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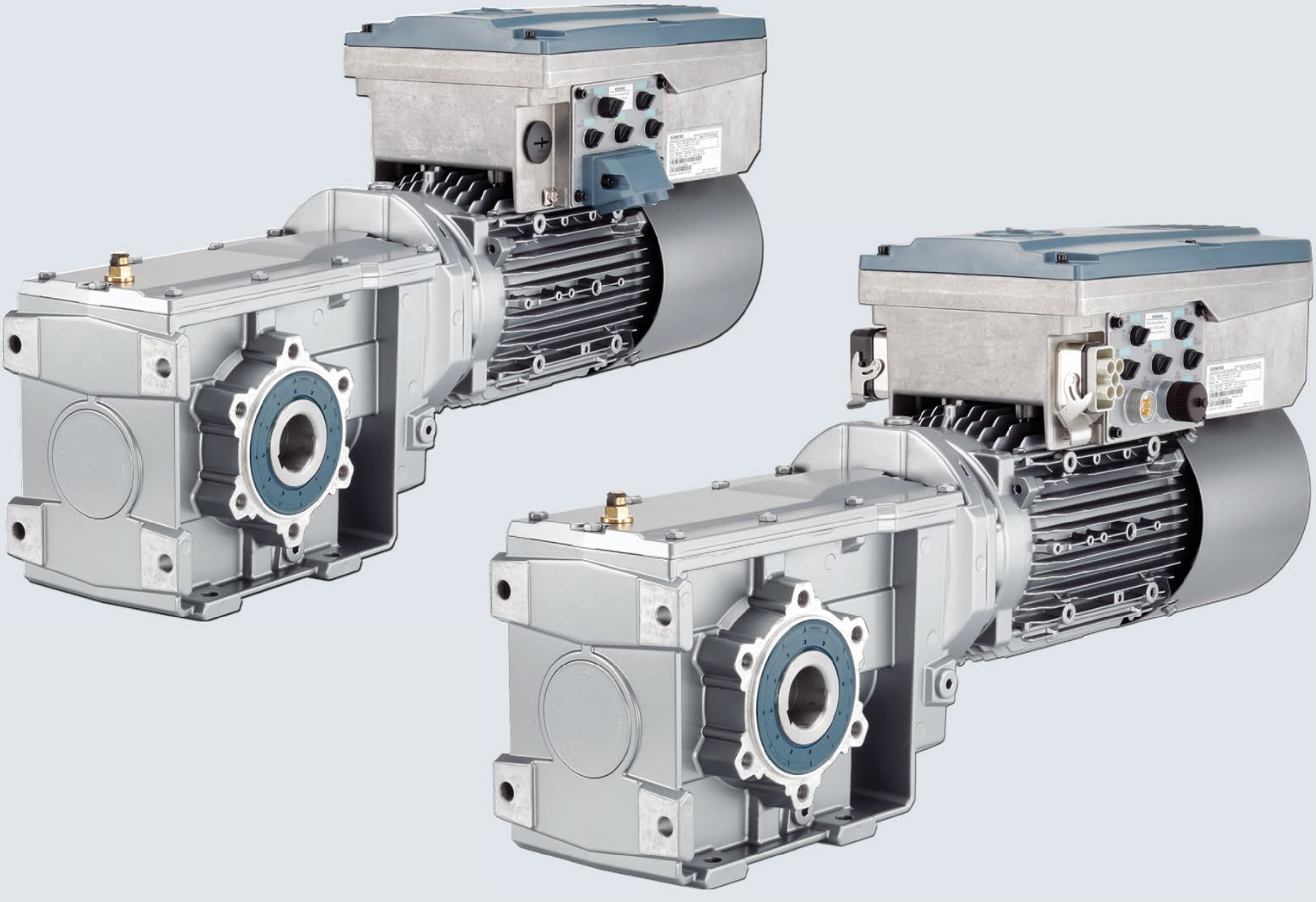

Operating Instructions

SINAMICS

SINAMICS G110M

Distributed converter for
SIMOGEAR geared motors

Edition 04/2018

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SINAMICS G110M Distributed converter for SIMOGEAR geared motors

Operating Instructions

Edition 04/2018, Firmware V4.7 SP10

Original instructions
04/2018, FW V4.7 SP10
A5E31298649B AI

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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Changes in this manual

Essential changes with respect to Edition 04/2018

New functions

Firmware version 4.7 SP10 (Page 369)

Revised chapters

- The commissioning with the PC tool STARTER has been removed. The new commissioning tool for the PC is Startdrive and is described in this manual. The description of the Know How Protection and Write Protection still contains the function description using the STARTER software.
  If the user needs a description of the STARTER software, please refer to the previous versions of this manual.

Previous version of manual (https://support.industry.siemens.com/cs/us/en/view/109751325)

Corrections

- Revised information: Current derating depending on the installation altitude:

  Current derating as a function of the installation altitude (Page 366)

- New information: Controlling clockwise and counter-clockwise rotation using digital inputs:

  Controlling clockwise and counter-clockwise rotation via digital inputs (Page 152)

Table of contents

Fundamental safety instructions 1

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

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 optional components are available for the inverter? • What is the purpose of the optional components? • Which motors can be fed from the inverter? • Which commissioning tools are there?
Installation (Page 39)	• Which sequence is recommended when installing the inverter? • What does EMC-compliant installation actually mean? • Which options are available to install optional components below the inverter? • 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? • How is the braking resistor connected to the inverter? • Which terminals and fieldbus interfaces does the inverter have? • What are the interface functions?
Commissioning (Page 101)	• 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 139)	• Which functions are included in the inverter firmware? • How do the functions interoperate with one another? • How are the functions set?
Data backup and series commissioning (Page 303)	• 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 343)	• How are inverter components replaced? • How do you change the firmware version of the inverter?
Alarms, faults and system messages (Page 323)	• 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 361)	• What is the inverter technical data? • What do "High Overload" and "Low Overload" mean?
Appendix (Page 369)	• What are the new functions of the current firmware? • What are the most important inverter parameters? • How is the inverter operated using the BOP-2 Operator Panel? • 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 Identifying the components of the system

The SINAMICS G110M is a complete converter system for controlling the speed of a three-phase motor.

Each part of the system is shown in the following figure.

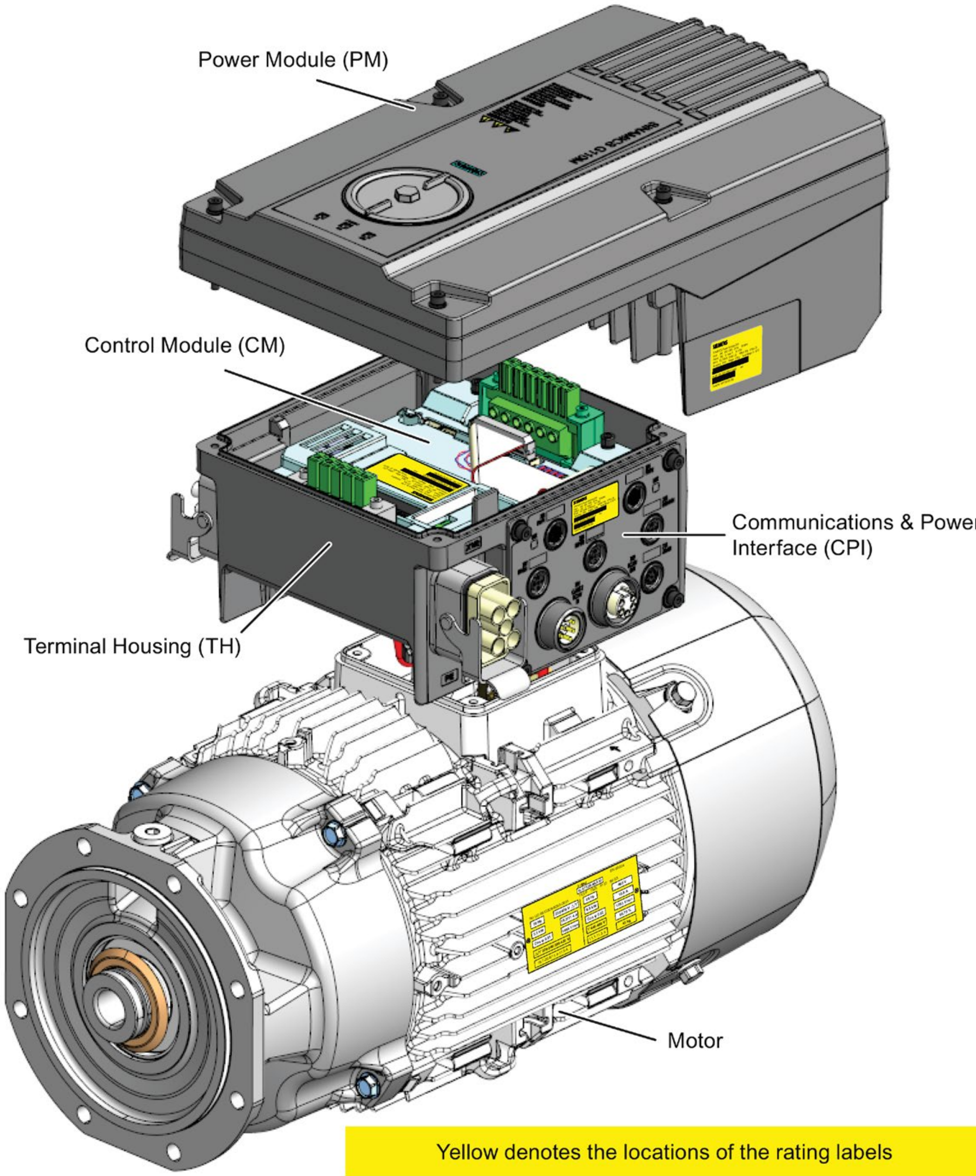
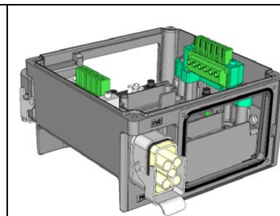
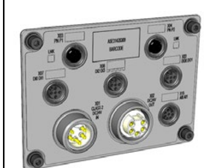
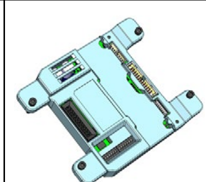
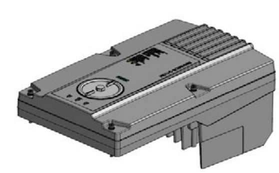
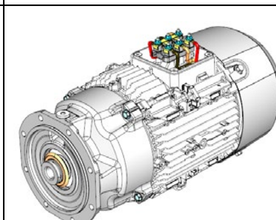


Figure 3-1 Identifying the components of the system

3.2 SINAMICS G110M converter

Overview

The SINAMICS G110M system consists of the following components:

Terminal Housing (TH)	The TH acts as the connection between the G110M and the motor. The TH replaces the normal motor terminal box. The TH contains the following components:		
	Communications and Power Interface (CPI)	The CPI provides all the input and outputs connections for the converter. In addition it allows for the provision of an optional external 24 V power supply.	
	Control Module (CM)	The CM interfaces with the CPI and the converter to provide all the command and control functions of the converter.	
Power Module (PM)	The PM provides the power to the converter and through the DC link provides power to the low voltage circuits in the CM and the PM.		
Three-phase motor	The SINAMICS G110M is designed for mounting on the SIMOGEAR geered motors. It is compatible with motors of frame sizes 71 to 112.		

The Power Modules are designed for a specific power range and the Terminal Housings are designed to work with specific motors. The Terminal Housing not only allows the direct mounting onto a motor but specific cable glands and mains connectors are specified. All the various combinations of Power Modules, Terminal Housings (including the Control Modules) and Options are given in the tables below.

⚠ CAUTION

Converter has the potential to start running of a PLC power-cycle

The converter has the potential to start running after a power-cycle of the controlling PLC, if an ON command was present prior to the power-cycle of the PLC.

It is the users responsibility to ensure that the converter runs only when it is appropriate of the user's application.

Table 3- 1 PM240M Power Modules - 3AC, 400 V, Class A, IP66

Frame size	Rated output power (kW)	Rated output current (A)	Article number
	based on High Overload (HO)		
FSA	0.37	1.3	6SL3517-1BE11-3AM0
FSA	0.75	2.2	6SL3517-1BE12-3AM0
FSA	1.1	3.1	6SL3517-1BE13-3AM0
FSA	1.5	4.1	6SL3517-1BE14-3AM0
FSB	2.2	5.6	6SL3517-1BE16-3AM0
FSB	3.0	7.3	6SL3517-1BE17-7AM0
FSB	4.0	8.8	6SL3517-1BE21-0AM0

Table 3- 2 CU240M Terminal Housing (including the Control Module)

Communications	Motor frame size	Mains / 24 V DC connections	Article number
USS	FS71	Cable glands	6SL3544-0LB02-1BA0
USS	FS80/90	Cable glands	6SL3544-0MB02-1BA0
USS	FS100/112	Cable glands	6SL3544-0NB02-1BA0
PROFIBUS	FS71	Cable glands	6SL3544-0LB02-1PA0
PROFIBUS	FS80/90	Cable glands	6SL3544-0MB02-1PA0
PROFIBUS	FS100/112	Cable glands	6SL3544-0NB02-1PA0
PROFIBUS	FS71	HanQ 4/2 / 7/8"	6SL3544-0TB02-1PA0
PROFIBUS	FS80/90	HanQ 4/2 / 7/8"	6SL3544-0PB02-1PA0
PROFIBUS	FS100/112	HanQ 4/2 / 7/8"	6SL3544-0QB02-1PA0
PROFINET	FS71	Cable glands	6SL3544-0LB02-1FA0
PROFINET	FS80/90	Cable glands	6SL3544-0MB02-1FA0
PROFINET	FS100/112	Cable glands	6SL3544-0NB02-1FA0

Communications	Motor frame size	Mains / 24 V DC connections	Article number
PROFINET	FS71	HanQ 4/2 / 7/8"	6SL3544-0TB02-1FA0
PROFINET	FS80/90	HanQ 4/2 / 7/8"	6SL3544-0PB02-1FA0
PROFINET	FS100/112	HanQ 4/2 / 7/8"	6SL3544-0QB02-1FA0
AS-i	FS71	Cable glands	6SL3544-0LB02-1MA0
AS-i	FS80/90	Cable glands	6SL3544-0MB02-1MA0
AS-i	FS100/112	Cable glands	6SL3544-0NB02-1MA0
AS-i	FS71	HanQ 4/2 / 7/8"	6SL3544-0TB02-1MA0
AS-i	FS80/90	HanQ 4/2 / 7/8"	6SL3544-0PB02-1MA0
AS-i	FS100/112	HanQ 4/2 / 7/8"	6SL3544-0QB02-1MA0

Every SINAMICS G110M is delivered with the following accessories:

All variants

- PTC connection cable - this is the extension cable used to connect the PTC wires from the motor to the connection on the CPI board.
- EM brake cable - this the extension cable used to connect the EM brake wires from the motor to the mains connector when the EM brake wire is too short.
- Pre-wired motor terminal cables ready for connecting to the motor terminals on the motor.
- Earthing cable for earthing the motor to the terminal housing (except FS80/90).
- PROFIBUS Communications cable for connecting the CPI board to the communications connection on the Control Module.

SINAMICS G110M HanQ 4/2 variant

- Male and female HanQ connectors, one of which is pre-wired with pins crimped on the other end ready for assembly.
- Blanking cap for users not wishing to utilize the power-through daisy chain.

Table 3- 3 SINAMICS G110M Options

Option	Description	Article number
24 V Power supply	Internal 24 V DC power supply for the CU240M	6SL3555-0PV00-0AA0
Internal braking resistor (FSA)	Continuous braking power 7.5 W, peak power 75 W (load period t_a=12s over a period t=240s) resistance 350 Ω	6SL3501-0BE18-8AA0
Internal braking resistor (FSB)	Continuous braking power 20 W, peak power 200 W (load period t_a=12s over a period t=240s) resistance 175 Ω	6SL3501-0BE22-0AA0
Glanded connector kit	Comprises the following connectors: • M20 screw gland - used for 24 V power supply daisy chain • M25 plastic gland - used for the 3-phase mains daisy chain • M12 plastic gland - used for the EM-brake cable entry.	6SL3566-2VA00-0GA0

Option	Description	Article number
HanQ connector kit	Comprises the following connectors: • Connector cap 7/8th internal thread - used for the 24 V power blanking cap • HanQ blanking cap - used for the mains input blankingcap • M12 plastic gland - used for the EM-brake cable entry.	6SL3566-2LA00-0GA0
Repair Switch	The Repair Switch allows the motor/converter to be isolated from the mains. This means that all power to the motor is terminated and the con-verter cannot start or stop the motor.	6SL3555-0PR01-0AA0
Wall Mount Kit (WMK)	The WMK allows the converter to be mounted on a wall or flat surface separate from the location of the motor.	6SL3566-1GA00-0GA0

Compatible motors for the SINAMICS G110M system

The SINAMICS G110M is designed for mounting on SIMOGEAR geared motors. It is compatible with motors from frame size 71 to frame size 112. For an overview of which motors can be operated with SINAMICS G110M in combination with SIMOGEAR, please read FAQ 1097385577 at the following link:

FAQ 1097385577 (https://support.industry.siemens.com/cs/us/en/view/109738577)

For further information on the possible SIMOGEAR geared motors in combination with the SINAMICS G110M see the MD50.1 catalog, SIMOGEAR geared motors and DT configurator.

3.3 General layout SINAMICS G110M system

Introduction

The locations and description of the various interface connections of the CU240M Terminal housing (including the Control Module (CM)) and the PM240M Power Module (PM) are detailed in the figure and table below.

The layout and interfaces of the AS-i variant is shown in a separate figure and table below. The connections on the terminal housing are delivered with either HAN Q (pluggable) or Glanded connectors depending on the variant that has been ordered.

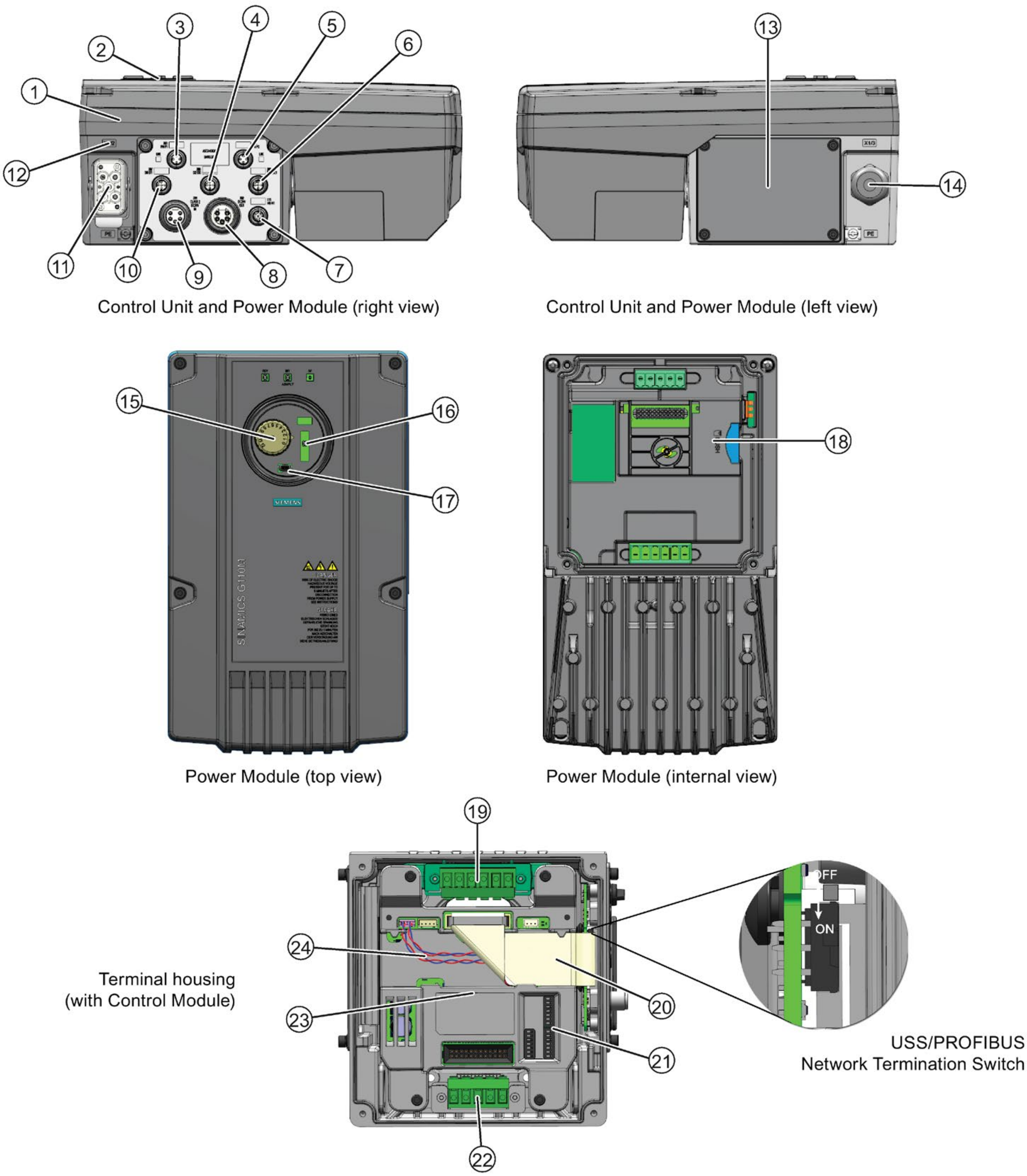


Figure 3-2 General layout of the system - all variants except CU240M AS-i

Table 3- 4 Description and location of interfaces

Item	Description	Item	Description
①	Power Module	⑬	Blanking plate - to seal the opposite side of the Terminal Housing from which the CPI has been fitted.
②	Interface cover	⑭	Cable gland or HANQ connections for left-side mounting or daisy chaining the mains supply
③	Communications port 1	⑮	Potentiometer
④	Digital input 2 and digital input 3	⑯	Optical I/O connection
⑤	Communications port 2	⑰	Mini USB connection
⑥	Digital output 0 and digital output 1	⑱	Memory card reader
⑦	Analog input 0 and analog input 1	⑲	Braking resistor & motor connection terminals
⑧	External 24 Vdc OUT	⑳	Communications & Power Interface (CPI) interface ribbon cable
⑨	External 24 Vdc IN	㉑	PROFIBUS/USS address and commissioning DIP switches 1 and 2
⑩	Digital input 0 and digital input 1	㉒	EM Brake & mains supply connection terminals
⑪	Mains supply connection	㉓	Control Module (CM)
⑫	Terminal housing	㉔	PROFIBUS/PROFINET/USS communications cable

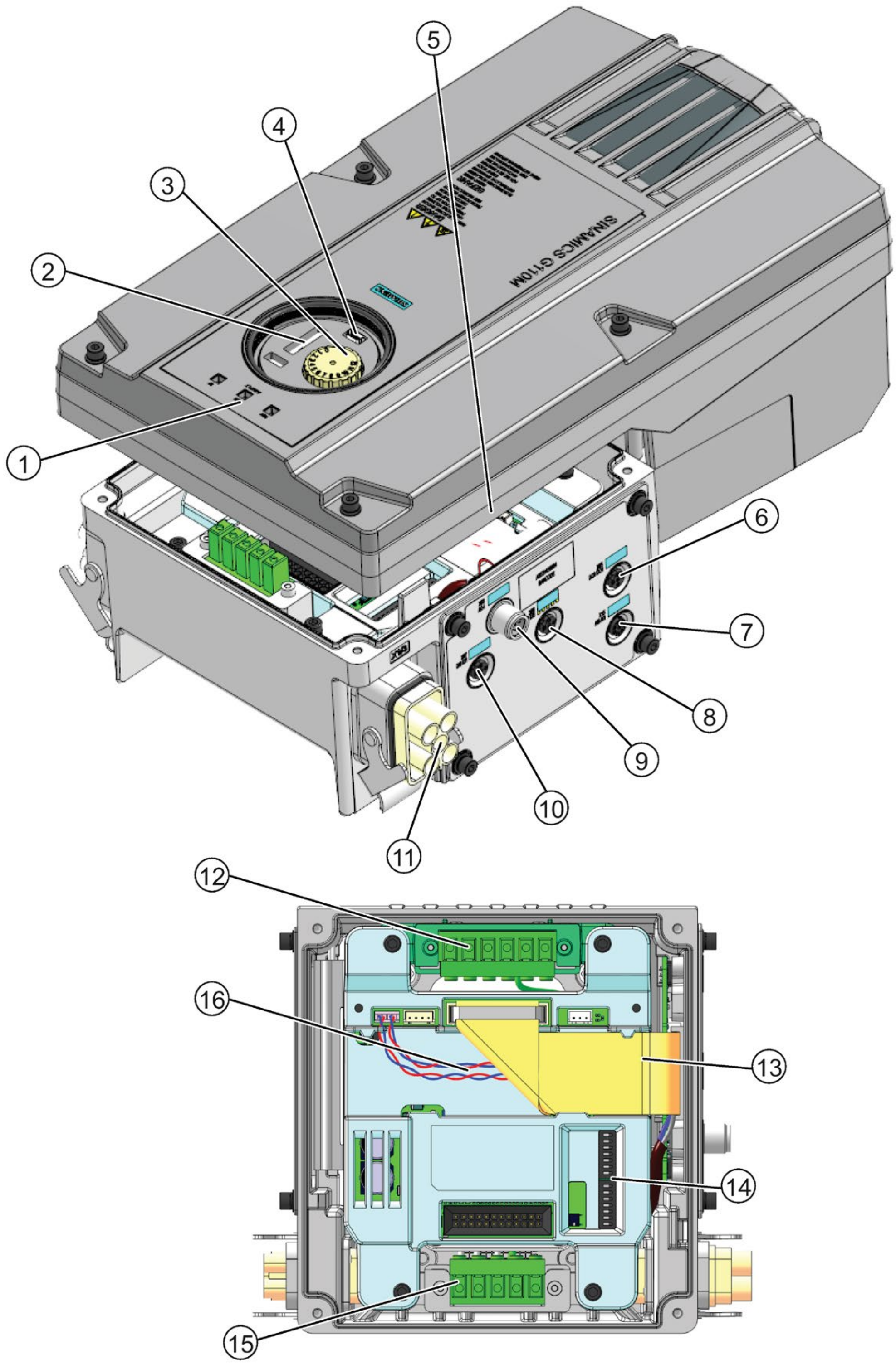


Figure 3-3 SINAMICS G110M ASi General Layout

Table 3- 5 Description and location of interfaces

Item	Description	Item	Description
①	Status LEDs	⑨	AS-i connection and Aux power
②	Optical I/O connection	⑩	Digital inputs 0 and 1
③	Potentiometer	⑪	Mains supply connection
④	Mini USB connection	⑫	Braking resistor & motor connection terminals
⑤	Card reader (on underside of Power Module)	⑬	Communications & Power Interface (CPI) interface ribbon cable
⑥	Digital outputs 0 and 1	⑭	Commissioning DIP switches 1 & 2
⑦	Analog inputs 0 and 1	⑮	EM brake & mains supply connection terminals
⑧	Digital inputs 2 and 3	⑯	Communications cable

3.4 Directives and standards

Relevant directives and standards

The following directives and standards are relevant for the inverters:

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).

Installation

4

⚠DANGER

Operation with ungrounded (IT) mains supplies can produce extremely dangerous conditions

The converter must always be grounded. If the converter is not grounded correctly, extremely dangerous conditions may arise within the inverter which could prove potentially fatal.

The converter can only be used on TT and TN mains supplies.

⚠DANGER

Risk of burns and fire due to high temperatures

During operation and for a short time after switching the converter off, the surfaces reach temperatures that can inflict burns or start fires!

Before attempting to touch the surfaces of the converter, ensure that enough time is given to allow the converter to cool down to a safe temperature to avoid personal injury.

Remove any flammable materials from around the converter to reduce the risk of fire.

⚠WARNING

Direct current on the PE conductor

This product can cause a direct current on the PE conductor.

If the wrong type of protection device is used, then the expected protection by such a device could fail to provide the expected protection.

If a residual current device (RCD) is used to provide protection in case of direct or indirect contact, **only a type B RCD** may be used on the power supply side of this product.

4.1 Mechanical Installation

Dimensions of the system

The converter has two frame sizes. Frame size A (FSA) and Frame size B (FSB), the dimensions of each frame size is given in the figure and table below.

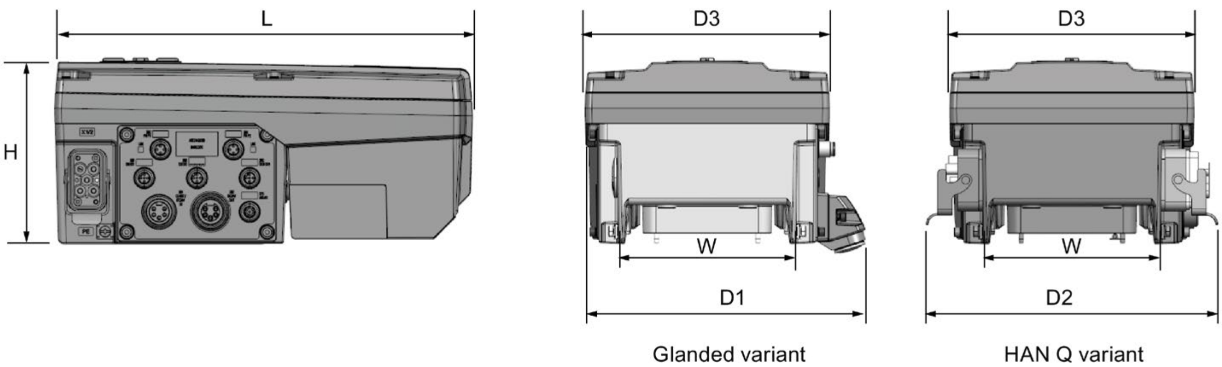


Figure 4-1 Dimensions of the converter

Table 4- 1 Converter dimensions

Frame size	H (mm)	L (mm)	D1 (mm)	D2 (mm)	D3 (mm)	W (mm) without glands
A	135	270	208	216	161	132
B	135	309	208	216	181	132

Clearance distance

The G110M system requires a minimum clearance distance around and above the converter of 150 mm.

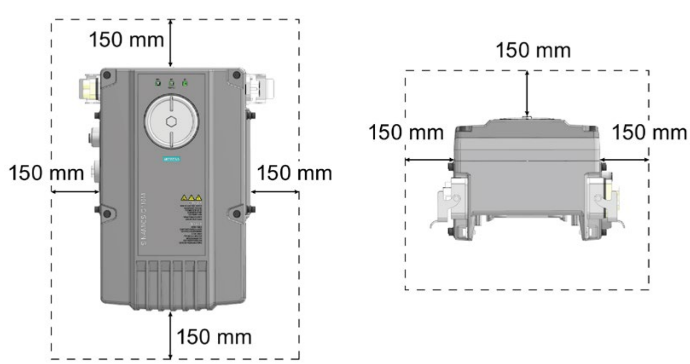


Figure 4-2 G110M Clearance distances

Terminal Housing dimensions and fixing points

The Terminal Housing of the G110M system replaces the existing terminal box on the connected motor. There are three different types of the Terminal Housings and they are shown in the following figure. All three Terminal Housings have the same external dimensions:

- Height: 92 mm.
- Width: 161 mm
- Depth: 171 mm

Please note that the fixing points (for securing the Terminal Housing to the motor) are indicated in RED. The FS 80/90 Terminal Housing has six fixing points, two of which are marked in GREEN and indicated by the ground symbol. These fixing points provide the correct earthing between the Terminal Housing and the motor and MUST be used.

All fixing bolts for the Terminal Housing are supplied with each Terminal Housing.

Note

FS 80/90 Terminal Housing 21 mm fixing screws

The 21 mm fixing screws for the FS 80/90 Terminal Housing are not supplied with the product.

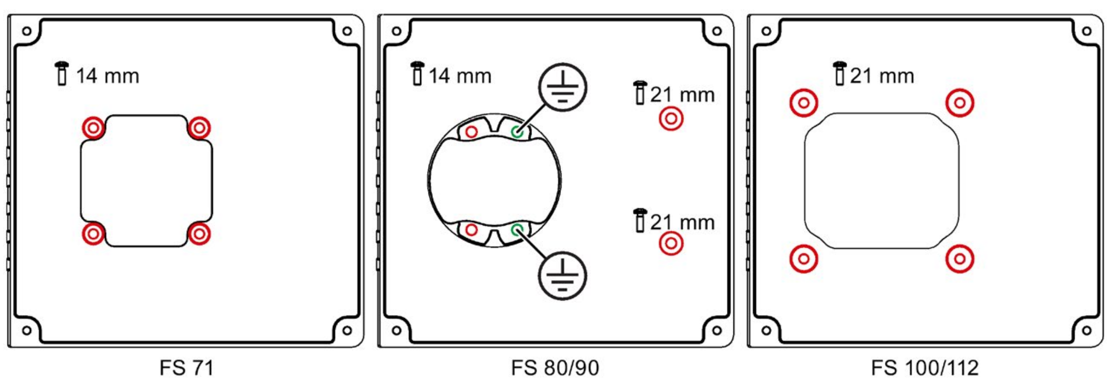


Figure 4-3 Terminal Housing dimensions

Motor dimensions

There are a large number of motors associated with the G110M system, with each motor being uniquely configured for the user requirements.

To ensure that the correct motor is selected the following sources of information should be consulted:

- The relevant system catalog, for example the SINAMICS G120 catalog.
- The relevant motor catalog.
- The Siemens "Configurator" online software application for dimensioning motors (Siemens motor configurator (https://eb.automation.siemens.com/goos/catalog/Pages/ProductData.aspx?catalogRegion=WW&language=en&nodeid=10028832&tree=CatalogTree&regionUrl=%2F&autoopen=false&activetab=product#topAnch&activetab=config&))

The "Configurator" tool allows the user to precisely configure a motor with all the accessories and options that are required, then generate dimensional data, including 2D and 3D CAD models, which can be downloaded to the users local system.

The figure below shows an example of the type of data available.

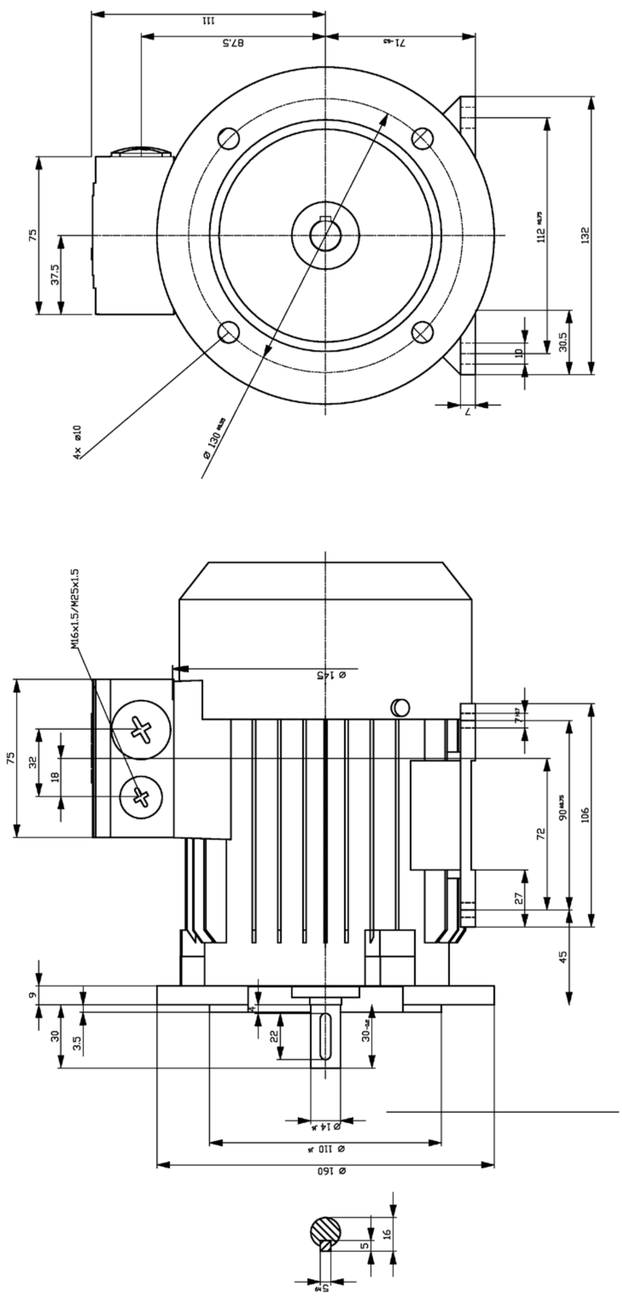


Figure 4-4 Example of the data available from the Sizer program

Mounting orientation

The G110M system has been designed to operate in any orientation depending on the motor mounting configuration.

4.2 System Installation

Overview

The SINAMICS G110M is generally delivered as a complete system, which comprises a Power Module, a Terminal Housing (which includes the Control Module) and a motor/geared motor. If the system is delivered as a complete system, then it is delivered totally assembled and all that is required is the external wiring of the system.

It is also possible that the SINAMICS G110M system is delivered as separate components, which will require the system to be fitted together before installation and commissioning can take place.

To perform the complete assembly of the system, the procedures in the following sections should be performed.

DANGER

Risk of electrical shock

When the converter and motor are powered-up, high voltages are present in the electrical components of the system, any contact with these components could result in severe personal injury or death.

During the installation procedure, the mains supply and external power sources should not be applied to the system.

CAUTION

Potential damage to the Communications and Power Interface (CPI) by the internal braking resistor

The internal braking resistor, when used, generates a large amount of heat. This heat has the potential to overheat the electrical components of the CPI.

The internal braking resistor must be fitted on the opposite side of the Terminal Housing from the CPI.

CAUTION

Risk of damage to wiring/cables in the Communications and Power Interface (CPI)

The Terminal Housing has two sets of terminals which are supported on two posts. The terminals are secured when the Control Module (CM) is screwed into place.

If any cables or wires are routed behind the terminal posts, the downward pressure from the terminal post clamps has the potential to damage any wire or cable routed behind the terminal support posts.

Do not route any cables or wires behind the terminal posts.

CAUTION

Converter must not be used as a step or ledge

The converter has not been designed to support a substantial weight and therefore must not be used as a step or a ledge.

Should substantial weight be placed on the system it could result in severe damage to the equipment which could adversely affect the application and any persons coming into contact with the system.

Note

Diagrams and illustrations

In some of the diagrams and illustrations throughout this section, the colour of components or cables have been selected to make them more visible and do not necessarily reflect the real colour of the component or cable. In some illustrations, components have been removed to enhance the clarity of what is being described.

Note

Use only Non-Drive End (NDE) motor configurations

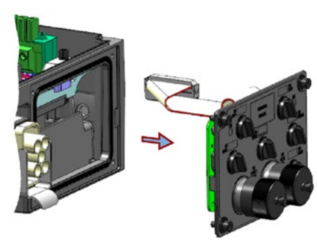
The SINAMICS G110M has been designed to be used in conjunction with NDE motors. Do not use standard motor terminal box mountings with the SINAMICS G110M systems.

Disassembly procedure

When the SINAMICS G110M is delivered as separate components, the Terminal Housing must be fitted to the motor. To accomplish this task it is necessary to disassemble the Terminal Housing to gain access to the motor mounting fixtures in the base of the Terminal Housing.

To disassemble the Terminal Housing, the following procedure should be performed.

1. **Remove the Communications & Power Interface (CPI)**

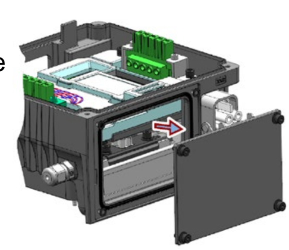


   1. Remove the CPI ribbon cable from the Control Module.
   2. Unscrew the four screws holding the CPI in place on the Terminal Housing.

   Notes:

   - The CPI ribbon cable is permanently attached to the CPI board and therefore no attempt should be made to remove it from the CPI board.
   - The seal on the Terminal Housing behind the CPI is a moulded seal and no attempt to remove them from the Terminal Housing should be made, as this would permanently damage the seal and significantly reduce the IP rating of the Terminal Housing.

2. **Remove the blanking plate**

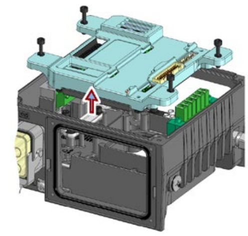


   1. Unscrew the four screws holding the blanking plate in place on the Terminal Housing.
   2. Do not try and remove the seal on the Terminal Housing.

   Note:

   The seal on the Terminal Housing behind the blanking plate is a moulded seal and no attempt to remove them from the Terminal Housing should be made, as this would permanently damage the seal and significantly reduce the IP rating of the Terminal Housing.

3. **Remove the Control Module**

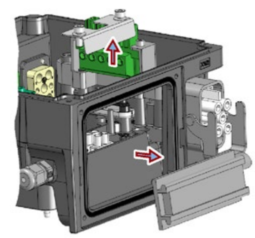
   

   1. Unscrew the four self-retaining screws that secure the Control Module in place.
   2. Carefully lift the Control Module out of the Terminal Housing.

   Note:

   The screws that secure the Control Module in place are self-retaining screws and cannot be fully removed from the Control Module casing.

4. **Remove the internal braking resistor**

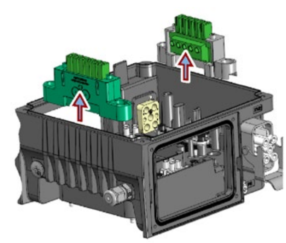
   

   1. Remove the internal resistor holding clamp.
   2. Disconnect the brake resistor wires from the motor terminals (R2 and R1).
   3. Slide the internal braking resistor out from the Terminal Housing.

   Note:

   - The internal braking resistor is an optional extra and should be fitted to the Terminal Housing.
   - The internal braking resistor must not be fitted on the same side as the CPI.

5. **Remove the Terminal Housing terminal connectors**

   1. Remove the mains terminals connector
   2. Remove the motor terminals connector

   Notes:

   - The terminal connectors are removed to allow easy access to the earthing posts located underneath the individual terminals.
   - There are no screws holding down the connectors - they are secured and held in place when the Control Module is fitted.

Installation procedure

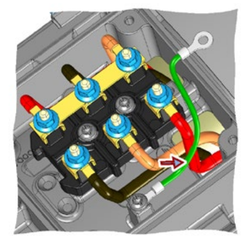
Having dismantled the SINAMICS G110M Terminal Housing, the following procedure should be performed to complete the installation of the whole system.

1. **Star and Delta Configuration**

   Configure the motor terminals for either star or delta configuration depending upon the voltage requirement of the application and the mains input voltage.

2. **Fit the earth cable to the motor**

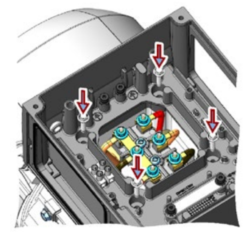
   1. Secure the earth cable to the motor terminal box.
   2. Ensure that the cable is facing in the correct direction to allow connection to the earthing post on the Terminal Housing.

   Note:

   - The earthing cable is supplied with the Terminal Housing.
   - On the FS80/90 Terminal Housings there are two additional fixing points which are the earthing points between the Terminal Housing and the motor. These earthing points must be used and therefore, the earthing cable does not need to be fitted.
   - If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.

3. **Fitting the Terminal Housing to the motor**



   1. Remove the existing motor Terminal Housing (the Terminal Housing will become the motor Terminal Housing).
   2. Align the Terminal Housing with the motor Terminal Housing.
   3. Secure the Terminal Housing to the motor Terminal Housing.

   Notes:

   - Ensure that the Terminal Housing is fitted to the motor with the Power Module heatsink over the non-drive end of the motor.
   - There are three different Terminal Housings, please ensure you have the correct Terminal Housing configuration for the motor to which it is to be fitted.
   - All the required fixing bolts are supplied in the packaging with the product.
   - On the FS80/90 Terminal Housings there are two additional fixing points which are the earthing points between the Terminal Housing and the motor. These earthing points must be used and therefore, the earthing cable does not need to be fitted.
   - The FS80/90 Terminal Housings cannot be fitted directly over the terminal block of the motor - the terminal block of the motor must be removed from the motor, then the Terminal Housing is fitted to the motor and then the motor terminal block is fitted back onto the motor.
   - Exact dimensions and fixing points of the Terminal Housing:
     Mechanical Installation (Page 40).
   - The tightening torques for fitting the Terminal Housing to the motor terminal box are contained in the Operating Instructions for the motor:
     LA/LE motors for mounting on SIMOGEAR gearboxes (http://support.automation.siemens.com/WW/view/en/60666508).
   - If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.

4. **Connect the motor earth cable to the Terminal Housing**

   1. Feed the motor earth cable through the Terminal Housing.
   2. Secure the motor earth cable to the Terminal Housing earthing post (1.5 Nm).

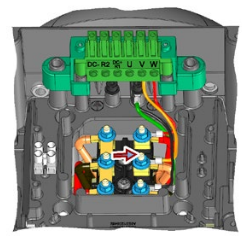
5. **Connect the Terminal Housing motor terminals to the motor**

   1. Connect the U, V and W terminals of the Terminal Housing to U1, V1 and W1 terminals of the motor.
   2. Ensure that the cables are routed as to not obstruct access to other components of the system.

   Note:

   - The motor terminals on the Terminal Housing are delivered pre-wired at the correct length for easy fitting.
   - The mains supply and motor terminals have a maximum torque of 0.8 Nm.

   The motor terminals on the Terminal Housing are delivered pre-wired at the correct length for easy fitting.The mains supply and motor terminals have a maximum torque of 0.8 Nm.

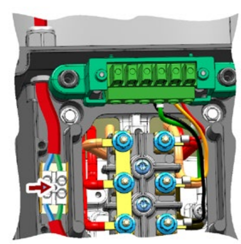


6. **Connect the EM brake cables**

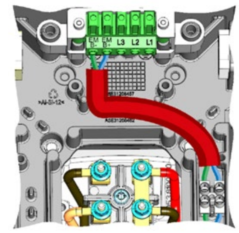
   1. Feed the external EM brake cable through the EM brake cable gland.
   2. Connect the external EM brake cable to the EM brake terminal block.
   3. Ensure that the plastic insulation sleeve is fitted correctly to the EM brake terminal block (which is part of the accessories supplied with the product).
   4. Tighten the cable gland to secure the cable in place.

   Notes:

   - Only a 180 Vdc EM brake can be used.
   - If a brake is not used the cable entry must be sealed with a blanking plug to ensure the IP65 rating of the system is maintained.



Connect the EM brake cables to the EM brake terminals

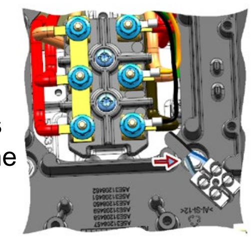


1. Connect the EM brake cables to the EM brake terminal block.
2. Connect the EM brake cables to the EMB+ and EMB- terminals on the terminal block.

Notes:

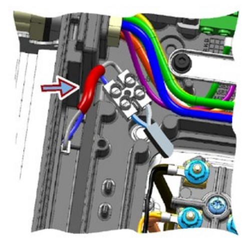
- Ensure that the cable is routed under the cable clamp.
- The terminals can accept cable to a maximum size of 4 mm^2.
- The EM brake is an optional extra which is ordered separately.

7. **Connect the motor temperature sensor**



1. Connect the motor temperature sensor cables to the temperature sensor terminal block.
2. Ensure that the cable is clear of any obstructions and does not restrict access to other cables and connectors within the Terminal Housing.

Connect the motor temperature sensor (second part)

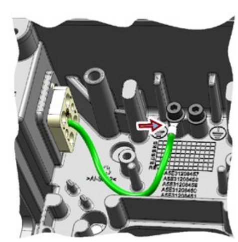


1. Connect the second part of the motor temperature sensor cable to the temperature sensor terminal block.
2. The connector on the second part of the motor temperature sensor is plugged into the Communications and Power Interface (CPI).

Notes:

- The motor temperature sensor terminal block has a diameter of 2.79 mm.
- The final connection of the temperature sensor cannot be completed until the CPI has been fitted. This will be done after the CPI is fitted, as shown later in this procedure.

8. **Connecting the mains earth cable (HANQ variant)**

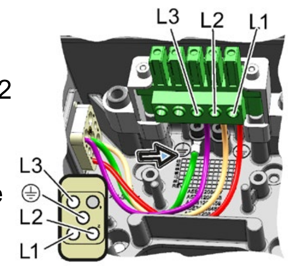


1. Connect the HANQ earth connection to the earthing post of the Terminal Housing.
2. Tighten the earthing post screw to 1.5 Nm.

Note:

If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.

9. **Connecting the mains cables (HANQ variant)**

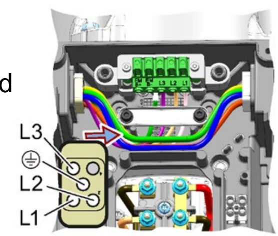


   1. Ensure that the cable clamp has been removed.
   2. Connect the HANQ L1, L2 and L3 connections to the L1, L2 and L3 connections on the mains connector.
   3. When the connections are completed, replace the cable clamp over the cables (ensuring that the cable clamp is the correct way round).

   Note:

   Tightening torque of the mains terminals are a maximum of 0.8 Nm.

10. **Connecting the power-through cables (HANQ variant)**



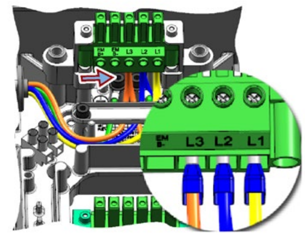
   To allow the power provided to one system to supply the power to another system in a daisy-chain, the input power is routed directly from the mains input HANQ connector to the mains output connector in the same Terminal Housing.

   1. Connect the Earth connection from the input HANQ connector to the output HANQ connector.
   2. Connect the L1 connection from the input HANQ connector to the output HANQ connector.
   3. Connect the L2 connection from the input HANQ connector to the output HANQ connector.
   4. Connect the L3 connection from the input HANQ connector to the output HANQ connector.

   Note:

   The power-through cables are provided with the Terminal Housing and are the correct size and dimensions to allow the power-through connections to be made easily.

11. **Connecting the power-through cables (Glanded variant)**



In the glanded variant the power-through connections use a different methodology.

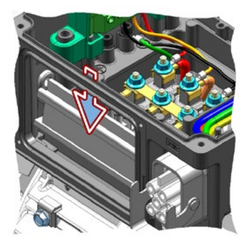
The Terminal Housing terminals L1, L2 and L3 require two cables to be fitted to each terminal - this makes the maximum cable cross-section 2.5 mm^2. The input and output cables are connected to the terminals through a twin ferrule connector, as shown in the callout in the figure on the right. The twin ferrules are available from Phoenix Connector under article number: 3200836.

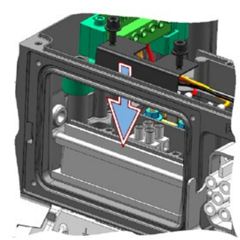
1. Connect the Input cables to the L1, L2 and L3 terminals of the Terminal Housing.
2. Connect the Input earth cable to the first earthing post of the Terminal Housing.
3. Connect the L1, L2 and L3 terminals of the Terminal Housing to the output cable through the cable gland.

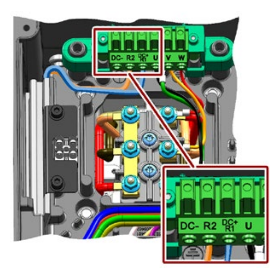
Note:

On the glanded variant no pre-cut cables are provided.

12. **Fitting the internal braking resistor**







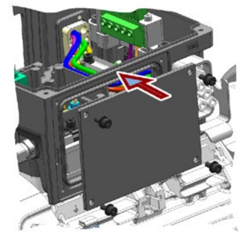
The internal braking resistor is an optional extra and is fitted into the Terminal Housing.

1. Slide the internal braking resistor into place on the opposite side to which the CPI will be fitted.
2. Fit the internal braking resistor securing bracket.
3. Secure the bracket in place using the two screws to a tightening torque of 1.5 Nm.
4. Connect the internal braking resistor cables to the R2 and R1 terminals of the Terminal Housing motor terminals.

Note:

The internal braking resistor can be fitted on the left or right side of the Terminal Housing, but must always be fitted on the opposite side of the Terminal Housing from Communications and Power Interface (CPI).

13. Fitting the blanking plate

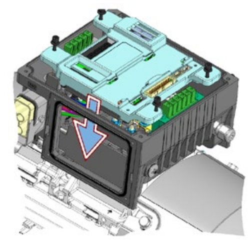


1. Using the four screws, fit the blank plate to the side of the Terminal Housing.
2. Ensure that no cables or components are trapped between the blanking plate and the Terminal Housing seal, as this would adversely affect the IP rating of the Terminal Housing.

Note:

Screws tightening torque: 1.5 Nm.

14. Fitting the Control Module

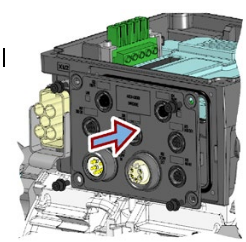


1. Ensuring that no wiring is trapped by the Control Module, place the module on the four supporting posts of the Terminal Housing.
2. Using the four screws (self-retaining), secure the Control Module into place.

Note:

Screws tightening torque: 1.5 Nm.

15. Fitting the Communications and Power Interface (CPI)

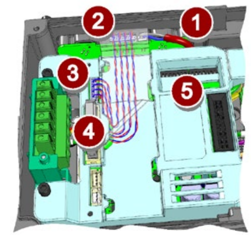


1. Using the four screws, fit the CPI to the side of the Terminal Housing.
2. Ensure that no cables or components are trapped between the CPI and the Terminal Housing seal, as this would adversely affect the IP rating of the Terminal Housing.

Notes:

- Screws tightening torque: 1.5 Nm.
- The Communications and Power Interface (CPI) can be fitted on the left or right side of the Terminal Housing, but must always be fitted on the opposite side of the Terminal Housing from the internal braking resistor.

16. Final connection and adjustments

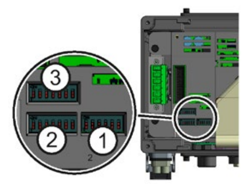


1. Connect the temperature sensor connector into the connector at the top edge of the CPI.
2. Connect the small communications connector into the connector at the top of the CPI.
3. Connect the large communications connector into the connector on the top of the Control Module.
4. Connect the CPI ribbon cable to the connector on the top of the Control Module.
5. Configure the DIP switches to the requirements of the application (see Step 17 below).

Note:

The PROFIBUS/PROFINET communications cable is not pre-fitted to the Control Module, it is part of the accessories supplied in the product packaging.

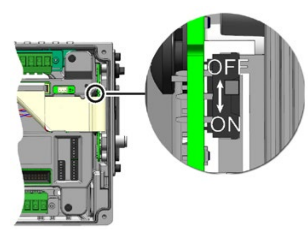
17. PROFIBUS / USS address and basic commissioning DIP-switches



There are three sets of DIP-switches that allow the user to configure the network device address and perform a basic commissioning of the system.

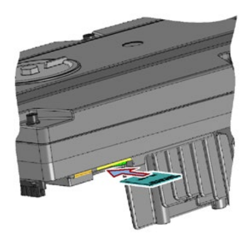
Quick Commissioning with DIP switches (Page 111)

18. PROFIBUS / USS network termination switch



When using the PROFIBUS or USS communications protocols, the last converter on the network must have the network termination switch in the ON position.

19. Fit memory card into the Power Module



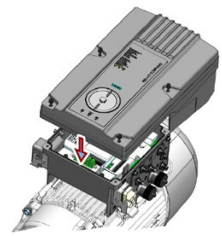
To allow parameter settings to be stored or copied to the converter, the memory card must be fitted into the memory card reader.

20. Fit Power Module onto the Terminal Housing

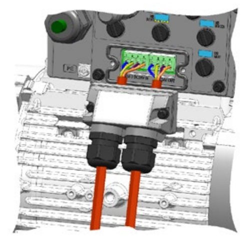
The Power Module is fitted on top of the Terminal Housing and screwed in place with the four self-retaining screws.

Note:

Screws tightening torque: 2.0 Nm.



21. Connecting the 24 V external supply (glanded variant - but not the AS-i variant)



1. Feed the two 4-core cables through the cable glands.
2. Connect each 4-core cable to the DC 24 V input and the DC 24 V output.
3. Secure the cable cover to the CPI using the two screws.
4. Tighten the cable glands to secure the cables in place.

Notes:

- The terminals for the 24 V external supply both input and output are as follows:
  - 1 = +24V unswitched
  - 2 = 0V unswitched
  - 3 = +24V switched
  - 4 = 0V switched
- Screws tightening torque: 1.5 Nm.
- The cable glands have a diameter of 20 mm
- Wiring dimensions:
  - 0.25 ... 2.5 mm^2 without isolated cable ends (ferrels).
  - 0.25 ... 1.5 mm^2 with isolated cable ends (ferrels).

Note

Unswitched and switched power supply

The unswitched 24 V power supply (also known as non-switched) on X1.2 and X1.4 provides power to the general electronics of the Control Unit. The switched 24 V power supply on X1.1 and X1.5 supplies power for the two digital outputs (DI0 and DI1).

For a complete explanation of the unswitched and switched 24 V supplies and their limitations, please read the FAQ at the following link:

Unswitched and switched 24 V supply (http://support.automation.siemens.com/WW/view/en/26986267)

After the system installation has been completed, the external electrical connections can be performed.

Electrical Installation (Page 61)

Grounding the Terminal Housing

To ensure that the Inverter is properly grounded and protected, an earthing cable **MUST** be fitted to the Terminal Housing of the G110M system.

- Connect the PE terminal on the left-hand side of the inverter to appropriate grounding point of the installation.
- Use a short wire connection.
- Clean the connection to the steel construction from paint or dirt.
- Use a ring clamp to terminate the cable to ensure a good physical connection which is resistant to accidental disconnection.

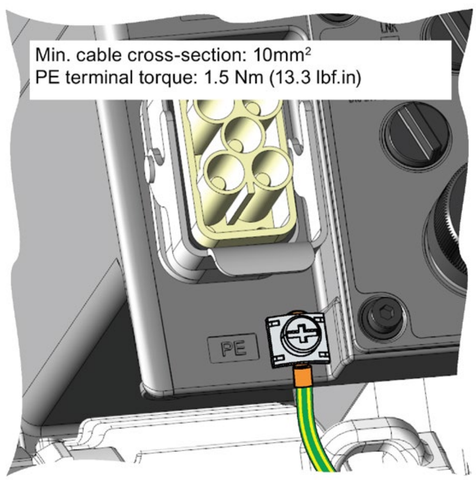


Figure 4-5 Terminal Housing PE terminal

4.2.1 Installing the 24V power supply

Introduction

The optional 24 V PSU allows the user to draw the necessary 24 V to power the internal electronics of the Control Module direct from the converters DC link voltage. This has the advantage that no external cabling is required and therefore, only a 3-phase mains supply cable is required.

The following electronics are powered by the optional 24 V PSU:

- Internal circuits in the Control Module (CM).
- Low voltage components in the Power Module (PM).
- All input and output, for example the digital outputs on the Communications and Power Interface (CPI).

At the base of the 24 V PSU housing is a cable gland opening (which is sealed with a blanking plug) which provides and entry point for the cables from an external braking resistor.

The optional 24 V PSU can be ordered using the following article number:

6SL3555-0PV00-0AA0

A brief description of the layout and the connections of the 24 V PSU are given in the following figure.

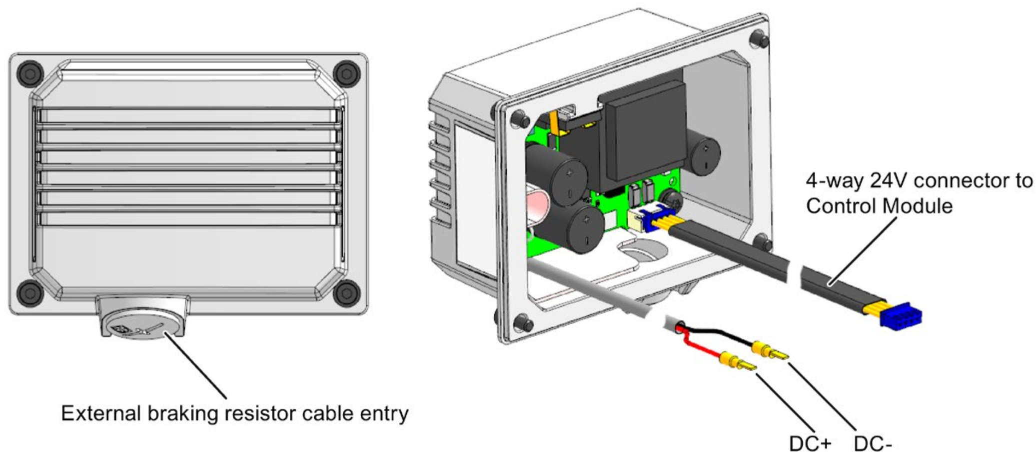


Figure 4-6 24V PSU Layout

Restrictions

> **DANGER**
>
> **Risk of electrical shock**
>
> The DC link within the Power Module (PM) carries high voltages which has the potential to cause severe personal injury.
>
> Before performing any installation work on the system, it is essential that all power supplies to the system are disconnected.
>
> After the power supplies have been disconnected from the system, it is necessary to wait for at least five minutes before accessing any electrical connections of the system, this allows time for the high voltage capacitors within the system to completely discharge.

