SIEMENS

SINAMICS

SINAMICS G120P Cabinet

Inverter – cabinet units 110 kW - 200 kW

Operating instructions

Auxiliary

11/2013

Answers for industry.

SIEMENS

SINAMICS

SINAMICS G120
Inverter cabinet units

Operating Instructions

11/2013
A5E32923362A

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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Ⓟ 11/2013 Technical data subject to change

Preface

User documentation

⚠ WARNING
Safety and warning information
Before installing and commissioning the inverter, make sure that you read all the safety notes and warnings carefully, including the warning labels on the equipment itself. The warning labels must always be legible. Missing or damaged labels must be replaced.

Structure of this documentation

The customer documentation comprises general and individual documentation.

The general documentation describes the topics that apply to all cabinet units:

- **Operating Instructions**
  The Operating Instructions consist of the following sections:
  - Device description
  - Mechanical installation
  - Electrical installation
  - Commissioning guide
  - Description of function
  - Maintenance instructions
  - Technical data
- **List Manual**
  The List Manual consists of the following sections:
  - Parameter list
  - Function diagrams
  - Fault/warning list

The individual device documentation describes precisely one customized cabinet unit and contains the following:

- **Dimension drawing**
  The dimension drawing documents the dimensions of the ordered cabinet unit.
- **Layout diagram**
  The components installed in the ordered cabinet units are shown in the layout diagram with the equipment and location codes.
- **Circuit diagram**
  The circuit diagram shows the electrical components installed in the ordered cabinet unit with the equipment and location codes, their interconnections and the customer interfaces.
- **Terminal diagram**
  The terminal diagram shows all the customer terminals in the ordered cabinet unit, and the associated internal wiring in the cabinet unit. This diagram documents the plant-side target wiring.
- **Spare parts list**
  All of the available spare parts for the ordered cabinet units are listed in the spare parts list with the equipment and the location codes.
- **Additional operating instructions**
  The instructions for supplier components installed in the ordered cabinet unit are included as original documentation.

Documentation on the Internet

The documentation for SINAMICS G120 can be found on the Internet at:
http://support.automation.siemens.com/WW/view/en/38797189/133300

Technical support

Time zone Europe/Africa	
Phone	+49 (0) 911 895 7222
Fax	+49 (0) 911 895 7223
Internet	http://www.siemens.com/automation/support-request

Time zone America	
Phone	+1 423 262 2522
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Internet	techsupport.sea@siemens.com

Time zone Asia/Pacific	
Phone	+86 1064 757 575
Fax	+86 1064 747 474
Internet	support.asia.automation@siemens.com

Spare parts

You will find spare parts on the Internet at:
http://support.automation.siemens.com/WW/view/en/16612315.

Internet address

Information about SINAMICS can be found on the Internet at the following address:
http://www.siemens.com/sinamics

EMC limit values for South Korea

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다. For sellers or other user, please keep in mind that this device in an A-grade electromagnetic wave device. This device is intended to be used in areas other than home.

The EMC limit values that have to be observed for South Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3 of category C2 or the limit value class A, Group 1 according to EN 55011.
With suitable additional measures the limit values according to category C2 or to limit class A, Group 1, are maintained. Additional measures, such as the use of an additional RFI suppression filter (EMC filter), may be necessary.
In addition, measures for a correct EMC-compliant configuration of the plant are described in detail in this manual and in the "SINAMICS Low-Voltage Configuration Manual".

Certification

The following certificates are contained in the "Safety and application information" tab of the documentation folder:

- EC declaration of conformity
- Certificate of compliance with order

Table of contents

1 Safety information

1.1 General safety instructions

DANGER

Danger to life when live parts are touched

Touching live parts can result in death or severe injury.

- Only work on electrical equipment if you are appropriately qualified.
- Always observe the country-specific safety rules for all work.

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify team members who will be affected by the procedure.
2. Disconnect the machine from the supply.
   - Switch off the machine.
   - Wait until the discharge time specified on the warning labels has elapsed.
   - Check that it really is in a zero-voltage state, from phase conductor to phase conductor and phase conductor to protective conductor.
   - Check that every auxiliary circuit is de-energized.
   - Ensure that the motors cannot move.
3. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water.
4. Isolate or neutralize all hazardous energy sources by closing switches, grounding or short-circuiting or closing valves, for example.
5. Take measures to prevent reconnection of the energy sources.
6. Make sure that the machine is completely locked out ... and that you have the right machine.

After you have completed the work, restore the operational readiness by following the above steps in the reverse order.

WARNING

Danger to life through a hazardous voltage when connecting an unsuitable power supply

In the event of a fault, touching live parts can result in death or severe injury.

- 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

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

Hazardous voltages can be present at the housing or exposed components on damaged devices.

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

WARNING

Danger to life through electric shock due to unconnected cable shields

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

- As a minimum, connect cable shields and the cores of power cables that are not used at one end at the grounded housing potential.

WARNING

Danger to life due to electric shock when not grounded

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

Danger to life due to electric shock when opening plug connections in operation

When opening plug connections in operation, arcs can result in severe 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

Danger to life due to fire spreading if the housing is inadequate

Fire and smoke development can cause severe injury or material damage.

- Install devices without a protective housing in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire inside and outside the device is prevented.
- Additionally, select the installation site so that an uncontrolled spreading of smoke can be avoided in the case of a fire.
- Ensure that smoke can escape via designated paths.

WARNING

Danger to life through unexpected movement of machines when using mobile wireless devices or mobile phones

Using mobile radios or mobile phones with a transmit power > 1 W closer than approx. 2 m to the components may cause the devices to malfunction, influence the functional safety of machines therefore putting people at risk or causing material damage.

- When close to components, switch off all wireless devices and mobile phones.

WARNING

Danger to life due to the motor catching fire in the event of insulation overload

There is a greater load on the motor insulation through a ground fault in an IT system. A possible result is the failure of the insulation with a risk for personnel through smoke development and fire.

- Use a monitoring device that signals an insulation fault.
- Correct the fault as quickly as possible so the motor insulation is not overloaded.

WARNING

Danger to life due to fire if overheating occurs because of insufficient ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel through smoke development and fire. 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. They can be found in the dimension drawings or in the "Product-specific safety instructions" at the start of the respective section.

WARNING

Danger of an accident occurring due to missing or illegible warning labels

Missing or illegible warning labels can result in death or serious injury.

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

1.2 Safety instructions for electromagnetic fields (EMF)

⚠ WARNING

Danger to life from electromagnetic fields

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment such as transformers, inverters or motors.

People with pacemakers or implants are at a special risk in the immediate vicinity of these devices/systems.

- Keep a distance of at least 2 m.

1.3 Handling electrostatic sensitive devices (ESD)

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

NOTICE

Damage caused by electric fields or electrostatic discharge

Electric fields or electrostatic discharge can result in malfunctions as a result of damaged individual parts, 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 or aluminum foil.
- Only touch components, modules and devices if you are first grounded by applying one of the following measures:
  - 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).

1.4 Residual risks of power drive systems

Residual risks of power drive systems

The control and drive components of a drive system are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used.

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety information and instructions on the components and in the associated technical user documentation.

When assessing the machine's risk in accordance with the respective local regulations (e.g. EC Machinery Directive), the machine manufacturer 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 components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / mobile phones in the immediate vicinity of the controller
   - External influences/damage
2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences/damage

   Inverters of the Open Type/IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that the contact with fire inside and outside the inverter is not possible.

3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions not within the scope of 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

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Note

The components must be protected against conductive contamination (e.g. by installing them in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12).

Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

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

Device overview 2

2.1 Section content

This chapter provides information on the following:

- Introduction to the cabinet units
- The main components and features of the cabinet unit
- The cabinet unit wiring
- Explanation of the type plate

2.2 Applications, features

2.2.1 Field of applications

SINAMICS G120P Cabinet inverter cabinet units are specially designed to meet the requirements of drives for pumps, fans and compressors (without constant torque) with low performance requirements without regenerative feedback.

2.2.2 Features, quality, service

Features

The accuracy of sensorless vector control ensures that the system can be used for a wide variety of applications and, as a result, an additional speed sensor is not required.

The SINAMICS G120P Cabinet takes this into account and, as a result, offers a low-cost drive solution tailored to actual requirements.

In addition, factors have been considered to ensure easy handling of the drive from the planning and design phase through to operation. These factors include:

- Compact, modular, service-friendly design.
- Straightforward planning/design and commissioning thanks to the SIZER and STARTER tools.
- Ready-to-use to facilitate the installation process.
- Quick, menu-driven commissioning with no complex parameterization.
- Clear and convenient drive monitoring/diagnostics, commissioning and operation via an operator panel with measured values displayed in plain text.

- SINAMICS as an integral part of Totally Integrated Automation (TIA). The TIA concept offers an optimized range of products for automation and drive technology. This concept is characterized by planning/design, communication, and data management procedures that are consistent throughout the product range. SINAMICS is totally integrated in the TIA concept.
  Separate S7/PCS7 blocks and faceplates for WinCC are available.
- Integration in SIMATIC H systems via a Y link.

Quality

The SINAMICS G120P Cabinet inverter cabinet units are manufactured to meet high standards of quality and exacting demands.

This results in a high level of reliability, availability, and functionality for our products.

The development, design, and manufacturing processes, as well as order processing and the logistics supply center have been certified according to DIN ISO 9001 by an independent authority.

Service

Our worldwide sales and service network offers our customers consulting services tailored to their needs, provides support with planning and design, and offers a range of training courses.

Detailed contact information and the current link to our website can be found in the preface.

2.3 Design

The SINAMICS G120P Cabinet units are characterized by their compact, modular, and service-friendly design.

A wide range of electrical and mechanical components enable the drive system to be optimized for the appropriate requirements.

Two cabinet unit versions are available depending on the options that are chosen.

2.3.1 Enclosed drive type A

Type A permits the installation of all available line supply connection components, such as the main circuit breaker, main contactor, line fuses, radio interference suppression filter, motor components, and additional protection and monitoring devices.

The cabinet unit consists of a cabinet panel with an overall width of 1000 mm.

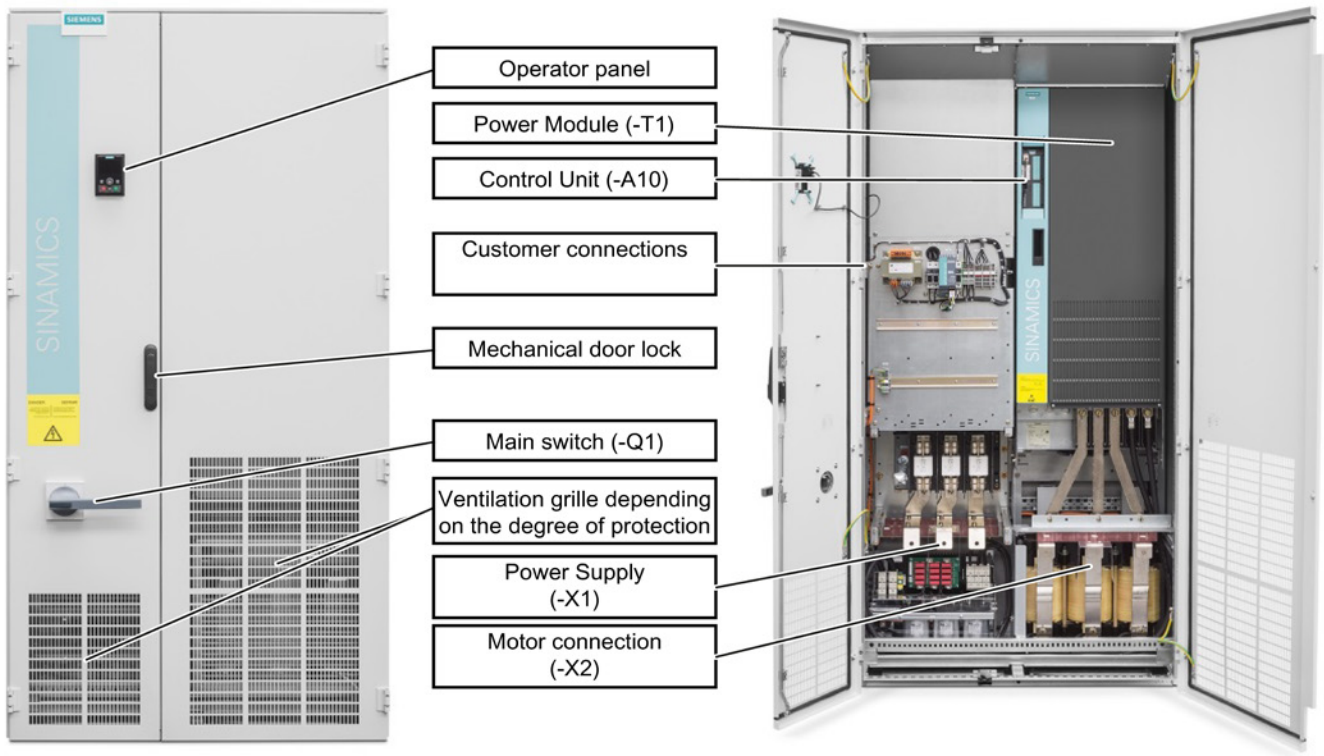


Figure 2-1 Example of the cabinet drive, type A (e.g. 160 kW, 3-phase 400 VAC) (layout and components shown may vary depending on the type)

2.3.2 Enclosed chassis type C

Type C has a particularly space-optimized design with integrated line reactor.

This type can be used, for example, when the line supply connection components, such as the main contactor and main circuit breaker with fuses for conductor protection and semi-conductor protection, are installed in an existing central low-voltage distribution unit.

Line fuses are required for conductor protection. Line fuses can also be used to protect the semiconductors of the inverter.

The cabinet unit simply comprises a single cabinet with a width of 600 mm.

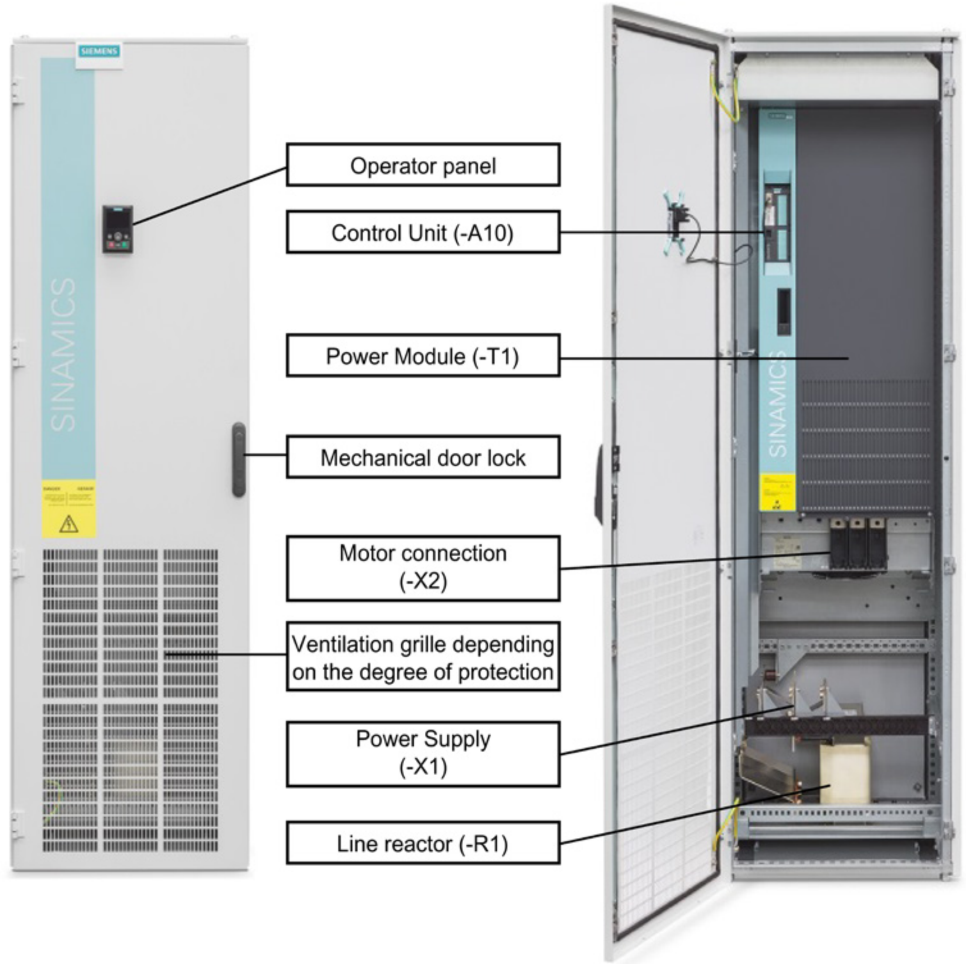


Figure 2-2 Example of the cabinet drive, type C (e.g. 200 kW, 3-phase 400 VAC) (layout and components shown may vary depending on the type)

2.4 Wiring principle

Circuit principle, types A and C

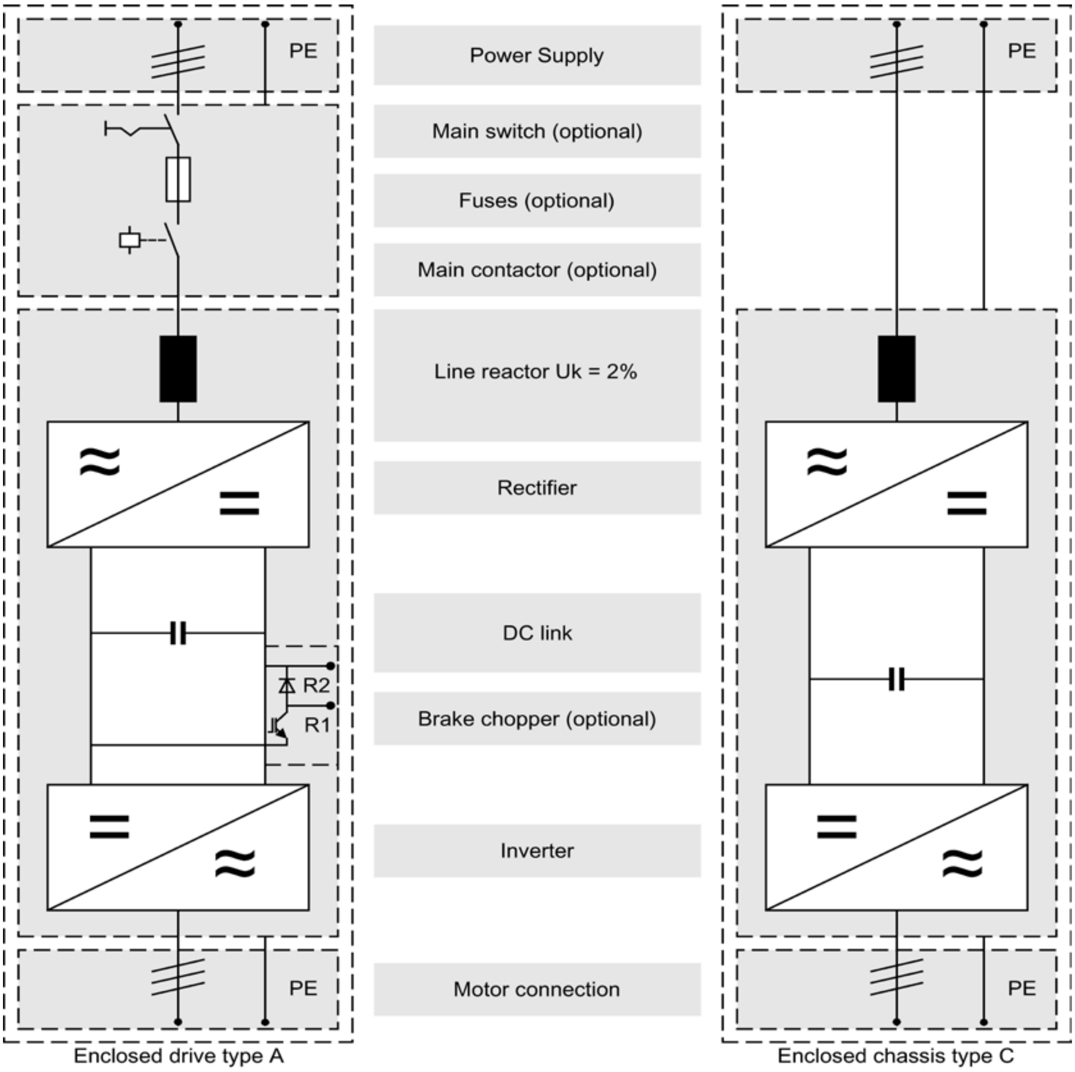


Figure 2-3 Circuit principle, types A and C

2.5 Type plate

Specifications on the type plate

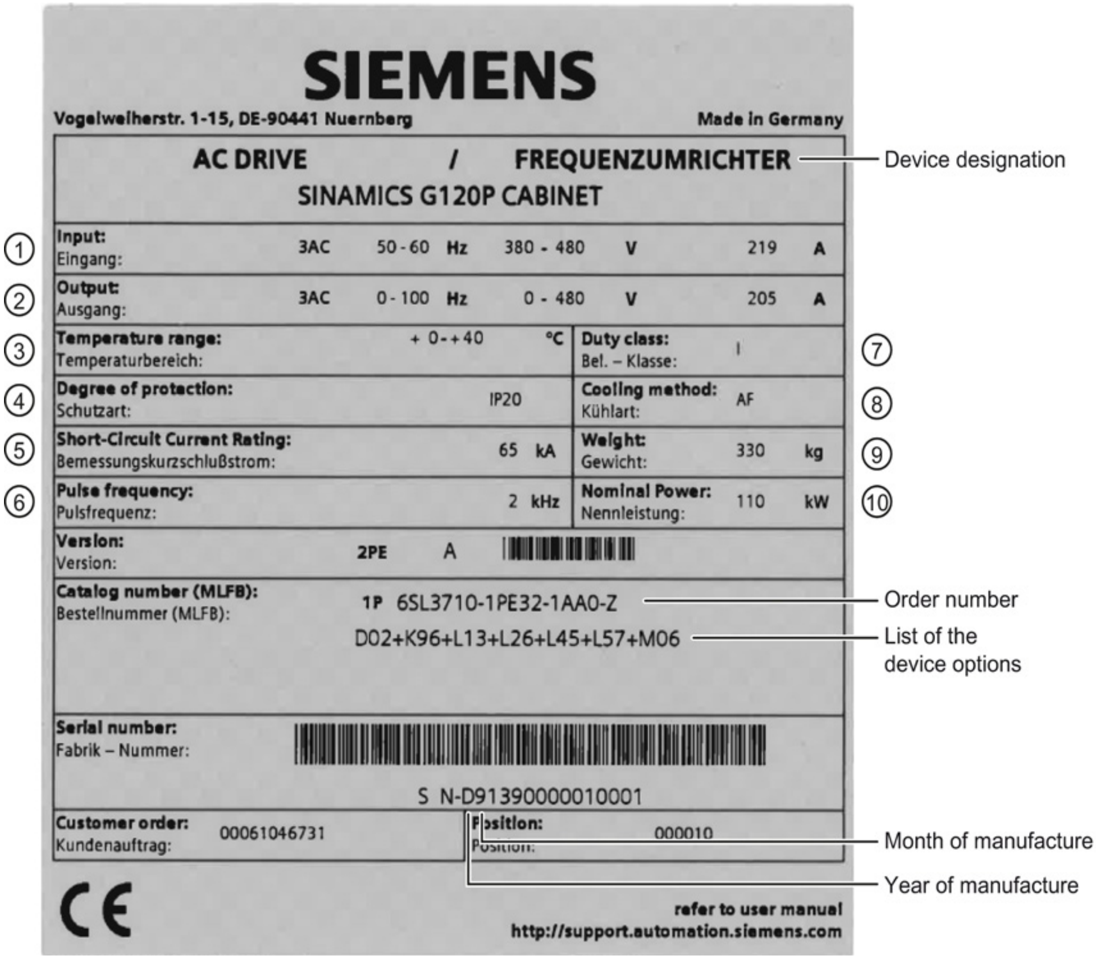


Figure 2-4 Type plate for the cabinet unit

Type plate specifications (from type plate above)

Position	Specification	Value	Explanation
①	Input	3-phase 50 - 60 Hz 380 - 480 VAC 219 A	Three-phase connection Line frequency Rated input voltage Rated input current
②	Output	3-phase 0 - 100 Hz 0 - 480 VAC 205 A	Three-phase connection Output frequency Rated output voltage Rated output current
③	Temperature range	+0 ... +40 °C	Ambient temperature range within which the enclosed drive can operate under 100% load
④	Degree of protection	IP20	Degree of protection
⑤	Short-circuit current rating	65 kA	Short-circuit current rating
⑥	Pulse frequency	2 kHz	Rated pulse frequency
⑦	Duty class load class	I	I: Duty class I according to EN 60146-1-1 = 100% (continuously) (with the specified current values, the cabinet unit can operate continuously under 100% load)
⑧	Cooling method	AF	A: Cooling medium: air F: Circulation method: forced cooling, drive unit (fan) in the device
⑨	Weight	330 kg	Weight of the enclosed drive
⑩	Nominal power	110 kW	Rated power

Date of manufacture

The date of manufacture can be determined as follows:

Table 2- 1 Production year and month

Letter/number	Year of manufacture		Letter/number	Month of manufacture
D	2013		1 ... 9	January to September
E	2014		O	October
F	2015		N	November
H	2016		D	December
J	2017			

Explanation of the option short codes

Table 2- 2 Explanation of the option short codes

		Type A	Type C
Line-side options			
L00	Line filter for use in the first environment to EN 61800-3, category C2 (TN/TT systems with grounded neutral point)	✓	–
L13	Main contactor	✓	–
L26	Main circuit-breaker, incl. fuses	✓	–
Motor-side options			
L07	dv/dt filter compact plus voltage peak limiter	✓	–
L08	Motor reactor	✓	–
L10	dv/dt filter plus voltage peak limiter	✓	–
Line-side and motor-side options			
M70	EMC shielding busbar with PE busbar	✓	✓
Control Units			
K96	CU230P-2 PROFINET Control Unit	✓	✓
K97	CU230P-2 PROFIBUS DP Control Unit	✓	✓
K98	CU230P-2 HVAC Control Unit	✓	✓
K99	CU230P-2 CAN Control Unit	✓	✓
Safety functions			
L45	EMERGENCY OFF pushbutton installed in the cabinet door	✓	–
L57	EMERGENCY OFF category 0, 24 VDC	✓	–
L60	EMERGENCY STOP category 1, 24 VDC	✓	–
Increase in degree of protection			
M21	Degree of protection IP21	✓	✓
M23	Degree of protection IP23	✓	✓
M43	Degree of protection IP43	✓	✓
M54	Degree of protection IP54	✓	✓
Mechanical options			
M06	Base 100 mm high, RAL 7035	✓	✓
M07	Cable compartment 200 mm high, RAL 7035	✓	✓
Other options			
K74	Auxiliary power supply, 230 VAC	✓	–
L50	Cabinet lighting with service socket	✓	–
L55	Cabinet anti-condensation heating	✓	✓
L62	Braking unit 50 kW / 200 kW	✓	–

		Type A	Type C
Documentation (standard: English/German)			
D02	Customer documentation (circuit diagram, terminal diagram, layout diagram) in DXF format	✓	✓
D04	Customer documentation as hard copy	✓	✓
D14	Draft of customer documentation	✓	✓
D56	Documentation language: English/Russian	✓	✓
D58	Documentation language: English/French	✓	✓
D60	Documentation language: English/Spanish	✓	✓
D80	Documentation language: English/Italian	✓	✓
D84	Documentation language: English/Chinese	✓	✓
Languages (standard: English/German)			
T58	Type plate data in English/French	✓	✓
T60	Type plate data in English/Spanish	✓	✓
T80	Type plate data in English/Italian	✓	✓
Inverter acceptance in customer's absence (not shown on the type plate)			
F03	Visual acceptance	✓	✓
F71	Function test of the inverter without motor connected	✓	✓
F75	Function test of the inverter with test bay motor (no load)	✓	✓
F77	Insulation test on the inverter	✓	✓
F97	Customer-specific inverter acceptance inspections (on request)	✓	✓

✓ indicates that this option is available for that type.

– indicates that this option is not available for that type.

Mechanical installation 3

3.1 Section content

This chapter provides information on the following:

- The conditions for transporting, storing, and installing the cabinet unit
- Preparing and installing the cabinet unit

3.2 Transport, storage

Transportation

> ⚠ **WARNING**
>
> **Danger to life due to improper transporting of the unit**
>
> The unit can tip over if you transport it incorrectly – or if you use transport equipment that is not permitted for the purpose. This can result in death, serious injury or material damage.
>
> - Ensure that only trained personnel transport the device with approved transport equipment and lifting tools.
> - Observe the center of gravity specifications. A label or stamp is attached to each transportation unit and precisely shows the center of gravity of the cabinet.
> - Transport the unit only in the original marked upright position. Do not tilt the device or allow it to fall.
> - The forks of the truck must protrude at the rear of the transport pallet. The floor panels of the transport units do not support loading.

> ⚠ **WARNING**
>
> **Danger to life through the use of non-approved fork-lift trucks**
>
> If the forks are too short, this can cause the transport unit/cabinet to tip over resulting in death, serious injury, or damage to the cabinet.
>
> - The forks of the truck must protrude at the rear of the transport pallet. The floor panels of the transport units do not support loading.
> - Only use fork-lift trucks approved for this purpose to transport the units.

Note

Notes regarding transportation

- The devices are packaged by the manufacturer in accordance with the climatic conditions and stress encountered during transit and in the recipient country.
- The notes on the packaging for transportation, storage, and proper handling must be observed.
- For transportation using forklifts, the devices must be set down on a wooden pallet.
- When the devices are unpacked, they can be transported using the transport eyebolts or rails affixed to the cabinet. The load must be distributed evenly. Heavy blows or impacts must be avoided during transit and when the devices are being set down, for example.
- Shock/tilt indicators are affixed to the packaging to detect unacceptable impact or tilting of the cabinet unit during transport (see Chapter "Transport Indicators").
- Permitted ambient temperatures:
  -25° to +70° C, class 2K3 according to IEC 60721-3-2
  Briefly down to -40° C for max. 24 hours

Note

Notes regarding damage in transit

- Carry out a thorough visual inspection of the device before accepting the delivery from the transportation company. Pay special attention to transport damage that is not readily apparent but indicated by the tilt and shock indicators.
- Ensure that you have received all the items specified on the delivery note.
- Notify the transportation company immediately of any missing components or damage.
- If you identify any hidden defects or damage, contact the transportation company immediately and ask them to examine the device.
- If you fail to contact them immediately, you may lose your right to claim compensation for the defects and damage.
- If necessary, you can request the support from your local Siemens office.

Storage

The devices must be stored in clean, dry rooms. Temperatures between -25° C and +55° C are permissible (class 1K4 according to EN 60721-3-1). Temperature variations greater than 20 K per hour are not permitted.

If the cabinet is stored for a prolonged period once it has been unpacked, cover it or take other appropriate measures to ensure that it does not become dirty and that it is protected against environmental influences. If such measures are not taken, the warranty becomes invalid in the event of a claim for damages.

NOTICE

Material damage resulting from switching on the device without forming the DC-link capacitors

After a storage duration exceeding two years, switching on the device without forming the DC-link capacitors can cause it to become damaged.

- Before switching on the device, it should be formed after a storage duration exceeding two years, see Forming the DC-link capacitors (Page 472).

NOTICE

Material damage to the hoods caused by impermissible mechanical loading

The separately delivered hoods may be damaged if they are subjected to mechanical loading before being installed on the cabinets.

- Do not apply any mechanical loads to the hoods.

3.3 Assembly

WARNING

Danger to life if the general safety instructions and remaining risks are not carefully observed

If the general safety instructions and remaining risks are not observed, accidents can occur involving severe injuries or death.

- Observe the general safety instructions.
- When assessing the risk, take into account residual risks.

3.3.1 Mechanical installation: checklist

Use the following checklist to guide you through the mechanical installation procedure for the cabinet unit. Read the "Safety instructions" section at the start of these Operating Instructions before you start working on the device.

Note

Checking the checklist

Check the boxes in the "Available" column appropriately if the associated task/option applies to the cabinet unit. In the same way, check the "Completed" column once you have finished the installation procedure to confirm that the activities are complete.

Item	Activity	Available	Completed
1	Check the shipping and handling monitors prior to assembly. Refer to "Mechanical installation/Assembly/Preparatory steps/Shipping and handling monitors".	☐	☐
2	The ambient conditions must be permissible. See "Technical data/General technical data". The enclosed units must be firmly attached using the anchor points provided (see "Mechanical Installation/Preparation"). The cooling air can flow unobstructed.	☐	☐
3	The minimum ceiling height (for unhindered air outlet) specified in the Operating Instructions must be observed. The cooling air supply must be not be obstructed (see "Mechanical installation/preparation").	☐	☐
4	Components that are supplied separately for transport reasons (e.g. air deflectors, canopies or hoods) must be fitted (see "Mechanical installation/fitting of canopies for IP20 degree of protection and type A" or "Mechanical installation/fitting of additional canopies (option M21) or hoods (option M23, M43, M54)").	☐	☐
5	The clearance around an open door (escape route) specified in the applicable accident prevention guidelines must be observed.	☐	☐

3.3.2 Preparation

3.3.2.1 Requirements for installation location

The cabinet units are designed for installation in closed, electrical operating areas in compliance with EN 61800-5-1. A closed electrical operating area is a room or area containing electrical equipment that can be accessed by trained personnel only. Access is controlled by a door or other form of barrier that can be opened only by means of a key or other tool. The room or area is also clearly marked with appropriate warning notices.

The operating areas must be dry and free of dust. The air supplied must not contain any electrically conductive gas, vapors, or dust, which could impair operation. It may be necessary to filter the air supplied to the room where the equipment is installed. If the air contains dust, filter mats (option M54) can be installed in front of the ventilation grills of the cabinet doors and also in front of the optional hoods. Option M54 offers additional protection against water sprayed against the housing from any direction and corresponds to degree of protection IP54.

The permissible values for climatic ambient conditions must be taken into account.

At temperatures > 40° C (104° F) and altitudes > 1000 m, the devices must be derated.

The basic version of the cabinet units complies with the IP20 degree of protection in accordance with EN 60529.

Installation is realized in accordance with the dimension drawings supplied. The clearance between the top of the cabinet and the ceiling is also specified in the dimension drawings.

The cooling air for the power unit is drawn in from the front through the ventilation grills in the lower part of the cabinet doors. The hot air is discharged through the perforated top panel or the ventilation grilles in the top cover (with option M23/M43/M54). Cooling air can also be supplied from below through raised/intermediate floors or air ducts, etc. To allow this, openings must be made in the bottom panel or individual bottom panels must be removed.

According to EN 61800-3, the cabinet units are not intended for use in low-voltage public line supplies that supply residential buildings. High-frequency interference may occur if it is used in this type of line supply.
Additional measures (e.g. line filter, option L00) can be fitted for use in the first environment according to EN 61800--3 Category C2.

Note

Radio service interference due to radio disturbances in residential environments

In a residential environment this product can cause radio disturbances, which may make interference suppression measures necessary.

This device is not designed for unrestricted operation in the first environment (residential environment) and may not be used in the first environment without suitable interference suppression measures.

- Have qualified personnel carry out the installation and commissioning with suitable interference suppression measures.

3.3.2.2 Requirements on the levelness of the floor

The foundation at the installation location of the cabinet devices must be level to ensure proper functioning of the cabinet units.

- Care must be taken to ensure that the doors can be opened and closed and that the locking systems work properly.
- Flat sections (such as doors, side panels and hoods) must be sealed correctly to ensure compliance with the specified degree of protection.
- When cabinets are connected (e.g., transport units), air must be prevented from entering through the gaps.

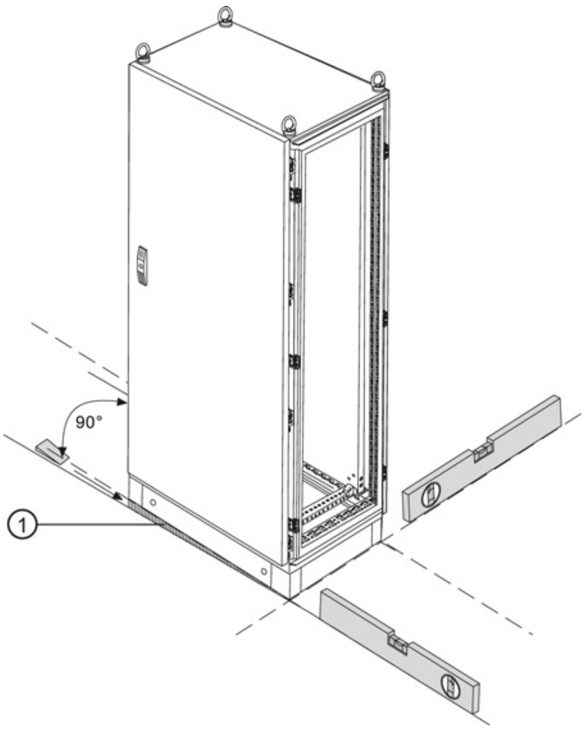


Figure 3-1 Requirements on the levelness of the floor

The following points must be observed to ensure full functionality of the cabinet units:

- The foundation must be level.
- Irregularities must be leveled out.
- Gaps where air can enter caused by leveling measures (e.g.: ① in the diagram) must be sealed.

3.3.2.3 Shipping and handling indicators

The cabinet units are equipped with tilt and shock indicators to monitor for damage during transit.

Figure 3-2 Tilt indicator

Figure 3-3 Shock indicator

Position of the shipping and handling monitors

The tilt indicators are affixed to the top of the cabinet unit inside the doors.

The shock indicators are affixed to the bottom of the cabinet unit inside the doors.

Checking the shipping and handling monitors prior to commissioning

It is essential to check the shipping and handling monitors prior to commissioning the inverter.

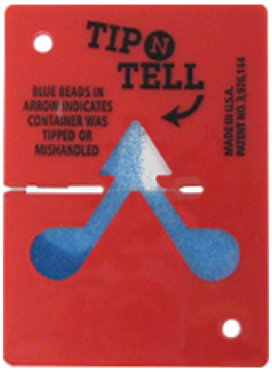


Figure 3-4 Tilt indicator tripped

The tilt indicator provides immediate visible evidence of whether the cabinet units have been handled and stored upright. Blue-colored quartz sand begins to flow into the arrow-shaped indicator area. The tilt indicator has tripped when the blue color extends beyond the middle line of the arrowhead.

Figure 3-5 Shock indicator tripped

The shock indicator shows if an acceleration has exceeded 98.1 m/s^2 (10 x g) and indicates the direction of acceleration. The black color of the arrows indicates that an impermissible shock load has occurred in the direction of the arrow.

⚠ WARNING
Danger to life caused by device damage during tripped shock or tilt indicators If a shock or tilt indicator has been tripped, safe operation of the device cannot be guaranteed. This can result in death, serious injury or material damage. • Terminate the commissioning if one of the shock or tilt indicators has been tripped. • Contact Technical Support immediately for clarification.

Removing the shipping and handling monitors prior to commissioning

NOTICE
Material damage caused by transport indicators remaining in the device during operation
If transport indicators remain in the device during operation, material damage can result from falling off or through temperature damage. • Remove the transport indicators before commissioning the inverter.

3.3.2.4 Unpacking

Unpacking

Check the delivery against the delivery note to ensure that all the items have been delivered. Check that the cabinet is intact and has not been damaged.

The packaging material must be disposed of in accordance with the applicable country-specific guidelines and rules.

3.3.2.5 Required tools

You require the following tools for installation:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench 5 Nm to 50 Nm
- Screwdriver, size 2
- T20 torx screwdriver
- T25 torx screwdriver
- T30 torx screwdriver

A socket wrench kit with two long extensions is recommended.

3.3.3 Installation

3.3.3.1 Lifting the cabinet off the transport pallet

Lifting the cabinet off the transport pallet

The applicable local guidelines regarding the transportation of the cabinet from the transport palette to the installation location must be observed.

A crane transport assembly is fitted to the top of the cabinet.

The fixing screws of the transport pallets can be removed without having to lift the cabinet unit. The positions of the fixing screws are indicated by red markings on the outside of the pallets.

Figure 3-6 Lifting from the transport pallet (left: without base; right: with base)

For cabinet units without base (in the figure on the left), the fixing screws of the transport pallets must be removed from the bottom of the pallet.
For cabinet units with base (in the figure on the right), the fixing screws of the transport pallet are accessible only after the cover is opened. They can then be loosened and removed directly from the front.

WARNING

Danger to life caused by the non-observance of restrictions concerning the weight and the center of gravity

The non-observance of restrictions concerning the weight and the center of gravity can cause death or severe injury during lifting and transport activities.

- The weight specified on the packaging and the designated center of gravity must always be taken into account when the cabinet is lifted and transported.
- This potential hazard must be taken into account particularly once you have unscrewed the cabinet units from the transport pallet.

Center of gravity of the cabinet

The diagram below shows the center of gravity of the cabinet (for all sizes), which must always be taken into account when lifting and installing the cabinet.

