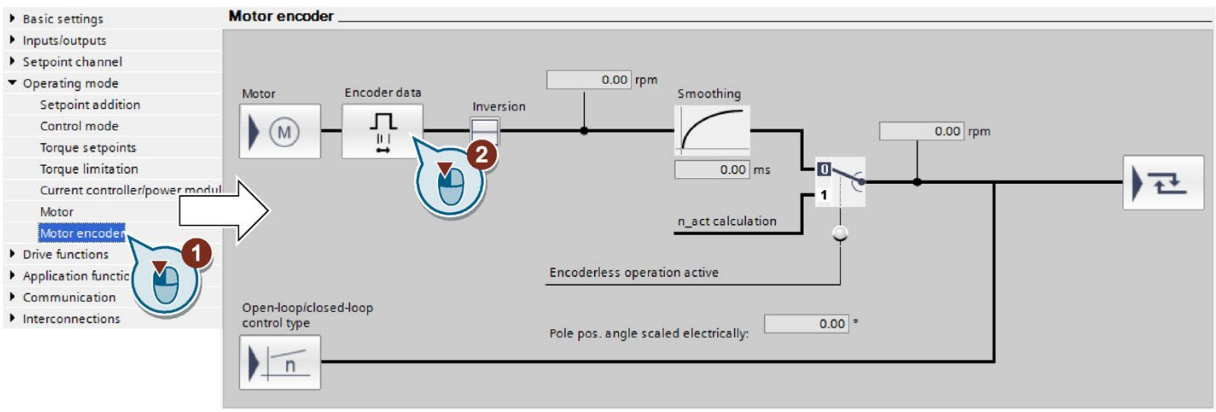
After the configuration you may now adapt the encoder data.

Preconditions

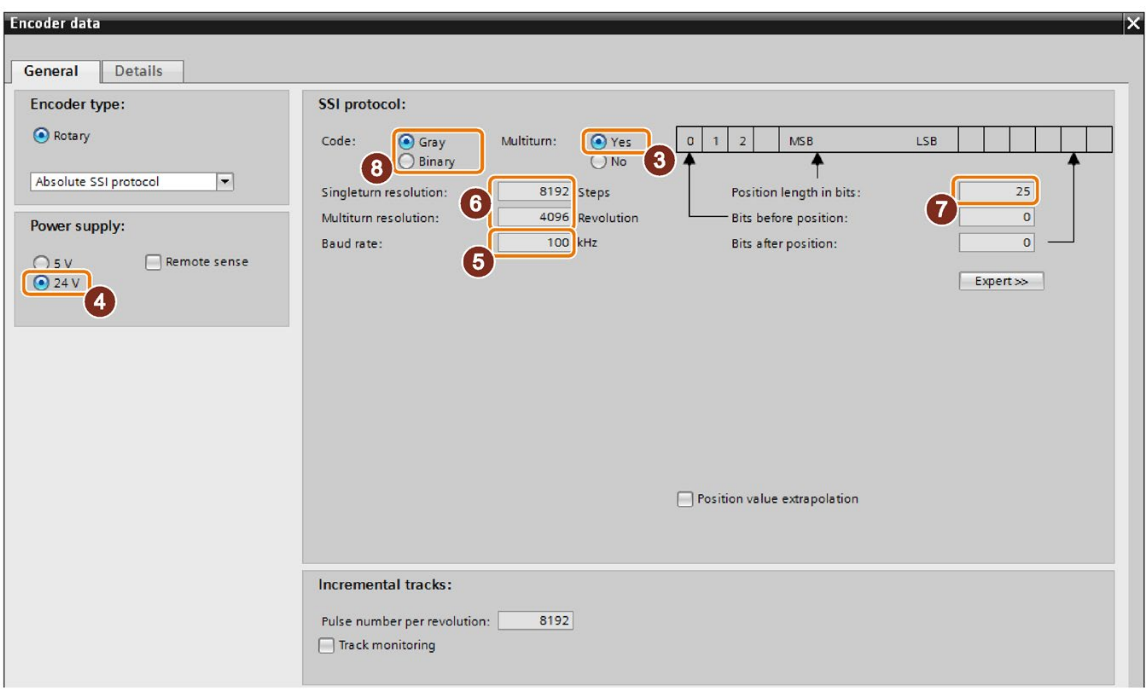
- You have now configured an absolute encoder.
- You have completely configured the drive.