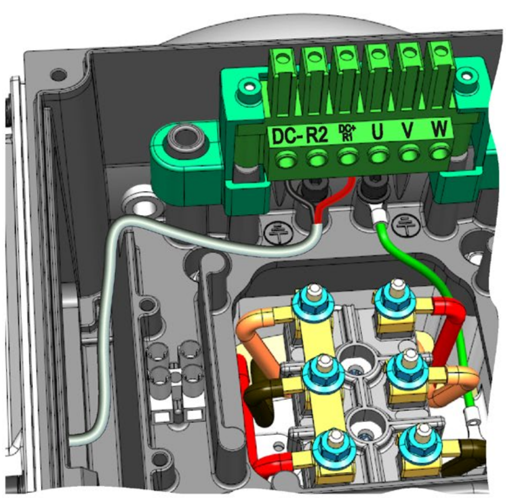
The following restrictions should be observed when installing the 24 V PSU:

- If an external braking resistor is not used, the cable gland opening must be sealed with a blanking plug to maintain the IP rating of the system.
- The 24 V DC IN and OUT connectors and the CPI must be sealed with screw caps to maintain the IP rating of the system.

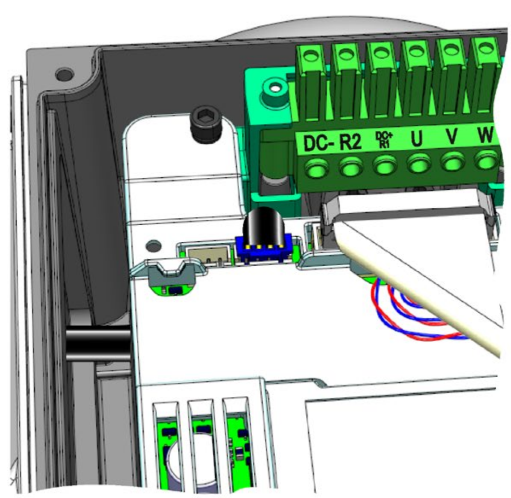
- When using the 24 V PSU there is no longer any isolation between the 24 V PSU and the digital outputs of the system.
- Since the 24 V PSU utilizes the DC link voltage to provide the 24 V supply to the Control Module, when the mains supply is disconnected, all power will be lost to the Control Module.

Installation

1. Disconnected all power supplies to the system and wait 5 minutes.
2. Remove the Power Module (PM).
3. Remove the blank plate from the side of the terminal housing.
4. Remove the Control Module (CM).
5. Fit the 24 V PSU to the side of the terminal housing, ensuring that no cables or wiring are trapped between the 24 V PSU and the terminal housing. Tightening torque: 1.5 Nm.
6. Connect the input cable to the DC link terminals in the terminal housing (black to DC- and red to DC+).
7. The 4-way 24 V cable is routed underneath and then over the top of the CM.
8. Fit the 4-way connector as shown in the illustration below.
9. Fit the CM back into place - ensuring that it securely fastened into place.
10. Replace the PM.
11. Fit blanking cap to the 7/8th connector (note: there is no 7/8th connector on the USS variant and the AS-i variant has no 7/8th connector or terminals).
12. Power can now be restored to the system.



Fitting the DC+ and DC- inputs to the terminals



Fitting the 24 V cable to the Control Module

Figure 4-7 Fitting the input and output connections

Using the external power supply with the G110M AS-i variant

The 24 V power supply for the G110M AS-i variant is typically provided by the yellow and black AS-i cables that create the AS-i network.

The yellow cable is the communications cable but also provides the power to:

- The Control Module
- The digital inputs
- The analog inputs

The black cable is the auxiliary cable and provides power to:

- Low voltage components of the Power Module
- The digital outputs
- The Fan (used with the Wall Mount Kit only).

The external 24 V power supply can be used in place of the black auxiliary cable (you cannot use both at the same time), but the G110M AS-i must always use the yellow cable, as the G110M AS-i cannot be used as a stand-alone converter.

Note

Loss of power to the 24 V external supply

If the mains supply to the converter is removed, then the external 24 V supply will lose power, as it draws its power from the converters DC link. The yellow AS-i cable will still provide power to the Control Module and the digital and analog inputs, so that the AS-i communications will still be active.

Figure 4-8 AS-i Cables (with M12 connector)

4.3 Electrical Installation

4.3.1 SINAMICS G110M Electrical data

Power Module specifications - 3AC 380 V (-10%) ... 480 V (+10%)

Table 4- 2 Rated Output, Input and Fuses

Product	Frame size	Rated output		HO		Fuse*	
				Rated output current	Rated input current		3NA3…
6SL3517-…		kW	hp	A	A	A	Type
1BE11-3AM0	A	0.37	0.5	1.3	1.3	10	803 -
1BE12-3AM0	A	0.75	1.0	2.2	2.0	10	803 -
1BE13-3AM0	A	1.1	1.5	3.1	2.8	10	803 -
1BE14-3AM0	A	1.5	2.0	4.1	3.6	10	803 -
1BE16-3AM0	B	2.2	3.0	5.6	5.3	20	807 -
1BE17-7AM0	B	3.0	4.0	7.3	6.9	20	807 -
1BE21-0AM0	B	4.0	5.0	8.8	8.0	20	807 -
*For UL applications use Class J or CC fuses.							

Standby current

The PM240M Power Module has a unique standby current characteristic which needs to be taken into account when calculating the requirements of the line supply.

The standby current is the current that the Power Module requires when the Converter is in the ready-to-run mode. This means that the Converter is powered-up but the motor is not running. The phenomenon of capacitive reactive current standby occurs in all Power Modules and Converters with filter capacitors on the line side.

In applications where a number of Converters are connected to one line supply and where only a small proportion of the Converters will be running at any one time, the standby currents in the non-running Converters must be considered when calculating the size of the conductors and selecting the correct protective devices on the line supply of the system.

The Control Module (CM) and the communications input and outputs are normally powered by a Class 2 external 24 V supply, which does not influence the standby current of the Converter. However, the optional 24 V PSU draws it power directly from the DC link of the

Power Module (PM), in this case, the standby current of the Converter increases, by an additional current of 15 mA.

The standby currents for all the possible combinations of the SINAMICS G110M are given in the following table:

Table 4- 3 SINAMICS G110M Standby currents

Device	Power supply	Standby current (mA)
G110M FSA (0.37 ... 1.5 kW)	Mains only	325
G110M FSB (2.2 ... 4.0 kW)	Mains only	445
G110 FSA + Optional 24 V PSU or External 24 V	Mains + Optional 24 V PSU or External 24 V*	340
G110 FSB + Optional 24 V PSU or External 24 V	Mains + Optional 24 V PSU or External 24 V*	460
PROFIBUS / USS CM only	External 24 V only* (mains supply switched off)	235
PROFINET / AS-i CM only	External 24 V only* (mains supply switched off)	290

* The optional 24 V PSU is an orderable item which is designed specifically for use with the SINAMICS G110M converter. The 24 V PSU is fitted to the terminal housing as shown in Installing the 24V power supply (Page 57). The external 24 V supply is sourced by the user and is connected to the converter through the 24 V connections as shown in Connection and cables (Page 68).

The maximum combined current for all digital inputs is 200 mA, the maximum combined currents for all the digital outputs is 500 mA.

CAUTION

Thermal stability of the system

The SINAMICS G110M system is comprised of a motor and a converter which are designed to work together. The system can generate a significant amount of heat which can affect the performance of your application.

If the duty cycles of the system are not calculated properly, it could result in your application not working efficiently and produce nuisance trips from overtemperature faults.

To ensure the thermal stability of the system, duty cycles should be calculated using the lowest rated component of the system - this should be either the motor or the converter depending on the your application.

NOTICE

Line impedance

To ensure trouble free operation we recommend the mains supply impedance is less than 1% (RSC > 100).

NOTICE

UL transient surge suppression requirements

To ensure that the electrical installation of this equipment complies with the UL requirements for transient surge protection, the following requirement must be strictly adhered to:

Transient surge suppression shall be installed on the line side of this equipment and shall be rated 480 v (phase to ground), 480 v (phase to phase), suitable for overvoltage category III and shall provide protection for a VPR maximum of 2 kv, type 1 or type 2 SPD application.

Note

Optional 24 V PSU loss of power

The optional 24 V PSU derives power from the mains supply to the converter. Should the mains supply be removed from the converter, the 24 V PSU will not longer provide power to the control and communications components of the

converter.

4.3.2 EMC installation guidelines

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

4.3.2.2 Basic EMC rules

Measures to limit Electromagnetic Interference (EMI)

In the following list are the necessary measures that must be taken to ensure the correct installation of the Converter within a system, which should minimize the effects 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.
- Do not route signal and data cables parallel to the line supply cables.
- Signal and data cables should not cross the line supply cables; if crossing is necessary, they should cross at an angle of 90 °.
- Shield analog 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) separately from signal and data cables. The minimum distance should be approximately 25 cm.

Cable shields

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

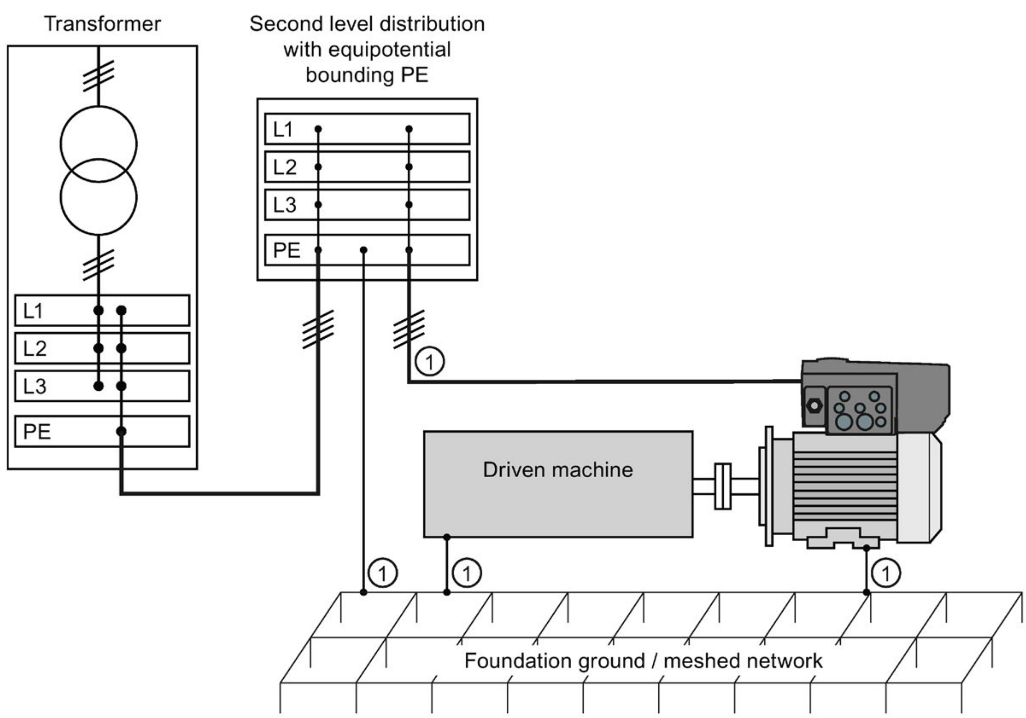
- In the case of both signal and data cables, the cable shields should be connected by means of suitable EMC glands. The cables must connect the shields to the shield bonding options for cables and the unit housing respectively with excellent electrical conductivity and a large contact area.
- Use only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

4.3.2.3 Equipotential bonding

Equipotential bonding within the drive system has to be established by connecting all electrical and mechanical drive components (transformer, motor and driven machine) to the grounding system. These connections are established by means of standard heavy-power PE cables, which do not need to have any special high-frequency properties. In addition to these connections, the converter (as the source of the high-frequency interference) and all other components in each drive system (motor and driven machine) must be interconnected with respect to a high-frequency point of view. For this purpose cables with good high-frequency properties must be used.

Grounding and high-frequency equipotential bonding measures

The following figure illustrates all grounding and high-frequency equipotential bonding measures using an example with the SINAMICS G110M.



① Conventional grounding system without special high-frequency properties

Figure 4-9 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

The ground connections ① represent the conventional grounding system for the drive components. They are made with standard, heavy-power PE conductors without special high-frequency properties and ensure low frequency equipotential bonding as well as protection against injury.

The line supply cable of the converter can be unshielded. The converter has to be grounded by this cable.

The converter enclosure provides high-frequency equipotential bonding between the converter and the motor.

The connection provides solid bonding for high-frequency currents between the metal body of the converter and the unpainted metal mounting frame. This connection should be made with short, finely stranded, braided copper wires.

Additional measures

Finely stranded, braided copper cables have to be routed in parallel with the cable shields in the following cases:

- Old installations with already existing unscreened cables
- Cables with poor high-frequency properties
- Installations with bad grounding systems

The connections in the following figure provide a solid, high-frequency bonding between the driven machine and the converter.

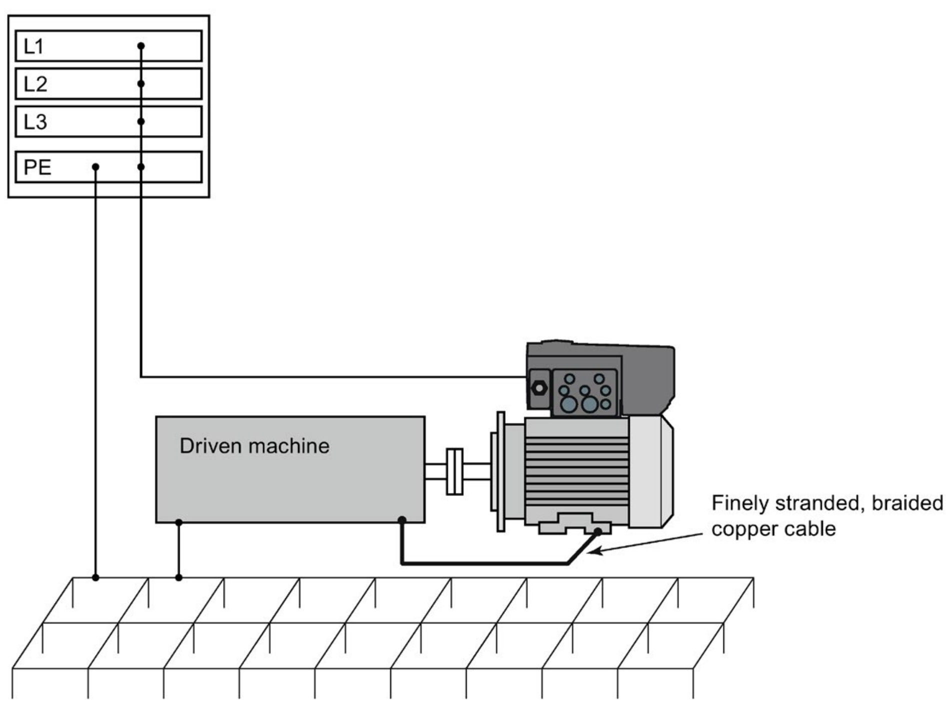


Figure 4-10 Additional high-frequency bonding of the drive system

4.3.3 Protective conductor

WARNING

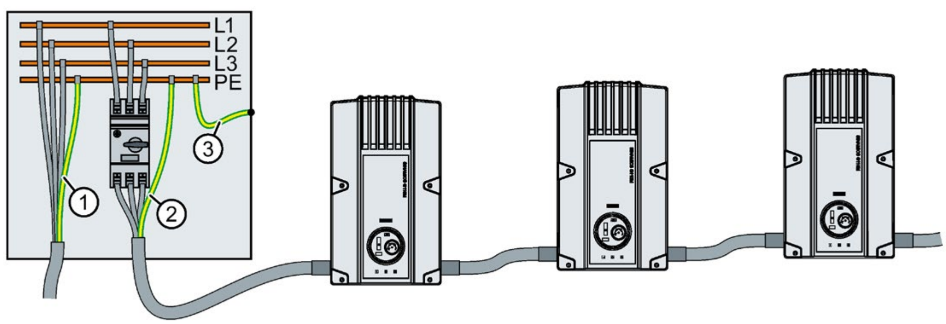
Danger to life caused by high leakage currents for an interrupted protective conductor

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

The minimum cross-section of the protective conductor ① … ③ depends on the cross-section of the line feeder cable:

- Line feeder cable ≤ 16 mm^2

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

- 16 mm^2 < line feeder cable ≤ 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 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 individual 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.

4.3.4 Connection and cables

The following block diagrams and tables describe the details and limitations of the connections on the converter.

Wiring stripping

The following components are delivered with pre-prepared cables and no wire stripping is necessary:

- Internal 24 V DC power supply
- Internal braking resistor for FSA
- Internal braking resistor for FSB
- Motor EM brake
- The motor terminals for the terminal housing (for connection to the motor terminals).

All other connections to the Phoenix mains and motor connectors need to be stripped to a length of 10 mm, with a maximum torque of 0.8 Nm.

Cable lengths

The maximum cable lengths for all the converters are shown in the following table.

Table 4- 4 Maximum cable lengths

Cable	Screening	Max. length
Digital inputs	Unscreened	15 m (49 ft)
Digital outputs	Unscreened	15 m (49 ft)
Analog input	Screened	15 m (49 ft)
Motor cable with Wall Mount Kit		5 m (16.40 ft)

The maximum cable lengths for communications are determined by a number of factors, for example, the maximum length of the cable for USS and PROFIBUS are dependent on the data transfer rate being utilized by the network.

In some cases, it is possible to extend the cable length by the use of appropriate repeaters. The maximum cable lengths for the various communications protocols are given in the following table:

Table 4- 5 Maximum cable lengths for USS, PROFIBUS, PROFINET and AS-i

Communications protocol	Transfer rate or cable type	Maximum overall length of cable
USS		
	9.6 kbit/s	1200 m (3,940 ft)
	19.2 kbit/s	1200 m (3,940 ft)
	38.4 kbit/s	1200 m (3,940 ft)
	187.5 kbit/s	1000 m (3,280 ft)
PROFIBUS-DP		
	9.6 - 187.5 kbit/s	1000 m (3.280 ft)
	500 kbit/s	400 m (1,312 ft)
	1.5 Mbit/s	200 m (656 ft)
	3, 6 and 12 Mbit/s	100 m (328 ft)
PROFINET		
	CAT5 network cable	100 m (328 ft)
AS-i		
	Maximum length per segment	100 m (328 ft)

Permissible AS-i cable lengths

The maximum length of any one segment on the AS-i network is normally 100 m (328 ft). However there are a number of devices that allow the length of network segments to be extended.

Repeater

A repeater allows the maximum cable length to be extended to 300 m (984 ft) using the maximum of two repeaters. Slave nodes can be used on both sides of a repeater.

Extender

The extender allows the distance between the AS-i master and an AS-i segment of the network to be extended to a maximum of 100 m (328 ft). With repeaters connected in parallel, a cable length significantly longer than 300 m (984 ft) can be achieved. The maximum

span is 500 m (1640 ft). The only limitation of the extender is that slaves can only be used downstream from the extender.

Extension plug

Using the extension plug, the maximum possible cable length in an AS-i segment can be doubled from 100 m (328 ft) to 200 m (656 ft). The extension plug is a passive device and is connected to the part of the AS-i network furthest from the power unit. Only one power

unit is required to power the slaves on the segement up to 200 m (656 ft).

Outline block diagram

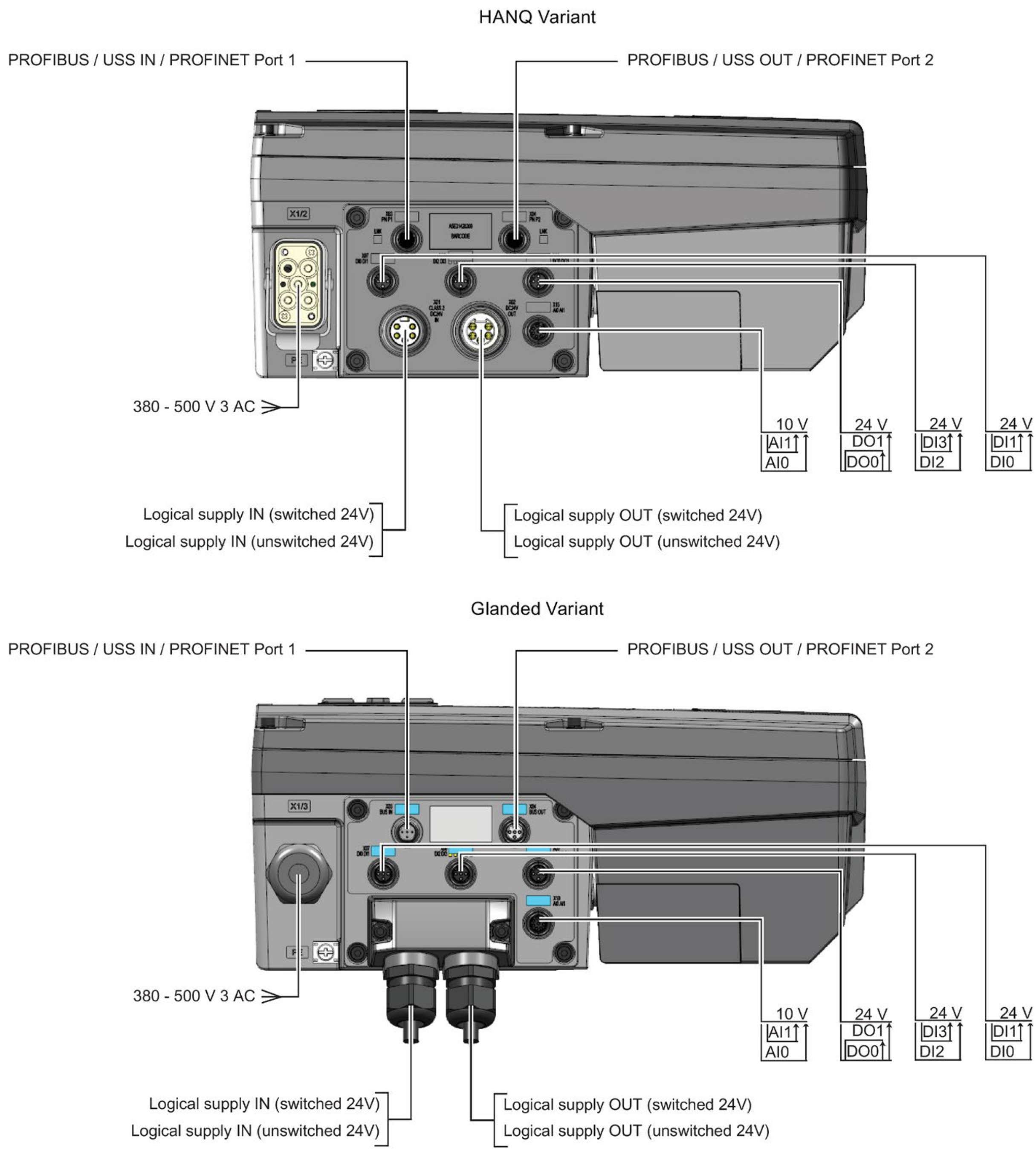
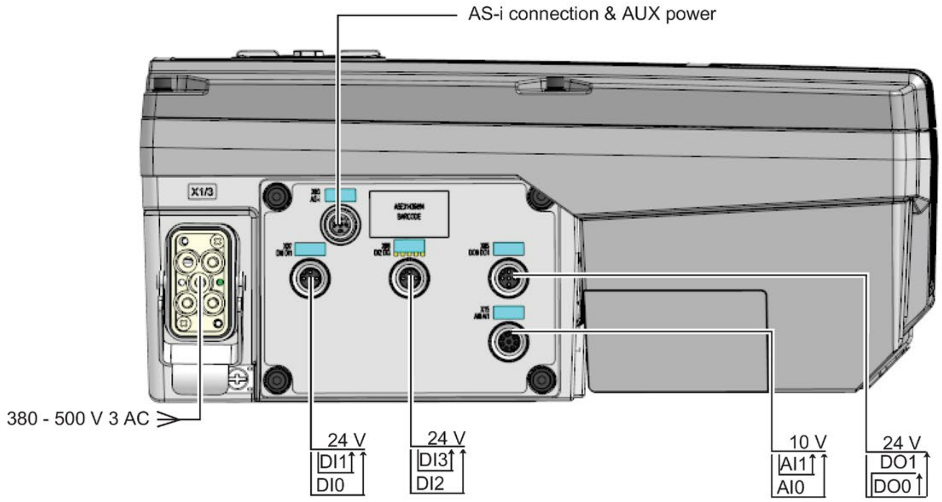


Figure 4-11 Outline block diagram SINAMICS CU240M and PM240M

Outline block diagram (AS-i variant)

HANQ Variant



Glanded Variant

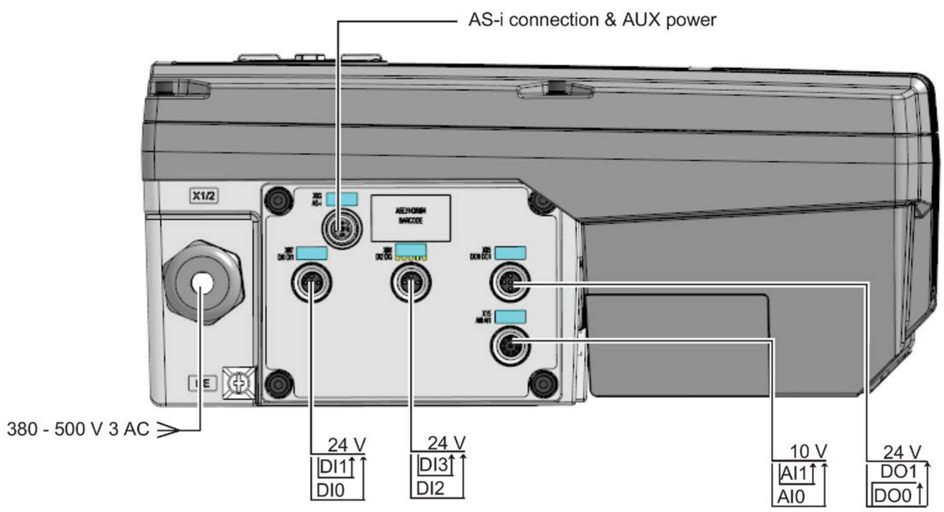


Figure 4-12 Outline block diagram AS-i

Cable, connectors and tools specifications

The detailed specifications for the cables, connectors and tools required to manufacture the necessary cables for the SINAMICS G110M are listed in the following documents and can be accessed using the relevant links:

SINAMICS and motors for Single-Axis Drives D31 catalog (https://w3app.siemens.com/mcms/infocenter/content/en/Pages/order_form.aspx?nodeKey=key_566000&infotype=catalogs&linkit=null)

Siemens supplementary product information (http://support.automation.siemens.com/WW/view/en/65355810)

The connections that are detailed in this section relate to the physical connections that exist on the converter.

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).

Note

Mains supply impedance

To ensure trouble free operation we recommend the mains supply impedance is less than 1% (RSC > 100).

Connection and terminal diagrams

Note

Orientation of Connectors

The connection diagrams given in this manual show the physical connections on the Communications and Power Interface (CPI). Different manufacturers of mating connectors may have differing pinout arrangements, it is essential that when making-up the necessary cables and connectors that the connections match those given in the connection diagrams.

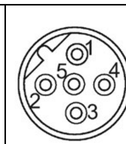
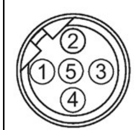
For example, the orientation of the key-notch on the CPI connector may not match the key-notch on the mating cable connector being constructed, in this instance the pin numbers on the connector being made needs to be ignored to allow the correct orientation and wiring of the connector to ensure a proper match to the connector on the CPI.

Note

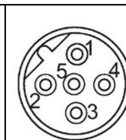
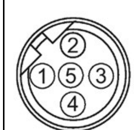
Important notes for connecting I/Os and communication

- The connection pinouts refer to the actual connectors on the Communications and Power Interface (CPI).
- The Control Module (CM) is fitted inside the terminal housing and is connected by ribbon cable to the CPI.

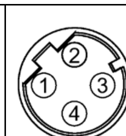
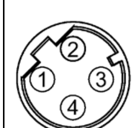
USS terminal diagram

X03	USS IN	1 Not connected 2 RS485N 3 Not connected 4 RS485P 5 Functional Earth		M12 connector, 5 Pole, male
X04	USS OUT	1 Not connected 2 RS485N 3 Not connected 4 RS485P 5 Functional Earth		M12 connector, 5 Pole, female

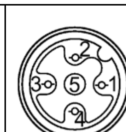
PROFIBUS terminal diagram

X03	PROFIBUS DP IN	1 Not connected 2 Data A (N) 3 Not connected 4 Data B (P) 5 Functional Earth		M12 connector, 5 Pole, male
X04	PROFIBUS DP OUT	1 Not connected 2 Data A (N) 3 Not connected 4 Data B (P) 5 Functional Earth		M12 connector, 5 Pole, female

PROFINET terminal diagram

X03	PROFINET Port 1	1 Transmission Data + 2 Receive Data + 3 Transmission Data - 4 Receive Data -		M12 connector, 4 Pole, female
X04	PROFINET Port 2	1 Transmission Data + 2 Receive Data + 3 Transmission Data - 4 Receive Data -		M12 connector, 4 Pole, female

AS-i terminal diagram

X03	AS-i Connection	1 AS-i + 2 AUX- 3 AS-i - 4 AUX + 5 Functional Earth		M12 connector, 5 Pole, female

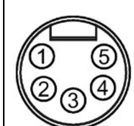
24V Power supply - USS, PROFIBUS, PROFINET

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 off brings all of the actuators connected to the digital outputs into the no-voltage state.

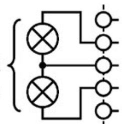
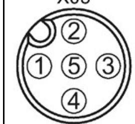
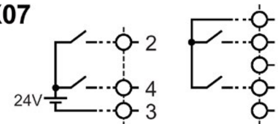
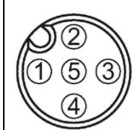
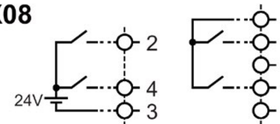
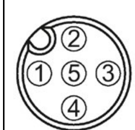
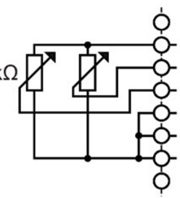
If you don't need the switching of 2L+ power supply, then both the switched as well as the non-switched 24 V may come from the same supply.

<table>
<tr><td>X01
24 V, IN
1 Switched 0V (2M)
2 Unswitched 0V (1M)
3 Functional Earth
4 Unswitched +24V (1L+)
5 Switched +24V (2L+)</td><td>HANQ
</td><td rowspan="3">Glanded

1. +24 V unswitched
2. 0 V unswitched
3. +24 V switched
4. 0 V switched</td></tr>
<tr><td>X02
24 V, OUT
1 Switched 0V (2M)
2 Unswitched 0V (1M)
3 Functional Earth
4 Unswitched +24V (1L+)
5 Switched +24V (2L+)</td><td></td></tr>
<tr><td colspan="2">Type: 7/8 " - 16UN connector, female</td></tr>
</table>

I/O terminal diagram - all varaints

The maximum combined current for all digital inputs is 200 mA and the maximum combined current for all digital outputs is 500 mA.

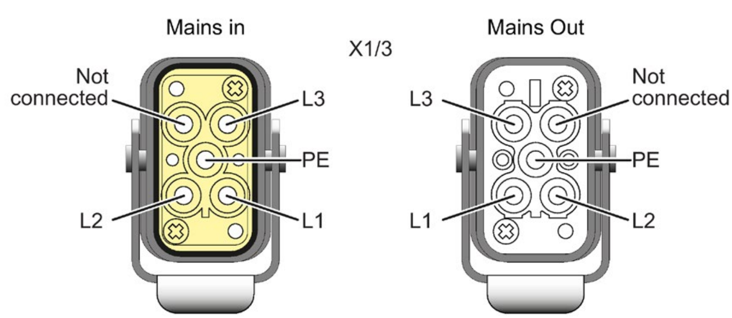
X05  24 V 500 mA max.	1 Not connected 2 Digital Output 1 3 Switched 0V (2M) 4 Digital Output 0 5 Functional Earth	X05 	M12 connector, 5 Pole, female Specification: PNP, SIMATIC-compatible, low <5 V, high > 10 V maximum, input voltage 30 V. The Control Module (CM) is fitted inside the terminal housing and is connected by ribbon cable to the CPI.
X07  24V	1 Unswitched 24V (1L+) 2 Digital Input 1 3 Unswitched 0V (1M) 4 Digital Input 0 5 Functional Earth		
X08  24V	1 Unswitched 24V (1L+) 2 Digital Input 3 3 Unswitched 0V (1M) 4 Digital Input 2 5 Functional Earth		
X10 / X15  >4.7 kΩ	1 Not connected 2 +10 V 3 Analog input 0 + 4 Analog input 1 + 5 Analog input 0 - 6 Analog input 1 - 7 Unswitched 0 V 8 Not connected		M12 connector, 8 Pole, female • X10 for USS, Profibus and Profinet, • X15 for AS-i

Terminal housing mains supply connections

Type: HAN Q4/2 (Input and Output), 3 AC 380 V (-10%) ... 480 V (+10%)

Important:
The pinouts refer to the actual connectors on the terminal housing.

The terminal designation X1/3 is used because the mains input and output can be swapped around depending on which side of the terminal housing the CPI is mounted.



Internal motor and power connection

The internal motor and power connections on the G110M system are located inside the Control Unit and motor housing. The connections are shown in the following figure.

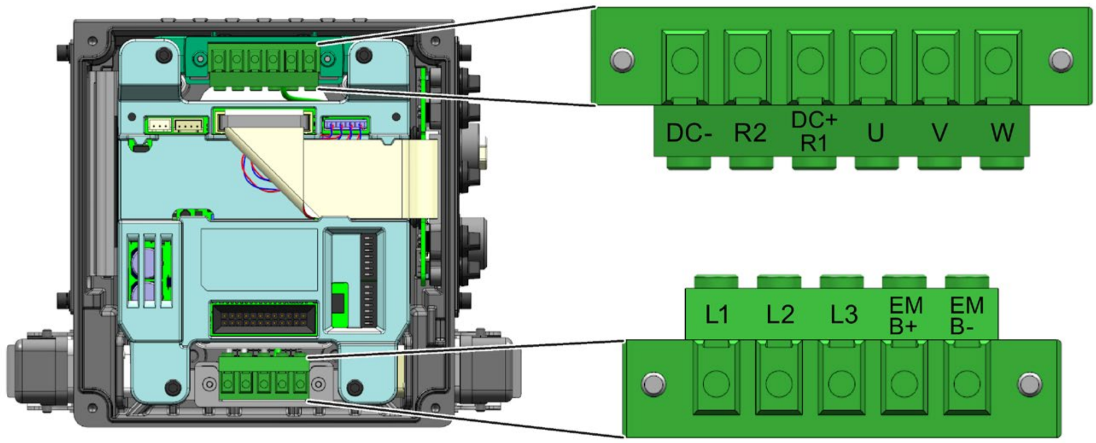
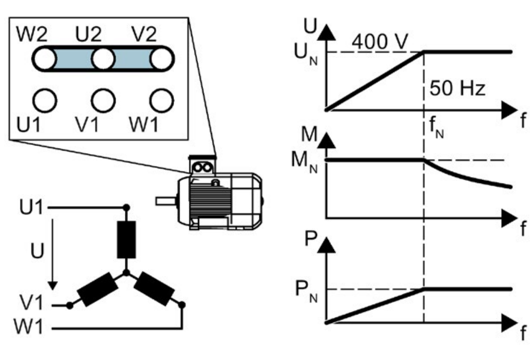


Figure 4-13 Control Unit motor and power connections

4.3.5 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

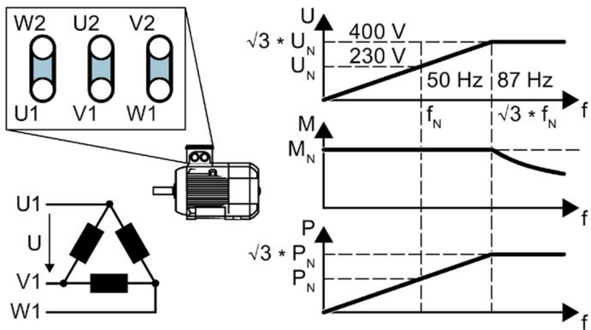


In a star connection, the motor can provide its rated torque M_N in the range 0 … rated frequency f_N.

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.

4.3.6 Cable protection

Cable protection for individual converters

If you individually protect an Inverter, then you must protect the Inverter feeder cable using a fuse.

Table 4- 6 Individual fuse protection

Rated power	Power Module	Frame size	Fuse	
0.37 kW	6SL3517-1BE11-3AM0	FSA	10 A	3NA3803
0.75 kW	6SL3517-1BE12-3AM0	FSA	10 A	3NA3803
1.1 kW	6SL3517-1BE13-3AM0	FSA	10 A	3NA3803
1.5 kW	6SL3517-1BE14-3AM0	FSA	10 A	3NA3803
2.2 kW	6SL3517-1BE16-3AM0	FSB	20 A	3NA3807
3 kW	6SL3517-1BE17-3AM0	FSB	20 A	3NA3807
4 kW	6SL3517-1BE21-3AM0	FSB	20 A	3NA3807

For additional information, please refer to Catalog D31at the following link:

SINAMICS and motors for Single-Axis Drives D31 catalog (https://intranet.automation.siemens.com/mcms/infocenter/content/en/Pages/order_form.aspx?nodeKey=key_566000&infotype=catalogs&linkit=null)

Installation using power-through daisy chain

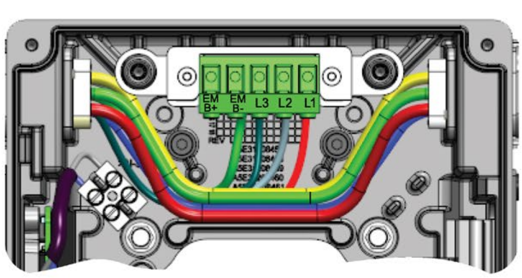
The SINAMICS G110M system has been designed to allow a converter to utilize power-through to provide the mains power for a number of converters in a daisy chain.

The maximum current limits for the daisy chain are given below:

- For the HanQ variants the maximum current of the daisy chained converters must not exceed 16 A.
- For the Glanded variants the maximum current on the daisy chained converters must not exceed 12 A.
- For both HanQ and Glanded variants the input for the daisy chained converters can be protected by a 20 A fuse.

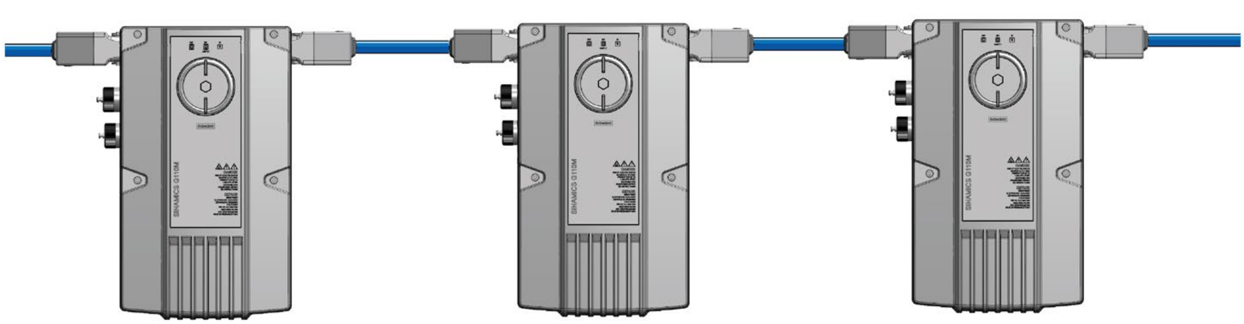
It is the users responsibility to ensure that the current limits are not exceeded.

The methodology for daisy chaining a number of Inverter is shown in the following diagram.



HanQ variant wiring example

Glanded variant wiring example



Note:
The cable clamp has been removed from the HanQ variant to allow the mains terminal wiring to be easily visible - the cable clamp must be in place before power is applied to the system.

Figure 4-14 Daisy chaining power between Inverters

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.

Connecting the motor holding brake

The Motor Holding Brake (MHB) function of the Control Units comprise dedicated hardware and software to control the actions of the MHB on the motor which is connected to the Inverter.

The MHB is connected to the Inverter using the EMB- and EMB+ terminals of the mains connectors in the Control Unit housing. The Power Module must be removed to access these terminals.

When the motor holding brake is connected to the Inverter , 180 V DC (at 400 VAC mains voltage) is supplied to the motor holding brake and the software within the Inverter monitors the correct functioning of the brake.

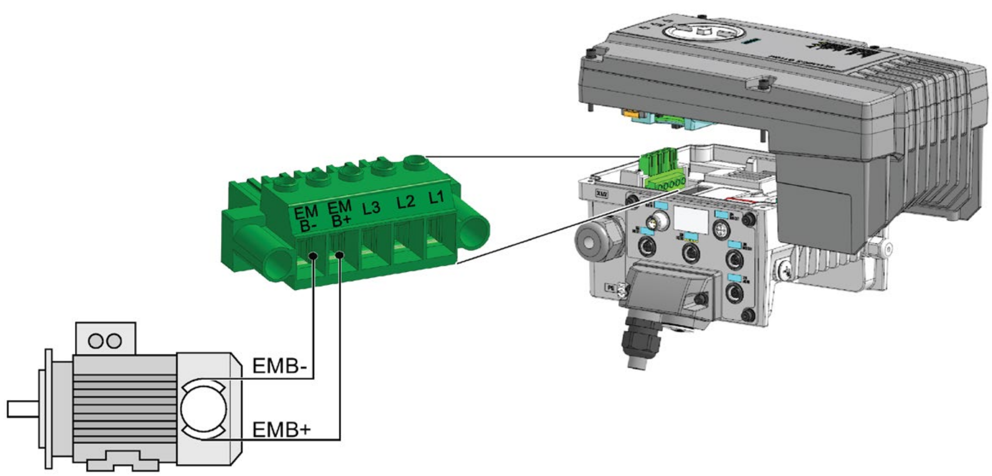


Figure 4-15 Simplied diagram of the motor holding brake connections

4.3.7 Connecting the PROFINET interface

Industrial Ethernet Cables and cable length

Listed in the table below are the recommended Ethernet cables.

Table 4- 7 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.

4.3.8 Terminal assignment dependent on interface configuration

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

When you put the frequency inverter into operation, you can change the function of each of its inputs and outputs and the setting of the fieldbus interface.

To make the setting process easier, the inverter has various predefined assignments (macros).

Only the inputs and outputs whose functions change by selecting a specific assignment, are shown on the following pages.

Procedure

1. Think about which of the input and output functions you are using in the application.
2. Find the I/O configuration (macro) that best suits your application.
3. Note the macro number of the corresponding default setting.

   You must set this macro number when putting the frequency inverter into operation.

You have found the appropriate inverter pre-assignment.
❒

4.3.9 Wiring example for the factory settings

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

Factory pre-assignment of the interfaces on the drive

For a complete technical specification of the individual connections, please refer to following section of this manual:

Connection and cables (Page 68)

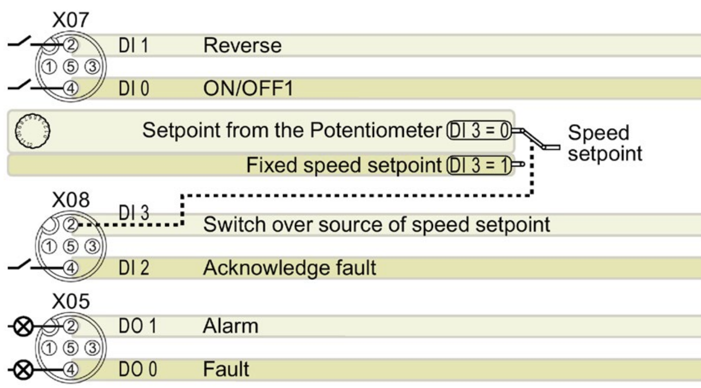


Figure 4-16 Macro 29 - Conveyer with potentiometer and fixed setpoint (Default USS)

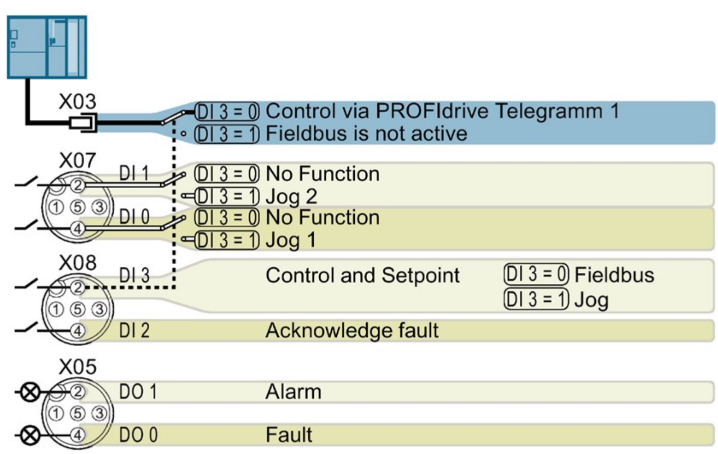


Figure 4-17 Macro 7 - Switch over between fieldbus and jogging using DI 3 (default DP/PN)

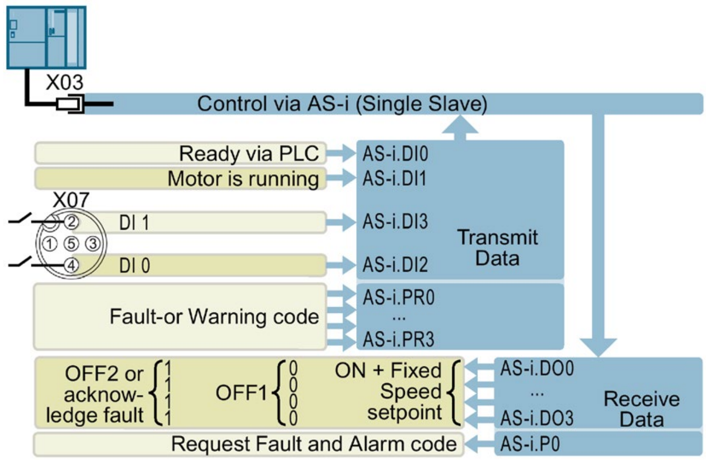


Figure 4-18 Macro 30 - ASi Single slave with fixed setpoints (default ASi)

Note

Unswitched and switched power supply

The unswitched 24 V power supply (also known as non-switched) on X1.2 and X1.4 provides power to the general electronics of the Control Unit. The switched 24 V power supply on X1.1 and X1.5 supplies power for the two digital outputs (DI0 and DI1).

For a complete explanation of the unswitched and switched 24 V supplies and their limitations, please read the FAQ at the following link:

Unswitched and switched 24 V supply (http://support.automation.siemens.com/WW/view/en/26986267)

Macros for the CU240M

The macros that are available for the CU240M Control Modules are shown in the figures below. Macro 7 is the default setting for the CU240M DP and CU240M PN Control Modules, Macro 21 is the default settings for the CU240M USS Control Module and Macro 30 is the default settings for the CU240M ASi Control Modules.

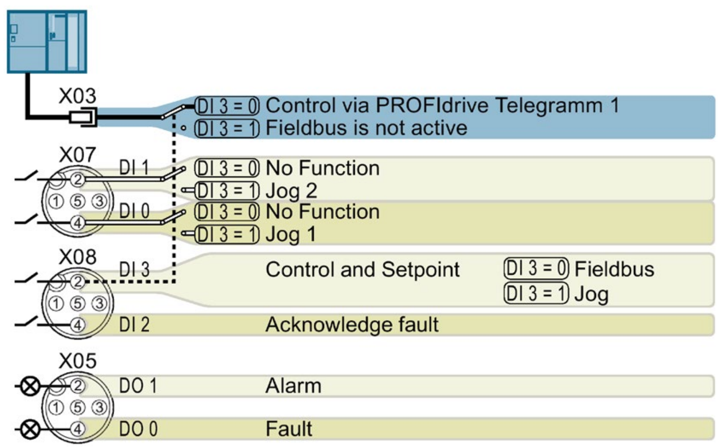


Figure 4-19 Macro 7 - Switch over between fieldbus and jogging using DI 3 (default DP/PN)

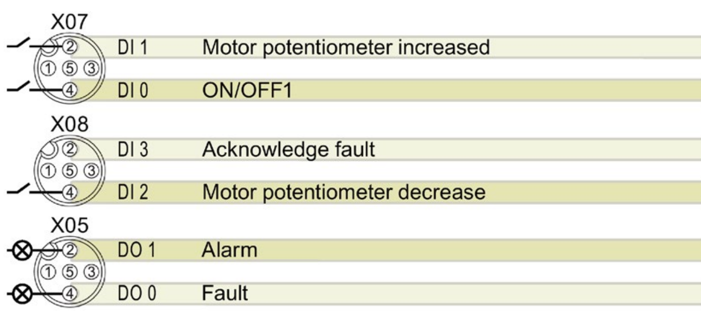


Figure 4-20 Macro 9 - Motorized potentiometer (MOP)

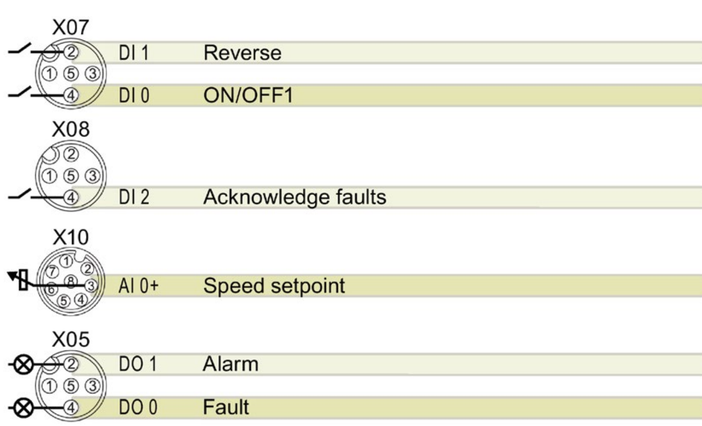


Figure 4-21 Macro 12 - Two-wire control with method 1

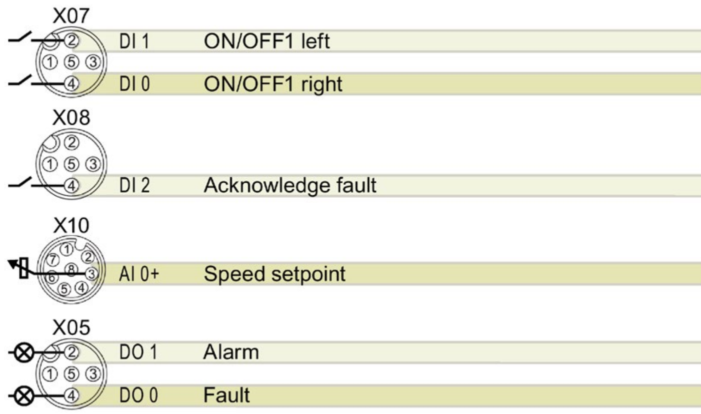


Figure 4-22 Macro 17 - Two-wire control with method 2

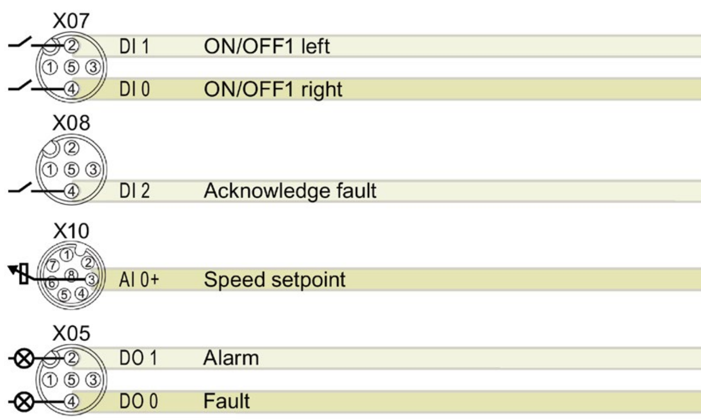


Figure 4-23 Macro 18 - Two-wire control with method 3

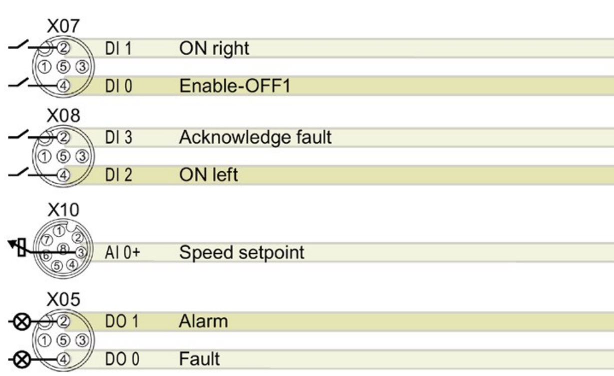


Figure 4-24 Macro 19 - Three-wire control with method 1

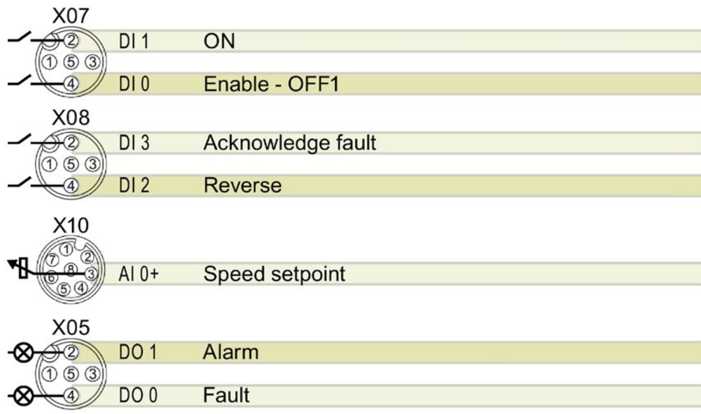


Figure 4-25 Macro 20 - Three-wire control with method 2

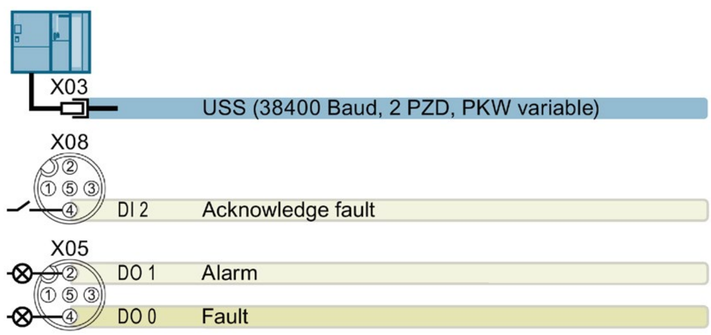


Figure 4-26 Macro 21 - Fieldbus USS

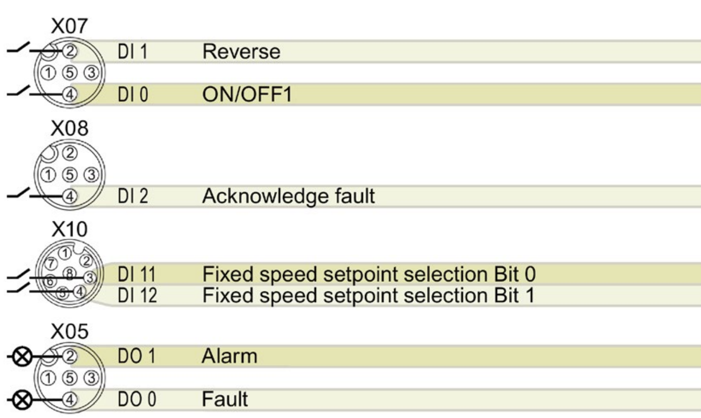


Figure 4-27 Macro 28 - Conveyor with 2 fixed setpoints

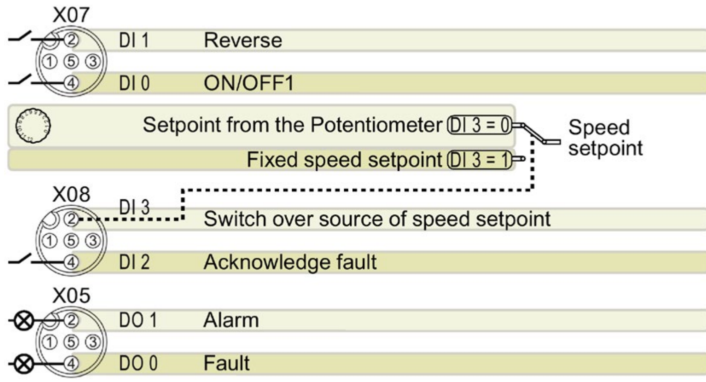


Figure 4-28 Macro 29 - Conveyer with potentiometer and fixed setpoint (default USS)

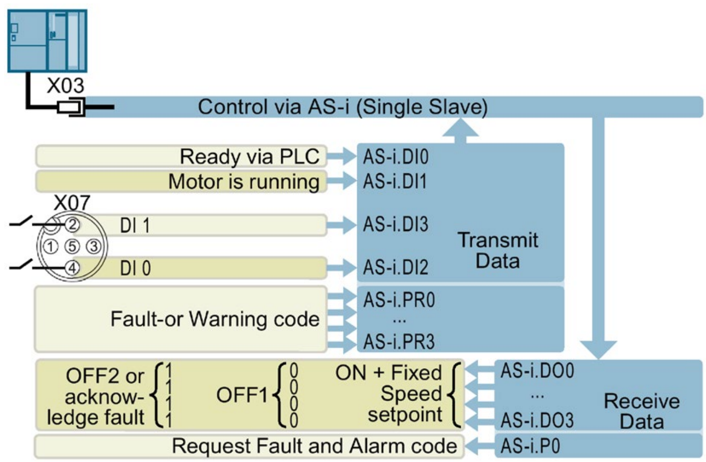


Figure 4-29 Macro 30 - ASi Single slave with fixed setpoints (default ASi)

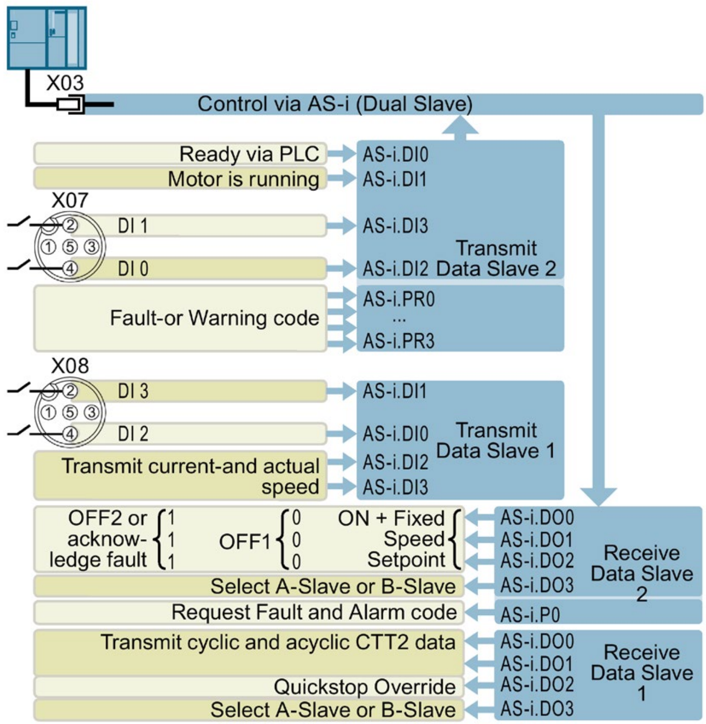


Figure 4-30 Macro 31 - ASi Dual slave with fixed setpoints

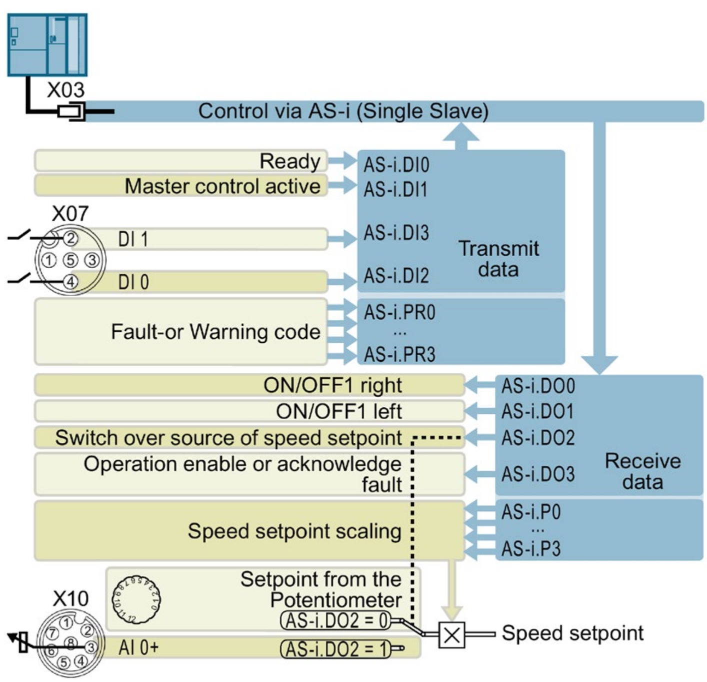


Figure 4-31 Macro 32 - ASi Single slave with analog setpoint

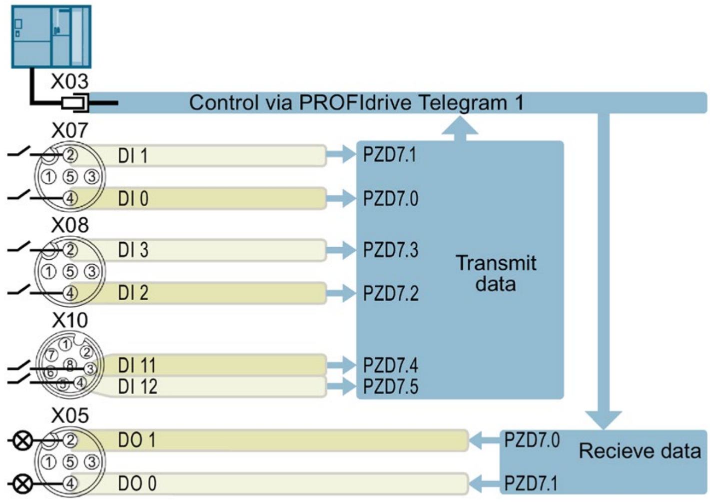


Figure 4-32 Macro 33 - 4DI decentral conveyor with fieldbus

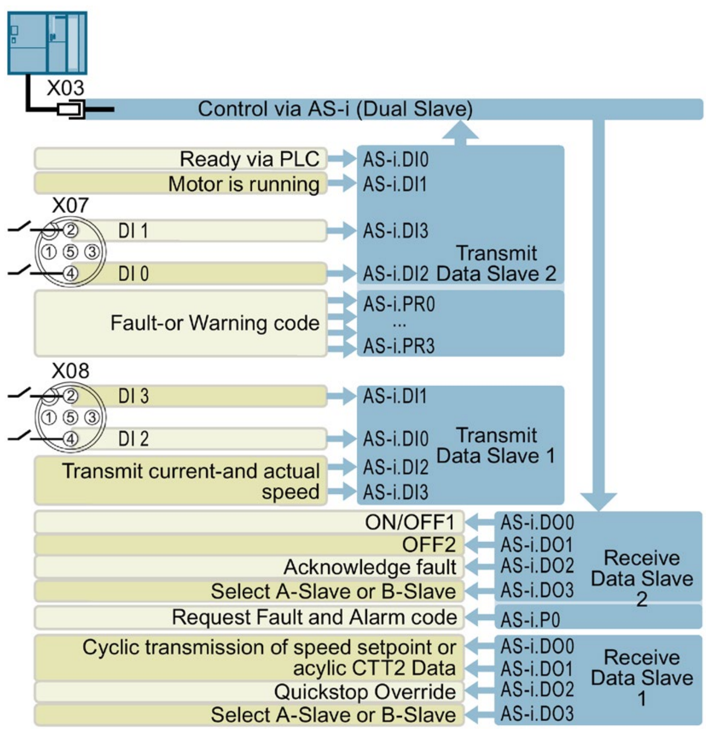


Figure 4-33 Macro 34 - ASi Dual slave with setpoint

4.4 Connecting the inverter to the fieldbus

4.4.1 Fieldbus version of the Control Module

Fieldbus interfaces of the Control Modules

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

Fieldbus	Profile			S7 Communi-cations	Control Module
	PROFIdrive	PROFIsafe	PROFIenergy		
PROFIBUS (Page 93)	✓	✓	---	✓	CU240M DP
PROFINET (Page 89)	✓	✓	✓	✓	CU240M PN
USS (Page 393)	---	---	---	---	CU240M USS
AS-i (Page 393)	---	---	---	---	CU240M AS-i

Further information on PROFIsafe can be found in the Safety Integrated Function Manual.