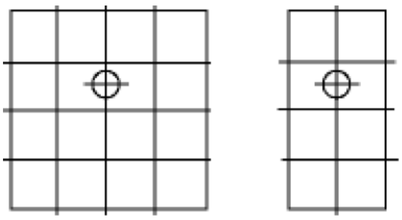


Figure 3-7 Center of gravity of the cabinet

Note

Center of gravity of the cabinet

A label with the precise position of the center of gravity of the cabinet is attached to each cabinet or each transport unit.

3.3.3.2 Disassembling the crane transport assembly

The cabinet units are equipped either with transport eyebolts of carrying rails.

Figure 3-8 Example of a carrying rail

Removal

The transport eyebolts can be unscrewed and removed. Depending on the length of the cabinet or transport unit, the support rails can have a varying number of fastening screws. These must be unscrewed and removed before the rails can be removed.

⚠ WARNING
Danger of an accident occurring due to improper handling of carrying rails The improper handling of heavy carrying rails during disassembly can cause injuries or material damage. • Ensure careful handling of the carrying rails during disassembly. • Prevent screws from falling into the unit during disassembly and so causing damage during operation.

Original roof screws

Figure 3-9 Original roof screws, accessory kit

After removing the crane transport aids, the removed transport eyebolts or the fixing screws of the transport beam must be replaced by the original roof screws from the accessories kit supplied in order to ensure compliance with the degree of protection and proper grounding of the cabinet.

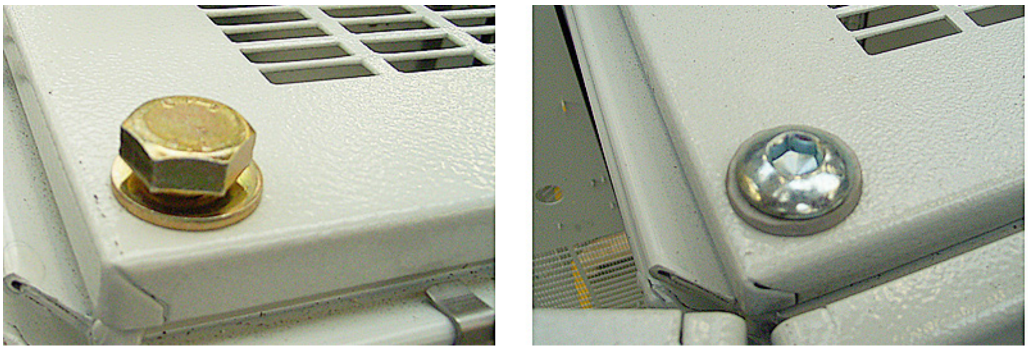


Figure 3-10 Delivery state (left), original roof screws (right)

3.3.3.3 Connection to the foundation

Connection to the foundation

Four holes for M12 screws are provided on each enclosure panel to secure the enclosure to the ground. The fixing dimensions are specified in the dimension drawings.

Every cabinet panel must be attached to the ground using at least two opposing attachment points (1 screw each in the front and rear part of the cabinet panel).
If this is not possible for reasons of accessibility, then the attachment points of the adjacent cabinet panels must be correspondingly raised.
Generally, as many attachment points as possible should be used.

3.3.4 Assembly of the air deflectors for IP20 degree of protection and type A

To ensure the correct air circulation, an additional air deflector is delivered for type A in the IP20 degree of protection that must be mounted once the cabinet has been installed.

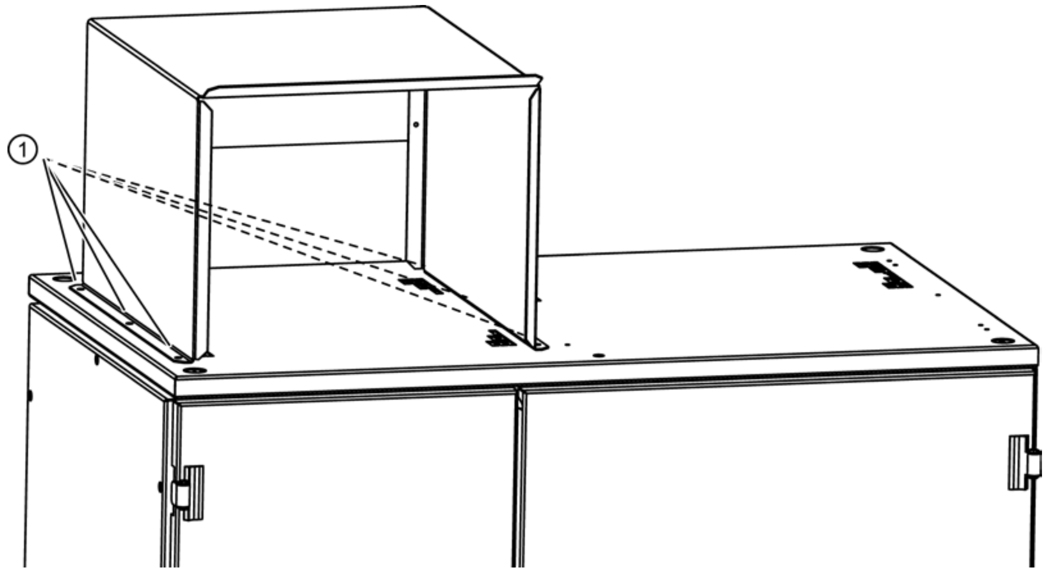


Figure 3-11 Assembly of the air deflectors for IP20 degree of protection and type A

To assemble the air deflector:

1. Position the air deflector on the top panel of the left-hand cabinet panel so that the drilled holes of the air deflector (①) match the holes of the top panel.
2. Assemble the six supplied self-tapping screws and tighten them with 5 Nm torque.

3.3.5 Fitting additional canopies (option M21) or hoods (option M23, M43, M54)

To increase the degree of protection of the cabinets from IP20 (standard) to IP21, IP23, IP43, or IP54, additional canopies or hoods are supplied. These must be fitted once the cabinets have been installed.

Description

Degree of protection IP21

The degree of protection can be increased to IP21 by fitting an additional canopy. The canopy is mounted protruding above the cabinet on spacers, 300 mm above the top cover of the cabinet. Fitting a canopy increases the height of all cabinets by 300 mm.

Degree of protection IP23

Cabinet units with degree of protection IP23 are supplied with additional hoods, as well as plastic ventilation grilles and braided plastic in the air inlet (doors) and outlet (hoods). Air escapes from the front. The hood is secured via the four crane hook holes in the cabinet. Hoods increase the height of the cabinet by 400 mm.

Degree of protection IP43

Cabinet units with degree of protection IP43 are supplied with additional hoods, as well as plastic ventilation grilles and close-meshed braided plastic in the air inlet (doors) and outlet (hoods). Air escapes from the front. The hood is secured via the four crane hook holes in the cabinet. Attaching the hoods increases the height of the cabinet units by 400 mm.
Compliance with degree of protection IP43 requires an intact filter medium, which must be serviced at regular intervals depending on the prevailing ambient conditions.

Degree of protection IP54

Cabinet units with degree of protection IP54 are supplied with additional hoods, plastic ventilation grilles, and a filter medium in the air inlet (doors) and outlet (hoods). Air escapes from the front. The hood is secured via the four crane hook holes in the cabinet. Hoods increase the height of the cabinet by 400 mm.
Compliance with degree of protection IP54 requires an intact filter medium, which must be replaced at regular intervals dependiing on the prevailing ambient conditions. Filters can be fitted and replaced from outside the cabinet relatively easily.

Note

Early mounting of the canopy or hood!

It is recommended to mount the canopy or hood at an early stage to prevent foreign matter entering the cabinet devices.

Mounting a canopy to increase the degree of protection to IP21 (option M21)

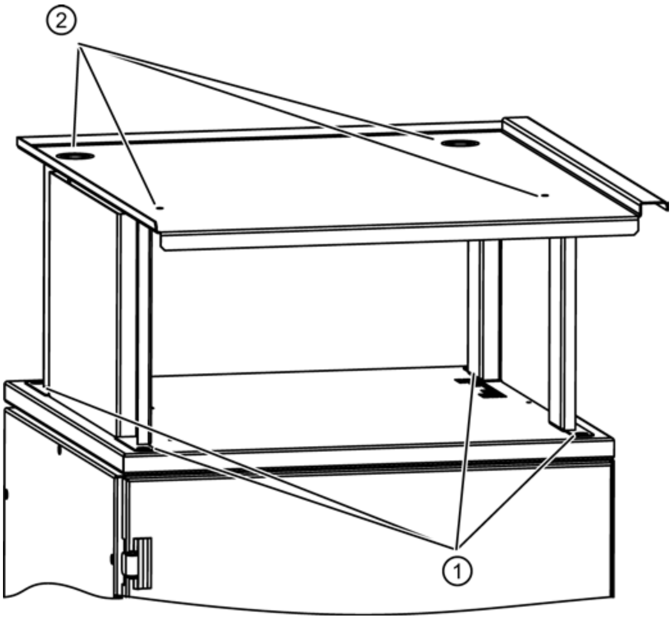


Figure 3-12 Mounting of a canopy for type C

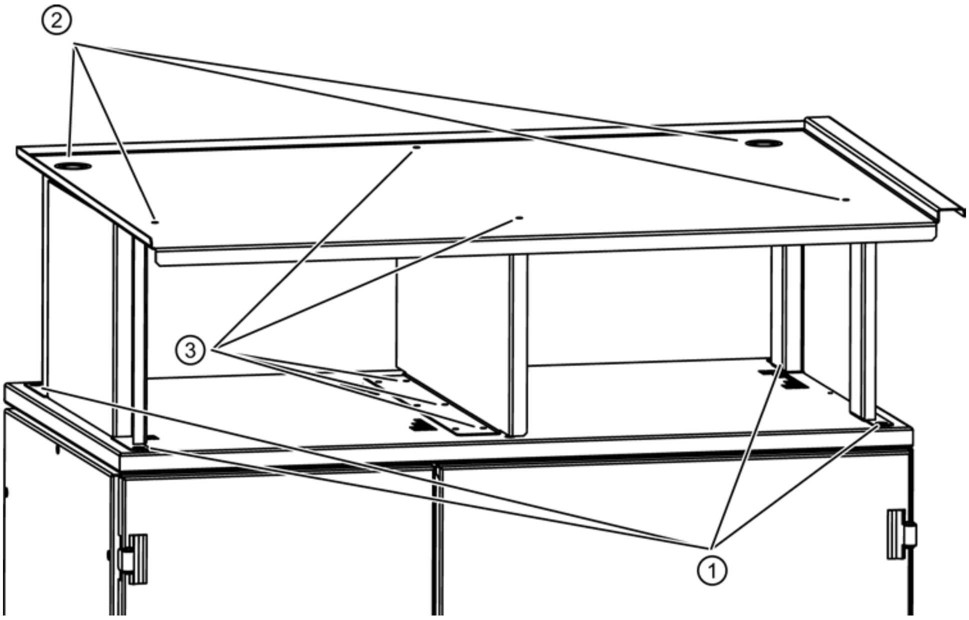


Figure 3-13 Mounting of a canopy for type A

The canopy is mounted to the cabinet roof using the original roof screws.
An additional vertical partition is mounted for type A cabinets so that the hot air from the right-hand cabinet panel cannot be drawn into the left-hand cabinet panel.

1. Remove the original roof screws and the crane transport assemblies.
2. Mount the side panels to the corners on the cabinet roof.
   Fasten the spacers using the original roof screws ① (tightening torque: 50 Nm for M12).
3. Mount the canopy on the spacers.
   Attach the screws ⑤ from above through the canopy (tightening torque: 5 Nm for M6).
4. Only for type A cabinets:
   Mount the partition in the center of the cabinet using the supplied self-tapping screws ③ (tightening torque: 5 Nm for M5) and at the top on the canopy (tightening torque: 5 Nm for M6).

Note

Mounting the canopies with cabinets connected in series

There are overlaps on the sides of the canopies to prevent water dripping into the spaces between cabinets connected in series. When fitting the canopies, make sure these overlaps engage.

Mounting a hood to increase the degree of protection to IP23/IP43/IP54 (option M23/M43/M54)

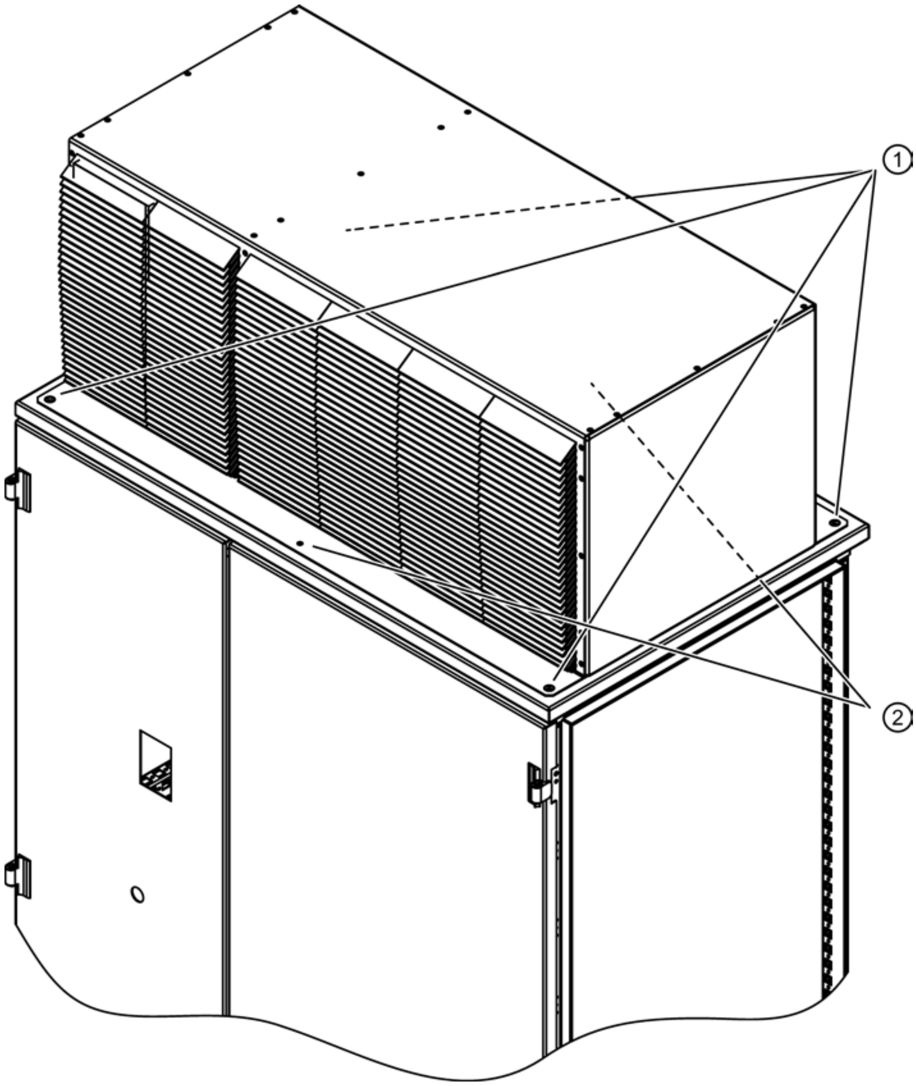


Figure 3-14 Mounting a hood

The hood is mounted to the cabinet roof using the original roof screws.

1. Remove the original roof screws and any crane transport assemblies.
2. Only for hoods of options M43 and M54:
   Use the provided sealing tape to attach the contact surfaces of the hood.
3. Mount the hood to the corners on the cabinet roof.
   Fasten the hood using the original roof screws ① (tightening torque: 50 Nm for M12).
4. Only for type A cabinets:
   Also fasten the hood in the center of the cabinet using the two supplied self-tapping screws ② (tightening torque: 5 Nm for M5).

Electrical installation 4

4.1 Section content

This section provides information on the following:

- Establishing the electrical connections for the cabinet unit
- Adjusting the fan voltage and the internal power supply to local conditions (line voltage)
- The interfaces of the cabinet unit
- The interfaces of the additional options

4.2 Checklist for electrical installation

Use the following checklist to guide you through the electrical installation procedure for the cabinet unit. Read the "Safety instructions" section at the start of these Operating Instructions before you start working on the device.

Note

Checking the checklist

Check the boxes in the "Available" column appropriately if the associated task/option applies to the cabinet unit. In the same way, check the "Completed" column once you have finished the installation procedure to confirm that the activities are complete.

<table>
<tr><th>Item</th><th colspan="2">Activity</th><th>Available</th><th>Completed</th></tr>
<tr><td colspan="3">Power connections</td><td></td><td></td></tr>
<tr><td>1</td><td colspan="2">The line-side and motor-side power cables must be dimensioned and routed in accordance with the ambient and routing conditions. The maximum permissible cable lengths between the inverter and motor must be observed depending on the type of cable used (see "Electrical installation / Power connections / Connection cross-sections and cable lengths").
The PE ground at the motor must be fed back directly to the cabinet unit.
The cables must be properly connected to the cabinet unit terminals and tightened with a torque of 50 Nm. The cables must also be connected to the motor and the low-voltage switchgear with the required torques.</td><td>☐</td><td>☐</td></tr>
<tr><td>2</td><td colspan="2">The cables between the low-voltage switchgear and the cabinet unit must be protected with line fuses to provide adequate conductor protection (DIN VDE 100, Part 430 and/or IEC 60364-4-43) With type C, combined fuses must be used for conductor and semi-conductor protection (EN 60269-4). See "Technical data" for the appropriate fuses.</td><td>☐</td><td>☐</td></tr>
<tr><td>3</td><td colspan="2">For strain relief, the cables must be clamped on the cable propping bar (C-type mounting bar).</td><td>☐</td><td>☐</td></tr>
<tr><td>4</td><td colspan="2">When EMC-shielded cables are used, screwed glands that connect the shield to ground with the greatest possible surface area must be provided on the motor terminal box. On the cabinet, the cables must be grounded with the clips supplied with the EMC shield bus with the greatest possible surface area. (The shielding busbar is included for option L00) (see "Electrical installation/EMC-conform design".)</td><td>☐</td><td>☐</td></tr>
<tr><td>5</td><td colspan="2">The cable shields must be properly applied and the cabinet properly grounded at the appropriate points (see "Electrical installation / EMC-compliant installation").</td><td>☐</td><td>☐</td></tr>
<tr><td>6</td><td colspan="2">If the unit is operated on a non-grounded supply (IT system), the connection clip for the basic interference suppression module in the Power Module must be opened (see "Electrical installation / power connections / opening the connection clip for the basic interference suppression module for operation on a non-grounded supply (IT system)").</td><td>☐</td><td>☐</td></tr>
<tr><td>7</td><td colspan="2">The type plate can be used to ascertain the date of manufacture. If the period from the date of manufacture to initial commissioning or the cabinet unit downtime is less than 2 years, the DC-link capacitors do not have to be formed. If the downtime period is longer than 2 years, they must be reformed in accordance with the description found in "Maintenance and servicing/forming the DC-link capacitors."</td><td>☐</td><td>☐</td></tr>
<tr><td>8</td><td colspan="2">With an external auxiliary supply, the cable for the 230 VAC supply must be connected to terminal –X40, while the cable for the 24 VDC supply must be connected to terminal –X9 (see "Electrical installation / power connections / external supply of the auxiliary supply from a secure line").</td><td>☐</td><td>☐</td></tr>
<tr><td>9</td><td>Option K74
Auxiliary power supply,
230 VAC</td><td>The voltage of the auxiliary power supply (-T10) must be adapted to the supply voltage of the cabinet unit (see "Electrical installation / additional connections / auxiliary power supply, 230 VAC (option K74)").</td><td>☐</td><td>☐</td></tr>
</table>

Item	Activity		Available	Completed
Signal connections				
10	Cabinet unit operation by higher-level controller / control room. The control cables must be connected in accordance with the interface assignment and the shield applied. Taking into account electrical interference and the distance from power cables, the digital and analog signals must be routed with separate cables.		☐	☐
Options				
11	Option L07 dv/dt filter compact plus Voltage Peak Limiter	During commissioning, the filter must be selected via STARTER or IOP. You are advised to check the selection by ensuring that p0230 is set to 2. The required parameters are set automatically (see "Electrical installation / Other connections / dv/dt filter compact plus Voltage Peak Limiter (option L07)").	☐	☐
12	Option L10 dv/dt filter plus Voltage Peak Limiter	During commissioning, the filter must be selected via STARTER or IOP. You are advised to check the selection by ensuring that p0230 is set to 2. The required parameters are set automatically (see "Electrical installation / Other connections / dv/dt filter plus Voltage Peak Limiter (option L10)").	☐	☐
15	Option L45 EMERGENCY OFF pushbutton installed in the cabinet door	The contacts of the EMERGENCY OFF pushbutton are available at terminal -X120 and can be picked off so that they can be integrated in an on-site higher-level protection concept (see "Electrical installation / Other connections / EMERGENCY OFF pushbutton, integrated in the door of the cabinet unit (option L45)").	☐	☐
13	Option L50 Cabinet lighting with service socket	The 230 V auxiliary supply for the cabinet lighting with an integrated service socket must be connected to terminal -X390 and protected with a fuse (max. 10 A) on-site (see "Electrical installation / Other connections / Cabinet lighting with service socket (option L50)").	☐	☐
14	Option L55 Cabinet anti-condensation heating	The 230 V auxiliary supply for the anti-condensation heating of the cabinet (230 V / 50 Hz, 100 W / or 230 V / 50 Hz 2 x 100 W for cabinets with a width of 800 ... 1200 mm) must be connected to terminals -X240: 1 to 3 and protected with fuses (max. 16 A) (see "Electrical installation / Other connections / Anti-condensation heating for cabinet (option L55)").	☐	☐
16	Option L57 EMERGENCY OFF category 0, 24 VDC	EMERGENCY OFF category 0 stops the drive in an uncontrolled manner. No additional wiring is necessary when implemented in conjunction with option L45. If the cabinet unit is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120 (see "Electrical installation / other connections / EMERGENCY OFF category 0, 24 VDC (option L57)").	☐	☐

Item	Activity		Available	Completed
17	Option L60 EMERGENCY STOP category 1, 24 VDC	EMERGENCY STOP category 1 stops the drive in a controlled manner. It may be necessary to use braking units because of the load characteristic and the required shutdown times. No additional wiring is necessary when implemented in conjunction with option L45. If the cabinet unit is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120. The timer relay at -K120 must be adapted to match system requirements (see "Electrical installation / other connections / EMERGENCY STOP category 1, 24 VDC (option L60)").	☐	☐
18	Option L62 Braking unit 50 kW / 200 kW	The connection cables and the grounding for the braking resistor must be connected to terminals G and H on the Braking Module. The thermoswitch on the braking resistor and the terminal -X30:10/11 unit must be connected (see "Electrical installation / additional connections / braking unit 50 kW (option L62)").	☐	☐

Required tools

To install the connections, you require the following tools:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench 5 Nm to 50 Nm
- Screwdriver, size 2
- T20 torx screwdriver
- T25 torx screwdriver
- T30 torx screwdriver

4.3 Insulation test

Insulation test

In accordance with EN 60204-1, an insulation test must be performed on the machine/system.

The test may be done with one of the following tests:

- Insulation resistance test
- Voltage test

⚠DANGER
Danger to life when live parts are touched during a test
Touching live parts can result in death or severe injury.
• Disconnect the machine/system from the power supply before making the test.

Insulation resistance testing

Insulation resistance testing should be preferably carried out. The insulation resistance when carrying out the test must not be less than 1 MΩ Testing is carried out with 500 VDC between the main-circuit conductors [1)] and the protective conductor system. Testing may be carried out on individual sections of the system.

Exception: A lower resistance value is permissible for certain components of the electrical equipment; however, the value must not be lower than 50 kΩ.

SINAMICS cabinet units are covered by this exception. They must therefore be disconnected during testing and tested separately.

[1)] Main circuits are circuits that are electrically connected to the line voltage.

Voltage test

Note

Test equipment for detecting voltage

Test equipment according to EN 61180-2 should be used for voltage testing.

The rated frequency for the test voltage must be 50 Hz or 60 Hz.

The maximum test voltage must be either twice the rated voltage value for the equipment power supply or 1000 V. The higher of the two values should be used. The maximum test voltage must be applied between the conductors of the main circuits [1)] and the protective conductor system for approx. 1 s.

Components and devices that are not rated to withstand this test voltage must be disconnected prior to testing.

Components and devices that have been voltage tested according to their product standard may be disconnected during testing.

The SINAMICS cabinet units are voltage tested in accordance with EN 61800-5-1 and are to be disconnected during this test.
If they cannot be disconnected, input and output terminals must be short-circuited and a bypass installed. In this case, a DC voltage that is 1.5 times the AC test voltage should be used for testing.

[1)] Main circuits are circuits that are electrically connected to the line voltage.

4.4 Important safety precautions

⚠WARNING

Danger to life if the general safety instructions and remaining risks are not carefully observed

If the general safety instructions and remaining risks are not observed, accidents can occur involving severe injuries or death.

- Observe the general safety instructions.
- When assessing the risk, take into account residual risks.

⚠WARNING

Danger to life due to electric shock when using unsuitable fuses

If unsuitable fuses are used, an electric shock can cause severe injury or death.

- Use only fuses recommended in the technical data.

⚠DANGER

Danger to life through electric shock due to the residual charge of the DC-link capacitors

Because of the DC-link capacitors, a hazardous voltage is still present for a while after the power supply has been switched off.

Contact with live parts can result in death or serious injury.

- Open the unit only after the time specified on the warning label has elapsed.
- Before starting any work, check that the system is in a voltage-free state by measuring all terminals, also to ground.

Note

Touch protection

The cabinet units for opened cabinet door have touch protection according to BGV A3 in accordance with EN 50274.

These protective covers may need to be removed during installation and connection procedures. Once work has been completed, the protective covers must be properly refitted.

4.5 Introduction to EMC

What is meant by EMC?

Electromagnetic compatibility (EMC) describes the capability of an electrical device to function satisfactorily in an electromagnetic environment without itself causing interference unacceptable for other devices in the environment.

EMC therefore represents a quality feature for the

- Internal noise immunity: Resistance to internal electrical disturbances
- External noise immunity: resistance against external electromagnetic disturbances
- Noise emission level: environmental effects caused by electromagnetic emissions

To ensure that the cabinet unit functions satisfactorily in the system, the environment subject to interference must not be neglected. For this reason, special requirements exist regarding the structure and the EMC of the system.

Operational reliability and noise immunity

In order to achieve the greatest possible operational reliability and immunity to noise of a complete system (converter, automation, drive machines etc.), measures must be taken by the converter manufacturer and the user. Only when all these measures are fulfilled can the faultless functioning of the converter be guaranteed and the specified legal requirements (2004/108/EC) be met.

Noise emissions

Product standard EN 61800–3 outlines the EMC requirements for variable-speed drive systems. It specifies requirements for converters with operating voltages of less than 1000 V. Different environments and categories are defined depending on where the drive system is installed.

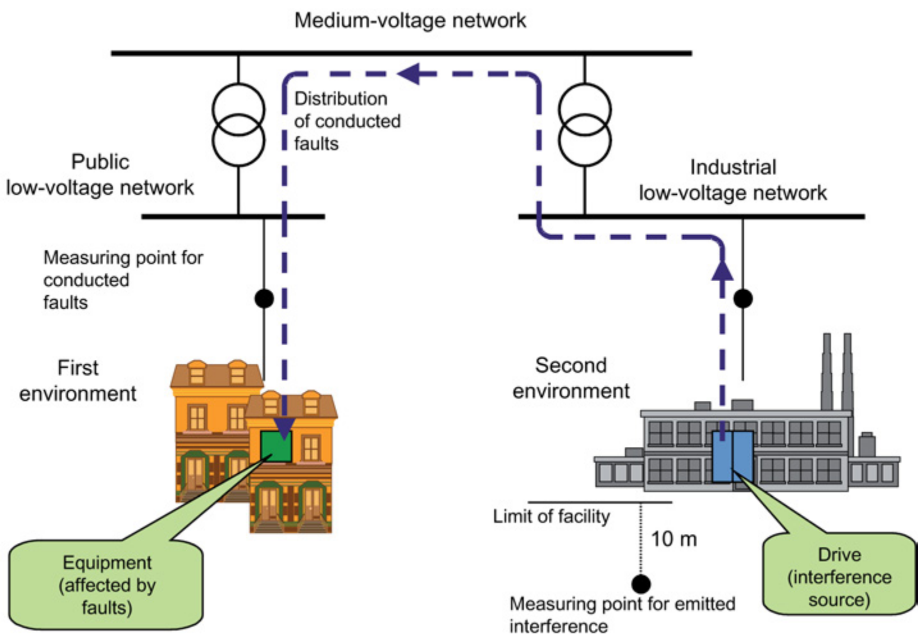


Figure 4-1 Definition of the first and second environments

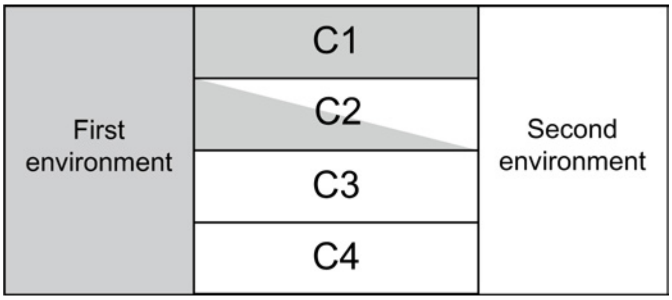


Figure 4-2 Definition of categories C1 to C4

Table 4- 1 Definition of the first and second environments

Definition of the first and second environments	
First environment	Residential buildings or locations at which the drive system is connected to a public low-voltage supply network without a transformer.
Second environment	Industrial locations supplied by a medium-voltage network via a separate transformer.

Table 4- 2 Definition of categories C1 ... C4

Definition of categories C1 ... C4	
Category C1	Rated voltage <1000 V; unrestricted use in the first environment.
Category C2	Rated voltage for stationary drive systems <1000 V; for use in the second environment. For use in the first environment only when sold and installed by skilled personnel.
Category C3	Rated voltage <1000 V; use in the second environment only.
Category C4	Rated voltage ≥1000 V or for rated currents ≥ 400 A in complex systems in the second environment.

4.6 EMC compliant design

The following section provides some basic information and guidelines that will help you comply with the EMC and CE guidelines.

cabinet assembly

- Connect painted or anodized metal components using toothed self-locking screws or remove the insulating layer.
- Use unpainted, de-oiled mounting plates.
- Establish a central connection between ground and the protective conductor system (ground).

Shield gaps

- Bridge shield gaps (at terminals, circuit breakers, contactors, and so on) with minimum impedance and the greatest possible surface area.

Using large cross-sections

- Use underground and grounding cables with large cross-sections or, better still, with litz wires or flexible cables.

Laying the motor supply cable separately

- The distance between the motor cable and signal cable should be > 20 cm. Do not lay signal cables and motor cables in parallel to each other.

Laying the equipotential bonding cable

- It is recommended to lay the equipotential bonding cable parallel to the control lines with a minimum cross-section of 16 mm^2.

Use anti-interference elements

- If relays, contactors, and inductive or capacitive loads are connected, the switching relays or contactors must be provided with anti-interference elements.

Cable installation

- Cables that are subject to or sensitive to interference should be laid as far apart from each other as possible.
- All cables are to be laid as close as possible to grounded enclosure parts such as mounting plates or cabinet frames. This reduces both noise radiation and interference injection.
- Reserve cores of signal and data cables must be grounded at both ends to achieve an additional shielding effect.
- Long cables should be shortened or laid in noise resistant areas to avoid additional connecting points.
- If it is impossible to avoid crossing cables, conductors or cables that carry signals of different classes must cross at right angles, especially if they carry sensitive signals that are subject to interference.
  - Class 1:
    unshielded cables for ≤ 60 V DC
    unshielded cables for ≤ 25 V AC
    shielded analog signal cables
    shielded bus and data cables
    operator panel interfaces, incremental/absolute encoder lines
  - Class 2:
    unshielded cables for > 60 V DC and ≤ 230 V DC
    unshielded cables for > 25 V AC and ≤ 230 V AC
  - Class 3:
    unshielded cables for > 230 V AC/DC and ≤ 1000 V AC/DC

Shield connection

- Shields must not be used to conduct electricity. In other words, they must not simultaneously act as neutral or PE conductors.
- Apply the shield so that it covers the greatest possible surface area. You can use ground clamps, ground terminals, or ground screw connections.
- Avoid extending the shield to the grounding point using a wire (pigtail) because this will reduce the effectiveness of the shield by up to 90%.
- Attach the shield to a shield bar directly after the line inlet into the cabinet. Insulate the entire shielded cable and route the shield up to the device connection, but do not connect it again.

I/O interfacing

- Create a low-impedance ground connection for additional cabinets, system components, and distributed devices with the largest possible cross-section (at least 16 mm²).
- Ground unused lines at one end in the cabinet.
- Choose the greatest possible clearance between the power and signal cables (at least 8" (20 cm)). The greater the distance over which the cables are routed in parallel, the greater the clearance must be. If a sufficient clearance cannot be maintained, you must install additional shields.
- Avoid unnecessarily long cable loops.

Filtering cables

- Line supply cables and power supply cables for devices and modules may have to be filtered in the cabinet to reduce incoming or outgoing disturbances.
- To reduce emissions, the device is equipped with a radio interference suppression filter as standard (in accordance with the limit values defined in category C3). Optional filters can be fitted for use in the first environment (category C2).

Protective ground conductors

- According to EN 61800-5-1, Section. 6.3.6.7, the minimum cross-section of the protective ground conductor must conform to the local safety regulations for protective ground conductors for equipment with a high leakage current.

4.7 Power connections

WARNING

Danger to life through electric shock caused by the interchanging or short-circuiting of the device connections

The interchanging of the power connections or the short-circuiting of the DC-link connections would damage the device that can cause death or severe injuries.

- Do not interchange input and output terminals of the device.
- Do not interchange or short-circuit the DC-link terminals.

Note

Ground leakage circuit-breaker

The device must not be operated via a ground leakage circuit-breaker (EN 61800-5-1).

4.7.1 Cable lugs

Cable lugs

The cable connections on the devices are designed for cable lugs according to DIN 46234 or DIN 46235.

For connection of alternative cable lugs, the maximum dimensions are listed in the table below.
These cable lugs are not to exceed these dimensions, as mechanical fastening and adherence to the voltage distances is not guaranteed otherwise.

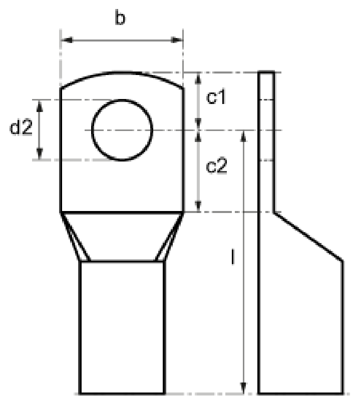


Figure 4-3 Dimensions of the cable lugs

Table 4- 3 Dimensions of the cable lugs

Screw / bolts	Connection cross-section [mm²]	d2 [mm]	b [mm]	l [mm]	c1 [mm]	c2 [mm]
M8	70	8.4	24	55	13	10
M10	185	10.5	37	82	15	12
M10	240	13	42	92	16	13
M12	95	13	28	65	16	13
M12	185	13	37	82	16	13
M12	240	13	42	92	16	13
M16	240	17	42	92	19	16

4.7.2 Connection cross-sections, cable lengths

Connection cross-sections

The connection cross-sections for the line connection, motor connection, and ground connection for your device are specified in the tables provided in the "Technical specifications" section.

Cable lengths

The maximum permissible cable lengths are specified for standard cable types or cable types recommended by SIEMENS. Longer cables can only be used after consultation.

The listed cable length represents the actual distance between the inverter and the motor, taking into account factors such as parallel laying, current-carrying capacity, and the laying factor.

- Unshielded cable (e.g. Protodur NYY):
  - Without motor-side reactors / dv/dt filter: max. 200 m
  - With motor-side reactors / dv/dt filter: max. 450 m
- Shielded cable (e.g. Protodur NYCWY, Protoflex EMV 3 Plus):
  - Without motor-side reactors / dv/dt filter: max. 100 m
  - With motor-side reactors / dv/dt filter: max. 300 m

Note

Shielded cables

The PROTOFLEX-EMV-3 PLUS shielded cable recommended by Siemens is the protective conductor and comprises three symmetrically-arranged protective conductors. The individual protective conductors must each be provided with cable eyes and be connected to ground. The cable also has a concentric flexible braided copper shield. To comply with EN 61800-3 regarding radio interference suppression, the shield must be grounded at both ends with the greatest possible surface area.

On the motor side, cable glands that contact the shield with the greatest possible surface area are recommended for the terminal boxes.

4.7.3 Connecting the motor and power cables

Connecting the motor and power cables on the cabinet unit

Note

Position of the connections

For the position of the connections, see the layout diagrams.

---

1. Open the cabinet, remove the covers (if necessary) in front of the connection panel for motor cables (terminals U2/T1, V2/T2, W2/T3; X2) and power cables (terminals U1/L1, V1/L2, W1/L3; X1).
2. Insert the cables through the elastic cable entry below the connection panel.
   For example, you can use a knife to make a circular slit to the cable entry at the appropriate positions and then introduce the cable from below so that a subsequent sealing is not required.

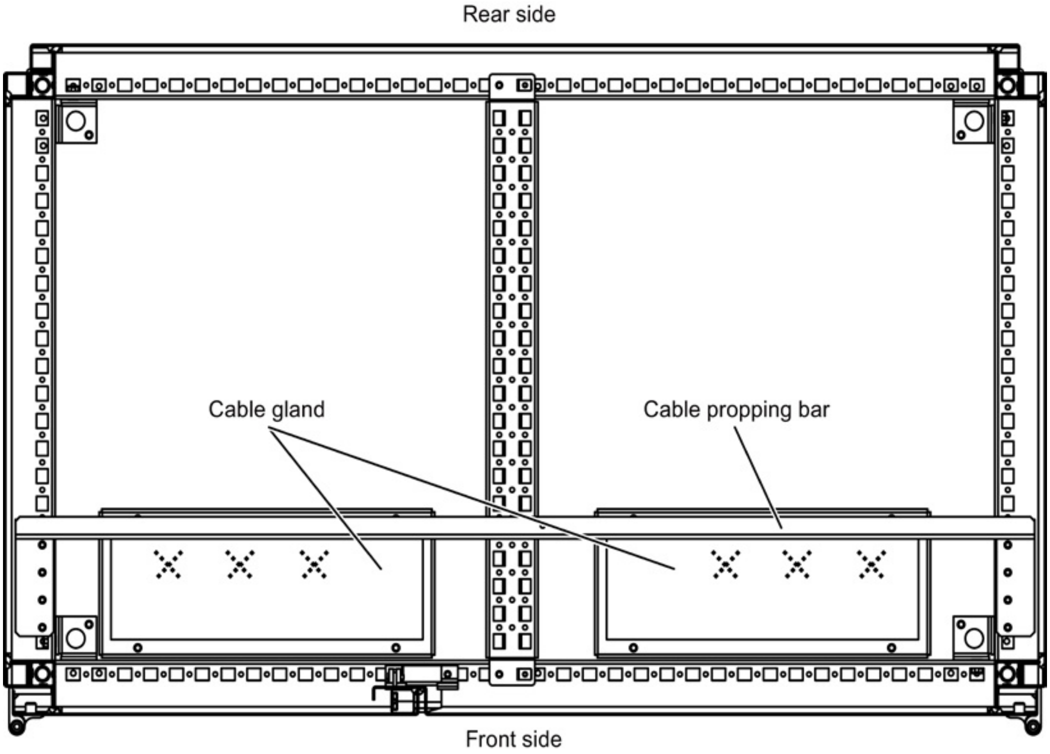


Figure 4-4 Bottom panel with cable entries with indicated cut-outs

3. Screw the protective earth (PE) into the appropriate terminal (with earth symbol) (50 Nm for M12) at the points provided in the cabinet.
4. Connect the motor cables to the connections.
   Make sure that you connect the conductors in the correct sequence: U2/T1, V2/T2, W2/T3 and U1/L1, V1/L2, W1/L3!

NOTICE
Material damage due to loose power connections
Insufficient tightening torques or vibrations can result in faulty electrical connections. This can cause fire damage or malfunctions. • Tighten all power connections with the specified tightening torques, e.g. line supply connection, motor connection, DC-link connections. • Check regularly all power connections by retightening them with the prescribed tightening torque. This applies in particular after transport.

Note

PE connection of the motor

The PE connection on the motor must be guided back directly to the cabinet unit and connected there.

Direction of motor rotation

EN 60034-7 defines the two ends of an electric motor as follows:

- DE (Drive End): usually the drive end of the motor
- NDE (Non-Drive End): usually the non-drive end of the motor

An electric motor rotates clockwise if the shaft rotates in the clockwise direction when viewing the drive end.

For electric motors with 2 shaft ends, the direction of rotation must be determined based on the shaft end specified as the drive end.