Procedure

1. Select the "Motor encoder" screen form.

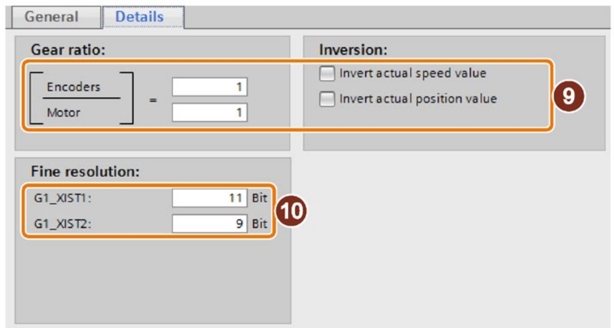


2. Select the "Encoder data" button.
3. … 10. In the "Encoder data" screen form, adapt the settings corresponding to the data sheet of your encoder.



Property	Value	General encoder data	Parameter
Principle of operation	Multiturn	③	p0404.2 = 1
Operating voltage	10 V … 30 V	④	p0404.21 = 1
Clock frequency of the SSI interface	100 kHz … 1 MHz	⑤	p0427 = 100

Property	Value	General encoder data	Parameter
Digital resolution	25 bit (8192 steps x 4096 revolutions)	⑥	p0423 = 8192 p0421 = 4096
SSI telegram	25 bit, without parity	⑦	p0447 = 25
Code type	Gray	⑧	p429.0 = 0



The "Details" tab is used for application-specific settings:

- ⑨ When required, invert the encoder signal.
- ⑩ The fine resolution can be separately set for the process data Gx_XIST1 and Gx_XIST2.

  2 bit fine resolution is practical for square wave encoders. Typically, sin/cos encoders have an 11 bit fine resolution.

You have adapted the encoder data.
❒

A.3.2 Connecting a fail-safe digital input

The following examples show the interconnection of a fail-safe 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 inverter 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.

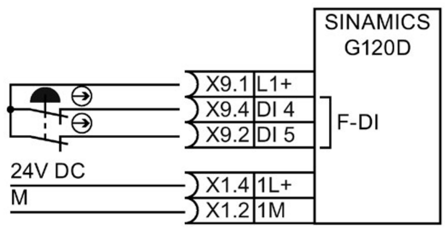


Figure A-6 Connecting a sensor, e.g. Emergency Stop mushroom push-button or limit switch

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.

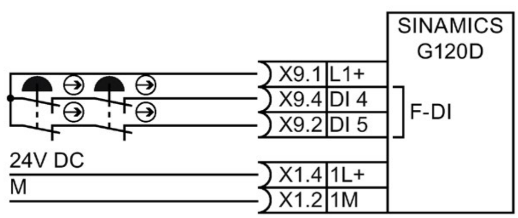


Figure A-7 Connecting electromechanical sensors in series

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 389)

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.

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="2">p0400[0]</td><td colspan="4">Encoder type selection (Factory setting: 0)
Selects the encoder from the list of encoder types supported by the firmware of the Control Unit.</td></tr>
<tr><td>0</td><td>No encoder</td><td>3005</td><td>1024 HTL A/B without zero mark</td></tr>
</table>

Parameter	Description				
	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 Setting a non standard SSI 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.