Further information on fieldbus, profiles and interfaces can be found in the Fieldbus Function Manual.

For a list of all the manuals associate with this product, see Manuals for your converter (Page 393).

4.4.2 PROFINET

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

The inverter in PROFINET IO operation

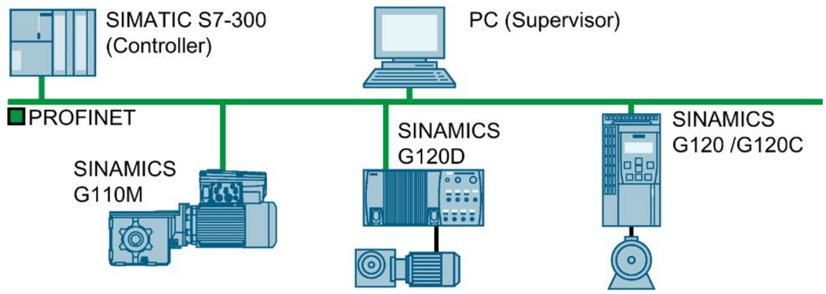


Figure 4-34 The inverter in PROFINET IO operation

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

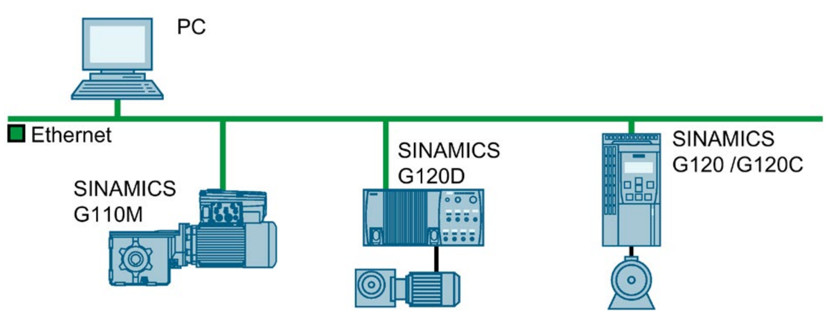


Figure 4-35 The inverter as Ethernet node

See also

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

PROFINET (http://www.automation.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".

Manuals for your converter (Page 393)

4.4.2.1 Connect the converter to PROFINET

Procedure

1. Connect the inverter to the control via the PROFINET socket X03.

   Connection and cables (Page 68)

   The maximum permitted cable length from the previous station and to the subsequent one is 100 m.
2. Externally supply the inverter with 24 V DC through X01.

You have now connected the inverter to the control system via PROFINET DP.
❒

4.4.2.2 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 92)

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 160)

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)

4.4.2.3 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.
❒

4.4.3 PROFIBUS

4.4.3.1 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.

   General layout SINAMICS G110M system (Page 32)

   The maximum permitted cable length to the previous station and the subsequent one is 100 m at a baud rate of 1 Mbit/s.
2. Externally supply the inverter with 24 V DC through X01.

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

4.4.3.2 What do you have to set for communication via PROFIBUS?

Configuring PROFIBUS communication

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

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

Installing the GSD (Page 94)

Setting the address

Set the address of the PROFIBUS slave.

Setting the address (Page 94)

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.

Integrating the inverter in PROFIBUS (Page 93)

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)

4.4.3.3 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.
❒

4.4.3.4 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:

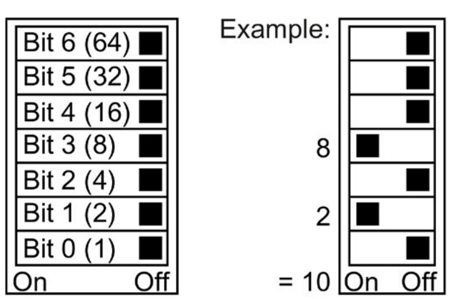


Figure 4-36 Address switch with example for bus address 10

  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.

General layout SINAMICS G110M system (Page 32)

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.
❒

4.4.4 Communications via AS-i

General information

The inverter operates based on the extended AS-i specification V3.0.

The signaling is made as Manchester-coded current pulses superimposed on the 28 V supply. Decouple the 28 V supply with inductances so that the receivers can decouple the transferred messages.

The Control Unit power consumption is approx. 90 mA provided you do not use any digital or analog inputs. When you use digital and analog inputs, the power requirement can be as high as 300 mA.

The inverter supports the Single Slave and Dual Slave modes.

In Single Slave mode, the inverter has an address in the AS-i network over which four bits are transferred. In Dual Slave mode, each inverter has two AS-i addresses over each of which four bits are transferred.

In the Single Slave mode, communication is realized in accordance with protocol 7.F.E. In the Dual Slave mode, communication is realized in accordance with protocols 7.A.5 and 7.A.E.

Default settings for commissioning

To configure the communication of the inverter via AS-i, the following possibilities are available for commissioning the inverter:

- Default setting 30 - Single Slave mode, standard addressing
  Single Slave mode with specification of a fixed frequency via the control
- Default setting 31 - Dual Slave mode with fixed setpoints
  Dual Slave mode with specification of a fixed frequency via the control
- Default setting 32 - Single Slave mode, modified addressing:
  Single Slave mode with "ON clockwise / OFF1", "ON counter-clockwise / OFF1", speed setpoint via CDS0 or CDS1
- Default setting 34 - Dual Slave mode with "ON/OFF1", "OFF2"
  Dual Slave mode with "ON/OFF1", "OFF2", speed setpoint via control

Details about the default settings are provided in the operating instructions of your inverter.

Inverter factory setting (Page 106)

Connection

The following table shows the AS-i plug assignment. Further connection information is contained in the AS-Interface system manual.

AS-i System Interface Manual
(https://support.industry.siemens.com/cs/gb/en/view/1171856)

Table 4- 8 Pin assignment

X03 AS-i (M12)	Pin	Function	Description
	1	AS-i +	AS-i plus signal
	2	0 V	Reference potential for terminal 4
	3	AS-i -	AS-i minus signal
	4	24 V	24 V auxiliary voltage
	5	Not assigned	

4.4.4.1 Setting the address

As factory setting, all AS-i slaves have address 0. Slaves with address 0 are not included in the communication.

The addresses must be unique, although they can be mixed as required.

You have the following options when making the address assignment:

- Automatic addressing via the AS-i master
- Addressing via the addressing device
- Addressing via parameters

Before you set the address, you must specify whether the inverter is integrated as Single Slave or Dual Slave in the AS-i network.

- p2013 = 0: Single Slave (factory setting)
- p2013 = 2: Dual Slave

If for the commissioning you select the default setting 30 or 32 (Single Slave), or 31 or 34 (Dual Slave), p2013 is assigned the appropriate value.

Note

Changes made to p2012 and p2013

Changes made to the p2012 and p2013 parameters take effect immediately after the change.

If you work with Startdrive, you must back up the changes so they are not lost when the system is switched off and on again.

Automatic addressing via the AS-i master

Single Slave

For automatic addressing, the address is specified by the AS-i master. For a Single Slave, the master checks which slave has address 0 and assigns it the next free address. This address is also written to parameter p2012. If more than one slave has address 0, an automatic addressing is not possible.

Dual Slave

For automatic addressing, the address is specified by the AS-i master. If both slaves have address 0, the second slave is hidden and the control assigns a valid address for slave 1.

Slave 2 then becomes visible with address 0 and can be addressed.

Automatic addressing is not always possible for older AS-i masters. In this case, use the manual addressing and set the address from an addressing device, via Startdrive or from an operator panel on the inverter.

Further information is contained in the AS-Interface system manual, Section "Setting the AS-i address"

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856)

Addressing via the addressing device (e.g. 3RK1904-2AB02)

Addressing via the addressing device is made offline.

Further information is contained in the AS-Interface system manual, Section "Setting the AS-i address"

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856)

Addressing via parameters

The address assignment is made with the p2012[0] and p2012[1] parameters.

If you assign the address via Startdrive, you must back up the settings so that they are not lost if the power fails.

- Address range for Single Slave inverter, profile 7.F.E
  - p2012[1]: 0 … 31, range for the A address, 0A … 31A
- Address range for Dual Slave inverter, profile 7.A.5 or 7.A.E
  - p2012[0]: 0 … 31, 33 … 63 for slave 1:
  - p2012[1]: 0 … 31, 33 … 63 for slave 2:

  with

  - 0 … 31 range for the A address, 0A … 31A
  - 33 … 63 range for B address, 1B … 31B

4.4.4.2 Using the AS-i Programmer

Setting the slave address with the AS-i Address Programmer

The Inverter contains two logical AS-i slaves. Either slave can be assigned an address in the range 1A...31A or 1B...31B. The addresses can be allocated to the slaves sequentially, for example, 3A and 4A, 10B and 11B or they can occupy the same number using extended addressing, for example, 20A and 20B. If necessary they can have completely different unassociated addresses, for example, 14A and 16B.

The decision on how to allocate these addresses must also take into account the addressing used in the PLC program by either adherence to the memory map of the AS-i master or the way in which the inputs and outputs can be allocated by the PLC hardware configuration.

The default address of both slaves is 0.

Setting the AS-i address of slave 1

1. Plug the AS-i Programmer into the addressing socket of the Inverter.
2. Turn the dial on the Programmer to the **ADDR** position. The display will indicate that this mode has been selected.

3. Press the button; the screen will display the text, **SEt 0** with a small flashing **0** to the left of the display.

4. Press the button until you reach the required number.
   By pressing both the and simultaneously, you can toggle between A and B identifiers of the address.
5. Press the button to confirm the selected address.
   ProG is momentarily displayed, followed by **AddrES**.
   The number allocated to slave 1 is now shown at the bottom of the display.

Setting the AS-i address of slave 2

1. Press the button; the display shows the text **SEArcH** followed by **uSE 0**.
   A small 0 is displayed to the left of the display and the number of the first slave that has already been allocated to slave 1 is shown at the bottom of the display.

2. Press the button to select this number.
   SEt 0 appears and the small **0** in the left of the display starts flashing.

3. Press the button until you reach the required number.
   By pressing both the and simultaneously, you can toggle between A and B identifiers of the address.
4. Press the button to accept this number.
   ProG is displayed briefly.
   Both of the numbers allocated to the slaves are now displayed in the lower part of the screen.

Changing existing addresses of the AS-i slaves

If the allocated addresses used two different numbers, for example, 10A and 11A, then if one of the slave addresses is reset to 0 the other slave is not affected.

If the allocated addresses use the same number, for example, 20A and 20B, then if one slave addresses is reset to 0, then both slaves numbers will be reset to 0.

Modifying an existing address of a single slave within the Inverter will not affect the address of the other slave.

To change an existing address of a slave, the following procedure should be performed:

1. Plug the AS-i Programmer into the addressing socket of the Inverter
2. Turn the dial on the Programmer to the **ADDR** position. The display will indicate that this mode has been selected.

3. Press the button; the screen will display **uSE** and the number of the lower addressed slave.
   The existing slave addresses are shown at the bottom of the display.

4. Press the and buttons to select the slave address number to be changed.
5. Press the button; the display now shows **SEt**.
   The selected number will begin to flash.

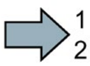
6. Press the and buttons to select the new slave address number.

7. Press the button to confirm the new address.
   ProG is displayed briefly followed by confirmation of the address change.

Commissioning 5

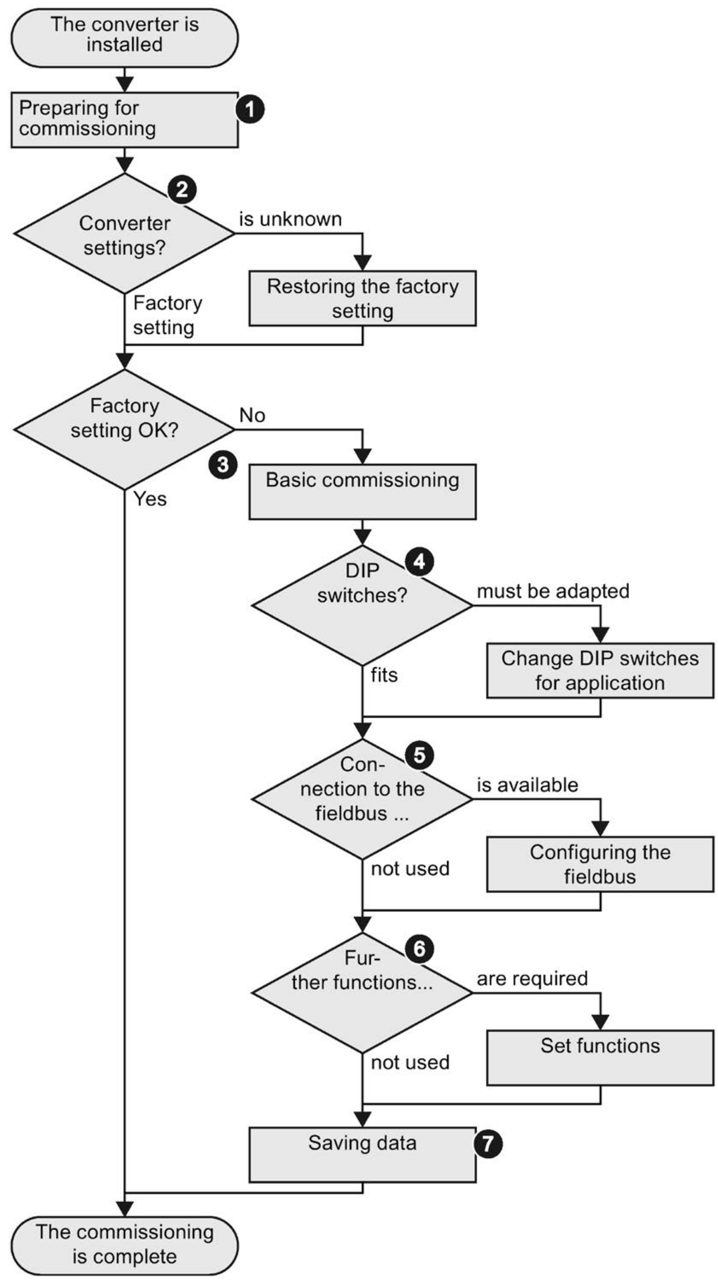
5.1 Commissioning guidelines

We recommend the following procedure:



1. Define the requirements of your application placed on the drive.
   → (Page 103) .
2. Reset the converter when required to the factory setting.
   → (Page 111) .
3. Check whether the factory setting of the converter is appropriate for your application.

   If not, start with the basic commissioning.
   → (Page 103) .
   → (Page 114) .
4. Check whether you need to adapt the commissioning DIP switches.
   → (Page 89).
5. If necessary, adapt the communications interface in the converter.
   → (Page 145) .
6. If necessary, set further functions in the converter.
   → (Page 139) .
7. Save your settings.
   → (Page 303) .



You have fully commissioned the converter.

5.2 Commissioning tools

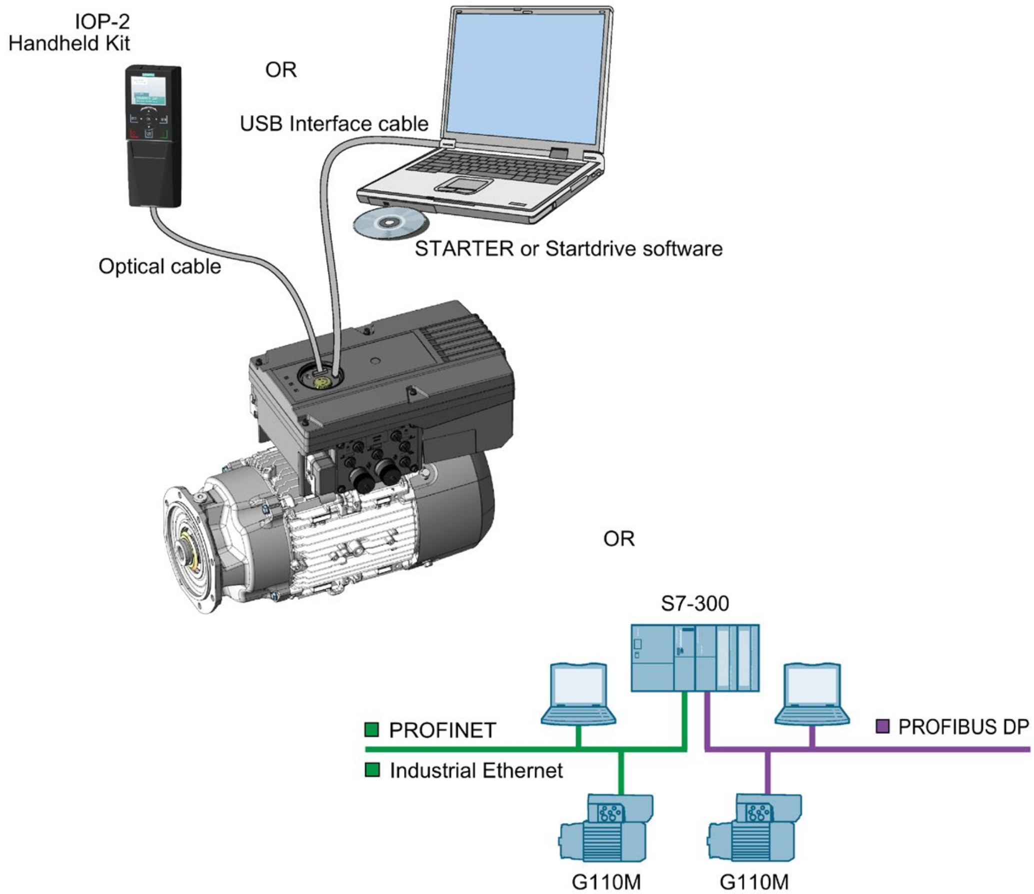


Figure 5-1 Commissioning tools - PC or IOP Handheld Kit

Table 5- 1 Components and tools for commissioning and data backup

Component or tool		**Article number**
Operator Panel	IOP-2 Handheld Kit	6SL3255-0AA00-4HA1
Optical cable	Required for using IOP Handheld Kit with CU240M	3RK1922-2BP00
STARTER 1)	Commissioning tool (PC software) - Version 4.3.3 or later	DVD: 6SL3072-0AA00-0AG0
StartDrive 2)	Commissioning tool (PC software) - Version 12 or later	DVD: 6SL3072-4CA02-1XG0
PC Connection Kit	Contains the 3 m USB cable necessary to connect your converter to a PC.	6SL3255-0AA00-2CA0
SD card 	Optional memory card for storing and transferring the converter settings	6SL3054-4AG00-2AA0

[1] Internet: STARTER download (http://support.automation.siemens.com/WW/view/en/26233208)

[2] Internet:StartDrive download (http://support.automation.siemens.com/WW/view/en/68034568)

5.3 Prepare commissioning

Overview

Before starting commissioning, you must know the answer to the following questions:

Inverter

- **What are the data specifications of my inverter?**
  → Figure 3-1 Identifying the components of the system (Page 28).
- **How is the inverter integrated in the higher-level control system?**
  → Via the terminals or the fieldbus interface?

Saving non-standard motor data to EEPROM

When performing a factory reset on the converter, all parameter data is reset to the factory default settings. The default settings for the motor data assumes you are using a Siemens standard 4-pole motor.

If you are not using a Siemens standard 4-pole motor with a motor which has the same rating as the converter, for example, a 1.5 kW converter and a 1.5 kW motor, then your application will not work correctly after a factory reset.

When using a non-standard motor, the motor data must be saved to the converter's non-volatile memory (EEPROM), this will ensure that even after a factory reset, your unique motor data will not be overwritten and will remain intact.

To save your unique motor data to the converter's EEPROM, the following procedure should be performed.

1. Commission the converter using the STARTER Quick Commissioning wizard.
2. Ensure that a motor data identification is performed, at the completion of the commissioning procedure.
3. Perform a "Copy from RAM to ROM".
4. Set parameter p0726 to 1.
5. When the motor data save is complete, parameter p0726 will be set back to 0.
6. The motor data is saved to the converter's EEPROM.

NOTICE
Saving motor data to the EEPROM is permanent When the motor data is saved the converter's EEPROM, the data is permanently stored in the EEPROM and will never be overwritten by any reset function of the converter. To change the motor data stored in the EEPROM, the procedure outlined above must be performed again with the new required motor data.

5.3.1 Collecting motor data

The SINAMICS G110M system is generally delivered as a completely assembled, Inverter, Power Module and motor, but it may be necessary to input specific motor data depending on the requirements of the users application. All the necessary motor data is displayed on the motor rating label as shown in the following example.

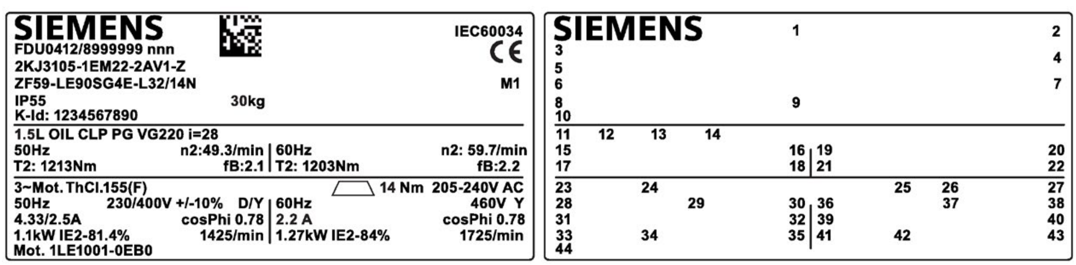


Figure 5-2 SIMOGEAR motor rating label example

1 Matrix code

2 Applied standard

3 Serial No.
FDU = Siemens AG, Bahnhofstr. 40, 72072 Tübingen, Germany

4 CE marking or other marking, if required

5 Article No.

6 Model - Type - Size

7 Mounting position

8 Degree of protection according to IEC 60034-5 or IEC 60529

9 Weight m [kg]

10 Customer ID

11 Oil quantity [l] main gearbox / intermediate gearbox

12 Type of oil

13 Oil viscosity ISO VG class according to DIN 51519 / ISO 3448

14 Total transmission ratio i

Frequency 1

15 Rated frequency f [Hz]

16 Gearbox output speed n_2 [rpm]

17 Geared motor output torque T_2 [Nm]

18 Service factor f_B

Frequency 2

19 Rated frequency f [Hz]

20 Gearbox output speed n2 [rpm]

21 Geared motor output torque T2 [Nm]

22 Service factor f_B

Motor data

23 Phase number and type of current for the motor

24 Temperature class Th.Cl.

25 Symbols (IEC 60617-2): = brake

26 Rated braking torque T_{Br} [Nm]

27 Brake supply voltage U [V]

Frequency 1

28 Rated frequency f [Hz]

29 Rated voltage / range U [V]

30 Circuit, graphical symbols according to DIN EN 60617 Part 6 / IEC 60617-6

31 Rated current I_N [A]

32 Power factor cos φ

33 Rated power P_N [kW], duty type (if ≠ S1)

34 Efficiency class marking according to IEC 60034-30

35 Rated speed n_N [rpm]

Frequency 2

36 Rated frequency f [Hz]

37 Rated voltage / range U [V]

38 Rated current I_N [A]

39 Power factor cos φ

40 Circuit, graphical symbols according to DIN EN 60617 Part 6 / IEC 60617-6

41 Rated power P N [kW], duty type (if ≠ S1)

42 Efficiency class marking

43 Rated speed n_N [rpm]

44 Motor designation, active part

- If you use the STARTER commissioning tool and a SIEMENS motor, you only need to specify the article number of the motor, otherwise you must note the data from the motor rating label.
- Pay attention to the connection of the motor (star connection [Y] or delta connection [Δ]). Note the appropriate motor data for connecting.
- Motor ambient temperature if it differs from the factory setting = 20° C.

5.3.2 Inverter factory setting

Motor

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

Inverter interfaces

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

Wiring example for the factory settings (Page 81)

Switching the motor on and off

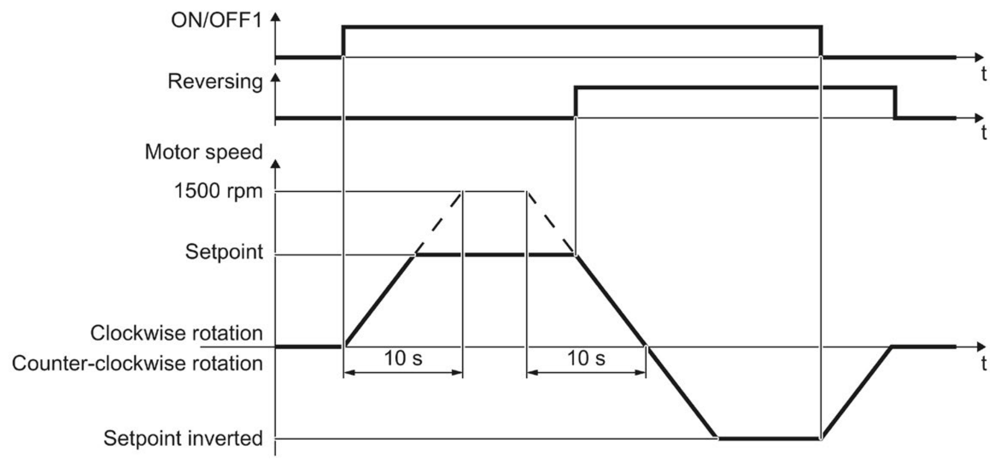


Figure 5-3 Switching on and switching off the motor and reversing in the factory setting

The inverter is set in the factory as follows:

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

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

Switching the motor on and off in the jog mode

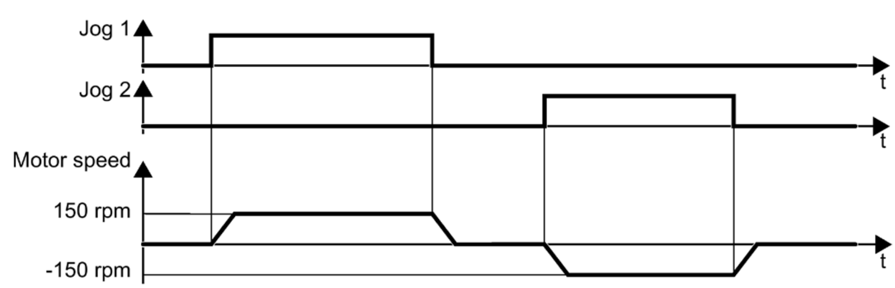


Figure 5-4 Jogging the motor with the factory settings

In the case of inverters with a PROFIBUS or PROFINET interface, operation can be switched via digital input DI 3. The motor is either switched on and off via PROFIBUS – or operated in jog mode via its digital inputs.

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

5.3.3 V/f control or speed control

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

- V/f control (calculation of the motor voltage using a characteristic curve)
- Closed-loop speed control (also: field-oriented control or vector control)

Criteria for selecting either V/f control or speed control

In many applications, the V/f control suffices to change the speed of induction motors. Examples of typical applications for V/f control include:

- Pumps
- Fans
- Compressors
- Horizontal conveyors

When compared to V/f control, vector control offers the following advantages:

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

Examples of typical applications in which speed control is used:

- Hoisting gear and vertical conveyors
- Winders
- Extruders

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

- If the motor is too small in comparison to the converter (the rated motor power must not be less than one quarter of the rated converter power)
- When you operate several motors on one converter
- When the maximum motor speed exceeds the following values:

Converter pulse frequency	2 kHz	4 kHz and higher
Pole number of the motor	4-pole	4-pole
Maximum motor speed [rpm]	4980	7200

5.3.4 Minimum and maximum speed

Minimum and maximum speed

- Minimum speed - factory setting 0 [rpm]

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

  The inverter limits the motor speed to the maximum speed.

Operate the inverter with the factory setting

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

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

5.4 Quick commissioning

5.4.1 Motor data using p300 and p301

Preassigned motor data using p0300 and p0301

The SINAMICS G110M software has been configured to utilize the input of the motor data using a motor code. There are two parameters associated with this function, they are p0300 (motor type) and p0301 (motor code).

When the SINAMICS G110M is ordered and delivered as a complete system, the motor data is already correctly configured and does not require any adjustment.

When the SINAMICS G110M is ordered and delivered as separate items, the user must install the system and enter the relevant motor data during basic commissioning.

When commissioning of the motor is required, there are two options available to the user:

Commissioning using motor codes

When commissioning using the motor codes, for example, in STARTER utilizing the "Expert List", the follow steps should be performed:

1. Set p0010 = 1.
2. Set p0300 to 100 (1LE1 standard induction motor) or 177 (1LA7 standard induction motor).
3. Enter the relevant motor code into p0301 as shown in the following table:

Motor type	Power rating (kW)	Motor code for p0301
1LA7	0.37	17726
1LE1	0.75	12017
1LE1	1.10	12018
1LE1	1.50	12019
1LE1	2.20	12020
1LE1	3.00	12021
1LE1	4.00	12023

When the relevant motor code is entered, the motor data automatically assigned for the selected motor. The user can then complete the commissioning process without the need to perform a motor ID.

Commissioning without using motor codes

When commissioning the system without using motor codes, the following steps must be performed, otherwise the motor will not be commissioned correctly.

1. Set p0010 = 1 (Enter the quick commissioning mode).
2. Set p0300 = 1 (Induction motor [rotating]).
3. Set p0301 = 0 (This disables the automatic motor data assignment).
4. Complete the commissioning process, entering the motor data (from the motor rating label) into the relevant parameters.
5. Set p3900 = 1, 2 or 3 to end quick commissioning, depending on the users requirements.

⚠ CAUTION

Parameter p0301 must be set to 0

When commissioning using the manual input of motor data, it is important that p0301 is set to 0.

If p0301 is not set to 0, then even if the motor ID function is selected at the completion of the commissioning process, no motor ID will actually be performed. If the motor ID is not performed it could leave the motor in an unpredictable state and that may adversely affect the users application.

Therefore, it is essential that p0301 is checked to ensure it is actually set to 0.

Commissioning with the Intelligent Operator Panel (IOP)

When using the basic commissioning wizard on the IOP the user will presented with a screen asking for the motor type (p0300) to be entered. Depending on the value that is input into the IOP, there are two different branches to the commissioning wizard.

Action 1(using motor codes):

1. If 100 or 177 is entered, the user is then presented with the motor code screen (p0301).
2. Entered the relevant code for the motor.
3. The motor data is automatically assigned for the motor.
4. The basic commissioning wizard continues but does not ask for any further motor data to be entered.

Action 2 (no motor codes):

1. If 1 is entered (Induction motor), the IOP will automatically set p0301 to 0.
2. The basic commissioning wizard continues and asks for the relevant motor data to be entered during the commissioning process.

5.4.2 Quick Commissioning with DIP switches

Overview

The CU240M Control Modules have been designed to allow quick commissioning to be performed using a set of three DIP switches. The DIP switches are located on the Control Module, as shown in the figure below.

Note

CU240M Control Modules naming convention

Although the CU240M is given a Control Unit designation, the actual device is called a Control Module. The reason for the naming convention is that the Terminal Housing, the Communications and Power Interface, including the Control Module comprise all the components that make up a standard Control Unit configuration; but when assembly and installing the SINAMICS G110M system, the Control Module requires a unique designation so that it can be easily identified in the installation procedures.

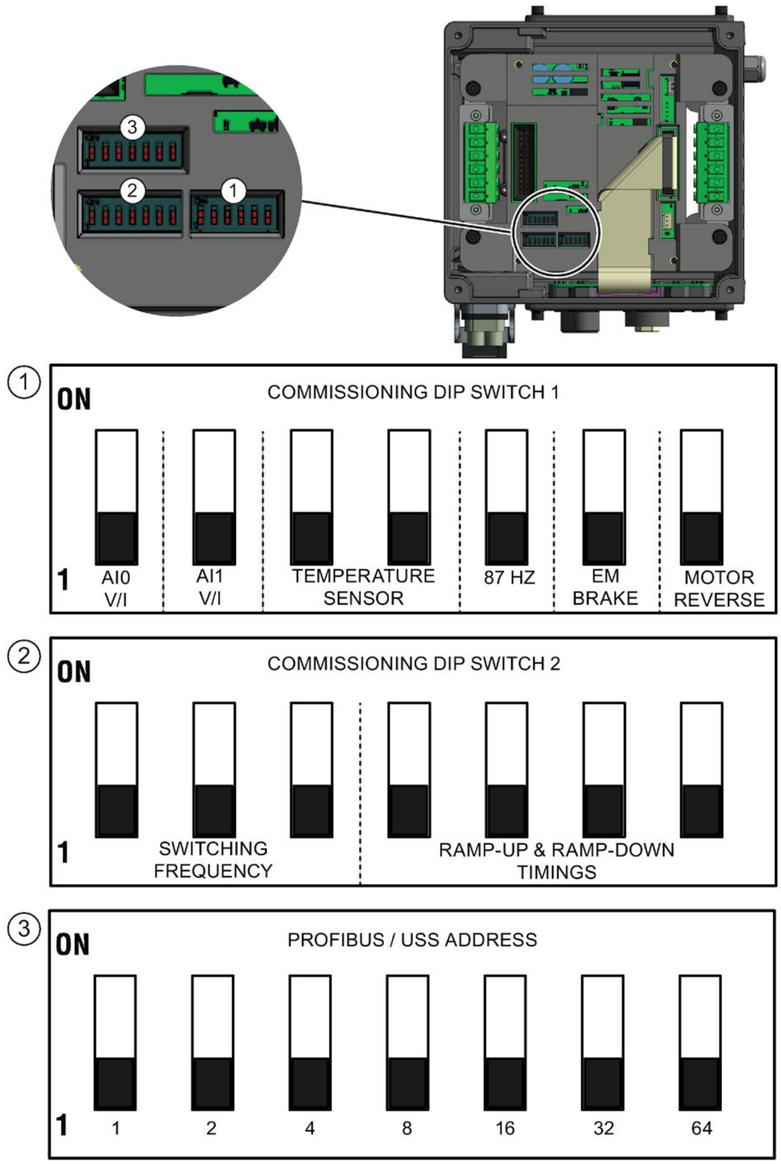


Figure 5-5 DIP Switches location

Accessing the DIP switches

⚠ DANGER
Dangerous voltages and currents are present in the active converter When power is applied to the converter, even when it is not active, dangerous levels of voltage and current are present in the system. Before attempting the removal of any components of the system the following steps should be taken to ensure that the system is completely safe: 1. Ensure that the converter is not running, if so, the converter must be stopped. 2. Disconnect all mains power supplies to the system. If an external 24 V supply is connected to the system, then this does not have to be disconnected. 3. Wait 5 minutes to allow all the residual current and voltages to dissipate fully.

Generally the G110M system is delivered fully assembled on a motor which prohibits easy access to the DIP switches. To access the DIP switches it is necessary to remove the Power Module; this action is illustrated in the figure below.

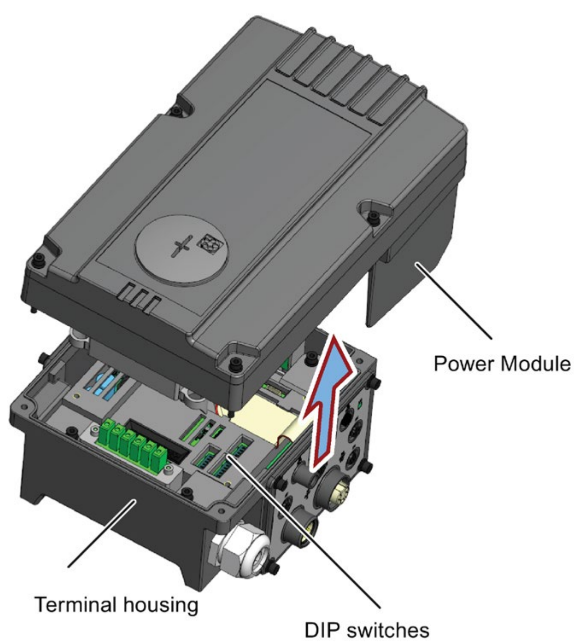


Figure 5-6 Removing the Power Module

Description of the DIP switches functions

When the DIP switches are in the OFF position, the value of the function is defined by the default value of the parameter. If the DIP switch is activated for a specific function, then the parameters for that function cannot be modified by manually editing the parameter value, i.e. ready-only.

The DIP switches allows specific functions of the converter to be set and are shown in the table below.

Table 5- 2 Function of the DIP switches

DIP switch	Function
①	Selects current or voltage input for the analog inputs.
	Temperature sensor - sets the type of temperature sensor fitted to the motor.
	87 Hz characteristic - set "ON" to operate the motor with the 87 Hz characteristic.
	Electromechanical (EM) brake - select on if an EM brake is fitted.
	Motor reverse
②	Switching frequency - the user can select one of seven different switching frequencies.
	Ramp-up and ramp-down timings - user can select from 0.1 seconds to 70 seconds
③	PROFIBUS address DIP-switch for use with the PROFIBUS and USS variant of the CU240M.

Examples of the DIP switches and their individual settings are illustrated in the figures below.

Example: Set address = 10

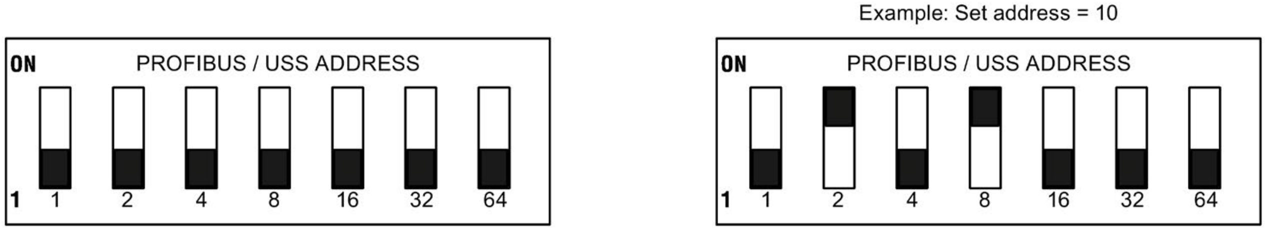
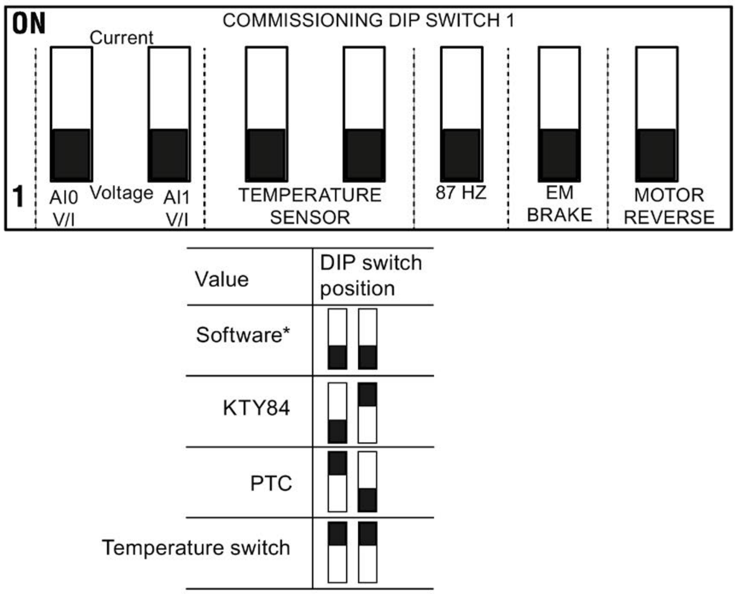


Figure 5-7 PROFIBUS address DIP Switch



*SOFTWARE:
When the DIP switches are in the OFF position the value of the function is defined by the default parameter value or a user-defined value.

PARAMETER MODIFICATION:
If the DIP switch is activated for a specific function, the parameters for that function cannot be modified by editing the actual parameter.

Figure 5-8 Commissioning DIP Switch 1

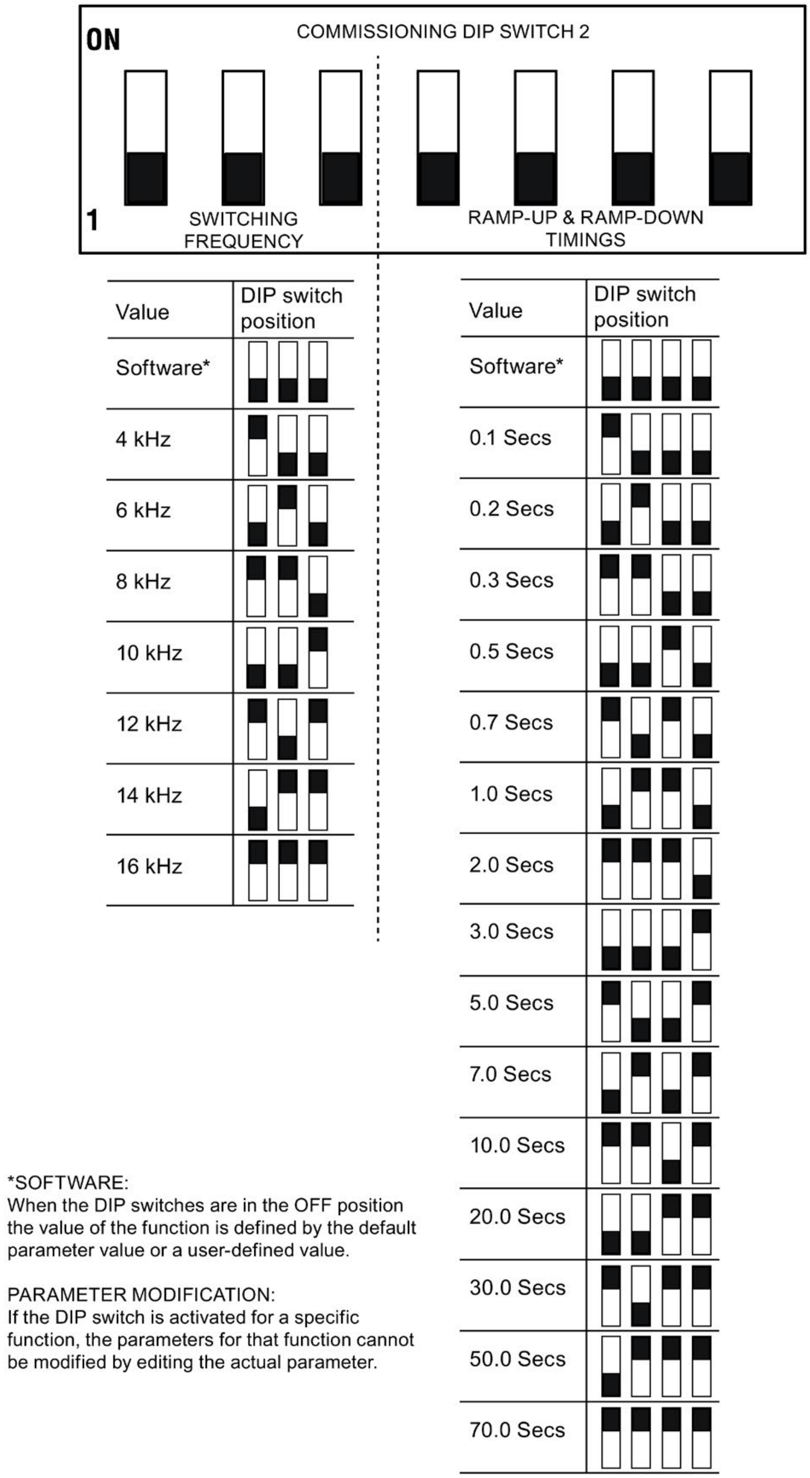


Figure 5-9 Commissioning DIP Switch 2

5.4.3 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 102).

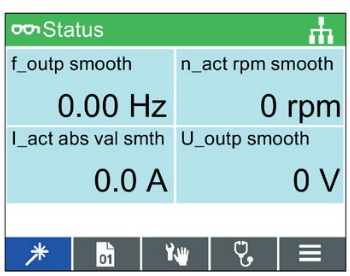
Note

Screens and sequence may vary

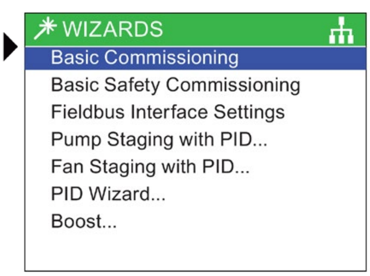
The sequence of the commissioning process and the actual screens may vary according to the following influences:

- 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.

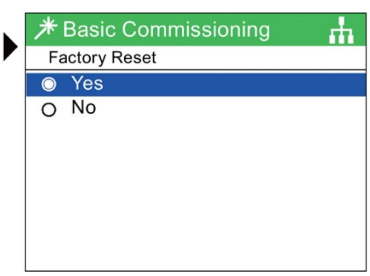
In all the scenarios, the IOP-2 will always display the appropriate commissioning screens and sequence for the device to which it is connected.



Select Wizards

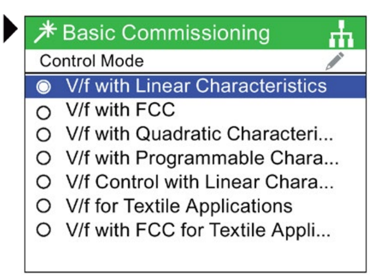


Select Basic Commissioning wizard

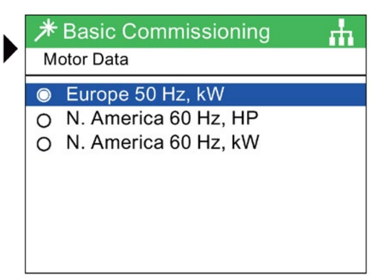


Select Factory Reset (yes or no)

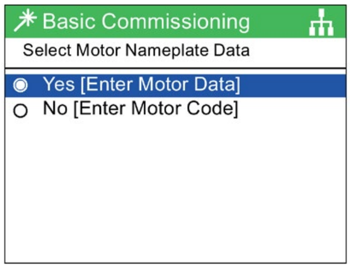
Select Continue



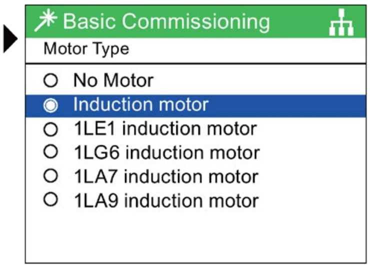
Select Control Mode



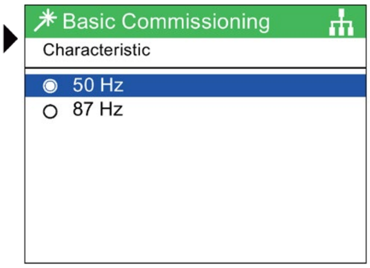
Select Motor Data



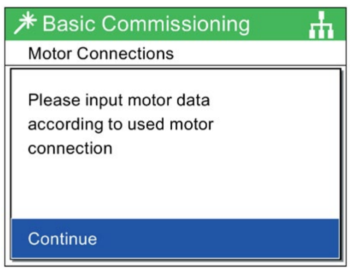
Select Enter Motor Data



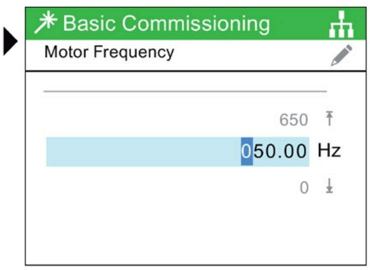
Select Motor Type



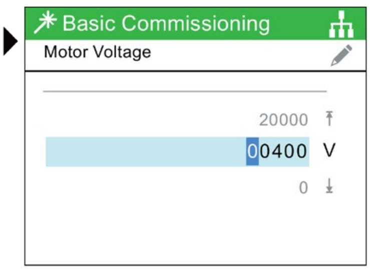
Select Characteristic



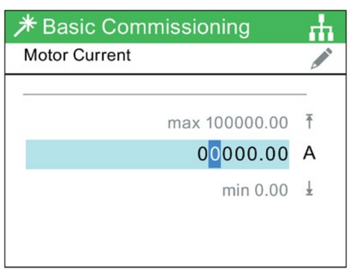
Select Continue



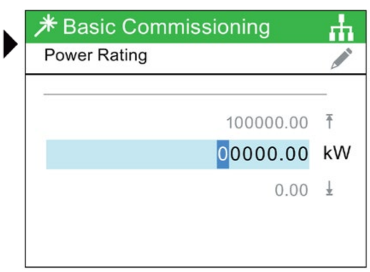
Input Motor Frequency



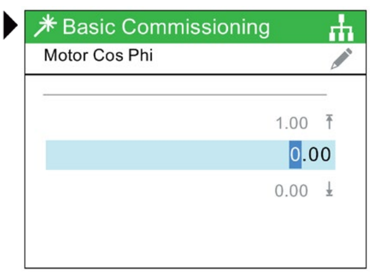
Input Motor Voltage



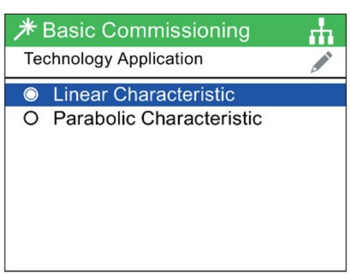
Input Motor Current



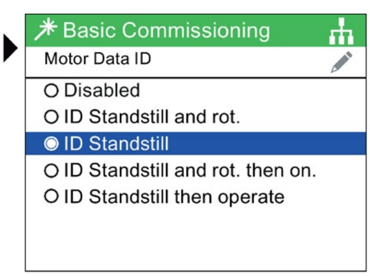
Input Power Rating



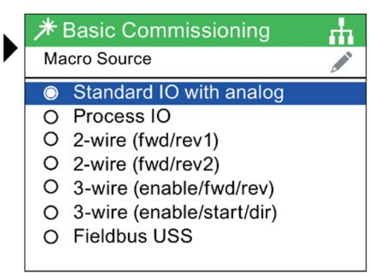
Input Motor Speed



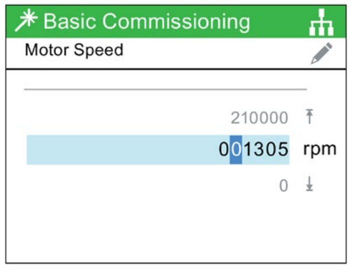
Select Technology Application



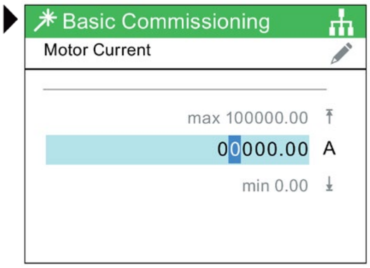
Select required Motor Data ID function



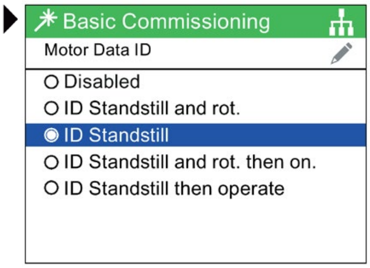
Select Macro Source



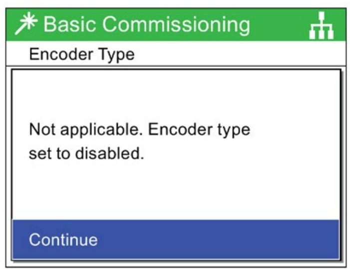
Input the Motor Speed



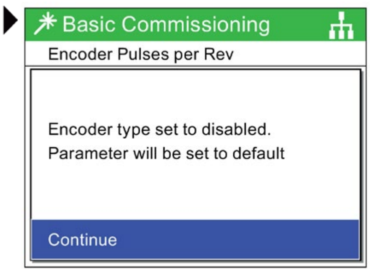
Input Current Limit



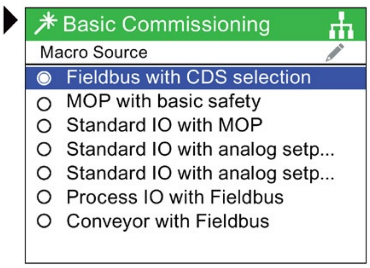
Select Motor Data ID option



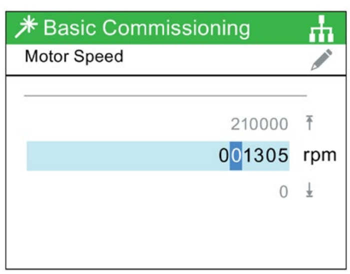
Input Encoder Type



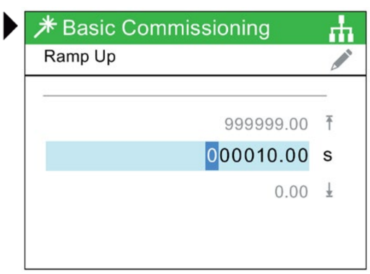
Input Encoder Pulses per rev



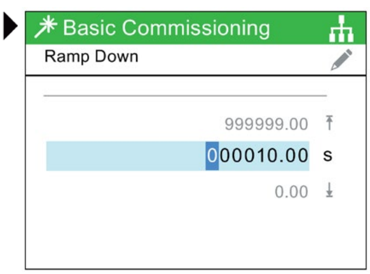
Select Macro Source



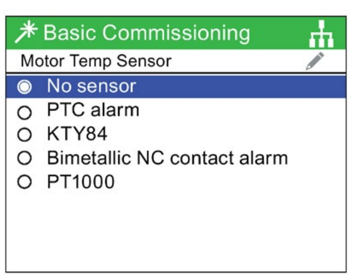
Input Maximum Speed



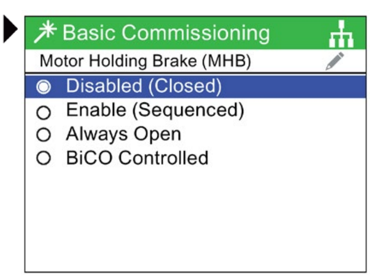
Input Ramp-up time



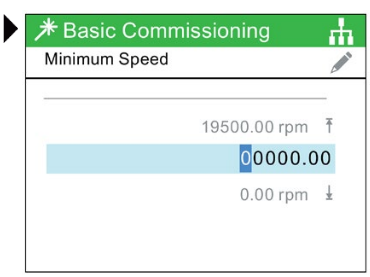
Input Ramp-down time



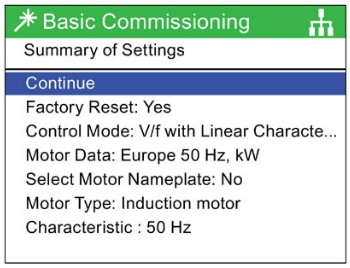
Select Motor Temperature Sensor



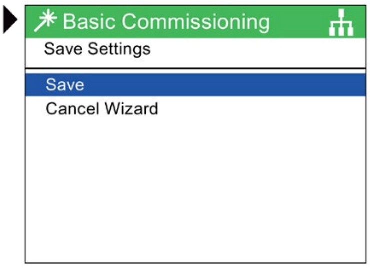
Select Motor Holding Brake option



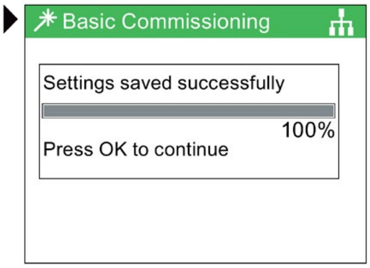
Input Minimum Motor Spped



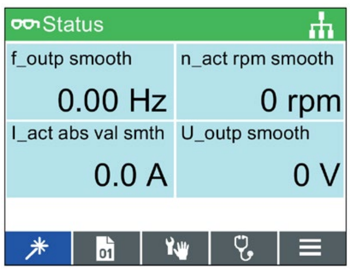
Summary of settings - Select Continue



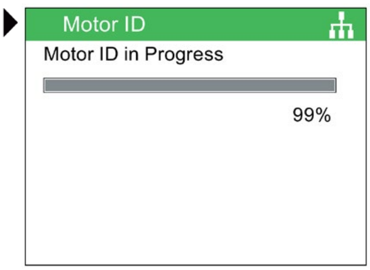
Save Settings



Settings saved



Status Screen displayed



On first ON command - Motor ID is performed

5.4.4 p0015 Macros

Macros for the CU240M

The macros that are available for the CU240M Control Modules are shown in the figures below. Macro 7 is the default setting for the CU240M DP and CU240M PN Control Modules, Macro 21 is the default settings for the CU240M USS Control Module and Macro 30 is the default settings for the CU240M ASi Control Modules.