Note

Siemens motors with 2 shaft ends

For Siemens motors with two shaft ends, the drive side (DS) is the shaft end nearest to the terminal box.

For clockwise rotation, the electric motor must be connected according to the following table.

Table 4- 4 Cabinet unit and motor connection terminals

Cabinet unit (connection terminals)	Motor (connection terminals)
U2/T1	V
V2/T2	V
W2/T3	W

In contrast to the connection for the clockwise phase sequence, two phases have to be reversed with a counter-clockwise phase sequence (looking at the drive shaft).

Note

Information on the phase sequence

If the motor was connected with an incorrect direction of phase rotation, it can be corrected without replacement of the phase sequence via p1820 (reverse output phase sequence).

With motors that can be star-connected or delta-connected, it must be ensured that the windings are interconnected consistent with the operating voltage indicated on the type plate or in the motor documentation. Make sure that the winding insulation of the connected motor has sufficient insulation strength to meet the requirements for inverter operation.

4.7.4 Open the connection clip to the basic interference suppression module for operation on an ungrounded line supply (IT system)

If the cabinet unit is operated from a non-grounded supply (IT system), the connection to the basic interference suppression module of the Power Module must be opened.

> ⚠ WARNING
>
> **Danger to life through electric shock or fire with a closed connection clip for a non-grounded supply (IT system)**
>
> Failure to open the connection clip to the basic interference suppression module on a non-grounded line supply (IT system) can cause module damage or fire with damage to life due to an electric shock or smoke gas.
>
> - Open the connection clip to the basic interference suppression module for operation on an ungrounded line supply (IT system)

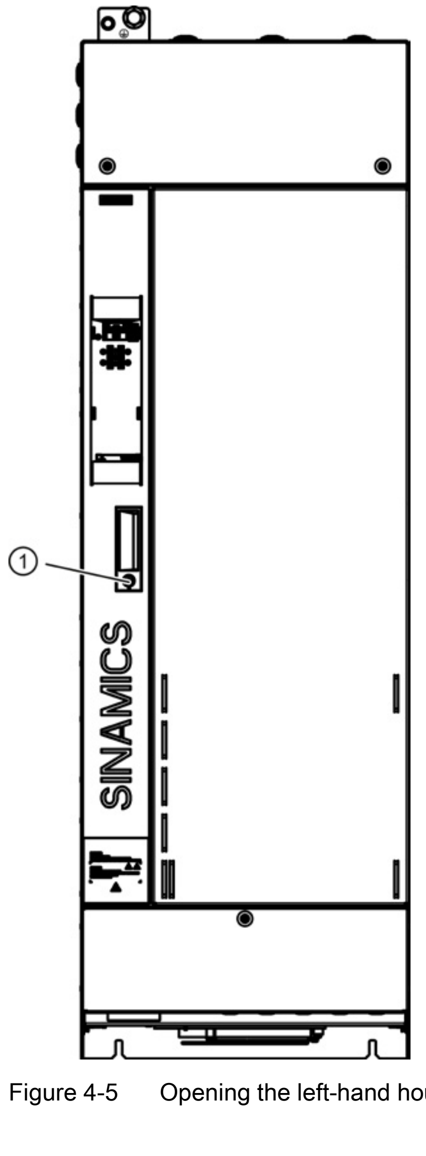


Figure 4-5 Opening the left-hand housing flap

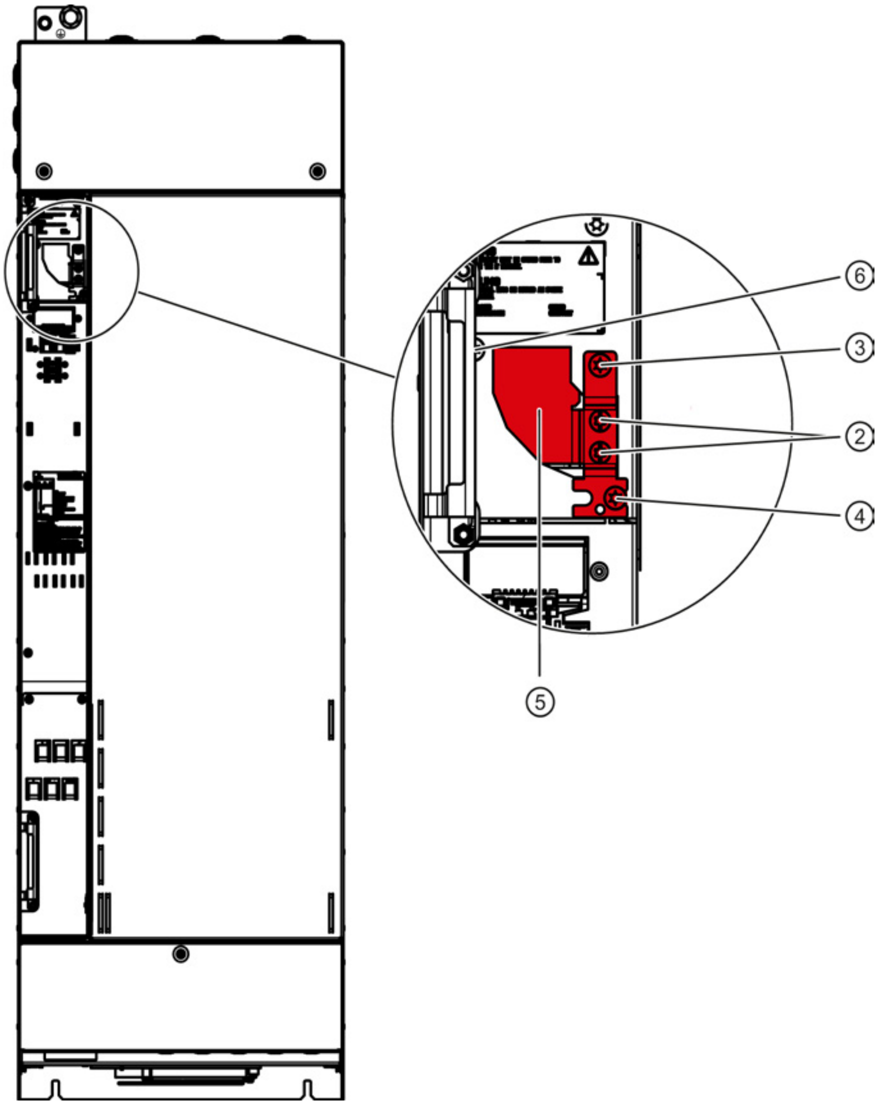


Figure 4-6 Opening the connection to the basic interference suppression module, frame size GX

The connection is opened as follows:

1. Release the left-hand housing flap by rotating latch ① and opening the housing flap.
2. Release the two screws ②; they are captive.
3. Release screws ③ and ④; however, do not remove the screws.
4. Swivel the connection clip ⑤ around the axis of rotation of screw ③ towards the left, until the connection clip can be fastened using screw ⑥.
5. Tighten screws ③ and ⑥ with 6 Nm.

4.8 External Supply of the Auxiliary Supply from a Secure Line

Description

An external auxiliary supply is always required when the communication and closed-loop control are to be independent of the supply system. An external auxiliary supply is particularly recommended for low-power lines susceptible to short-time voltage dips or power failures.

With an external supply independent of the main supply, warnings and fault messages may still be displayed on the operator panel and internal protection and monitoring devices if the main supply fails.

⚠ WARNING

Danger to life due to dangerous electrical voltage from an external auxiliary supply

When the external auxiliary supply is connected, dangerous voltages are present in the cabinet unit even when the main circuit-breaker is open. Touching live parts can result in death or severe injury.

- Observe the general safety rules when working on the device.

Note

External auxiliary supply for automatic restart

An external auxiliary supply (infeed) must always be used if the automatic restart (WEA) function is to be used with integrated EMERGENCY OFF option (L57) or EMERGENCY STOP option (L60).
Otherwise, the automatic restart function does not work.

Table 4- 5 Connection options for the external auxiliary voltage depending on the selected type and options.

Cabinet unit type and options	External supply of auxiliary voltage independent of the main supply	
	24 VDC Terminal –X9	230 VAC Terminal –X40
- With no further options - Type C	X	-
- Option L13 - Option L57, L60 - Type A and option M23, M43, M54	-	X

4.8.1 230 VAC auxiliary supply

The fuse must not exceed 16 A.

The connection is protected inside the cabinet with 3 A or 5 A.

Connection

- On terminal block -X40, remove the jumpers between terminals 1 and 2 as well as 5 and 6.
- Connect the external 230 V AC supply to terminals 2 (L1) and 6 (N).

Maximum connectable cross-section: 4 mm²

4.8.2 24 VDC auxiliary supply

The power requirement is 2 A.

Connecting

Connect the external 24 VDC supply to terminals 1 (P 24 V) and 2 (M_{ext}) of terminal block –X9.

Maximum connectable cross-section: 1.5 mm²

4.9 Signal connections

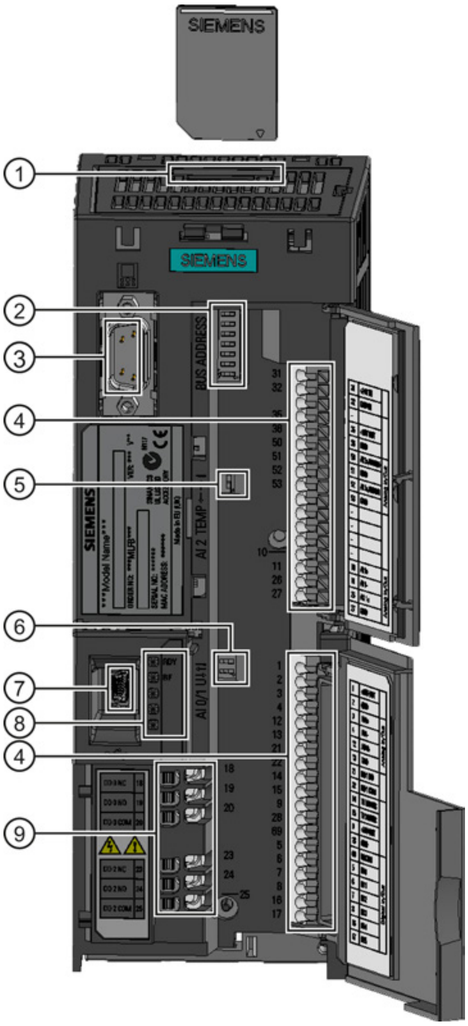
4.9.1 CU230P-2 Control Unit

One of the following CU230P-2 Control Units that handles the communication and open-loop/closed-loop control functions is provided as closed-loop module:

Control Unit	CU230P-2 PN	CU230P-2 DP	CU230P-2 HVAC	CU230P-2 CAN
Fieldbus interface	PROFINET IO	PROFIBUS DP	RS485 (USS, Modbus RTU, BACnet MS/TP, P1)	CANopen
Digital inputs	6	6	6	6
Analog inputs	4	4	4	4
Digital outputs	3	3	3	3
Analog outputs	2	2	2	2
Motor temperature sensor connection	1	1	1	1
Option short codes	K96	K97	K98	K99

4.9.1.1 CU230P-2 PN Control Unit (option K96)

Connection overview



①	Memory card slot	⑥	Switch for AI0 and AI1 (voltage/current)
②	Address switch for the fieldbus (not for CU230P-2 PN)	⑦	USB interface for connection to a PC
③	Connection to the Operator Panel	⑧	Status LEDs
④	Terminal blocks	⑨	Terminal block with 2 relay outputs
⑤	Switch for AI2 (current/temperature)		

Figure 4-7 CU230P-2 PN Control Unit connection overview

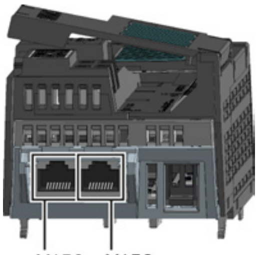


Figure 4-8 X150 - CU230P-2 PN interfaces (view from below)

The X150 P1 and P2 interfaces for connection to PROFINET are located on the device lower side.

Connection example

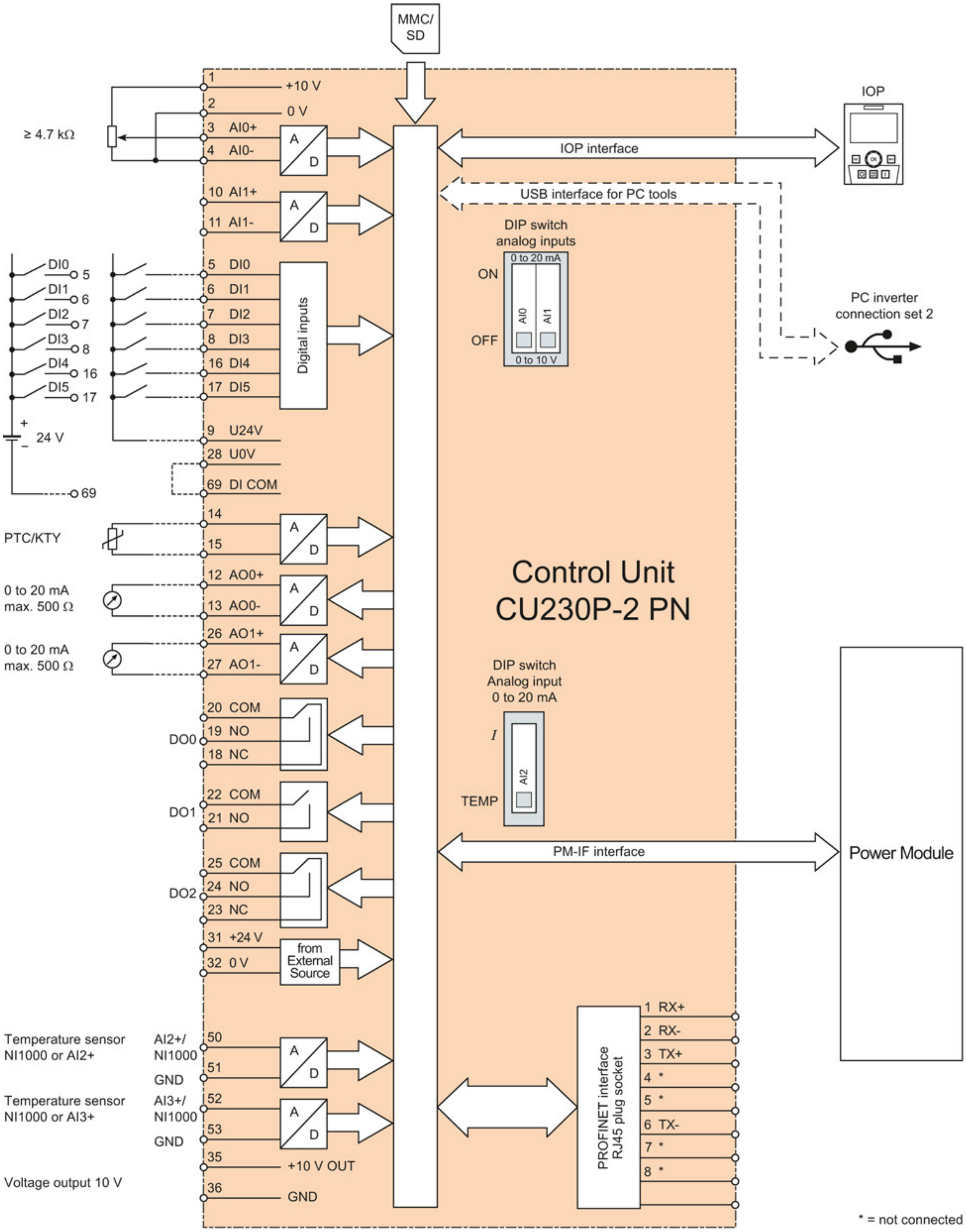


Figure 4-9 CU230P-2 PN connection example

Digital inputs

Table 4- 6 Digital inputs

Pin	Designation [1)]	Technical data
5	DI 0	Voltage: 24 VDC Maximum current consumption: 15 mA Potential separation: The reference potential is terminal 69 Switching level 0 -> 1: +11 V 1 -> 0: +5 V
6	DI 1	
7	DI 2	
8	DI 3	
16	DI 4	
17	DI 5	
69	DI COM	Reference potential for DI 0 ... 5
Max. connectable cross-section: 1.5 mm²		

1) DI: Digital input; DI COM: Ground reference

Digital outputs

Table 4- 7 Digital outputs

Pin	Designation [1)]	Technical data
18	DO 0 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
19	DO 0 NO	
20	DO 0 COM	
21	DO 1 NO	Contact type: Normally-open contact Max. switching voltage: 30 VDC Max. switching current: at 30 VDC: 0.5 A
22	DO 1 COM	
23	DO 2 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
24	DO 2 NO	
25	DO 2 COM	
Max. connectable cross-section: 2.5 mm²		

1) DO: Digital output; NO: Normally-open contact; NC: Normally-closed contact; COM: mid-position contact

Analog inputs

Table 4- 8 Analog inputs

Pin	Designation [1)]	Technical data
3	AI0+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
4	AI0-	
10	AI1+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
11	AI1-	
50	AI2+/TEMP	Non-isolated input, switchable between current and temperature sensors, type Pt1000/LG-Ni1000 Value range: - Current: 0/4 ... 20 mA - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
51	GND	Reference potential for the AI2/internal electronics ground
52	AI3+/TEMP	Non-isolated input for temperature sensors, type Pt1000/LG-Ni1000 Value range: - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
53	GND	Reference potential for the AI3/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) AI: Analog input; GND: reference potential

Analog outputs

Table 4- 9 Analog outputs

Pin	Designation [1)]	Technical data
12	AO0+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
13	GND	Reference potential for the AO0/internal electronics ground
26	AO1+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
27	GND	Reference potential for the AO1/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) AO: Analog output; GND: reference potential

Motor temperature sensor interface

Table 4- 10 Motor temperature sensor interface

Pin	Designation	Technical data
14	T1 MOTOR	Positive input for motor temperature sensor Type: PTC, KTY sensor, Thermo-Click
15	T2 MOTOR	Negative input for motor temperature sensor
Max. connectable cross-section: 1.5 mm²		

Power supply

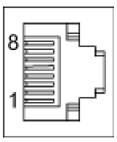
Table 4- 11 Power supply

Pin	Designation [1)]	Technical data
9	+24 V OUT	Power supply output 24 VDC, max. 200 mA
28	GND	Reference potential of the power supply/internal electronics ground
1	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
2	GND	Reference potential of the power supply/internal electronics ground
31	+24 V IN	Power supply input 18 ... 30 VDC, max. 1500 mA
32	GND IN	Reference potential of the power supply input
35	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
36	GND	Reference potential of the power supply/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) GND: reference potential

X150 P1/P2 PROFINET interface

Table 4- 12 X150 P1 and X150 P2 PROFINET

	Pin	Signal name	Technical data
	1	RXP	Receive data +
	2	RXN	Receive data -
	3	TXP	Transmit data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	TXN	Transmit data -
	7	Reserved, do not use	
	8	Reserved, do not use	
Connector type: RJ45 socket Cable type: PROFINET			

4.9.1.2 CU230P-2 DP Control Unit (option K97)

Connection overview

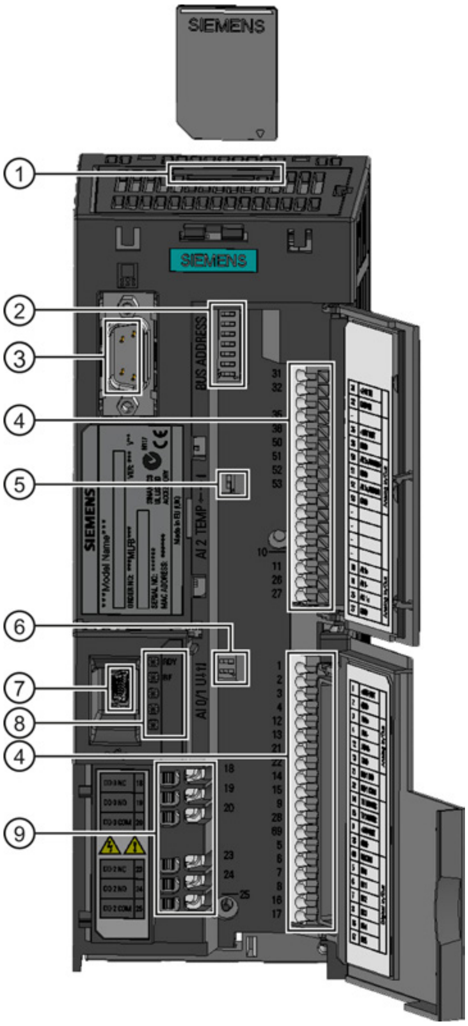


Figure 4-10 CU230P-2 DP Control Unit connection overview

CU230P-2 DP Control Unit interfaces:

① Memory card slot

② Address switch for the fieldbus

③ Connection to the Operator Panel

④ Terminal blocks

⑤ Switch for AI2 (current/temperature)

⑥ Switch for AI0 and AI1 (voltage/current)

⑦ USB interface for connection to a PC

⑧ Status LEDs

⑨ Terminal block with 2 relay outputs

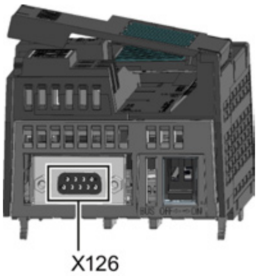


Figure 4-11 X126 - CU230P-2 DP interface (view from below)

The X126 (socket) interface for connection to PROFIBUS DP is located on the device lower side.

Connection example

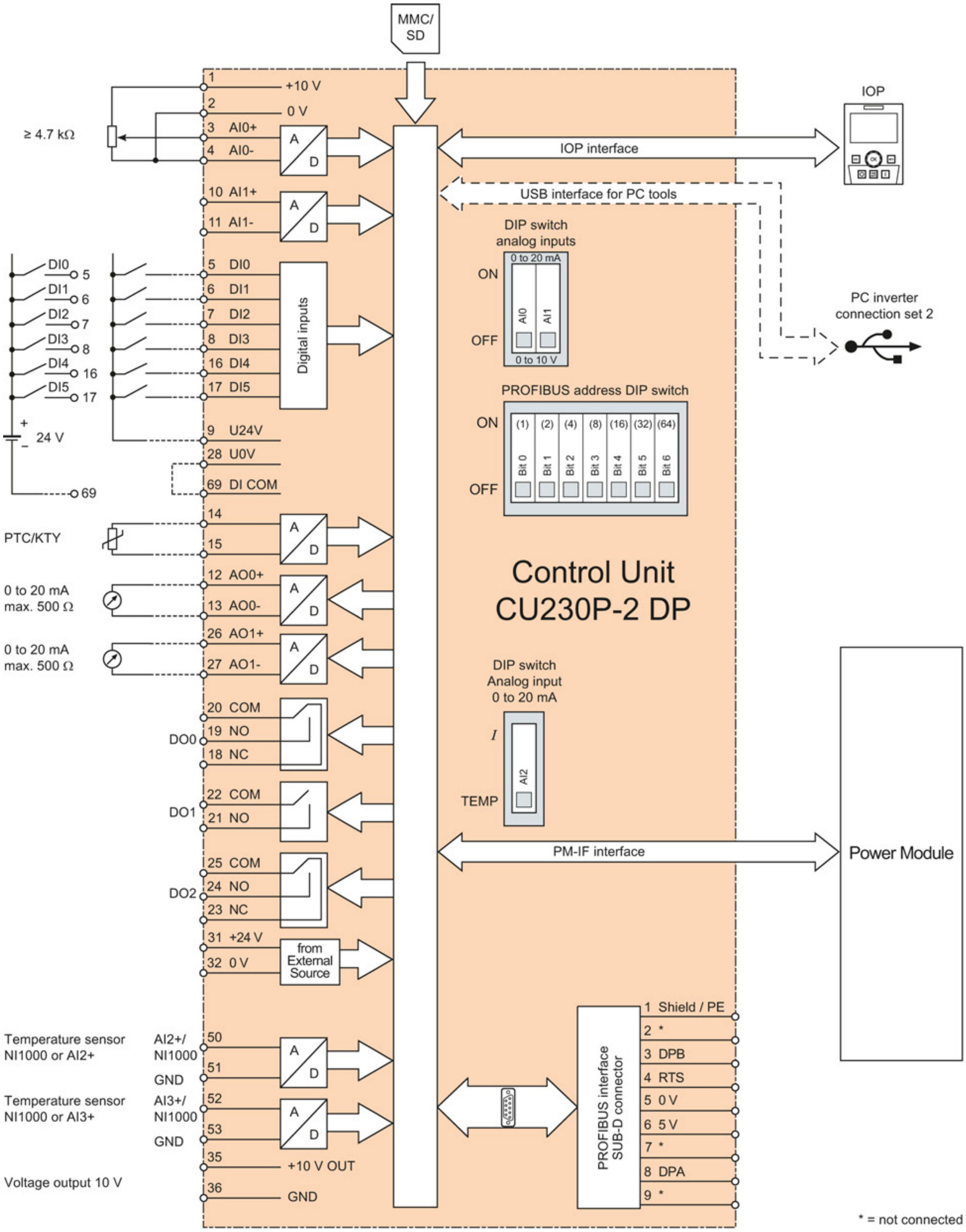


Figure 4-12 Connection example of CU320-2 DP

Digital inputs

Table 4- 13 Digital inputs

Pin	Designation [1]	Technical data
5	DI 0	Voltage: 24 VDC Maximum current consumption: 15 mA Potential separation: The reference potential is terminal 69 Switching level 0 -> 1: +11 V 1 -> 0: +5 V
6	DI 1	
7	DI 2	
8	DI 3	
16	DI 4	
17	DI 5	
69	DI COM	Reference potential for DI 0 ... 5
Max. connectable cross-section: 1.5 mm²		

[1] DI: Digital input; DI COM: Ground reference

Digital outputs

Table 4- 14 Digital outputs

Pin	Designation [1]	Technical data
18	DO 0 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
19	DO 0 NO	
20	DO 0 COM	
21	DO 1 NO	Contact type: Normally-open contact Max. switching voltage: 30 VDC Max. switching current: at 30 VDC: 0.5 A
22	DO 1 COM	
23	DO 2 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
24	DO 2 NO	
25	DO 2 COM	
Max. connectable cross-section: 2.5 mm²		

[1] DO: Digital output; NO: Normally-open contact; NC: Normally-closed contact; COM: mid-position contact

Analog inputs

Table 4- 15 Analog inputs

Pin	Designation [1)]	Technical data
3	AI0+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
4	AI0-	
10	AI1+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
11	AI1-	
50	AI2+/TEMP	Non-isolated input, switchable between current and temperature sensors, type Pt1000/LG-Ni1000 Value range: - Current: 0/4 ... 20 mA - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
51	GND	Reference potential for the AI2/internal electronics ground
52	AI3+/TEMP	Non-isolated input for temperature sensors, type Pt1000/LG-Ni1000 Value range: - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
53	GND	Reference potential for the AI3/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1)] AI: Analog input; GND: reference potential

Analog outputs

Table 4- 16 Analog outputs

Pin	Designation [1)]	Technical data
12	AO0+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
13	GND	Reference potential for the AO0/internal electronics ground
26	AO1+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
27	GND	Reference potential for the AO1/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1)] AO: Analog output; GND: reference potential

Motor temperature sensor interface

Table 4- 17 Motor temperature sensor interface

Pin	Designation	Technical data
14	T1 MOTOR	Positive input for motor temperature sensor Type: PTC, KTY sensor, Thermo-Click
15	T2 MOTOR	Negative input for motor temperature sensor
Max. connectable cross-section: 1.5 mm²		

Power supply

Table 4- 18 Power supply

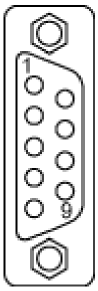
Pin	Designation [1)]	Technical data
9	+24 V OUT	Power supply output 24 VDC, max. 200 mA
28	GND	Reference potential of the power supply/internal electronics ground
1	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
2	GND	Reference potential of the power supply/internal electronics ground
31	+24 V IN	Power supply input 18 ... 30 VDC, max. 1500 mA
32	GND IN	Reference potential of the power supply input
35	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
36	GND	Reference potential of the power supply/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) GND: reference potential

X126: PROFIBUS connection

The PROFIBUS is connected by means of a 9-pin SUB D socket (X126). The connections are electrically isolated.

Table 4- 19 PROFIBUS interface X126

	Pin	Signal name	Meaning	Range
	1	-	Not assigned	
	2	M24_SERV	Power supply for teleservice, ground	0 V
	3	RxD/TxD–P	Receive/transmit data P (B)	RS485
	4	CNTR–P	Control signal	TTL
	5	DGND	PROFIBUS data reference potential	
	6	VP	Supply voltage plus	5 V ± 10%
	7	P24_SERV	Power supply for teleservice, + (24 V)	24 V (20.4 ... 28.8 V)
	8	RxD/TxD–N	Receive/transmit data N (A)	RS485
	9	-	Not assigned	

Note

Remote diagnostics

A teleservice adapter can be connected to the PROFIBUS interface (X126) for remote diagnosis purposes.
The power supply for the teleservice terminals 2 and 7 withstands a max. load and continued short-circuit current of 150 mA.

⚠ CAUTION

Do not connect CAN cables to interface X126

No CAN cables must be connected to interface X126.
If CAN cables are connected, the Control Unit and other CAN bus nodes may be destroyed.

⚠ CAUTION

Use equipotential bonding conductor

An equipotential bonding conductor with a cross-section of at least 25 mm² must be used between components in a system that are located a considerable distance from each other. If an equipotential bonding conductor is not used, high leakage currents that could destroy the Control Unit or other PROFIBUS nodes can be conducted via the PROFIBUS cable.

Connectors

The cables must be connected via PROFIBUS connectors as they contain the necessary terminating resistors.

A suitable PROFIBUS connector with a straight cable output is shown below.

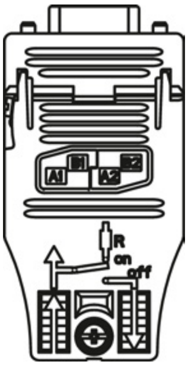


Figure 4-13 PROFIBUS connector without PG/PC connection, order number 6GK1500-0FC10

Bus terminating resistor

The bus terminating resistor must be switched on or off depending on its position in the bus, otherwise the data will not be transmitted properly.

The terminating resistors for the first and last nodes in a line must be switched on; the resistors must be switched off at all other connectors.

The cable shield must be connected at both ends over large-surface area contacts.

Note

Connector type

Depending on the connector type, the correct assignment of the connector must be ensured (IN/OUT) in conjunction with the terminating resistor.

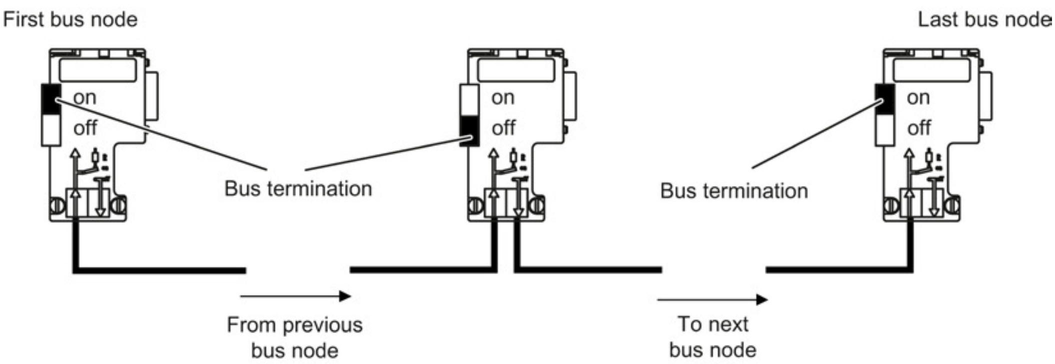


Figure 4-14 Position of the bus terminating resistors

PROFIBUS address switches

You set the PROFIBUS address of the inverter using the address switch on the Control Unit, in parameter p0918 or in STARTER.

In parameter p0918 (factory setting: 126) or in STARTER, you can only set the address if all address switches are set to "OFF" (0) or "ON" (1).

If you have specified a valid address with the address switches, this address will always be the one that takes effect and parameter p0918 cannot be changed.

Valid address range: 1 … 125

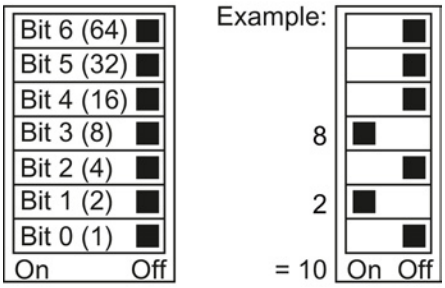


Figure 4-15 PROFIBUS address switches

After setting the address, the supply voltage must be switched off and on so that the change takes effect.

4.9.1.3 CU230P-2 HVAC Control Unit (option K98)

Connection overview

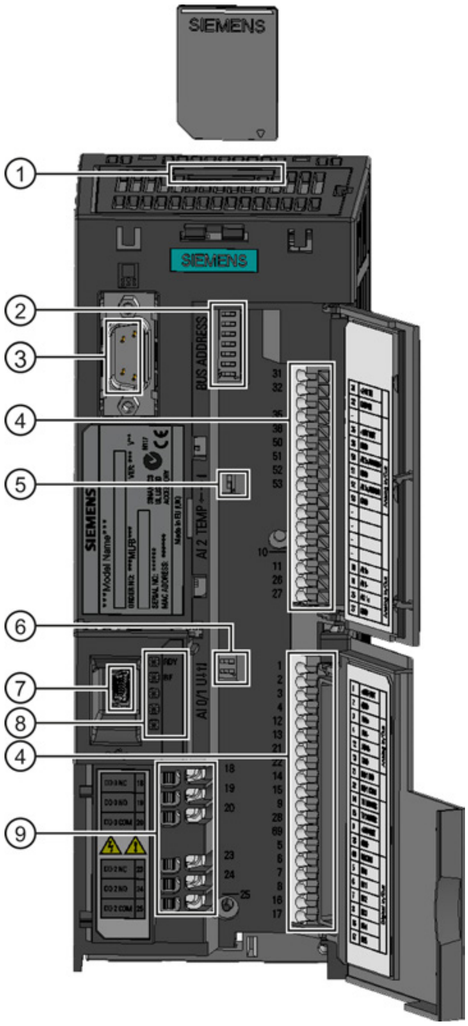


Figure 4-16 CU230P-2 HVAC Control Unit connection overview

CU230P-2 HVAC Control Unit interfaces:

① Memory card slot

② Address switch for the fieldbus

③ Connection to the Operator Panel

④ Terminal blocks

⑤ Switch for AI2 (current/temperature)

⑥ Switch for AI0 and AI1 (voltage/current)

⑦ USB interface for connection to a PC

⑧ Status LEDs

⑨ Terminal block with 2 relay outputs

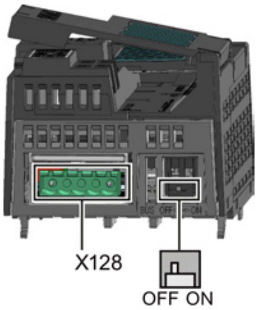


Figure 4-17 X128 - CU230P-2 HVAC interface (view from below)

The X128 interface for connections to the fieldbus and the switch with the bus terminating resistor are located on the device lower side.

Connection example

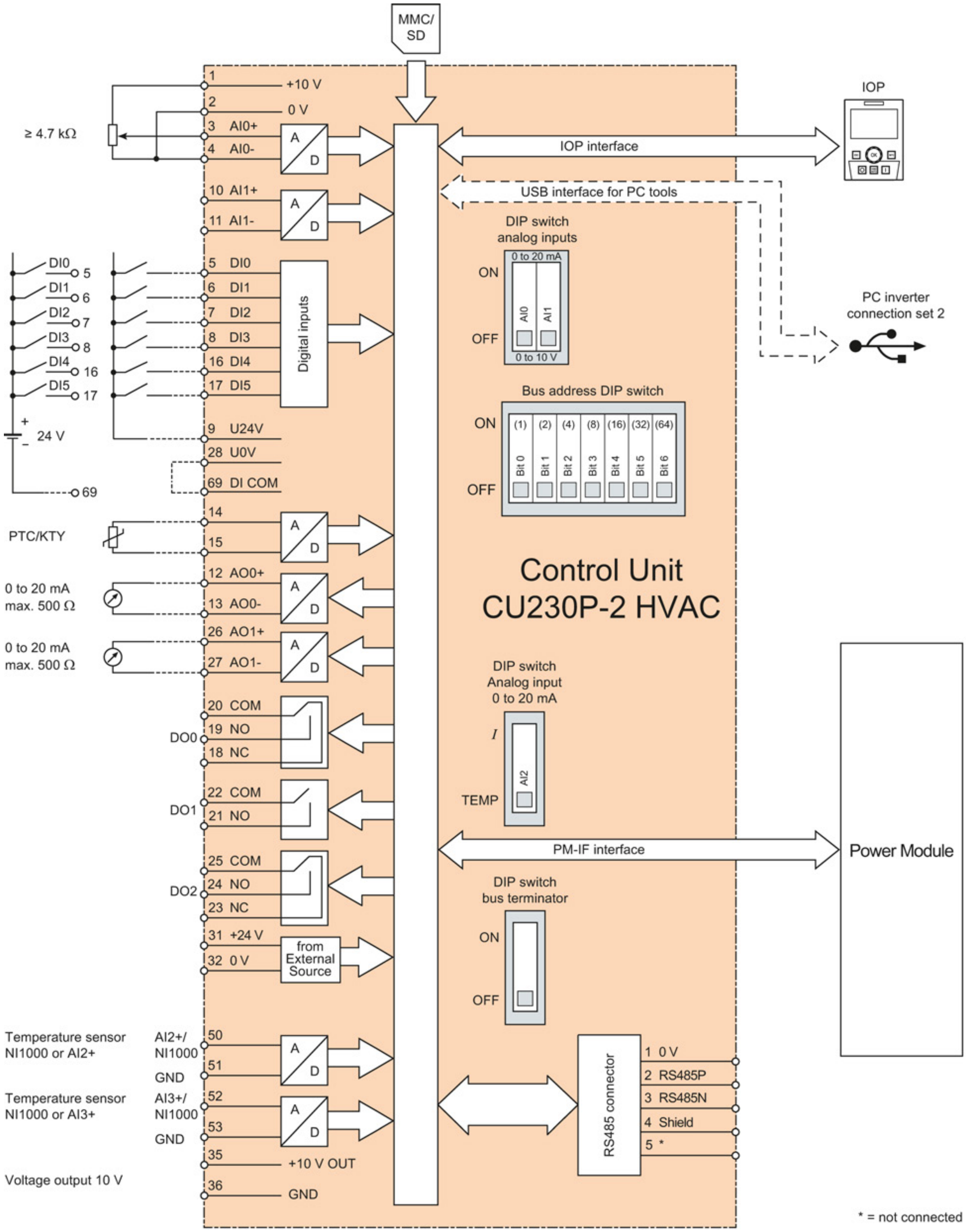


Figure 4-18 CU230P-2 HVAC connection example

Digital inputs

Table 4- 20 Digital inputs

Pin	Designation [1)]	Technical data
5	DI 0	Voltage: 24 VDC Maximum current consumption: 15 mA Potential separation: The reference potential is terminal 69 Switching level 0 -> 1: +11 V 1 -> 0: +5 V
6	DI 1	
7	DI 2	
8	DI 3	
16	DI 4	
17	DI 5	
69	DI COM	Reference potential for DI 0 ... 5
Max. connectable cross-section: 1.5 mm²		

[1)] DI: Digital input; DI COM: Ground reference

Digital outputs

Table 4- 21 Digital outputs

Pin	Designation [1)]	Technical data
18	DO 0 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
19	DO 0 NO	
20	DO 0 COM	
21	DO 1 NO	Contact type: Normally-open contact Max. switching voltage: 30 VDC Max. switching current: at 30 VDC: 0.5 A
22	DO 1 COM	
23	DO 2 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
24	DO 2 NO	
25	DO 2 COM	
Max. connectable cross-section: 2.5 mm²		

[1)] DO: Digital output; NO: Normally-open contact; NC: Normally-closed contact; COM: mid-position contact

Analog inputs

Table 4- 22 Analog inputs

Pin	Designation [1]	Technical data
3	AI0+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
4	AI0-	
10	AI1+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
11	AI1-	
50	AI2+/TEMP	Non-isolated input, switchable between current and temperature sensors, type Pt1000/LG-Ni1000 Value range: - Current: 0/4 ... 20 mA - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
51	GND	Reference potential for the AI2/internal electronics ground
52	AI3+/TEMP	Non-isolated input for temperature sensors, type Pt1000/LG-Ni1000 Value range: - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
53	GND	Reference potential for the AI3/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1] AI: Analog input; GND: reference potential

Analog outputs

Table 4- 23 Analog outputs

Pin	Designation [1]	Technical data
12	AO0+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
13	GND	Reference potential for the AO0/internal electronics ground
26	AO1+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
27	GND	Reference potential for the AO1/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1] AO: Analog output; GND: reference potential

Motor temperature sensor interface

Table 4- 24 Motor temperature sensor interface

Pin	Designation	Technical data
14	T1 MOTOR	Positive input for motor temperature sensor Type: PTC, KTY sensor, Thermo-Click
15	T2 MOTOR	Negative input for motor temperature sensor
Max. connectable cross-section: 1.5 mm²		

Power supply

Table 4- 25 Power supply

Pin	Designation [1]	Technical data
9	+24 V OUT	Power supply output 24 VDC, max. 200 mA
28	GND	Reference potential of the power supply/internal electronics ground
1	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
2	GND	Reference potential of the power supply/internal electronics ground
31	+24 V IN	Power supply input 18 ... 30 VDC, max. 1500 mA
32	GND IN	Reference potential of the power supply input
35	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
36	GND	Reference potential of the power supply/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) GND: reference potential

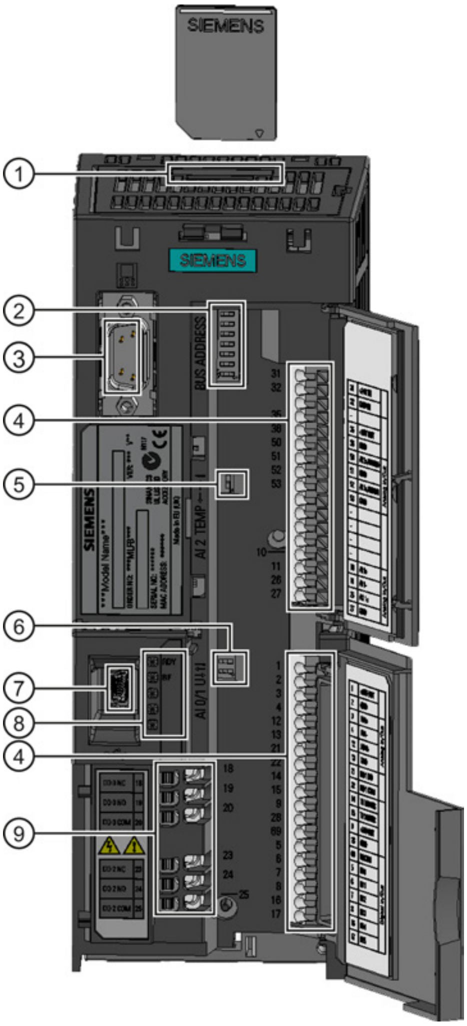
X128: serial interface (RS232)

Table 4- 26 Serial interface (RS485) X128

Terminal	Designation	Technical data
1	0 V	Ground reference
2	RS485P	Receive and transmit +
3	RS485N	Receive and transmit -
4	GND	Cable shield
5	--	not used
Max. connectable cross-section: 1.5 mm²		

4.9.1.4 CU230P-2 CAN Control Unit (option K99)

Connection overview



①	Memory card slot	⑥	Switch for AI0 and AI1 (voltage/current)
②	Address switch for the fieldbus	⑦	USB interface for connection to a PC
③	Connection to the Operator Panel	⑧	Status LEDs
④	Terminal blocks	⑨	Terminal block with 2 relay outputs
⑤	Switch for AI2 (current/temperature)		

Figure 4-19 CU230P-2 CAN Control Unit connection overview

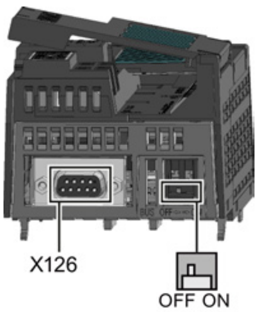


Figure 4-20 X126 - CU230P-2 CAN interface (view from below)

The X126 interface for connections to the fieldbus and the switch with the bus terminating resistor are located on the device lower side.