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="4">p0400[1]</td><td colspan="4">Encoder type selection (Factory setting: 0)
Selects the encoder from the list of encoder types supported by the firmware of the Control Unit.</td></tr>
<tr><td>0</td><td colspan="3">No encoder</td></tr>
<tr><td>3081</td><td colspan="3">SSI, Singleturn, 24 V</td></tr>
<tr><td>3082</td><td colspan="3">SSI, Multiturn 4096, 24 V</td></tr>
<tr><td rowspan="11">p0404[1]</td><td colspan="4">Encoder configuration effective (Factory setting: 0000 0000 0010 0000 0000 0000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>00</td><td>Linear encoder</td><td>Yes</td><td>No</td></tr>
<tr><td>01</td><td>Absolute encoder</td><td>Yes</td><td>No</td></tr>
<tr><td>02</td><td>Multiturn encoder</td><td>Yes</td><td>No</td></tr>
<tr><td>03</td><td>Track A/B sq-wave</td><td>Yes</td><td>No</td></tr>
<tr><td>09</td><td>SSI encoder</td><td>Yes</td><td>No</td></tr>
<tr><td>12</td><td>Equidistant zero mark</td><td>Yes</td><td>No</td></tr>
<tr><td>13</td><td>Irregular zero mark</td><td>Yes</td><td>No</td></tr>
<tr><td>14</td><td>Distance-coded zero mark</td><td>Yes</td><td>No</td></tr>
<tr><td>21</td><td>Voltage level 24 V</td><td>Yes</td><td>No</td></tr>
<tr><td>p0407[1]</td><td colspan="4">Linear encoder grid division (Factory setting: 16000 [nm])
Sets the grid division for a linear encoder.</td></tr>
<tr><td>p0408[1]</td><td colspan="4">Rotary encoder pulse No. (Factory setting: 2048)
Sets the number of encoder pulses.</td></tr>
<tr><td rowspan="3">p0410[1]</td><td colspan="4">Encoder inversion actual value (Factory setting: 0000 bin)</td></tr>
<tr><td>Bit 00</td><td colspan="3">1 signal: Invert speed actual value</td></tr>
<tr><td>Bit 01</td><td colspan="3">1 signal: Invert position actual value</td></tr>
<tr><td>p0418[1]</td><td colspan="4">Fine resolution Gx_XIST1 (in bits) (factory setting: 2)
The parameter applies for the following process data:
• Gx_XIST1
• Gx_XIST2 for reference mark or flying measurement
The fine resolution specifies the fraction between two encoder pulses. Depending on the physical measurement principle, an encoder pulse can be broken down into a different number of fractions (e.g. squarewave encoder: 2 bit = resolution 4).</td></tr>
<tr><td>p0419[1]</td><td colspan="4">Fine resolution absolute value Gx_XIST2 (in bits) (factory setting: 2)</td></tr>
<tr><td>p0421[1]</td><td colspan="4">Absolute encoder rotary multiturn resolution (factory setting: 4096)
Sets the number of rotations that can be resolved for a rotary absolute encoder.</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>p0422[1]</td><td>Absolute encoder linear measuring step resolution (factory setting: 100 [nm])
Sets the resolution of the absolute position for a linear absolute encoder.</td></tr>
<tr><td>p0423[1]</td><td>Absolute encoder rotary singleturn resolution (factory setting: 8192)
Sets the number of measuring steps per revolution for a rotary absolute encoder. The resolution refers to the absolute position.</td></tr>
<tr><td>p0425[1]</td><td>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.</td></tr>