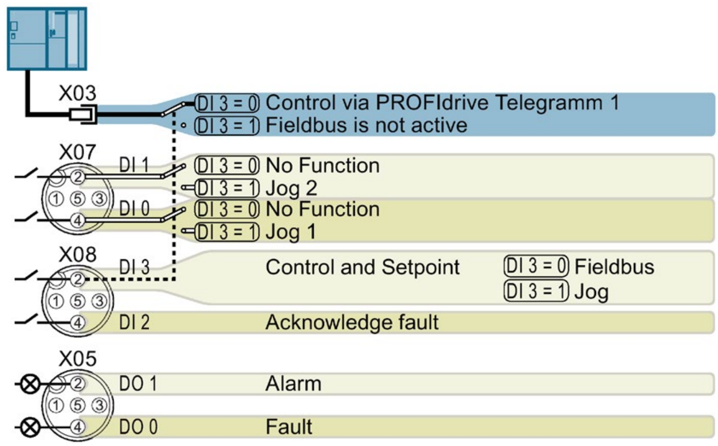


Figure 5-10 Macro 7 - Switch over between fieldbus and jogging using DI 3 (default DP/PN)

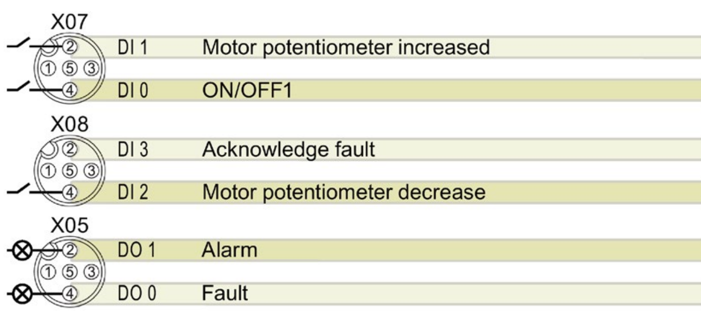


Figure 5-11 Macro 9 - Motorized potentiometer (MOP)

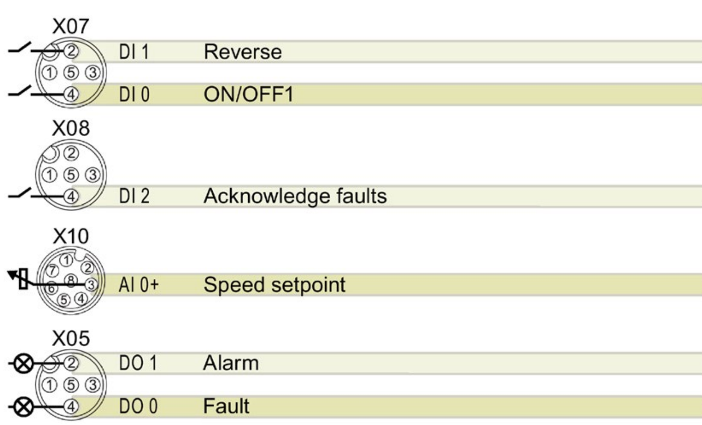


Figure 5-12 Macro 12 - Two-wire control with method 1

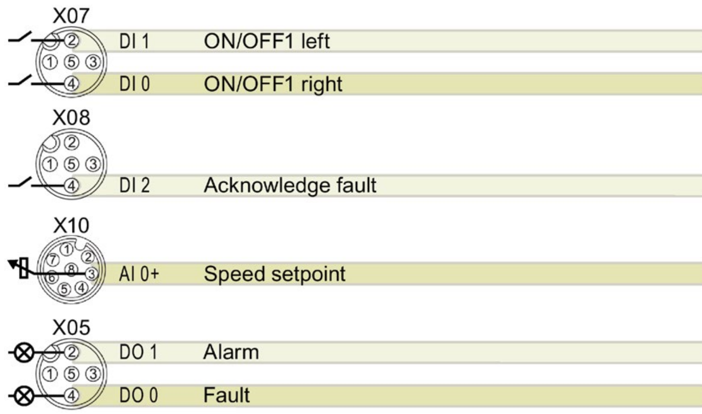


Figure 5-13 Macro 17 - Two-wire control with method 2

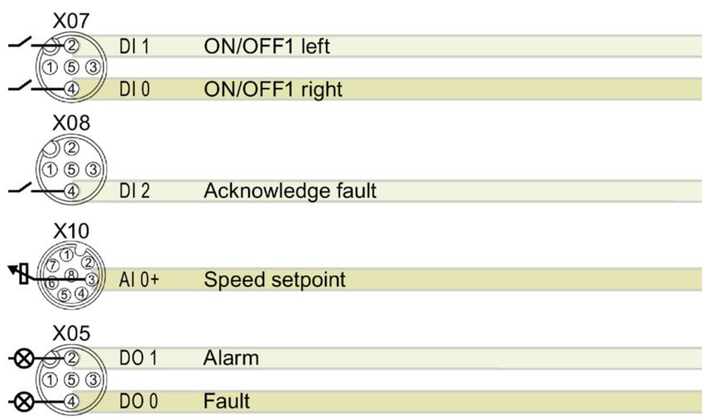


Figure 5-14 Macro 18 - Two-wire control with method 3

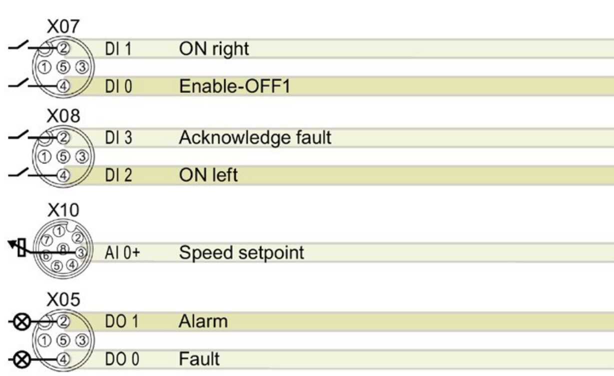


Figure 5-15 Macro 19 - Three-wire control with method 1

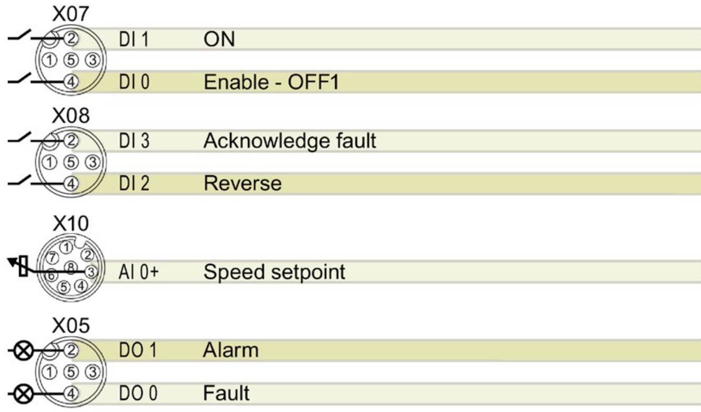


Figure 5-16 Macro 20 - Three-wire control with method 2

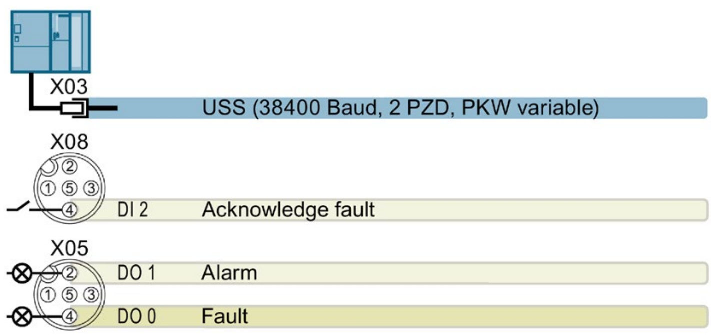


Figure 5-17 Macro 21 - Fieldbus USS

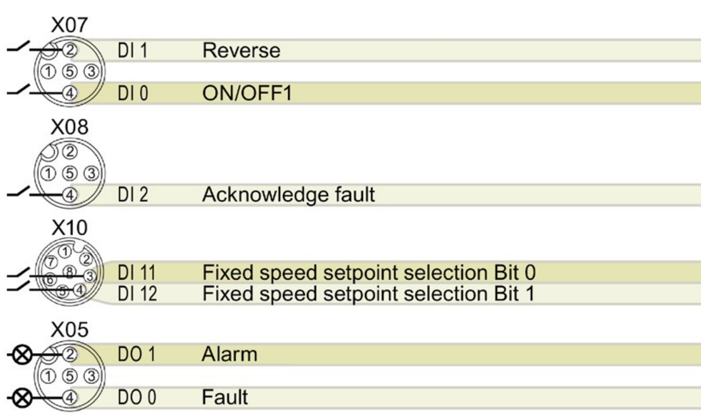


Figure 5-18 Macro 28 - Conveyor with 2 fixed setpoints

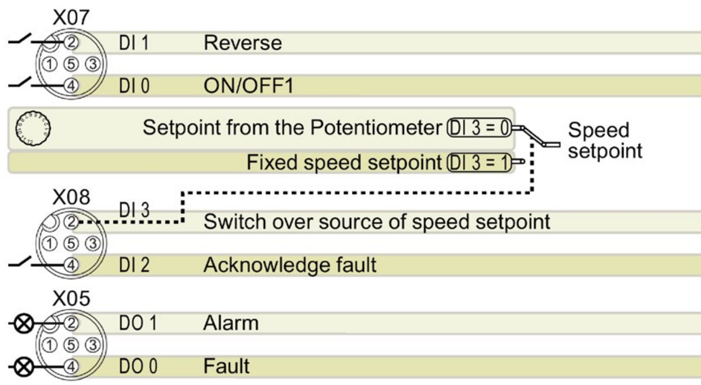


Figure 5-19 Macro 29 - Conveyer with potentiometer and fixed setpoint (default USS)

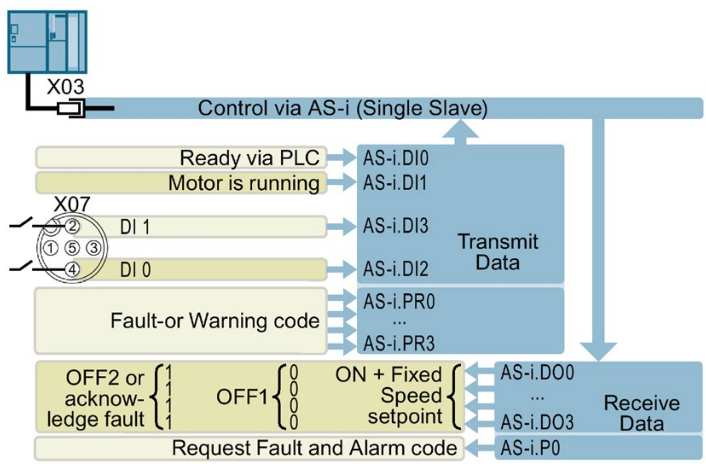


Figure 5-20 Macro 30 - ASi Single slave with fixed setpoints (default ASi)

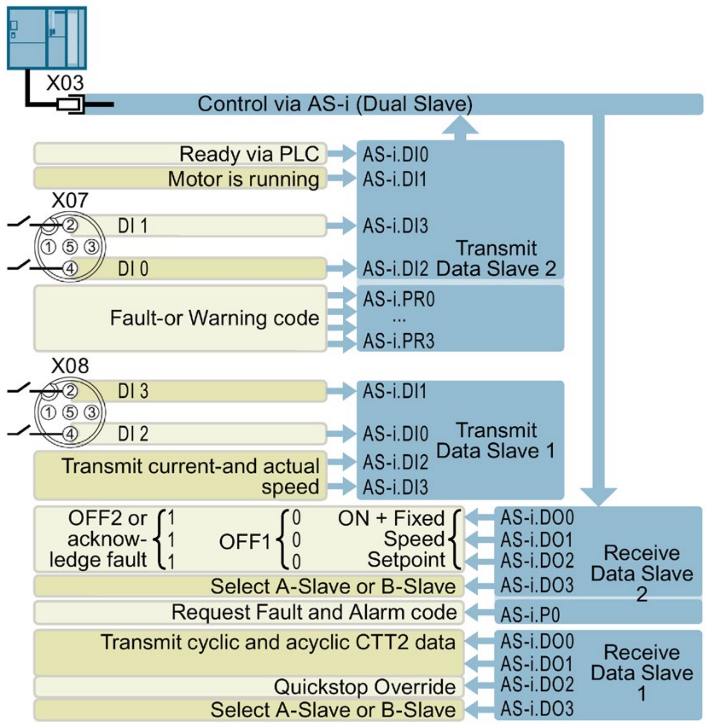


Figure 5-21 Macro 31 - ASi Dual slave with fixed setpoints

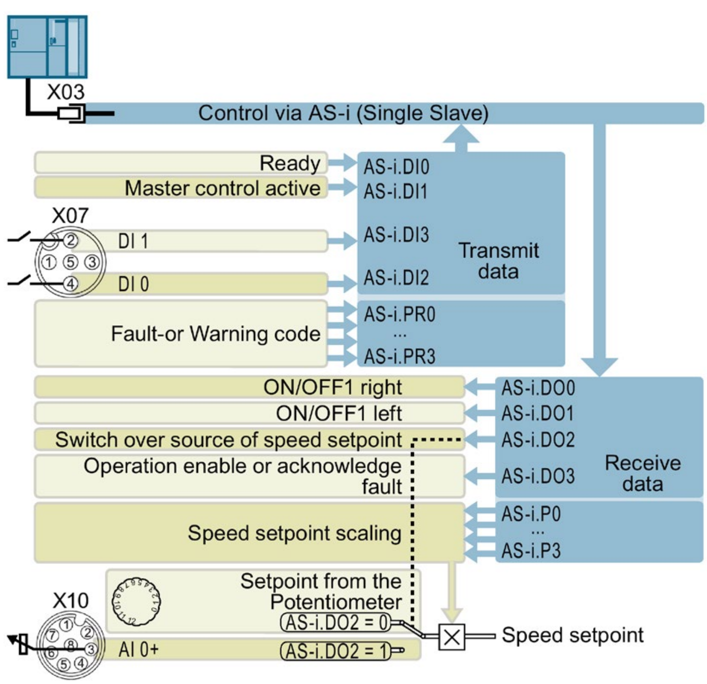


Figure 5-22 Macro 32 - ASi Single slave with analog setpoint

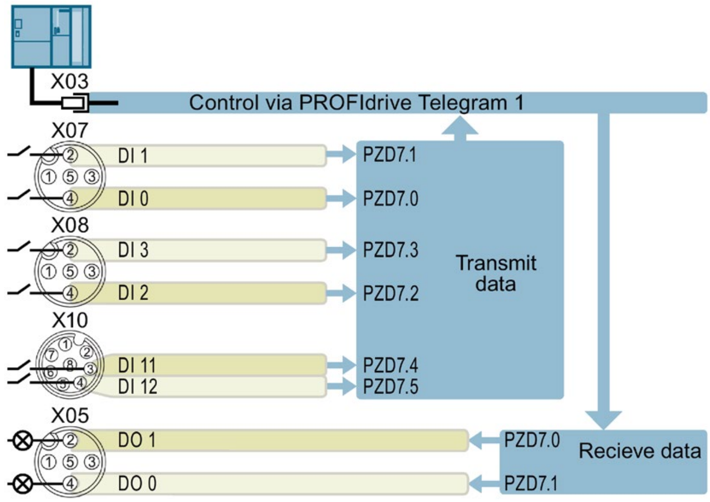


Figure 5-23 Macro 33 - 4DI decentral conveyor with fieldbus

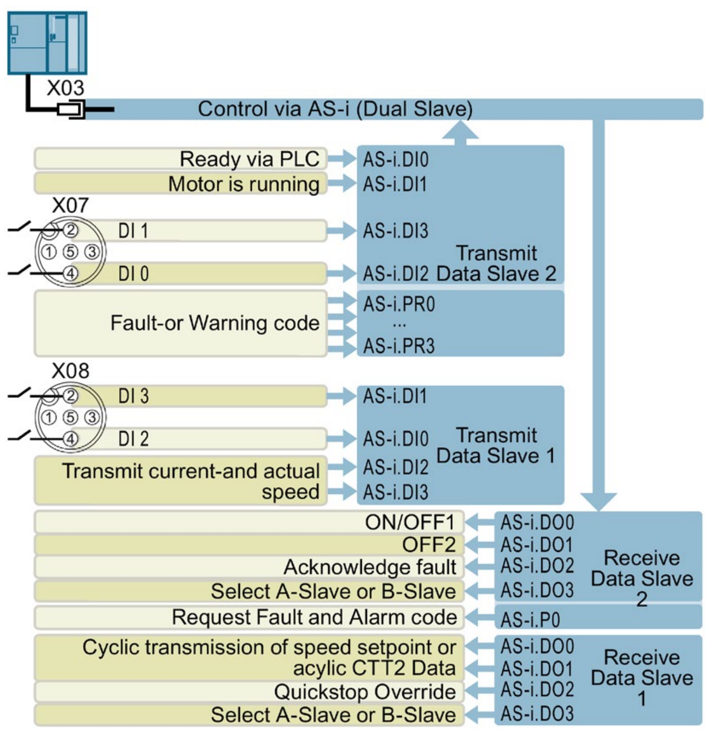


Figure 5-24 Macro 34 - ASi Dual slave with setpoint

5.4.5 Quick commissioning with a PC

The screen forms that are shown in this manual show generally valid examples. The number of setting options available in screen forms depends on the particular inverter type.

Commissioning using STARTER

The following interfaces - which are control unit dependent - are available:

Table 5- 3 Connection possibilities for STARTER

Type	USB	PROFIBUS	PROFINET
PC connected to CU using	USB cable	PROFIBUS interface	PROFINET interface
Interface	Mini-USB	M12 - 5 pole con-nector	M12 - 4 pole con-nector
Restrictions	-	up to 125 slaves	None

In the following the commissioning via USB is described.

5.4.5.1 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.

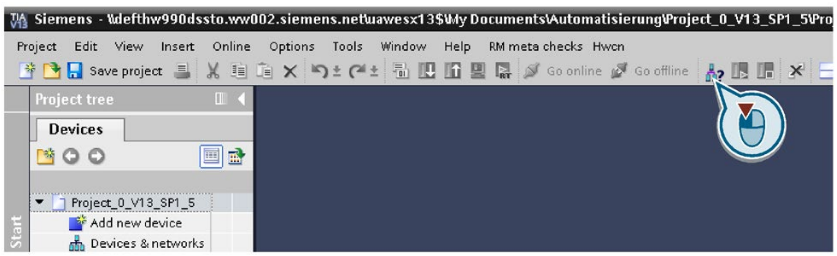
You have created a new project.
❒

5.4.5.2 Transfer inverters connected via USB into the project

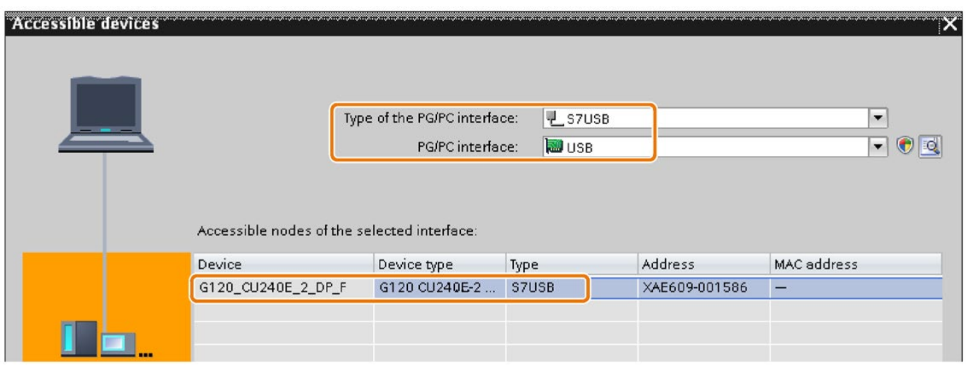
Integrating the inverter into the project

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.

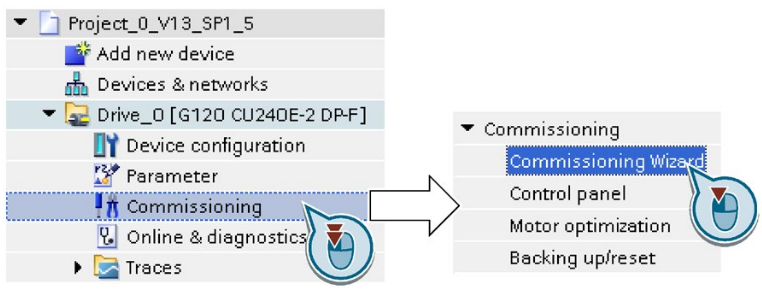
6. Transfer the inverter into the project using the menu: "Online - Upload device as new station (hardware and software)".

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

5.4.5.3 Go online and start the commissioning Wizard

Procedure

1. Select your project and go online: 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.
❒

Procedure

Setpoint specification

The wizard only displays the "setpoint input" if you configured an inverter with PROFINET or PROFIBUS interface.

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

Select whether the ramp-function generator for the speed setpoint is implemented in the higher-level control or in the inverter.

Open-loop/closed-loop ...

Select the control mode.

Selecting the control mode (Page 131)

Defaults of the setpoi...

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

p0015 Macros (Page 120)

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.

Drive options

If a braking resistor is installed, you set the maximum braking power to which the braking resistor will be subjected.

Motor

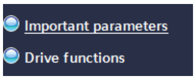
Select your motor.

Enter the motor data according to the rating plate of your motor.
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.



Set the most important parameters to suit your application.

Application:

- [0]: In all applications that do not fall under [3]
- [3]: Applications involving pumps and fans with optimized efficiency. The setting only makes sense for steady-state operation with slow speed changes.

Motor identification:

- [1]: Recommended setting for "speed control" control type. 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:

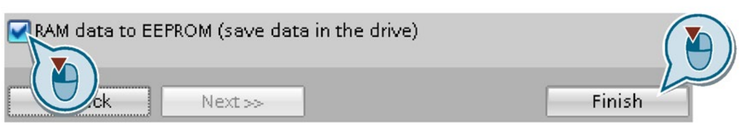
  – You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.

  – 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".

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.

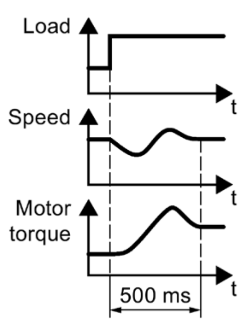
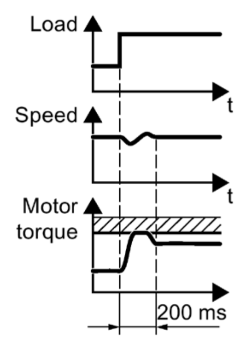


You have entered all of the data that is necessary for the quick commissioning of the inverter.

❒

5.4.5.4 Selecting the control mode

Suitable applications and typical control properties

<table>
<tr><th></th><th>U/f control or FCC (flux current control) without an encoder</th><th>Vector control without an encoder</th><th>Vector control with encoder</th></tr>
<tr><td>Application examples</td><td>Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)
Pumps, fans, and compressors with flow characteristic</td><td>Horizontal conveyor technology (conveyor belts, roller conveyors, chain conveyors)
Extruder
Centrifuges
Pumps and compressors with displacement machines</td><td>Vertical conveyor technology (conveyor belts, roller conveyors, chain conveyors)
Lifters/Lowerers
Stacker cranes</td></tr>
<tr><td rowspan="2">Motors that can be operated</td><td>Induction motors</td><td>Induction motors
Encoderless 1FK7 synchronous motors
Reluctance motors</td><td>Induction motors</td></tr>
<tr><td colspan="3">The rated current of the motor must lie in the range of 13 % … 100 % of the rated current of the inverter.</td></tr>
<tr><td rowspan="2">Properties of closed-loop motor control</td><td rowspan="2">Responds to speed changes with a typical settling time of 100 ms … 200 ms
Responds to load surges with a typical settling time of 500 ms

U/f and FCC are suitable for the following cases:
For power-up times 0 → rated speed > 2 s
For applications with increasing load torque without load impulses
The closed-loop control is insensitive to inaccurate motor data settings, e.g. the motor temperature</td><td colspan="2">The vector control responds to speed changes with a typical settling time of < 100 ms.
The vector control responds to load impulses with a typical settling time of 200 ms.

The vector control is required in the following cases:
For power-up times 0 → rated speed < 2 s
For applications with fast and high load impulses</td></tr>
<tr><td>Typically achieves a torque accuracy of ± 5 % for 15 % … 100 % of the rated speed</td><td>Extends the torque accuracy of ± 5 % to speeds < 15 % of the rated speed.</td></tr>
<tr><td>Max. output frequency</td><td>550 Hz</td><td colspan="2">240 Hz</td></tr>
<tr><td>Torque control</td><td>Closed-loop torque control not possible</td><td>Torque control for speeds > 15 % of the rated speed</td><td>Torque control from speeds = 0.</td></tr>
</table>

5.4.5.5 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

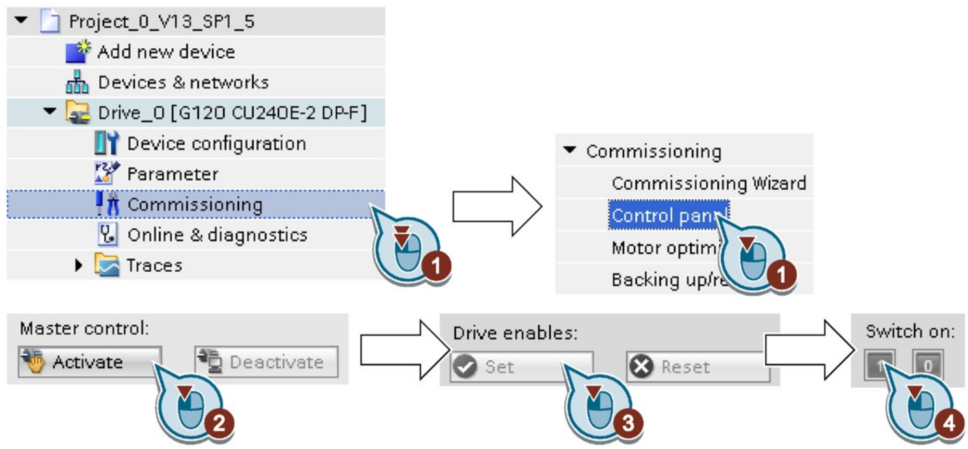
- You have selected a method of motor data identification during quick commissioning, e.g. measurement of the motor data while the motor is stationary.

  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.

5.5 Restoring the factory settings

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.

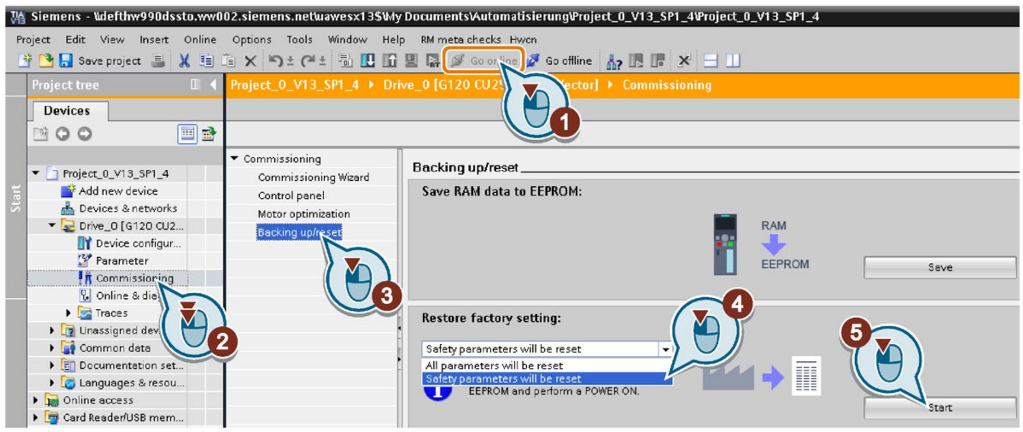
The settings of the safety functions are protected by a password.

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.

5.5.1 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 210)

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.

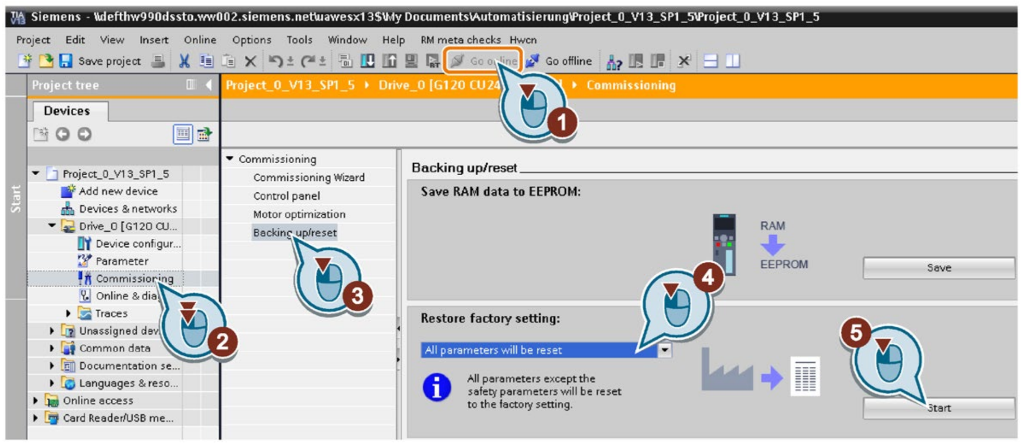
6. Wait until the inverter sets p0971 = 0.
7. Switch off the inverter power supply.
8. Wait until all LEDs on the inverter are dark.
9. Switch on the inverter power supply again.

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

5.5.2 Restore the factory settings (without safety functions)

Restore the factory inverter settings

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 the BOP-2 operator panel

1. In the "Options" menu, select the "DRVRESET" entry
2. Confirm the reset using the OK key.
3. 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 converter functions

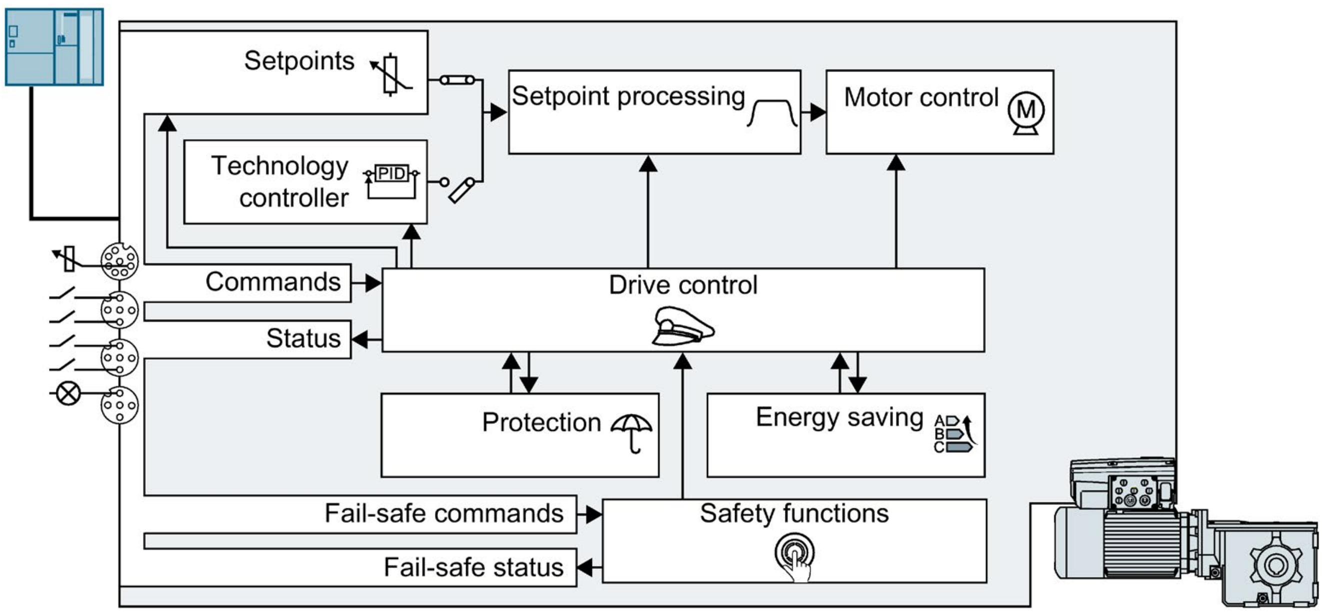


Figure 6-1 Overview of converter functions

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.

Sequence control when switching the motor on and off (Page 142)

Adapt the default setting of the inputs and outputs (Page 145)

Drive control via PROFIBUS or PROFINET (Page 160)

Control via AS-i (Page 176)

Jogging (Page 187)

Limit position control (Page 188)

Quick Stop function (Page 192)

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

Switching over the drive control (command data set) (Page 195)

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

Motor holding brake (Page 198)

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

Free function blocks (Page 202)

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

Selecting physical units (Page 203)

Safety functions

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

Safe Torque Off (STO) safety function (Page 207)

Setpoints and setpoint processing

The setpoint normally defines the motor speed.

Setpoints (Page 221)

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 234)

Technology controller

The technology controller controls process variables, e.g. pressure, temperature, level or flow. The motor control receives the setpoint either from the higher-level control or from the technology controller.

PID technology controller (Page 243)

Motor control

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

Motor control (Page 247)

The inverter provides several methods to brake the motor electrically. During electrical braking, the motor develops a torque that reduces the speed to standstill.

Electrically braking the motor (Page 271)

Protection of the drive and the driven load

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

Overcurrent protection (Page 277)

Inverter protection using temperature monitoring (Page 278)

Motor temperature monitoring using a temperature sensor (Page 281)

Motor protection by calculating the temperature (Page 285)

Motor and inverter protection by limiting the voltage (Page 287)

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

Monitoring the driven load (Page 288)

Energy saving

The converter can optimize the efficiency of the motor.

Efficiency optimization (Page 294)

The inverter calculates how much energy controlled inverter operation saves when compared to mechanical flow control (e.g. throttle).

Calculating the energy saving for fluid flow machines (Page 298)

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.

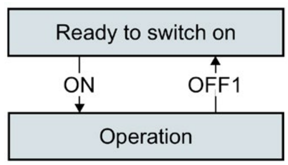


Figure 6-2 Simplified representation of the sequence control

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

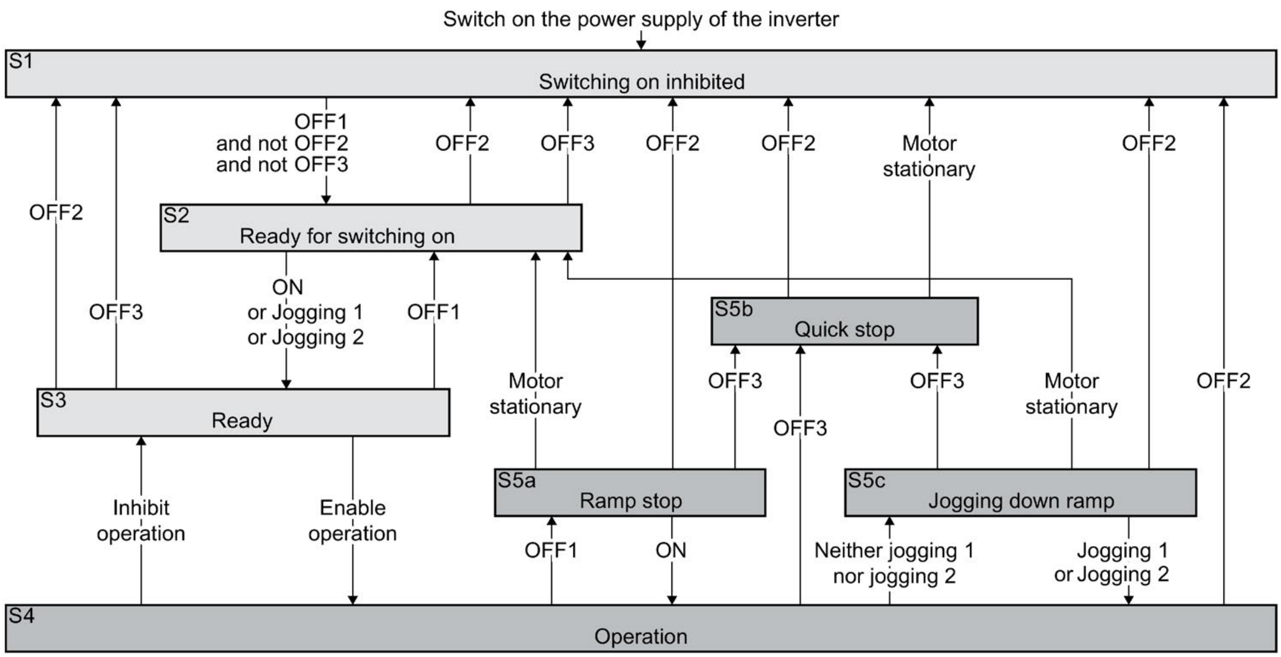


Figure 6-3 Sequence control of the inverter when the motor is switched on and off

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 inputs and outputs

In the inverter, the input and output signals are interconnected with specific inverter functions using special parameters. The following parameters are available to interconnect signals:

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

This chapter describes how you adapt the function of individual inverter inputs and outputs using binectors and connectors.

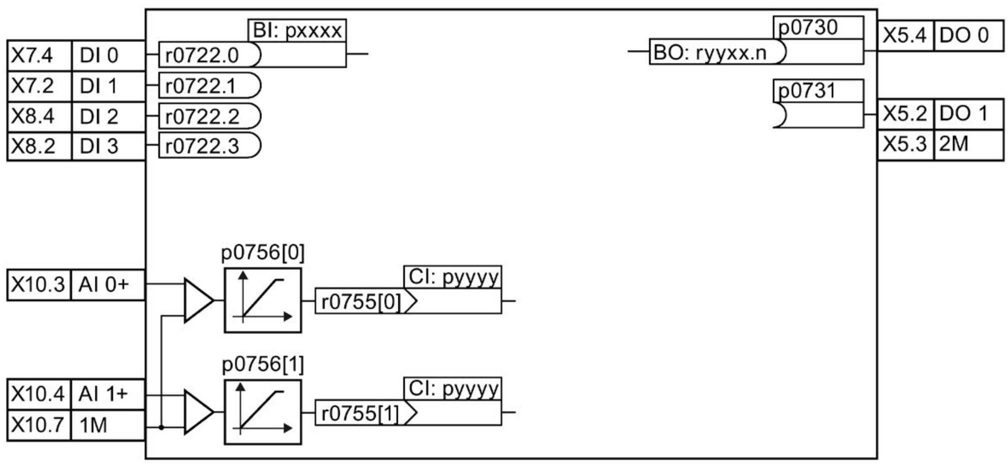
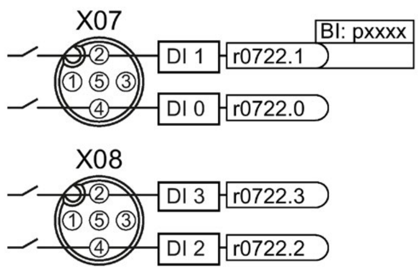


Figure 6-4 Internal interconnection of the inputs and outputs

6.3.1 Digital Inputs

Changing the function of the digital input



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

Interconnecting signals in the inverter (Page 380)

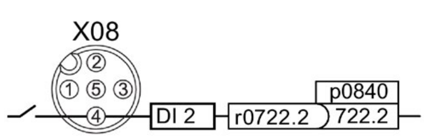
Binector inputs are marked with "BI" in the parameter list of the List Manual.

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
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



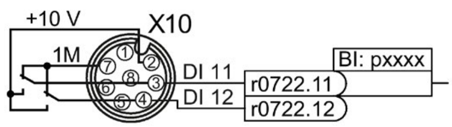
In order to switch on the motor with digital input DI 2, you have to connect the status parameter of DI 2 to p0840: Set p0840 = 722.2.

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.

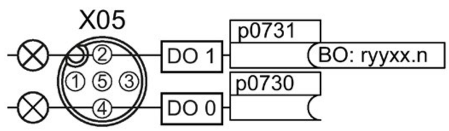
Analog inputs as digital inputs



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

6.3.2 Digital outputs

Changing the function of the digital output



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

Interconnecting signals in the inverter (Page 380)

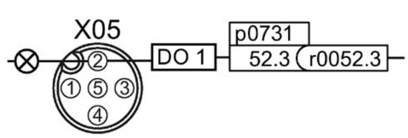
Binector outputs are marked with "BO" in the parameter list of the List Manual.

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.

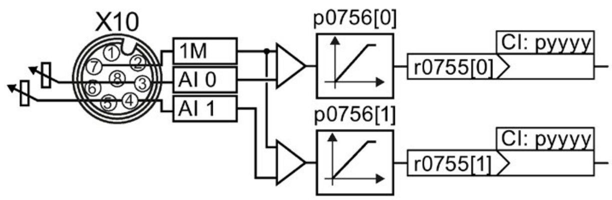
Advanced settings

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.

6.3.3 Analog inputs

Changing the function of the analog input



1. Define the analog input type using parameter p0756 and the DIP switches on the Control Unit for current or voltage input.
2. Specify the function of the analog input by interconnecting parameter p0755 with a connector input CI of your choice, for example as a speed setpoint.

Define the analog input

⚠WARNING
Maximum voltage for analog input
The maximum voltage difference between the individual analog input connections and the ground must not exceed 35 V. If the system is operated when the load resistor is switched on (DIP switch set to "A"), the voltage between differential the individual analog inputs must not exceed 10 V or the injected 80 mA current otherwise the input will be damaged.

⚠CAUTION
Analog DIP switch and parameter settings
The selection of current (I) or voltage (V) input can be accomplished using the DIP switched on the Control Module. Parameter p0756 must also be modified to ensure that the p0756 reflects the settings of the DIP switch. If there is a difference between the two settings the motor may run faster or slower than expected if the analog input is used as a setpoint source.

The converter offers a set of DIP switches where the type of analog input can be selected. This is shown in the following figure:

For further information on commissioning using the DIP switch, see Quick Commissioning with DIP switches (Page 111).

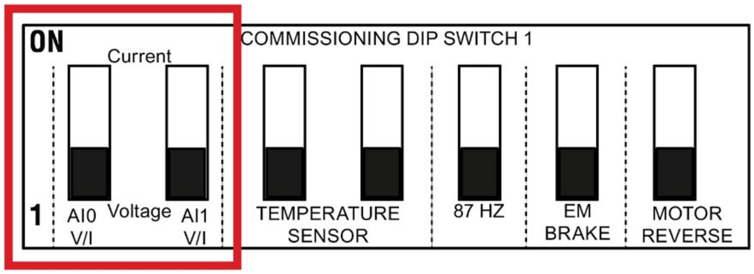


Figure 6-5 Analog DIP Switch

As previously mentioned, parameter p0756 can be modified to change the type of analog input. The default settings for parameter p0756 and its default settings are given in the following table.

Analog input		Value range	Parameter default settings
AI0	Unipolar voltage input	0 V ... +10 V	p0756 [0] = 0
AI1	Unipolar voltage input	0 V ... + 10 V	p0756 [1] = 0

The complete settings available for parameter p0756 are shown below.

0:	Unipolar voltage input	0 V ... +10 V
1:	Unipolar voltage input monitored	+2 V ... +10 V
2:	Unipolar current input	0 mA ... +20 mA
3:	Unipolar current input monitored	+4 mA ... +20 mA
9:	Unipolar voltage input	0 V ... +3 V

If you change the analog input type using p0756, then the inverter automatically selects the appropriate scaling of the analog input.

You can define your own characteristic that matches your particular application. The linear scaling characteristic is defined using two points (p0757, p0758) and (p0759, p0760). Parameters p0757 … p0760 are assigned to an analog input via their index, e.g. parameters p0757[0] … p0760[0] belong to analog input 0.

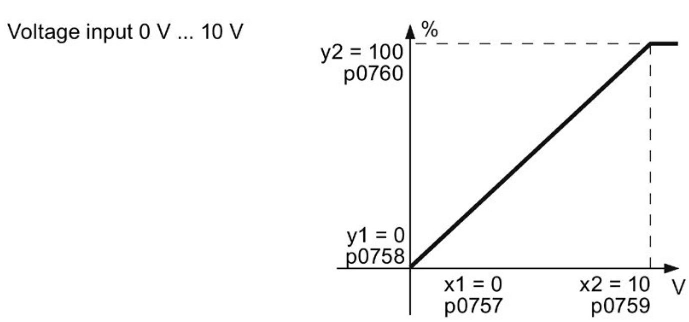


Figure 6-6 Scaling characteristics

Table 6- 5 Parameters for the scaling characteristic and wire break monitoring

Parameter	Description
p0757	**x-coordinate of 1st characteristic point [V]**
p0758	**y coordinate of the 1st characteristic point [% of p200x]** p200x are the parameters of the reference variables, e.g. p2000 is the reference speed.
p0759	**x-coordinate of 2nd characteristic point [V]**
p0760	**y-coordinate of 2nd characteristic point [% of p200x]**
p0761	**Wire breakage monitoring response threshold**

Defining the analog input function

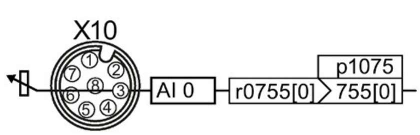
You define the analog input function by interconnecting a connector input of your choice with parameter p0755 . Parameter p0755 is assigned to the particular analog input via its index, e.g. parameter p0755[0] is assigned to analog input 0.

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

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

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

Defining the analog input function - example



In order to use the analog input AI 0 as the source for the supplementary setpoint, you have to set p1075 = 755[0].

Advanced settings

Signal smoothing

When required, you can smooth the signal, which you read-in via an analog input, using parameter p0753.

You can find more information in the parameter list and in function diagram 2251 of the List Manual.

Manuals for your converter (Page 393)

Specify deadband

Small signals of a few millivolts are often corrupted by interference in the cable. To be able to enter a setpoint of exactly 0 V via an analog input, you must specify a deadband.

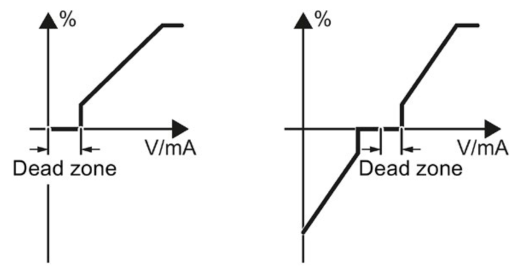


Figure 6-7 Deadband of the analog input

Table 6- 7 Settings of the deadband of the analog inputs

Parameter	Description
p0764[0]	**Deadband of the analog input AI0** (factory setting: 0)
p0764[1]	**Deadband of the analog input AI1** (Factory setting: 0)

6.4 Controlling clockwise and counter-clockwise rotation via digital inputs

The inverter has a different methods for controlling the motor using two or three commands.

Overview

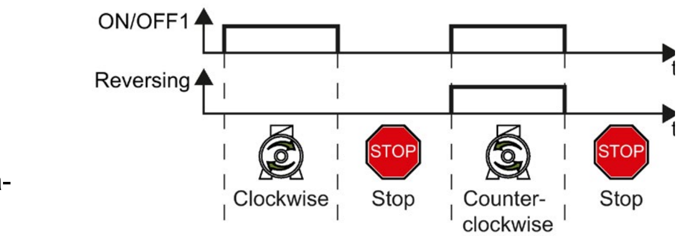
Two wire control, method 1

ON/OFF1:

Switches the motor on or off

Reversing:

Reverses the motor direction of rotation



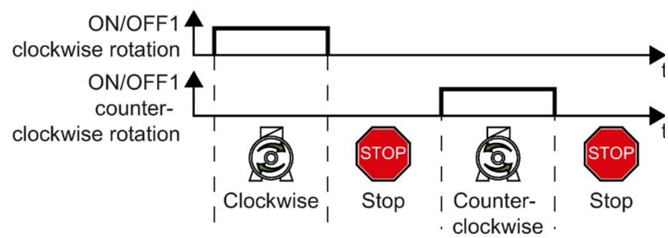
Two wire control, method 2 - and two-wire control, method 3

ON/OFF1 clockwise rotation:

Switches the motor on or off, clockwise rotation

ON/OFF1 counter-clockwise rotation:

Switches the motor on or off, counter-clockwise rotation



Three wire control, method 1

Enable/OFF1:

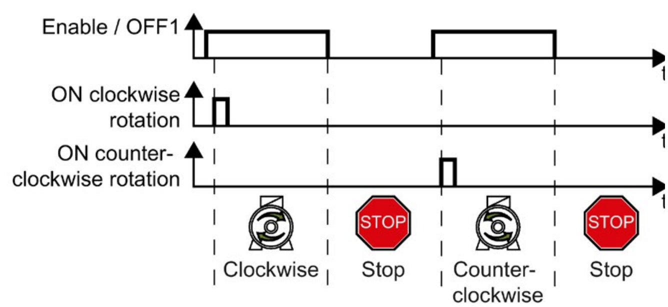
Enables the motor to be switched on or switched off

ON clockwise rotation:

Switches on the motor, clockwise rotation

ON counter-clockwise rotation:

Switches on the motor, counter-clockwise rotation



Three wire control, method 2

Enable/OFF1:

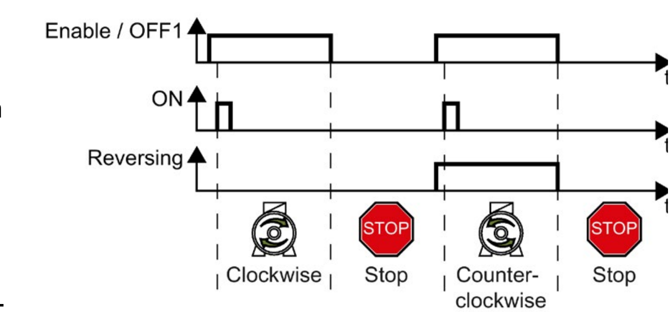
Enables the motor to be switched on or switched off

ON:

Switches on the motor

Reversing:

Reverses the motor direction of rotation



6.4.1 Two-wire control, method 1

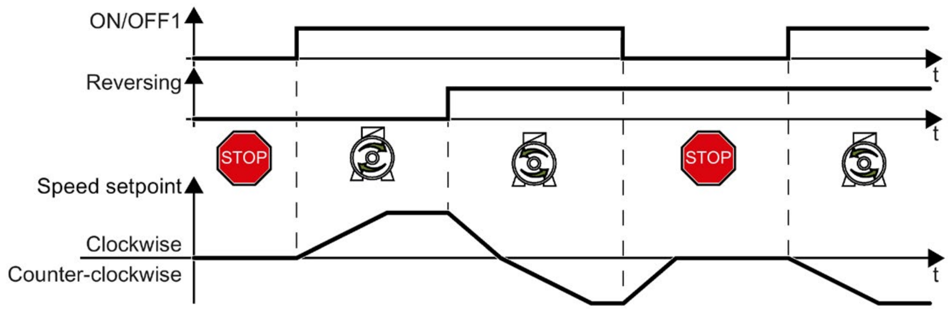


Figure 6-8 Two-wire control, method 1

Command "ON/OFF1" switches the motor on and off. The "Reversing" command inverts the motor direction of rotation.

Table 6- 8 Function table

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

Table 6- 9 Select two-wire control, method 1

Parameter	Description
p0015 = 12	**Macro drive unit** You must carry out quick commissioning in order to set parameter p0015. Assigning digital inputs DI to the commands: DI 0: ON/OFF1 DI 1: Reversing

Table 6- 10 Changing the assignment of the digital inputs

Parameter	Description
p0840[0 … n] = 722.x	**BI: ON/OFF1** (ON/OFF1) Example: p0840 = 722.3 ⇒ DI 3: ON/OFF1
p1113[0 … n] = 722.x	**BI: Setpoint inversion** (reversing)

6.4.2 Two-wire control, method 2

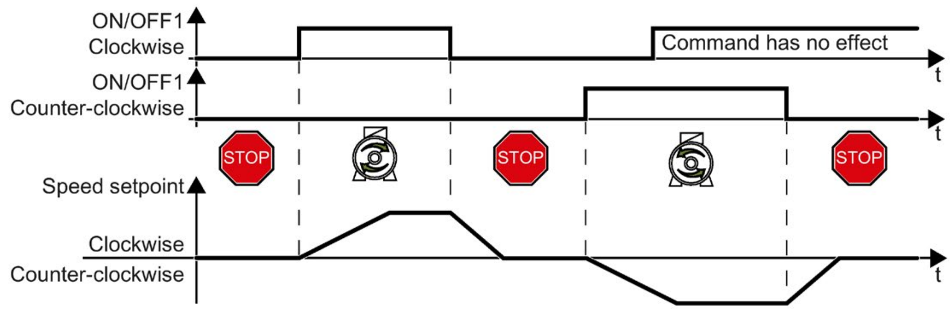


Figure 6-9 Two-wire control, method 2

Commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. The inverter only accepts a new command when the motor is at a standstill.

Table 6- 11 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	OFF1: The motor stops.
1	0	ON: Clockwise motor rotation.
0	1	ON: Counter-clockwise motor rotation.
1	1	ON: The motor direction of rotation is defined by the command that first reaches state "1".

Table 6- 12 Select two-wire control, method 2

Parameter	Description
p0015 = 17	**Macro drive unit** You must carry out quick commissioning in order to set parameter p0015. Assigning digital inputs DI to the commands: DI 0: ON/OFF1 clockwise rotation DI 1: ON/OFF1 counter-clockwise rotation

Table 6- 13 Changing the assignment of the digital inputs

Parameter	Description
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (ON/OFF1 clockwise rotation)
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON/OFF1 counter-clockwise rotation) Example: p3331 = 722.0 ⇒ DI 0: ON/OFF1 counter-clockwise rotation

6.4.3 Two-wire control, method 3

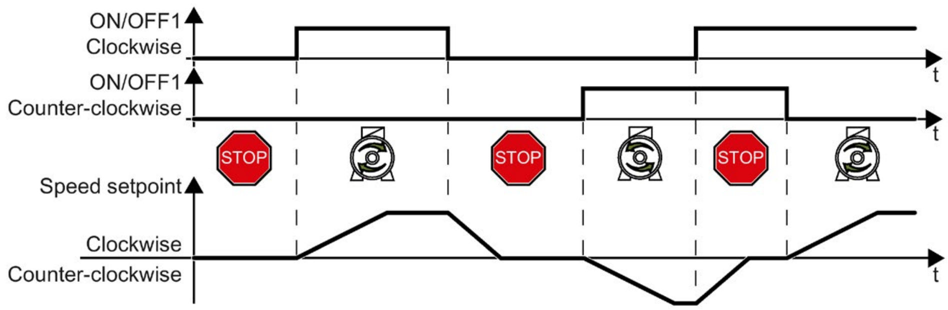


Figure 6-10 Two-wire control, method 3

Commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. The inverter accepts a new command at any time, independent of the motor speed.

Table 6- 14 Function table

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

Table 6- 15 Select two-wire control, method 3

Parameter	Description
p0015 = 18	**Macro drive unit** You must carry out quick commissioning in order to set parameter p0015. Assigning digital inputs DI to the commands: DI 0: ON/OFF1 clockwise rotation DI 1: ON/OFF1 counter-clockwise rotation

Table 6- 16 Changing the assignment of the digital inputs

Parameter	Description
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (ON/OFF1 clockwise rotation)
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON/OFF1 counter-clockwise rotation) Example: p3331 = 722.0 ⇒ DI 0: ON/OFF1 counter-clockwise rotation

6.4.4 Three-wire control, method 1

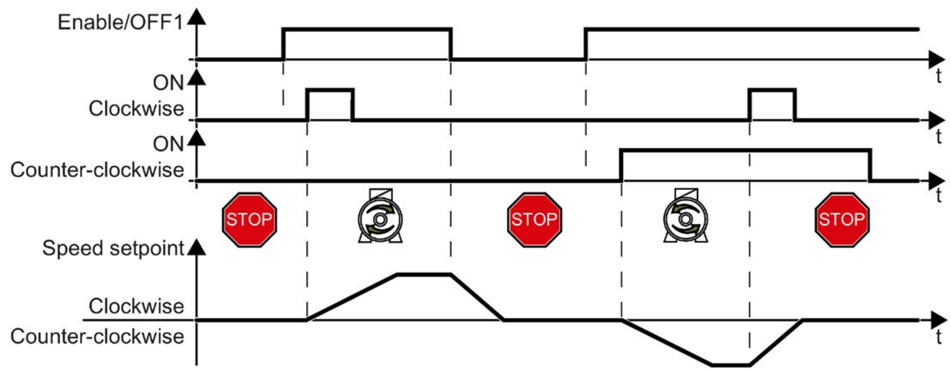


Figure 6-11 Three-wire control, method 1

The "Enable" command is a precondition for switching on the motor. Commands "ON clockwise rotation" and "ON counter-clockwise rotation" switch on the motor - and simultaneously select a direction of rotation. Removing the enable switches the motor off (OFF1).

Table 6- 17 Function table

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

Table 6- 18 Select three-wire control, method 1

Parameter	Description
p0015 = 19	**Macro drive unit** You must carry out quick commissioning in order to set parameter p0015. Assigning digital inputs DI to the commands: DI 0: Enable / OFF1 DI 1: ON clockwise rotation DI 2: ON counter-clockwise rotation

Table 6- 19 Changing the assignment of the digital inputs

Parameter	Description
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (enable/OFF1)
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON clockwise rotation)
p3332[0 … n] = 722.x	**BI: 2/3 wire control command 3** (ON counter-clockwise rotation) Example: p3332 = 722.0 ⇒ DI 0: ON counter-clockwise rotation

6.4.5 Three-wire control, method 2

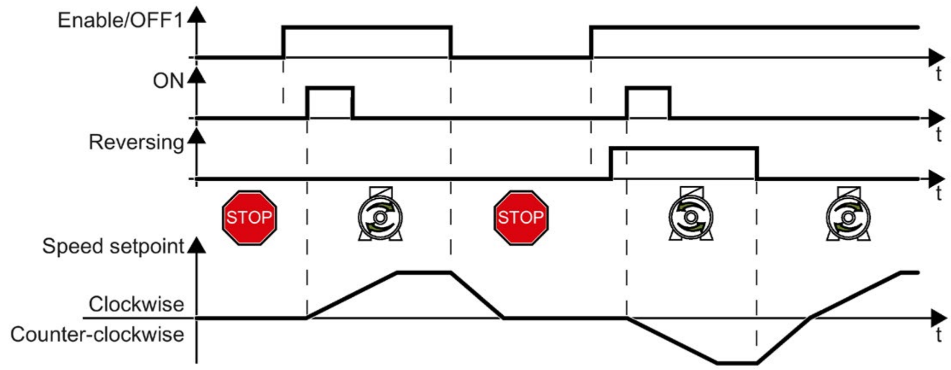


Figure 6-12 Three-wire control, method 2

The "Enable" command is a precondition for switching on the motor. The "ON" command switches the motor on. The "Reversing" command inverts the motor direction of rotation. Removing the enable switches the motor off (OFF1).

Table 6- 20 Function table

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

Table 6- 21 Select three-wire control, method 2

Parameter	Description
p0015 = 20	**Macro drive unit** You must carry out quick commissioning in order to set parameter p0015. Assigning digital inputs DI to the commands: DI 0: Enable / OFF1 DI 1: ON DI 2: Reversing

Table 6- 22 Changing the assignment of the digital inputs

Parameter	Description
p3330[0 … n] = 722.x	**BI: 2/3 wire control command 1** (enable/OFF1)
p3331[0 … n] = 722.x	**BI: 2/3 wire control command 2** (ON) Example: p3331 = 722.0 ⇒ DI 0: ON command
p3332[0 … n] = 722.x	**BI: 2/3 wire control command 3** (reversing)

6.5 Drive control via PROFIBUS or PROFINET

6.5.1 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.

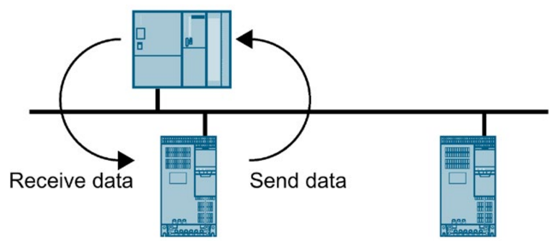


Figure 6-13 Cyclic data exchange

Inverter and control system pack their data in telegrams.

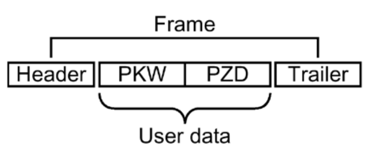


Figure 6-14 Telegram structure

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.