Connection example

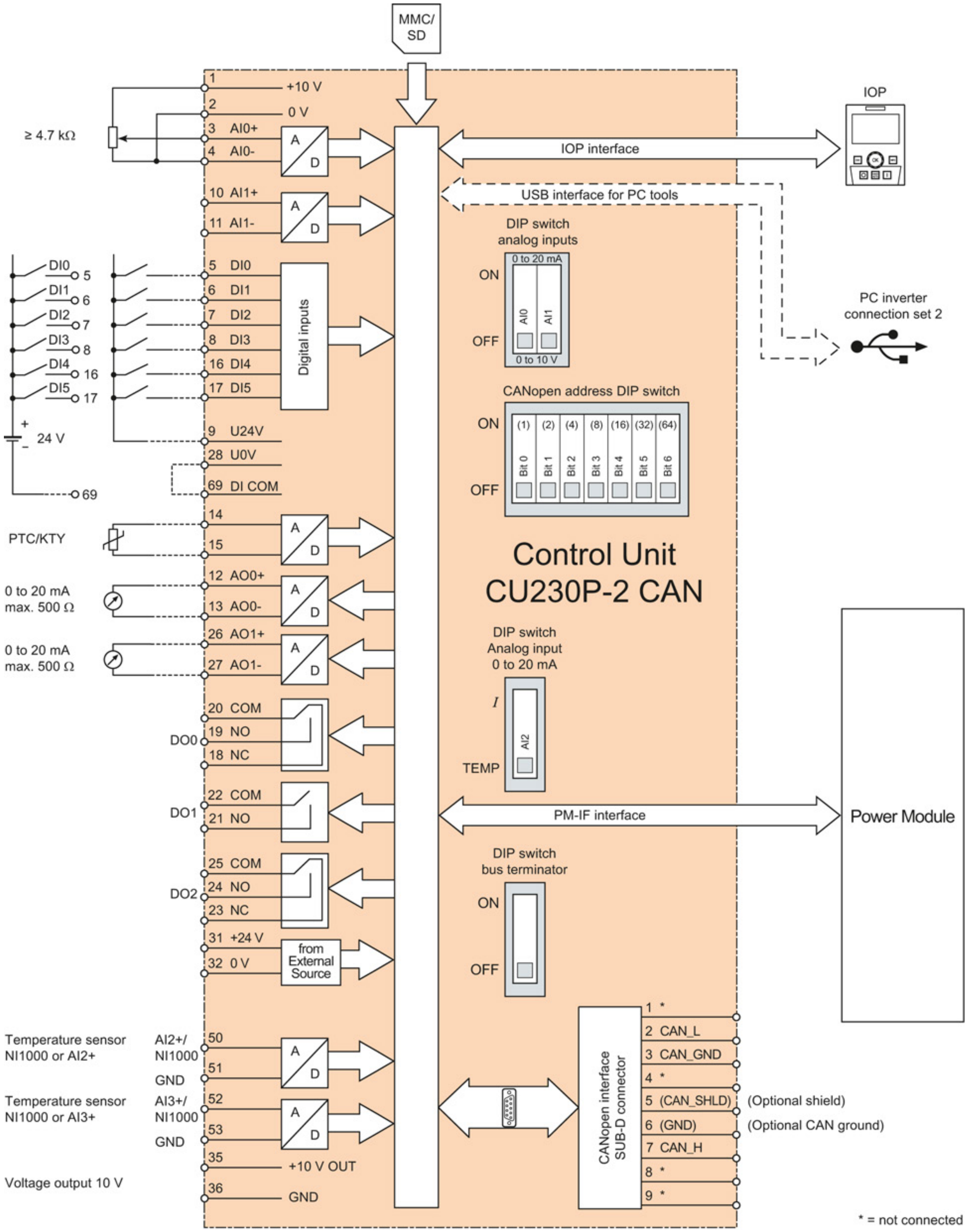


Figure 4-21 CU230P-2 CAN connection example

Digital inputs

Table 4- 27 Digital inputs

Pin	Designation 1)	Technical data
5	DI 0	Voltage: 24 VDC Maximum current consumption: 15 mA Potential separation: The reference potential is terminal 69 Switching level 0 -> 1: +11 V 1 -> 0: +5 V
6	DI 1	
7	DI 2	
8	DI 3	
16	DI 4	
17	DI 5	
69	DI COM	Reference potential for DI 0 ... 5
Max. connectable cross-section: 1.5 mm²		

1) DI: Digital input; DI COM: Ground reference

Digital outputs

Table 4- 28 Digital outputs

Pin	Designation 1)	Technical data
18	DO 0 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
19	DO 0 NO	
20	DO 0 COM	
21	DO 1 NO	Contact type: Normally-open contact Max. switching voltage: 30 VDC Max. switching current: at 30 VDC: 0.5 A
22	DO 1 COM	
23	DO 2 NC	Contact type: Changeover contact Max. switching voltage: 250 VAC, 30 VDC Max. switching current: - at 250 VAC: 2 A - at 30 VDC: 5 A
24	DO 2 NO	
25	DO 2 COM	
Max. connectable cross-section: 2.5 mm²		

1) DO: Digital output; NO: Normally-open contact; NC: Normally-closed contact; COM: mid-position contact

Analog inputs

Table 4- 29 Analog inputs

Pin	Designation [1]	Technical data
3	AI0+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
4	AI0-	
10	AI1+	Differential input, switchable between current and voltage Value range: 0 ... 10 V, -10 ... +10 V, 0/2 ... 10 V, 0/4 ... 20 mA
11	AI1-	
50	AI2+/TEMP	Non-isolated input, switchable between current and temperature sensors, type Pt1000/LG-Ni1000 Value range: - Current: 0/4 ... 20 mA - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
51	GND	Reference potential for the AI2/internal electronics ground
52	AI3+/TEMP	Non-isolated input for temperature sensors, type Pt1000/LG-Ni1000 Value range: - Pt1000: +50 ... +250° C - LG-Ni1000: +50 ... +150° C
53	GND	Reference potential for the AI3/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1] AI: Analog input; GND: reference potential

Analog outputs

Table 4- 30 Analog outputs

Pin	Designation [1]	Technical data
12	AO0+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
13	GND	Reference potential for the AO0/internal electronics ground
26	AO1+	Non-isolated output, freely programmable Value range: 0 ... 10 V, 0/4 ... 20 mA
27	GND	Reference potential for the AO1/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

[1] AO: Analog output; GND: reference potential

Motor temperature sensor interface

Table 4- 31 Motor temperature sensor interface

Pin	Designation	Technical data
14	T1 MOTOR	Positive input for motor temperature sensor Type: PTC, KTY sensor, Thermo-Click
15	T2 MOTOR	Negative input for motor temperature sensor
Max. connectable cross-section: 1.5 mm²		

Power supply

Table 4- 32 Power supply

Pin	Designation [1)]	Technical data
9	+24 V OUT	Power supply output 24 VDC, max. 200 mA
28	GND	Reference potential of the power supply/internal electronics ground
1	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
2	GND	Reference potential of the power supply/internal electronics ground
31	+24 V IN	Power supply input 18 ... 30 VDC, max. 1500 mA
32	GND IN	Reference potential of the power supply input
35	+10 V OUT	Power supply output 10 VDC ±0.5 V, max. 10 mA
36	GND	Reference potential of the power supply/internal electronics ground
Max. connectable cross-section: 1.5 mm²		

1) GND: reference potential

X126: CAN Bus connection

Table 4- 33 CAN Bus connection X12

Pin	Designation	Technical data
1	--	not used
2	CAN_L	CAN signal (dominant low)
3	CAN_GND	CAN ground
4	--	not used
5	(CAN_SHLD)	Optional shield
6	(GND)	Optional ground
7	CAN_H	CAN signal (dominant high)
8	--	not used
9	--	not used
Connector type: 9-pin SUB-D male		

4.9.2 Terminal block -X9

Note

Pre-assignment of the X9 terminal block

Depending on the cabinet type and option selection, the X9 terminal block can already be pre-assigned from the factory.

The factory setting and description of the X9 terminal block can be found in the circuit diagrams.

Position

The position of the terminal block X9 within the cabinet unit is indicated in the following diagram.

Figure 4-22 Position of the X9 terminal block

Shield support

The shield connection of shielded control cables on the terminal block -X9 is established in the immediate vicinity of the terminal block. For this purpose, the mounting plates have cutout sections which are used to snap the supplied shield springs into place. The shields of incoming and outgoing cables must be applied directly to these shield connections. It is important here to establish the greatest possible area of contact and a good conductive connection.

Note

Shield springs

These shield springs can be used for all control cables in the cabinet unit because all the shield connections are identical in design.

⚠ **CAUTION**

Danger of injury due to cut injuries occurring when the shield is connected

The sharp edges of the shield springs can cause cut injuries.

- Use the appropriate personnel protection equipment, e.g. gloves.

X9: Customer terminal block

Terminal	Name	Significance	Input/ output	Technical data
1	P24		Input	
2	M24		Input	
3	External alarm		Input	
4	External fault		Input	
5	Emergency off	Emergency Stop, Category 0	Input	
6	Emergency stop	Emergency Stop, Category 1	Input	
7	M24		Input	
8	$V_{DC\ link}$ loaded	Enable signal "$V_{DC\ link}$ charged"	Output	
9				
10				
11	HS1	Line contactor control	Output	
12	HS2	Line contactor control	Output	

Maximum connection cross section: 2.5 mm²

Note

Open input

An open input is interpreted as "low".

4.10 Other connections

Depending on the options installed, further connections have to be established, for example, 230 VAC auxiliary power supply, dv/dt filter plus Voltage Peak Limiter, connection for external auxiliary equipment, EMERGENCY OFF button, cabinet illumination with service socket, anti-condensation heating for cabinet, contactor combination (EMERGENCY OFF / EMERGENCY STOP), braking unit.

Detailed information on connecting individual options with interfaces can be found on the customer DVD supplied with the device.

4.10.1 Auxiliary power supply, 230 VAC (option K74)

Description

The auxiliary power supply provides the auxiliary voltages required for external control circuits of the cabinet unit on the plant side.

Adapting the auxiliary power supply (-T10)

A transformer (-T10) is installed to produce the auxiliary voltages of the cabinet unit. The location of the transformer is indicated in the layout diagrams supplied.

When delivered, the transformer is always set to the highest level. If necessary, jumpers must be used to change to the available line voltage.

The tables below show the appropriate transformer setting for the control power supply based on the existing line voltage.

Table 4- 34 Line voltage assignments for the internal power supply

Line voltage	Jumper at the transformer position (-T10)
380 V	31 - 38
400 V	32 – 38
415 V	31 – 37
440 V	32 – 37
460 V	32 – 36
480 V	33 – 36

Once the jumpers have been set, the secondary voltage should be 230 VAC.

Note

Consequences of unmatched transformer

If the transformer is not set to the actual line voltage, the internal power supply will not be correct.

4.10.2 dv/dt filter compact plus Voltage Peak Limiter (option L07)

Description

The dv/dt filter compact plus Voltage Peak Limiter comprises two components: the dv/dt reactor and the **V**oltage **P**eak **L**imiter, which cuts off the voltage peaks and returns the energy to the DC link. The dv/dt filter compact plus Voltage Peak Limiter is designed for use with motors for which the voltage strength of the insulation system is unknown or insufficient.

The dv/dt filter compact plus Voltage Peak Limiter limits the voltage load on the motor cables to values in accordance with the limit value curve A in compliance with IEC/TS 60034-25:2007.

The rate of voltage rise is limited to < 1600 V/µs, the peak voltages are limited to < 1400 V.

Restrictions

The following restrictions should be noted when a dv/dt filter compact plus Voltage Peak Limiter is used:

- Maximum permissible motor cable lengths:
  – Shielded cable: max. 100 m
  – Unshielded cable: max. 150 m

> ⚠ WARNING
>
> **Danger to life due to fire at the dv/dt filter for low output frequencies**
>
> Uninterrupted duty at an output frequency less than 10 Hz can produce thermal overload and destroy the dv/dt filter. The possible consequence is danger to persons due to smoke development and fire.
>
> - Do not operate a dv/dt filter compact plus Voltage Peak Limiter continuously with an output frequency less than 10 Hz.
> - Load the dv/dt filter for maximum 5 minutes for an output frequency less than 10 Hz with a subsequent duration of 5 minutes with an output frequency greater than 10 Hz.

> NOTICE
>
> **Material damage due to component failure for operation of the dv/dt filter without connected motor**
>
> When a dv/dt filter compact plus Voltage Peak Limiter is used, the drive must not be operated without a connected motor, otherwise the filter could be destroyed because of component failure.
>
> - Never operate the dv/dt filter compact plus Voltage Peak Limiter without a connected motor.

Note

Setting of pulse frequencies

It is permissible to set pulse frequencies in the range between the rated pulse frequency and the relevant maximum pulse frequency when a dv/dt filter compact plus Voltage Peak Limiter is used. "Current derating as a function of the pulse frequency" of the inverter must be observed here (refer to the technical data).

Commissioning

During commissioning, the dv/dt filter compact plus Voltage Peak Limiter must be logged on using STARTER or the IOP operator panel (p0230 = 2).

Note

Reset when establishing the factory setting

When the factory settings are established, parameter p0230 is reset.
The parameter must be reset if the system is commissioned again.

4.10.3 dv/dt filter plus Voltage Peak Limiter (option L10)

Description

The dv/dt filter plus Voltage Peak Limiter comprises two components: the dv/dt reactor and the **V**oltage **P**eak **L**imiter, which cuts off the voltage peaks and returns the energy to the DC link.

The dv/dt filters plus Voltage Peak Limiter must be used for motors for which the proof voltage of the insulation system is unknown or insufficient.

The dv/dt filter plus Voltage Peak Limiter limits the voltage gradient to values < 500 V/µs and the typical transients to the values below (with motor cable lengths of < 150 m):

- < 1000 V at V_{line} < 575 V

Restrictions

The following restrictions should be observed when a dv/dt filter plus Voltage Peak Limiter is used:

- Maximum permissible motor cable lengths:
  - Shielded cable: max. 300 m
  - Unshielded cable: max. 450 m

NOTICE
Material damage due to component failure for operation of the dv/dt filter without connected motor
When a dv/dt filter plus Voltage Peak Limiter is used, the drive must not be operated without a connected motor, otherwise the filter could be destroyed because of component failure.
• Never operate the dv/dt filter plus Voltage Peak Limiter without a connected motor.

Note

Setting of pulse frequencies

It is permissible to set pulse frequencies in the range between the rated pulse frequency and the relevant maximum pulse frequency when a dv/dt filter plus Voltage Peak Limiter is used. When so doing, take into account the "Current derating as a function of the pulse frequency; see Technical data.

Commissioning

During commissioning, the dv/dt filter plus Voltage Peak Limiter must be logged on using STARTER or the IOP operator panel (p0230 = 2).

Note

Reset when establishing the factory setting

When the factory settings are established, parameter p0230 is reset.
The parameter must be reset if the system is commissioned again.

4.10.4 EMERGENCY OFF button installed in the cabinet door (option L45)

Description

The EMERGENCY OFF button with protective collar is integrated in the door of the cabinet unit. The contacts of the button are connected to terminal block –X120. In conjunction with options L57 and L60, EMERGENCY OFF Category 0 and EMERGENCY STOP Category 1 can be activated.

A braking unit may be necessary to achieve the required shutdown times.

Note

Pressing the EMERGENCY OFF button

When the EMERGENCY OFF button is pressed, the motor coasts to a standstill and the main motor voltage is disconnected (in accordance with EN 60204-1 (VDE 0113)) in conjunction with options L57 and L60. Auxiliary voltages, such as for anti-condensation heating, may still be present. Certain sections of the inverter (e.g. the closed-loop controller or any auxiliary equipment) also remain live. If all the voltages have to be completely disconnected, the EMERGENCY OFF button must be integrated in a protection concept, which must be implemented on the line side. For this purpose, an NC contact is installed at terminal block -X120.

Connecting

Table 4- 35 Terminal block X120 –checkback contact "EMERGENCY OFF button in the cabinet door"

Terminal	Designation [1)]	Technical data
1	NC 1	Checkback contacts of EMERGENCY OFF button in cabinet door
2		Max. load current: 10 A
3	NC 2 [2)]	Max. switching voltage: 250 VAC
4		Max. switching capacity: 250 VA Required minimum load: ≥1 mA

1) NC: Normally-closed contact
2) Factory setting in inverter for options L57 and L60
Max. connectable cross-section: 4 mm^2

4.10.5 Cabinet lighting with service socket (option L50)

Description

Option L50 includes cabinet lighting with an additional service socket for grounding socket-outlet (connector type F) according to CEE 7/4. The power supply for the cabinet lighting and the service socket is external and must be fuse-protected for max. 10 A.

It is an LED flashlight with an on/off switch, magnetic holders, and an approx. 3-m connecting cable. In the as-delivered condition, the flashlight is already positioned at the defined marks in the cabinet door and the connecting cable is wound on the holder.

Note

During operation of the cabinet unit, the cabinet lighting must remain attached in its position on the cabinet door. The position on the cabinet door is marked by an adhesive label. The connecting cable must be wound on its holder.

Connection

Table 4- 36 Terminal block X390 – connection for cabinet lighting with service socket

Terminal	Designation	Technical data
1	L1	230 V AC power supply
2	N	
3	PE	Protective conductor

Max. connectable cross-section: 4 mm^2

4.10.6 Cabinet anti-condensation heating (option L55)

Description

The anti-condensation heating is used at low ambient temperatures and high levels of humidity to prevent condensation forming.

One 100 W heater is installed for a 600 mm cabinet panel, and two 100 W heaters for an 800/1000 and 1200 mm cabinet panel. The power supply (110 to 230 VAC) must be provided externally and protected with a fuse of up to 16 A.

⚠WARNING

Danger to life due to dangerous voltage when cabinet anti-condensation heating is used

When the cabinet anti-condensation heating is connected, dangerous voltages are present in the cabinet unit even when the main circuit-breaker is open. Touching live parts can result in death or severe injury.

- Observe the general safety rules when working on the device.

⚠CAUTION

Danger of injury through contact to hot surfaces on the cabinet anti-condensation heating

In operation, the cabinet anti-condensation heating can reach high temperatures, which can cause burns if touched.

- Allow the cabinet anti-condensation heating to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g. gloves.

Note

Provide power supply

The supply voltage can be provided using a temperature control on the system to avoid unnecessarily operating the anti-condensation heating for higher ambient temperatures.

Connecting

Table 4- 37 Terminal block X240 – connection for cabinet anti-condensation heating

Terminal	Designation	Technical data
1	L1	110 to 230 VAC Power supply
2	N	
3	PE	Protective conductor

Max. connectable cross-section: 4 mm^2

4.10.7 EMERGENCY STOP Category 0; 24 VDC (option L57)

Description

EMERGENCY OFF Category 0 for uncontrolled stop according to EN 60204-1. This function disconnects the cabinet unit from the power supply via the line contactor, while bypassing the electronics by means of a safety combination according to EN 60204-1. The motor then coasts to a stop. To prevent the main contactor from switching under load, an OFF2 is triggered simultaneously. The operational status is indicated by means of three LEDs (-K120).

Note

Pressing the EMERGENCY OFF button

When the EMERGENCY OFF button is pressed, an uncontrolled stop of the motor takes place and the main motor voltage is disconnected in accordance with EN 60204-1. Auxiliary voltages (e.g. for illumination or anti-condensation heating) may still be present. Certain sections of the inverter (e.g. the closed-loop controller or any auxiliary equipment) also remain live.

Connecting

Table 4- 38 Terminal block X120 – connection for EMERGENCY OFF Category 0, 24 VDC

Terminal	24 VDC pushbutton circuit
3	Loop-in the EMERGENCY OFF button from line side, remove jumper 3-6 and connect the button
6	
4	Jumper wired in the factory
5	
15	"On" for monitored start: Remove jumper 15–16 and connect the pushbutton
16	

1) NO: Normally-open contact

Max. connectable cross-section: 4 mm^2

Diagnosis

Messages output during operation and in the event of faults (meaning of LEDs on -K120) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.10.8 EMERGENCY STOP Category 1; 24 VDC (option L60)

Description

EMERGENCY STOP Category 1 for controlled stopping according to EN 60204-1. This function stops the drive by means of a quick stop along a deceleration ramp that must be parameterized. The cabinet unit is then disconnected from the power supply via the line contactor, while bypassing the electronics by means of a safety combination in accordance with EN 60204-1.
The operating state and the function are indicated by five LEDs (-K120).

Note

Pressing the EMERGENCY OFF button

When the EMERGENCY OFF button is pressed, a controlled stop of the motor takes place and the main motor voltage is disconnected in accordance with EN 60204-1. Auxiliary voltages (e.g. for illumination or anti-condensation heating) may still be present. Certain sections of the inverter (e.g. the closed-loop controller or any auxiliary equipment) may also remain live.

Connecting

Table 4- 39 Terminal block X120 – connection for EMERGENCY STOP Category 1 (24 VDC)

Terminal	Technical data
3	Loop-in EMERGENCY OFF button from line side, remove jumper 3-6 and connect the button
6	
15	"On" for monitored start: Remove jumper 15–16 and connect the pushbutton
16	

[1] NO: Normally-open contact
Max. connectable cross-section: 4 mm²

Setting

The time (0.5 to 30 s) set for the contactor safety combination (-K120) should be longer than (or at least equal to) the time that the drive requires to reach a standstill via the quick stop (OFF3 ramp-down time, p1135), as the inverter is disconnected from the power supply when the time expires (at -K120).

Diagnosis

Messages output during operation and in the event of faults (meaning of LEDs on -K120) are described in the "Additional Operating Instructions" of the Operating Instructions.

4.10.9 Braking unit 50 kW (option L62)

Description

Braking units are used when regenerative energy occurs occasionally and briefly, for example when the brake is applied to the drive (EMERGENCY STOP). Braking units comprise a Braking Module and a braking resistor, which must be fitted externally. To monitor the braking resistor, it has an integrated thermostatic switch, which is included in the shutdown circuit of the cabinet unit.

Table 4- 40 Load data for the braking units

Line voltage	Continuous chopper power P_{DB}	Chopper P_{20} output P_{20}	Braking resistor R_B	Max. current
380 V ... 480 V	50 kW	200 kW	3.1 Ω ± 8%	275 A

Installing the braking resistor

The braking resistor should not be installed in the vicinity of the inverter. The installation location must fulfill the following conditions:

- The braking resistors are only suitable for floor mounting.
- The maximum cable length between the cabinet unit and braking resistor is 100 m.
- Sufficient space must be available for dissipating the energy converted by the braking resistor.
- A sufficient distance from flammable objects must be maintained.
- The braking resistor must be installed as a free-standing unit.
- Objects must not be placed on or anywhere above the braking resistor.
- The braking resistor should not be installed underneath fire detection systems, since these could be triggered by the resulting heat.
- For outdoor installation, a hood must be provided to protect the braking resistor from precipitation (in accordance with degree of protection IP20).

⚠ WARNING

Danger to life due to fire for an inadequate installation

If an inadequate installation is performed (non-observance of the cooling clearances or inadequate separations to inflammable objects), there is the danger of fire damage with death or severe injury.

- It is essential that you maintain a cooling clearance of 200 mm on all sides of the braking resistor with ventilation grills.
- Maintain sufficient clearance to objects that can burn.

> ⚠ **CAUTION**
>
> **Danger of injury due to touching hot surfaces on the braking resistor**
>
> In operation, the braking resistor can reach high temperatures, which can cause burns if touched.
>
> - Allow the braking resistor to cool down before starting any work.
> - Use the appropriate personnel protection equipment, e.g. gloves.

Table 4- 41 Dimensions of the braking resistor

	Unit	50 kW resistor (option L62)
Width	mm	736
Height	mm	1321
Depth	mm	484

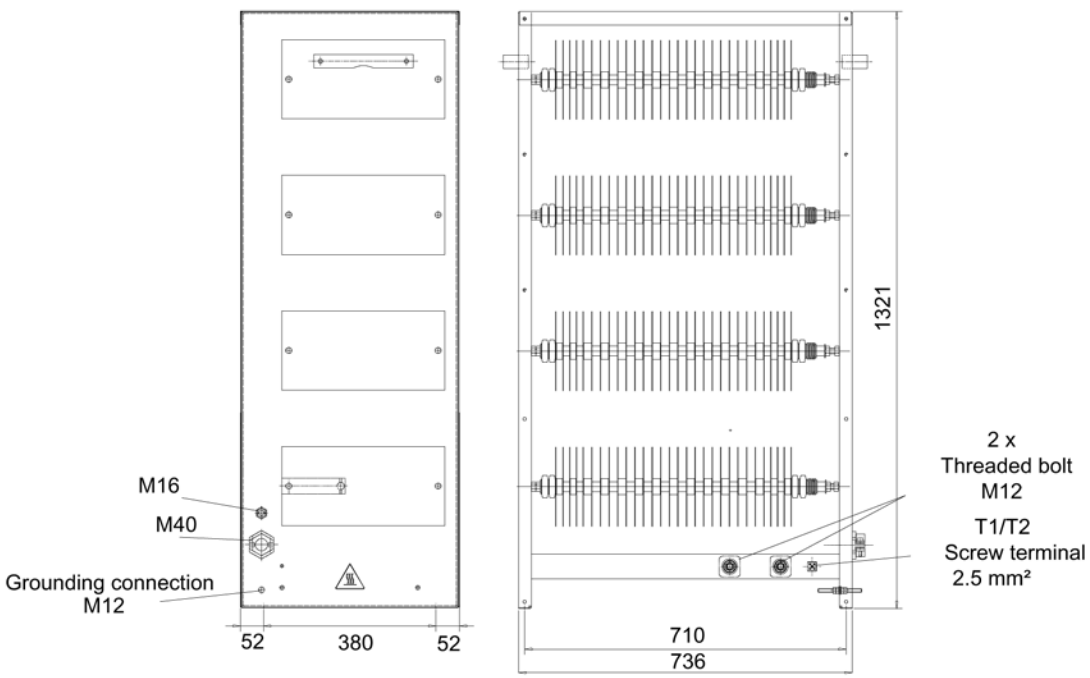


Figure 4-23 Dimension drawing for braking resistor (50 kW)

Connecting the braking resistor

WARNING

Danger to life due to fire caused by ground fault / short-circuit for non-protected connections to the braking resistor

Non-fused connections to the braking resistor can cause fire with smoke development in the event of a short-circuit or ground fault that can cause severe injuries or death.

- Lay the cables to the braking resistor so that a ground fault or short-circuit is precluded.
- Comply with local installation regulations that enable this fault to be ruled out.
- Protect the cables from mechanical damage.
- Adopt one of the following measures:
  - Use cables with double insulation.
  - Maintain adequate clearances, using spacers, for example.
  - Route the cables in separate cable ducts or pipes.

NOTICE

Material damage due to exceeding the maximum permitted cable length

Exceeding the maximum permitted cable length to the braking resistor can cause material damage in the event of component failure.

- Observe the maximum cable length between the cabinet unit and the braking resistor of 100 m.

Table 4- 42 Terminals G and H on the Braking Module – connection for external braking resistor

Terminal	Description of function
G	Braking resistor connection
H	Braking resistor connection

Max. connectable cross-section:
- Finely stranded: 35 mm²
- Multi-stranded: 50 mm²

Connecting the thermostatic switch

The thermoswitch in the external braking resistor is connected at terminal X30:10/11. In the delivered state, a jumper is present on both terminals that must be removed to evaluate the thermoswitch.

If the thermoswitch is tripped, the external failure 1 (F07860) is initiated and the inverter switched-off with OFF2.

Table 4- 43 Connection of the thermoswitch to the external braking resistor

Terminal	Description of function	Technical data
T1	Thermostatic switch connection	Voltage: 250 VAC Load current: Max. 1 A
T2	Thermostatic switch connection	

Max. connectable cross-section: 2.5 mm²

Table 4- 44 Connection of the external braking resistor thermoswitch to terminal X30

Terminal	Description of function
10	Thermostatic switch connection
11	Thermostatic switch connection

Max. connectable cross-section: 2.5 mm²

4.10.9.1 Commissioning

Option L62 must be selected for commissioning using STARTER or IOP.

For operation with a braking chopper, the braking power of the braking resistor must be entered into parameter p0219. As a consequence, the Vdc max controller is automatically deactivated (p1240 = 0) and the minimum ramp-down time (p1127) and the regenerative power limit (p1531) are adapted.

4.10.9.2 Diagnosis and duty cycles

Diagnosis

If the thermostat is opened due to a thermal overload on the braking resistor, fault F7860 ("External Fault 1") is triggered and the drive is switched off with OFF2.

If the braking chopper initiates a failure and generator energy is still present, the drive will be shutdown with fault F30002 "DC-link overvoltage" with OFF2.

Duty cycles

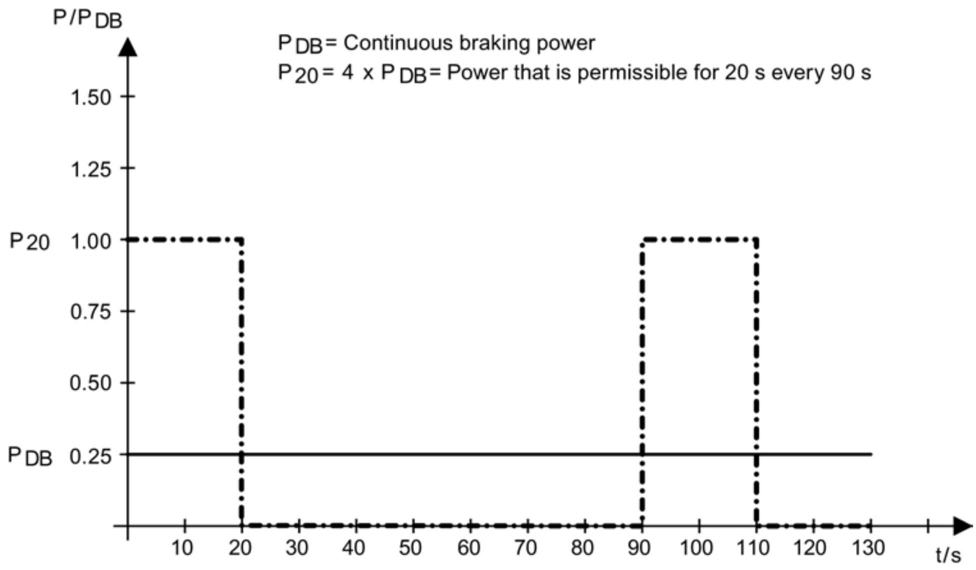


Figure 4-24 Duty cycles for the braking resistors

4.10.9.3 Threshold switch

The response threshold at which the Braking Module is activated and the DC-link voltage generated during braking are specified in the following table.

Table 4- 45 Response thresholds of the Braking Module

Rated voltage	Response threshold	Switch position	Comment
380 ... 480 V	770 V	1	770 V is the delivery condition setting. With line voltages of between 380 V and 400 V, the response threshold can be set to 670 V to reduce the voltage stress on the motor and drive. This does, however, reduce the possible braking power with the square of the voltage (670/770)² = 0.75. The maximum possible braking power is therefore 75%.
	670 V	2	

5 Commissioning

5.1 Section content

This section provides information on the following:

- Pre-assignment of inputs/outputs and wiring for p0015 macros
- Initial commissioning of the cabinet unit (initialization) with STARTER and IOP
  - Entering the motor data (drive commissioning)
  - Entering the most important parameters (basic commissioning), concluding with motor identification

Important information prior to commissioning

> ⚠ **WARNING**
>
> **Danger to life if the safety instructions and residual risks are not carefully observed**
>
> If the general safety instructions and remaining risks are not observed, accidents can occur involving severe injuries or death.
>
> - Observe the general safety instructions.
> - When assessing the risk, take into account residual risks.

> ⚠ **WARNING**
>
> **Danger to life as a result of incorrect or modified parameterization**
>
> As a result of incorrect parameterization, machines can malfunction, which in turn can lead to injuries or death.
>
> - Protect the parameterization (parameter assignments) against unauthorized access.
> - Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

The cabinet unit offers a varying number of internal signal interconnections depending on the delivery condition and the options installed. For the inverter control to be able to process the signals correctly, several software settings must be made.

During initial power-up of the Control Unit and during the initial commissioning, parameter macros are executed and the necessary settings made.
The settings are documented in the Appendix.

After initial power-up, initial commissioning, and also following a "Parameter reset to factory settings," individual parameter values deviate from the factory settings stated in the List Manual.

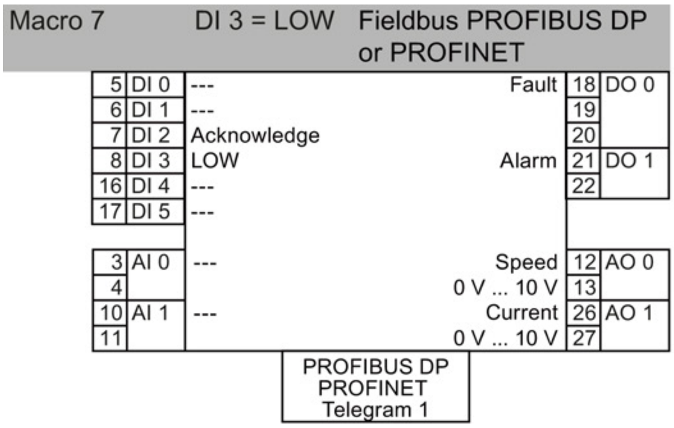
5.2 Pre-assignment of inputs/outputs and wiring via p0015 macros

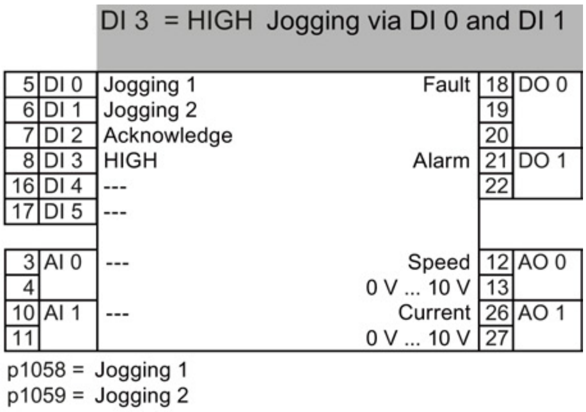
Example for (p0015) I/O pre-assignments macro

The following examples show the pre-assigned inputs and outputs defined automatically depending on the macro that is selected during the initial commissioning. Because the assignments of the inputs and outputs are specific for each Control Unit type, the following information serves only as example. The inputs and outputs can be configured manually if no suitable macro for the application can be found.