<tr><td>p0426[1]</td><td>Encoder zero mark differential distance (Factory setting: 1)
Sets the differential distance with distance-coded zero marks [signal periods].
The value corresponds to jump displacement of "zero mark with interference".</td></tr>
<tr><td>p0427[1]</td><td>Encoder SSI baud rate (Factory setting: 100 [kHz])</td></tr>
<tr><td>p0428[1]</td><td>Encoder SSI monoflop time (Factory setting: 30 [µs])
Sets the minimum delay time between two data transfers of the absolute value for an SSI encoder.</td></tr>
<tr><td>p0429[1]</td><td>Encoder SSI configuration (Factory setting: 0000 0000 bin)
<table>
<tr><th>Bit</th><th>Signal name</th><th>1 signal</th><th>0 signal</th></tr>
<tr><td>00</td><td>Transfer code</td><td>Binary code</td><td>Gray code</td></tr>
<tr><td>02</td><td>Transfer absolute value twice</td><td>Yes</td><td>No</td></tr>
<tr><td>06</td><td>Data line during the monoflop time</td><td>High level</td><td>Low level</td></tr>
</table></td></tr>
<tr><td>p0430[1]</td><td>Sensor Module configuration (Factory setting: 0000 0000 0000 0000 0000 0000 0000 0000 bin)
<table>
<tr><th>Bit</th><th>Signal name</th><th>1 signal</th><th>0 signal</th></tr>
<tr><td>21</td><td>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.</td><td>Yes</td><td>No</td></tr>
<tr><td>25</td><td>Switch-off encoder voltage supply during parking</td><td>Yes</td><td>No</td></tr>
<tr><td>27</td><td>Extrapolate position values</td><td>Yes</td><td>No</td></tr>
</table>
A bit-wise configuration is only possible if the corresponding property is also present in r0458.</td></tr>
<tr><td>p0434[1]</td><td>Encoder SSI error bit (Factory setting: 0)
Sets the position and level of the error bit in the SSI protocol.
<table>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td>Position of the error bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td>Level (0: Low level, 1: High level).</td></tr>
<tr><td>d</td><td>State of the evaluation (0: Off, 1: On with 1 error bit, 2: On with 2 error bits ... 9: On with 9 error bits).</td></tr>
</table>
Example: p0434 = 1013 → The evaluation is switched in and the error bit is at position 13 with a low level.</td></tr>
<tr><td>p0435[1]</td><td>Encoder SSI alarm bit (Factory setting: 0)
Sets the position and level of the alarm bit in the SSI protocol.
<table>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td>Position of the alarm bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td>Level (0: Low level, 1: High level).</td></tr>
<tr><td>d</td><td>State of the evaluation (0: Off, 1: On).</td></tr>
</table>
p0435 = 1014 → The evaluation is switched in and the alarm bit is at position 14 with a low level.</td></tr>
<tr><td>p0436[1]</td><td>Encoder SSI parity bit (Factory setting: 0)
Sets the position and parity of the parity bit in the SSI protocol.
<table>
<tr><td rowspan="3">Value = dcba</td><td>ba</td><td>Position of the parity bit in the protocol (0 ... 63).</td></tr>
<tr><td>c</td><td>Parity (0: even, 1: uneven).</td></tr>
<tr><td>d</td><td>State of the evaluation (0: Off, 1: On).</td></tr>
</table>
p0436 = 1015 → The evaluation is switched in and the parity bit is at position 15 with even parity.</td></tr>
</table>