6.5.2 Telegrams

Telegrams that are available

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

Telegram 1

	PZD01	PZD02
Receive user data	STW1	NSOLL_A
Send user data	ZSW1	NIST_A

16-bit speed setpoint

Telegram 20

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

16-bit speed setpoint for VIK-Namur

Telegram 350

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

16-bit speed setpoint with torque limiting

Telegram 352

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06
STW1	NSOLL_A	Process data for PCS7			
ZSW1	NIST_A GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE

16-bit speed setpoint for PCS7

Telegram 353

	PZD01	PZD02
PKW	STW1	NSOLL_A
PKW	ZSW1	NIST_A GLATT

16-bit speed setpoint with reading and writing to parameters

Telegram 354

	PZD01	PZD02	PZD03	PZD04	PZD05	PZD06
PKW	STW1	NSOLL_A	Process data for PCS7			
	ZSW1	NIST_A GLATT	IAIST_ GLATT	MIST_ GLATT	WARN_ CODE	FAULT_ CODE

16-bit speed setpoint for PCS7 with reading and writing to parameters

Telegram 999

PZD01	PZD02	PZD03	PZD04	PZD05	PZD06	PZD07	PZD08	PZD09	PZD10	PZD11	PZD12	PZD13 ... PZD17
STW1	Telegram length for the receive data											
ZSW1	Telegram length for the transmit data											

Unassigned interconnection and length

Table 6- 23 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
PZD	Process data	PKW	Parameter channel
STW	Control word	MIST_GLATT	Actual smoothed torque
ZSW	Status word	PIST_GLATT	Actual smoothed active power
NSOLL_A	Speed setpoint	M_LIM	Torque limit value
NIST_A	Speed actual value	FAULT_CODE	Fault code
NIST_A_GLATT	Smoothed actual speed value	WARN_CODE	Alarm code
IAIST_GLATT	Smoothed current actual value	MELD_NAMUR	Message according to the VIK-NAMUR definition

Interconnection of the process data

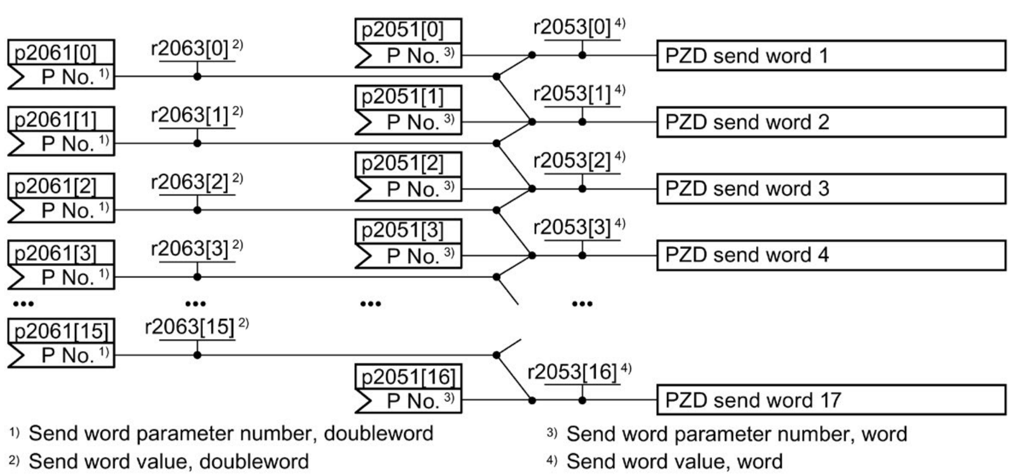


Figure 6-15 Interconnection of the send data

In the inverter, the send data are available in the "Word" format (p2051) - and in the "Double word" format (p2061). If you set a specific telegram, or you change the telegram, then the inverter automatically interconnects parameters p2051 and p2061 with the appropriate signals.

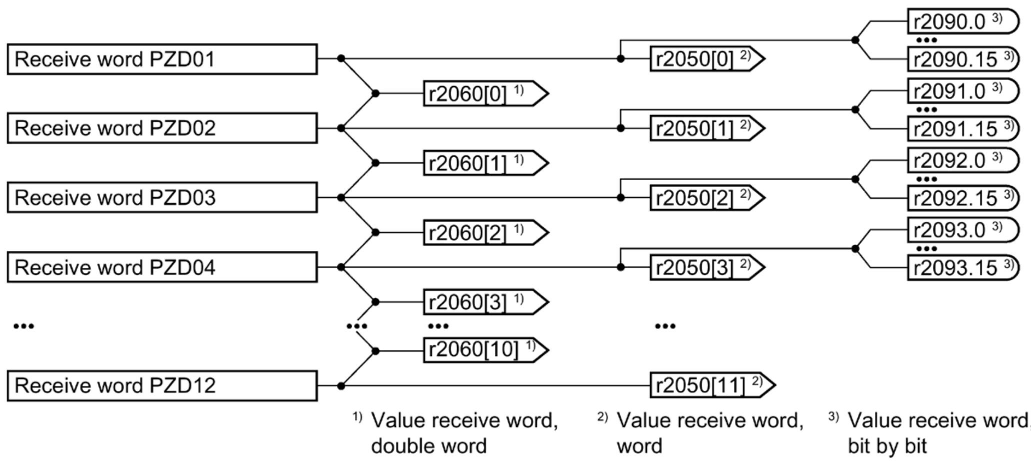


Figure 6-16 Interconnection of the receive data

The inverter saves the receive data in the "Word" format (r2050), in the "Double word" format (r2060) and bit by bit (r2090 …r2093). If you set a specific telegram, or you change the telegram, then the inverter automatically interconnects parameters r2050, r2060 and r2090 …r2093 with the appropriate signals.

If you wish to adapt a predefined telegram, then you must interconnect the send and receive data with the appropriate signals. To facilitate manual interconnection of send and receive data, you must first adapt parameters p0922 and p2079.

Manuals for your converter (Page 393)

For additional details relating to freely interconnecting process data, refer to the List Manual, function diagrams 2420 and 2472.

Manuals for your converter (Page 393)

6.5.3 Control and status word 1

Control word 1 (STW1)

<table>
<tr><th rowspan="2">Bit</th><th colspan="2">Significance</th><th rowspan="2">Explanation</th><th rowspan="2">Signal interconnection in the inverter</th></tr>
<tr><th>Telegram 20</th><th>All other telegrams</th></tr>
<tr><td rowspan="2">0</td><td colspan="2">0 = OFF1</td><td>The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill.</td><td rowspan="2">p0840[0] = r2090.0</td></tr>
<tr><td colspan="2">0 → 1 = ON</td><td>The inverter goes into the "ready" state. If, in addition bit 3 = 1, then the inverter switches on the motor.</td></tr>
<tr><td rowspan="2">1</td><td colspan="2">0 = OFF2</td><td>Switch off the motor immediately, the motor then coasts down to a standstill.</td><td rowspan="2">p0844[0] = r2090.1</td></tr>
<tr><td colspan="2">1 = No OFF2</td><td>The motor can be switched on (ON command).</td></tr>
<tr><td rowspan="2">2</td><td colspan="2">0 = Quick stop (OFF3)</td><td>Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.</td><td rowspan="2">p0848[0] = r2090.2</td></tr>
<tr><td colspan="2">1 = No quick stop (OFF3)</td><td>The motor can be switched on (ON command).</td></tr>
<tr><td rowspan="2">3</td><td colspan="2">0 = Inhibit operation</td><td>Immediately switch-off motor (cancel pulses).</td><td rowspan="2">p0852[0] = r2090.3</td></tr>
<tr><td colspan="2">1 = Enable operation</td><td>Switch-on motor (pulses can be enabled).</td></tr>
<tr><td rowspan="2">4</td><td colspan="2">0 = Disable RFG</td><td>The inverter immediately sets its ramp-function generator output to 0.</td><td rowspan="2">p1140[0] = r2090.4</td></tr>
<tr><td colspan="2">1 = Do not disable RFG</td><td>The ramp-function generator can be enabled.</td></tr>
<tr><td rowspan="2">5</td><td colspan="2">0 = Stop RFG</td><td>The output of the ramp-function generator stops at the actual value.</td><td rowspan="2">p1141[0] = r2090.5</td></tr>
<tr><td colspan="2">1 = Enable RFG</td><td>The output of the ramp-function generator follows the setpoint.</td></tr>
<tr><td rowspan="2">6</td><td colspan="2">0 = Inhibit setpoint</td><td>The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator.</td><td rowspan="2">p1142[0] = r2090.6</td></tr>
<tr><td colspan="2">1 = Enable setpoint</td><td>Motor accelerates with the ramp-up time p1120 to the setpoint.</td></tr>
<tr><td>7</td><td colspan="2">0 → 1 = Acknowledge faults</td><td>Acknowledge fault. If the ON command is still active, the inverter switches to the "switching on inhibited" state.</td><td>p2103[0] = r2090.7</td></tr>
<tr><td>8, 9</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">10</td><td colspan="2">0 = No control via PLC</td><td>Inverter ignores the process data from the fieldbus.</td><td rowspan="2">p0854[0] = r2090.10</td></tr>
<tr><td colspan="2">1 = Control via PLC</td><td>Control via fieldbus, inverter accepts the process data from the fieldbus.</td></tr>
<tr><td>11</td><td colspan="2">1 = Direction reversal</td><td>Invert setpoint in the inverter.</td><td>p1113[0] = r2090.11</td></tr>
<tr><td>12</td><td colspan="4">Not used</td></tr>
</table>

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
13	---[1]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

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

Status word 1 (ZSW1)

Bit	Significance		Remarks	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
0	1 = Ready for switching on		Power supply switched on; electronics initialized; pulses locked.	p2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the 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 active		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 = Switching on inhibited active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint / actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the inverter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	1 = current or torque limit reached	1 = torque limit reached	Comparison value for current or torque has been reached or exceeded.	p2080[11] = r0056.13 / r1407.7
12	---[1]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12

Bit	Significance		Remarks	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal inverter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counter-clockwise		Internal inverter actual value < 0	
15	1 = CDS display	0 = Alarm, inverter thermal overload		p2080[15] = r0836.0 / r2135.15

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

6.5.4 Control and status word 3

Control word 3 (STW3)

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

Bit	Meaning Telegram 350	Explanation	Signal interconnection in the inverter [1)]
14	Not used		
15	1 = CDS bit 1	Changes over between settings for different operation interfaces (command data sets).	p0811[0] = r2093.15

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

Status word 3 (ZSW3)

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

6.5.5 NAMUR message word

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

Table 6- 24 Fault word according to the VIK-NAMUR definition and interconnection with parameters in the inverter

Bit	Significance	P no.
0	1 = Control Unit signals a fault	p2051[5] = r3113
1	1 = line fault: Phase failure or inadmissible voltage	
2	1 = DC link overvoltage	
3	1 = Power Module fault, e.g. overcurrent or overtemperature	
4	1 = inverter overtemperature	
5	1 = ground fault/phase fault in the motor cable or in the motor	
6	1 = motor overload	
7	1 = communication error to the higher-level control system	
8	1 = fault in a safety-relevant monitoring channel	
10	1 = fault in the internal inverter communication	
11	1 = line fault	
15	1 = other fault	

6.5.6 Parameter channel

Structure of the parameter channel

The parameter channel consists of four words. The 1st and 2nd words transfer the parameter number, index and the type of task (read or write). The 3rd and 4th words contain the parameter content. The parameter contents can be 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters).

Bit 11 in the 1st word is reserved and is always assigned 0.

<table>
<tr><td colspan="7">Parameter channel</td></tr>
<tr><td colspan="3">PKE (1st word)</td><td colspan="2">IND (2nd word)</td><td colspan="2">PWE (3rd and 4th words)</td></tr>
<tr><td>15...12</td><td>11</td><td>10 ... 0</td><td>15 ... 8</td><td>7 ... 0</td><td>15 ... 0</td><td>15 ... 0</td></tr>
<tr><td>AK</td><td>SPM</td><td>PNU</td><td>Subindex</td><td>Page index</td><td>PWE 1</td><td>PWE 2</td></tr>
</table>

You can find application examples relating to the parameter channel at the end of this section.

AK: Request and response IDs

Bits 12 … 15 of the 1st The parameter channel words contain the request and response identifier AK.

Table 6- 25 Request identifiers, control → inverter

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

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

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

Table 6- 26 Response identifiers, inverter → control

AK	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1)]
4	Transfer parameter value (field, word) [2)]
5	Transfer parameter value (field, double word) [2)]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the control, refer to the following table.
8	No master controller status / no authorization to change parameters of the parameter channel interface

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

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

Table 6- 27 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element error value that cannot be changed)
0B hex	**No master control** (change request but with no master control, see also p0927.)
0C hex	**Keyword missing**
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the inverter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → inverter")
6B hex	**No change access for a controller that is enabled**. (The operating state of the inverter prevents a parameter change)

No.	Description
86 hex	**Write access only for commissioning (p0010 = 15)** (operating state of the inverter prevents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (example: a parameter value is too large for the inverter power)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

PNU (parameter number) and page index

The parameter number is located in value PNU in the 1st word of the parameter channel (PKE).

The page index is located in the 2nd word of the parameter channel (IND bit 7 … 0).

Parameter number	PNU	Page index
0000 … 1999	0000 … 1999	0 hex
2000 … 3999	0000 … 1999	80 hex
6000 … 7999	0000 … 1999	90 hex
8000 … 9999	0000 … 1999	20 hex
10000 … 11999	0000 … 1999	A0 hex
20000 … 21999	0000 … 1999	50 hex
30000 … 31999	0000 … 1999	F0 hex
60000 … 61999	0000 … 1999	74 hex

Subindex

For indexed parameters, the parameter index is located in subindex (IND Bit 15 … 8) as hexadecimal value.

PWE: Parameter value or connector

Parameter values or connectors can be located in the PWE.

Table 6- 28 Parameter value or connector

<table>
<tr><th></th><th>PWE 1</th><th colspan="2">PWE 2</th></tr>
<tr><td rowspan="4">Parameter value</td><td>Bit 15 … 0</td><td>Bit 15 … 8</td><td>Bit 7 … 0</td></tr>
<tr><td>0</td><td>0</td><td>8-bit value</td></tr>
<tr><td>0</td><td colspan="2">16-bit value</td></tr>
<tr><td colspan="3">32-bit value</td></tr>
</table>

	PWE 1	PWE 2	
Connector	Bit 15 … 0	Bit 15 … 10	Bit 9 … 0
	Number of the connector	3F hex	The index or bit field number of the connector

6.5.7 Examples for using the parameter channel

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

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

- **PKE, Bit 12 … 15 (AK): = 6** (request parameter value (field))
- **PKE, Bit 0 … 10 (PNU): = 1841** (parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 … 15 (subindex): = 2** (index of parameter)
- **IND, bit 0 … 7 (page index): = 90 hex** (offset 6000 corresponds to 90 hex)
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 6-17 Telegram for a read request from p7841[2]

Write request: Change restart mode (p1210)

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

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

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

Figure 6-18 Telegram, to activate the automatic restart with p1210 = 26

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

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

- **PKE, bit 12 … 15 (AK): = 7 hex** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)
- **IND, bit 8 … 15 (subindex): = 1 hex** (CDS1 = Index 1)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **PWE1, Bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)
- **PWE2, Bit 10 … 15: = 3F hex** (drive object - for SINAMICS G120, always 63 = 3f hex)
- **PWE2, Bit 0 … 9: = 2 hex** (Index of Parameter (DI 2 = 2))

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15...12	11	10 ... 0	15 ... 8	7 ... 0	15 ... 0	15 ... 10	9 ... 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 6-19 Telegram, to assign DI 2 with ON/OFF1

6.5.8 Extending the telegram

Overview

When you have selected a telegram, the inverter interconnects the corresponding signals with the fieldbus interface. Generally, these interconnections are locked so that they cannot be changed. However, with the appropriate setting in the inverter, the telegram can be extended or even freely interconnected.

Extending the telegram

Procedure

1. Set p0922 = 999.
2. Set parameter p2079 to the value of the corresponding telegram.

   The interconnections contained in the telegram are locked.
3. Extend the telegram by "attaching" additional signals.

   Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have extended the telegram.
❒

Freely interconnecting signals in the telegram

Procedure

1. Set p0922 = 999.
2. Set p2079 = 999.

   The interconnections contained in the telegram are enabled.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have freely interconnected the signals transferred in the telegram.
❒

6.5.9 Slave-to-slave communication

Overview

"Direct data exchange" is sometimes called "slave-to-slave communication" or "data exchange broadcast". With direct data exchange, slaves exchange data without any direct involvement of the master.

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

Manuals for your converter (Page 393)

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.

Manuals for your converter (Page 393)

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)

6.6 Control via AS-i

6.6.1 Single slave mode

In Single Slave mode, four bits are available for the communication between the AS-i master and the inverter. The four bits are used to transfer process data. In parallel, the control can start a diagnostic request via AS-i.P0.

The following default settings are available; both work with profile 7.F.E.

- Default setting 30: Standard Single Slave mode
- Default setting 32: Modified Single Slave mode

Default setting 30: Standard Single Slave mode

In standard addressing, the control specifies the speed setpoint via the motor control bits (AS-i.DO0 … AS-i.DO3).

Control -> inverter

- AS-i.DO0 -> p1020 = 2093.0 Fixed speed bit 0
- AS-i.DO1 -> p1021 = 2093.1 Fixed speed bit 1
- AS-i.DO2 -> p1022 = 2093.2 Fixed speed bit 2
- AS-i.DO3 -> p1023 = 2093.3 Fixed speed bit 3

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

Inverter -> control

If the control specifies the speed setpoint, the inverter replies:

- p2080[0] = 53.13 -> AS-i.DI0 Operational enable for PLC
- p2080[1] = 899.11 -> AS-i.DI1 Pulses enabled
- p2080[2] = 722.0 -> AS-i.DI2 State DI0
- p2080[3] = 722.1 -> AS-i.DI3 State DI1

If the control sends a diagnostic request via AS-i.P0, the inverter replies with the currently pending fault or alarm messages.

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

Default setting 32: Modified Single Slave mode

In Single Slave mode with modified addressing the control specifies the following:

Control -> inverter

- AS-i.DO0 -> p3330.0 = 2093.0 ON clockwise / OFF 1
- AS-i.DO1 -> p3331.0 = 2093.1 ON counter-clockwise / OFF 1
- AS-i.DO2 -> p0810 = 2093.2 Speed via potentiometer or AI0
- AS-i.DO3 -> p2104 = 2093.3 Acknowledge errors with a positive edge
  p0852 = 2093.3 Operating enable, if p2093.3 = 1

Inverter -> control

The inverter sends as response:

- p2080[0] = 899.0 -> AS-i.DI0 Ready to switch on
- p2080[1] = 807.0 -> AS-i.DI1 Control priority
- p2080[2] = 722.0 -> AS-i.DI2 State DI0
- p2080[3] = 722.1 -> AS-i.DI3 State DI1

If an alarm or fault is pending in the inverter, it sends a warning or fault message.

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

Scaling factors for the speed

The scaling factor is specified via AS-i.P0 … AS-i.P3. A diagnostic request is also performed when AS-i.P0 is sent.

This means, if the control specifies a scaling factor and an alarm or fault is pending in the inverter, it sends the current alarm or fault messages and accepts simultaneously the sent value consisting of AS-i.P0 … AS-i.P3 as new scaling factor.

- AS-i.P0 Scaling factor bit 0
- AS-i.P1 Scaling factor bit 1
- AS-i.P2 Scaling factor bit 2
- AS-i.P3 Scaling factor bit 3

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

6.6.2 Dual slave mode

In Dual Slave mode, eight bits are available for the communication between the AS-i master and the inverter. The eight bits are used to transfer process data. In parallel, the control can start a diagnostic request via AS-i.P0.

The following default settings are possible:

- Default setting 31: Dual Slave mode with fixed setpoints
- Default setting 34: Dual Slave mode with setpoint via AS-i field bus

Default setting 31: Dual Slave mode with fixed setpoints

The control accesses the two slaves of the inverter each via four bits.

Via slave 2, in accordance with profile 7.A.E, the control specifies the speed setpoint via the motor control bits (AS-i.DO0 … AS-i.DO2).

Via slave 1, the control sends data in cyclical or acyclical mode, in accordance with profile 7.A.5.

The control requires one bit per slave in order to specify the slave.

Default setting 31, slave 2 with profile 7.A.E: Control -> inverter

- AS-i.DO0 -> p1020.0 = 2093.0 Fixed speed bit 0
- AS-i.DO1 -> p1021.0 = 2093.1 Fixed speed bit 1
- AS-i.DO2 -> p1022.0 = 2093.2 Fixed speed bit 2

- AS-i.DO3 -> Select slave A or slave B, interconnected internally

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

If the control specifies the speed setpoint, the inverter replies:

Default setting 31, slave 2 with profile 7.A.E: Inverter -> control

- p2080[0] = 53.13 PLC ready to switch on -> AS-i.DI0
- p2080[1] = 899.11 Pulses enabled -> AS-i.DI1
- p2080[2] = 722.0 State DI0 -> AS-i.DI2
- p2080[3] = 722.1 State DI1 -> AS-i.DI3

If the control sends a diagnostic request via AS-i.P0, the inverter replies with the currently pending fault or alarm messages.

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

Default setting 31, slave 1 with profile 7.A.5: Control -> inverter

- AS-i.DO0 -> Time signal for the CTT2 transfer from the AS-i master
- AS-i.DO1 -> Data bit for the CTT2 transfer, four bytes cyclically or acyclically via PIV. The reading and writing of parameters is possible via the PIV. Because data is transferred bit-by-bit, the read and write process is very slow.
- AS-i.DO2 -> p0881 = 2093.4 Override quick stop
- AS-i.DO3 -> Select slave A or slave B, interconnected internally

Default setting 31, slave 1 with profile 7.A.5: Inverter -> control

- p2080[4] = 722.2 State DI2 -> AS-i.DI0
- p2080[5] = 722.3 State DI3 -> AS-i.DI1
- Serial data transfer CTT2, four bytes cyclically or acyclically via PIV. The reading and writing of parameters is possible via the PIV. Because data is transferred bit-by-bit, the read and write process is very slow. -> AS-i.DI2
- Time signal for the CTT2 transfer to the AS-i master -> AS-i.DI3

Default setting 34: Dual Slave mode with setpoint via AS-i field bus

The control accesses the two slaves of the inverter each via four bits.

Via slave 2, in accordance with profile 7.A.E, the control specifies the commands listed below (AS-i.DO0 … AS-i.DO2).

Via slave 1, the control sends the command for quick stop and the data in cyclical or acyclical mode.

The control requires one bit per slave in order to specify the slave.

Default setting 34, slave 2 with profile 7.A.E: Control -> inverter

- AS-i.DO0 -> ON / OFF 1
- AS-i.DO1 -> OFF 2
- AS-i.DO2 -> Acknowledge fault
- AS-i.DO3 -> Select slave A or slave B, interconnected internally

If the control specifies the speed setpoint, the inverter replies:

Default setting 34, slave 2 with profile 7.A.E: Inverter -> control

- p2080[0] = 53.13 PLC ready to switch on -> AS-i.DI0
- p2080[1] = 899.11 Pulses enabled -> AS-i.DI1
- p2080[2] = 722.0 State DI0 -> AS-i.DI2
- p2080[3] = 722.1 State DI1 -> AS-i.DI3

If the control sends a diagnostic request via AS-i.P0, the inverter replies with the currently pending fault or alarm messages.

AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

Default setting 34, slave 1 with profile 7.A.5: Control -> inverter

- AS-i.DO0 -> Time signal for the CTT2 transfer from the AS-i master
- AS-i.DO1 -> Data bit for the CTT2 transfer, four bytes cyclically or acyclically via PIV. The reading and writing of parameters is possible via the PIV. Because data is transferred bit-by-bit, the read and write process is very slow.
- AS-i.DO2 -> p0881 = 2093.4 Override quick stop
- AS-i.DO3 -> Select slave A or slave B, interconnected internally

Default setting 34, slave 1 with profile 7.A.5: Inverter -> control

- p2080[4] = 722.2 State DI2 -> AS-i.DI0
- p2080[5] = 722.3 State DI3 -> AS-i.DI1
- Serial data transfer CTT2, four bytes cyclically or acyclically via PIV. The reading and writing of parameters is possible via the PIV. Because data is transferred bit-by-bit, the read and write process is very slow. -> AS-i.DI2
- Time signal for the CTT2 transfer to the AS-i master -> AS-i.DI3

6.6.3 Assignment tables

Fixed speeds - Single Slave

Table 6- 29 Fixed speeds via the motor control bits

AS-i.DO3	AS-i.DO2	AS-i.DO1	AS-i.DO0	Response in the inverter
0	0	0	0	OFF1
0	0	0	1	On + fixed speed 1 (factory setting: 1500 rpm)
0	0	1	0	On + fixed speed 2 (factory setting: -1500 rpm)
0	0	1	1	On + fixed speed 3 (factory setting: 300 rpm)
0	1	0	0	On + fixed speed 4 (factory setting: 450 rpm)
0	1	0	1	On + fixed speed 5 (factory setting: 600 rpm)
0	1	1	0	On + fixed speed 6 (factory setting: 750 rpm)
0	1	1	1	On + fixed speed 7 (factory setting: 900 rpm)
1	0	0	0	On + fixed speed 8 (factory setting: 1050 rpm)
1	0	0	1	On + fixed speed 9 (factory setting: 1200 rpm)
1	0	1	0	On + fixed speed 10 (factory setting: 1350 rpm)
1	0	1	1	On + fixed speed 11 (factory setting: 1500 rpm)
1	1	0	0	On + fixed speed 12 (factory setting: 1650 rpm)
1	1	0	1	On + fixed speed 13 (factory setting: 1800 rpm)
1	1	1	0	On + fixed speed 14 (factory setting: 1950 rpm)
1	1	1	1	Acknowledge fault or OFF2

Modified addressing - scaling factors

Table 6- 30 Scaling of the speed setpoint via AS-i.P0 … AS-i.P3

AS-i.P3	AS-i.P2	AS-i.P1	AS-i.P0	Scaling factor	Frequency (Hz)
1	1	1	1	1	50
1	1	1	0	0.9	45
1	1	0	1	0.8	40
1	1	0	0	0.7	35
1	0	1	1	0.6	30
1	0	1	0	0.5	25
1	0	0	1	0.45	22.5
1	0	0	0	0.4	20
0	1	1	1	0.35	17.5
0	1	1	0	0.3	15
0	1	0	1	0.25	12.5
0	1	0	0	0.2	10
0	0	1	1	0.15	7.5
0	0	1	0	0.1	5

AS-i.P3	AS-i.P2	AS-i.P1	AS-i.P0	Scaling factor	Frequency (Hz)
0	0	0	1	0.07	3.5
0	0	0	0	0.05	2.5

Fixed speeds - Dual Slave

Table 6- 31 Fixed speeds via the motor control bits and response in the inverter

AS-i.DO2	AS-i.DO1	AS-i.DO0	Response in the inverter
0	0	0	OFF1
0	0	1	On + fixed speed 1 (factory setting: 1500 rpm)
0	1	0	On + fixed speed 2 (factory setting: -1500 rpm)
0	1	1	On + fixed speed 3 (factory setting: 300 rpm)
1	0	0	On + fixed speed 4 (factory setting: 450 rpm)
1	0	1	On + fixed speed 5 (factory setting: 600 rpm)
1	1	0	On + fixed speed 6 (factory setting: 750 rpm)
1	1	1	Acknowledge fault or OFF2

Alarm and fault messages

Table 6- 32 Alarm and fault messages via RP0 … RP3 from the inverter to the AS-i master

RP3	RP2	RP1	RP0	AS-i.P0 = 0 -> alarm messages	AS-i.P0 = 1 -> faults
0	0	0	0	No alarm	No fault
0	0	0	1	not used	Overtemperature, F00004, F00006
0	0	1	0	not used	not used
0	0	1	1	No load (A07929)	not used
0	1	0	0	Overtemperature (A07400, A07404. A30502)	I^2t overload (F30005, F07936)
0	1	0	1	Overvoltage (A07400, A07404, A30502)	Equipment malfunction (F30009, F01000, F01001, F01002, F01005, F01015, F01018, F01029, F01000-F01300)
0	1	1	0	not used	not used
0	1	1	1	Undervoltage (A30041, A07402, A07403, A30016)	Motor-PTC sensor malfunction (F07011, F07016)
1	0	0	0	I^2t overload (A08705)	Overvoltage (F30002, F30011)
1	0	0	1	not used	not used
1	0	1	1	not used	Undervoltage (F00003, F30040, F07802)
1	1	0	0	not used	Short-circuit at the output (F30001, F30017, F30021, F07801, F07808, F07900, F30017, F07807)
1	1	0	1	Motor phase loss	Motor phase loss (F30015, F07902)

RP3	RP2	RP1	RP0	AS-i.P0 = 0 -> alarm messages	AS-i.P0 = 1 -> faults
1	1	1	0	not used	Safety fault (F016xx)
1	1	1	1	Other alarms	Other faults

6.6.4 Cyclic and acyclic communication via CTT2

Via CTT2 (Combined Transaction Type 2), both cyclical and acyclical communication is performed via AS-i. Because only one channel is available (AS-i.DO1 master -> slave or AS-i.DI3 slave -> master), a concurrent cyclical and acyclical data exchange is not possible.

The communication type (cyclical or acyclical) is always coded in the first byte in accordance with the following table.

Table 6- 33 CTT2 commands

Code (hex)	Explanation/meaning	Followed by
Cyclic communication		
Access to analog values via DS140 … DS147. See CP 343−2 / CP 343−2 P AS−Interface master (https://support.industry.siemens.com/cs/gb/en/view/1171856), Chapter 4		4 bytes: PWE1, PWE2
		4 bytes: PWE1, PWE2
Acyclic communication - standard		
10 hex	Read request: Master -> slave	2 bytes: Index, length
50 hex	Read request OK: Slave -> master	Index, data
90 hex	Read request failed: Slave -> master	1 byte: Standard error code (3 hex)
11 hex	Write request: Master -> slave	Index, length, data
51 hex	Write request OK: Slave -> master	
91 hex	Write request failed: Slave -> master	1 byte: Standard error code (3 hex)
Acyclic communication - manufacturer-specific		
12 hex	Read request: Master -> slave	Index, length
52 hex	Read request OK: Slave -> master	Data
92 hex	Read request failed: Slave -> master	Fault object
13 hex	Write request: Master -> slave	Index, length, data
53 hex	Write request OK: Slave -> master	
93 hex	Write request failed: Slave -> master	Fault object
1D hex	Exchange request: Master -> slave	Index, read length, write length, write data
5D hex	Exchange request OK: Slave -> master	PKE, index, n-2 data
9D hex	Exchange request faulty: Slave -> master	Fault object

If an acyclical request cannot be executed by the inverter, it replies with one of the following error messages.

Error message	Meaning
0	No fault
1	Invalid index
2	Incorrect length
3	Request not implemented
4	Busy (the request could not be processed completely within the time window, retry later)
5	Last acyclical request was not confirmed
6	Invalid subindex
7	"Selective read request" command missing

6.6.5 Cyclic communication

Inverter -> master

The inverter cyclically transfers the data from p2051[1] and p2051[2] in four bytes to the master. You can process these four bytes in the control as for analog data. Refer to the documentation for the AS-i master for detailed information about access to analog data.

If you selected default setting 31 or 34 during the commissioning, the two indexes are interconnected as follows:

- p2051[1] = 63: Smoothed actual speed value
- p2051[2] = 27: Absolute smoothed actual current value

The values for transfer are normalized in accordance with the Profidrive N2 data type. Using p2051[1] and p2051[2] you can interconnect any other or connector parameters and transfer to the control.

Master -> inverter

The master transfers the data in the "Combined Transaction Type 2" (CTT2) to the inverter and writes it to r2050[1] and r2050[2].

To process these values in the inverter, you must appropriately interconnect r2050[1] and r2050[2] in the inverter. This means, when the control sends the speed setpoint, you must interconnect parameter p1070 (source for the main setpoint) with r2050 as follows:
p1070[0] = 2050[1]

Note

Internal interconnection with default setting 34

If, when commissioning, you select "Default setting 34", then the main setpoint is internally interconnected with r2050[1].

Once a setpoint has been transferred completely, the setpoint present in the control will be transferred as next setpoint. Any setpoint changes made during the transfer are not considered.

6.6.6 Acyclic communication - standard

This type of acyclical communication supports the ID read request and the diagnostic read request. All other requests receive the "request not implemented" message response.

- ID request:
  - Master -> slave | 10 hex | 00 hex | nn hex |
  - Slave -> master | 50 hex | 00 hex | Manufacturer's ID | Product ID | BB hex |
- Diagnostic request:
  - Master -> slave | 10 hex | 01 hex | nn hex |
  - Slave -> master no error | 50 hex | 01 hex | 00 hex |:
    Slave -> master general error | 50 hex | 01 hex | 99 hex |

The following repsonse is issued for all other write or read requests:

- Read requests | 90 hex | 03 hex |
- Write requests | 91 hex | 03 hex |

6.6.7 Acyclic communication - manufacturer-specific

The manufacturer-specific acyclical communication is performed via data record 47 in PIV format. The PIV format structure is identical with that for the USS parameter channel.

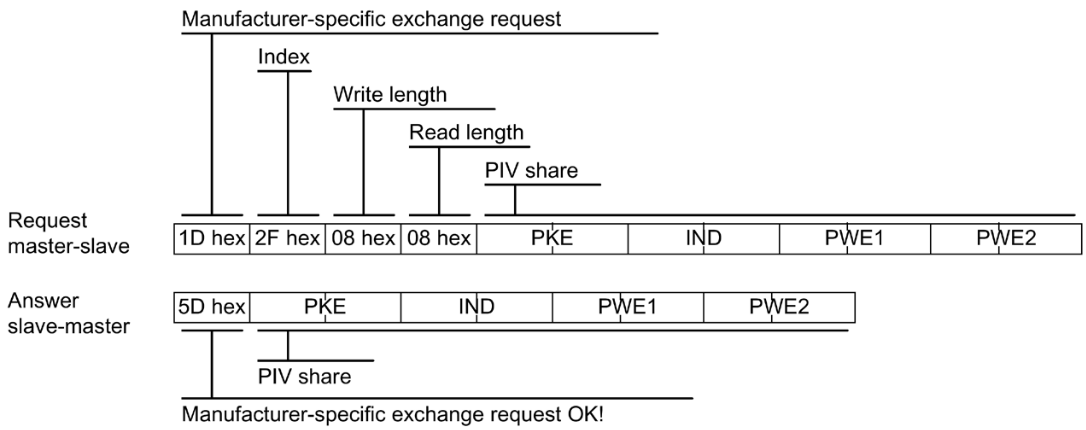
AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

To reduce the transfer volume, there is not only the "normal" "data exchange" PIV mechanism, but also the "Read data" and "Write data" commands.

- Data exchange:
  - Control -> inverter request
  - Inverter -> control response
- Read data:
  The inverter sends a read command, and the data of the last exchange request or write request is transferred from the inverter to the control.
- Write data
  Write OK: -> 53 hex.

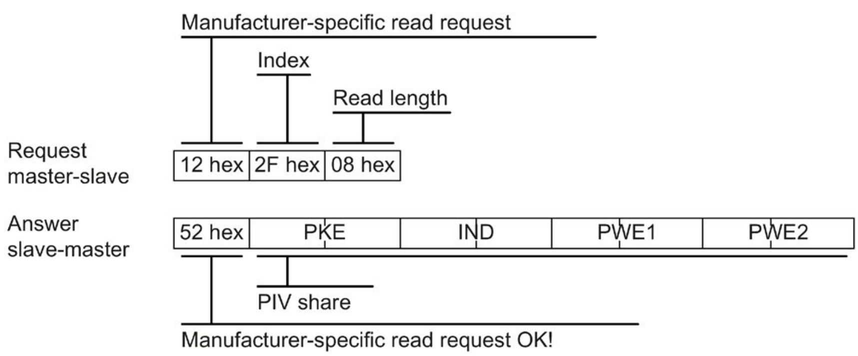
Because the PIV transfer protocol specifies the transfer direction independently, all parameters can be transferred as data exchange request/response. Requests for reading and writing data are included primarily to reduce the transferred data volume for the repeated reading or writing of parameters.

Data exchange

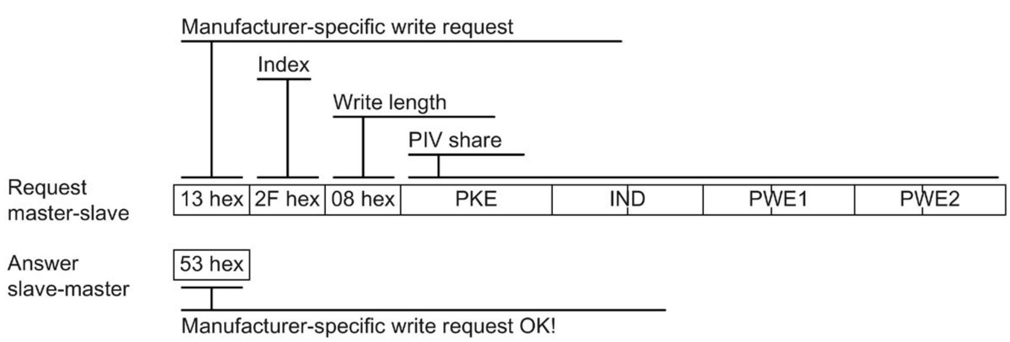


Reading data

The data for the last write or exchange request is read



Writing data



In the event of a fault, the inverter sends the following telegram as reponse to the master:

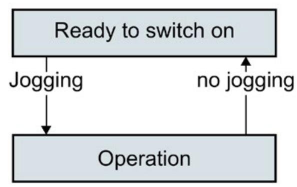
93 hex	00 hex	PWE1

.

Value for PWE: Fault table from AS-i System Interface Manual (https://support.industry.siemens.com/cs/gb/en/view/1171856).

6.7 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.

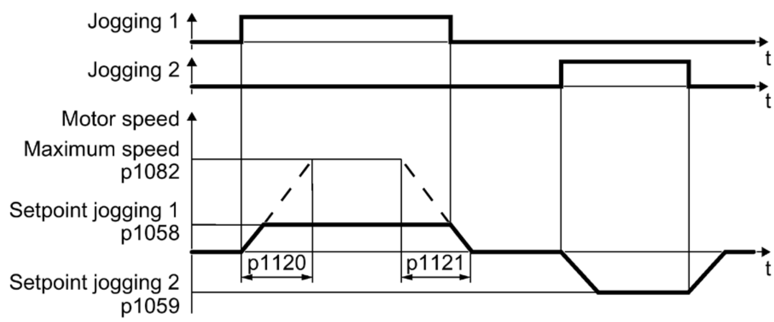


Figure 6-20 Behavior of the motor when "jogging"

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.

6.8 Limit position control

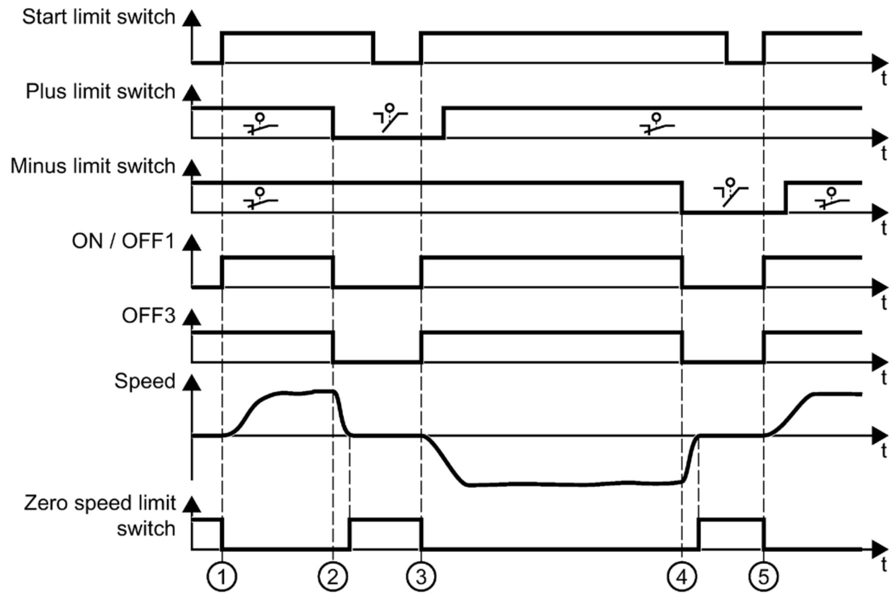
Limit position and limit switch

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.

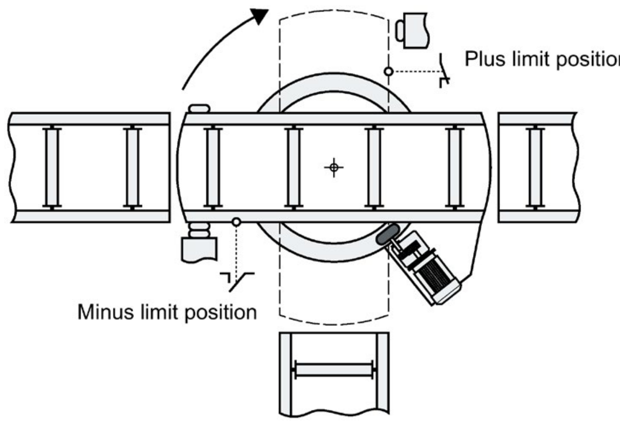
Figure 6-21 Limit position control of the inverter

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

See also

Fixed speed setpoint as setpoint source (Page 231)

Application example: Roller conveyor with rotary table

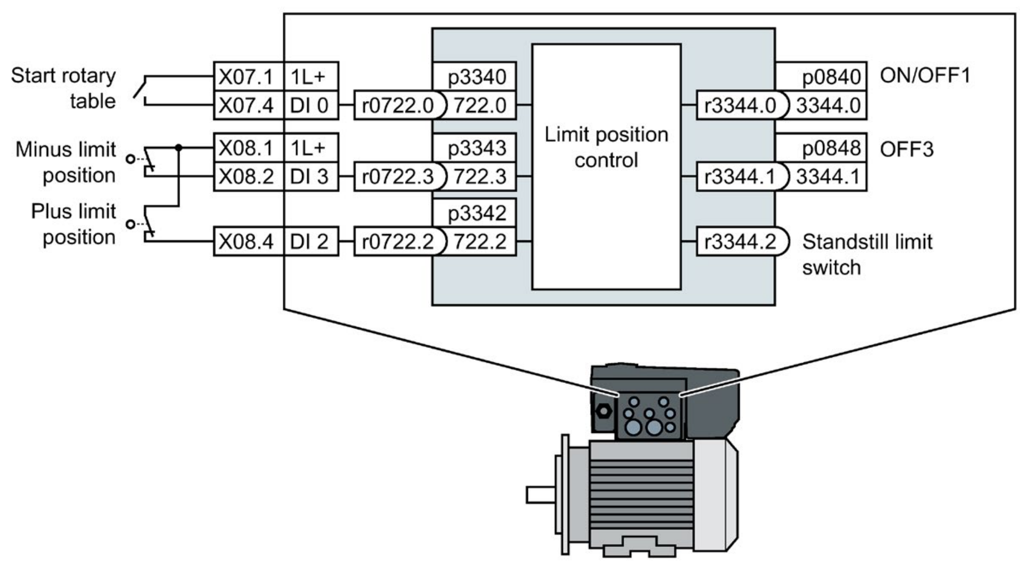


A rotary table in a roller conveyor redirects the material at the crossing of two conveyor lines. The rotary table rotates through 90° from one limit position to the other. Two limit switches signal the respective limit position. The signal to start the rotary table comes from the higher-level controller.

Procedure

To adapt the limit position control of the inverter to the application, proceed as follows:

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 limit positions or open one of the limit switches manually.
4. Specify a speed setpoint. We recommend that you use a fixed setpoint for the limit position control.

   Fixed speed setpoint as setpoint source (Page 231).
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.

6.9 Quick Stop function

Overview

The Quick Stop function enables a load on a conveyor system to be detected and if Quick Stop is enabled, stop the load on the conveyor section.

The load on the conveyor section moves towards a dedicated sensor, as shown in the figure below.

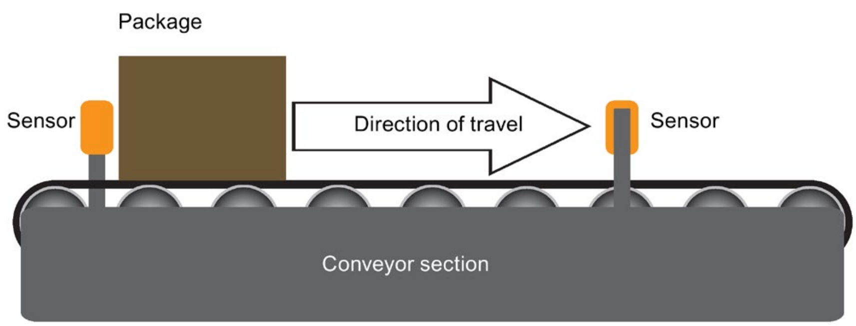


Figure 6-22 Conveyor example 1

The front edge of the load is detected by the sensor, which initiates the Quick Stop function.

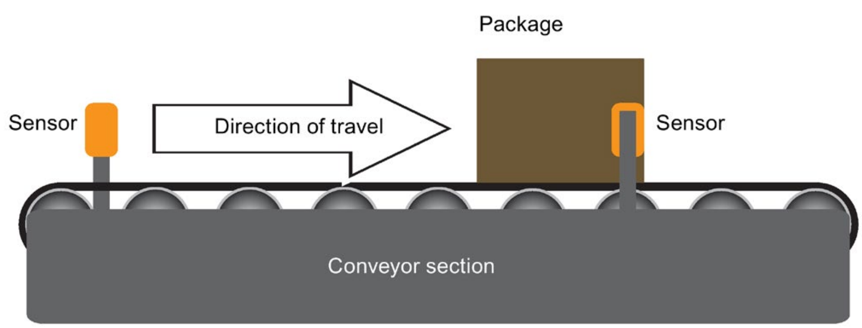


Figure 6-23 Conveyor example 2

The load is then slowed down and stopped.

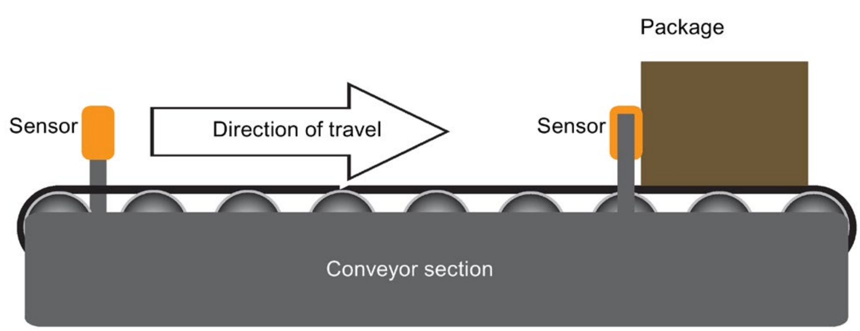


Figure 6-24 Conveyor example 3

There are two sensors on the conveyor section, so that the Quick Stop function can stop the conveyor section in either direction when a load is detected.

How does it work?

The Quick Stop function is configured using BICO parameters and they are explained in the table below.

Table 6- 34 Quick Stop parameters

Parameter	Description	Remarks
P0881	Quick Stop function Input 1 is ON	Allows Quick Stop source 1 command to be selected using BICO. The signal is expected to be active low (default setting P0886 = 2).
P0882	Quick Stop function Input 2 is ON	Allows Quick Stop source 2 command to be selected using BICO. The signal is expected to be active low (default setting (P0886 = 2).
P0883	Quick Stop override	Allows Quick Stop override command source to be selected using BICO. The signal is expected to be active high.

r0885	Quick Stop status	Bit field describing status of quick stop
		Bit /description 1 0
		`00: Quick Stop is active Yes No`
		`01: Quick Stop selected Yes No`
		`02: Override selected Yes No`
		`03: -`
		`04: Quick Stop Enabled Yes No`

P0886	Quick Stop input type	Control Word for selecting the Quick Stop input type.
		`0: Quick Stop not selected`
		`1: Quick Stop input active high`
		`2: Quick Stop input active low`
		`3: Quick Stop input positive edge triggered`
		`4: Quick Stop input negative edge triggered`

When the Quick Stop function is activated, an OFF1 command is initiated. The motor will be slowed and brought to a standstill using the ramp-down times set in parameter P1121. The default setting for P1121 is 10 seconds and this value may need adjusted to ensure that the load on the conveyor section is brought to a halt at the correct position on the conveyor section

Setting the ramp-down time too short can cause the Inverter to trip with either and overcurrent or overvoltage fault.

The controlling system detects that the Quick Stop function has been activated and can, by use of the appropriate ON command or the 'Quick Stop override" signal restart the motor as required.

Using parameter P0886, it is possible to set the type of reaction required to stop the conveyor section. There are basically two trigger methods, edge triggered signals or level triggered signals. Each type of triggering method produces a different reaction to the OFF1 command and the restarting of the motor. These reactions are shown in the figures below:

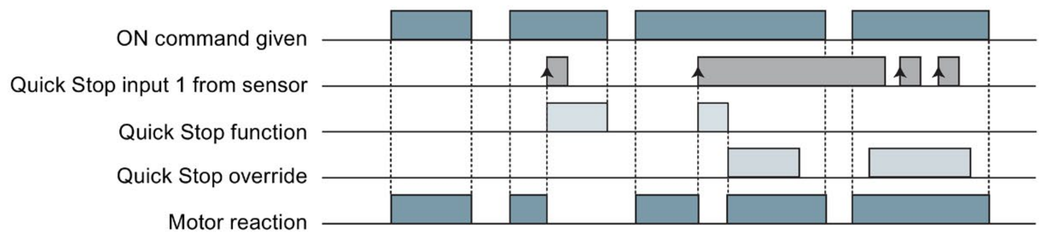


Figure 6-25 Positive edge triggered signals reactions

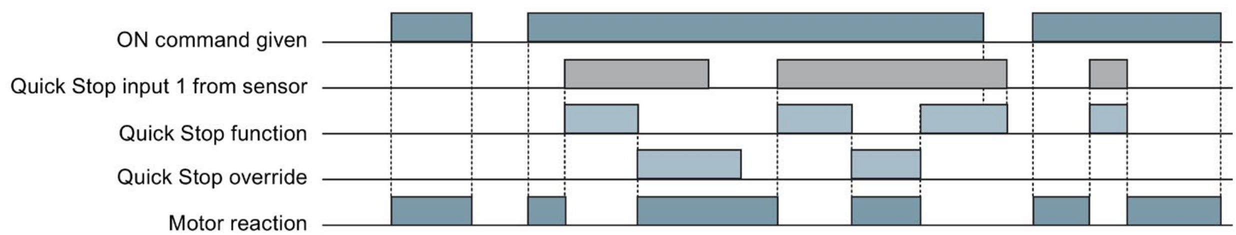


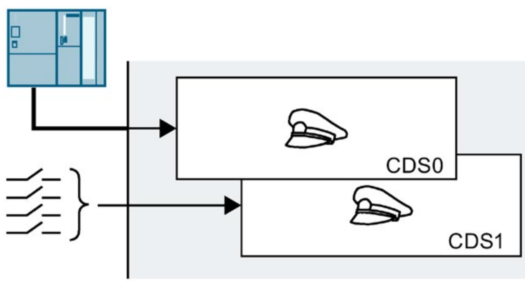
Figure 6-26 High level triggered signals reactions

6.10 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.

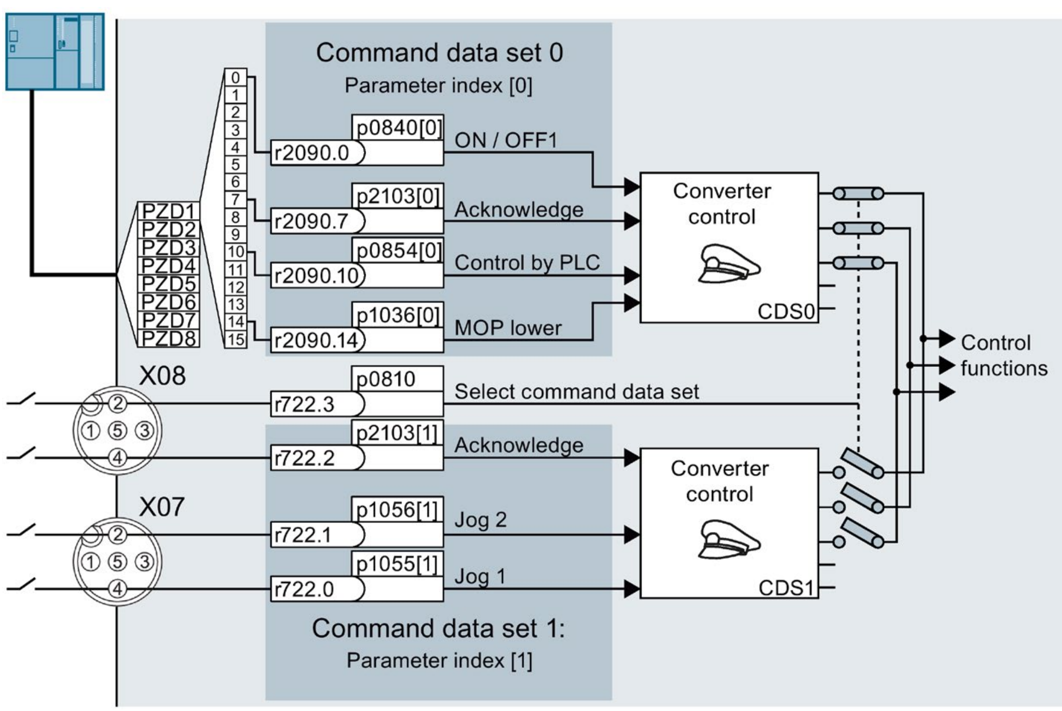


Figure 6-27 Example for the various command data sets

As in the example above, you obtain the interconnection if you configured the interfaces of the inverter with p0015 = 7 in the basic commissioning, also see section Quick commissioning (Page 109).

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

6.11 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

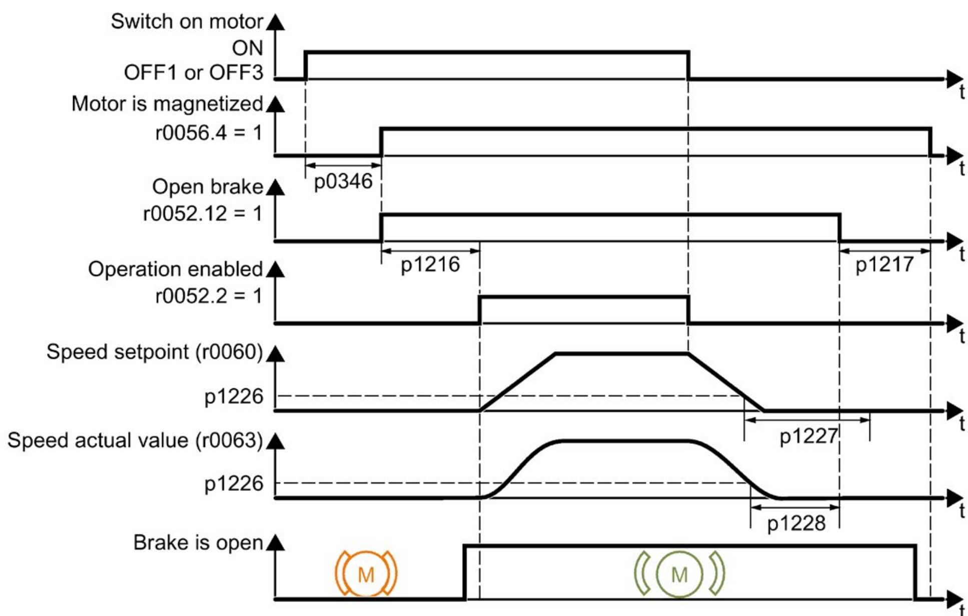


Figure 6-28 Motor holding brake function

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

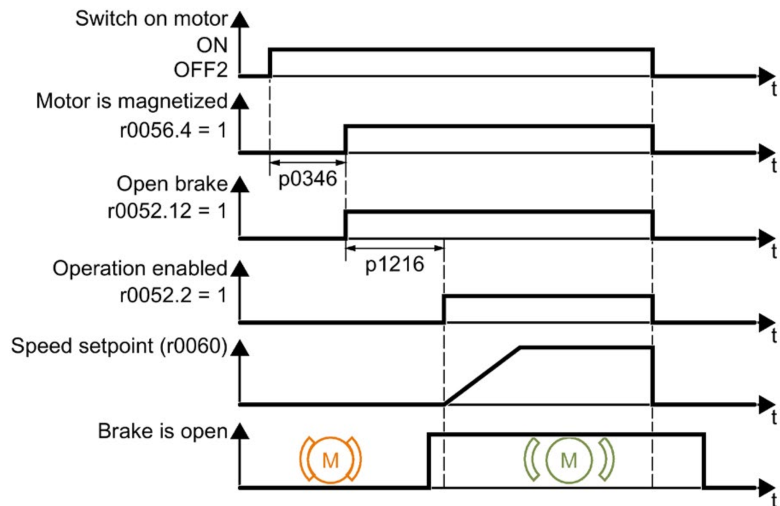


Figure 6-29 Controlling the motor holding brake after OFF2

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- 35 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- 36 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.

6.12 Free function blocks

6.12.1 Overview

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

The following free function blocks are available:

- AND, OR, XOR, and NOT logic
- RSR (RS flip-flop), DSR (D flip-flop) flip-flops
- Timers MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), and PST (pulse stretching)
- ADD (adder), SUB (subtractor), MUL (multiplier), DIV (divider), AVA (absolute value generated), NCM (comparator), and PLI (polyline) arithmetic functions
- LIM (limiter), PT1 (smoothing), INT (integrator), DIF (differentiator) controllers
- NSW (analog) BSW (binary) switches
- LVM limit value monitoring

The number of free function blocks in the inverter is limited. You can only use a function block once. The inverter has 3 adders, for instance. If you have already configured three adders, then no other adders are available.

6.12.2 Further information

Application description for the free function blocks

Further information is provided on the Internet:

Function Manual (https://support.industry.siemens.com/cs/gb/en/view/60467055/29243398027)

6.13 Selecting physical units

6.13.1 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- 37 Parameters involved when selecting the motor standard

Parameter	Designation	Motor standard IEC/NEMA, p0100 =		
		0[1)] IEC motor 50 Hz, SI units	1 NEMA motor 60 Hz, US units	2 NEMA motor 60 Hz, SI units
r0206	Power Module rated power	kW	hp	kW
p0219	Braking resistor braking power	kW	hp	kW
p0307	Rated motor power	kW	hp	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
p0341	Motor moment of inertia	kgm²	lb ft²	kgm²
p0344	Motor weight	kg	Lb	kg
r0394	Rated motor power	kW	hp	kW
r1493	Total moment of inertia, scaled	kgm²	lb ft²	kgm²

[1)] Factory setting

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

6.13.2 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.

6.13.3 Technological unit of the technology controller

Options when selecting the technological unit

p0595 defines in which technological unit the input and output variables of the technology controller are calculated, e.g. [bar], [m³/min] or [kg/h].

Reference variable

p0596 defines the reference variable of the technological unit for the technology controller.

Unit group

Parameters involved with p0595 belong to unit group 9_1.

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

Manuals for your converter (Page 393)

Special features

You must optimize the technology controller after changing p0595 or p0596.

6.13.4 Setting the system of units and technology unit

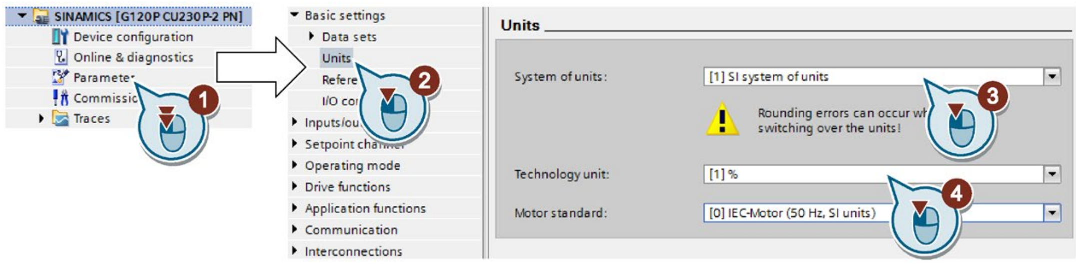
Setting using Startdrive

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.

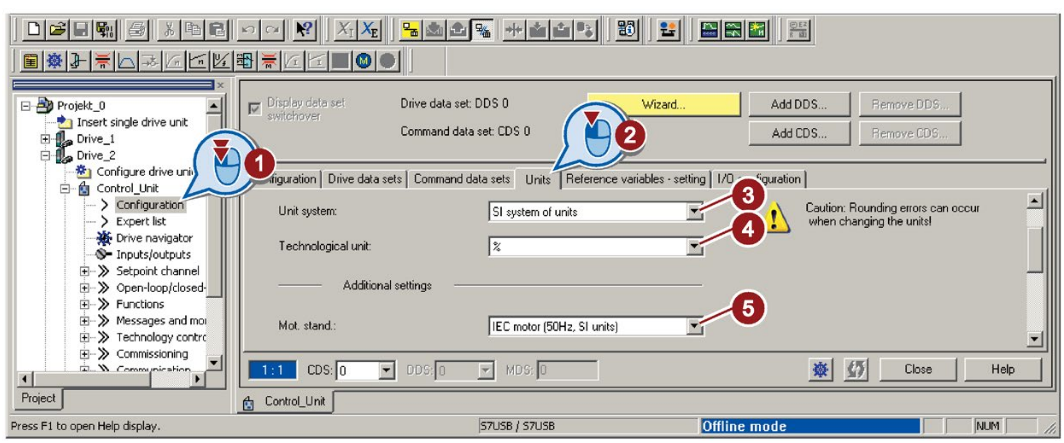
   The inverter signals that offline, other units and process variables are set than in the inverter itself.
7. Accept these settings in the inverter.