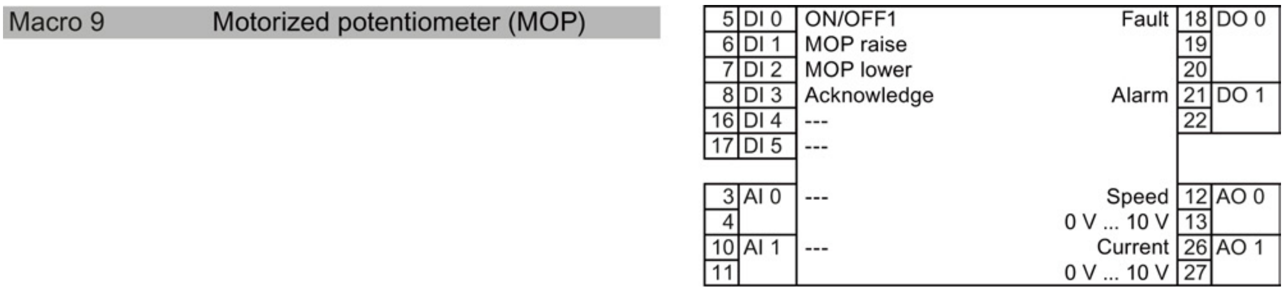
Automatic/local - Changeover between fieldbus and jog mode

Factory setting for inverters with PROFIBUS or PROFINET interface:





Motorized potentiometer



Applications with analog setpoint

Macro 12 — Setpoint via analog input

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	Reversing		19	
7	DI 2	Acknowledge		20	
8	DI 3	---	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	Setpoint	Speed	12	AO 0
4		I□■U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Process industry

Macro 14 — DI 3 = LOW — Fieldbus PROFIBUS DP or PROFINET

5	DI 0	---	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

PROFIBUS DP
PROFINET
Telegram 20

DI 3 = HIGH — Motorized potentiometer (MOP)

5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH	Alarm	21	DO 1
16	DI 4	MOP raise		22	
17	DI 5	MOP lower			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Macro 15 — DI 3 = LOW — Analog setpoint

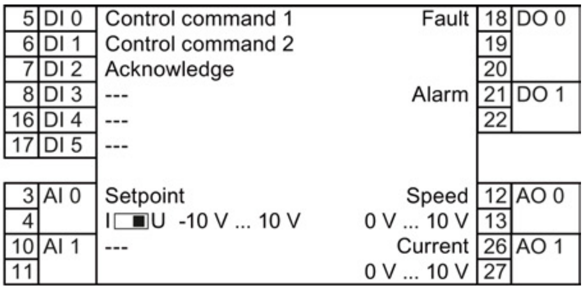
5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	LOW	Alarm	21	DO 1
16	DI 4	---		22	
17	DI 5	---			
3	AI 0	Setpoint	Speed	12	AO 0
4		I□■U -10 V ... 10 V	0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

DI 3 = HIGH — Motorized potentiometer (MOP)

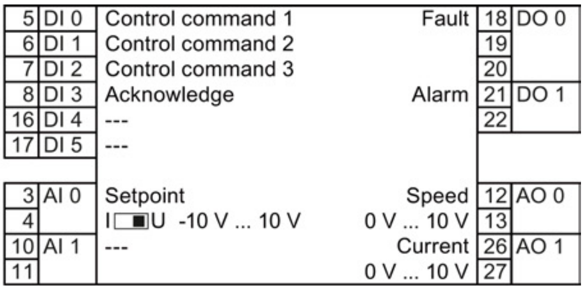
5	DI 0	ON/OFF1	Fault	18	DO 0
6	DI 1	External fault		19	
7	DI 2	Acknowledge		20	
8	DI 3	HIGH	Alarm	21	DO 1
16	DI 4	MOP raise		22	
17	DI 5	MOP lower			
3	AI 0	---	Speed	12	AO 0
4			0 V ... 10 V	13	
10	AI 1	---	Current	26	AO 1
11			0 V ... 10 V	27	

Two- or three-wire control

	Macro 12	Macro 17	Macro 18
Two-wire control	Method 1	Method 2	Method 3
Control command 1	ON/OFF1	ON/OFF1 clockwise	ON/OFF1 clockwise
Control command 2	Reversing	ON/OFF1 counterclockwise	ON/OFF1 counterclockwise

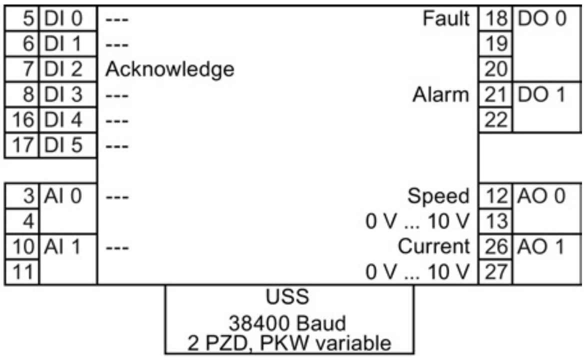


	Macro 19	Macro 20
Three-wire control	Method 1	Method 2
Control command 1	Enable/OFF1	Enable/OFF1
Control command 2	ON clockwise	ON
Control command 3	ON counterclockwise	Reversing



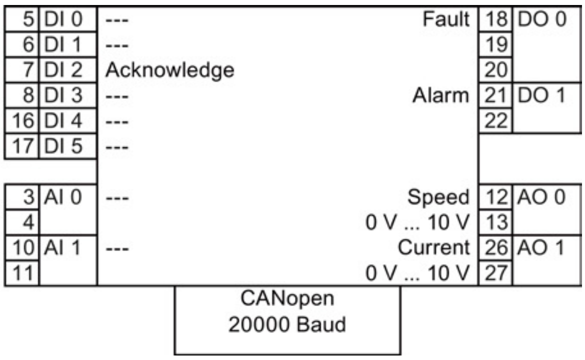
Communication with a higher-level control via USS

Macro 21	Fieldbus USS
	p2020 = Baud rate p2022 = PZD number p2023 = PKW count



Communication with a higher-level control via CANopen

Macro 22	Fieldbus CANopen
	p8622 = CAN bit rate



5.3 STARTER commissioning tool

Description

You can use the STARTER commissioning tool to configure and commission SINAMICS drives and drive systems. The drive can be configured using the STARTER drive configuration wizard.

Note

STARTER online help

This section shows you how to carry out commissioning using STARTER. STARTER features a comprehensive online help function, which provides detailed explanations of all the processes and available system settings.
For this reason, this section only describes the individual commissioning steps.

Prerequisite: STARTER Version

The following STARTER version is required for commissioning SINAMICS with firmware V4.6:

- STARTER V4.3.2

Prerequisites for installing STARTER

Hardware

The following minimum requirements must be complied with:

- PG or PC
- Pentium III, at least 1 GHz, (> 1 GHz recommended)
- 1 GB work memory (2 GB recommended)
- Screen resolution 1024×768 pixels, 16-bit color depth
- Free hard disk space > 3 GB

Software

The following minimum prerequisites must be observed when using STARTER without an existing STEP-7 installation:

- Microsoft Internet Explorer V6.0 or higher

32-bit operating systems:

- Microsoft Windows 2003 Server SP2
- Microsoft Windows Server 2008
- Microsoft Windows XP Professional SP2 *) and SP3
- Microsoft Windows 7 Professional incl. SP1
- Microsoft Windows 7 Ultimate incl. SP1
- Microsoft Windows 7 Enterprise incl. SP1 (standard installation)

64-bit operating systems:

- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 7 Enterprise SP1 (standard installation)
- Microsoft Windows Server 2008 R2

*) restricted test scope

STARTER setup is possible with native Windows versions with Asian languages only if the Windows XP or Windows 7 software is an MUI version.

Acrobat Reader V5.0 or higher is required to open the function diagrams in the online help.

Note

Requirements in conjunction with STEP7

If STARTER is used in combination with other STEP7 components, the prerequisites for the S7 components shall apply.

5.3.1 Installing STARTER

STARTER is installed using the "setup" file on the customer DVD supplied. When you double-click the "Setup" file, the installation Wizard guides you through the process of installing STARTER.

Note

Installation time

The installation time depends on the computer performance and from where the software is installed (e.g. DVD, hard disk, network). We recommend that you install the software from a local data carrier.

5.3.2 Explanations regarding the STARTER user interface

STARTER features four operating areas:

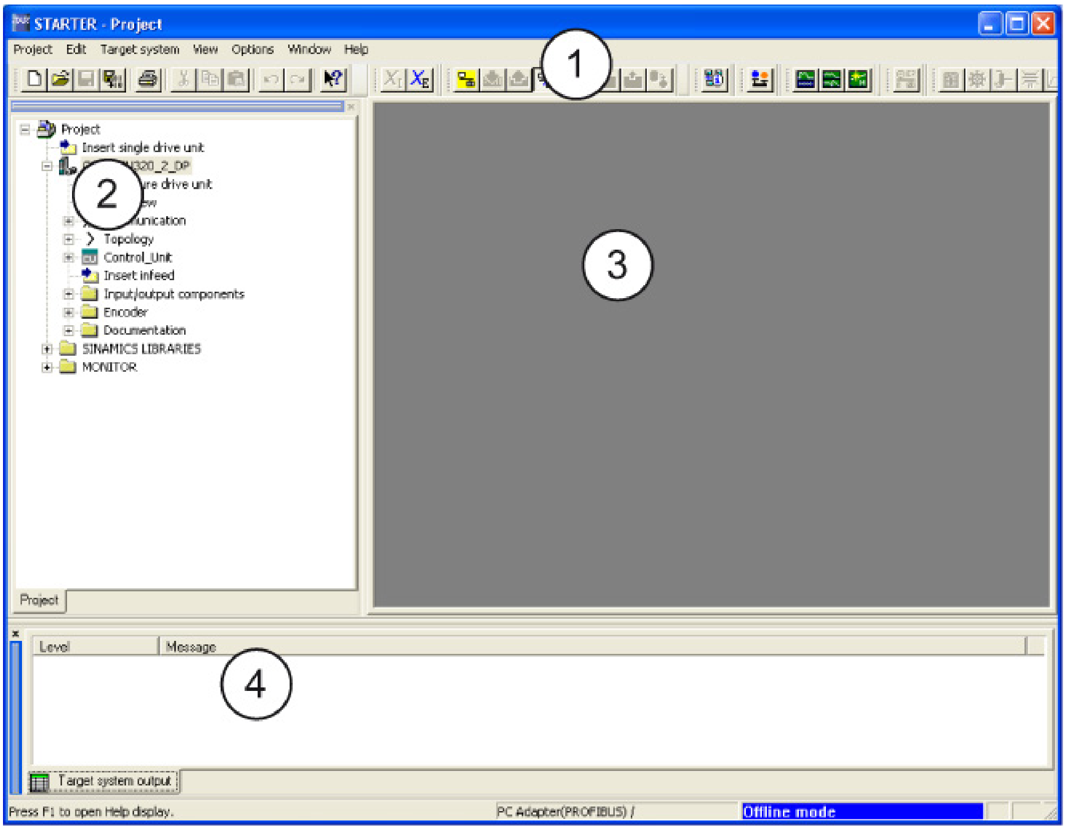


Figure 5-1 STARTER operating areas

Operating area	Explanation
1: Toolbars	In this area, you can access frequently used functions via the icons.
2: Project navigator	The elements and projects available in the project are displayed here.
3: Working area	In this area, you can change the settings for the drive units.
4: Detail view	Detailed information about faults and alarms, for example, is displayed this area.

5.4 Procedure for commissioning via STARTER

Basic procedure using STARTER

STARTER uses a sequence of dialog screens for entering the required drive unit data.

Note

Default settings in dialog screens

These dialog screens contain default settings, which you may have to change according to your application and configuration.

This is intentional!
Objective: By taking time to consider what configuration data you enter, you can prevent inconsistencies between the project data and drive unit data (identifiable in online mode).

5.4.1 Creating the project

Click the STARTER symbol on the desktop to start the STARTER commissioning tool.

The first time you run the software, the main screen (shown below) appears with the following windows:

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below as a numbered step sequence.

Accessing the STARTER project wizard

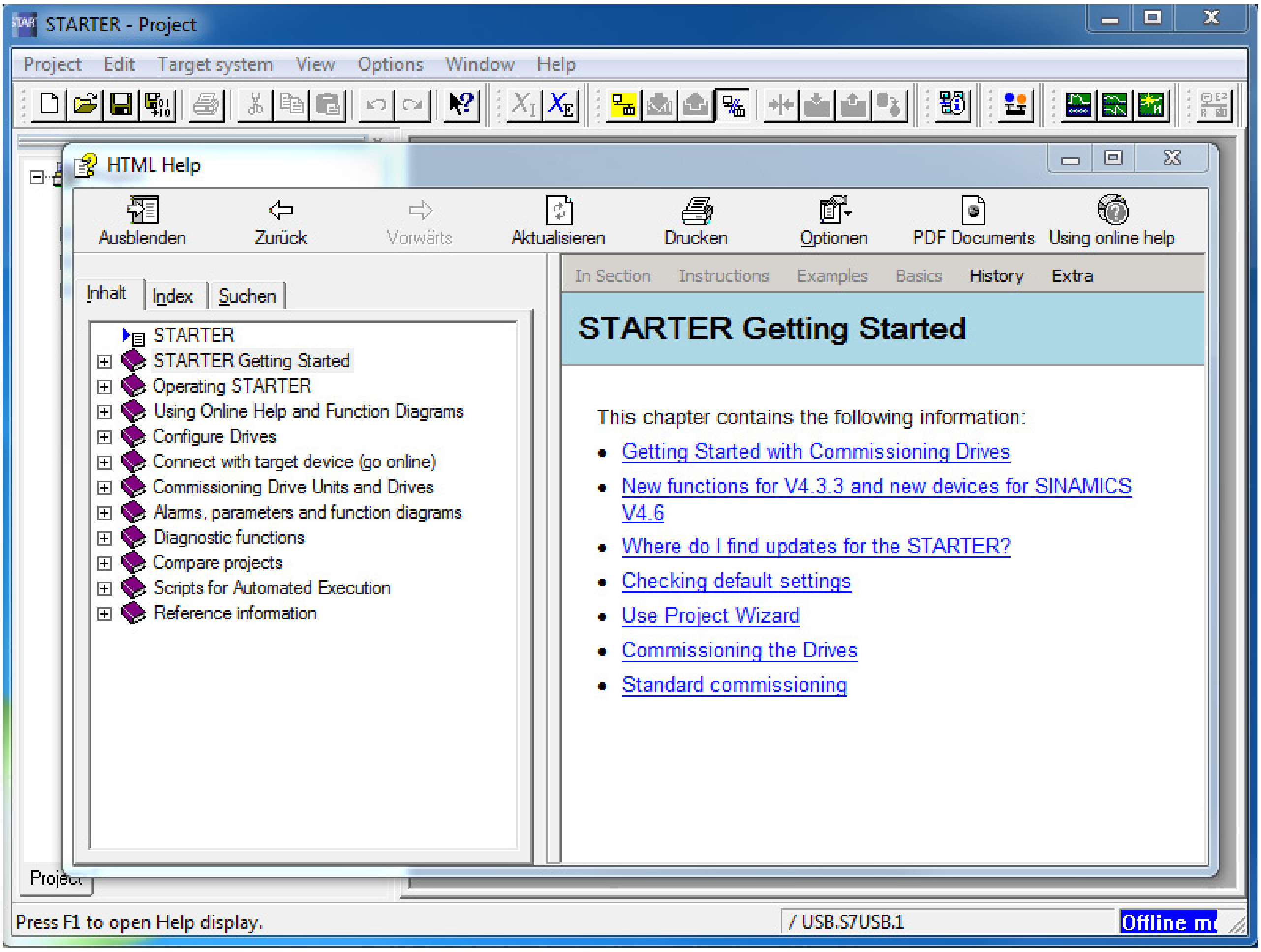


Figure 5-2 Main screen of the STARTER parameterization and commissioning tool

⇒ Close the "STARTER Getting Started Drive Commissioning" screen by choosing **HTML Help > Close.**
The online help can be hidden permanently by deselecting **Tools > Settings > Display "Getting Started" at start**

Note

Project wizard

When you deactivate the **Display wizard during start** checkbox, the project wizard is no longer displayed the next time you start STARTER.

You can call up the project wizard by choosing **Project > New with Wizard**.

To deactivate the online help for **Getting Started**, follow the instructions provided in Help.

The online help can be opened again at any time with **Tools > Settings > Show Getting Started on Start**.

STARTER features a detailed online help function.

The STARTER project wizard

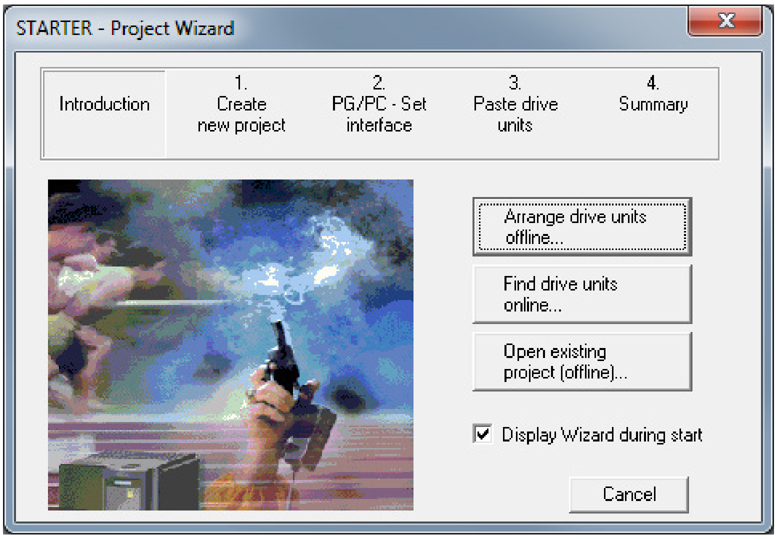


Figure 5-3 STARTER project wizard

⇒ Click **Arrange drive units offline...** in the STARTER project wizard.

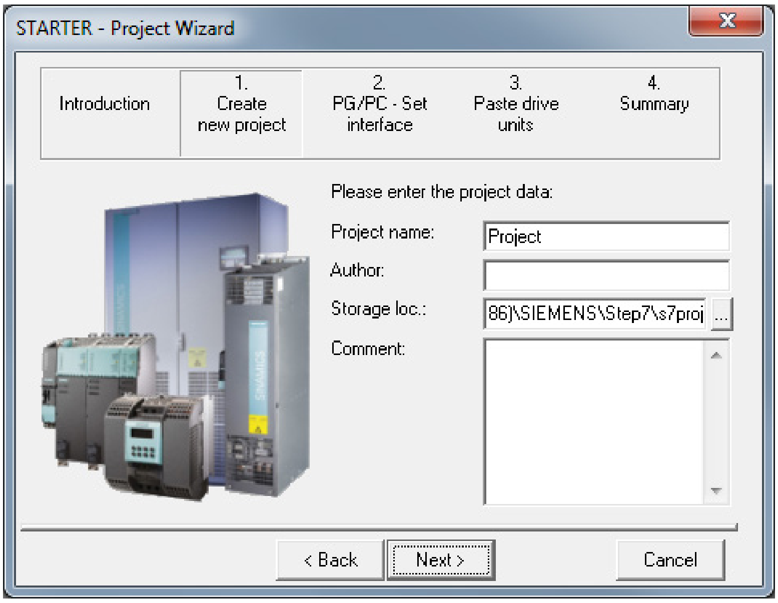


Figure 5-4 Create new project

⇒ Enter a **project name** and, if necessary, the **author, memory location** and a **comment**.

⇒ Click **Continue >** to set up the PG/PC interface.

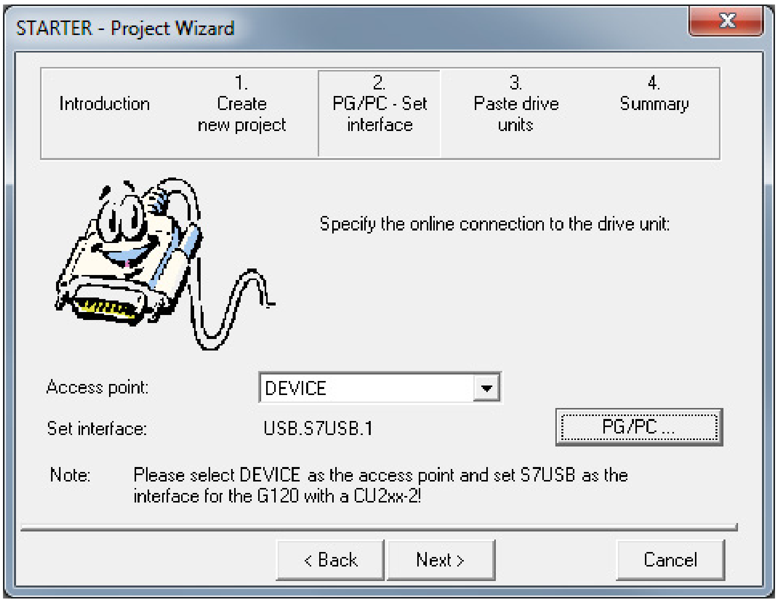


Figure 5-5 Set up interface

⇒ Under **Access point:**, select the interface corresponding to your device configuration:

- Select the DEVICE access, if the connection to the drive unit is established via the USB interface.
- Select the S7ONLINE access (STEP7), if the connection to the drive unit is established via PROFINET or PROFIBUS.

⇒ Click **PG/PC ...** and set up the interface in accordance with your device configuration. The **Properties...**, **Copy...**, **Delete...** and **Select...** buttons are now active.

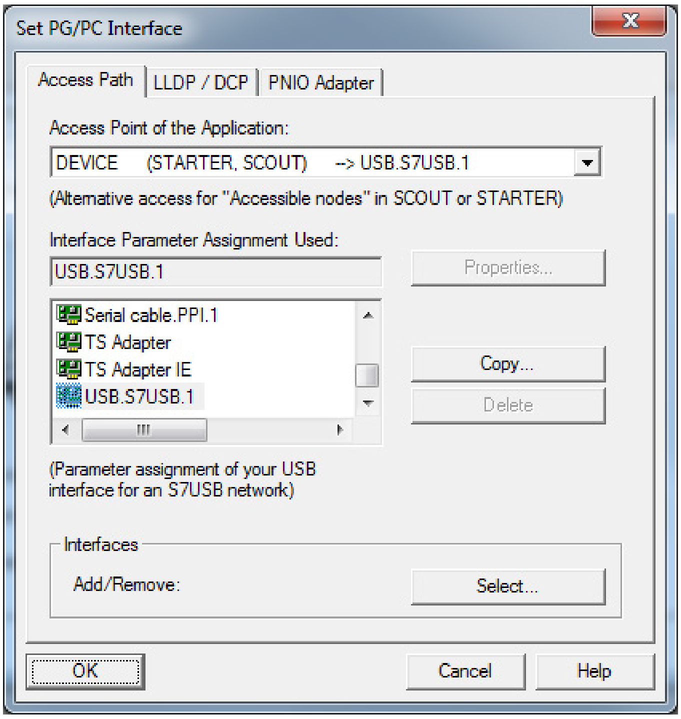


Figure 5-6 Setting the interface

⇒ Once you have done this, click **OK** to confirm the settings and return to the project wizard.

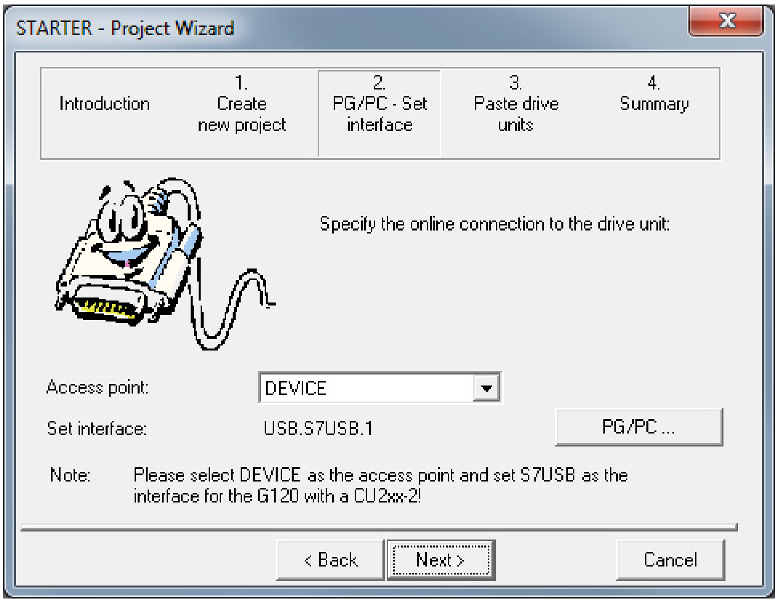


Figure 5-7 Complete setting the interface

⇒ Click **Continue >** to set up a drive unit in the project wizard.

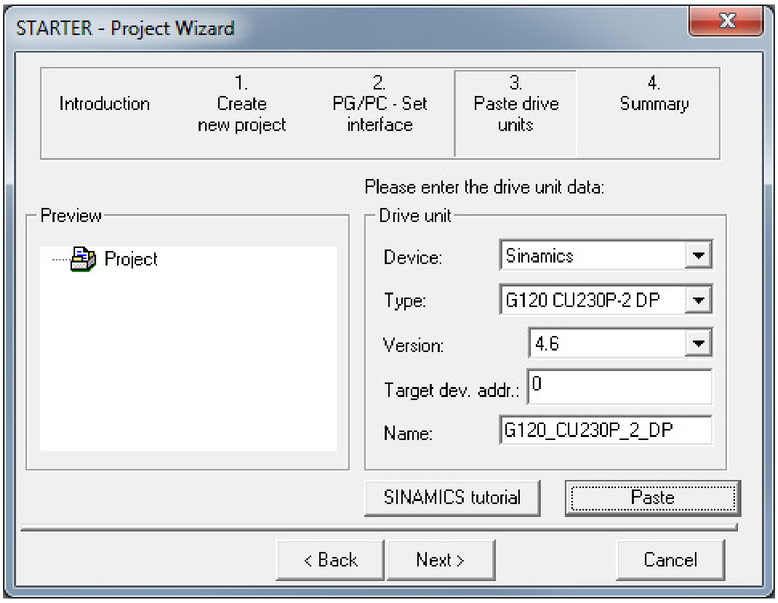


Figure 5-8 Inserting the drive unit

⇒ Choose the following data from the list fields:
Device: SINAMICS
Type: Select one the following types:
- G120P CU230-2 PN for option K96
- G120P CU230-2 DP for option K97
- G120P CU230-2 HVAC for option K98
- G120P CU230-2 CAN for option K96
Version: 4.6
Target device address: the corresponding bus address for the cabinet unit
The entry in the **Name:–** field is user defined.

⇒ Click **Insert**
The selected drive unit is displayed in a preview window in the project wizard.

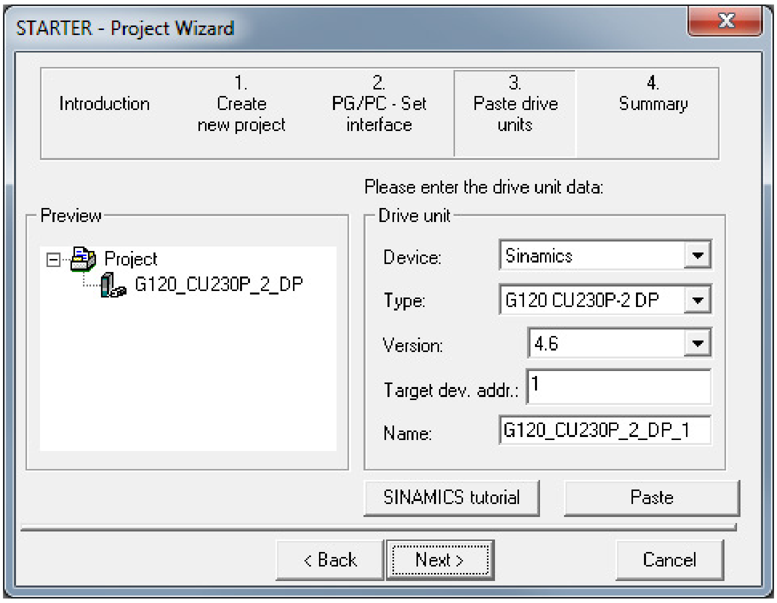


Figure 5-9 Drive unit inserted

⇒ Click **Continue >**
A project summary is displayed.

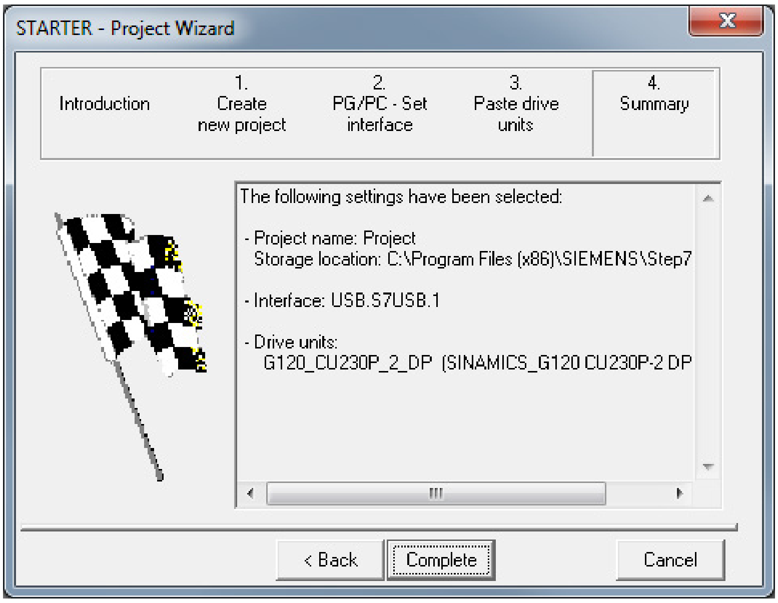


Figure 5-10 Summary

⇒ Click **Complete** to finish creating a new drive unit project.

5.4.2 Configure the drive unit

In the project navigator, open the component that contains your drive unit.

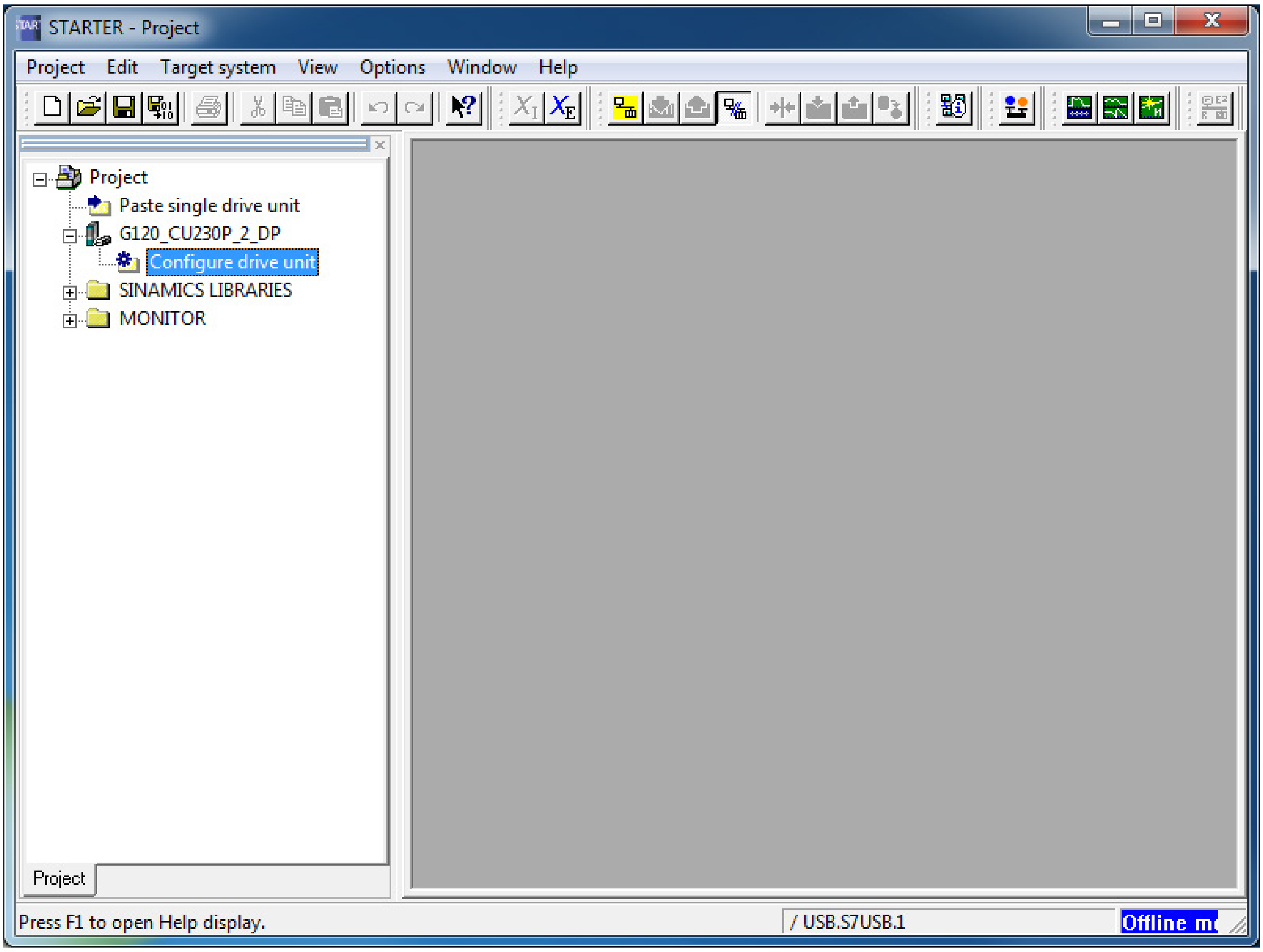


Figure 5-11 Project navigator – configuring the drive unit

⇒ In the project navigator, click the plus sign next to the drive unit that you want to configure. The plus sign becomes a minus sign and the drive unit configuration options are displayed as a tree below the drive unit.

⇒ Double-click **Configure the drive unit**.

Configuring the drive unit

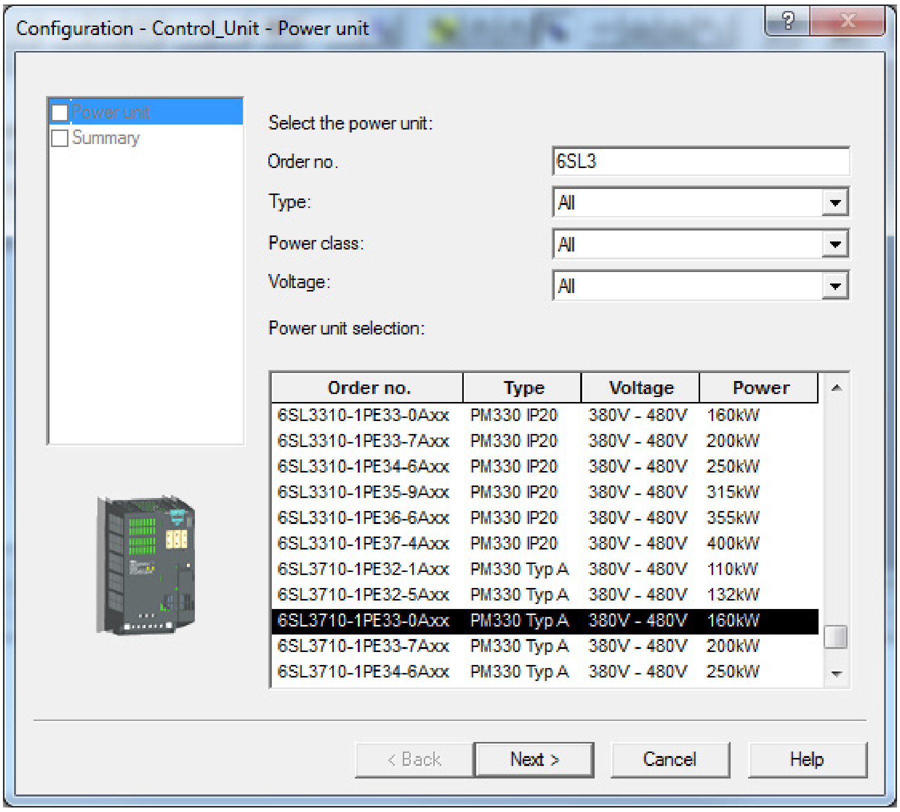


Figure 5-12 Configuring the drive unit

⇒ Select from **Order no.**, **Type:**, **Performance class:** and **Voltage:** the appropriate device properties in order to restrict the number of devices under **Power unit selection**.

⇒ Select from the list under **Power unit selection:** the appropriate drive unit using the order number, type, voltage and power (see type plate).

⇒ Click **Continue >**

Selecting options

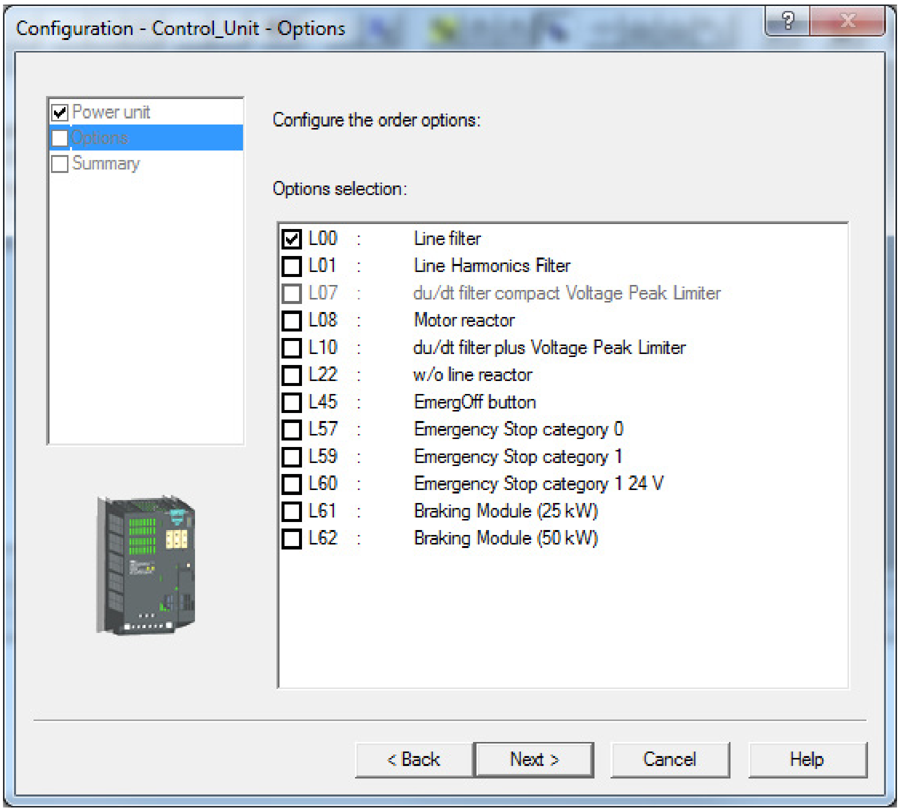


Figure 5-13 Selecting options

⇒ From the combination box **Options selection:** select the options belonging to your drive unit by clicking on the corresponding checkbox (see type plate).

Note

Motor reactor or dv/dt filter

During option selection it is essential to activate any motor reactor (option L08) or dv/dt filter (option L07, L10) being used, otherwise the motor control will not perform at its best.

Note

Check option selection

Check your options carefully against the options specified on the type plate.

⇒ Check your options carefully and then click **Continue >**

Summary of the configuration

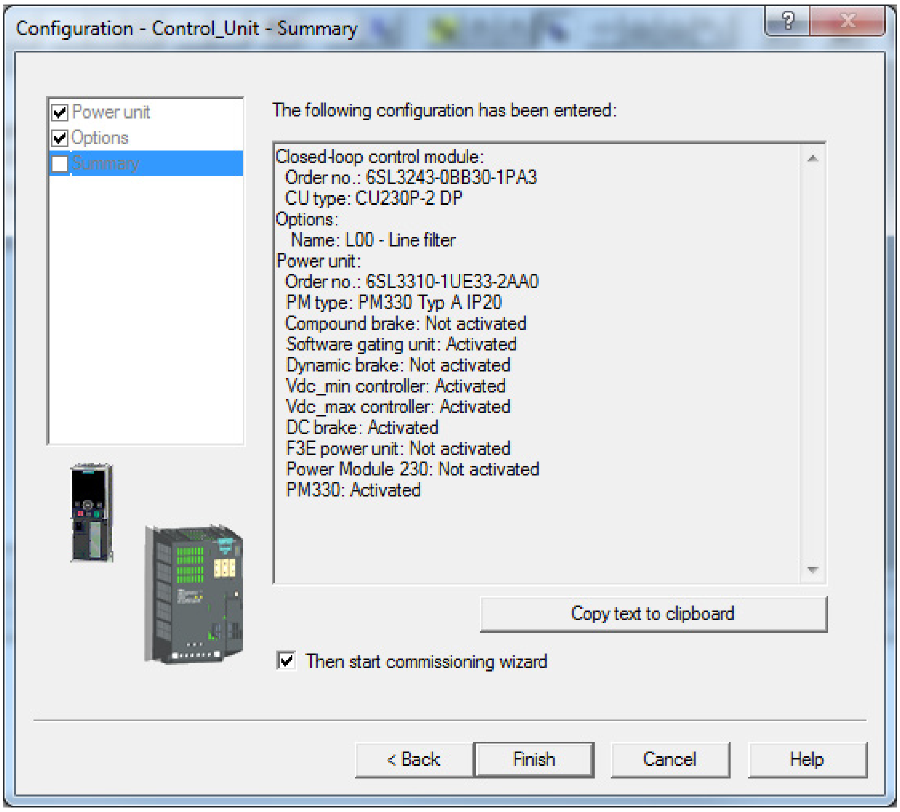


Figure 5-14 Summary of the configuration

⇒ Click the **Copy text to clipboard** button to copy the summary of the drive unit data displayed on the screen to a word processing program for further use.

⇒ Select **Then start commissioning wizard** if the commissioning wizard should be run immediately after the end of the configuration.

⇒ Click **Complete**.