<table>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="11">p0437[1]</td><td colspan="4">Sensor Module configuration extended (Factory setting: 0000 0000 0000 0000 0000 1000 0000 0000 bin)</td></tr>
<tr><td>Bit</td><td>Signal name</td><td>1 signal</td><td>0 signal</td></tr>
<tr><td>00</td><td>Data logger</td><td>Yes</td><td>No</td></tr>
<tr><td>01</td><td>Zero mark edge detection</td><td>Yes</td><td>No</td></tr>
<tr><td>02</td><td>Correction position actual value XIST1</td><td>Yes</td><td>No</td></tr>
<tr><td>04</td><td>Edge evaluation bit 0</td><td>Yes</td><td>No</td></tr>
<tr><td>05</td><td>Edge evaluation bit 1</td><td>Yes</td><td>No</td></tr>
<tr><td>06</td><td>Freeze the speed actual value for dn/dt errors</td><td>Yes</td><td>No</td></tr>
<tr><td>11</td><td>Fault handling after PROFIdrive</td><td>Yes</td><td>No</td></tr>
<tr><td>12</td><td>Activate additional messages</td><td>Yes</td><td>No</td></tr>
<tr><td>13</td><td>Support absolute position for incremental encoder</td><td>Yes</td><td>No</td></tr>
<tr><td></td><td>26</td><td>Deselect track monitoring</td><td>Yes</td><td>No</td></tr>
<tr><td rowspan="2">p0438[1]</td><td colspan="4">Squarewave encoder filter time (Factory setting: 0.64 [μs])</td></tr>
<tr><td>0</td><td colspan="3">No filtering</td></tr>
<tr><td>p0439[1]</td><td colspan="4">Encoder ramp-up time (Factory setting: 0 [ms])</td></tr>
<tr><td>p0446[1]</td><td colspan="4">Encoder SSI number of bits before the absolute value (Factory setting: 0)</td></tr>
<tr><td>p0447[1]</td><td colspan="4">Encoder SSI number of bits absolute value (Factory setting: 25)</td></tr>
<tr><td>p0448[1]</td><td colspan="4">Encoder SSI number of bits after the absolute value (Factory setting: 0)</td></tr>
<tr><td>p0449[1]</td><td colspan="4">Encoder SSI number of bits, filler bits (Factory setting: 1)
Sets the number of filler bits for double absolute value transfer in the SSI protocol.
This parameter is only of significance for p0429.2 = 1.</td></tr>
<tr><td>r0452[1]</td><td colspan="4">Squarewave encoder filter time display</td></tr>
<tr><td>p0453[1]</td><td colspan="4">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.</td></tr>
</table>