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

Procedure

Proceed as follows to select the motor standard and system of units using STARTER:

1. Select in the "Configuration" project tree.
2. Select under the "Units" tab.

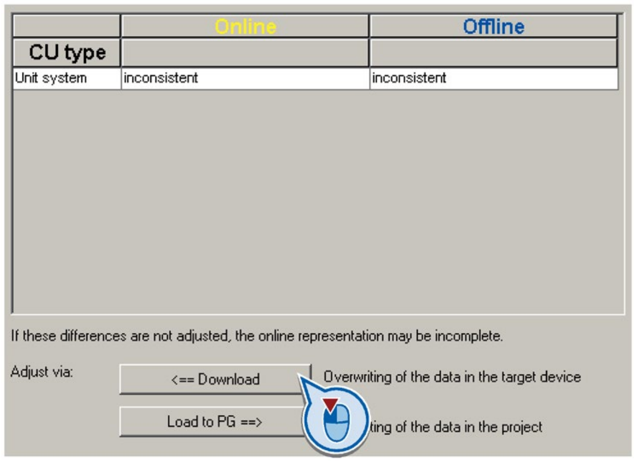


3. Select the system of units.
4. Select the technological unit of the technology controller.
5. Select the motor standard.
6. Save your settings.

7. Go online.

   The inverter signals that offline, other units and process variables are set than in the inverter itself.

8. Accept these settings in the inverter.



You have selected the motor standard and system of units using STARTER.

6.14 Safe Torque Off (STO) safety function

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

Manuals and technical support (Page 393)

6.14.1 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.

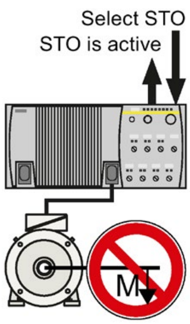


Table 6- 38 The principle of operation of STO

	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.	---

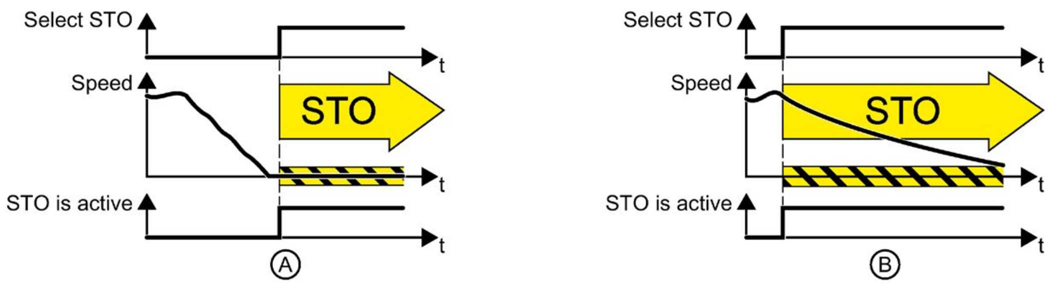


Figure 6-30 Functionality of STO when the motor is at standstill (A) and rotating (B)

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:

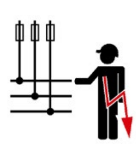
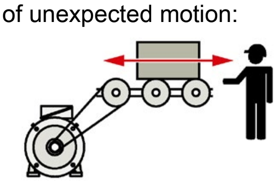
"[…] [The inverter] does not supply any energy to the motor which can generate a torque (or for a linear motor, a force)."

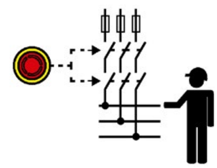
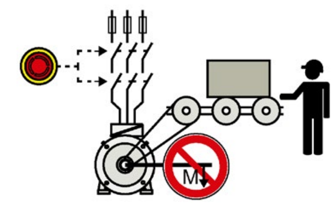
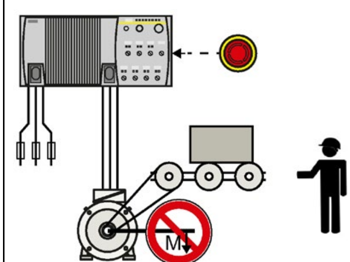
⇒ The STO inverter function is in conformance to IEC/EN 61800-5-2.

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.

6.14.2 ((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.

6.14.3 Commissioning STO

6.14.3.1 ((Commissioning tools))

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

Commissioning tools (Page 102)

6.14.3.2 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.

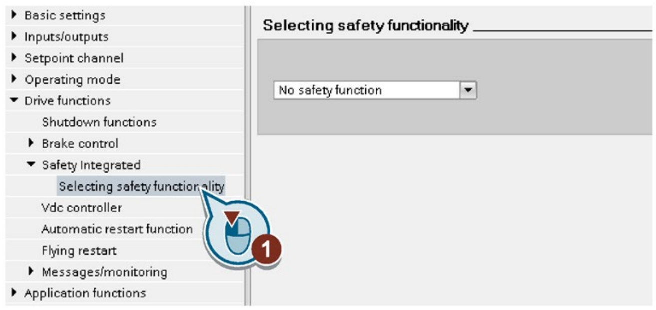
No.	Description	
p9761	**Entering a password** (factory setting 0000 hex)	
	0:	No password set
	1 … FFFF FFFF:	Password is set

No.	Description
p9762	New password
p9763	Password confirmation

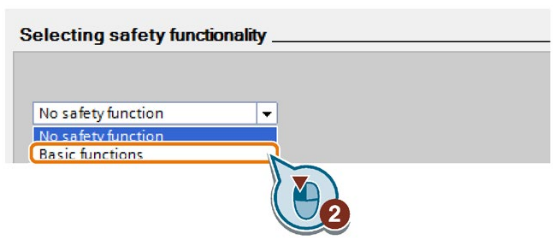
6.14.3.3 Configuring a safety function

Procedure

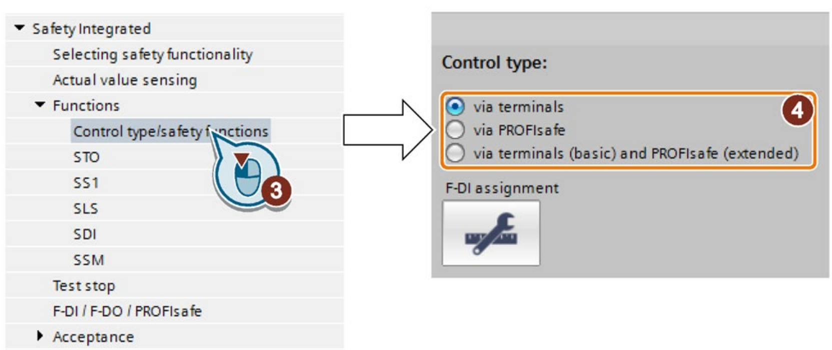
1. Select "Select safety functionality".



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.

Manuals for your converter (Page 393)

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

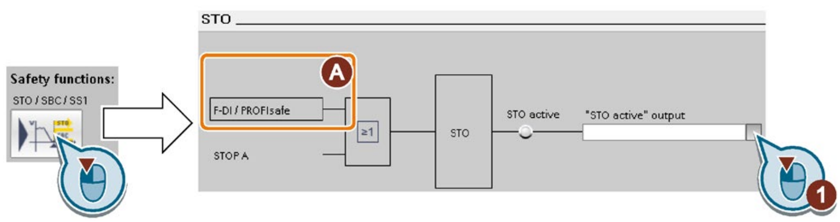
Parameter	Description	
	1 hex	Basic functions via onboard terminals has been enabled
p9761	**Enter a password** (factory setting: 0000 hex) Permissible passwords lie in the range 1 … FFFF FFFF.	
p9762	**New password**	
p9763	**Password confirmation**	

6.14.3.4 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.

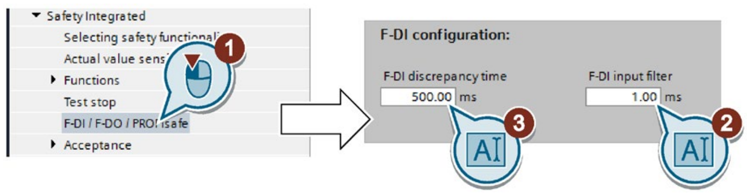
Parameter	Description
r9773.01	**1 signal**: STO is active in the drive

6.14.3.5 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.

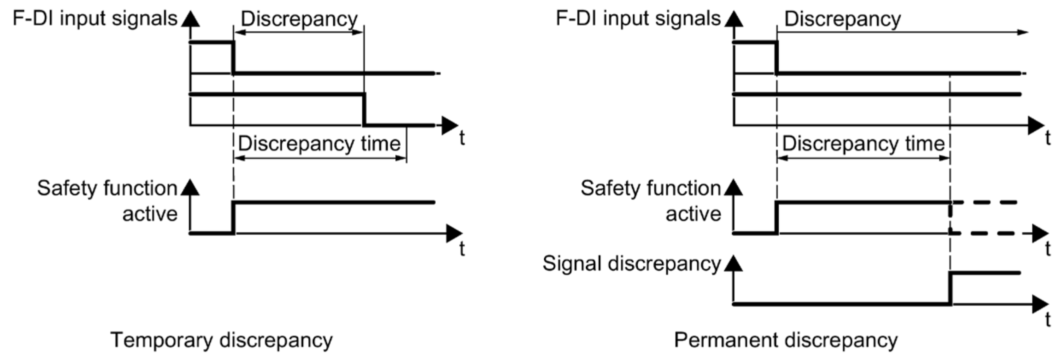


Figure 6-31 Simultaneity monitoring with discrepancy time

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.

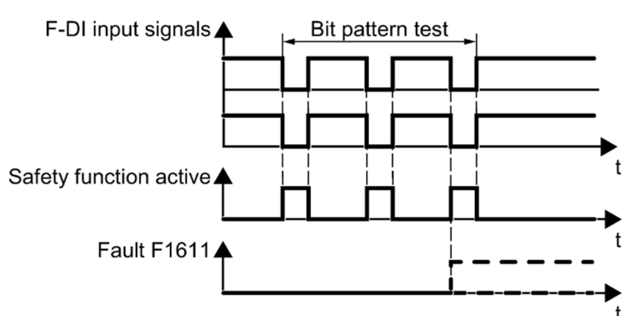


Figure 6-32 Inverter response to a bit pattern test

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

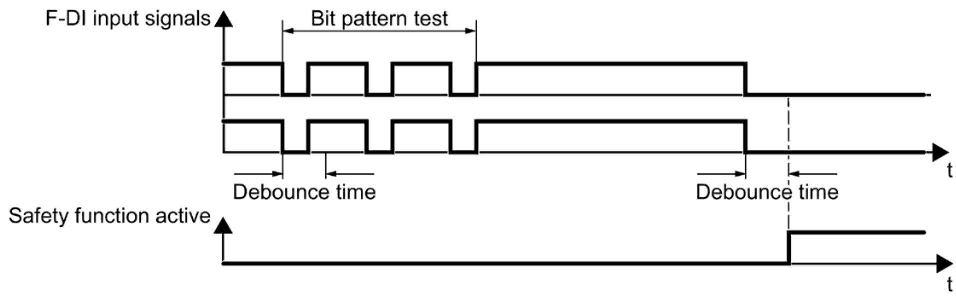


Figure 6-33 Filter to suppress brief signals

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

6.14.3.6 (Basic filter parameters))

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 .

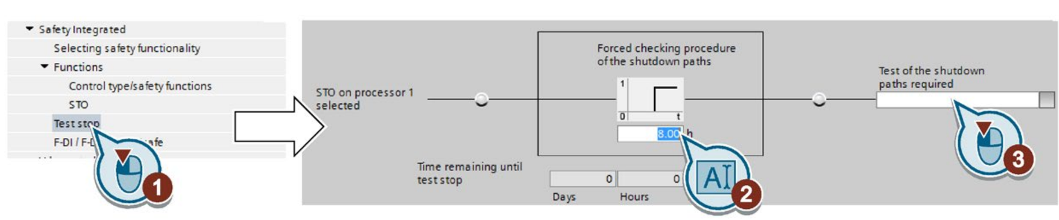
If you use an input as a fail-safe input, set the debounce time as described above.

6.14.3.7 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.

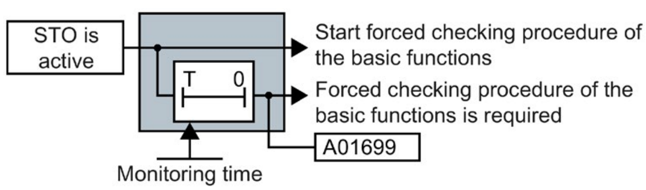


Figure 6-34 Starting and monitoring the forced checking procedure (test stop)

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.

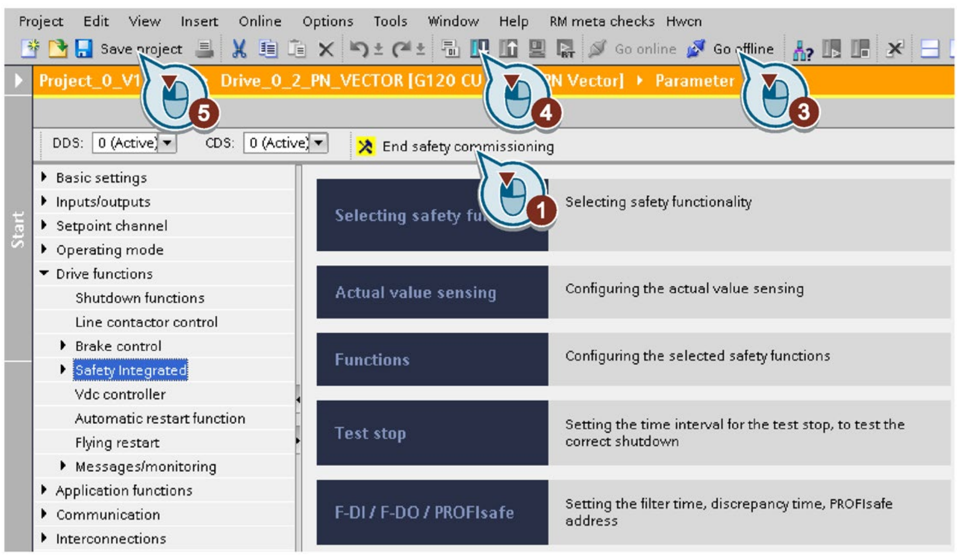
6.14.3.8 Finalizing online commissioning

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

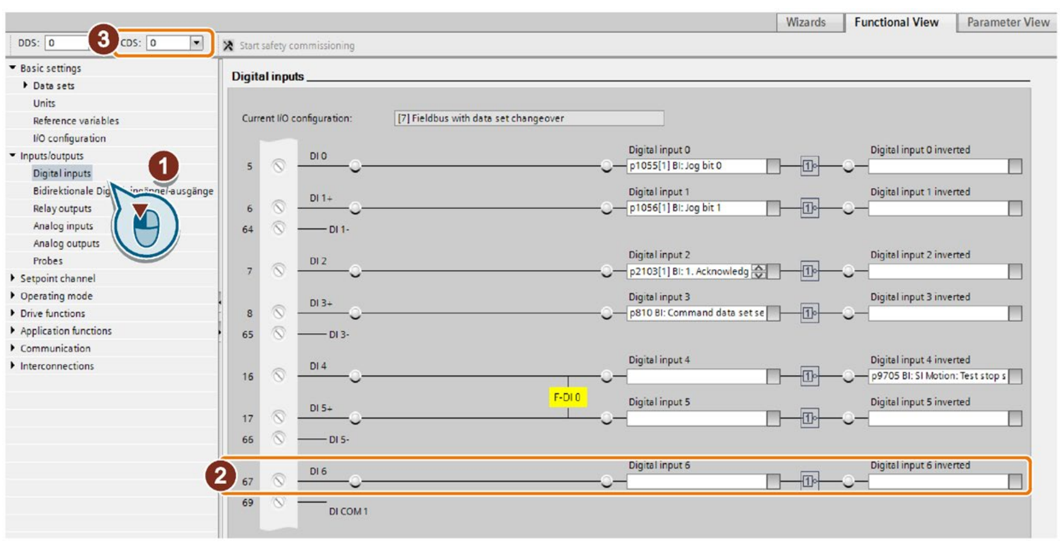
Parameter	Description
p0010 = 0	**Drive commissioning parameter filter** 0: Ready
p0971 = 1	**Save parameter** 1: Save the drive object (copy from RAM to ROM) After the inverter has saved the parameters in a non-volatile fashion, then p0971 = 0.

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.

❒

6.14.3.9 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)

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

6.15 Setpoints

6.15.1 Overview

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

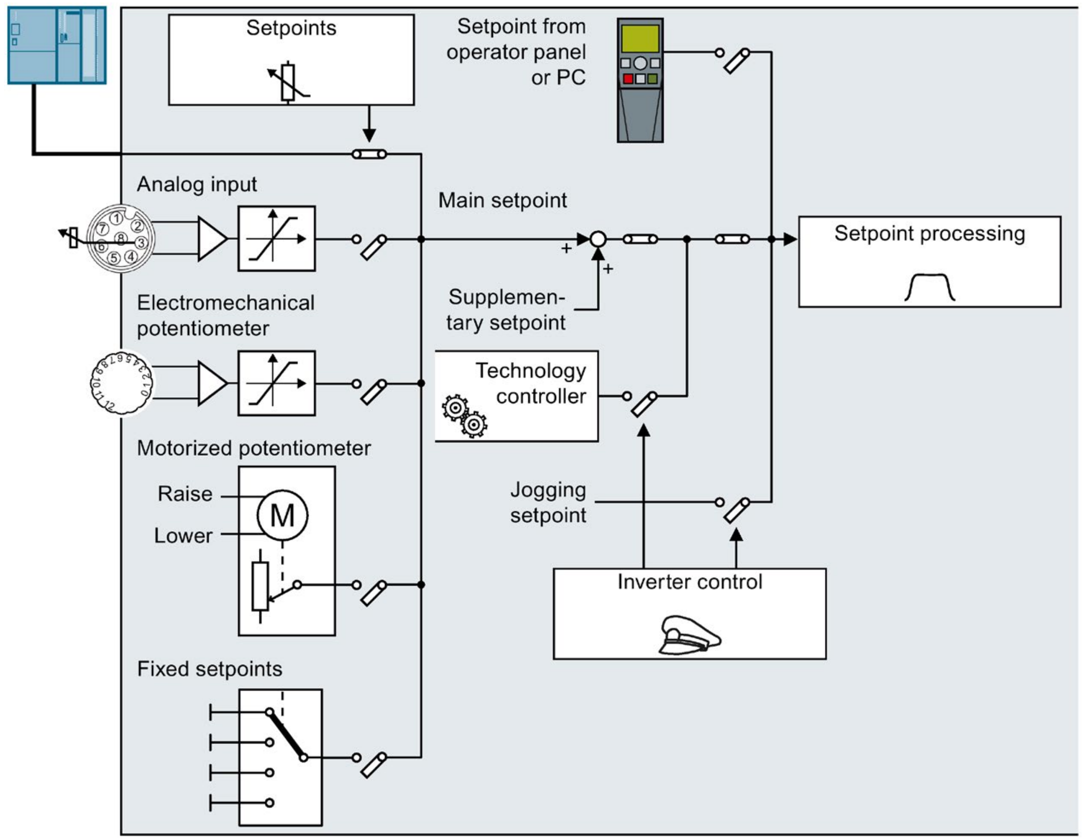


Figure 6-35 Setpoint sources for the inverter

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

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

You have the same selection options when selecting the source of the supplementary setpoint.

Under the following conditions, the inverter switches from the main setpoint to other setpoints:

- When the technology controller is active and appropriately interconnected, its output specifies the motor speed.
- When jogging is active.
- When controlling from an Operator Panel or a STARTER or Startdrive PC tool.

6.15.2 Analog input as setpoint source

Function description

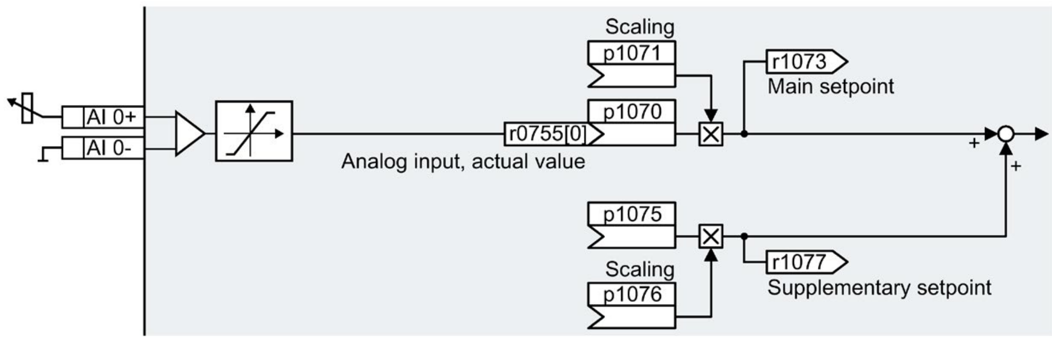


Figure 6-36 Example: Analog input 0 as setpoint source

In the quick commissioning, you define the preassignment for the inverter interfaces. Depending on what has been preassigned, after quick commissioning, the analog input can be interconnected with the main setpoint.

Example

Setting with analog input 0 as setpoint source:

Parameter	Description
p1070 = 755[0]	Interconnects main setpoint with analog input 0
p1075 = 755[0]	Interconnects supplementary setpoint with analog input 0

Parameter

Parameter	Description	Setting
r0755[0...1]	CO: CU analog inputs, actual value in percent	Displays the actual referenced input value of the analog inputs [0] = analog input 0 [1] = analog input 1
p1070[0…n]	CI: Main setpoint	Signal source for the main setpoint The factory setting depends on the inverter. Inverter with PROFIBUS or PROFINET interface: [0] 2050[1] Inverter 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

Further information

For further information refer to the function diagrams 2250 ff and 3030 of the List Manual.

See also

Analog inputs (Page 149)

6.15.3 Specifying the setpoint via the fieldbus

Function description

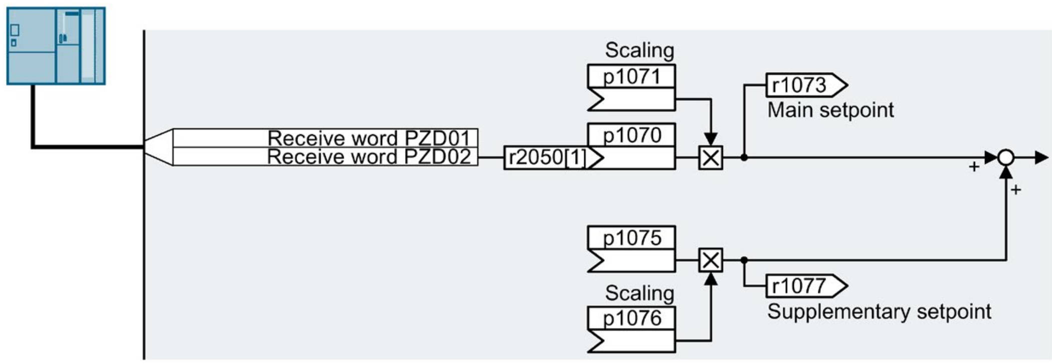


Figure 6-37 Fieldbus as setpoint source

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

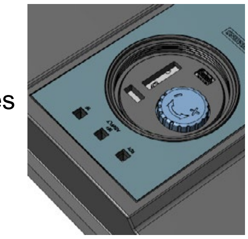
Parameter	Description	Setting
p1070[0…n]	CI: Main setpoint	Signal source for the main setpoint The factory setting depends on the Control Unit. With PROFIBUS or PROFINET interface: [0] 2050[1] Without PROFIBUS or PROFINET interface: [0] 755[0]
p1071[0…n]	CI: Main setpoint scaling	Signal source for scaling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

6.15.4 Electromechanical potentiometer



The converter has an electromechanical potentiometer.

The potentiometer is hardwired with the internal analog input 2.

When using USS or Modbus communications, the potentiometer provides by default the main setpoint.

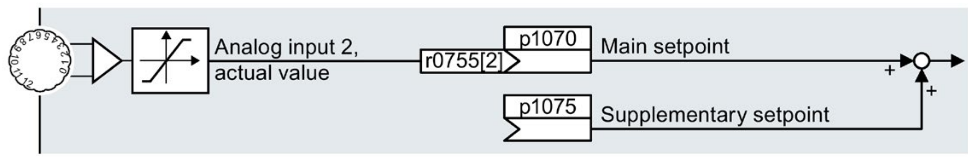


Figure 6-38 Potentiometer as setpoint source

Table 6- 39 Setting the potentiometer as setpoint source

Parameter	Remark
p1070 = 755[2]	**Main setpoint** Interconnect the main setpoint with the internal analog input 2
p1075 = 755[2]	**Additional setpoint** Interconnect the additional setpoint with the internal analog input 2.

6.15.5 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.

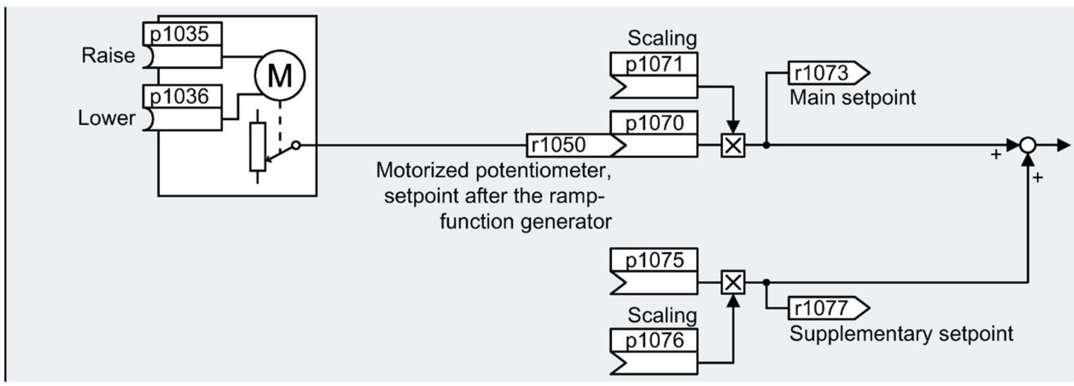


Figure 6-39 Motorized potentiometer as setpoint source

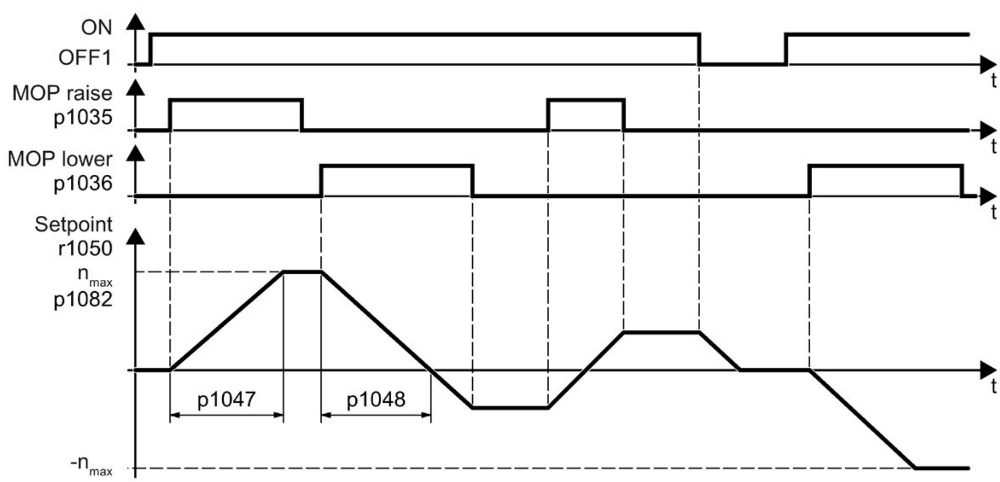


Figure 6-40 Function chart of the motorized potentiometer

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- 40 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- 41 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.

6.15.6 Fixed speed setpoint as setpoint source

Function description

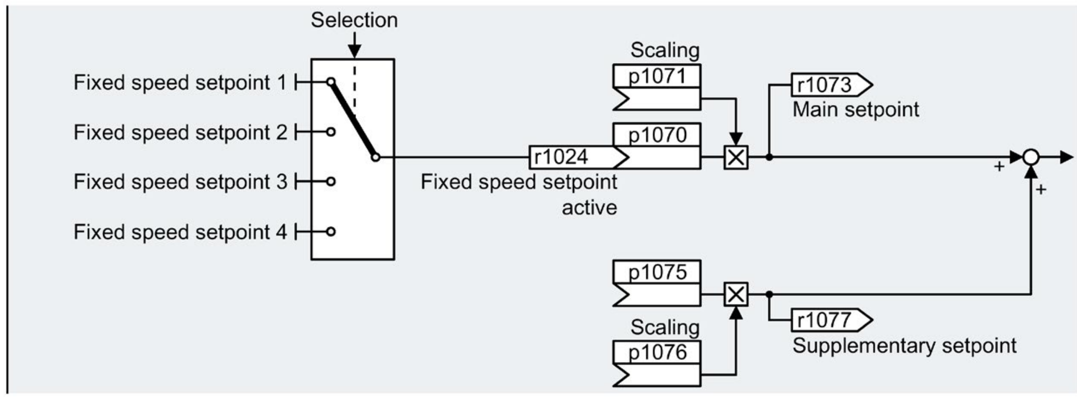


Figure 6-41 Fixed speed setpoint as setpoint source

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.

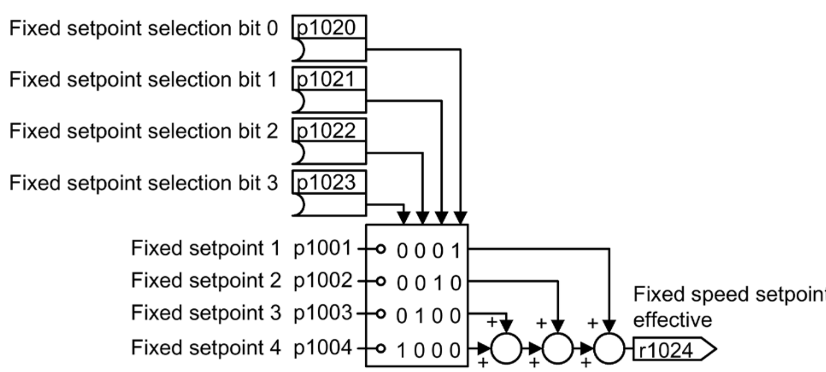


Figure 6-42 Direct selection of the fixed speed setpoint

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.

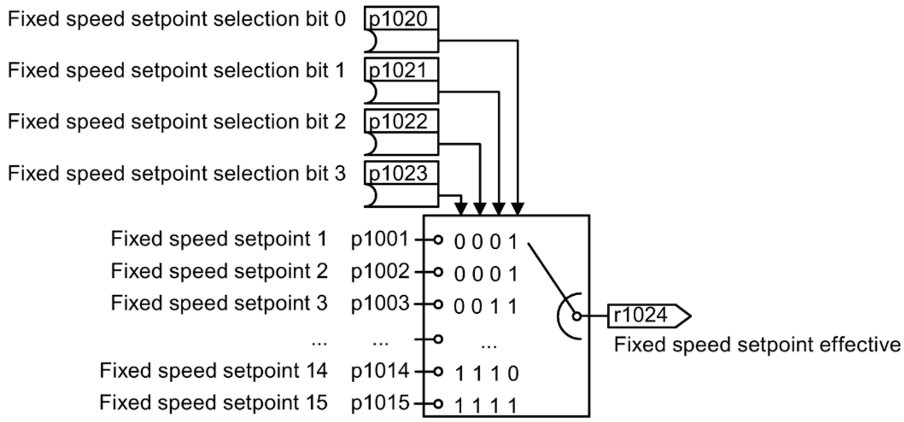


Figure 6-43 Binary selection of the fixed speed setpoint

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- 42 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- 43 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.

6.16 Setpoint calculation

6.16.1 Overview

Overview

Setpoint processing influences the setpoint using the following functions:

- "Invert" inverts the motor direction of rotation.
- The "Inhibit direction of rotation" function prevents the motor from rotating in the incorrect direction; this function can make sense for conveyor belts, extruders, pumps and fans, for example.
- The "Skip frequency bands" prevent the motor from being continuously operated within these skip bands. This function avoids mechanical resonance effects by only permitting the motor to operate briefly at specific speeds.
- The "Speed limitation" function protects the motor and the driven load against excessively high speeds.
- The "Ramp-function generator" function prevents the setpoint from suddenly changing. As a consequence, the motor accelerates and brakes with a reduced torque.

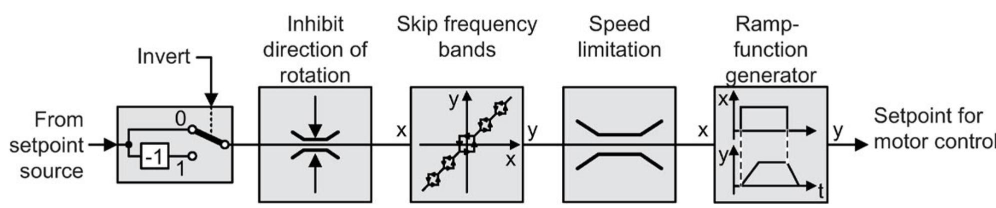
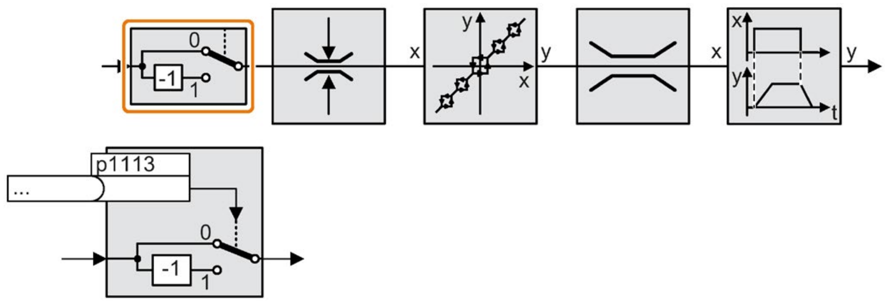


Figure 6-44 Setpoint processing in the inverter

6.16.2 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- 44 Application examples showing how a setpoint is inverted

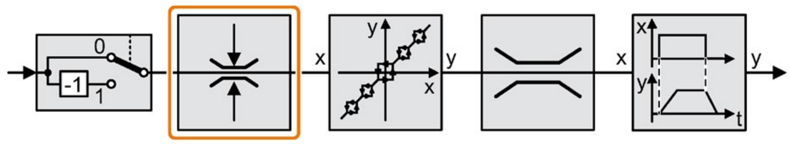
Parameter	Description
p1113 = 722.1	Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Inverter inverts the setpoint.
p1113 = 2090.11	Inverts the setpoint via the fieldbus (control word 1, bit 11).

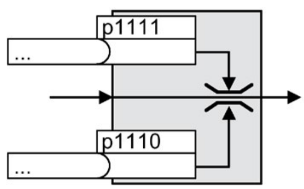
Parameter

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.

6.16.3 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- 45 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

6.16.4 Skip frequency bands and minimum speed

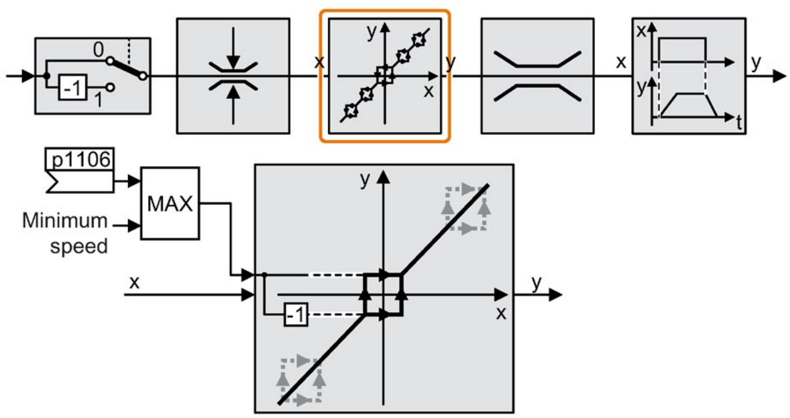
Skip frequency bands

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.

Manuals for your converter (Page 393)

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- 46 Setting the minimum speed

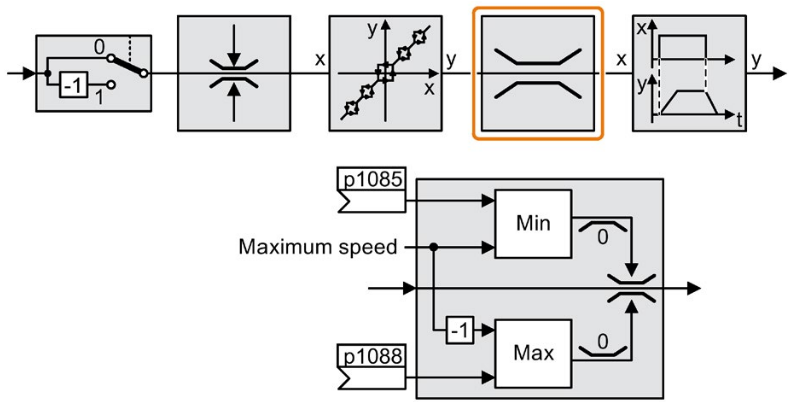
Parameter	Description
p1080	**Minimum speed** (factory setting: 0 rpm)
p1106	**CI: Minimum speed signal source** (factory setting: 0) Dynamic specification of the minimum speed

See also

Inverter factory setting (Page 106)

6.16.5 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- 47 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)

6.16.6 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

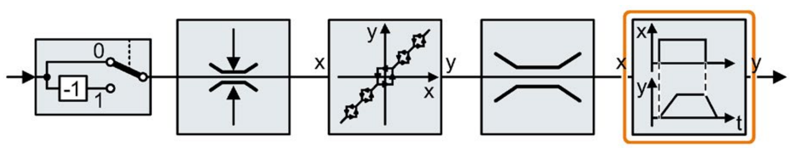
  The expanded ramp-function generator limits not only the acceleration but also the change in acceleration (jerk) by rounding the setpoint. In this case, the torque does not rise suddenly in the motor.

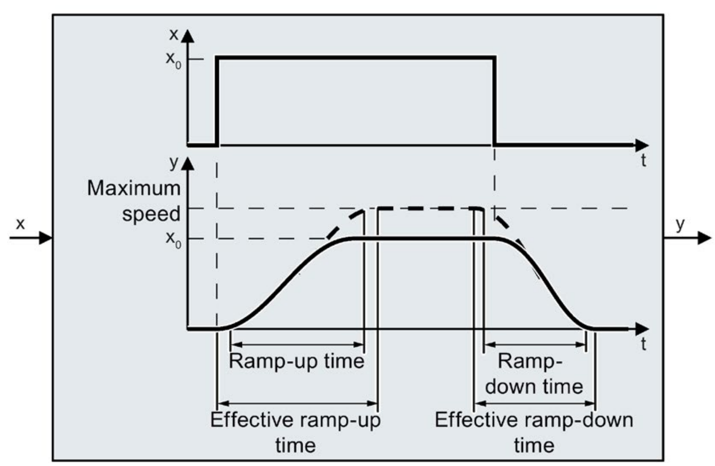
- Basic ramp-function generator

  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).



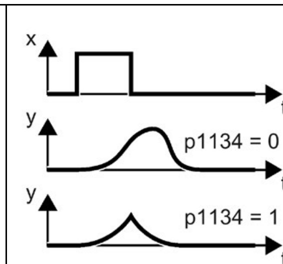


Initial and final rounding permit smooth, jerk-free acceleration and braking.

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- 48 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.

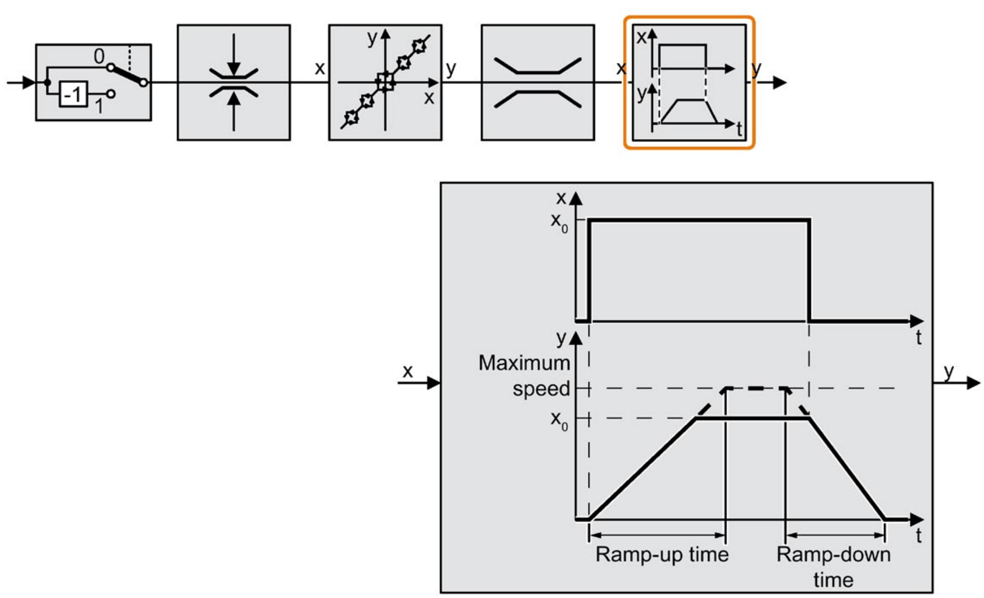
3. Evaluate your drive response.
   - If the motor accelerates too slowly, then reduce the ramp-up time.

     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- 49 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- 50 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.

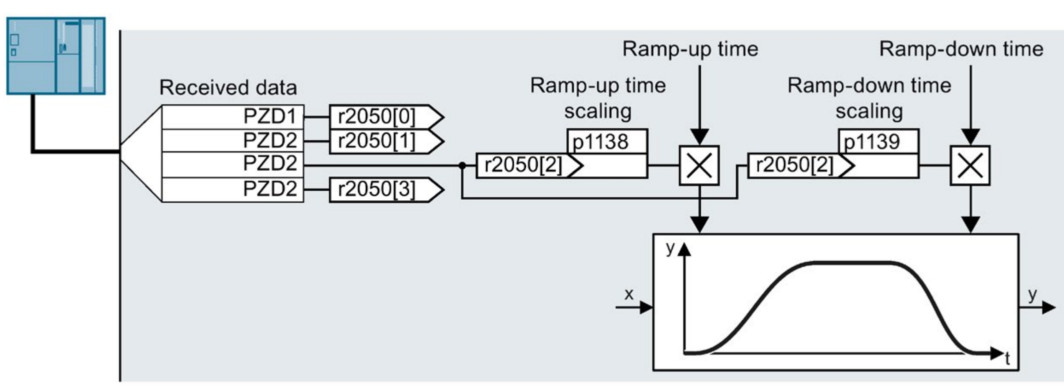


Figure 6-45 Application example for changing the ramp-function generator times in operation

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.

  Extending the telegram (Page 175)
- 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:

Function Manual (https://support.industry.siemens.com/cs/gb/en/view/60467055/29243398027)

6.17 PID technology controller

Overview

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

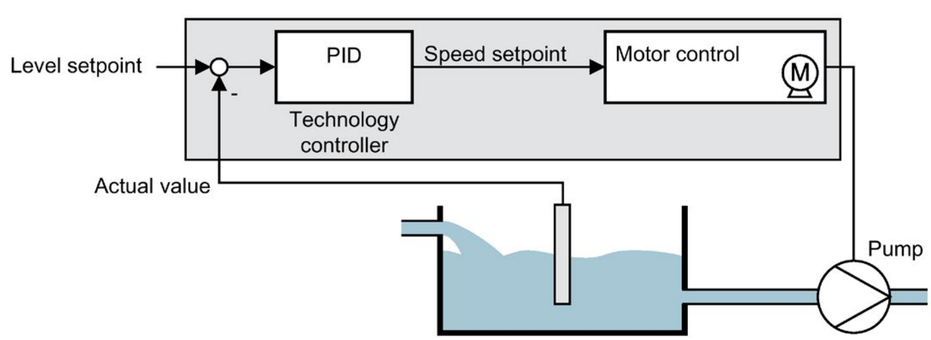


Figure 6-46 Example: Technology controller as a level controller

Precondition

Additional functions

The motor closed-loop control is set

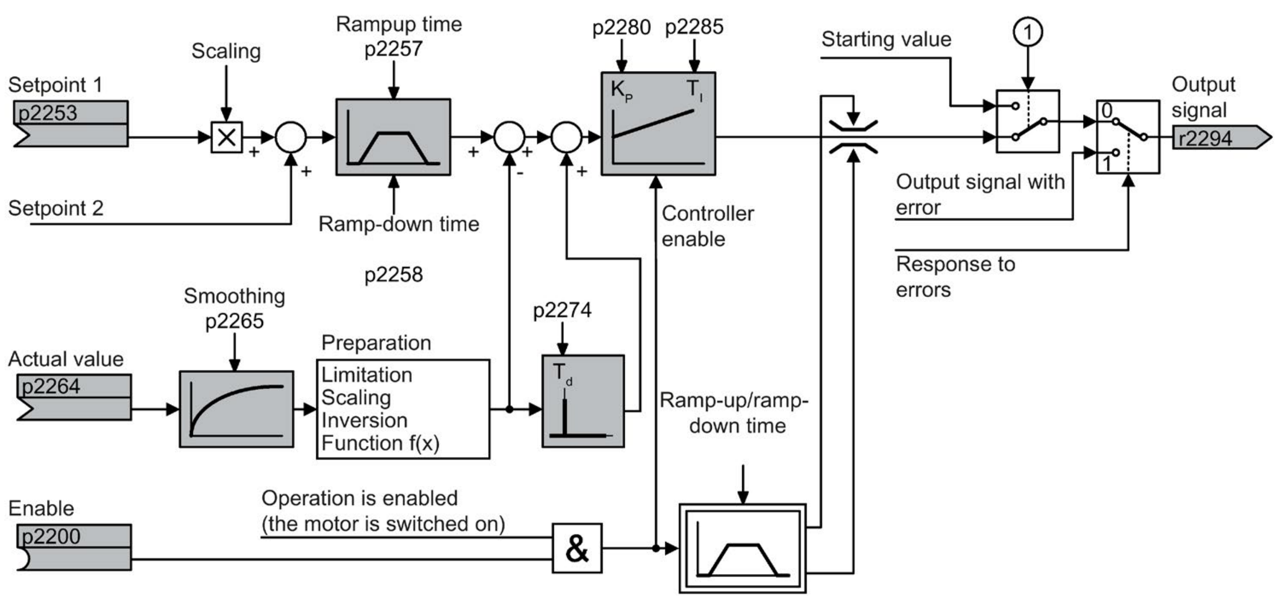
Tools

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

Function description

Function diagram

The technology controller is implemented as a PID controller (controller with proportional, integral, and derivative action).



① The inverter uses the start value when all the following conditions are simultaneously satisfied:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

Figure 6-47 Simplified representation of the technology controller

Basic settings

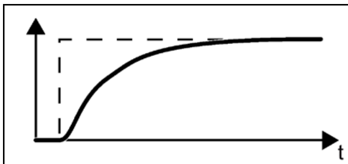
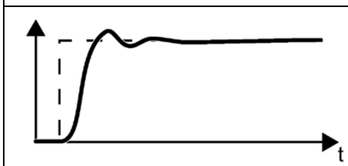
The settings required as a minimum are marked in gray in the function diagram:

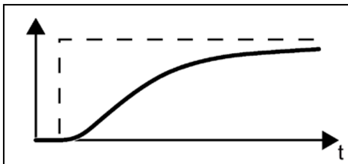
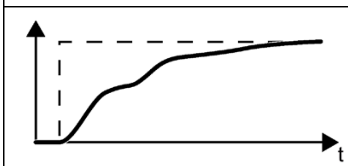
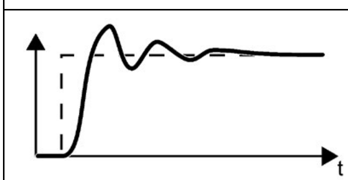
- Interconnect setpoint and actual values with signals of your choice
- Set ramp-function generator and controller parameters K_P, T_I and T_d.

Set controller parameters K_P, T_I and T_d.

Procedure

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

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

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

3. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.

You have manually set the technology controller.
❒

Limiting the output of the technology controller

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

Parameter

Table 6- 51 Basic settings

Parameter	Description	Setting
p2200	BI: Technology controller enable	1 signal: Technology controller is enabled. Factory setting: 0
r2294	CO: Technology controller output signal	To interconnect the main speed setpoint with the technology controller output, set p1070 = 2294.
p2253	CI: Technology controller setpoint 1	Setpoint for the technology controller. Example: p2253 = 2224: Fixed setpoint p2201 is interconnected with the setpoint of the technology controller. p2220 = 1: The fixed setpoint p2201 is selected. Factory setting: 0
p2264	CI: Technology controller actual value	Technology controller actual value. Factory setting: 0
p2257, p2258	Technology controller ramp-up time and ramp-down time [s]	Factory setting: 0.0 s
p2274	Technology controller differentiation time constant T_d [s]	The differentiation improves the rise time for very slow controlled variables, e.g. a temperature control. Factory setting: 0.0 s
p2280	Technology controller proportional gain K_P	Factory setting: 1.0
p2285	Technology controller integration time (integral time) T_d	Factory setting: 30 s

Table 6- 52 Limiting the output of the technology controller

Parameter	Description	Setting
p2297	CI: Technology controller maximum limiting signal source	Factory setting: 1084
p2298	CI: Technology controller minimum limiting signal source	Factory setting: 2292
p2291	CO: Technology controller maximum limiting [%]	Factory setting: 100 %
p2292	CO: Technology controller minimum limiting [%]	Factory setting: 0 %

Table 6- 53 Adapting the actual value of the technology controller

Parameter	Description	Setting
p2267	Technology controller upper limit actual value [%]	Factory setting: 100 %
p2268	Technology controller lower limit actual value [%]	Factory setting: -100 %
p2269	Technology controller gain actual value [%]	Factory setting: 100 %
p2271	Technology controller actual value inversion	Technology controller actual value inversion If the actual value decreases with increasing motor speed, then p2271 must be set = 1. 0: no inversion 1: actual value signal is inverted Factory setting: 0
p2270	Technology controller actual value function	Technology controller actual value function 0: no function 1: √ 2: x^2 3: x^3 Factory setting: 0

Further information

For additional information refer to the function diagrams 7950 ff of the List Manual.

You will find additional information on the following PID controller components in the Internet at:

- Setpoint input: Analog value or fixed setpoint
- Setpoint channel: Scaling, ramp-function generator and filter
- Actual value channel: Filter, limiting and signal processing
- PID controller Principle of operation of the D component, inhibiting the I component and the control sense
- Enable, limiting the controller output and fault response

FAQ (http://support.automation.siemens.com/WW/view/en/92556266)

6.18 Motor control

The inverter has two alternative methods to control (closed loop) the motor speed:

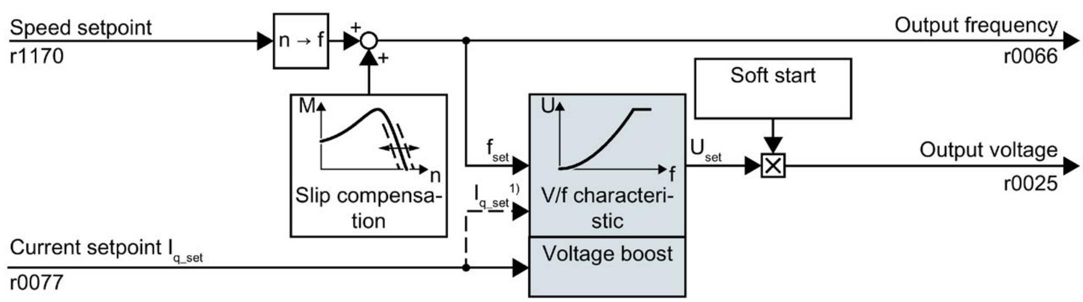
- U/f control
- Vector control

6.18.1 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 6-48 Simplified function diagram of the U/f control

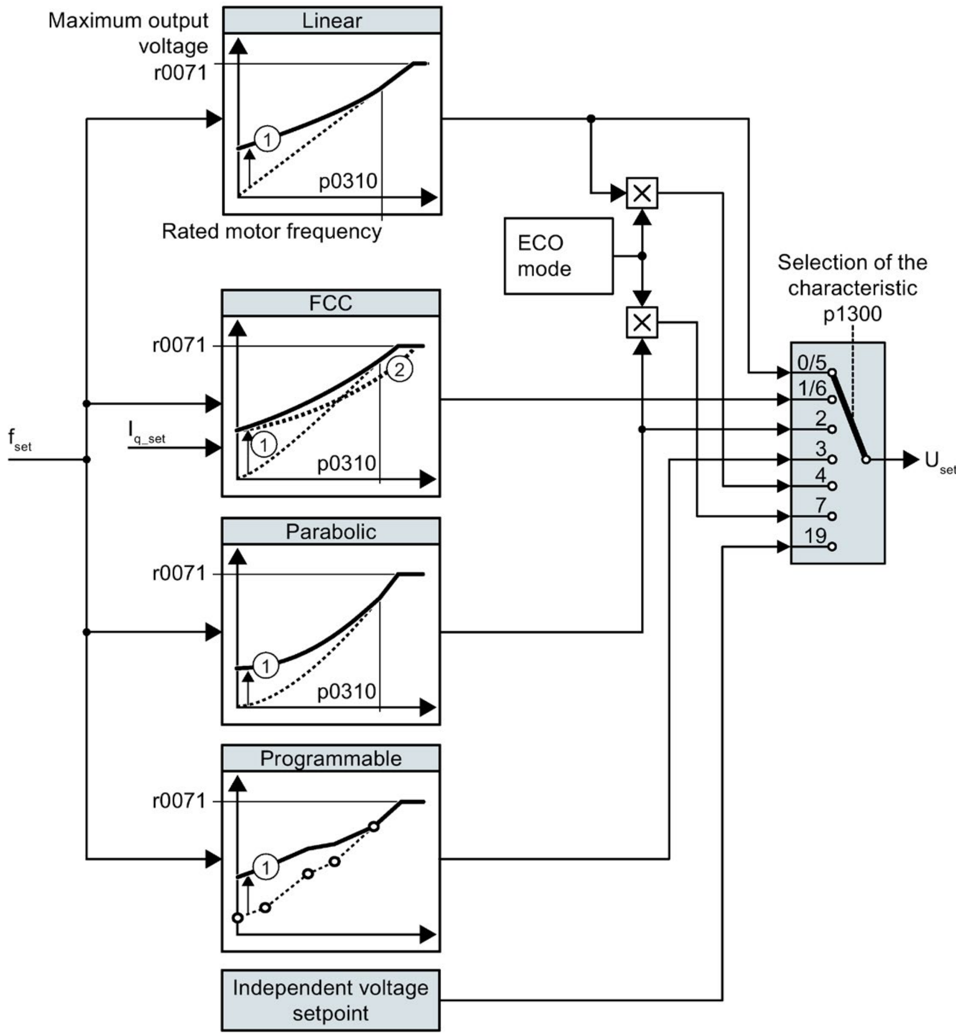
One function not shown in the simplified function diagram is the resonance damping for damping mechanical oscillations. You will find the complete function diagrams 6300 et seq. in the List Manual.

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

6.18.1.1 Characteristics of U/f control

The inverter has different V/f characteristics.



① The voltage boost of the characteristic optimizes the speed control at low speeds

② With the flux current control (FCC), the inverter compensates for the voltage drop in the stator resistor of the motor

Figure 6-49 Characteristics of V/f control

The inverter increases its output voltage to the maximum possible output voltage. The maximum possible output voltage of the inverter depends on the line voltage.

When the maximum output voltage is reached, the inverter only increases the output frequency. At this point, the motor enters the field weakening range: At constant torque, the slip decreases quadratically as the speed increases.

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

- Ratio between the inverter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible output voltage as a function of the input voltage is provided in the technical data.

Technical data (Page 361)

6.18.1.2 Selecting the U/f characteristic

Table 6- 54 Linear and parabolic 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 less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after quick commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 6- 55 Characteristics for special applications

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

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

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

6.18.1.3 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.

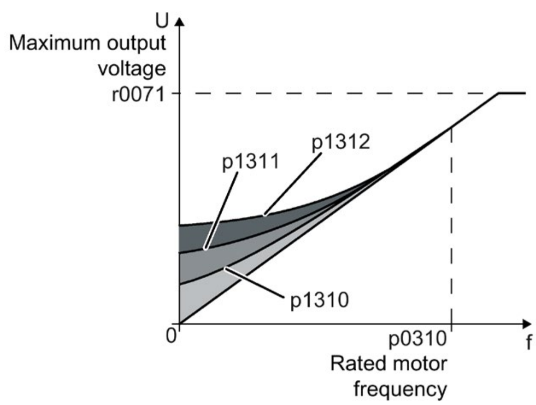


Figure 6-50 The resulting voltage boost using a linear characteristic as example

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").

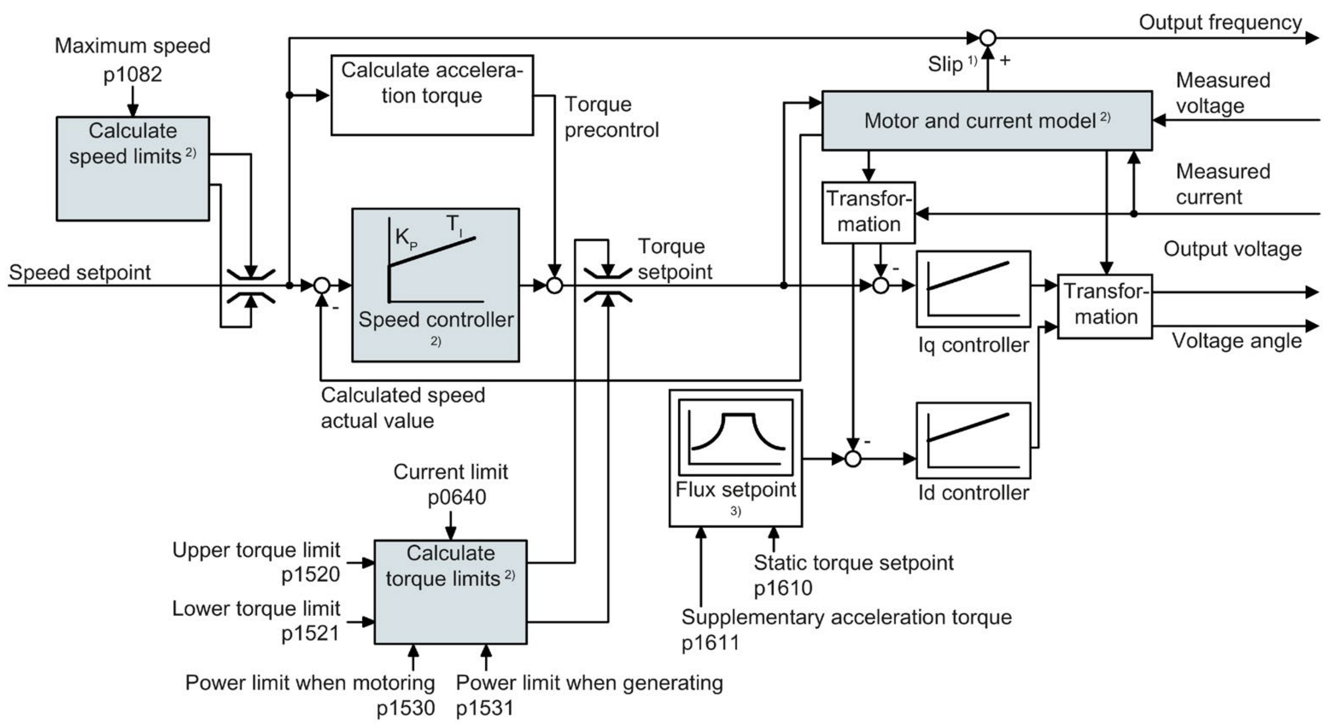
You will find more information on this function in the parameter list and in function diagram 6301 in the List Manual.

6.18.2 Sensorless vector control with speed controller

6.18.2.1 Structure of vector control without encoder (sensorless)

Overview

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



1) for induction motors

2) Settings that are required

Figure 6-51 Simplified function diagram for sensorless 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

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.

All of the function diagrams 6020 ff. for vector control are provided in the List Manual.

Manuals for your converter (Page 393)

Settings that are required

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.

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 198)
- For pulling loads, carefully comply with the recommended settings for vector control.

  Advanced settings (Page 258)

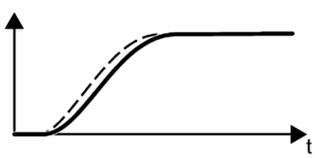
6.18.2.2 Optimizing the closed-loop speed controller

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:

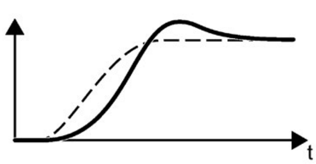


The speed setpoint (broken line) increases with the set ramp-up time and rounding.

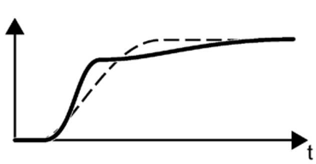
The speed actual value follows the setpoint without any over-shoot.

Control optimization required

In some cases, the self optimization result is not satisfactory, or self optimization is not possible as the motor cannot freely rotate.



Initially, the speed actual value follows the speed setpoint with some delay, and then overshoots the speed setpoint.



First, the actual speed value increases faster than the speed setpoint. Before the setpoint reaches its final value, it passes the actual value. Finally, the actual value approaches the setpoint without any significant overshoot.