5.4.3 Commissioning a drive unit

Selecting the control structure

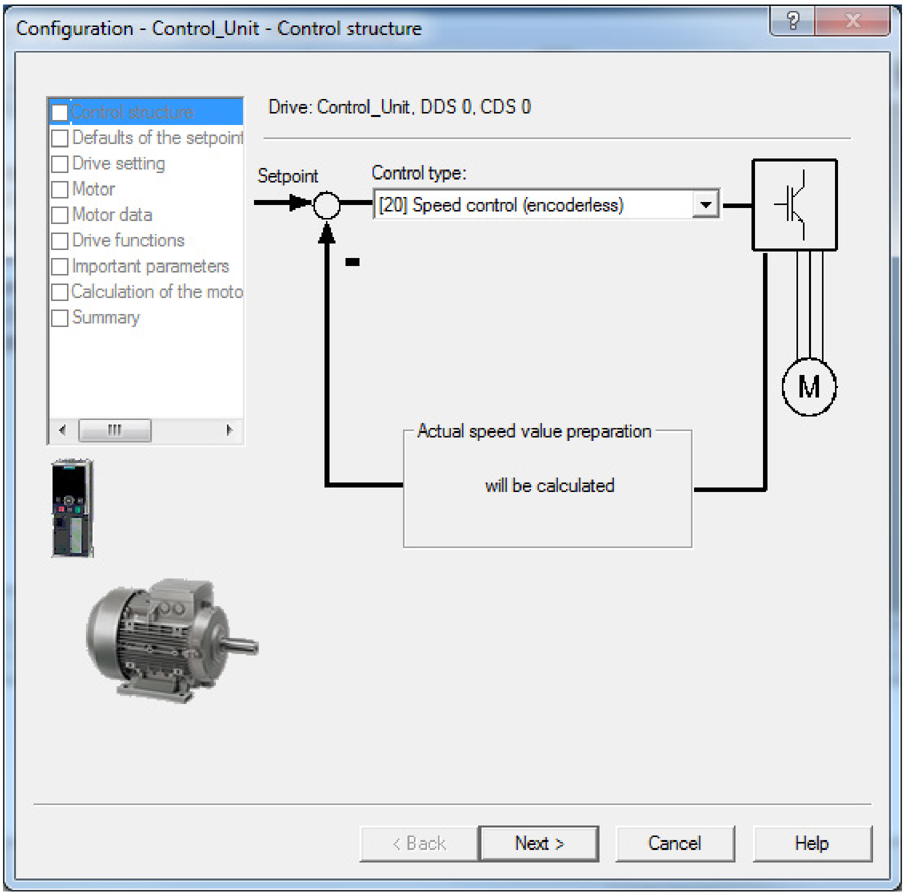


Figure 5-15 Selecting the control structure

⇒ Select the corresponding settings for the closed-loop control structure:

Control mode:
Depending on the selected control, you can select from one of the following open-loop/closed-loop control modes:

- 0: V/f control with linear characteristic

  1: V/f control with linear characteristic and FCC

  2: V/f control with parabolic characteristic

  4: V/f control with linear characteristic and ECO

  7: V/f control with parabolic characteristic and ECO

  20: Speed control (without encoder)

⇒ Click **Continue >**

Default settings for setpoints/command sources

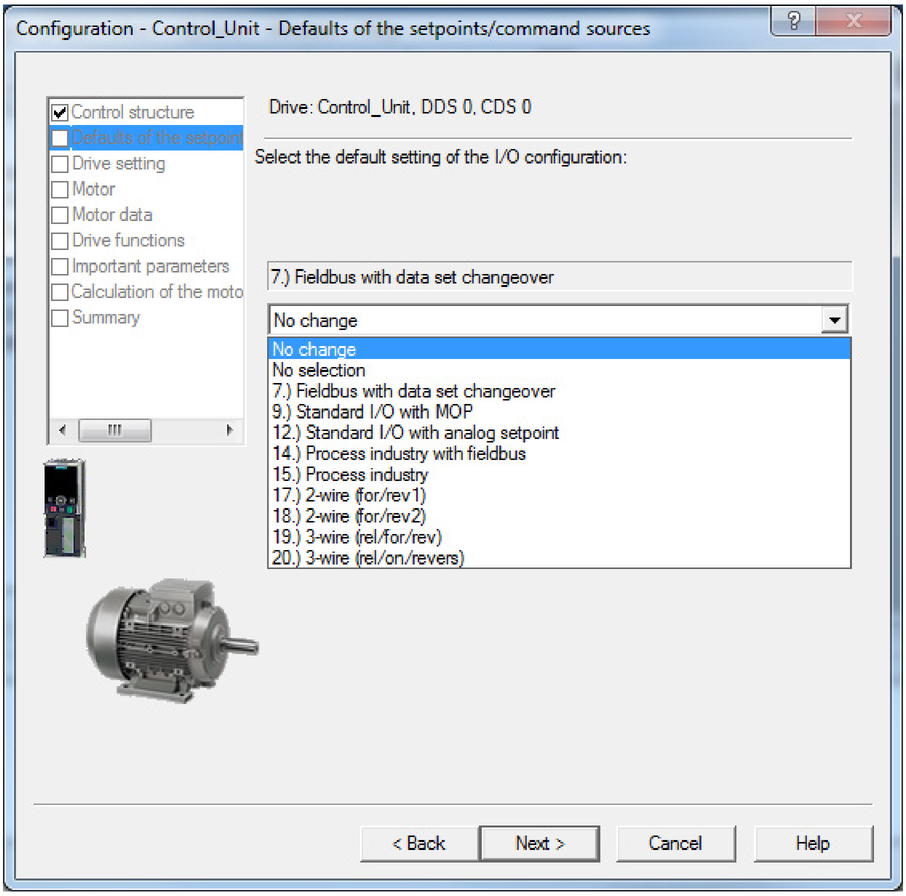


Figure 5-16 Default settings for setpoints/command sources

⇒ Select the preselection of the setpoints and command sources; the list of selection options depends on the deployed Control Unit, see also Section Pre-assignment of inputs/outputs and wiring via p0015 macros (Page 120):

- No selection
- 7.) Fieldbus with data set switchover
- 9.) Standard I/O with motorized potentiometer
- 12.) Standard I/O with analog setpoint
- 14.) Process industry with fieldbus
- 15.) Process industry
- 17.) 2-wire (forward/backward1)
- 18.) 2-wire (forward/backward2)
- 19.) 3-wire (enable/forward/backward)
- 20.) 3-wire (enable/on/reverse)

⇒ Click **Continue >**

Configuring the drive unit properties

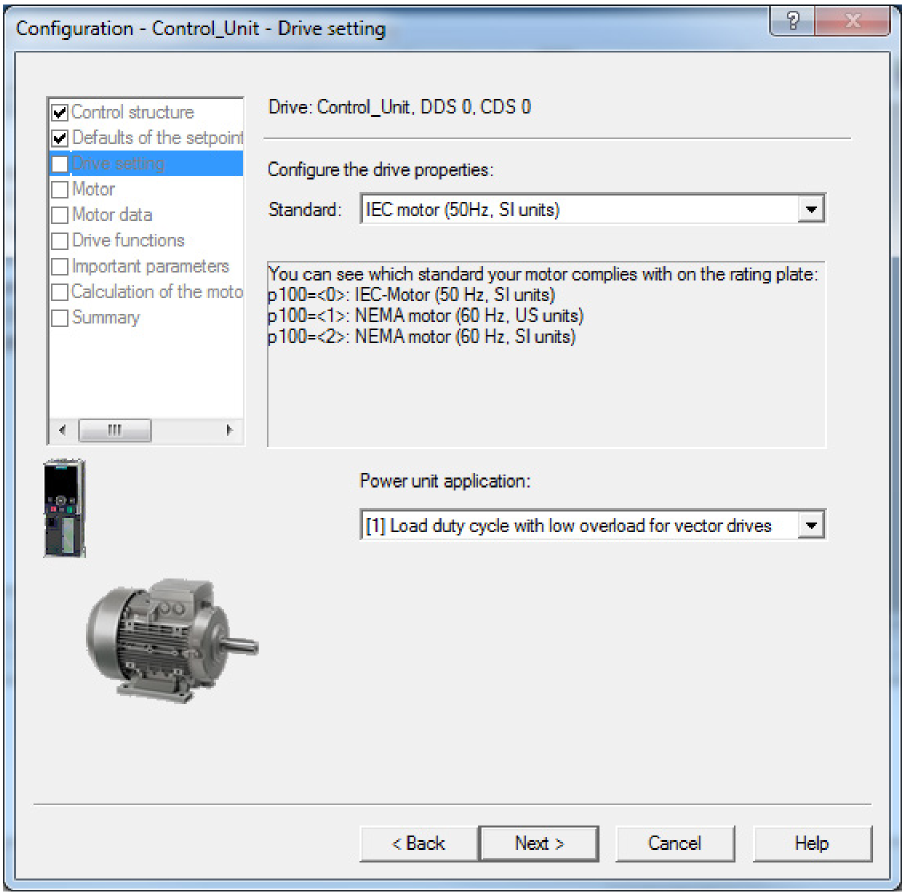


Figure 5-17 Configuring the drive unit properties

⇒ Under **Standard:**, choose the appropriate standard for your motor, whereby the following is defined:

- IEC motor (50 Hz, SI unit): Line frequency 50 Hz, motor data in kW
- NEMA motor (60 Hz, US unit): Line frequency 60 Hz, motor data in hp
- NEMA motor (60 Hz, SI unit): Line frequency 60 Hz, motor data in kW

⇒ Under **Power unit application:** only the following duty cycle can be selected:

- 1: Load duty cycle with slight overload condition for vector drives

⇒ Click **Continue >**

Configuring the motor – Selecting the motor type

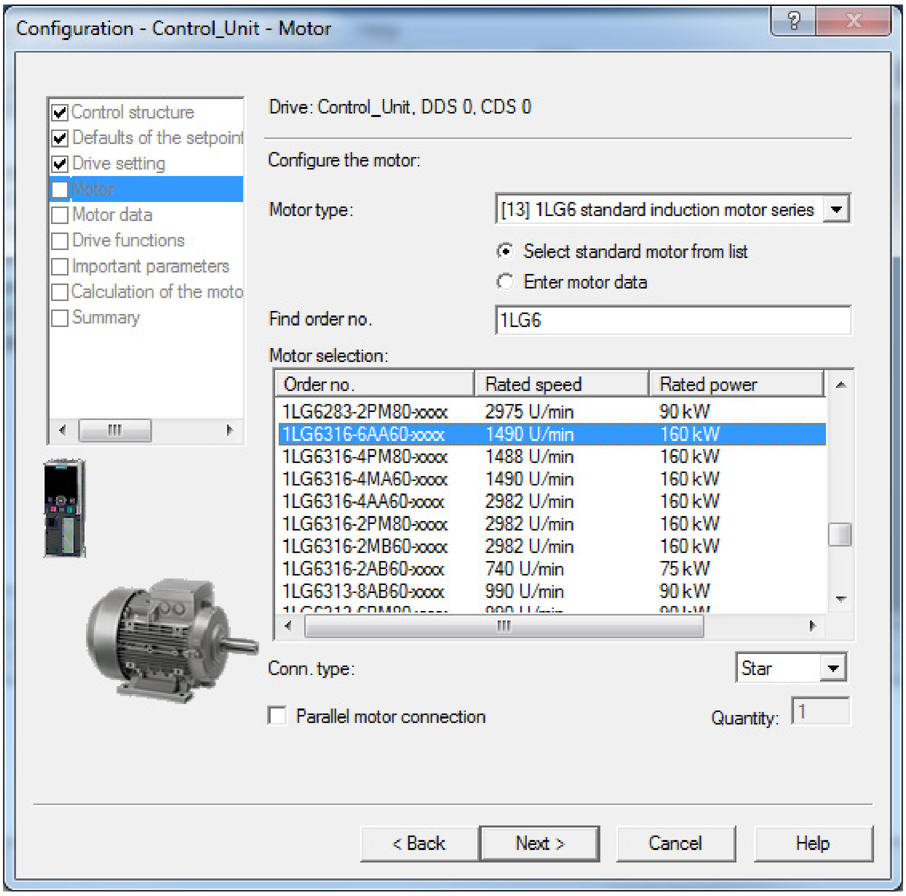


Figure 5-18 Configuring the motor – Selecting the motor type

⇒ From the selection box next to **Motor type:**, select the appropriate motor for your application.

⇒ Select under **Connection type:** whether the motor is connected in star- or delta connection.

⇒ In the **Parallel connection motor** field, enter the number of motors connected in parallel, if necessary. Motors connected in parallel must be of the same type and size.

Note

Selecting the motor type

The selection of the motor type is used to pre-assign specific motor parameters and to optimize the operating characteristics and behavior. Details are described in the List Manual in the p0300 parameter.

Note

Parallel connection of motors

When connecting motors in parallel, observe the notes in parameter p0306 in the List Manual.

⇒ Click **Continue >**

Configuring the motor – Entering motor data

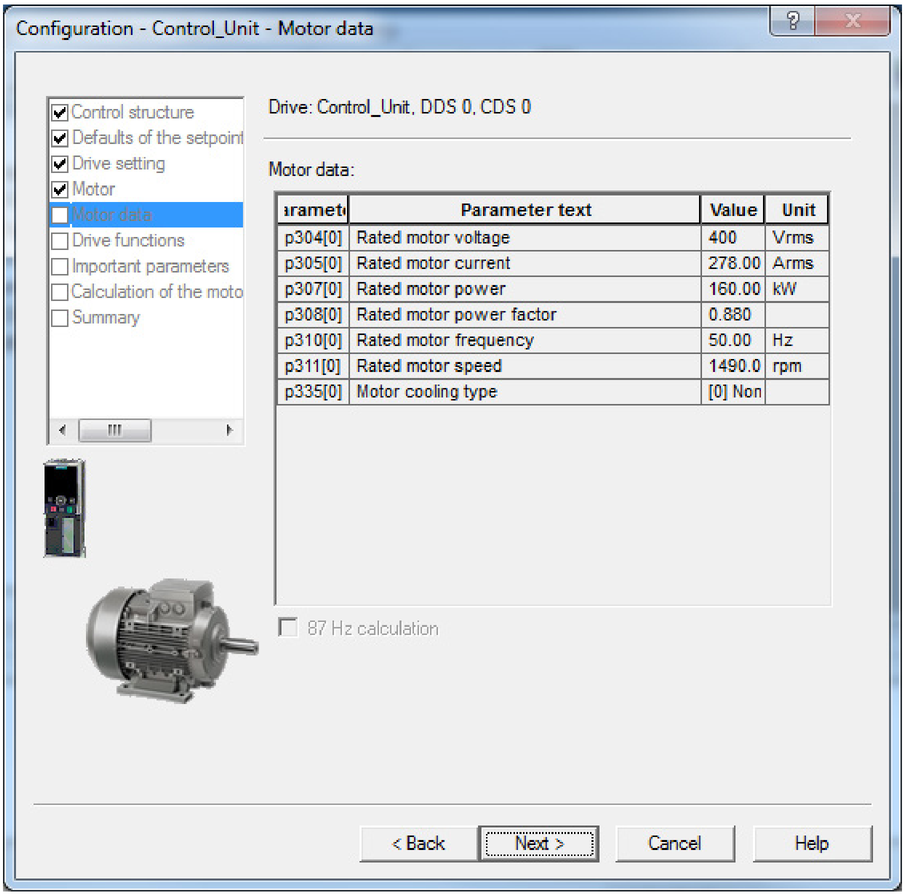


Figure 5-19 Configuring the motor – Entering motor data

⇒ Enter the motor data (see motor type plate).

⇒ If the motor has a delta connection, you can select in **87Hz calculation** that the motor is operated with 87 Hz.

⇒ Click **Continue >**

Calculate the motor data

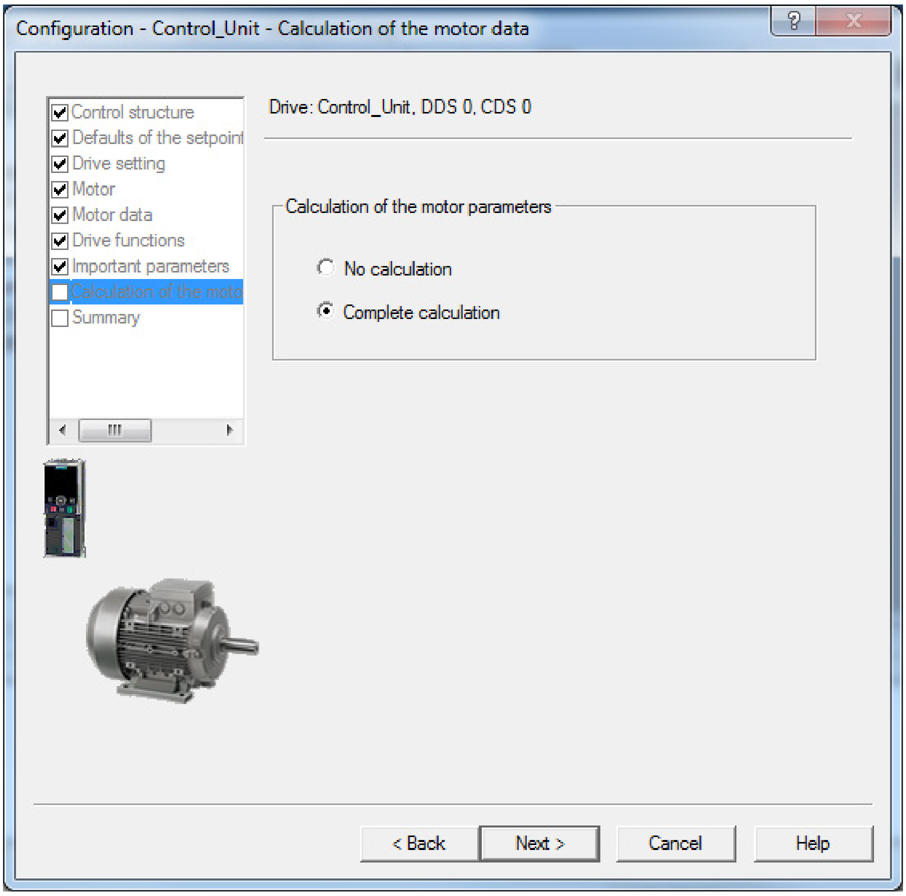


Figure 5-20 Calculate the motor data

⇒ In **Calculation of the motor parameters**, select the appropriate default settings for your device configuration.

⇒ Click **Continue >**

Specifying the motor identification

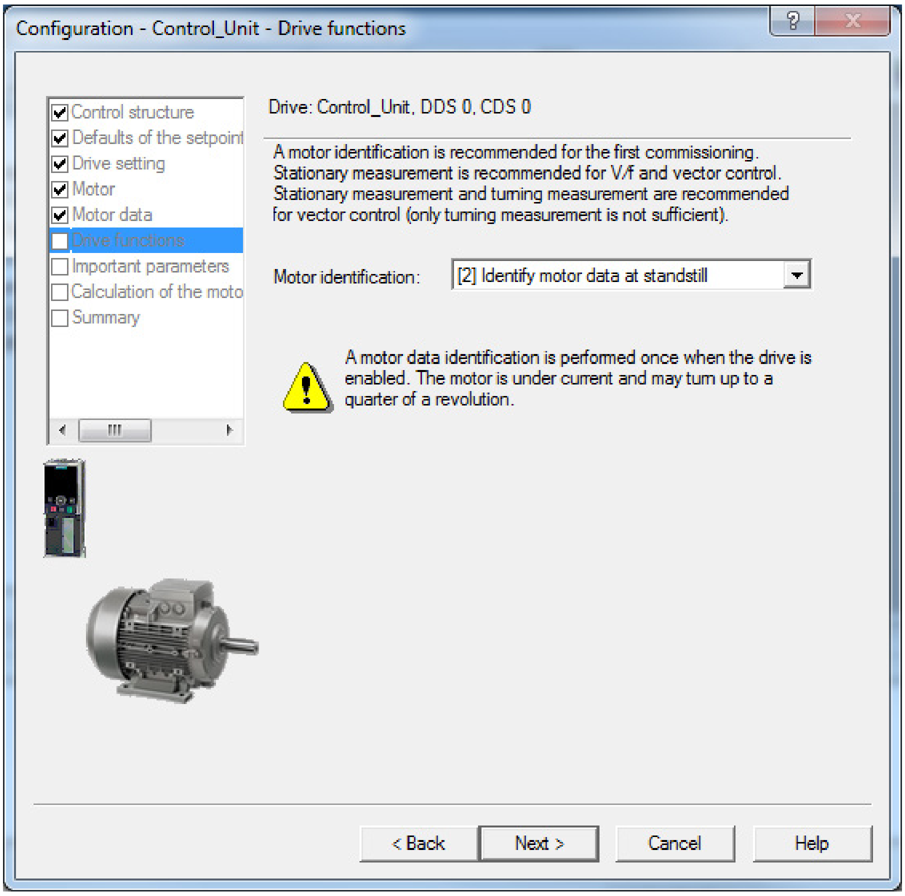


Figure 5-21   Specifying the motor identification

⇒ Select the type of **motor identification**:

- (0): Disabled
- (1): Motor data identification at standstill and when the motor is rotating
- (2): Motor data identification at standstill
- (3): Motor data identification when the motor is rotating

Note

The motor identification in standstill is the correct selection for SINAMICS G120P in many cases.

If increased demands are placed on the accuracy of the torque or speed, it is also desirable to perform the measurement when the motor is rotating.

⚠ WARNING

Danger to life during the motor identification for a rotating motor

The selection of the motor identification for a rotating motor causes the rotating measurement to be performed after completion of the commissioning and the next drive release.

During the rotating measurement, the drive triggers movements in the motor that can reach the maximum motor speed. The EMERGENCY OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

⇒ Click **Continue >**

Entering important parameters

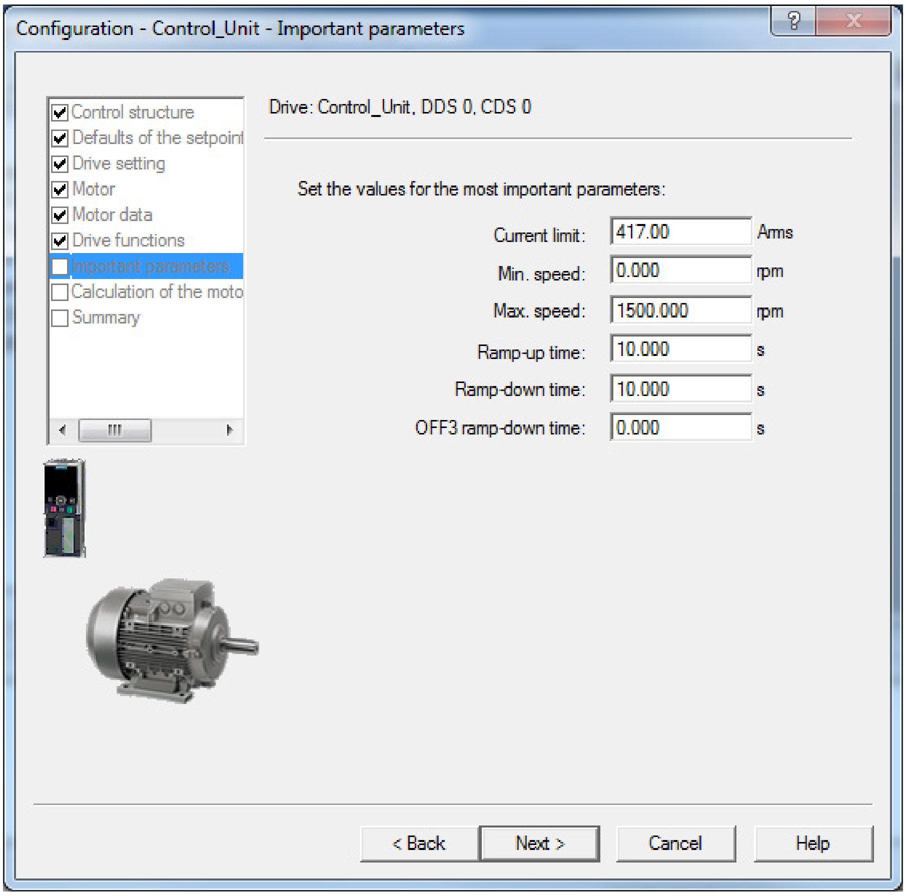


Figure 5-22 Important parameters

⇒ Enter the required parameter values.

Note

Tooltips

STARTER provides tool tips if you position your cursor on the required field **without clicking in the field**.

⇒ Click **Continue >**

Summary of the drive unit data

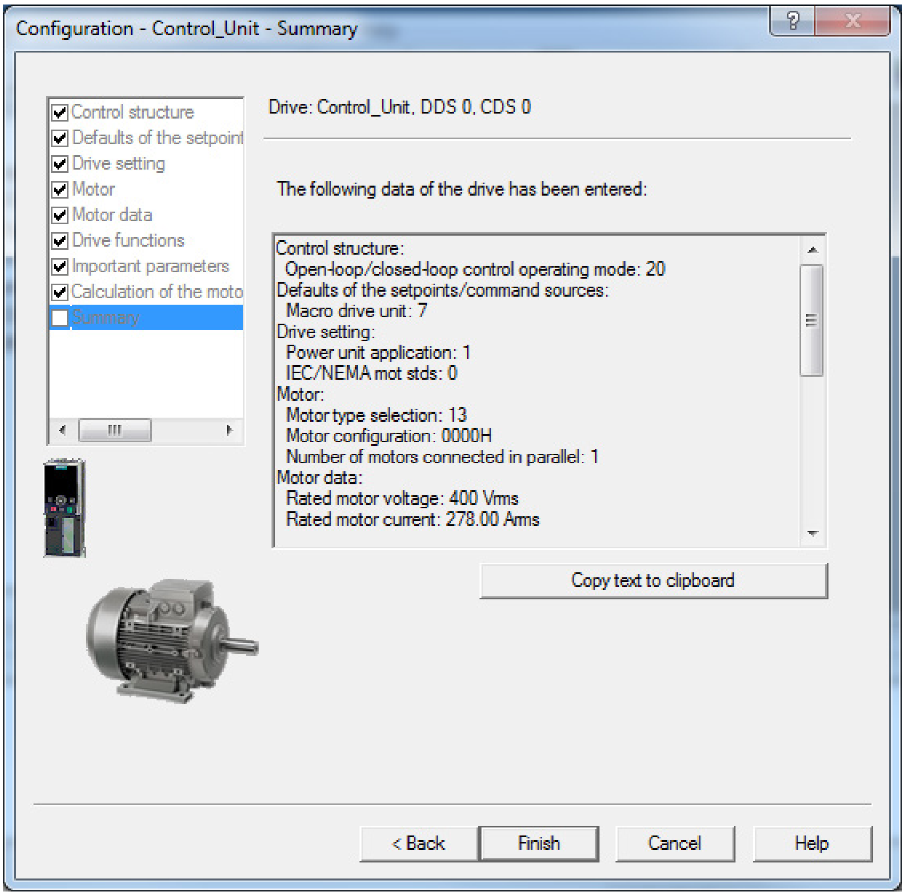


Figure 5-23 Summary of the drive unit data

⇒ You can use the **Copy to clipboard** function to copy the summary of the drive unit data displayed on the screen to a word processing program for further use.

⇒ Click **Finish.**

⇒ Save your project to the hard disk by choosing **Project > Save**.

5.4.4 Transferring the drive project

You have created a project and saved it to your hard disk. You now have to transfer your project configuration data to the drive unit.

Specifying the target device selection and access point

To connect to the target system, the selected access point to the selected access point must be specified.

In the menu bar, select **Target system** > **Select target devices ...**; the following dialog screen appears.

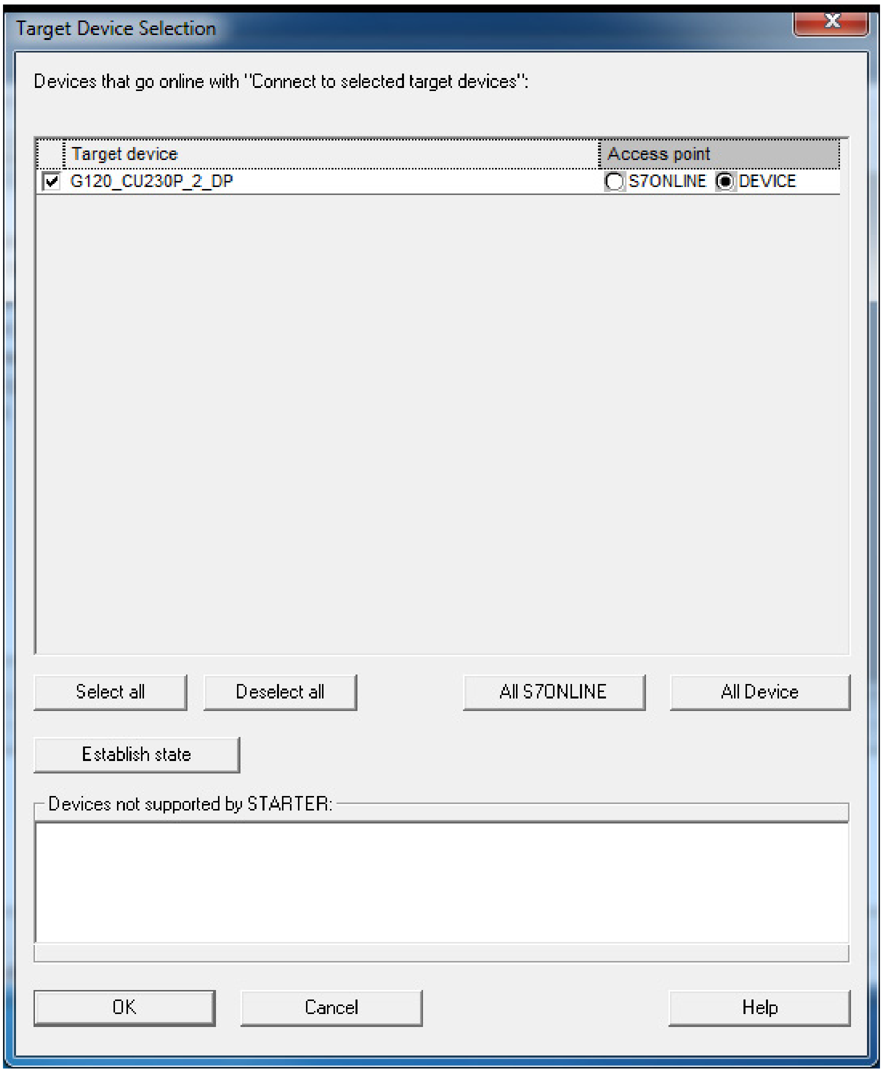


Figure 5-24 Specifying the target device selection and access point

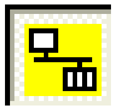
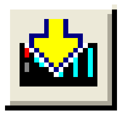
The dialog screen lists all existing devices in the project.

Specify access point:

- Select DEVICE access for a device, if the connection to the programming device or PC is established via the USB interface.
- Select S7ONLINE access for a device, if the connection to the programming device or PC is established via PROFINET or PROFIBUS.

Transferring the STARTER project to the drive unit

To transfer the STARTER project you created offline to the drive unit, carry out the following steps:

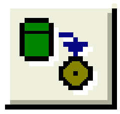
Step		Selection in toolbar
1	Choose the menu item **Project > Connect to selected target system**	
2	Choose the menu item **Target system > Load > Load project to target system**	

Note

Save project data so it is protected from power failure

The project has now been loaded to the drive unit. This data is currently available only in the drive unit's volatile memory and not in the non-volatile memory!

To store the project data on the drive unit so that it is protected in the event of a power failure, carry out the following step.

Step		Selection in toolbar
3	Choose **Target system > Copy from RAM to ROM**	

Note

Copy from RAM to ROM

The **Copy from RAM to ROM** button is only active when the drive unit is selected in the project navigator.

Results of the previous steps

- You have created a drive unit project offline using STARTER.
- You have saved the project data to the hard disk on your PC.
- You have transferred the project data to the drive unit.
- You have saved your project data on your drive unit so that it is backed up in the event of a power failure.

Note

Tip for working with STARTER

The STARTER commissioning tool supports complex drive system operations.

If you are confronted with any system conditions in online mode that are beyond your control, you are advised to delete the drive project from the project navigator and carefully create a new project in STARTER using the appropriate configuration data for your application.

5.5 Commissioning with the IOP

5.5.1 The IOP operator panel

Description

The IOP (Intelligent Operator Panel) with the following features is located in the enclosure door of the drive for operating, monitoring, and commissioning tasks:

- Graphic-capable, back-lit LCD for plain-text display and a "bar-type display" for process variables
- Help function describing causes of and remedies for faults and alarms
- ON/OFF keys for the operational control of a drive
- MANUAL/AUTO switchover for selecting the control terminal (master control assigned to operator panel or the terminal strip / fieldbus)
- Navigation wheel for specifying the setpoints or parameter values and for the prompted navigation in the menu system
- Two-stage security concept to protect against accidental or unauthorized changes to settings
- IP54 degree of protection (when installed).

Layout and functions

The layout of the IOP is shown below:

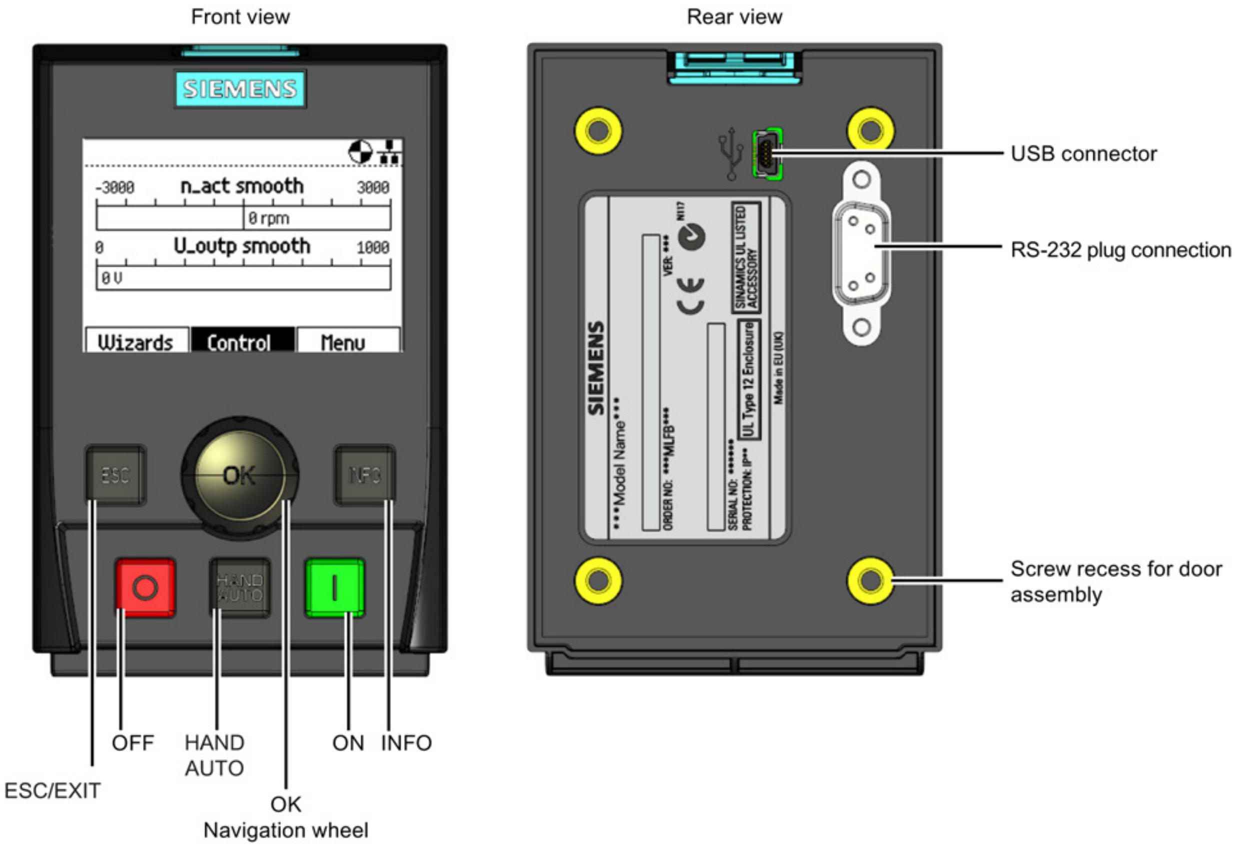


Figure 5-25 IOP layout

The IOP has a navigation wheel and five further keys. The associated functions are shown in the table below.

Table 5- 1 Functions of the IOP keys

Key	Function
	The navigation wheel has the following functions: • In a menu, turning the key changes the selection. • If a selection is marked, pressing the key confirms the selection. • When a parameter is changed, turning the key changes the displayed value. Turning clockwise increases the value; turning counterclockwise decreases the value. • When parameters or search values are changed, it is possible to change individual digits or the complete value. Pressing the navigation wheel for a longer time (> 3 seconds) switches between the two different change modes.
	The ON key has the following functions: • In the AUTO mode, the display shows an information screen which shows that the command source is AUTO and that it can be changed by pressing the MANUAL/AUTO key. • In the MANUAL mode, the inverter is started. The symbol for the inverter state begins to turn. MANUAL mode can be selected during active AUTO mode. The motor continues to run with the most recently selected speed setpoint. If the inverter runs in MANUAL mode, the motor stops when a switch is made to AUTO mode.
	The OFF key has the following functions: • If the key is pressed for longer than 3 seconds, the inverter performs the OFF2 command and the motor coasts down to standstill. Comment: If the OFF key is pressed twice within 3 seconds, the inverter also performs the OFF2 command. • If the key is pressed for less than 3 seconds, the following actions are performed: – In the AUTO mode, the display shows an information screen which shows that the command source is AUTO and that it can be changed by pressing the MANUAL/AUTO key. The inverter is not stopped. – In the MANUAL mode, the inverter performs an OFF1 command and the motor comes to standstill in the ramp-down time set in parameter p1121.
	The ESC key has the following functions: • If the key is pressed for less than 3 seconds, the IOP returns to the previous screen or, if a value was changed, the new value will not be saved. • If the key is pressed for longer than 3 seconds, the IOP returns to the Status screen. If the ESC key is pressed in Parameter change mode, the data will be saved only when the OK key is pressed.
	The INFO key has the following functions: • Display additional information about the currently selected position. • Pressing the INFO key again returns to the previous screen. • Pressing the INFO key during the IOP ramp-up places the IOP into DEMO mode. To end DEMO mode, switch the IOP off and on again.
	The MANUAL/AUTO key is used to switch the command source between MANUAL and AUTO. • MANUAL specifies the IOP as command source. • AUTO specifies an external source (e.g. fieldbus) as command source.

For further explanations about the settings and menus, see Operation with the IOP (Page 290).

DEMO mode

DEMO mode makes it possible to use the IOP for demonstration purposes without having any effect on the connected inverters. In DEMO mode, you can navigate through menus and select functions. The complete communication with the inverter is blocked, however, to ensure that the inverter does not respond to commands issued by the IOP.

Locking and unlocking the keypad

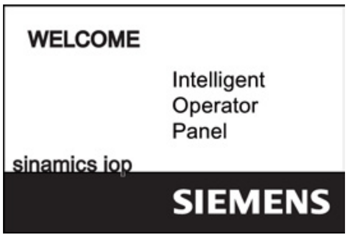
Press the **ESC** and **INFO** keys together for at least 3 seconds to lock the IOP keypad. Press the **ESC** and **INFO** keys together for at least 3 seconds to unlock the keypad.

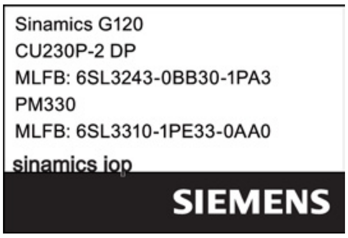
5.5.2 Initial setting

Initial setting

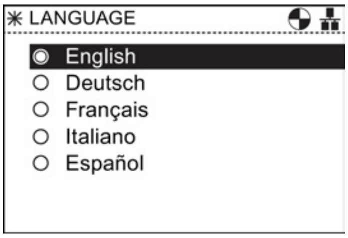
Once the IOP has been switched on, it detects automatically the Control Unit and Power Module type on which it was attached. When the IOP is used for the first time, it selects automatically the standard language as well as the date and time setting.

After the display of the Initial commissioning screen, the IOP shows details about the Control Unit and Power Module type, including the order numbers.

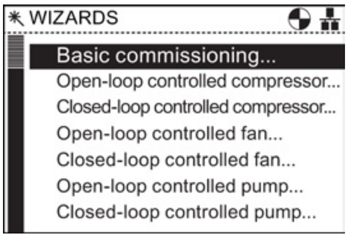




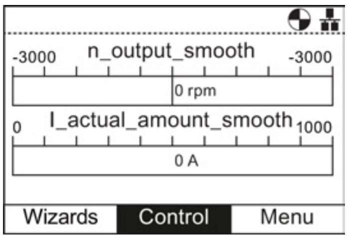
After the display of the Identification screen, the Language selection screen is displayed.



Once the language has been selected, the Wizard menu is displayed.



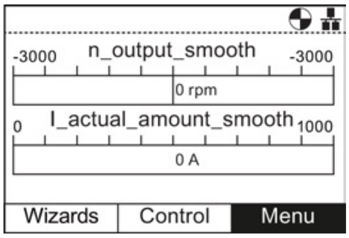
If the Wizard menu is not required, press the Esc key to return to the standard Status screen.

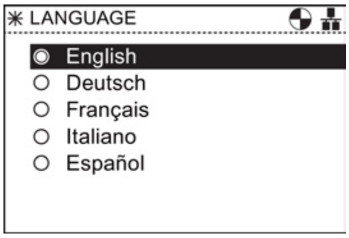


Selecting the language

Proceed as follows to set the IOP language:

1. Turn the **navigation wheel** and select "**Menu**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Menu**" screen appears.
4. Turn the **navigation wheel** and select "**Options**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Options**" screen appears.
7. Turn the **navigation wheel** and select "**Panel settings**".
8. Confirm the selection by pressing the **navigation wheel**.
9. Turn the **navigation wheel** and select the desired language.
10. Confirm the selection by pressing the **navigation wheel**.
11. The "**Language**" screen appears.
12. Turn the **navigation wheel** and select the desired language.
13. Confirm the selection by pressing the **navigation wheel**.
14. The IOP contents are now displayed in the selected language.
15. The IOP returns to the "**Options**" menu.
16. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

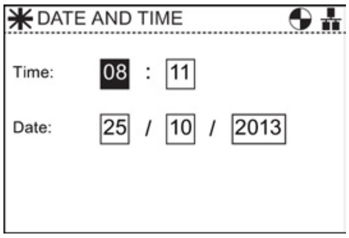




The number of available languages depends on which languages have been added or deleted by the user and the IOP software version.