For further information, please refer to the List Manual.

A.6 Acceptance tests for the safety functions

A.6.1 Recommended acceptance test

The following descriptions for the acceptance test are recommendations that illustrate the principle of acceptance. You may deviate from these recommendations if you check the following once you have completed commissioning:

- Correct assignment of the interfaces of each converter with the safety function:
  - Fail-safe inputs
  - PROFIsafe address
- Correct setting of the STO safety function.

Note

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

Note

Non-critical alarms

The following alarms are issued following each system ramp-up and are not critical for acceptance:

- A01697
- A01796

A.6.2 Acceptance test STO (basic functions)

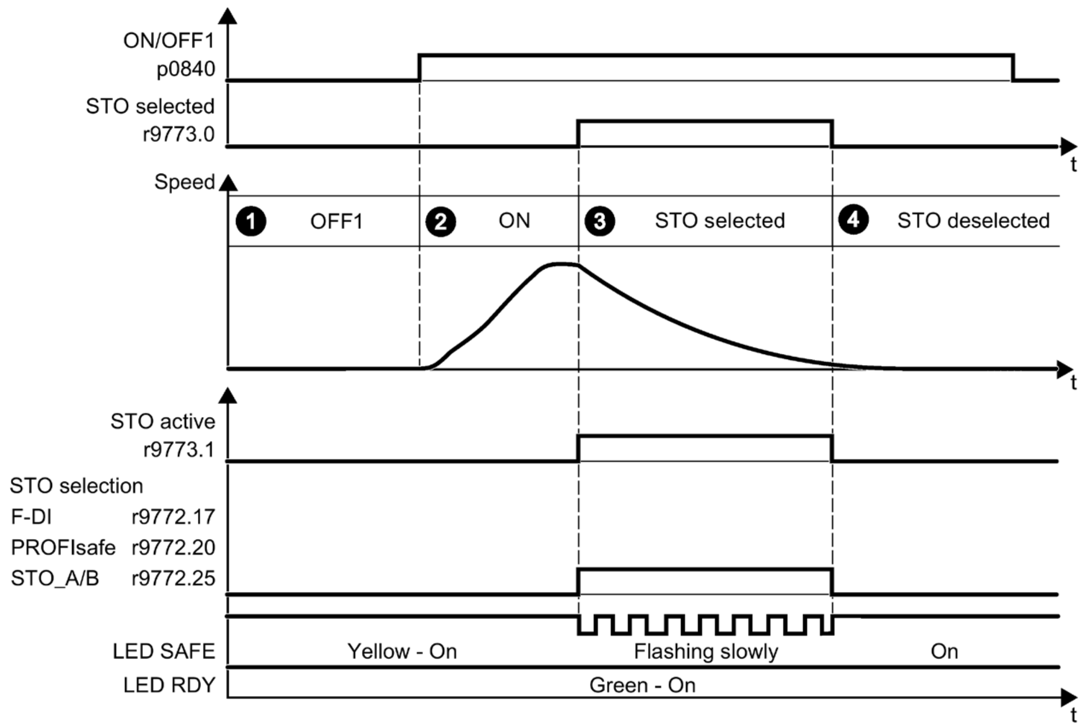


Figure A-8 Acceptance test for STO (Basic Functions)

Procedure

<table>
<tr><td colspan="5"></td><td>Status</td></tr>
<tr><td rowspan="3">1.</td><td colspan="4">The inverter is ready</td><td></td></tr>
<tr><td colspan="4">• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).</td><td></td></tr>
<tr><td colspan="4">• STO is not active (r9773.1 = 0).</td><td></td></tr>
<tr><td rowspan="4">2.</td><td colspan="4">Switch on motor</td><td></td></tr>
<tr><td>2.1.</td><td colspan="3">Enter a speed setpoint ≠ 0.</td><td></td></tr>
<tr><td>2.2.</td><td colspan="3">Switch on the motor (ON command).</td><td></td></tr>
<tr><td>2.3.</td><td colspan="3">Check that the correct motor is running.</td><td></td></tr>
<tr><td rowspan="4">3.</td><td colspan="4">Select STO</td><td></td></tr>
<tr><td>3.1.</td><td colspan="3">Select STO while the motor is running.
Test each configured activation, e.g. via digital inputs and PROFIsafe.</td><td></td></tr>
<tr><td rowspan="2">3.2.</td><td colspan="3">Check the following:</td><td></td></tr>
<tr><td>When controlled via PROFIsafe</td><td>When controlled via an F-DI failsafe digital input</td><td>When controlled via STO_A and STO_B terminals on a PM240-2 or PM240P-2 Power Module</td><td></td></tr>
</table>

					Status
		• The inverter signals the following: "STO selection via PROFIsafe" (r9772.20 = 1)	• The inverter signals the following: "STO Selection via terminal" (r9772.17 = 1)	• The inverter signals the following: "STO Selection via terminal on Power Module" (r9772.25 = 1)	
		• If a mechanical brake is not available, the motor coasts down. A mechanical brake brakes the motor and holds it to ensure that it remains at standstill.			
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			
		• The inverter signals the following: "STO is selected" (r9773.0 = 1). "STO is active" (r9773.1 = 1).			
4.	**Deselect STO**				
	4.1.	Deselect STO.			
	4.2.	Check the following:			
		• STO is not active (r9773.1 = 0).			
		• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).			

You have performed the acceptance test of the STO function.
❒

A.6.3 Machine documentation

Machine or plant description

Designation	
Type	
Serial number	
Manufacturer	
End customer	
Overview diagram of the machine and/or system:	

Inverter data

The inverter data include the hardware version of the safety-relevant inverter.

Labeling the drive	Article number and hardware version of the inverter

Function table

The active safety functions depending on the operating mode and safety equipment are shown in the function table.

Operating mode	Safety equipment	Drive	Selected safety function	Checked

Table A- 9 Example of a function table

Operating mode	Safety equipment	Drive	Selected safety function	Checked
Automatic	*Protective door closed*	*Conveyor belt*	---	---
	Protective door open	*Conveyor belt*	*STO*	
	Emergency Stop button pressed	*Conveyor belt*	*STO*	

Acceptance test reports

File name of the acceptance reports	

Data backup

Data	Storage medium			Holding area
	Archiving type	Designation	Date	
Acceptance test reports				
PLC program				
Circuit diagrams				

Countersignatures

Commissioning engineer

The commissioning engineer confirms that the tests and checks listed above have been correctly executed.