In the two cases describe above, we recommend that you manually optimize the speed control.

Optimizing the speed controller

Preconditions

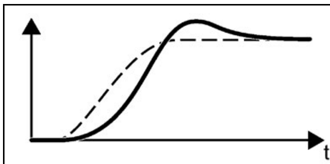
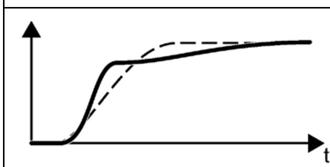
- Torque precontrol is active: p1496 = 100 %.
- The load moment of inertia is constant and independent of the speed.

- 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.

Mastering critical applications

The drive control can become unstable for drives with a high load moment of inertia and gearbox backlash or a coupling between the motor and load that can possibly oscillate. In this case, we recommend the following settings:

- Increase p1452 (smoothing the speed actual value).
- Increase p1472 (integral time T_I): $T_I \geq 4 \cdot$ p1452
- If, after these measures, the speed controller does not operate with an adequate dynamic performance, then increase p1470 (gain K_P) step-by-step.

The most important parameters

Table 6- 56 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 %.
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)

6.18.2.3 Advanced settings

K_P- and $T_I$adaptation

K_p and T_I adaptation suppress speed control oscillations that may occur. The "rotating measurement" of the motor data identification optimizes the speed controller. If you have performed the rotating measurement, then the K_p- and $T_n$adaptation has been set.

You can find additional information in the List Manual:

- Vector control with speed controller: Function diagram 6050
- Vector control after presetting the application class Dynamic Drive Control Function diagram 6824

Droop

For mechanically coupled drives, there is the risk that the drives oppose one another: Small deviations in the speed setpoint or actual value of the coupled drives can mean that the drives are operated with significantly different torques.

The droop function ensures even torque distribution between several mechanically coupled drives.

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

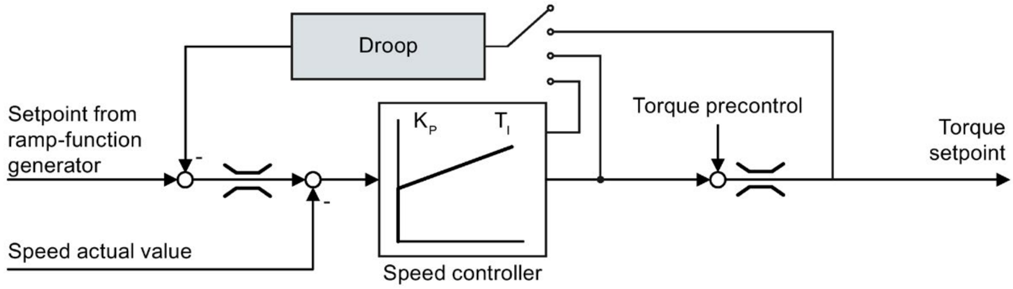


Figure 6-52 Effect of droop in the speed controller

When droop is active, the ramp-function generators of all of the coupled drives must be set to have identical ramp-up and ramp-down times as well as rounding-off.

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)

After selecting application class "Dynamic Drive Control", droop is no longer possible.

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

Par.	Explanation
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).

6.18.2.4 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.

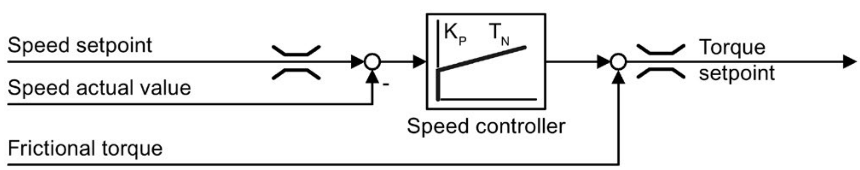


Figure 6-53 Precontrol of the speed controller with frictional torque

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

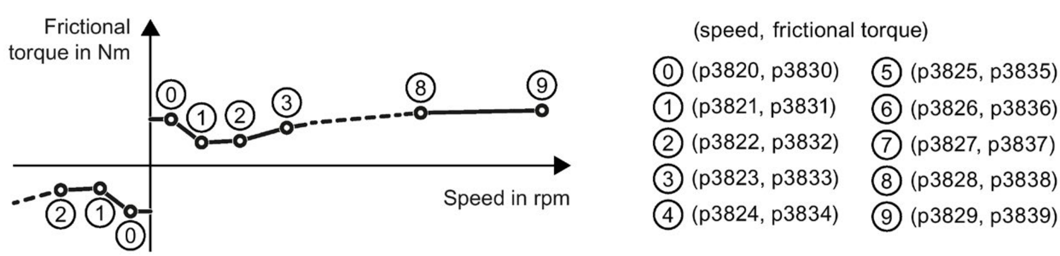


Figure 6-54 Friction characteristic

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	

Parameter	Explanation
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.

6.18.2.5 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).

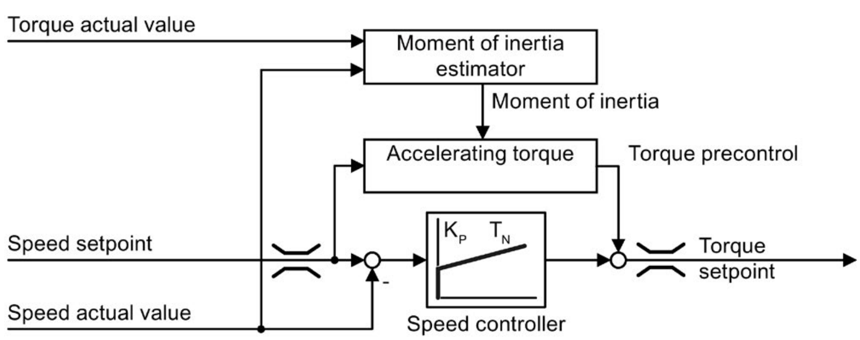


Figure 6-55 Influence of the moment of inertia estimator on the speed control

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

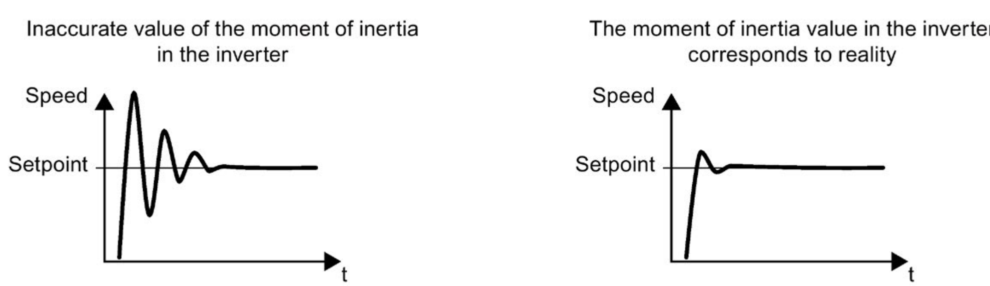


Figure 6-56 Influence of the moment of inertia on the speed

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.

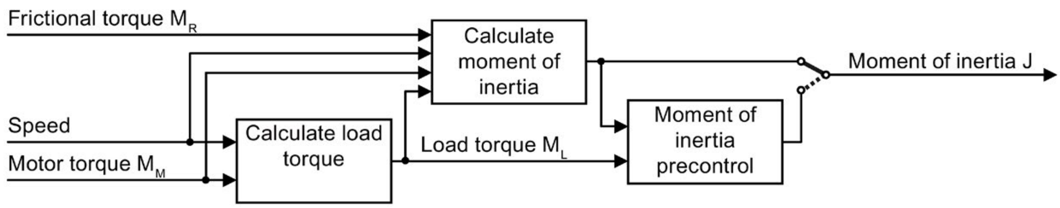


Figure 6-57 Overview of the function of the moment of inertia estimator

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

Friction characteristic (Page 260)

How does the inverter calculate the load torque?

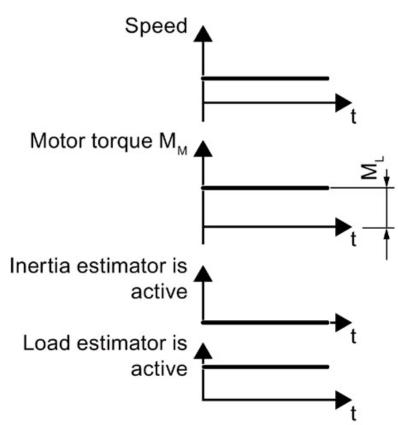


Figure 6-58 Calculating the load torque

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

How does the inverter calculate the moment of inertia?

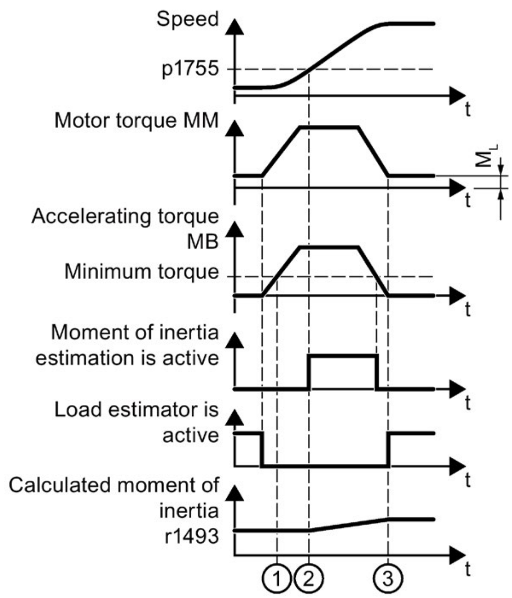


Figure 6-59 Calculating the moment of inertia

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 $1/s^2$ (≙ 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.

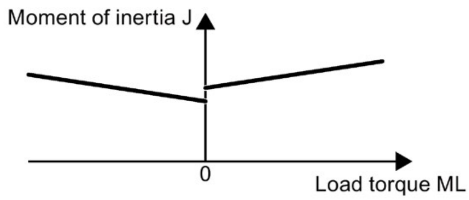


Figure 6-60 Moment of inertia precontrol

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

<table>
<tr><th>Parameter</th><th colspan="3">Explanation</th></tr>
<tr><td>r0333</td><td colspan="3">Rated motor torque [Nm]</td></tr>
<tr><td>p0341</td><td colspan="3">Motor moment of inertia (factory setting: 0 kgm²)
The inverter sets the parameter when selecting a listed motor. The parameter is then write-protected.</td></tr>
<tr><td>p0342</td><td colspan="3">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</td></tr>
<tr><td rowspan="6">p1400</td><td colspan="3">Speed control configuration</td></tr>
<tr><td>.18</td><td colspan="2">1 signal: Moment of inertia estimator active</td></tr>
<tr><td>.20</td><td colspan="2">1 signal: Acceleration model on</td></tr>
<tr><td rowspan="2">.22</td><td>1 signal</td><td>Moment of inertia estimator retain value when motor switched off</td></tr>
<tr><td>0 signal</td><td>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.</td></tr>
<tr><td>.24</td><td>1 signal</td><td>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.</td></tr>
<tr><td rowspan="5">r1407</td><td colspan="3">Status word, speed controller</td></tr>
<tr><td>.24</td><td colspan="2">1 signal: Moment of inertia estimator is active</td></tr>
<tr><td>.25</td><td colspan="2">1 signal: Load estimator is active</td></tr>
<tr><td>.26</td><td colspan="2">1 signal: Moment of inertia estimator is engaged</td></tr>
<tr><td>.27</td><td colspan="2">1 signal: Shortened moment of inertia estimation is active.</td></tr>
<tr><td>r1493</td><td colspan="3">Total moment of inertia, scaled
r1493 = p0341 × p0342 × p1496</td></tr>
<tr><td>p1496</td><td colspan="3">Acceleration precontrol scaling (factory setting: 0 %)
According to rotating measurement of the motor data identification is p1496 = 100%.</td></tr>
<tr><td>p1498</td><td colspan="3">Load moment of inertia (factory setting: 0 kgm²)</td></tr>
<tr><td rowspan="3">p1502</td><td colspan="3">Freeze moment of inertia estimator (factory setting: 0)
If the load torque changes when accelerating the motor, set this signal to 0.</td></tr>
<tr><td colspan="2">0 signal</td><td>Moment of inertia estimator is active</td></tr>
<tr><td colspan="2">1 signal</td><td>Determined moment of inertia is frozen</td></tr>
</table>

Parameter	Explanation
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

<table>
<tr><th>Parameter</th><th colspan="4">Explanation</th></tr>
<tr><td>p1226</td><td colspan="4">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.</td></tr>
<tr><td>p1560</td><td colspan="4">Moment of inertia estimator accelerating torque threshold value (factory setting: 10%)</td></tr>
<tr><td>p1561</td><td colspan="3">Moment of inertia estimator change time inertia (factory setting: 500 ms)</td><td rowspan="2">The lower that p1561 or p1562 is, the shorter the moment of inertia estimator measurements.
The larger p1561 or p1562 is, the more accurate the results provided by the moment of inertia estimator.</td></tr>
<tr><td>p1562</td><td colspan="3">Moment of inertia estimator change time load (factory setting: 10 ms)</td></tr>
<tr><td>p1563</td><td colspan="4">Moment of inertia estimator load torque positive direction of rotation (factory setting: 0 Nm)</td></tr>
<tr><td>p1564</td><td colspan="4">Moment of inertia estimator load torque negative direction of rotation (factory setting: 0 Nm)</td></tr>
<tr><td rowspan="7">p5310</td><td colspan="4">Moment of inertia precontrol configuration (factory setting: 0000 bin)</td></tr>
<tr><td>.00</td><td colspan="3">1 signal: Activates calculation of the characteristic (p5312 … p5315)</td></tr>
<tr><td>.01</td><td colspan="3">1 signal: Activates moment of inertia precontrol</td></tr>
<tr><td rowspan="4"></td><td>p5310.00 = 0, p5310.01 = 0</td><td colspan="2">Deactivating moment of inertia precontrol</td></tr>
<tr><td>p5310.00 = 1, p5310.01 = 0</td><td colspan="2">Adapting the moment of inertia precontrol</td></tr>
<tr><td>p5310.00 = 0, p5310.01 = 1</td><td colspan="2">Activating the moment of inertia precontrol.
The characteristic of the moment of inertia precontrol remains unchanged.</td></tr>
<tr><td>p5310.00 = 1, p5310.01 = 1</td><td colspan="2">Activating the moment of inertia precontrol. The inverter adapts the characteristic in parallel.</td></tr>
<tr><td rowspan="7">r5311</td><td colspan="4">Moment of inertia precontrol status word</td></tr>
<tr><td>.00</td><td colspan="3">1 signal: New measuring points for the characteristic of the moment of inertia precontrol are available</td></tr>
<tr><td>.01</td><td colspan="3">1 signal: New parameters are been calculated</td></tr>
<tr><td>.02</td><td colspan="3">1 signal: Moment of inertia precontrol active</td></tr>
<tr><td>.03</td><td colspan="3">1 signal: The characteristic in the positive direction of rotation has been calculated and is ready</td></tr>
<tr><td>.04</td><td colspan="3">1 signal: The characteristic in the negative direction of rotation has been calculated and is ready</td></tr>
<tr><td>.05</td><td colspan="3">1 signal: The inverter writes actual results to the parameter</td></tr>
</table>

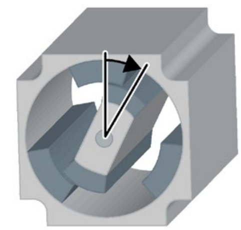
Parameter	Explanation	
p5312	**Moment of inertia precontrol linear positive** (factory setting: 0 1/s²)	In a positive direction of rotation: Moment of inertia = p5312 × load torque + p5313
p5313	**Moment of inertia precontrol constant positive** (factory setting: 0 kgm²)	
p5314	**Moment of inertia precontrol linear negative** (factory setting: 0 1/s²)	In a negative direction of rotation: Moment of inertia = p5314 × load torque + p5315
p5315	**Moment of inertia precontrol constant negative** (factory setting: 0 kgm²)	

6.18.2.6 Pole position identification

The pole position of a synchronous motor

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

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



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

Pole position identification

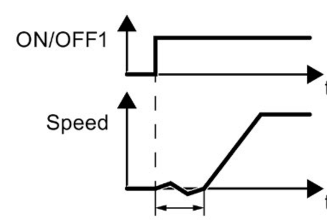
The inverter must measure the pole position for motors not equipped with an encoder, or for encoders, which do not supply the information regarding the pole position.

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

Motor without an encoder

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

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



Identifying the pole position using a measurement

6.18.3 Torque control

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

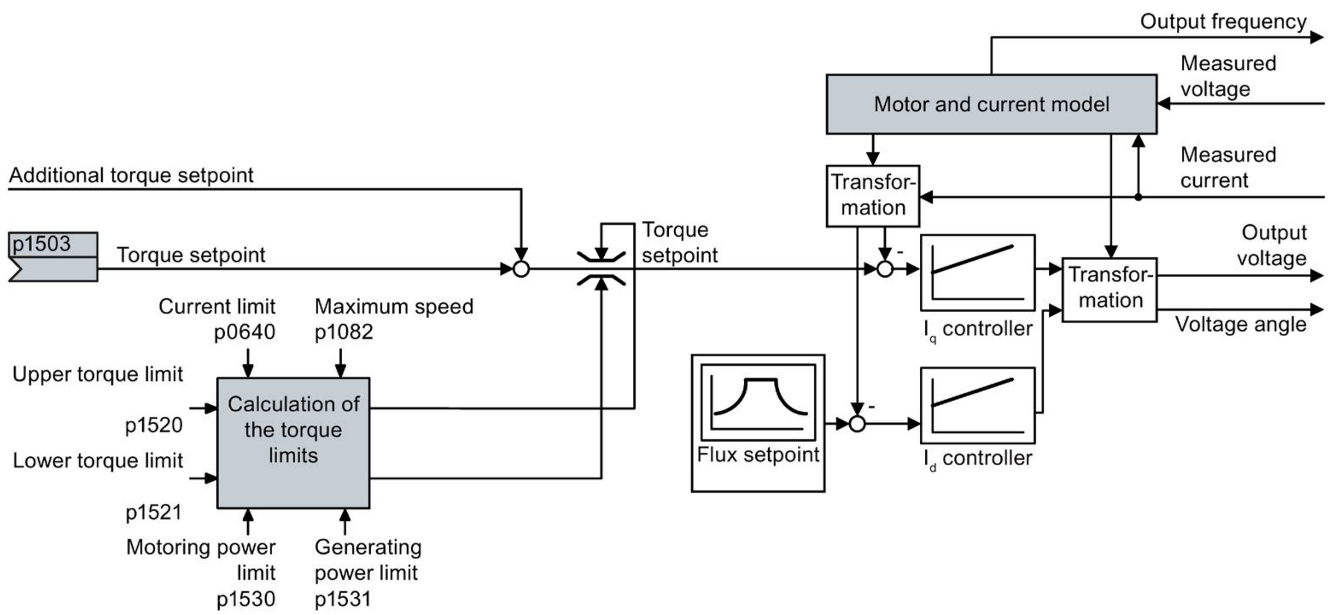


Figure 6-61 Simplified function diagram of the closed-loop torque control

Typical applications for torque control

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

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

The most important settings

Prerequisites for the correct functioning of the torque control:

- You have set the motor data correctly during the quick commissioning

  Quick commissioning (Page 109)
- You have performed a motor data identification on the cold motor

Parameter	Description
p1300	**Control mode:** 22: Torque control without speed encoder
p0300 … p0360	**Motor data** is transferred from the motor type plate during quick commissioning and calculated with the motor data identification
p1511	**Additional torque**
p1520	**Upper torque limit**
p1521	**Lower torque limit**
p1530	**Motoring power limit**
p1531	**Regenerative power limit**

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

6.19 Electrically braking the motor

A differentiation is made between mechanically braking and electrically braking a motor:

- Mechanical brakes are generally motor holding brakes that are closed when the motor is at a standstill. Mechanical operating brakes, that are closed while the motor is rotating are subject to a high wear and are therefore often only used as an emergency brake.
  If your motor is equipped with a motor holding brake, then you should use the inverter functions to control this motor holding brake, see Section Motor holding brake (Page 198).
- The motor is electrically braked by the inverter. An electrical braking is completely wear-free. Generally, a motor is switched off at standstill in order to save energy and so that the motor temperature is not unnecessarily increased.

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.

6.19.1 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

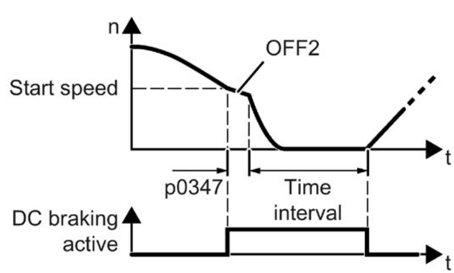
NOTICE
Motor overheating as a result of DC braking
The motor will overheat if you use DC braking too frequently or use it for too long. This may damage the motor. • Monitor the motor temperature. • Allow the motor to adequately cool down between braking operations. • If necessary, select another motor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



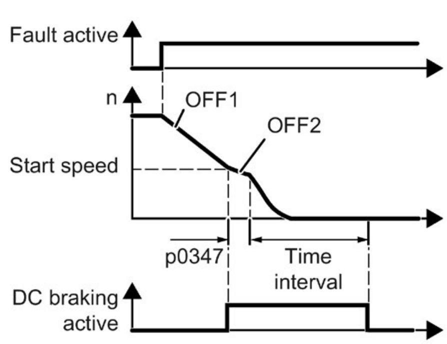
Requirement:

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



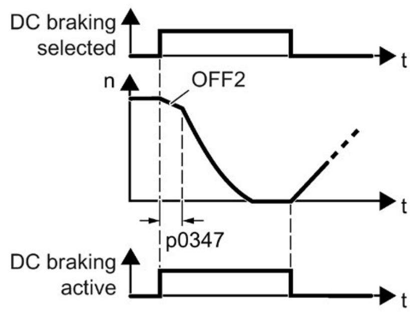
Requirement:

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:

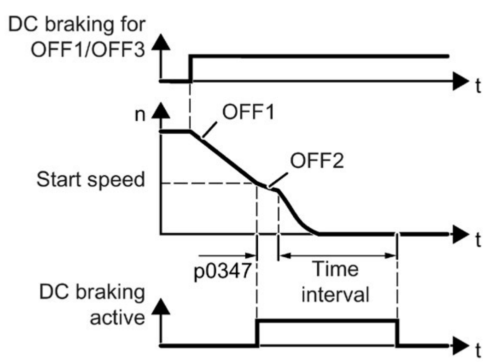
p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)

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)

Parameter	Description	
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- 57 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.	

DC braking voltages

The line supply voltage available to the Inverter determines the amount of rectified brake voltage available for DC braking function. Listed in the following table are examples of the correlation between the input AC voltage to the available DC voltage for the DC braking function.

Line voltage	380 V AC	400 V AC	440 V AC	480 V AC	500 V AC
Rectified brake voltage	171 V DC	180 V DC	198 V DC	216 V DC	225 V DC

The following formula can be use a guide to the rectified brake voltage that is available from the line voltage:

Line voltage x 0.45 = Brake coil voltage

For example: 400 V AC x 0.45 = 180 V DC.

6.19.2 Dynamic braking

Typical applications for dynamic braking require continuous braking and acceleration operations or frequent changes of the motor direction of rotation:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

Principle of operation

The DC link voltage increases as soon as the motor supplies regenerative power to the inverter when braking. The regenerative power means that the DC link voltage in the inverter increases. Depending on the DC link voltage, the inverter outputs the regenerative power to the braking resistor through the braking chopper. The braking resistor converts the regenerative power into heat, therefore preventing DC link voltages > Vdc_max.

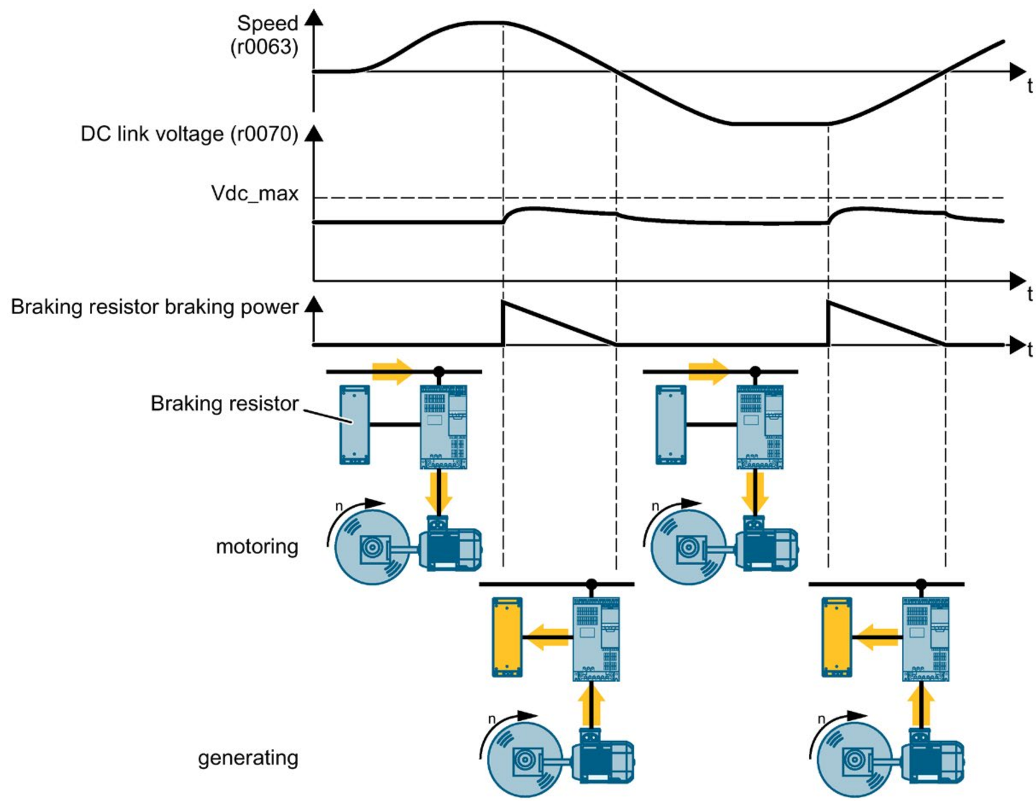
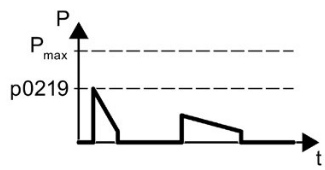


Figure 6-62 Simplified representation of dynamic braking with respect to time

Set dynamic braking

Parameter	Description
p0219	**Braking power of the braking resistor** (factory setting: 0 kW) For p0219 > 0, the inverter deactivates the VDC_max controller. For vector control, p0219 defines the regenerative power limit p1531.  Using p0219, you define the maximum braking power that the braking resistor must absorb. Table 3-3 SINAMICS G110M Options (Page 31) For an excessively low braking power, the inverter extends the motor ramp-down time. The SIZER PC tool supports you when calculating the braking power. Configuring support (Page 394)

An application example for configuring a drive with braking resistor is provided in the Internet:

Engineering and commissioning series lifting equipment/cranes (https://support.industry.siemens.com/cs/de/en/view/103156155)

6.20 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- 58 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.

6.21 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.

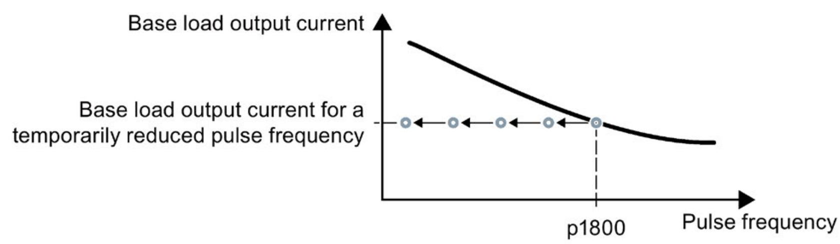
   

   Figure 6-63 Derating characteristic and base load output current for overload

   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.

6.22 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.

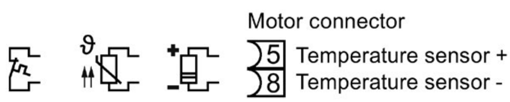
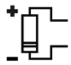


Figure 6-64 Connect the motor's temperature sensor to the Power Module

KTY84 sensor

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



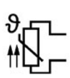
Using a KTY sensor, the inverter monitors the motor temperature and the sensor itself for wire-break or short-circuit:

- 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 changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.

Temperature switch

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

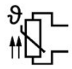
PTC sensor



The inverter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The inverter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the inverter shuts down with fault F07016.

Pt1000 sensor



Using a Pt1000 sensor, the inverter monitors the motor temperature and the sensor itself for wire breakage and/or short-circuit:

- Temperature monitoring:
  Using a Pt1000 sensor, the inverter evaluates the motor temperature in the range from - 48 °C ... +248 °C.
  You set the temperature for the alarm and fault thresholds using parameters p0604 and p0605.
  - 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 changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 603 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.

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 using KTY84/Pt1000.
p0605	**Mot_temp_mod 1/2 / sensor threshold and temperature value** (factory setting: 145° C) For monitoring the motor temperature using KTY84/Pt1000.
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 the current limit.

Parameter	Description	
	2, 12:	Alarm A07910 and fault F07011 The inverter does not reduce the current limit.
p0640	**Current limit** [A]	

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

6.23 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.

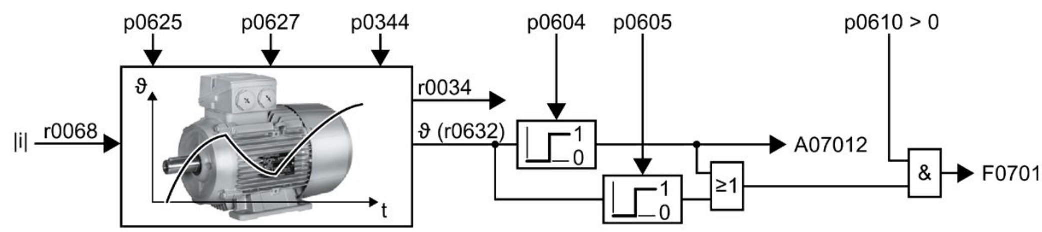


Figure 6-65 Thermal motor model 2 for induction motors

Table 6- 59 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.

6.24 Motor and inverter protection by limiting the voltage

What causes an excessively high voltage?

To drive the load, an electric motor converts electrical energy into mechanical energy. If the motor is driven by its load, e.g. due to the load moment of inertia when braking, then the energy flow reverses: The motor temporarily operates as generator, and converts mechanical energy into electrical energy. The electrical energy flows from the motor to the inverter. If the inverter cannot output the electrical energy supplied by the motor, e.g. to a braking resistor, then the inverter stores the energy in its DC link capacitance. As a consequence, the DC link voltage Vdc in the inverter is higher.

An excessively high DC link voltage damages the inverter and also the motor. As a consequence, the inverter monitors its DC link voltage - and when necessary switches off the motor and outputs fault "DC link overvoltage".

Protecting the motor and inverter against overvoltage

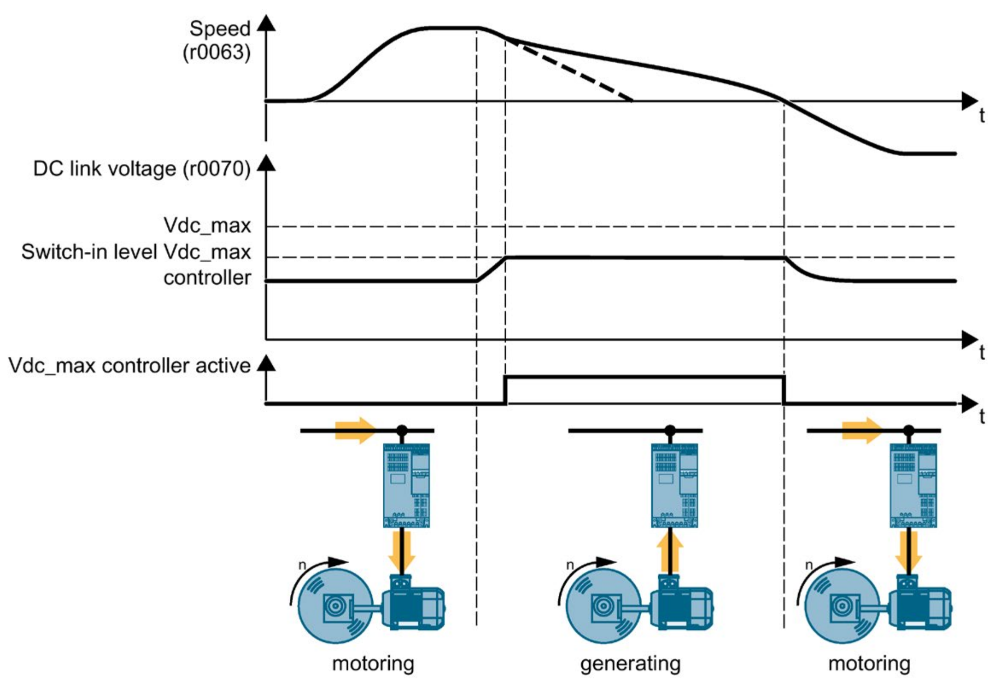


Figure 6-66 Simplified representation of the Vdc_max control

The Vdc_max control extends the motor ramp-down time when braking. The motor then only feeds so much energy into the inverter to cover the losses in the inverter. The DC link voltage remains in the permissible range.

The Vdc_max control is not suitable for applications where the motor is in continuous regenerative operation, e.g. as is the case for cranes and centrifuges.

Electrically braking the motor (Page 271)

Parameter for Vdc_max control

The parameters differ depending on the motor control mode.

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**VDC controller configuration**(factory setting: 1) 1: VDC controller is enabled
r1282	r1242	**Vdc_max control switch-on level** DC-link voltage value above which the Vdc_max control is activated
p1283	p1243	**Vdc_max control dynamic factor** (factory setting: 100 %) Scaling closed-loop control parameters p1290, p1291 and p1292
p1294	p1254	**Vdc_max control automatic ON level sensing**(factory setting, dependent on the Power Module) 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the switch-in thresholds of the Vdc_max control. Set this parameter to the actual value of the input voltage.

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

Manuals for your converter (Page 393)

6.25 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.

6.25.1 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

6.25.2 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.

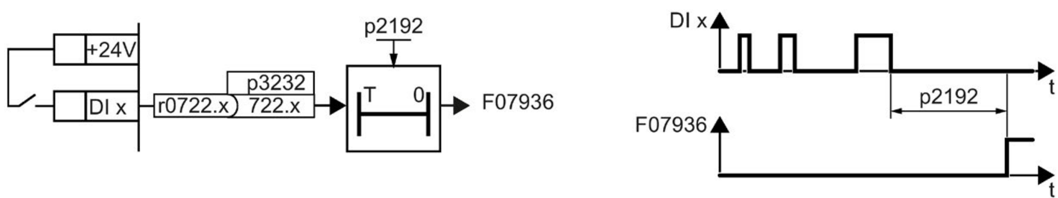
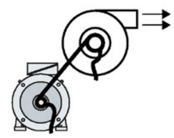


Figure 6-67 Function plan and time response of the speed monitoring

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

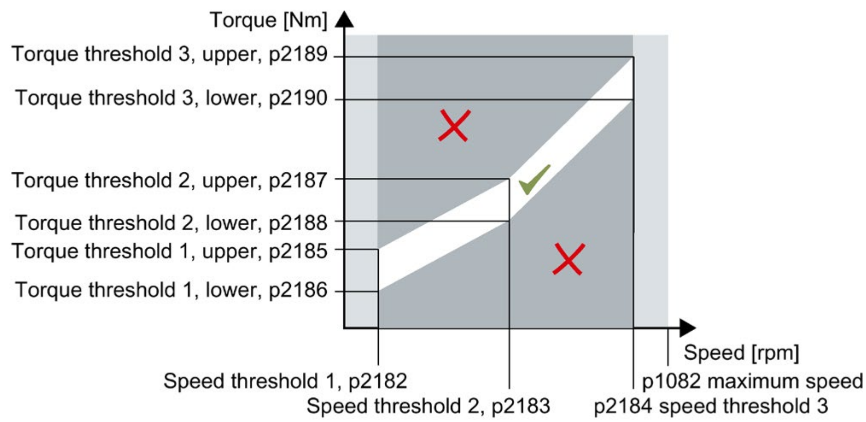
For more information, see the List Manual (the parameter list and function diagram 8013).

6.25.3 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.

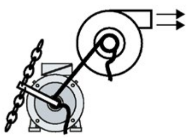
The inverter monitors the torque based on the envelope curve depending on the speed against a lower and upper torque.



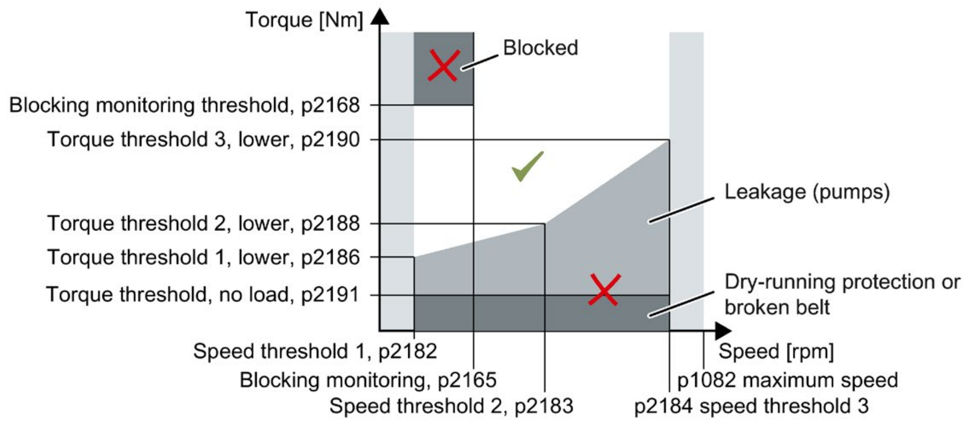
If the torque lies in the impermissible range longer than time p2192, the inverter reacts as specified in p2181.

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	



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.



If the torque and speed lie in the impermissible range longer than time p2192, the inverter reacts as specified in p2181.

For applications with pumps (p2193 = 4), the inverter detects the following states of the driven load:

- Blocked
- Leakage
- Dry running

For applications with fans or compressors (p2193 = 5), the inverter detects the following states of the driven load:

- Blocked
- Torn belt

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

When using the control mode "U/f control" (p1300 < 10), the "Blocking protection" function becomes active when the current limit is reached.

No-load monitoring (Page 288)

Parameter	Description	
p2165	**Load monitoring blocking monitoring threshold, upper**	
p2168	**Load monitoring blocking monitoring torque threshold**	
p2181	**Load monitoring response**	
	7:	A07891: Load monitoring, pump/fan blocked A07892: Load monitoring, pump/fan without load A07893: Load monitoring, pump leakage
	8:	F07894: Load monitoring, pump/fan blocked F07895: Load monitoring, pump/fan without load F07896: Load monitoring, pump leakage

Parameter	Description	
p2182	**Load monitoring speed threshold 1** • When using the control mode "U/f control" (p1300 < 10): p2182 > 10% of the rated speed • When using the control mode "encoderless vector control" (p1300 = 20): p2182 > p1755 (switchover speed, motor model)	The inverter interpolates linearly between characteristic points.
p2183	**Load monitoring speed threshold 2**	
p2184	**Load monitoring speed threshold 3**	
p2186	**Load monitoring torque threshold 1, lower**	
p2188	**Load monitoring torque threshold 2, lower**	
p2190	**Load monitoring torque threshold 3, lower**	
p2191	**Load monitoring torque threshold, no load**	
p2192	**Load monitoring delay time** When using the control mode "encoderless vector control" (p1300 = 20): • For operation with an induction motor: Set p2192 < 1 s or p1750.6 = 1 (the closed-loop control does not change to open-loop controlled mode for blocked motor) • For operation with synchronous and reluctance motors, the inverter sometimes cannot detect a blocked motor.	
p2193 = 4 or 5	**Load monitoring configuration** (factory setting: 1) 4: Pump monitoring: Differentiation between leakage and dry running 5: Fan monitoring: p2191 has no effect	

See also

Rotation monitoring (Page 290)

6.26 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

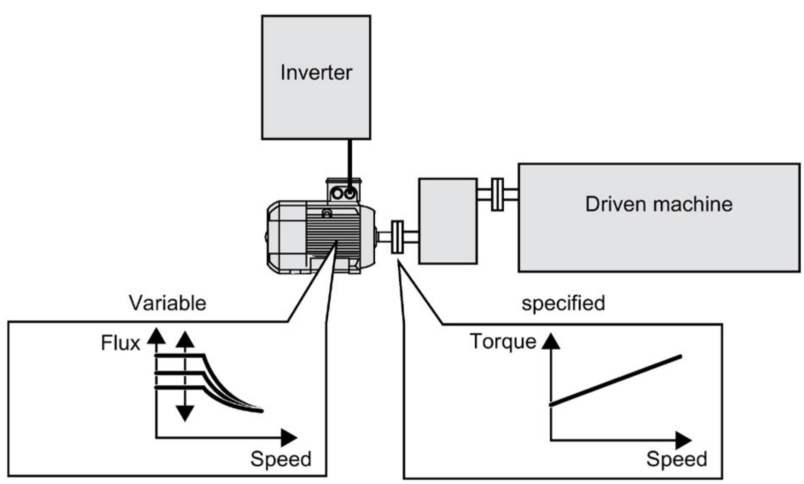


Figure 6-68 Efficiency optimization by changing the motor flux

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.

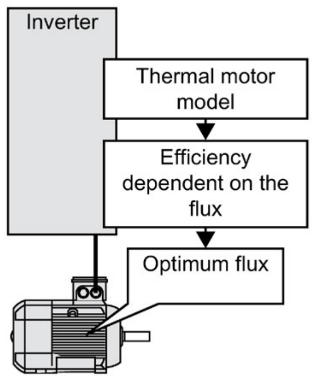
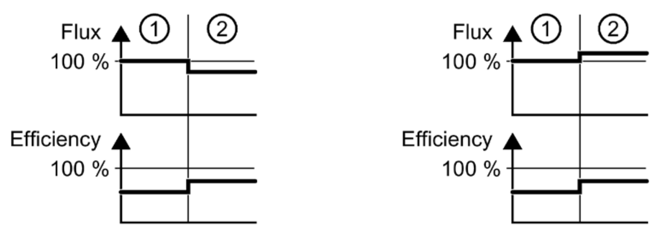


Figure 6-69 Determining the optimum flux from the motor thermal model

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.



① Efficiency optimization is not active
② Efficiency optimization is active

Figure 6-70 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

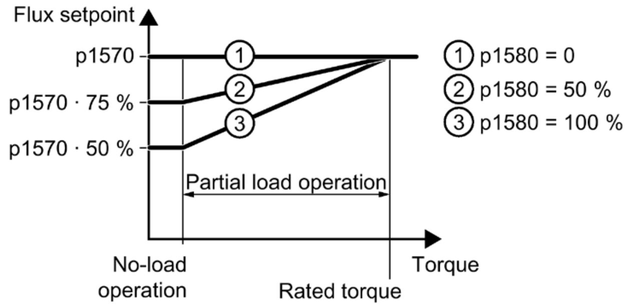


Figure 6-71 Reduce the flux setpoint in the partial load range of the motor

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.

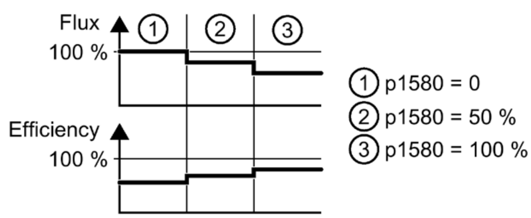


Figure 6-72 Qualitative result of efficiency optimization, method 1

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- 60 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- 61 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.

6.27 Calculating the energy saving for fluid flow machines

Fluid flow machines, which mechnically control the flow rate using valves or throttle flaps, operate with a constant speed corresponding to the line frequency.

Figure 6-73 Flow control with pump and throttle connected to a 50 Hz line supply

The lower the flow rate, the poorer the efficiency of the fluid flow machine (pump). The fluid flow machine (pump) has the poorest efficiency when the throttle or valve is completely closed. Further, undesirable effects can occur, for example the formation of vapor bubbles in liquids (cavitation) or the temperature of the medium being pumped can increase.

The inverter controls the flow rate by appropriately varying the speed of the fluid flow machine. As a consequence, the fluid flow machine has the optimum efficiency for each flow rate, and draws less electric power in the partial load range than for closed-loop control concepts based on valves and throttle flaps.

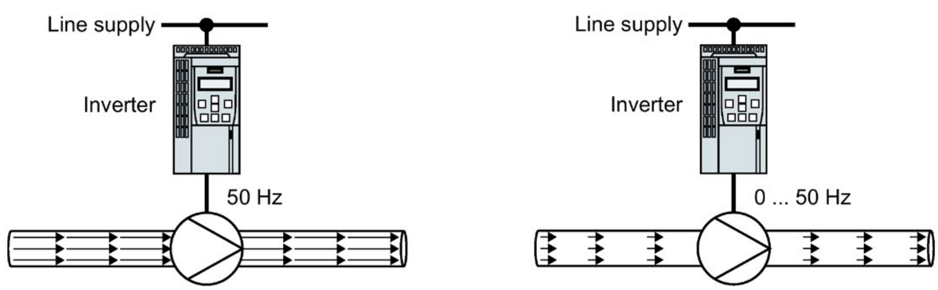
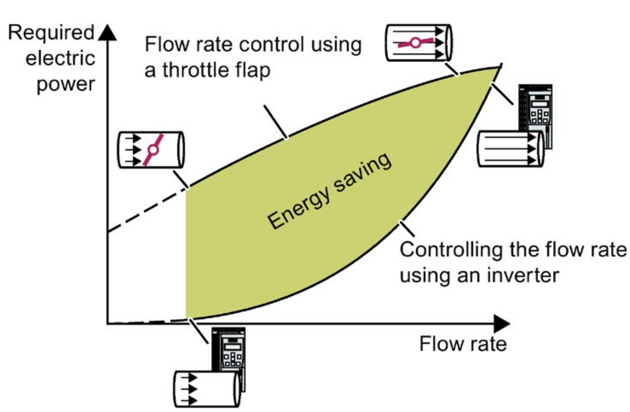


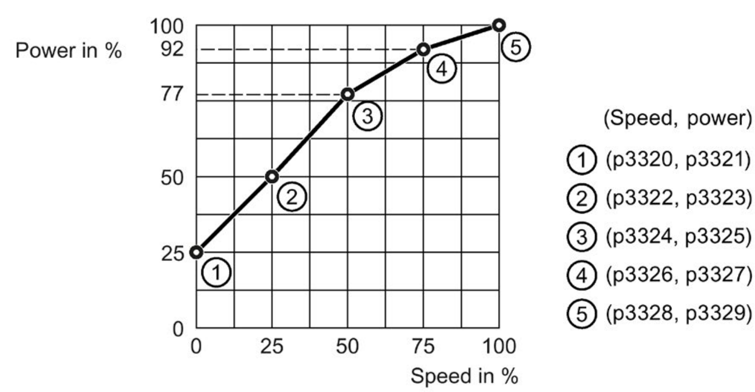
Figure 6-74 Flow control with pump and inverter

Function



The inverter calculates the energy saving from the flow characteristic associated with a mechanical flow control and the measured electric power that is drawn.

The calculation is suitable for centrifugal pumps, fans, radial and axial compressors, for instance.

Parameter	Description	
r0039	**Energy display** [kWh]	
	[0]	**Energy balance** Energy usage since the last reset
	[1]	Energy drawn since the last reset
	[2]	Energy fed back since the last reset
p0040	**Reset energy consumption display** A signal change 0 → 1 sets r0039[0…2] = 0, r0041 = 0 and r0042 = 0.	
r0041	**Energy consumption saved** (kWh) Energy saved referred to 100 operating hours. For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.	
r0042	**CO: Process energy display** [1 ≙ 1 Wh] For display as process variable. Enable with p0043.	
	[0]	**Energy balance** Energy consumption since the last reset.
	[1]	Energy drawn since the last reset
	[2]	Energy fed back since the last reset.
p0043	**BI: Enable energy usage display** 1 signal: Process energy display is active in r0042.	
p3320 … p3329	**Flow characteristic**  Factory setting of the flow characteristic To set the characteristic, you require the following data from the machine manufacturer for each speed interpolation point: • The flow rate of the fluid-flow machine associated with the 5 selected inverter speeds • The power drawn at constant speed associated with the five flow rates corresponds to the line frequency and mechanical throttling of the flow rate.	

6.28 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.

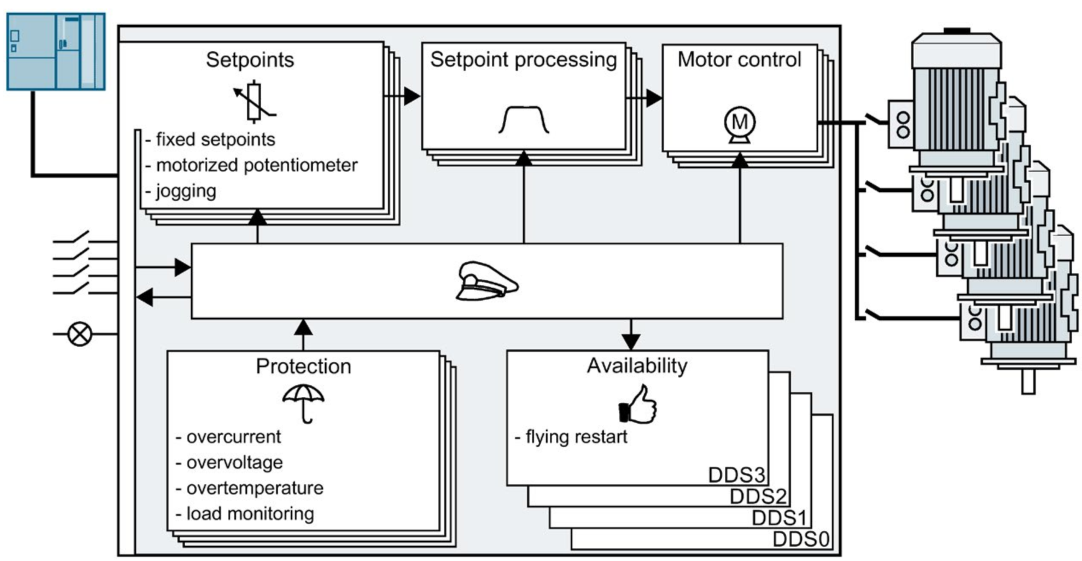


Figure 6-75 Switching over between different settings using drive data sets (DDS)

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

Table 6- 62 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- 63 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- 64 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).

Data backup 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.

Manuals for your converter (Page 393)

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 Backing up and transferring settings using 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.

See also

Commissioning tools (Page 102)

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. The converter then automatically ensures that the actual parameter settings are saved both in the converter as well as on the card.

The memory card reader is located on the underside of the Power Module. It is necessary to insert the card before Power Module is fitted securely to the Terminal Housing. Once fitted, the memory card cannot be removed without removing the Power Module from the Terminal Housing.

The following describes how you can save the Inverter parameter settings on the memory card.

Automatic upload

The inverter power supply has been switched off.

1. Insert an empty memory card into the card reader of the Power Module.
2. Fit the Power Module to the Terminal Housing - 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.
3. Connect the external 24 V supply to the External Interface Module (EIM).

After the Control Unit has been powered-up, the Inverter copies all modified parameters to the memory card.

Note

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

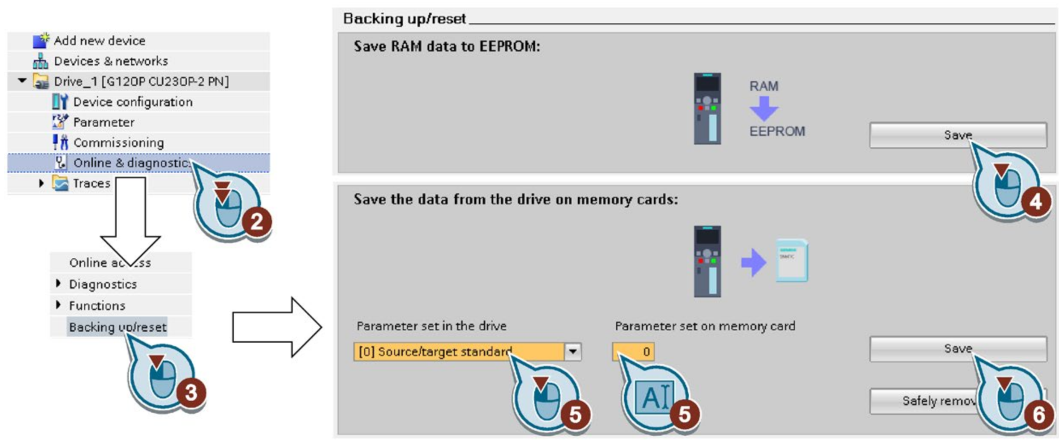
Manual upload

To manually upload the parameter settings, you will need to transfer the data to the memory card as follows:

1. Disconnect the mains supply and the 24 V external supply.
2. Wait 5 minutes to ensure that any residual power in the system as dissipated.
3. Ensure the application under the control of the converter is in a safe state.
4. Remove the Power Module from the Terminal Housing.
5. Insert the memory card into the memory card reader.

6. Fit the Power Module to the Terminal Housing - 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.
7. Reconnect the mains supply and the external 24 V supply to the system.

Procedure with Startdrive



1. Go online.
2. Select "Online & diagnostics".
3. Select "Backing up/reset".
4. Back up the settings to the EEPROM of the inverter.
5. Select the settings as shown in the diagram.
6. Start data transfer
7. Wait until Startdrive reports that data backup has been completed.

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

7.1.3 Transferring the settings from the memory card

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

Automatic download

To automatically upload the parameter settings, you will need to transfer the data from the memory card as follows:

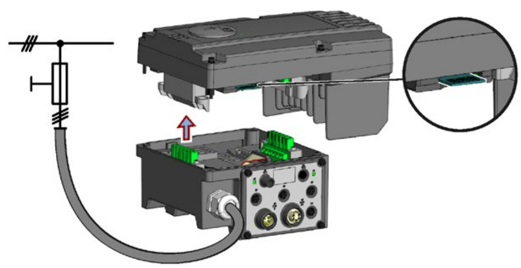
1. All mains supply and the 24 V external supply.
2. Wait 5 minutes to ensure that any residual power in the system as dissipated.
3. Ensure the application under the control of the converter is in a safe state.

4. Remove the Power Module from the Terminal Housing.
5. Insert the memory card, containing the parameter set data into the memory card reader.
6. Fit the Power Module to the Terminal Housing - 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.
7. Reconnect the mains supply and the external 24 V supply to the system.
8. On power-up the converter will automatically read the default parameter set data into the converters memory.

Manual data transfer

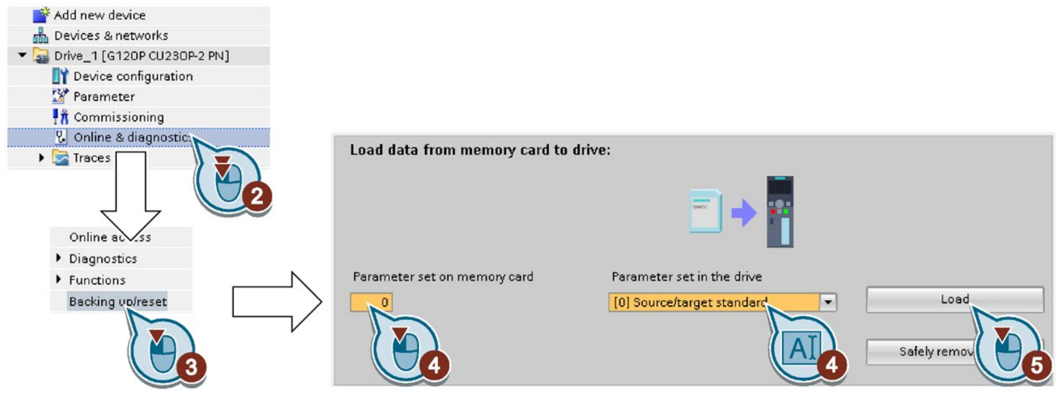
Procedure

1. All mains supply and the 24 V external supply.
2. Wait 5 minutes to ensure that any residual power in the system as dissipated.
3. Ensure the application under the control of the converter is in a safe state.
4. Remove the Power Module from the Terminal Housing.



5. Insert a blank formatted memory card into the memory card reader.
6. Fit the Power Module to the Terminal Housing - 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.
7. Reconnect the mains supply and the external 24 V supply to the system.
8. Follow the procedure outlined below to transfer the converters parameters to the memory card, using Startdrive.

Procedure with Startdrive



1. Go online.
2. Select "Online & diagnostics".
3. Select "Backing up/reset".
4. Select the settings as shown in the diagram.
5. Start data transfer
6. Wait until Startdrive has signaled that the data transfer has been completed.
7. Go offline.
8. Switch off the inverter power supply.
9. Wait until all LEDs on the inverter are dark.
10. Switch on the inverter power supply again.

    Your settings become effective after switching on.

You have transferred your settings from a memory card to the inverter.
❒

7.1.4 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

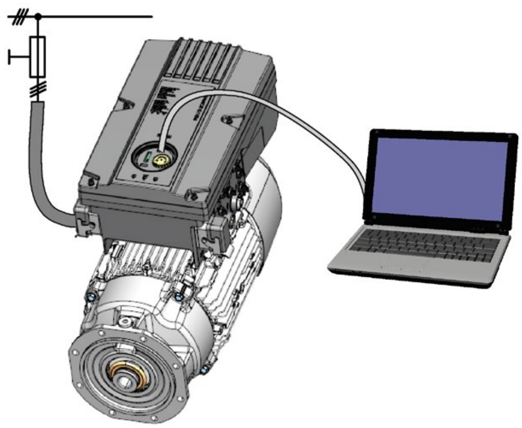
Message A01101 for a memory card that is not inserted is deactivated.
❒

Parameter

Parameter	Explanation	
p2118[0 … 19]	**Change message type message number** (factory setting: 0)	
p2119[0 … 19]	**Change message type** (factory setting: 0) 1: Fault 2: Alarm 3: No message	
r9401	**Safely remove memory card status**	
	.00	1 signal: Memory card inserted
	.01	1 signal: Memory card activated
	.02	1 signal: SIEMENS memory card
	.03	1 signal: Memory card used as USB data storage medium from the PC

7.2 Saving the settings to a PC

You can transfer the inverter settings to a PG/PC, or vice versa, the data from a PG/PC to the inverter.



Requirements

- The inverter power supply has been switched on.
- You to have installed the Startdrive commissioning tool on your PG/PC.
- PC and inverter are connected with one another via a USB cable or the fieldbus.

See also

Quick commissioning with a PC (Page 126)

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

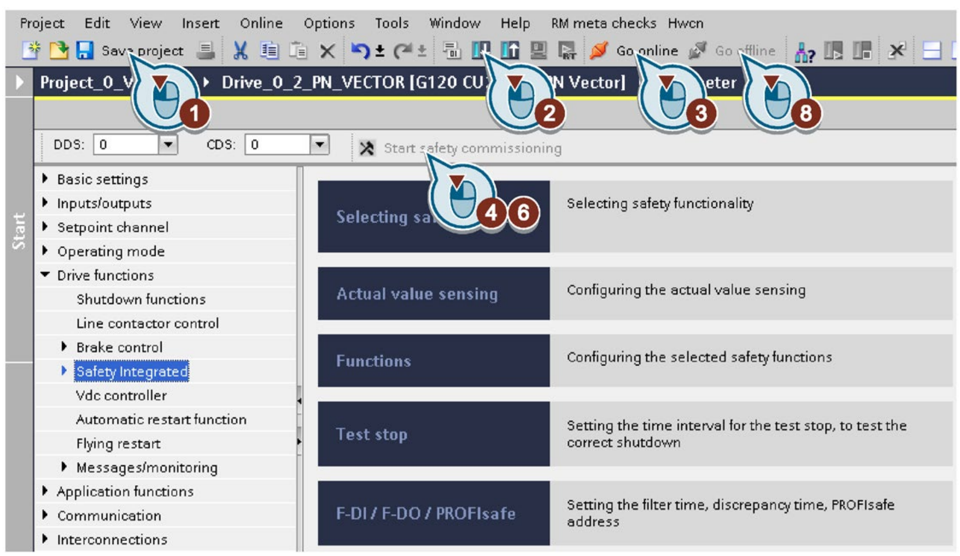
The procedure depends on whether you also transfer settings of safety functions or not.

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 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).

7.4 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.

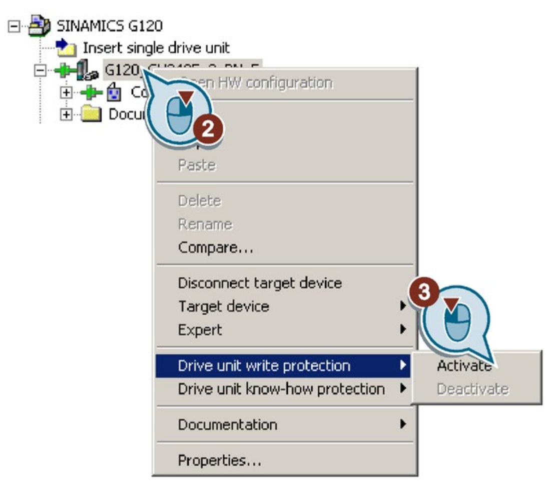
Write protection is applicable for all user interfaces:

- 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".