Setting the date and time

Proceed as follows to set the date and time:

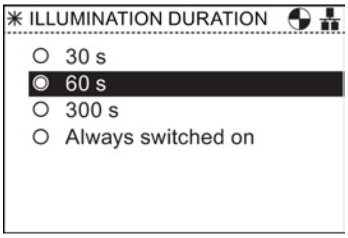


1. The "**Date and time**" screen appears.
2. Turn the **navigation wheel** to change the value.
3. Press the **navigation wheel** to confirm the value and to switch to the next field.
4. Turn the **navigation wheel** to change the value.
5. Press the **navigation wheel** to confirm the value and to switch to the next field.
6. Repeat this procedure for the date fields.
7. Once the last date field has been set, the IOP returns to the "**Options**" menu.
8. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

The time settings are normally made in the Control Unit. If the inverter has an integrated real-time clock, the IOP accepts the settings from the Control Unit.

Illumination duration

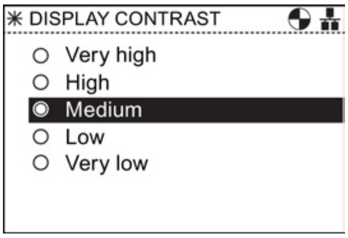
Proceed as follows to set the illumination duration of the display:



1. Turn the **navigation wheel** and select "**Menu**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Menu**" screen appears.
4. Turn the **navigation wheel** and select "**Options**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Options**" screen appears.
7. Turn the **navigation wheel** and select "**Panel settings**".
8. Confirm the selection by pressing the **navigation wheel**.
9. Turn the **navigation wheel** and select "**Illumination duration**".
10. Confirm the selection by pressing the **navigation wheel**.
11. The "**Illumination duration**" screen appears.
12. Turn the **navigation wheel** and select the desired illumination duration.
13. Confirm the selection by pressing the **navigation wheel**.
14. The IOP returns to the "**Options**" menu.
15. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

Display contrast

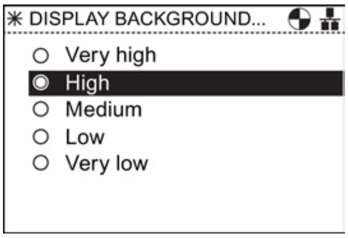
Proceed as follows to select the display contrast:



1. Turn the **navigation wheel** and select "**Menu**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Menu**" screen appears.
4. Turn the **navigation wheel** and select "**Options**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Options**" screen appears.
7. Turn the **navigation wheel** and select "**Panel settings**".
8. Confirm the selection by pressing the **navigation wheel**.
9. Turn the **navigation wheel** and select "**Display contrast**".
10. Confirm the selection by pressing the **navigation wheel**.
11. The "**Display contrast**" screen appears.
12. Turn the **navigation wheel** and select the desired display contrast.
13. Confirm the selection by pressing the **navigation wheel**.
14. The IOP returns to the "**Options**" menu.
15. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

Display background illumination

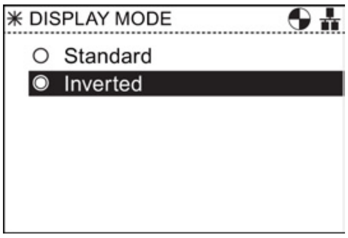
Proceed as follows to set the background illumination brightness:



1. Turn the **navigation wheel** and select "**Menu**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Menu**" screen appears.
4. Turn the **navigation wheel** and select "**Options**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Options**" screen appears.
7. Turn the **navigation wheel** and select "**Panel settings**".
8. Confirm the selection by pressing the **navigation wheel**.
9. Turn the **navigation wheel** and select "**Display background illumination**".
10. Confirm the selection by pressing the **navigation wheel**.
11. The "**Display background illumination**" screen appears.
12. Turn the **navigation wheel** and select the desired display background illumination.
13. Confirm the selection by pressing the **navigation wheel**.
14. The IOP returns to the "**Options**" menu.
15. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

Display mode

Proceed as follows to select the display mode:



1. Turn the **navigation wheel** and select "**Menu**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Menu**" screen appears.
4. Turn the **navigation wheel** and select "**Options**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Options**" screen appears.
7. Turn the **navigation wheel** and select "**Panel settings**".
8. Confirm the selection by pressing the **navigation wheel**.
9. Turn the **navigation wheel** and select "**Display mode**".
10. Confirm the selection by pressing the **navigation wheel**.
11. The "**Display mode**" screen appears.
12. Turn the **navigation wheel** and select the desired setting.
    – "**Normal**" causes black text to be displayed on a white background.
    – "**Inverse**" causes white text to be displayed on a black background.
13. Confirm the selection by pressing the **navigation wheel**.
14. The IOP returns to the "**Options**" menu.
15. Keep the "**Esc**" key pressed for longer than 3 seconds to return to the Status screen.

Entering the motor data

During initial commissioning, you have to enter motor data using the operator panel. Use the data shown on the motor type plate.

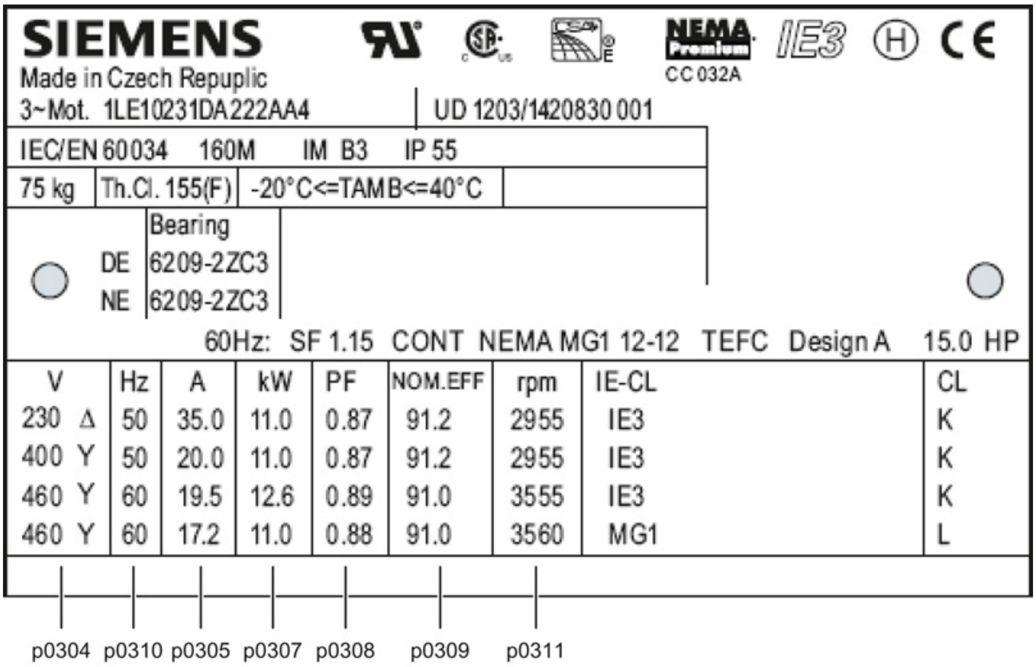


Figure 5-26 Example of a motor type plate

Table 5- 2 Motor data

	Parameter no.	Values	Unit
System of units for line frequency and entering motor data	p0100	0 1 2	IEC [50 Hz / kW] NEMA [60 Hz / hp] NEMA [60 Hz / kW]
Motor: Rated voltage Rated current Rated power Rated power factor cos φ (only for motor data in kW) Rated efficiency η (only for motor data in hp) Rated frequency Rated speed	 p0304 p0305 p0307 p0308 p0309 p0310 p0311		 [V] [A] [kW] / [hp] [%] [Hz] [min^{-1}] / [rpm]

5.5.3 Basic commissioning with IOP

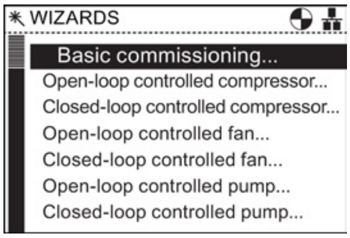
"Basic commissioning" wizard

The "Basic commissioning" wizard described below applies to Control Units as of software version 4.4.

Procedure

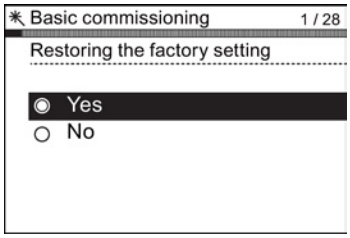
Proceed as follows to perform the basic commissioning of the inverter with the IOP:

0. Select "Basic commissioning..." in the "Wizard" menu.

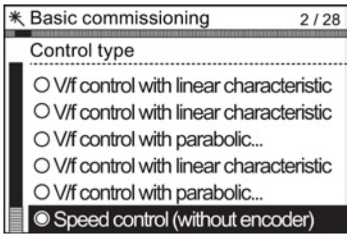


1. Select "Yes" or "No" to reset to the factory settings.

   The factory settings are reset before all parameter changes made during the basic commissioning have been saved.

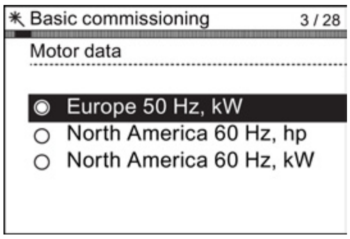


2. Select the control type for the connected motor.



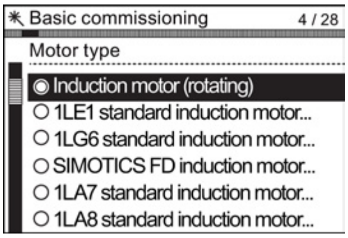
3. Select the appropriate motor data for your inverter and the connected motor.

   This data is required to calculate the correct speed and the displayed values for the application.



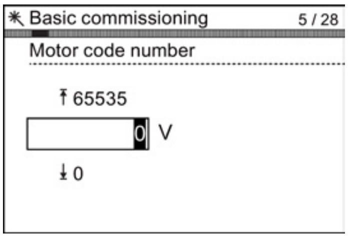
4. Select the motor type.

   The selection of the motor type is used to pre-assign specific motor parameters and to optimize the operating characteristics and behavior. Details are described in the List Manual in the p0300 parameter.



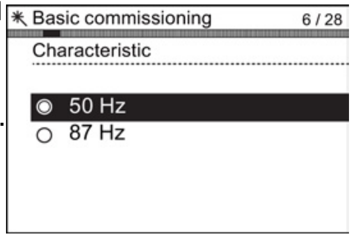
5. Enter the motor code number.

   When a motor type with value p0300 > 100 is selected, the input screen for the motor code number appears.

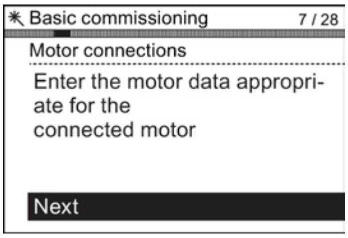


6. Select the frequency for your inverter and the connected motor.

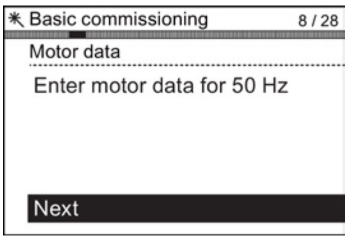
   The use of the 87-Hz characteristic curve permits operation of the motor with 1.73 times the normal speed.



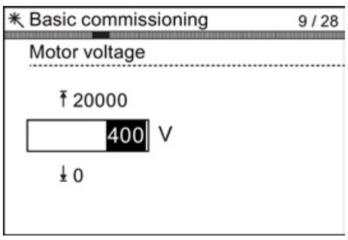
7. The wizard requests the data appropriate for the connected motor. This data can be found on the motor type plate.



8. The "Motor data" screen specifies the frequency characteristic curve of the connected motor.

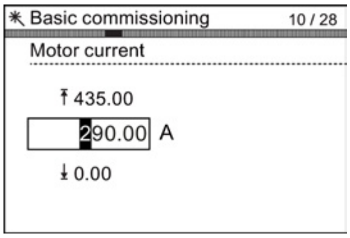


9. Enter the motor voltage from the motor type plate.



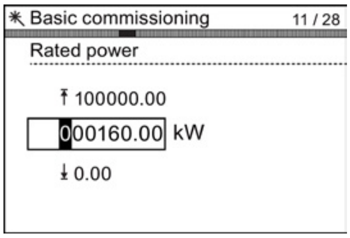
10. Enter the motor current from the motor type plate.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.



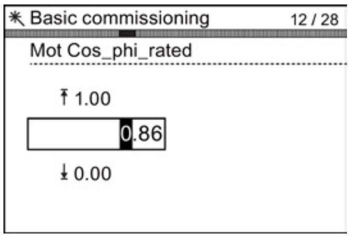
11. Enter the rated power from the motor type plate.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.



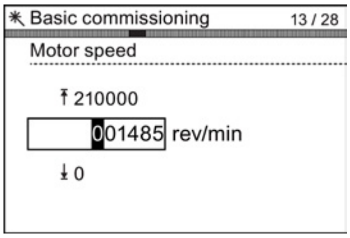
12. Enter the rated power factor (cos phi) from the motor type plate.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.



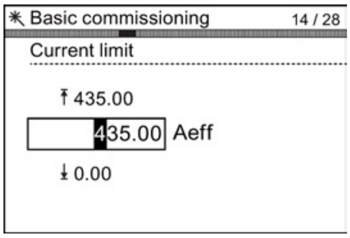
13. Enter the motor speed from the motor type plate.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.



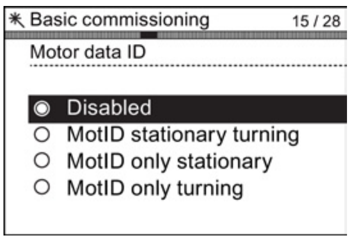
14. Enter the current limit.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.

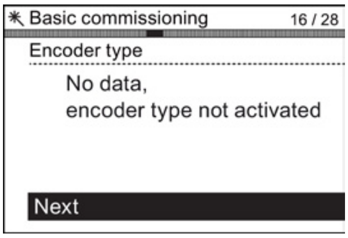


15. Select the type of the motor data identification.

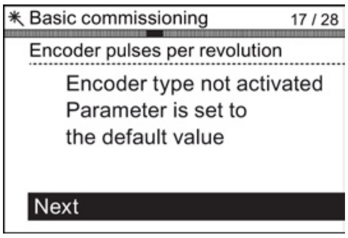
    If the motor data identification has been activated, the function will be started after the first ON command.



16. Because a speed sensor is not supported, the screen can be bypassed by pressing "OK" of the navigation wheel.

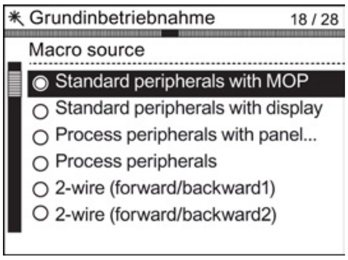


17. Because a speed sensor is not supported, the screen can be bypassed by pressing "OK" of the navigation wheel.



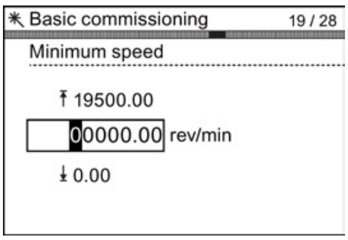
18. Select the appropriate macro for your application. Once the macro has been selected, all inputs, outputs, command sources and setpoints for the software are configured automatically.

    For more information, see the chapter titled Pre-assignment of inputs/outputs and wiring via p0015 macros (Page 120).



19. Select the minimum speed for the connected motor.

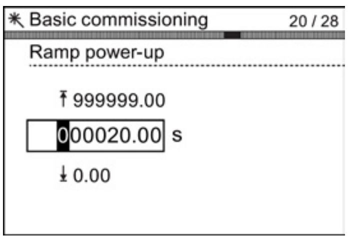
    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.



20. Specify the ramp-up time.

    In this time, the speed setpoint of the ramp-function generator is increased from standstill to the maximum speed (p1082).

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.

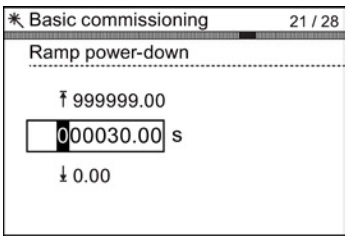


21. Specify the ramp-down time.

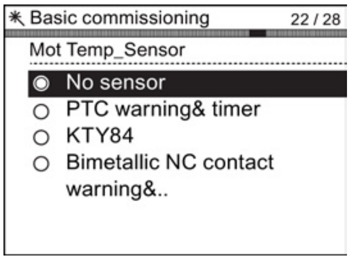
    In this time, the speed setpoint of the ramp-function generator is decreased from the maximum speed (p1082) to standstill.

    The ramp-down time always acts for an OFF1 command.

    Individual digits or the complete value can be changed. Change the input mode by pressing the navigation wheel for a longer time.

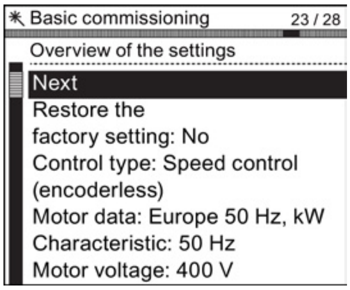


22. Select the type of the motor temperature sensor.



23. A summary of all settings is displayed.

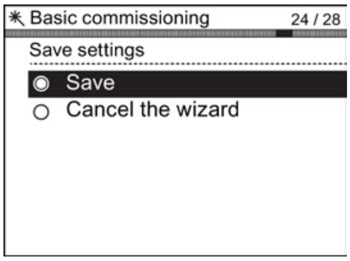
    If the settings are correct, select "Next".



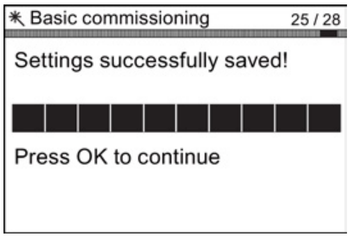
24. The final screen offers two options:
    - Save
    - Cancel the wizard

    Select "Save" to reset to the factory settings and save the settings in the inverter memory.

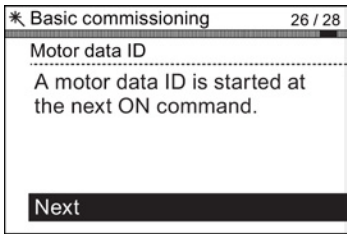
    The "Save mode parameters" function under "Parameter settings" in the "Menu" is used to assign the storage location of the data.



25. The successful saving of the settings is confirmed.



26. If the motor data identification has been activated, the selected function will be started after the next ON command.



Operation 6

6.1 Section content

This section provides information on the following:

- Basic information about the drive system
- Communication via
  - PROFINET IO
  - PROFIBUS DP
  - EtherNet/IP
  - RS485
  - CANopen
- Operation with the IOP

6.2 Basic information about the drive system

6.2.1 Parameters

Overview

The drive is adapted to the relevant drive task by means of parameters. Each parameter is identified by a unique parameter number and by specific attributes (e.g. read, write, BICO attribute, group attribute, and so on).

The parameters can be accessed via the following means:

- PC with the "STARTER" commissioning tool
- Intelligent Operator Panel IOP

Parameter types

The following adjustable and display parameters are available:

- Adjustable parameters (write/read)

  These parameters have a direct impact on the behavior of a function.

  Example: Ramp-up and ramp-down time of a ramp-function generator
- Display parameters (read only)

  These parameters are used to display internal variables.

  Example: Momentary motor current

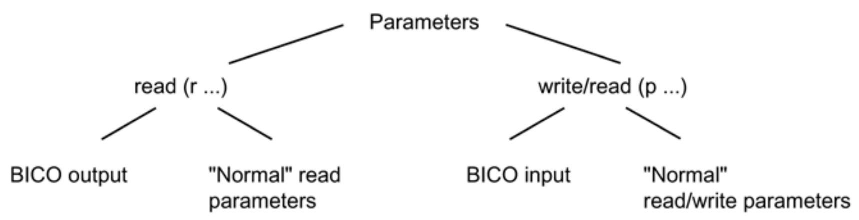


Figure 6-1 Parameter types

All these drive parameters can be read and changed via PROFIBUS or PROFINET using the mechanisms defined in the PROFIdrive profile.

Parameter categories

The parameters are divided into data sets (see "Operation / data sets") as follows:

- Data-set-independent parameters
  These parameters exist only once per drive object.
- Data-set-dependent parameters
  These parameters can exist several times and can be addressed via the parameter index for reading and writing. A distinction is made between various types of data set:
  - CDS: Command data set
    By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.
  - DDS: Drive data set
    The drive data set contains the parameters for switching between different drive control configurations.

  The CDS and DDS can be switched over during normal operation.

6.2.2 Data sets

Description

For many applications, it is beneficial if more than one parameter can be changed simultaneously by means of **one** external signal during operation or when the system is ready for operation.

This can be carried out using indexed parameters, whereby the parameters are grouped together in a data set according to their functionality and indexed. Indexing allows several different settings, which can be activated by switching the data set, to be defined in each parameter.

Note

Copying data sets

The command and drive data sets can be copied in STARTER (Drive -> Configuration -> "Command data sets" or "Drive data sets" tab).
The displayed command and drive data sets can be selected in the associated STARTER screen forms.

CDS: Command data set

The BICO parameters (binector and connector inputs) are grouped together in a command data set. These parameters are used to interconnect the signal sources of a drive (see "Operation/BICO technology: Interconnecting signals").

By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
  - ON/OFF, enable signals (p0844, etc.)
  - Jog (p1055, etc.)
- Connector inputs for setpoints (analog signals)
  - Main setpoint and main setpoint scaling (p1070, p1071)

In the delivery condition, two command data sets are available; this number can be increased to a maximum of four using p0170 (number of command data sets (CDS)).

The following parameters are available for selecting command data sets and for displaying the currently selected command data set:

Table 6- 1 Command data set: selection and display

CDS	Select bit 1 p0811	Select bit 0 p0810	Display	
			selected (r0836)	active (r0050)
0	0	0	0	0
1	0	1	1	1
2	1	0	2	2
3	1	1	3	3

If a non-existent command data set is selected, the current data set remains active.

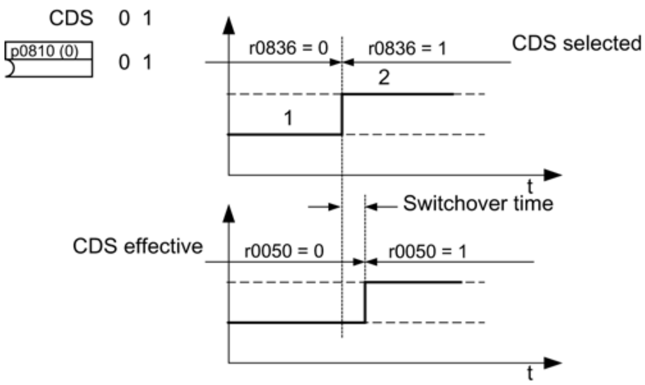


Figure 6-2 Example: Switching between command data set 0 and 1

DDS: Drive data set

A drive data set contains various adjustable parameters that are relevant with respect to open-loop and closed-loop drive control:

- Various control parameters, e.g.:
  - Fixed speed setpoints (p1001 to p1015)
  - Speed limits min./max. (p1080, p1082)
  - Characteristic data of ramp-function generator (p1120 ff)
  - Characteristic data of controller (p1240 ff)
  - ...

The parameters that are grouped together in the drive data set are identified in the parameter list by "Data set DDS" and are assigned an index [0..n].

It is possible to parameterize several drive data sets. You can switch easily between different drive configurations by selecting the corresponding drive data set.

Binector inputs p0820 and p0821 are used to select a drive data set. They represent the number of the drive data set (0 to 3) in binary format (where p0821 is the most significant bit).

- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1

Copying the command data set (CDS)

Set parameter p0809 as follows:

1. p0809[0] = Number of the command data set to be copied (source)
2. p0809[1] = Number of the command data to which the data is to be copied (target)
3. p0809[2] = 1

Start copying.

Copying is finished when p0809[2] = 0.

Copying the drive data set (DDS)

Set parameter p0819 as follows:

1. p0819[0] = Number of the drive data set to be copied (source)
2. p0819[1] = Number of the drive data set to which the data is to be copied (target)
3. p0819[2] = 1

Start copying.

Copying is finished when p0819[2] = 0.

Function diagram

FP 8560	Command data sets (CDS)
FP 8565	Drive data sets (DDS)

Parameter

- p0170 Number of command data sets (CDS)
- p0180 Number of drive data sets (DDS)
- p0809[0...2] Copy command data set CDS
- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection, bit 0
- p0821 BI: Drive data set selection, bit 1

6.2.3 BICO technology: Interconnecting signals

Description

Every drive contains a large number of interconnectable input and output variables and internal control variables.

BICO technology (Binector Connector Technology) allows the drive to be adapted to a wide variety of conditions.

Digital signals, which can be connected freely by means of BICO parameters, are identified by the prefix BI, BO, CI or CO in their parameter name. These parameters are identified accordingly in the parameter list or in the function diagrams.

Note

Using STARTER

The STARTER parameterization and commissioning tool is recommended when using BICO technology.

Binectors, BI: Binector input, BO: Binector output

A binector is a digital (binary) signal without a unit which can assume the value 0 or 1.

Binectors are subdivided into binector inputs (signal sink) and binector outputs (signal source).

Table 6- 2 Binectors

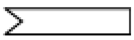
Abbreviation and symbol	Name	Description
BI 	Binector input Binector input (signal sink)	Can be interconnected to a binector output as source. The number of the binector output must be entered as a parameter value.
BO 	Binector output Binector output (signal source)	Can be used as a source for a binector input.

Connectors, CI: Connector input, CO: Connector output

A connector is a digital signal e.g. in 32–bit format. It can be used to emulate words (16 bits), double words (32 bits) or analog signals. Connectors are subdivided into connector inputs (signal sink) and connector outputs (signal source).

The options for interconnecting connectors are restricted to ensure that performance is not adversely affected.

Table 6- 3 Connectors

Abbreviation and symbol	Name	Description
CI 	Connector input Connector input (signal sink)	Can be interconnected to a connector output as source. The number of the connector output must be entered as a parameter value.
CO 	Connector output Connector output (signal source)	Can be used as a source for a connector input.

Interconnecting signals using BICO technology

To interconnect two signals, a BICO input parameter (signal sink) must be assigned to the desired BICO output parameter (signal source).

The following information is required in order to connect a binector/connector input to a binector/connector output:

- Binectors: Parameter number and bit number
- Connectors with no index: Parameter number
- Connectors with index: Parameter number and index

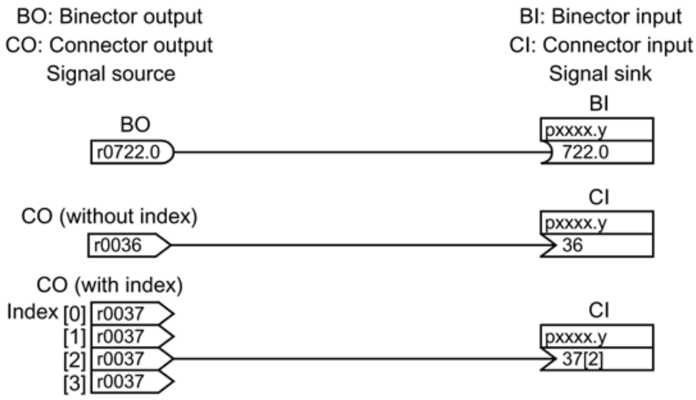


Figure 6-3 Interconnecting signals using BICO technology

Note

A connector input (CI) cannot be interconnected with any connector output (CO, signal source). The same applies to the binector input (BI) and binector output (BO).

"Data type" in the parameter list provides information about the data type of the parameter and the data type of the BICO parameter for each CI and BI parameter.

For CO and BO parameters, only the data type of the BICO parameter is given.

Notation:

- Data type BICO input: Data type parameter/Data type BICO parameter
  Example: Unsigned32 / Integer16
- Data type BICO output: Data type BICO parameter
  Example: FloatingPoint32

The possible interconnections between BICO input (signal sink) and BICO output (signal source) are described in the List Manual in the table "Possible combinations for BICO interconnections" in the section "Explanations on the parameter list".

The BICO parameter interconnection can be implemented in different data sets (CDS, DDS, etc.). The different interconnections in the data sets are activated by switching the data sets.

Example 1: interconnecting digital signals

Suppose you want to operate a drive via terminals DI 0 and DI 1 on the Control Unit using jog 1 and jog 2.

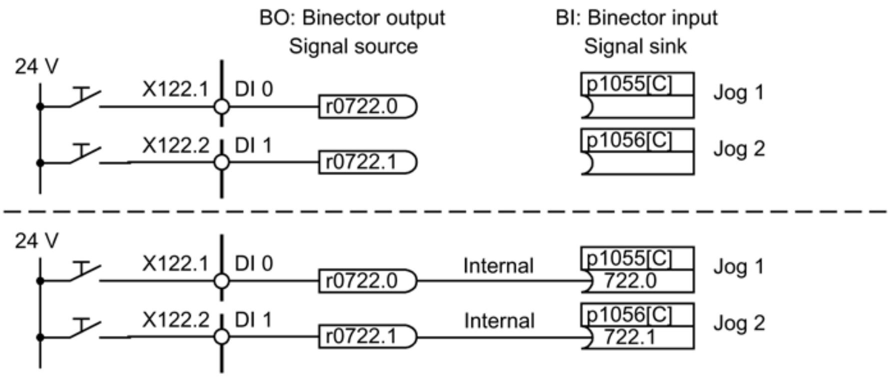


Figure 6-4 Interconnection of digital signals (example)

Binector-connector converters and connector-binector converters

Binector-connector converter

- Several digital signals are converted to a 32-bit integer double word or to a 16-bit integer word.
- p2080[0...15] BI: Binector-connector converter, status word 1
- p2081[0...15] BI: Binector-connector converter, status word 2
- p2082[0...15] BI: Binector-connector converter, status word 3
- p2083[0...15] BI: Binector-connector converter, status word 4
- p2084[0...15] BI: Binector-connector converter, status word 5

Connector-binector converter

- A 32-bit integer double word or a 16-bit integer word is converted to individual digital signals.
- p2099[0...1] CI: Connector-binector converter signal source

Fixed values for interconnection using BICO technology

The following connector outputs are available for interconnecting any fixed value settings:

- p2900[0...n] CO: Fixed value 1[%]
- p2901[0...n] CO: Fixed value 2[%]
- p2930[0...n] CO: Fixed value M [Nm]

Example:

These parameters can be used to interconnect the scaling factor for the main setpoint or to interconnect an additional torque.

6.3 Communication via PROFINET

The Control Unit provides the following functions:

• IRT without isochronous mode	
• MRP	Media redundancy, not bumpless with 200 ms Precondition: Ring topology
• MRPD	Media redundancy, bumpless Precondition: IRT and the ring topology created in the control
• Diagnostic alarms	According to error classes specified in the PROFIdrive profile. See Activating diagnostics via the control (Page 180).
• Device replacement without removable data storage medium	Precondition: Topology created in the control

The Control Units have two RJ45 sockets that you can use to implement a line topology. You can implement all topologies by using switches.

Additional information on PROFINET on the Internet

General information about PROFINET can be found at Industrial Communication (http://www.automation.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx).

The configuration of the functions is described in the PROFINET system description (http://support.automation.siemens.com/WW/view/en/19292127) manual.

6.3.1 What do you need for communication via PROFINET?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the inverter via the fieldbus.

Questions	Answer/description
Is the inverter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 178)
Do the IP address and device name in the inverter and controller match?	See: Configuring communication to the control (Page 178)
Is the same telegram set in the inverter as in the higher-level controller?	Set the telegram in the inverter, see: Select telegram (Page 179)
Are the signals that the inverter and the controller exchange via PROFINET correctly interconnected?	PROFIdrive-compliant interconnection in the inverter, see: PROFIdrive profile for PROFIBUS and PROFINET (Page 184)

6.3.2 Connect the converter to PROFINET

Connecting up

Connect the inverter (IO device) and your PG/PC (IO supervisor) via PROFINET cables with the control. The maximum permissible cable length is 100 m.

See also Section: CU230P-2 PN Control Unit (option K96) (Page 74).

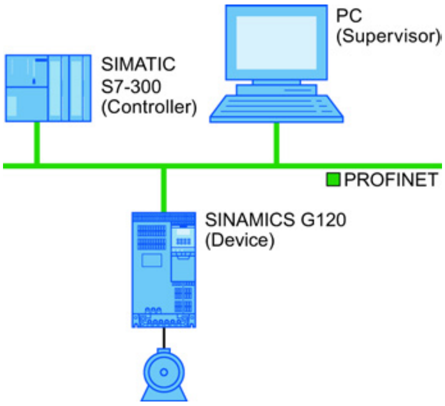


Figure 6-5 Example: PROFINET in a line topology

Recommended PROFINET connectors and pin assignment

We recommend the following connector with order number: 6GK1901-1BB10-2Ax0 for connecting the PROFINET cable.

Instructions for assembling the SIMATIC NET Industrial Ethernet FastConnect RF45 Plug 180 can be found on the Internet under product information "Assembly instructions for SIMATIC NET Industrial Ethernet FastConnect RJ45 Plug" (http://support.automation.siemens.com/WW/view/en/37217116/133300)".

Laying and shielding the PROFINET cable

Information can be found on the Internet: PROFIBUS user organization installation guidelines (http://www.profibus.com/downloads/installation-guide/).

6.3.3 Configuring communication to the control

Loading GSDML

In order to establish communication between the inverter and controller via PROFINET, you need the device file of the inverter "GSDML" for your controller. You can then configure the communication.

Procedure

Proceed as follows to load the GSDML of the inverter:

- Load the GSDML of the inverter into the PROFINET controller, i.e. into your controller. You can load the GSDML of your inverter in two ways:
  - You can find the GSDML of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
  - The GSDML is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the GSDML will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card as a compressed file (PNGSD.ZIP).
- Unpack the GSDML before you use the device file.

6.3.4 Select telegram

The following telegrams are available:

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in the basic commissioning, and select a telegram.	
p0922	**PROFIdrive telegram selection** Set the send and receive telegram, also see Cyclic communication (Page 184)	
	1: 20: 350: 352 353: 354: 999:	Standard telegram 1, PZD-2/2 (factory setting) Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4 Free telegram configuring with BICO, see Extend telegrams and change signal interconnection (Page 191)

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Commissioning (Page 119).

Procedure

Proceed as follows to set a specific telegram in the inverter:

- Use STARTER or the IOP to set parameter p0922 to the appropriate value.

6.3.5 Activating diagnostics via the control

The inverter provides the functionality to transfer fault and alarm messages (diagnostic messages) to the higher-level controller according to the PROFIdrive error classes.

The functionality must be selected in the higher-level controller and activated by powering up.

6.4 Communication via PROFIBUS

6.4.1 What do you need for communication via PROFIBUS?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the inverter via the fieldbus.

Questions	Description
Is the inverter correctly connected to the PROFIBUS?	See Section: Connect the frequency inverter to PROFIBUS (Page 180).
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring communication to the control (Page 181)
Do the addresses in the inverter and the higher-level controller match?	See Section: Setting the address (Page 182).
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram (Page 183).
Are the signals that the inverter and the controller exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the controller to the inverter. For the PROFIdrive-compliant interconnection in the inverter, see also Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 184).

6.4.2 Connect the frequency inverter to PROFIBUS

Permissible cable lengths, routing and shielding the PROFIBUS cable

For a data transfer rate of 1 Mbit/s, the maximum permissible cable length is 100 m.

You will find additional information on this topic on the Internet:

- Product support (http://www.automation.siemens.com/net/html_76/support/printkatalog.htm)

- PROFIBUS user organization installation guidelines (http://www.profibus.com/downloads/installation-guide/)

Recommended PROFIBUS connectors

We recommend connectors with the following order numbers for connecting the PROFIBUS cable:

- 6GK1500-0FC10
- 6GK1500-0EA02

Pin assignment at the inverter

For the pin assignment at the inverter refer to Section CU230P-2 DP Control Unit (option K97) (Page 80).

Communication with the controller even when the supply voltage on the Power Module is switched off

You must supply the Control Unit with 24 VDC at terminals X9:1,2 on the Power Module if you wish to maintain communication with the controller even when the line voltage is switched off.

In the case of short interruptions of the 24 V voltage supply, the inverter may report a fault without communications with the controller being interrupted.

6.4.3 Configuring communication to the control

To configure communication between the inverter and controller, you generally require the description file GSD of the inverter.

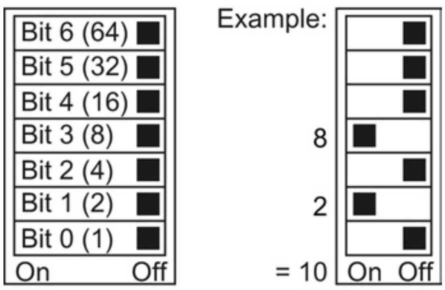
When STEP 7 and STARTER are installed, you do not need GSD.

Procedure

Proceed as follows to configure communication to the controller using GSD:

1. Obtain the GSD file of the inverter.
   You have two options:
   – You can find the GSD of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   – The GSD is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12, the inverter writes the GSD to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.
2. Import the GSD into the configuring tool of your controller.
3. Configure the communication between the controller and the inverter in your control.

6.4.4 Setting the address



You set the PROFIBUS address of the inverter using the address switch on the Control Unit, in parameter p0918 or in STARTER.

In parameter p0918 (factory setting: 126) or in STARTER, you can only set the address if all address switches are set to "OFF" (0) or "ON" (1).

If you have specified a valid address with the address switches, this address will always be the one that takes effect and parameter p0918 cannot be changed.

Valid address area: 1 … 125

The positions of the address switches are described in Section: CU230P-2 DP Control Unit (option K97) (Page 80).

Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – Using the address switches
   – With the IOP using p0918
   – In STARTER using screen form "Control Unit/Communication/PROFIBUS" or using the expert list in parameter p0918.
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

6.4.5 Select telegram

The following telegrams are available:

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in the basic commissioning, and select a telegram.	
p0922	**PROFIdrive telegram selection** Set the send and receive telegram, also see Cyclic communication (Page 184)	
	1: 20: 350: 352 353: 354: 999:	Standard telegram 1, PZD-2/2 (factory setting) Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4 Free telegram configuring with BICO, see Extend telegrams and change signal interconnection (Page 191)

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Commissioning (Page 119).

Procedure

Proceed as follows to set a specific telegram in the inverter:

- Use STARTER or the IOP to set parameter p0922 to the appropriate value.