Date	Name	Company/dept.	Signature
…	…	…	…

Machine manufacturer

The machine OEM confirms the correctness of the settings documented above.

Date	Name	Company/dept.	Signature
…	…	…	…

A.6.4 Documenting the settings for the basic functions, firmware V4.4 ... V4.7 SP6

Drive = <pDO-NAME_v>

Table A- 10 Firmware version

Name	Number	Value
Control Unit firmware version	r18	<r18_v>
SI version, safety functions integrated in the drive (processor 1)	r9770	<r9770_v>

Table A- 11 Monitoring cycle

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

Table A- 12 Checksums

Name	Number	Value
SI module identifier, Control Unit	r9670	<r9670_v>
SI module identifier, Power Module	r9672	<r9672_v>
SI reference checksum SI parameters (processor 1)	p9799	<p9799_v>
SI reference checksum SI parameters (processor 2)	p9899	<p9899_v>

Table A- 13 Settings of the safety functions

Name		Number	Value
SI enable, functions integrated in the drive		p9601	<p9601_v>
Only for the CU250S-2 Control Unit	SI enable safe brake control	p9602	<p9602_v>
SI PROFIsafe address		p9610	<p9610_v>
F-DI switch over discrepancy time		p9650	<p9650_v>
SI STO debounce time		p9651	<p9651_v>
Only for the CU250S-2 Control Unit	SI Safe Stop 1 delay time	p9652	<p9652_v>
SI forced dormant error detection timer		p9659	<p9659_v>
SI forced checking procedure STO via PM terminals time		p9661	<p9661_v>

Table A- 14 Safety logbook

Name	Number	Value
SI change control checksum	r9781[0]	<r9781[0]_v>
SI change control checksum	r9781[1]	<r9781[1]_v>
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.7 Manuals and technical support

A.7.1 Overview of the manuals

Manuals with additional information that can be downloaded:

- Getting Started SINAMICS G120D
  (https://support.industry.siemens.com/cs/ww/en/view/109477364)
  Installing the converter and commissioning.

- Operating instructions SINAMICS G120D with CU250D-2
  (https://support.industry.siemens.com/cs/ww/en/view/109477365)
  Installing, commissioning and maintaining the inverter. Extended commissioning (this manual).

- EMC installation guideline (http://support.automation.siemens.com/WW/view/en/60612658)
  EMC-compliant control cabinet design, potential equalization and cable routing.
- "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/ene/view/109751320)
  Commissioning and optimizing safety functions.
- List manual SINAMICS G120D (https://support.industry.siemens.com/cs/ww/en/view/109477255)
  Parameter list, alarms and faults. Graphic function diagrams.
- 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 inverter components, e.g. line reactors and line filters. The printed installation descriptions are supplied together with the components.

Finding the most recent edition of a manual

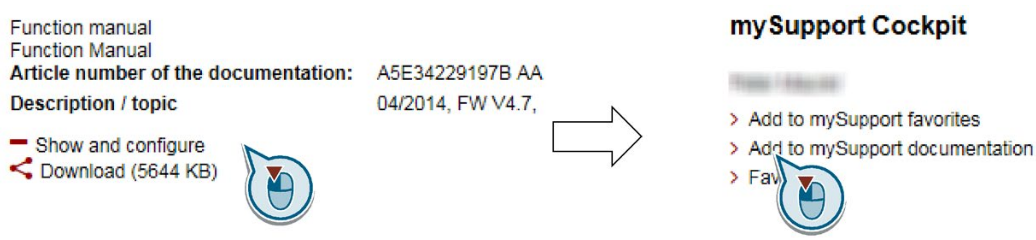
If there a multiple editions of a manual, select the latest edition:

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.7.2 Configuring support

Catalog

Ordering data and technical information for SINAMICS G inverters.

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.7.3 Product Support

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".

Index

Reference point approach, 110, 111, 172, 173

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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.