7.5 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.

<table>
<tr><th>Combination of know-how protection and copy protection</th><th colspan="2">Is a memory card necessary?</th></tr>
<tr><td>Know-how protection without copy protection</td><td colspan="2">The inverter can be operated with or without memory card.</td></tr>
<tr><td>Know-how protection with basic copy protection</td><td rowspan="2"></td><td rowspan="2">The inverter can only be operated with a SIEMENS memory card
Replacing a Control Module with active know-how protection (Page 347)</td></tr>
<tr><td>Know-how protection with extended copy protection</td></tr>
</table>

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 317)

2. Activate the know-how protection.

   Know-how protection (Page 318)

7.5.1 Extending the exception list for know-how protection

In the factory setting, the exception list only includes the password for know-how protection.

Before activating know-how protection, you can additionally enter the adjustable parameters in the exception list, which must still be able to be read and changed by end users – even if know-how protection has been activated.

You do not need to change the exception list, if, with exception of the password, you do not require additional adjustable parameters in the exception list.

Absolute know-how protection

If you remove password p7766 from the exception list, it is no longer possible to enter or change the password for know-how protection.

You must reset the 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

7.5.2 Activating and deactivating know-how protection

Activating know-how protection

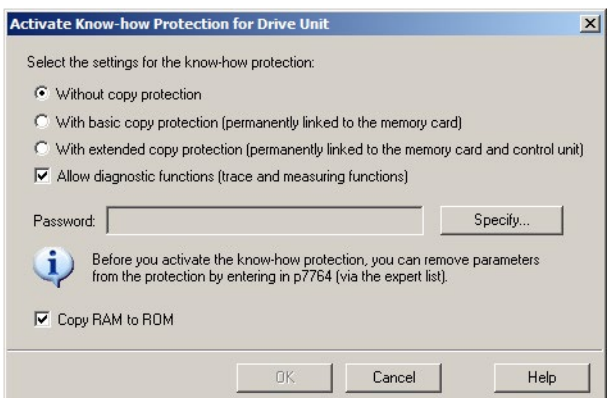
Preconditions

- 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 313)
Commissioning tools (Page 102)

Alarms, faults and system messages

8

8.1 Status LED overview

LED status indicators

The Power Module 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

The location of the various LEDs on the Power Module and Communications and Power Interface are shown in the figure below. The Power Interface is attached to the terminal housing.

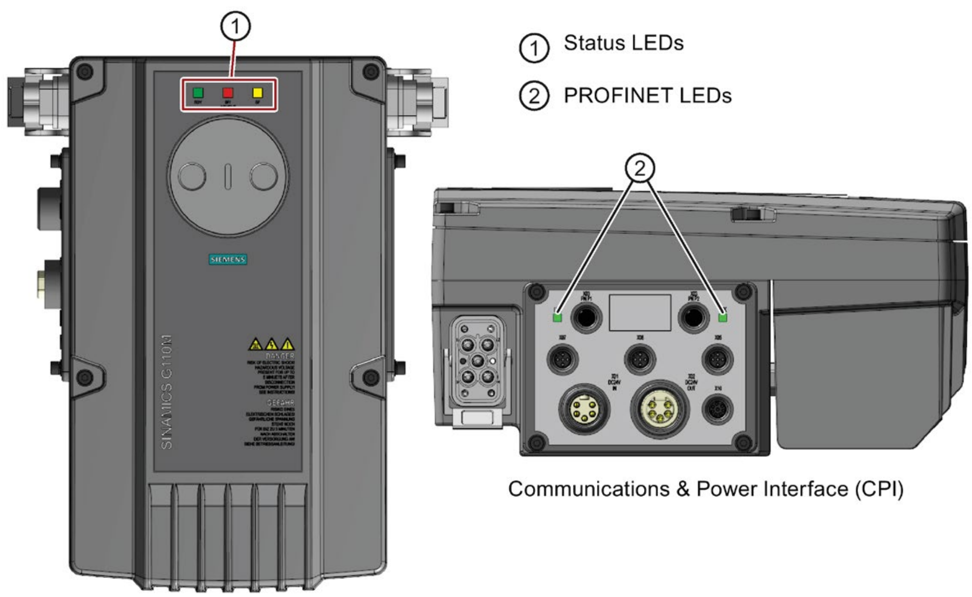
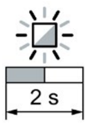
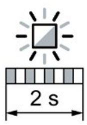
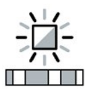


Figure 8-1 Status LED locations

8.2 Operating states indicated on LEDs

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

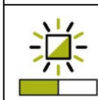
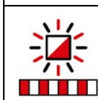
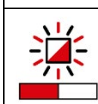
RDY	Explanation
	Temporary state after the supply voltage is switched on.
	The inverter is free of faults
	Commissioning or reset to factory settings
	A fault is active
	Firmware update is active
	Inverter waits until the power supply is switched off and switched on again after a firmware update

Table 8- 3 Integrated safety functions

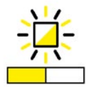
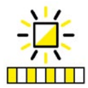
SAFE	Explanation
	One or more safety functions are enabled, but not active.
	One or more safety functions are active and error-free.
	The inverter has detected a safety function fault and initiated a stop response.

Table 8- 4 PROFINET fieldbus

LNK	Explanation
	Communication via PROFINET is error-free
	Device naming is active
	No communication via PROFINET

Table 8- 5 PROFINET and PROFIBUS fieldbuses

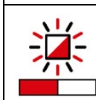
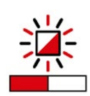
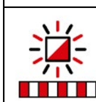
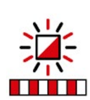
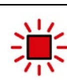
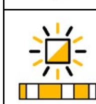
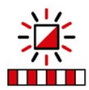
BF	Explanation	
	Data exchange between the inverter and control system is active	
	Fieldbus interface is not being used	
	The fieldbus is improperly configured.	
	RDY 	In conjunction with a synchronously flashing LED RDY: Inverter waits until the power supply is switched off and switched on again after 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	

Table 8- 6 Fieldbus AS-i

AS-i / FLT	Explanation
	System OK
	AS-i master not connected
	No communications between processors within the converter
	Slave address 0
	Converter trip

8.3 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.

8.4 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 inverted transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7, STARTER or TIA-Portal.

I&M0

Designation	Format	Example for the content	Valid for PROFINET	Valid for PROFIBUS
Manufacturer-specific	u8[10]	00 … 00 hex	---	✓
MANUFACTURER_ID	u16	42d hex (=Siemens)	✓	✓
ORDER_ID	Visible String [20]	„6SL3246-0BA22-1FA0“	✓	✓
SERIAL_NUMBER	Visible String [16]	„T-R32015957“	✓	✓
HARDWARE_REVISION	u16	0001 hex	✓	✓
SOFTWARE_REVISION	char, u8[3]	„V“ 04.70.19	✓	✓
REVISION_COUNTER	u16	0000 hex	✓	✓
PROFILE_ID	u16	3A00 hex	✓	✓
PROFILE_SPECIFIC_TYPE	u16	0000 hex	✓	✓
IM_VERSION	u8[2]	01.02	✓	✓
IM_SUPPORTED	bit[16]	001E hex	✓	✓

8.5 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 326)

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

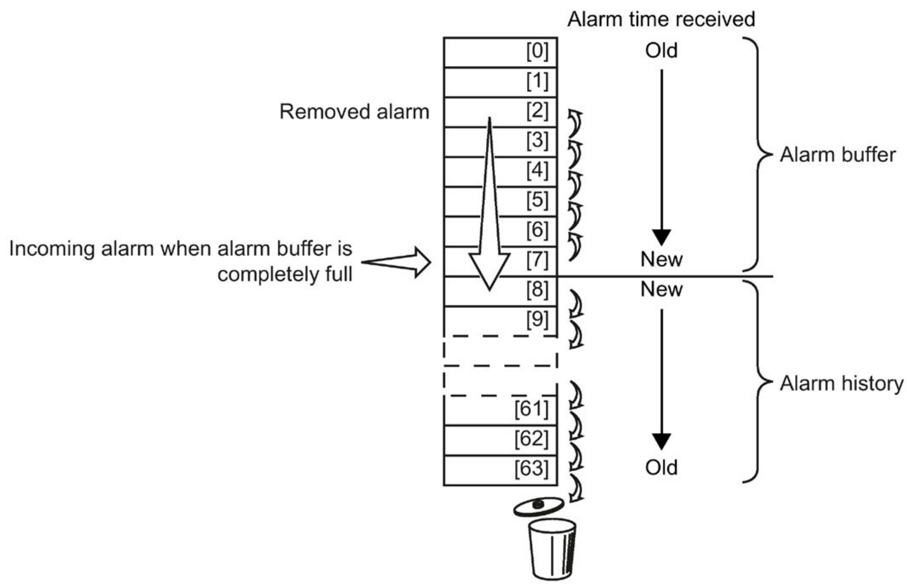


Figure 8-3 Shifting removed alarms into the alarm history

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.

8.6 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 326)

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

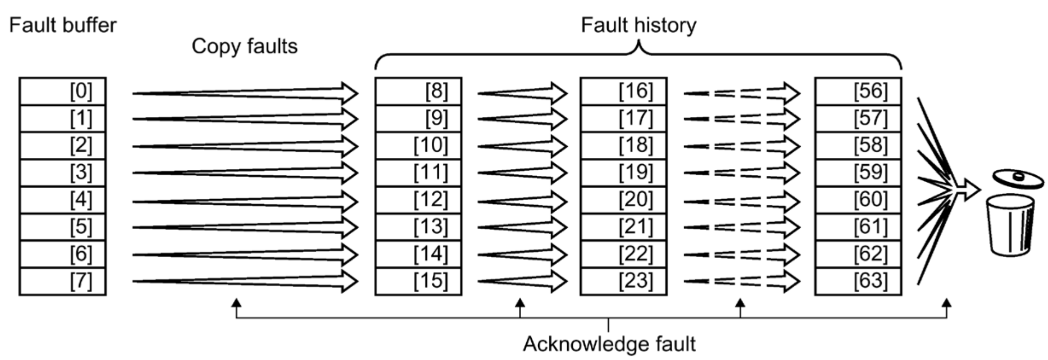


Figure 8-5 Fault history after acknowledging the faults

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.

8.7 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 8- 7 The most important alarms and faults

Number	Cause	Remedy	
F01000	Software fault in CU	Replace CU.	
F01001	Floating Point Exception	Switch CU off and on again.	
F01015	Software fault in CU	Upgrade firmware or contact technical support.	
F01018	Power-up aborted more than once	1. Switch the module off and on again. 2. After this fault has been output, the module is booted with the factory settings. 3. Recommission the converter.	
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (article number, MLFB) Check the module parameters and recommission if necessary.	
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).	
F01034	Unit switchover: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).	
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.	
F01044	Loading of memory data card defective	Replace memory card or CU.	
F01105	CU: Insufficient memory	Reduce number of data records.	
A01101	Memory card not available	Insert a memory card or disable the warning A01101. Activate message for a memory card that is not inserted (Page 309)	
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.	
F01205	CU: Time slice overflow	Contact technical support.	
F01250	CU hardware fault	Replace CU.	
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.	
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).	
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.	

Number	Cause	Remedy	
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.	
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The MODBUS master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)	
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.	
F03505	Analog input, wire break	Check the connection to the signal source for interrupts. Check the level of the signal supplied. The input current measured by the analog input can be read out in r0752.	
A03520	Temperature sensor fault	Check that the sensor is connected correctly.	
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?	
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).	

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

Num-ber	Cause	Remedy	
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.	
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.	
F07807	Short circuit detected	• Check the converter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been inter-changed.	
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: Remove the causes of these alarms.	
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for this fault.	
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).	
F07901	Motor overspeed	Activate precontrol of the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.	
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform motor identification. Check the current limits (p0640, r0067, r0289). If the cur-rent 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).	

Num-ber	Cause	Remedy	
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 toler-ance		
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.	
F07924	Torque/speed too high		
A07927	DC braking active	Not required	
A07980	Rotary measurement acti-vated	Not required	
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).	
A07991	Motor data identification activated	Switch on the motor and identify the motor data.	
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller to RUN mode. • If the error occurs repeatedly, check the set monitoring time p2044.	
F08502	Monitoring time sign-of-life expired	• Check the PROFINET connection.	
F08510	Send configuration data not valid	• Check the PROFINET configuration	
A08511	Receive configuration data not valid		
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).	
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.	
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred during check-ing of the memory card. • Insert a suitable memory card and switch the converter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).	

Number	Cause	Remedy	
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).	
F30004	Converter overtemperature	Check whether the converter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.	
F30005	I2t converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.	
F30011	Line phase failure	Check the converter's input fuses. Check the line cables.	
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).	

Number	Cause	Remedy	
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).	
F30022	Power Module: Monitoring U_{CE}	Check or replace the 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	
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.	
F30053	Error in FPGA data	Replace the Power Module.	
A30502	DC link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.	
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.	
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.	
F30850	Software fault in Power Module	Replace Power Module or contact technical support.	
A30920	Temperature sensor fault	Check that the sensor is connected correctly.	

For further information, please refer to the List Manual.

Manuals for your converter (Page 393)

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 converter 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 Overview of replacing converter components

In the event of a permanent function fault, you can replace the converter's Power Module (PM) or Control Module (CM) independently of one another. In the following cases, you may immediately switch on the motor again after the replacement.

⚠ WARNING

Recommissioning and removal of power before exchange of system components

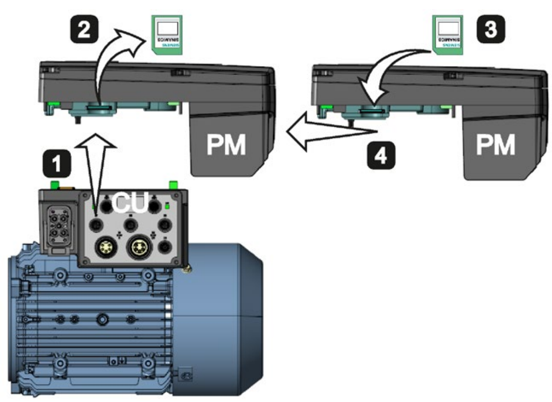
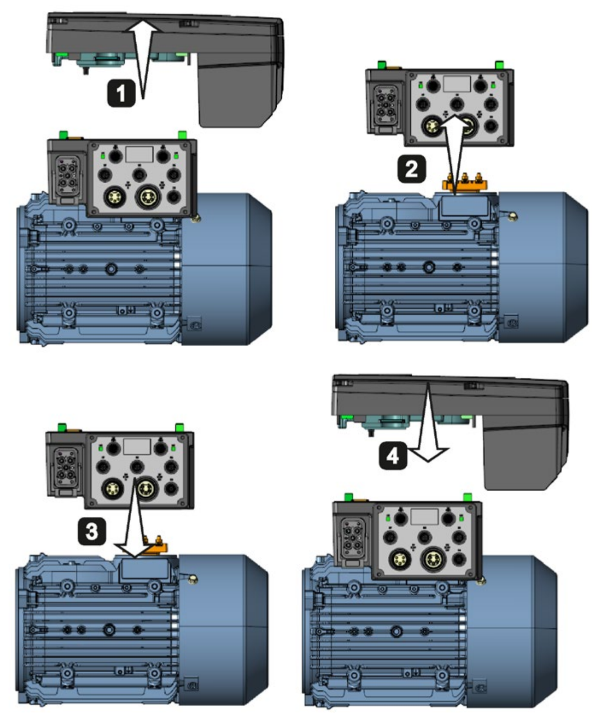
1. In all other cases, you must recommission the drive.
2. When exchanging the Terminal Housing (which contains the Control Module) or the Power Module, the power supply and external 24 V supply MUST be removed from the system before attempting any replacement of components.

Note

Memory card reader

The memory card reader is located on the side of the PM and is not accessible when the PM is fitted to the CU.

Component replacement, general

Replacing the Power Module with external backup of the settings, e.g. on a memory card		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)
			
	PM and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	The converter automatically loads the settings on the memory card into the new PM. If you have saved the settings of your converter on another medium, e.g. on an operator panel or on a PC, then after the replacement, the settings must be loaded into the converter.	

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, using the environment detection, you can replace a defective converter by a new device of the same type and with the identical software release without having to recommission the system.

You can either load the converter settings into the converter using the memory card, or – if you are using a SIMATIC S7 control with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

9.2.2 Replacing the Control Module

After commissioning has been completed, we recommend that you back up your settings on an external storage medium, e.g.: on a memory card or the operator panel.

If you do not back up your data, you have to recommission the drive when you replace the Control Unit.

Procedure for replacing a Control Module (CM)

DANGER

Dangerous voltages!

Hazardous voltages are still present for up to 5 minutes after the power supply has been switched off. Do not carry out any installation or replacement work before this time has expired.

No Hot-swap of components

The components of the SINAMICS G110M system cannot be swapped, installed or removed without securing any loads controlled by the application, removing the power supply from the system and waiting 5 minutes to allow the electrical components of the system to fully discharge.

CAUTION

Electrostatic discharge

Static discharges on surfaces or interfaces (e.g. terminal or connector pins) can cause malfunctions or defects. ESD protective measures should therefore be observed when working with converters or converter components.

Removing the Control Module

1. Disconnect all power supplies from the terminal housing.
2. Wait 5 minutes to allow all residual voltages and currents to dissipate.
3. Remove the Power Module (PM). See System Installation (Page 44).
4. Remove the Communications and Power Interface (CPI) ribbon cable from the Control Module (CM).
5. Remove the PROFIBUS/PROFINET communications cable from the CM.
6. Undo the four CM self-retaining screws.
7. Remove the CM.

Replacing the Control Module

1. Fit the new CM.
2. Secure the CM in place using the four self-retaining screws.
3. Reconnect the PROFIBUS/PROFINET communications cable to the CM.

4. Reconnect CPI ribbon cable to the CM.
5. Replace the PM. See System Installation (Page 44).
6. Reconnect all the power supplies to the terminal housing.
7. The converter goes into the "ready-to-switch-on" state.
8. If you have backed up your settings:
   – Load the settings from the operator panel or via STARTER into the converter.
   – For converters of the same type and the same firmware version, you can now switch-on the motor. Check the function of the drive.
   – For a different type of converter, the converter outputs alarm A01028. The alarm indicates that the settings that have been loaded are not compatible with the converter. In this case, clear the alarm with p0971 = 1 and recommission the drive.
9. If you have not backed up your settings, then you must recommission the drive.

9.2.3 Replacing a Control Module 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 305)

Transferring the settings from the memory card (Page 306)

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 318)
   - 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 318)
   - 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 318)
   - 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 318)
   - 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).

9.2.4 Replacing the Power Module

Procedure for replacing a Power Module

⚠DANGER

Dangerous voltages!

Hazardous voltages are still present for up to 5 minutes after the power supply has been switched off. Do not carry out any installation or replacement work before this time has expired.

No Hot-swap of components

The components of the SINAMICS G110M system cannot be swapped, installed or removed without securing any loads controlled by the application, removing the power supply from the system and waiting 5 minutes to allow the electrical components of the system to fully discharge.

⚠CAUTION

Electrostatic discharge

Static discharges on surfaces or interfaces (e.g. terminal or connector pins) can cause malfunctions or defects. ESD protective measures should therefore be observed when working with converters or converter components.

Removing the Power Module

1. Disconnect all external power to the system; this includes the line supply and the 24 Vdc supply to the Control Module (CM).
2. Wait 5 minutes to allow all residual voltages and currents to dissipate.
3. Undo the Power Module's (PM) four self-retaining screws.
4. Remove the PM from the Terminal Housing.
5. Remove the memory card from the memory card reader (if one is fitted).

Replacing the Power Module

1. Insert the memory card in the new PM.
2. Fit the PM onto the Terminal Housing.
3. Fasten the four self-retaining screws (ensuring the are tightened to the correct torque).
4. Reconnect the mains supply and the external 24 V supply to the system.
5. The CM will automatically read the default parameter set that is stored on the memory card.
6. The converter will then go into the "ready-to-switch-on" state.
7. If you have not backed up your settings, then you must recommission the drive.

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.

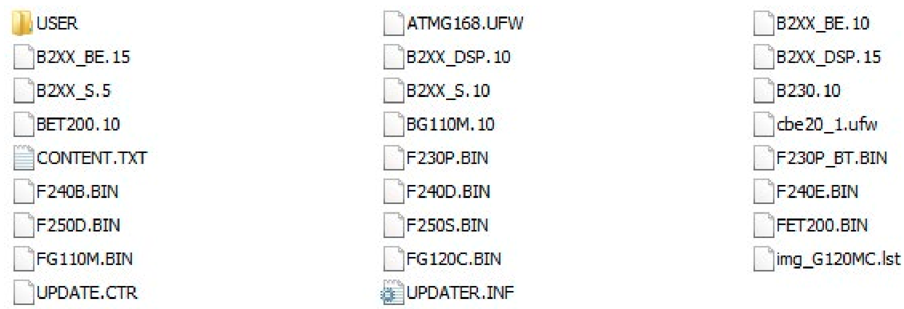


Figure 9-1 Example of memory card contents after the file transfer

   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 304)

Overview of firmware upgrades and downgrades

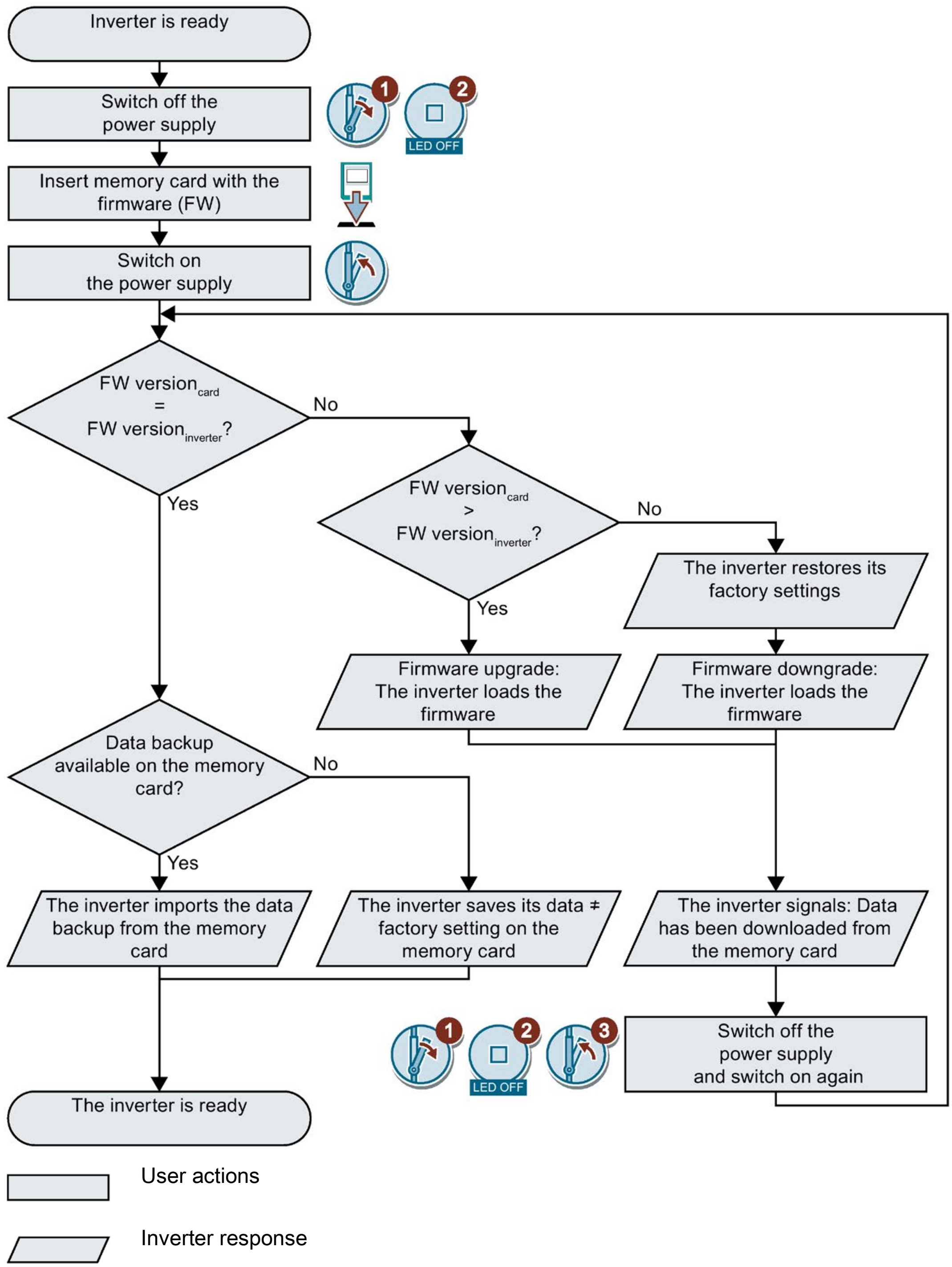


Figure 9-2 Overview of the firmware upgrade and firmware downgrade

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.

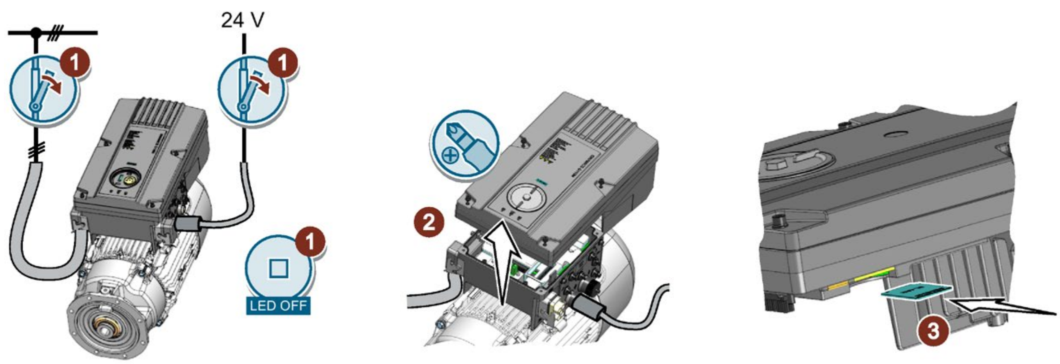
Requirements

- Your inverter's firmware is at least version V4.7.x.
- You have the memory card with the firmware for that particular inverter.

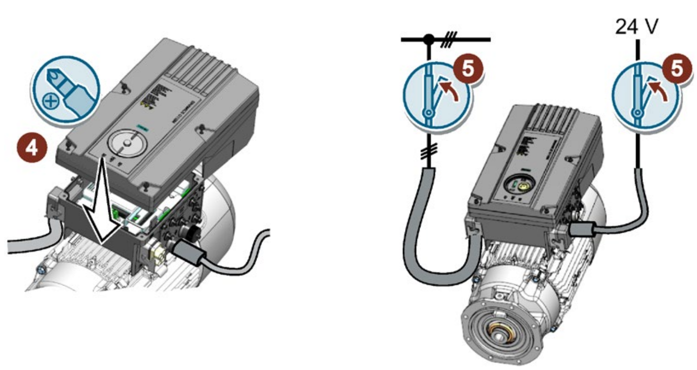
Procedure

1. Switch off the 24 V inverter power supply voltage.

   If the inverter is equipped with a module for the internal 24 V power supply, you must switch off the 400 V supply instead of the 24 V power supply.



2. Remove the Power Module.
3. Insert the card with the matching firmware into the slot on the lower side of the Power Module until you can feel it snap into place.
4. Mount the Power Module with the inserted firmware card.



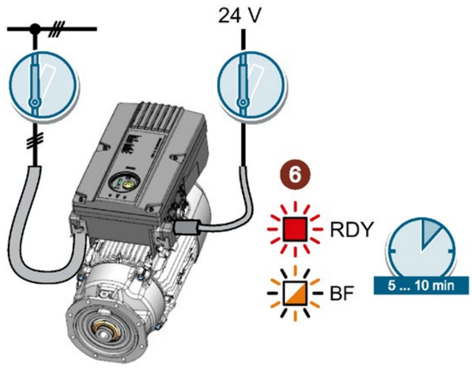
5. Switch on the 24 V inverter supply voltage.

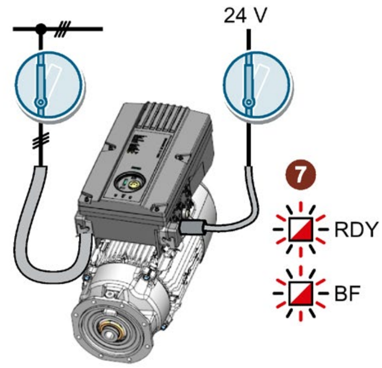
   If the inverter is equipped with a module for the internal 24 V power supply, you must switch on the 400 V supply instead of the 24 V power supply.

6. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The BF LED flashes orange with a variable frequency.





7. Once the transfer is completed, the RDY and BF LEDs flash slowly red (0.5 Hz).

Note

Damaged firmware due to a supply voltage interruption during transfer

If the power supply fails during the transfer, this can damage the inverter's firmware.

- Do not switch off the inverter's supply voltage while the transfer is running.

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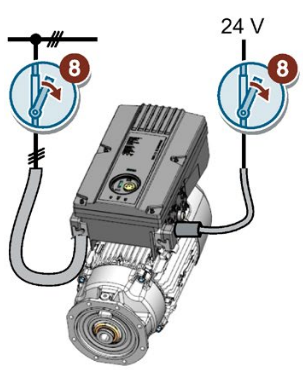
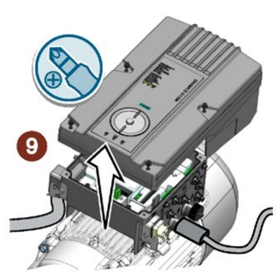
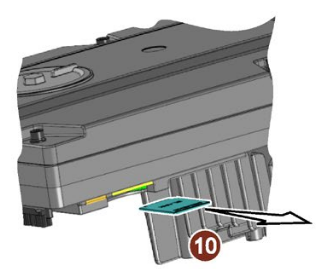
8. Switch off the 24 V or the 400 V supply voltage of the inverter.



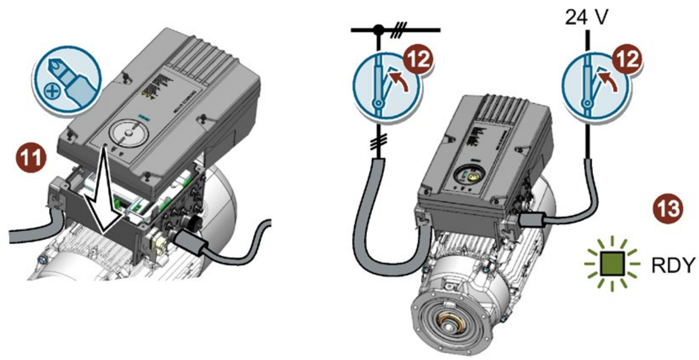




9. Remove the Power Module.

10. Withdraw the card with the firmware from the Power Module.

11.Mount the Power Module.



12.Switch on the 24 V inverter power supply voltage or the 400 V inverter supply.

13.If the firmware upgrade was successful, the inverter LED RDY turns green after several seconds.

You have successfully updated the inverter's firmware to a newer version.
❒

When there is an upgrade, your settings will be stored in the inverter.

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.

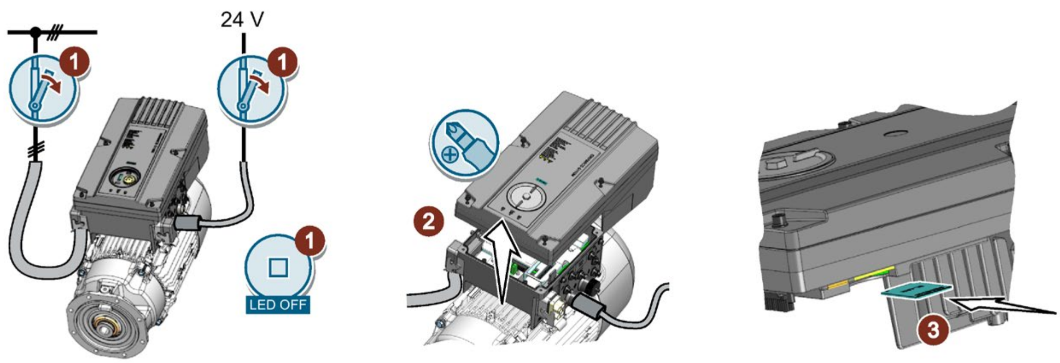
Requirements

- Your inverter's firmware is at least version V4.7.
- You have the memory card with the firmware for that particular inverter.
- You have saved your settings onto a memory card, in an operator panel or on a PC.

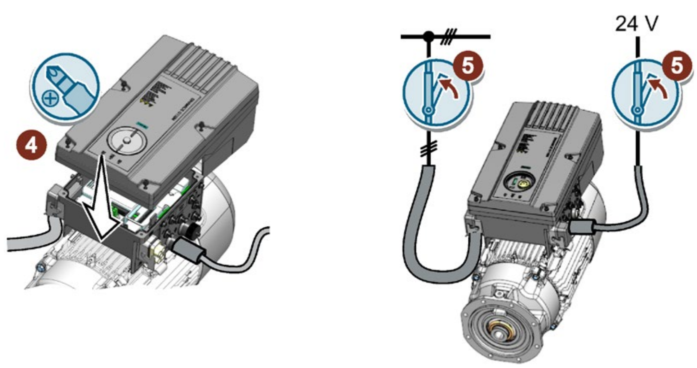
Procedure

1. Switch off the 24 V inverter power supply voltage.

   If the inverter is equipped with a module for the internal 24 V power supply, you must switch off the 400 V supply instead of the 24 V power supply.



2. Remove the Power Module.
3. Insert the card with the matching firmware into the slot on the lower side of the Power Module until you can feel it snap into place.
4. Mount the Power Module with the inserted firmware card.



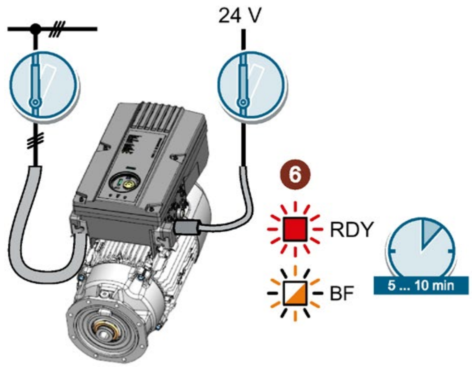
5. Switch on the 24 V inverter supply voltage.

   If the inverter is equipped with a module for the internal 24 V power supply, you must switch on the 400 V supply instead of the 24 V power supply.

6. The inverter transfers the firmware from the memory card into its memory.

   The transfer takes between 5 and 10 minutes.

   While data is being transferred, the LED RDY on the inverter stays red. The BF LED flashes orange with a variable frequency.



7. Once the transfer is completed, the RDY and BF LEDs flash slowly red (0.5 Hz).

Note

Damaged firmware due to a supply voltage interruption during transfer

If the power supply fails during the transfer, this can damage the inverter's firmware.

- Do not switch off the inverter's supply voltage while the transfer is running.

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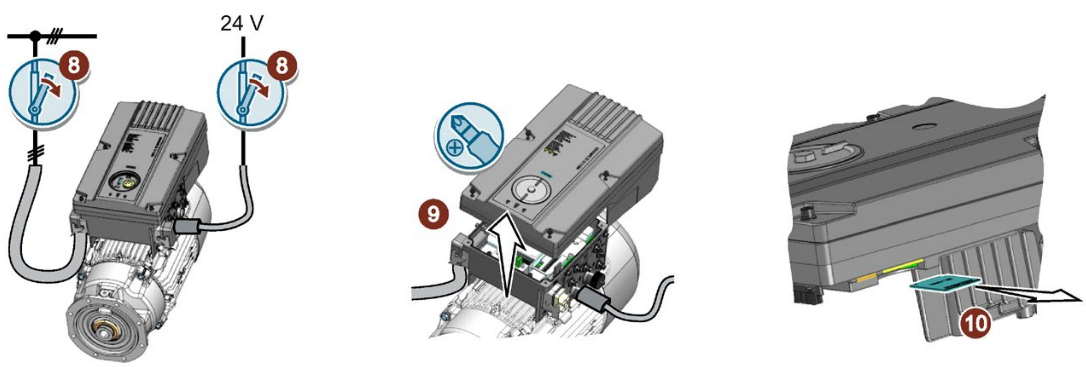
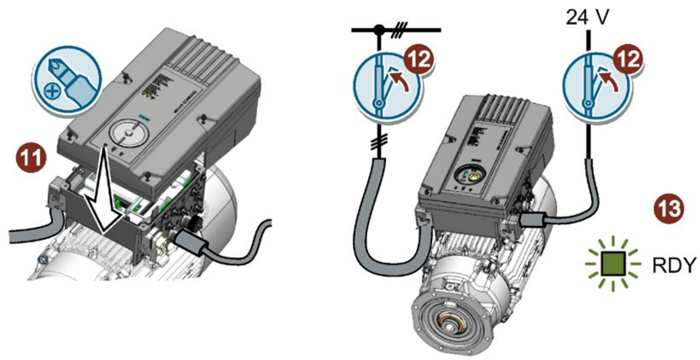
8. Switch off the 24 V or the 400 V supply voltage of the inverter.



9. Remove the Power Module.
10. Withdraw the card with the firmware from the Power Module.

11.Mount the Power Module.



12.Switch on the 24 V inverter power supply voltage or the 400 V inverter supply.

13.If the firmware downgrade was successful, after several seconds the inverter LED RDY turns green.

Following the firmware downgrade the inverter is reset to factory settings.

14.Take your settings over from your data backup to the inverter.

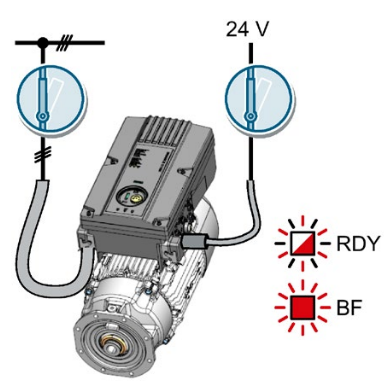
Data backup and series commissioning (Page 303)

You have updated the inverter's firmware to an older version and have adopted your saved settings in the inverter.
❒

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 V4.7.x.
  - For a downgrade at least V4.7.
- Have you inserted the card properly?
- Does the card contain the correct firmware?
- Repeat the appropriate procedure.

Technical data

10

10.1 Performance ratings of the Control Module - CU240M

Feature	Specification
Operating voltage	24 V DC External supply 24 V DC ± 15%
Setpoint resolution	0.01 Hz digital; 0.01 Hz serial
Digital inputs	4 programmable digital inputs • Voltage: ≤ 30 V • Voltage for "low" state: < 5 V • Voltage for "high" state: > 11 V • Current for 24 V input voltage: 6.8 mA … 7.2 mA • Minimum current for the "high" state: 0.3 mA … 3 mA • Compatible to SIMATIC outputs
Digital outputs	2 programmable digital outputs • 24 V DC / 0 A …0.5 A (resistive) • Current output ≤ 0.5 A in total when using both or a single digital output • Update time: 2 ms
Analog inputs	2 analog inputs • 0 V ... 10 V or 0 mA ... 20 mA • Resolution 12 bit • Can also be configured as digital inputs
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω, switching threshold 1650 Ω • KTY84 • Pt1000 • Temperature sensor with dry contact
PFH	5 × 10E-8 Probability of failure of the fail-safe functions (Probability of Failure per Hour)
USB interface	Mini-B (situated on the cover of the Power Module)

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 - PM240M

General performance ratings

Feature	Specification
Line operating voltage & power ranges	3 AC 380 V (- 10%) … 480 V (+ 10%) High Overload: 0.37 kW … 4.0 kW (0.5 hp … 5.0 hp)
Input frequency	47 Hz … 63 Hz
Output frequency	0 Hz … 650 Hz
cos φ	0.95
Inverter 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 (averages as 110%). For 4 kW variant: 1.6 x Nominal output current for 3 seconds followed by 1.5 x Nominal output current for 57 seconds every 300 seconds (averages as 110%).
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/IP66 (when Power Module and Control Unit is fully assembled).
Temperature range	CU: -10 °C … +55 °C (14 °F … 131 °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
EM Brake	180 V DC (400 V half-wave rectified) 1A maximum

10.3 SINAMICS G110M specifications

Power-dependent performance ratings

Note

UL certified Fuses must be used

UL certified Fuses must be used" it should state "In order that the system is in compliance with UL requirements, UL listed class J fuses must be used. The fuse rating of these fuses must be equal to or less that the ratings given in Table 4-2 Rated Output, Input and Fuses (Page 61).

IP protection of the system

The Power Module and the Terminal Housing (which includes the Control Module) when fully assembled and attach to the motor has an IP rating of IP65/66 depending on the version of the Control Module.

Table 10- 1 PM240M, Frame Sizes A, Class A filter, 3 AC 380 V … 480 V

Article No.	6SL3517-…	…1BE11-3AM0	…1BE12-3AM0	...1BE13-3AM0
Rated / LO power Rated / LO input current Rated / LO Output current		0.37 kW 1.3 A 1.3 A	0.75 kW 2.0 A 2.2 A	1.1 kW 2.8 A 3.1 A
HO power HO input current HO output current		0.37 kW 1.3 A 1.3 A	0.75 kW 2.0 A 2.2 A	1,1 kW 2.8 A 3.1 A
Fuse		10 A, class J, CC	10 A, class J, CC	10 A, class J, CC
Power losses		0.012 kW	0.014 kW	0.2 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		2.1 kg	2.1 kg	2.1 kg

Table 10- 2 PM240M, Frame Sizes A, Class A filter, 3 AC 380 V … 480 V

Article No.	6SL3517-…	…1BE14-3AM0
Rated / LO power Rated / LO input current Rated / LO Output current		1.5 kW 3.6 A 4.1 A
HO power HO input current HO output current		1,5kW 3.6 A 4.1 A
Fuse		10 A, class J, CC

Article No.	6SL3517-…	…1BE14-3AM0
Power losses		0.04 kW
Required cooling air flow		4.8 l/s
Cross section of line and motor cable		1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in
Weight		2.1 kg

Table 10- 3 PM240M, Frame Sizes B, Class A filter, 3 AC 380 V … 480 V

Article No. - Filtered	6SL3517-…	…1BE16-3AM0	…1BE17-7AM0	…1BE21-0AM0
Rated / LO power Rated / LO input current Rated / LO Output current		2.2 kW 5.3 A 5.9 A	3 kW 6.9 A 7.7 A	4 kW 8.0 A 10.2 A
HO power HO input current HO output current		2.2 kW 5.3 A 5.6 A	3 KW 6.9 A 7.3 A	4 kW 8.0 A 8.8 A
Fuse		20 A, Class J, CC	20 A, Class J, CC	20 A, Class J, CC
Power losses		0.153 kW	0.073 kW	0.091 kW
Required cooling air flow		24 l/s	24 l/s	24 l/s
Cross section of line and motor cable		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		3.4 kg	3.4 kg	3.4 kg

Minimum required resistance for the braking resistors

For each Power Module rating there is a minimum resistance required for the braking resistors associated with the specific power modules, please refer to the tables above for further details.

Table 10- 4 PM240M Power Modules - minimum resistance for braking resistors

Frame size	Rated output power (kW)	Rated output current (A)	Article number	Minimum resistance for braking resistors
	based on High Overload (HO)			
FSA	0.37	1.3	6SL3517-1BE11-3AM0	200 Ω
FSA	0.75	2.2	6SL3517-1BE12-3AM0	200 Ω
FSA	1.1	3.1	6SL3517-1BE13-3AM0	200 Ω
FSA	1.5	4.1	6SL3517-1BE14-3AM0	200 Ω
FSB	2.2	5.6	6SL3517-1BE16-3AM0	60 Ω
FSB	3.0	7.3	6SL3517-1BE17-7AM0	60 Ω
FSB	4.0	8.8	6SL3517-1BE21-0AM0	60 Ω

10.4 Ambient operating temperature

Temperature

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

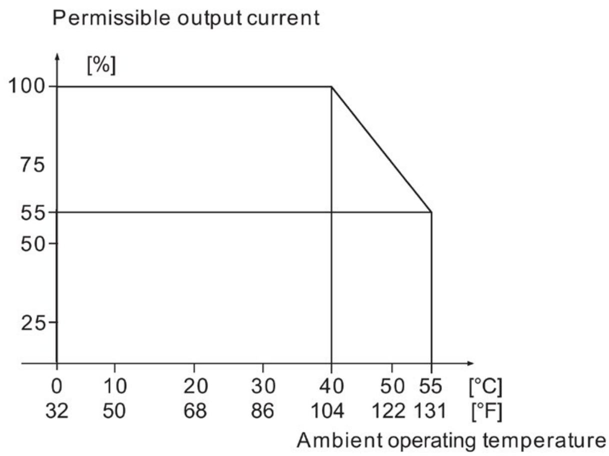


Figure 10-1 Power derating for temperature

Humidity range

Relative air humidity for the SINAMICS G110M is ≤ 95 % non-condensing.

Shock and vibration

Do not drop the SINAMICS G110M or expose to sudden shock. Do not install the SINAMICS G110M in an area where it is likely to be exposed to constant vibration.

Electromagnetic radiation

Do not install the SINAMICS G110M near sources of electromagnetic radiation.

Atmospheric pollution and water

When fully assembled the inverter has an IP65/IP66 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/IP66 rating.

Note

IP protection of the motor

The motors of the G110M system have a standard IP protection rating of IP54. The IP rating of the G110M system is determined by the lowest IP rating of its components

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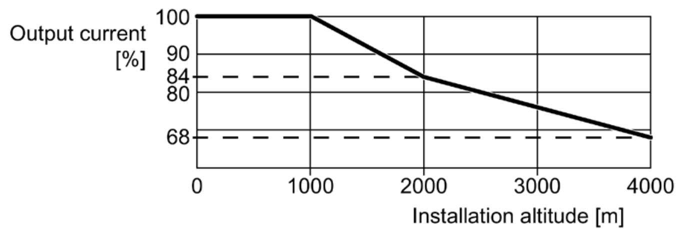
10.5 Current derating as a function of the installation altitude

Current derating depending on the installation altitude

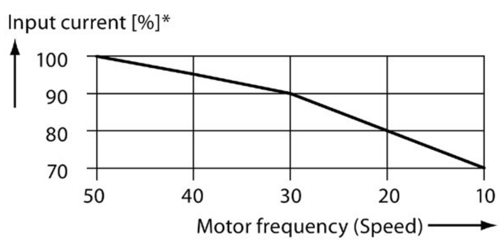
The permissible inverter output current is reduced above an installation altitude of 1000 m.



Motor speed

The speed at which the motor is running affects the temperature that is generated by the motor. At times it may be necessary to derate the speed of the motor by decrease the input current from the converter.

The derating curve in relationship to the input current from the converter is shown in the following diagram.



*
Up to the maximum capability of the converter output current.

10.6 Pulse frequency and current reduction

Relationship between pulse frequency and output base-load current reduction

Table 10- 5 Current reduction depending on pulse frequency [1]

Rated power based on LO	Rated output current at pulse frequency of						
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
0.37 kW	1.30 A	1.11 A	0.91 A	0.78 A	0.65 A	0.59 A	0.52 A
0.75 kW	2.2 A	1.9 A	1.5 A	1.3 A	1.1 A	1.0 A	0.9 A
1.1 kW	3.1 A	2.6 A	2.2 A	1.9 A	1.6 A	1.4 A	1.2 A

Rated power based on LO	Rated output current at pulse frequency of						
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
1.5 kW	4.1 A	3.5 A	2.9 A	2.5 A	2.1 A	1.8 A	1.6 A
2.2 kW	5.6 A	4.8 A	3.9 A	3.4 A	2.8 A	2.5 A	2.2 A
3.0 kW	7.3 A	6.2 A	5.1 A	4.4 A	3.7 A	3.3 A	2.9 A
4.0 kW	8.8 A	7.5 A	6.2 A	5.3 A	4.4 A	4.0 A	3.5 A

[1] The permissible motor cable length depends on the cable type and the chosen pulse frequency.

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	✓	✓	✓	✓	✓	✓	✓	✓	✓

Firmware upgrade and downgrade (Page 351)

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. Manuals for your converter (Page 393)	-	-	-	-	✓	✓	-	-	-
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 this manual (Page 3)

A.1.3 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. Manuals for your converter (Page 393)	-	-	✓	✓	✓	-	-	-	-
	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.1.4 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.1.5 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.1.6 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.

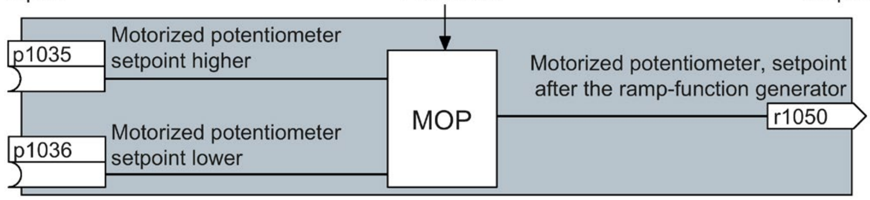


Figure A-1 Example of a block: Motorized potentiometer (MOP)

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.

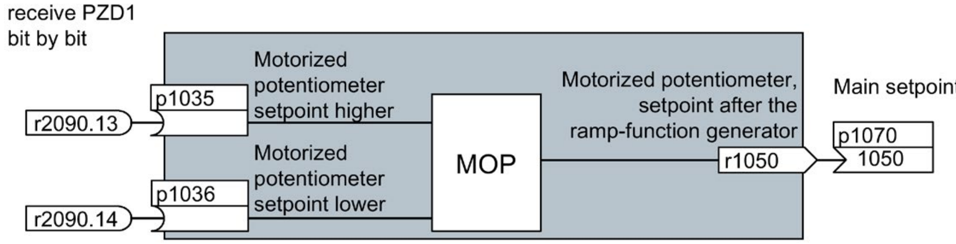


Figure A-2 Example: Signal interconnection of two blocks for digital input 0

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)

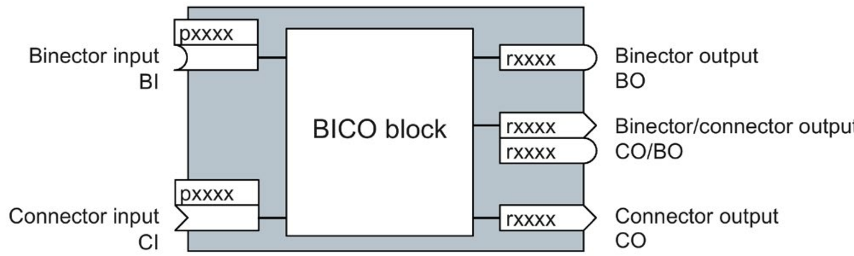


Figure A-3 Symbols for binector and connector inputs and outputs

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).

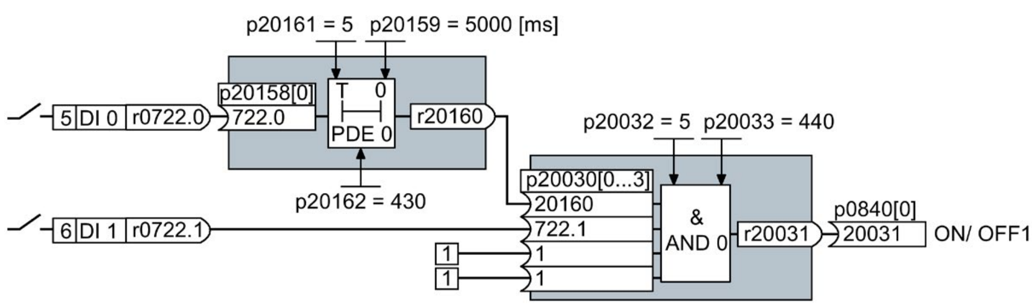


Figure A-4 Signal interconnection for control logic

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.

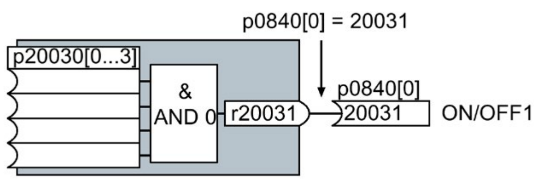


Figure A-5 Interconnecting blocks by setting p0840[0] = 20031

A.3 Acceptance tests for the safety functions

A.3.1 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.3.2 Acceptance test STO (basic functions)

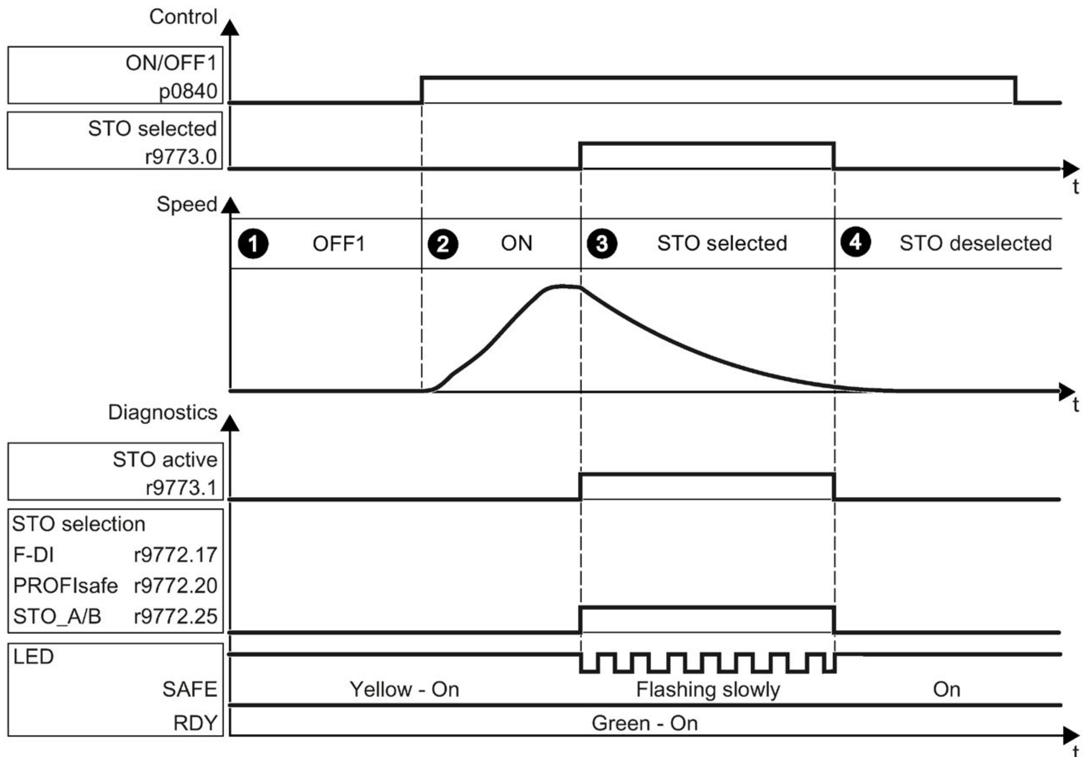


Figure A-6 Acceptance test for STO (basic functions)

To perform an acceptance test of the STO function as part of the basic functions, proceed as follows:

			Status
1.	**The inverter is ready**		
	• The inverter signals neither faults nor alarms of the safety functions (r0945[0…7], r2122[0…7]).		
	• STO is not active (r9773.1 = 0).		
2.	**Switch on motor**		
	2.1.	Enter a speed setpoint ≠ 0.	
	2.2.	Switch on the motor (ON command).	
	2.3.	Check that the correct motor is running.	
3.	**Select STO**		
	3.1.	Select STO while the motor is running. *Test each configured activation, e.g. via digital inputs and PROFIsafe.*	
	3.2.	Check the following:	

					Status
		When controlled via PROFIsafe	When controlled via fail-safe digital inputs (F-DI)	When controlled via terminals STO_A and STO_B on Power Module PM240M	
		• 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.3.3 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- 8 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.3.4 Documenting the settings for the basic functions, firmware V4.4 ... V4.7 SP6

Drive = <pDO-NAME_v>

Table A- 9 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- 10 Monitoring cycle

Name	Number	Value
SI monitoring clock cycle (processor 1)	r9780	<r9780_v>

Table A- 11 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- 12 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- 13 Safety logbook

Name	Number	Value
SI change control checksum	r9781[0]	<r9781[0]_v>
SI change control checksum	r9781[1]	<r9781[1]_v>

Name	Number	Value
SI change control time stamp	r9782[0]	<r9782[0]_v>
SI change control time stamp	r9782[1]	<r9782[1]_v>

A.4 Electromagnetic Compatibility

The SINAMICS G110M 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.

Table A- 14 Compliance Table

Category C2 - First Environment - Professional Use	
Article number	Remark
6SL3517-1BE11-*A*0 6SL3517-1BE12-*A*0 6SL3517-1BE13-*A*0 6SL3517-1BE14-*A*0 6SL3517-1BE16-*A*0 6SL3517-1BE17-*A*0 6SL351701BE21-*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 maximum cable length is 15 m, at a switching frequency of 4 kHz

Table A- 15 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: 6SL3517-1BE**-***A****	**Category C2** First Environment - Professional Use
Radiated emissions	Converter frame sizes A and B with integrated class A filter. Article number: 6SL3517-1BE11-***A***0 6SL3517-1BE12-***A***0 6SL3517-1BE13-***A***0 6SL3517-1BE14-***A***0 6SL3517-1BE16-***A***0 6SL3517-1BE17-***A***0 6SL3517-1BE21-***A***0 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 A- 16 Harmonic Currents

Typical Harmonic Current (% of rated input current) at U_K 1 %							
5th	**7th**	**11th**	**13th**	**17th**	**19th**	**23rd**	**25th**
24	11	9	7	6	5	4	4

Note

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 G110M drives have been tested in accordance with the immunity requirements of category C3 (industrial) environment:

Table A- 17 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 @ 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 @ 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	

A.5 Manuals and technical support

A.5.1 Manuals for your converter

Manuals with additional information that can be downloaded:

- Getting Started Guide
(http://support.automation.siemens.com/WW/view/en/84182041/133300)
Installing and commissioning the converter.
- Operating instructions (https://support.industry.siemens.com/cs/ww/en/view/102316337)
Installing, commissioning and maintaining the inverter. Advanced commissioning (this manual)
- Function Manual for Safety Integrated
(https://support.industry.siemens.com/cs/ww/en/view/109477367)
Configuring PROFIsafe. Installing, commissioning and operating fail-safe functions of the inverter
- Fieldbus function manual
(https://support.industry.siemens.com/cs/ww/en/view/109477369)
Configuring fieldbuses
- List Manual (https://support.industry.siemens.com/cs/ww/en/view/109478707)
Parameter list, alarms and faults. Graphic function diagrams
- IOP operating instructions
(https://support.industry.siemens.com/cs/ww/en/view/109478559)
Using the operator panel, mounting the door mounting kit for IOP

Finding the most recent edition of a manual

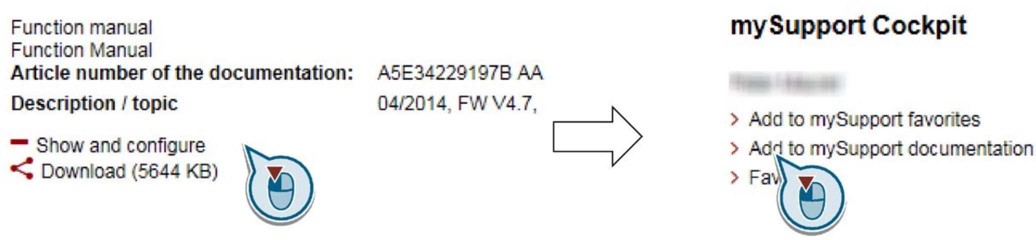
If there a multiple editions of a manual, select the latest edition:

Configuring a manual

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

MyDocumentationManager (https://www.industry.siemens.com/topics/global/en/planning-efficiency/documentation/Pages/default.aspx).

Select "Display and configure" and add the manual to your "mySupport-documentation":



Not all manuals can be configured.

The configured manual can be exported in RTF, PDF or XML format.

A.5.2 Configuring support

Catalog

Ordering data and technical information for SINAMICS G inverters.

Catalogs for download or online catalog (Industry Mall):

Everything about SINAMICS G110M (www.siemens.com/sinamics-g110m)

SIZER

The configuration tool for SINAMICS, MICROMASTER and DYNAVERT T drives, motor starters, as well as SINUMERIK, SIMOTION controllers and SIMATIC technology

SIZER on DVD:

Article number: 6SL3070-0AA00-0AG0

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

EMC (electromagnetic compatibility) technical overview

Standards and guidelines, EMC-compliant control cabinet design

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

EMC Guidelines configuration manual

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

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

Safety Integrated for novices technical overview

Application examples for SINAMICS G drives with Safety Integrated

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

A.5.3 Product Support

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".

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More information

SINAMICS inverter:
www.siemens.com/sinamics

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