6.5 PROFIdrive profile for PROFIBUS and PROFINET

6.5.1 Cyclic communication

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

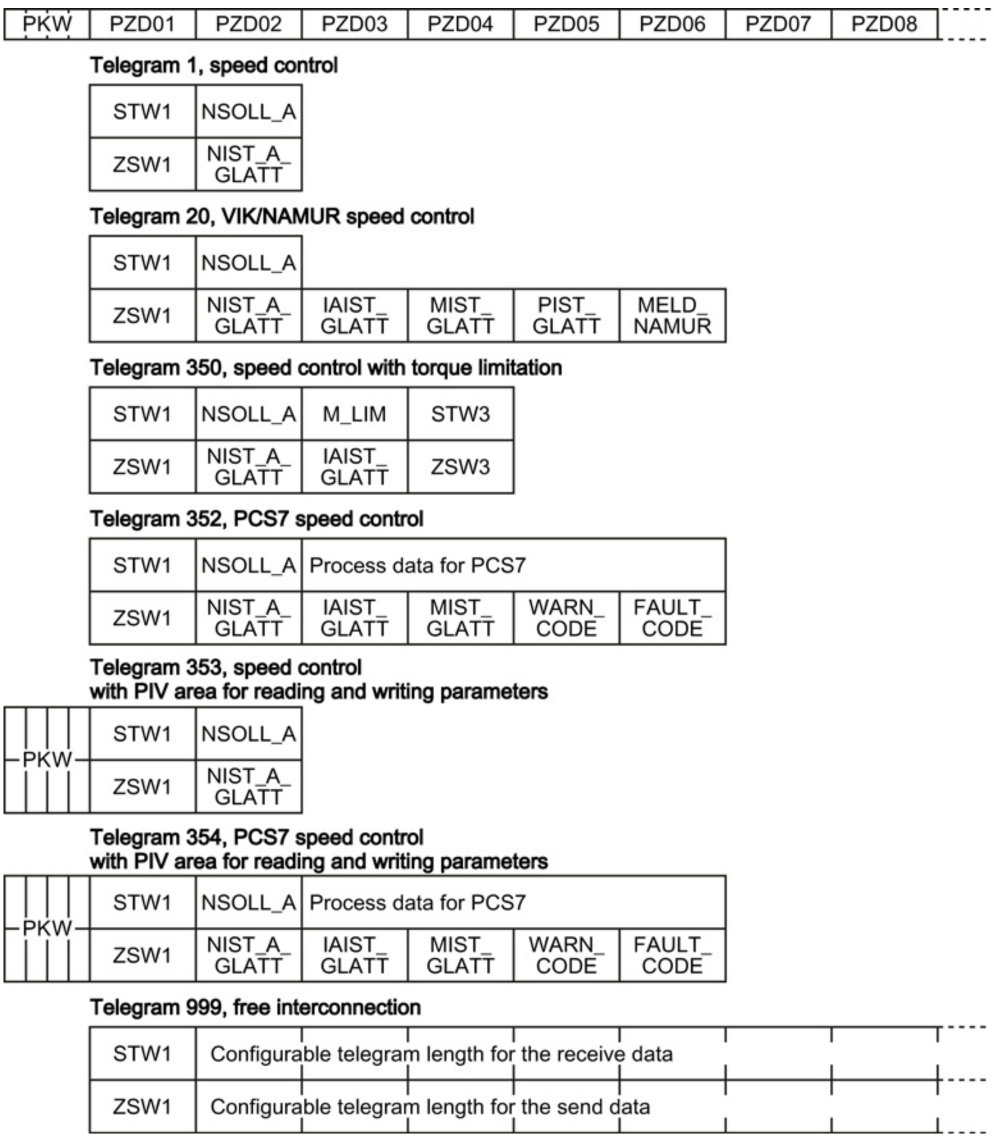


Figure 6-6 Telegrams for cyclic communication

Table 6- 4 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
STW1	Control word 1	MIST_GLATT	Current torque
ZSW1	Status word 1	PIST_GLATT	Current active power
STW3	Control word 3	M_LIM	Torque limit value
ZSW3	Status word 3	FAULT_CODE	Fault number
NSOLL_A	Speed setpoint	WARN_CODE	Alarm number
NIST_A_GLATT	Smoothed actual speed value	MELD_NAMUR	Fault word according to VIK-NAMUR definition
IAIST_GLATT	Smoothed actual current value		

Interconnection of the process data

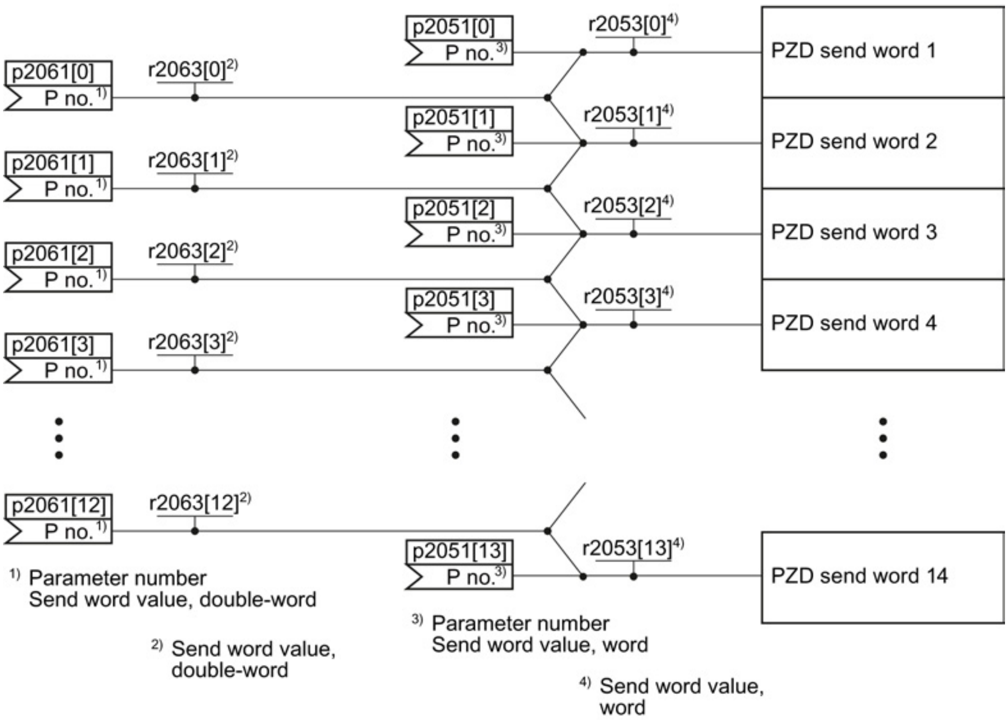


Figure 6-7 Interconnection of the send words

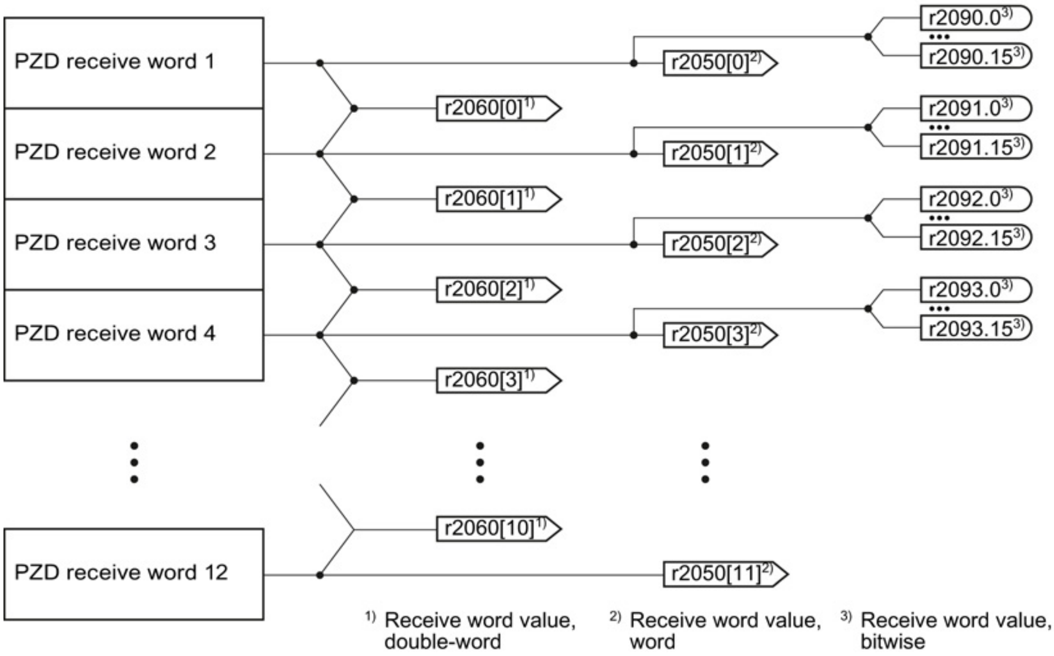


Figure 6-8 Interconnection of the receive words

The telegrams use - with the exception of telegram 999 (free interconnection) - the word-by-word transfer of send and receive data (r2050/p2051).

If you require an individual telegram for your application (e.g. for transferring double words), you can adjust one of the predefined telegrams via parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

6.5.1.1 Control and status word 1

The control and status words fulfill the specifications of PROFIdrive profile version 4.1 for the "closed-loop speed controlled" mode.

Control word 1 (STW1)

Control word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter). See also function diagram 2441/2442.

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

Status word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter). See also function diagram 2451/2452.

Bit	Significance		Comments	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
0	1 = Ready to start		The power supply is switched on; electronics initialized; pulses locked.	p2080[0] = r0899.0
1	1 = Ready		The 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		The motor follows the 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 = Closing lockout active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = Alarm active		The 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	0 = I, M or P limit reached		Comparison value for current, torque or power has been reached or exceeded.	p2080[11] = r1407.7
12	---1)	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal inverter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counterclockwise		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.

6.5.1.2 Control and status word 3

The control and status words fulfill the specifications of PROFIdrive profile version 4.1 for the "closed-loop speed controlled" mode.

Control word 3 (STW3)

Control word 3 has the following default assignment. You can change the signal interconnection. See also function diagram 2446.

Bit	Value	Significance Telegram 350	Explanation	Signal interconnection in the inverter [1)]
0	1	Fixed setpoint, bit 0	Selects up to 16 different fixed setpoints.	p1020[0] = r2093.0
1	1	Fixed setpoint, bit 1		p1021[0] = r2093.1
2	1	Fixed setpoint, bit 2		p1022[0] = r2093.2
3	1	Fixed setpoint, bit 3		p1023[0] = r2093.3
4	1	DDS selection, bit 0	Changes over between settings for different motors (drive data sets).	p0820 = r2093.4
5	1	DDS selection, bit 1		p0821 = r2093.5
6	–	Reserved		
7	–	Reserved		
8	1	Technology controller enable	--	p2200[0] = r2093.8
9	1	DC braking enable	--	p1230[0] = r2093.9
10	–	Reserved		
11	1	1 = Enable droop	Enable or inhibit speed controller droop.	p1492[0] = r2093.11
12	1	Torque control active	Changes over the control mode for vector control.	p1501[0] = r2093.12
	0	Closed-loop speed control active		
13	1	No external fault	--	p2106[0] = r2093.13
	0	External fault is active (F07860)		
14	–	Reserved		
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)

Status word 3 has the following standard assignment. See also function diagram 2456.

Bit	Value	Significance	Description	Signal interconnection in the inverter
0	1	DC braking active	--	p2051[3] = r0053
1	1	|n_act| > p1226	Absolute actual 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	Ramping completed	Ramp-function generator is not active.	
10	1	Technology controller output at lower limit	Technology controller output ≦ p2292	
11	1	Technology controller output at upper limit	Technology controller output > p2291	
12		Reserved		
13		Reserved		
14		Reserved		
15		Reserved		

6.5.1.3 Extend telegrams and change signal interconnection

When you have selected a telegram, the inverter interconnects the corresponding signals with the fieldbus interface. Generally, these interconnections are protected so that they cannot be changed. With the appropriate inverter settings, these interconnections can be changed.

Extending a telegram

Every telegram can be extended by "attaching" additional signals.

Procedure

Proceed as follows to extend a telegram:

1. Use STARTER or the IOP to set parameter p0922 = 999.
2. Set parameter p2079 to the appropriate value of the corresponding telegram.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

Parameter	Description	
p0922	**PROFIdrive telegram selection**	
	999:	Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended**	
	1: 20: 350: 352: 353: 354:	Standard telegram 1, PZD-2/2 Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.	
p2051[0…11]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller. For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

Procedure

Proceed as follows to change the signal interconnection of a telegram:

1. Use STARTER or the IOP to set parameter p0922 = 999.
2. Use STARTER or the IOP to set parameter p2079 = 999.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

Parameter	Description	
p0922	**PROFIdrive telegram selection**	
	999:	Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended**	
	999:	Free telegram (message frame) configuration
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.	
p2051[0…11]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.	

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

6.5.1.4 Data structure of the parameter channel

Structure of the parameter channel

The parameter channel consists of four words. 1. and 2nd word transfer the parameter number and index as well as the type of job (read or write) The 3rd and 4th word contains the parameter contents. 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.

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

You can find examples of telegrams at the end of this section.

Request and response IDs

Bits 12 to 15 of the 1st word of the parameter channel contain the request and response identifier.

Table 6- 5 Request identifiers, controller → inverter

Request identifier	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- 6 Response identifiers, inverter → controller

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1)]
4	Transfer parameter value (field, word) [2)]
5	Transfer parameter value (field, double word) [2)]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the controller, refer to the following table.
8	No master control 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- 7 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 closed-loop controller that is enabled** (operating state of the inverter prevents a parameter change)
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)

Offset and page index of the parameter numbers

Parameter numbers < 2000	PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).
Parameter numbers ≥ 2000	PNU = parameter number - offset. Write the parameter number minus the offset into the PNU (PKE bit 10 … 0). Write the offset in the page index (IND bit 7 … 0).

Parameter number	Offset	Page index								
		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as hex value into the subindex (IND bit 15 … 8).

Parameter contents

Parameter contents can be parameter values or connector parameters. For interconnecting connector parameters refer to BICO technology: Interconnecting signals (Page 172).

Enter the parameter value, right-justified, as follows in the 4th word of the parameter channel:

- 8-bit values: 4th word, bit 0 … 7,
  bits 8 … 15 of the 4th word and the 3rd word are zero.
- 16-bit values: 4th word, bits 0 … 15,
  The 3rd word is zero.
- 32-bit values: 3rd and 4th word

Enter a connector parameter as follows:

- Number of the connector parameter: 3rd word
- Drive object of the connector parameter: 4th word, bits 10 … 15
- The index or bit field number of the connector parameter: 4th word, bits 0 … 9

Telegram examples

Read request: Read out serial number of the Power Module (r7841[2])

To obtain the value of the indexed parameter r7841, 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 the parameter)
- **IND, bit 0 … 7 (page index): = 90 hex** (offset 6000 ≙ 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 6-9 Telegram for a read request from r7841[2]

Write request: Changing the automatic 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 hex** (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 6-10 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 fill 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 = index1)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 ≙ 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 or bit number of the parameter (DI 2 = 2))

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

Figure 6-11 Telegram to assign DI 2 with ON/OFF1

Other application examples

See also: Reading and writing parameters via PROFIBUS (http://support.automation.siemens.com/WW/view/en/8894584).

6.5.1.5 Slave-to-slave communication

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

Example: An inverter uses the actual speed value of another inverter as its speed setpoint.

Definitions

- **Publisher:** Slave, which sends data for direct communication.
- **Subscriber:** Slave, which receives the data for direct communication from the publisher.
- **Links and access points** define the data that is used for direct communication.

Restrictions

- Direct communication in the current firmware version is only possible for inverters with PROFIBUS communication.
- A maximum of 12 PZDs are permissible for each drive.
- A maximum of 4 links to a publisher are possible.

Procedure

To configure direct communication, proceed as follows:

1. In the controller, define:
   - Which inverters operate as publisher (sender) or subscriber (receiver)?
   - Which data or data areas do you use for direct communication?
2. In the inverter, define:

   How the subscriber processes the data transferred using direct communication?

6.5.2 Acyclic communication

You can communicate with the inverter both cyclically and acyclically via PROFIBUS and PROFINET.

The inverter supports the following types of acyclic communication:

- Reading and writing parameters via "data set 47" (up to 240 bytes per write or read request)
- Reading-out profile-specific parameters

Reading parameter values

Table 6- 8 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**Attribute** *10 hex:* Parameter value *20 hex:* Parameter description	**Number of indexes** *00 hex ... EA hex* (for parameters without index: 00 hex)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0000 hex ... FFFF hex* (for parameters without index: 0000 hex)		8
	…		…
Address, parameter 2	…		…
…	…		…
Address, parameter m	…		…

Table 6- 9 Inverter response to a read request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a read request)	**01 hex**: Inverter has executed the read request. **81 hex**: Inverter was not able to completely execute the read request.	0
	01 hex	**Number of parameters (m)** (identical to the read request)	2
Values, parameter 1	**Format** 02 hex: Integer8 03 hex: Integer16 04 hex: Integer32 05 hex: Unsigned8 06 hex: Unsigned16 07 hex: Unsigned32 08 hex: FloatingPoint 10 hex OctetString 13 hex TimeDifference 41 hex: Byte 42 hex: Word 43 hex: Double word 44 hex: Error	**Number of index values** or - for a negative response - **number of error values**	4
	Value of the 1st index or - for a negative response - **error value 1** You can find the error values in a table at the end of this section.		6
	…		…
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Changing parameter values

Table 6- 10 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex ... EA hex* (00 hex and 01 hex have the same significance)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0001 hex ... FFFF hex*		8
	…		…
Address, parameter 2	…		
…	…		…
Address, parameter m	…		

Data block	Byte n	Bytes n + 1	n
Values, parameter 1	**Format** *02 hex:* Integer 8 *03 hex:* Integer 16 *04 hex:* Integer 32 *05 hex:* Unsigned 8 *06 hex:* Unsigned 16 *07 hex:* Unsigned 32 *08 hex:* Floating Point *10 hex* Octet String *13 hex* Time Difference *41 hex:* Byte *42 hex:* Word *43 hex:* Double word	**Number of index values** *00 hex ... EA hex*	
	Value of the 1st index		
	…		
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Table 6- 11 Response, if the inverter has executed the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**02 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2

Table 6- 12 Response if the inverter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex or 02 hex	4
	Only for "Error" - **error value 1** You can find the error values in the table at the end of this section.		6
	Only for "Error" - **error value 2** Error value 2 is either zero, or it contains the number of the first index where the error occurred.		8
Values, parameter 2	...		
...	…		…
Values, parameter m	...		

Table 6- 13 Error value in the parameter response

Error value 1	Significance
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 parameter index 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 that cannot be changed)
09 hex	**Description data not available** (access to a description that does not exist, parameter value is available)
0B hex	**No master control** (change request but with no master control)
0F hex	**Text array does not exist** (although the parameter value is available, the request is made to a text array that does not exist)
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)
15 hex	**Response too long** (the length of the actual response exceeds the maximum transfer length)
16 hex	**Illegal parameter address** *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)*
17 hex	**Illegal format** (change request for an illegal or unsupported format)
18 hex	**Number of values not consistent** *(number of values of the parameter data to not match the number of elements in the parameter address)*
19 hex	**Drive object does not exist** (access to a drive object that does not exist)
6B hex	**No change access for a closed-loop controller that is enabled**
6C hex	**Unknown unit**.
6E hex	**Change request is only possible when the motor is being commissioned (p0010 = 3).**
6F hex	**Change request is only possible when the power unit is being commissioned (p0010 = 2).**
70 hex	**Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).**
71 hex	**Change request is only possible if the inverter is ready (p0010 = 0).**
72 hex	**Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).**
73 hex	**Change request is only possible during commissioning of the safety functions (p0010 = 95).**
74 hex	**Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).**
75 hex	**Change request is only possible in a commissioning state (p0010 ≠ 0).**
76 hex	**Change request is not possible for internal reasons (p0010 = 29).**
77 hex	**Change request is not possible at download.**
81 hex	**Change request is not possible at download.**
82 hex	**Transfer of the control authority (master) is inhibited by BI: p0806.**
83 hex	**Desired interconnection is not possible** (the connector output does not supply a float value although the connector input requires a float value)
84 hex	**Inverter does not accept a change request** (inverter is busy with internal calculations, see parameter r3996 in the inverter List Manual)

Error value 1	Significance
85 hex	**No access methods defined**.
86 hex	**Write access only during commissioning of the data records (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)

Other application examples

See also: Reading and writing parameters acyclically (http://support.automation.siemens.com/WW/view/en/29157692).

6.6 PROFIenergy profile for PROFINET

PROFIenergy is an energy management system for production plants, based on the PROFINET communication protocol. The functionality is certified and described in the PROFIenergy profile of the PNO.

The inverter supports the PROFIenergy profile V1.1 and the function unit class 3.

PROFIenergy functions of the inverter

The controller transfers the PROFIenergy commands in acyclic operation to the inverter in data set 80A0 hex.

Parameters r5600 to p5614 are reserved for PROFIenergy functions in the inverter.

The PROFIenergy status is output in r5600.

The following commands and queries are available for the control:

PROFIenergy control commands

- Start_Pause
  Switches from operating state S1 or S2 (start inhibit or start readiness) to energy-saving mode.
  Switches from energy-saving mode to the operating state.
- START_Pause_with_time_response
  Switches from operating state S1 or S2 (start inhibit or start readiness) to energy-saving mode and also specifies the transition times in the command response.
- End_Pause
  Switches from energy-saving mode to the operating state.
  Cancels the switching from the operating state to the energy-saving mode.

PROFIenergy status requests

- List_Energy_Saving_Modes
  Determines all supported energy-saving modes.
- GeLMode
  Determines information about the selected energy-saving mode.
- PEM_Status
  Determines the current PROFienergy status.
- PEM_Status_with_CTTO
  Determines the current PROFienergy status, such as the PEMStatus, together with the regular transition time to the operating state.
- PEIdentify
  Determines the supported PROFienergy commands.
- Query Version
  Shows the implemented PROFienergy profile.
- Get_Measurement_List
  This command returns the measured value IDs that can be accessed using the "Get_Measurement_Values" command.
- Get_Measurement_List_with_object_number
  This command returns the measured value IDs and the associated object number that can be accessed using the "Get_Measurement_Values_with_object_number" command.
- Get_Measurement_ Values
  The command returns the requested measured value using the measured value ID.
- Get_Measurement_Values_with_object_number
  The command returns the requested measured values using the measured value ID and the object number. The object number corresponds to the drive object ID.

Displaying

- r5600: Current energy-saving mode
- r5613: Interconnectable display of the PROFIenergy state
- A08800: PROFIenergy energy-saving mode active

General settings for PROFIenergy

- Minimum pause time: p5602
  The inverter enters energy-saving mode only when the pause time sent with the "Start_Pause" command is greater than or equal to the value for p5602.1. If the pause time is less than p5602.1, the inverter ignores the command.
- Maximum pause time: p5606

Block PROFIenergy control commands

If you set p5611.0 = 1, you block the response of the inverter to PROFIenergy control commands. In this case, the inverter ignores the PROFIenergy control commands.

Transition to the energy-saving mode from the PROFIdrive operating state (S4)

If you set p5611.2 = 1, you permit the transition to the energy-saving mode from the PROFIdrive operating state (S4).

You can select the following:

- p5611.1 = 1
  With the transition to the energy-saving mode, the inverter issues an OFF1 command and enters the start-inhibit state (S1).
- p5611.1 = 0
  You can use p5614 to interconnect a signal source that switches the inverter off and places it in the start-inhibit state (S1).

PROFIenergy measured values

PROFIenergy				Unit	SINAMICS source parameters		Value range
Measured value		Accuracy					
ID	Name	Domain	Class		Number	Name	
34	Active power	1	12	W	r0032	Active power smoothed	r2004
166	Power factor	1	12	1	r0038	Smoothed power factor	0 … 1
200	Active energy import	2	11	Wh	r0039[1]	Energy accepted	-

6.7 Communication via EtherNet/IP

Via EtherNet/IP you can enter commands and setpoints, read-out status information and actual values, change parameter values and reset faults.

Process data (setpoints, actual values, etc.) are transferred in EtherNet/IP using assemblies. In addition to the assemblies, there are objects that you can use to set the communication. The objects and assemblies supported by the inverter are described in Section Supported objects (Page 208)

6.7.1 Connect converter to Ethernet/IP

The Control Units have two RJ45 sockets for connection to the controller, which you can use to implement a line topology. You can implement all topologies by using switches.

We recommend the following connector with order number: 6GK1901-1BB10-2Ax0 for connecting an Ethernet cable.

Instructions for assembling the SIMATIC NET Industrial Ethernet FastConnect RF45 Plug 180 can be found on the Internet under product information "Assembly instructions for SIMATIC NET Industrial Ethernet FastConnect RJ45 Plug (http://support.automation.siemens.com/WW/view/en/37217116/133300)".

Procedure

To connect the inverter to a controller via Ethernet, proceed as follows:

1. Connect the inverter to the controller via an Ethernet cable.
2. Either
   create a generic I/O module (Page 215) in your controller for cyclic data exchange between the controller and the inverter
   or
   load the EDS file of the ODVA into the controller. You can find the file on the Internet at: http://www.odva.org/Home/CIPPRODUCTCOMPLIANCE/DeclarationsofConformity/EtherNetIPDOCs/tabid/159/lng/en-US/Default.aspx (http://www.odva.org/Home/CIPPRODUCTCOMPLIANCE/DeclarationsofConformity/EtherNetIPDOCs/tabid/159/lng/en-US/Default.aspx).

See also Section: CU230P-2 PN Control Unit (option K96) (Page 74).

Routing and shielding the Ethernet cable

Information can be found on the Internet: EtherNet/IP guidelines (http://www.odva.org/Home/ODVATECHNOLOGIES/EtherNetIP/EtherNetIPLibrary/tabid/76/lng/en-US/Default.aspx).

Commissioning the inverter in an EtherNet/IP network

To commission the inverter, using STARTER you must access the inverter via the USB interface. To do this, connect the computer to the inverter via the USB interface. See also Procedure for commissioning via STARTER (Page 126).

6.7.2 What do you need for communication via Ethernet/IP?

Check the communication settings using the following questions. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the inverter via the fieldbus.

- Is the inverter correctly connected to the EtherNet/IP?
- Is the EDS file (Page 204) installed in your control system?
- Have the bus interface and IP address been correctly set?
- Have the signals that the inverter and the control system exchange been correctly interconnected?

6.7.3 Communication settings for Ethernet/IP

General communication settings

In order to be able to communicate with a higher-level controller via EtherNet/IP, you must set parameter p2030 = 10.

Further, you must set the following data:

- IP address — in p8921 — currently valid value in r8931
- Subnet mask — in p8923 — currently valid value in r8933
- Default gateway — in p8922 — currently valid value in r8932
- Name of station — in p8920 — currently valid value in r8930

These parameters apply if p2030 = 10 is set, for EtherNet/IP, even if the parameter name indicates PROFINET.

Modified addresses only become effective if you switch-off the inverter and switch it on again; this includes any external 24 V supply that is being used.

Additional settings for communication via EtherNet/IP

Setting the communication profile

The inverter has two communication profiles

- p8980 = 0: SINAMICS profile (factory setting)
  A drive profile defined by Siemens for EtherNet/IP based on PROFIdrive
- p8980 = 1: ODVA AC/DC drive profile
  A drive profile defined by the ODVA organization

Telegram selection

You select the telegram using p0922.

You can select any of the listed telegrams if you are working with the SINAMICS profile.

If you use the AC/DC profile of the ODVA, select the standard telegram, p0922 = 1. You cannot work with the EDS file if you wish to use the assemblies described in Section Supported objects (Page 208). In this case, you must integrate the inverter into your controller.

Setting the bus monitoring time

You set the bus monitoring using parameter p8840 in the inverter.

If you set this parameter to 0, the inverter continues to operate even if the bus develops a fault condition. If you set a time ≠ 0, then the inverter switches off with F08501 "Setpoint timeout" if the controller does not issue any signals within this time.

6.7.4 Additional settings if you are working with the ODVA AC/DC drive profile

If you change the following settings in the inverter by accessing the appropriate parameters, you must switch-off the inverter and switched it on again in order that these changes become effective. The changes become immediately effective when making the changes via the controller with objects 90 hex or 91 hex.

Setting the off response for the motor

You set the standard off response for the inverter using parameter p8981:

- p8981 = 0: OFF1 (factory setting), also corresponds to the setting in the SINAMICS profile
- p8981 = 1: OFF2

You can find details on OFF1 and OFF2 in Section Switching the motor on and off (Page 334)

Setting the speed and torque scaling

You scale the speed and torque display using parameter p8982 or p8983.
Setting range: 2^5 to 2^{-5}.

Displaying the maximum process data that can be transferred (PZD)

- r2067[0] maximum interconnected PZD length - receiving
- r2067[1] maximum interconnected PZD length - sending

6.7.5 Supported objects

Ethernet/IP objects supported by the G120

Object class		Object name	Objects required	ODVA objects	SINAMICS objects
hex	dec				
1 hex	1	Identity Object	x		
4 hex	4	Assembly Object	x		
6 hex	6	Connection Manager Object	x		
28 hex	30	Motor Data Object		x	
29 hex	31	Supervisor Object		x	
2A hex	42	Drive Object		x	
32C hex	44	Siemens Drive Object			x
32D hex	45	Siemens Motor Data Object			x
90 hex	144	Parameter Object			x
91 hex	145	Parameter Object Free Access (DS47)			x
F5 hex	245	TCP/IP Interface Object [1)]	x		
F6 hex	246	Ethernet Link Object [1)]	x		
401 hex … 43E hex	1025 … 1086	Parameter object			x

[1)] these objects are part of the Ethernet/IP system management.

ODVA AC/DC assembly

Number		required/ optional	Type	Name
hex	dec			
14 hex	20	Required	Sending	Basic Speed Control Output
15 hex	21	Optional	Sending	Extended Speed Control Output
16 hex	22	Optional	Sending	Speed and Torque Control Output
17 hex	23	Optional	Sending	Extended Speed and Torque Control Output
18 hex	24	Optional	Sending	Process Control Output
19 hex	25	Optional	Sending	Extended Process Control Output
46 hex	70	Required	Receiving	Basic Speed Control Input
47 hex	71	Optional	Receiving	Extended Speed Control Input
48 hex	72	Optional	Receiving	Speed and Torque Control Input
49 hex	73	Optional	Receiving	Extended Speed and Torque Control Input
4A hex	74	Optional	Receiving	Process Control Input
4B hex	75	Optional	Receiving	Extended Process Control Input

Assembly Extended Speed Control with parameter assembly, Instance Number: 121, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Data Out 1 Value (Low Byte)							
5	Data Out 1 Value (High Byte)							
6	Data Out 2 Value (Low Byte)							
7	Data Out 2 Value (High Byte)							
8	Data Out 3 Value (Low Byte)							
9	Data Out 3 Value (High Byte)							
10	Data Out 4 Value (Low Byte)							
11	Data Out 4 Value (High Byte)							
12	Data Out 5 Value (Low Byte)							
13	Data Out 5 Value (High Byte)							
14	Data Out 6 Value (Low Byte)							
15	Data Out 6 Value (High Byte)							
16	Data Out 7 Value (Low Byte)							
17	Data Out 7 Value (High Byte)							
18	Data Out 8 Value (Low Byte)							
19	Data Out 8 Value (High Byte)							
20	Data Out 9 Value (Low Byte)							
21	Data Out 9 Value (High Byte)							
22	Data Out 10 Value (Low Byte)							
23	Data Out 10 Value (High Byte)							

Assembly Extended Speed Control with parameter assembly, Instance Number: 171, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Ref From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Data In 1 Value (Low Byte)							
5	Data In 1 Value (High Byte)							
6	Data In 2 Value (Low Byte)							
7	Data In 2 Value (High Byte)							
8	Data In 3 Value (Low Byte)							

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
9	Data In 3 Value (High Byte)							
10	Data In 4 Value (Low Byte)							
11	Data In 4 Value (High Byte)							
12	Data In 5 Value (Low Byte)							
13	Data In 5 Value (High Byte)							
14	Data In 6 Value (Low Byte)							
15	Data In 6 Value (High Byte)							
16	Data In 7 Value (Low Byte)							
17	Data In 7 Value (High Byte)							
18	Data In 8 Value (Low Byte)							
19	Data In 8 Value (High Byte)							
20	Data In 9 Value (Low Byte)							
21	Data In 9 Value (High Byte)							
22	Data In 10 Value (Low Byte)							
23	Data In 10 Value (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 22, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Assembly Basic Speed and Torque Control , Instance Number: 72, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Running Forward		RUN Forward
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly, Instance Number: 122, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0						Fault Reset		RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Assembly Basic Speed and Torque Control with parameter assembly, Instance Number: 172, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
						Running Forward		Faulted
1								
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

Extended Speed and Torque Control, Instance Number: 23, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							

Extended Speed and Torque Control, Instance Number: 73, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 123, type: Output

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0		NetRef	Net CtrL			Fault Reset	RUN Reverse	RUN Forward
1								
2	Speed Reference (Low Byte)							
3	Speed Reference (High Byte)							
4	Torque Reference (High Byte)							
5	Torque Reference (High Byte)							
6	Data Out 1 Value (Low Byte)							
7	Data Out 1 Value (High Byte)							
8	Data Out 2 Value (Low Byte)							
9	Data Out 2 Value (High Byte)							
10	Data Out 3 Value (Low Byte)							
11	Data Out 3 Value (High Byte)							
12	Data Out 4 Value (Low Byte)							
13	Data Out 4 Value (High Byte)							
14	Data Out 5 Value (Low Byte)							
15	Data Out 5 Value (High Byte)							
16	Data Out 6 Value (Low Byte)							
17	Data Out 6 Value (High Byte)							
18	Data Out 7 Value (Low Byte)							
19	Data Out 7 Value (High Byte)							
20	Data Out 8 Value (Low Byte)							
21	Data Out 8 Value (High Byte)							
22	Data Out 9 Value (Low Byte)							
23	Data Out 9 Value (High Byte)							
24	Data Out 10 Value (Low Byte)							
25	Data Out 10 Value (High Byte)							

Basic Speed and Torque Control with parameter assembly, Instance Number: 173, type: Input

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	At Reference	Ref From Net	Crtl From Net	Ready	Running Reverse	Running Forward	Warning	Faulted
1	Drive State							
2	Speed Actual (Low Byte)							
3	Speed Actual (High Byte)							
4	Torque Actual (High Byte)							
5	Torque Actual (High Byte)							
6	Data In 1 Value (Low Byte)							
7	Data In 1 Value (High Byte)							
8	Data In 2 Value (Low Byte)							
9	Data In 2 Value (High Byte)							
10	Data In 3 Value (Low Byte)							
11	Data In 3 Value (High Byte)							
12	Data In 4 Value (Low Byte)							
13	Data In 4 Value (High Byte)							
14	Data In 5 Value (Low Byte)							
15	Data In 5 Value (High Byte)							
16	Data In 6 Value (Low Byte)							
17	Data In 6 Value (High Byte)							
18	Data In 7 Value (Low Byte)							
19	Data In 7 Value (High Byte)							
20	Data In 8 Value (Low Byte)							
21	Data In 8 Value (High Byte)							
22	Data In 9 Value (Low Byte)							
23	Data In 9 Value (High Byte)							
24	Data In 10 Value (Low Byte)							
25	Data In 10 Value (High Byte)							

6.7.6 Create generic I/O module

For certain controllers, you cannot use the EDS file provided by the ODVA. In these cases, you must create a generic I/O module in the controller for the cyclic communication.

Procedure

Proceed as follows to create a generic I/O module:

1. In your controller, via "New module" create a new "I/O module", "Generic" type.
2. In the controller, enter the lengths for the process data for cyclic communication, which you have selected in STARTER, r2067[0] (input), r2067[1] (output), for example: Standard telegram 2/2.
3. In STARTER, set the same values for IP Address, Subnet Mask, Default Gateway and the Name of Station as in the controller (see Communication settings for Ethernet/IP (Page 206))

6.8 Communication via RS485

The RS485 interface is used to integrate the inverter in one of the following fieldbus systems:

- USS
- Modbus RTU
- BACnet
- P1

6.8.1 Integrating inverters into a bus system via the RS485 interface

Connecting to a network via RS485

Connect the inverter to your fieldbus via the RS485 interface. Position and assignment of the RS485 interface can be found in Section CU230P-2 HVAC Control Unit (option K98) (Page 89). This connector has short-circuit proof, isolated pins.

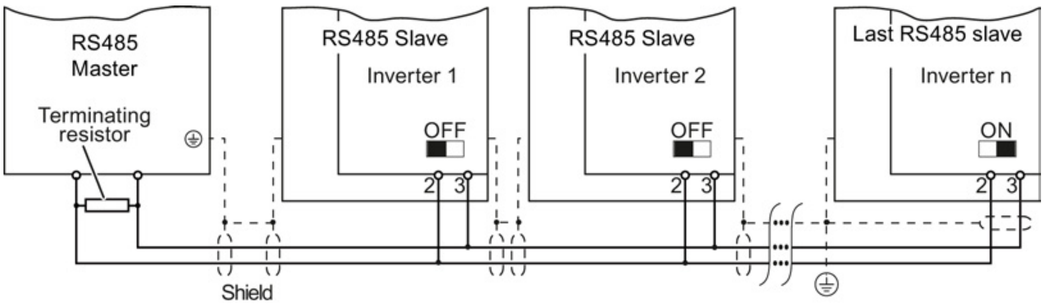


Figure 6-12 Communication network via RS485

You must switch-in the bus-terminating resistor for the first and last nodes. The position of the bus-terminating resistor can be found in Section CU230P-2 HVAC Control Unit (option K98) (Page 89).

Note

During bus operation the first and last bus subscriber must be constantly supplied with power as otherwise the communication with the other subscribers is broken.

With the exception of the first or last slave, when required you can remove slaves from the bus. To do this, withdraw the bus connector. When doing this, communication to the other nodes (stations) is not interrupted.

Communication with the controller even when the supply voltage on the Power Module is switched off

You must supply the Control Unit with 24 VDC at terminals X9:1,2 on the Power Module if you wish to maintain communication with the controller even when the line voltage is switched off.

In the case of short interruptions of the 24 V voltage supply, the inverter may report a fault without communications with the controller being interrupted.

6.8.2 Communication via USS

The USS protocol is a serial-data connection between one master and one or more slaves. A master is, for example:

- A programmable logic controller (e.g. SIMATIC S7-200)
- A PC

The inverter is always a slave.

A maximum of 31 slaves is possible.

The maximum cable length is 100 m.

Information about how to connect the inverter to the USS fieldbus is provided in Section Integrating inverters into a bus system via the RS485 interface (Page 216).

6.8.2.1 Basic settings for communication

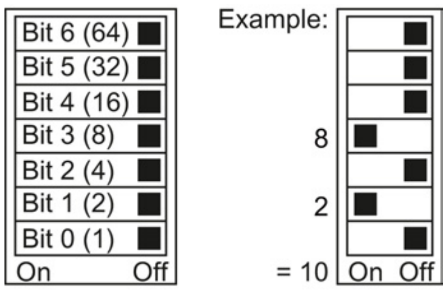
Setting the address

You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Valid address range: 1 … 30

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 0) will not be able to be changed.

The positions of the address switches are described in Section: CU230P-2 HVAC Control Unit (option K98) (Page 89).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - Using the address switches
   - With the IOP using p2021
   - In STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list in parameter p2021.
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

Additional settings

Parameter	Description
p0015 = 21	**Drive device macro** Select the I/O configuration (USS fieldbus)
p0791[0 … 1]	**Fieldbus analog outputs** Parameter to interconnect the analog outputs for control via the fieldbus
p2030 = 1	Fieldbus telegram selection 1: USS
p2020	**Baud rate** Factory setting = 38400 bit/s
p2022	**Fieldbus interface USS PZD number** Sets the number of 16-bit words in the PZD part of the USS telegram Setting range: 0… 8 (0 … 8 words)
p2023	**Fieldbus interface USS PIV number** Sets the number of 16-bit words in the PIV part of the USS telegram Setting range: • 0, 3, 4: 0, 3 or 4 words • 127: variable length
r2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface
p2040	**Fieldbus monitoring time** 0 ms … 1999999 ms, factory setting = 100 ms. The more slaves that are connected in the network, the longer the fieldbus monitoring time must be. If process data is not transferred within one cycle of the fieldbus monitoring time, then the inverter shuts down with fault F01910. p2040 = 0 ⇒ bus monitoring deactivated.

6.8.2.2 Telegram structure

Overview

A USS telegram comprises a series of elements with a defined sequence. Each element contains 11 bits.

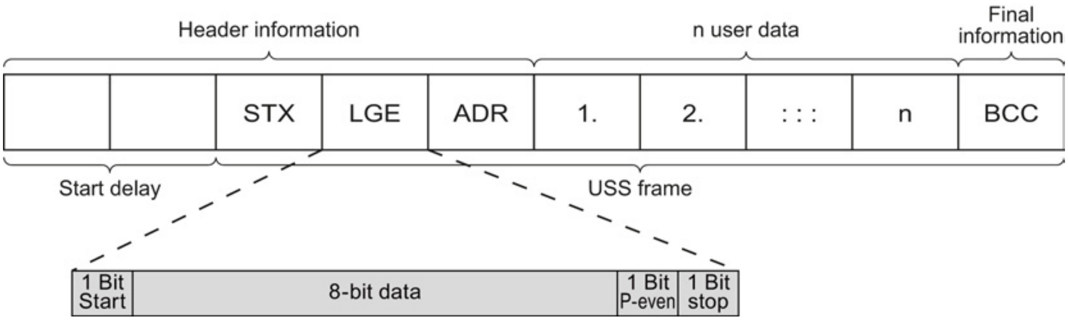
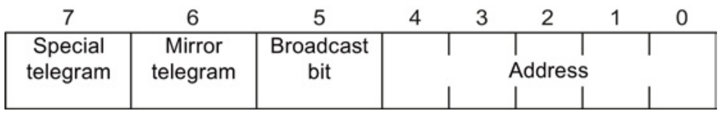


Figure 6-13 Structure of a USS telegram

Telegram part	Description
Start delay / response delay	There is always a start and/or response delay between two telegrams (see alsoTime-out and other errors (Page 226)).
STX	An ASCII character (02 hex) indicates the beginning of the message.
LGE	The telegram length "LGE" is calculated as follows: LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte)
ADR	 • Bit 7 = 0: Normal data exchange. Bit 7 = 1: To transfer telegrams that require a net data structure different from the device profile. • Bit 6 = 0: Normal data exchange. Bit 6 = 1: Testing the bus connection: The inverter returns the telegram unchanged to the master. • Bit 5 = 0: Normal data exchange. (Bit 5 = 1: Not supported in the inverter.) • Bits 0 ... 4: Address of the inverter.
Net data	See Section User data range of the USS telegram (Page 220).
BCC	Checksum (exclusive or) across all telegram bytes – with the exception of BCC.

6.8.2.3 User data range of the USS telegram

The user data area consists of the following elements:

- Parameter channel (PIV) for writing and reading parameter values
- Process data (PZD) for controlling the drive.

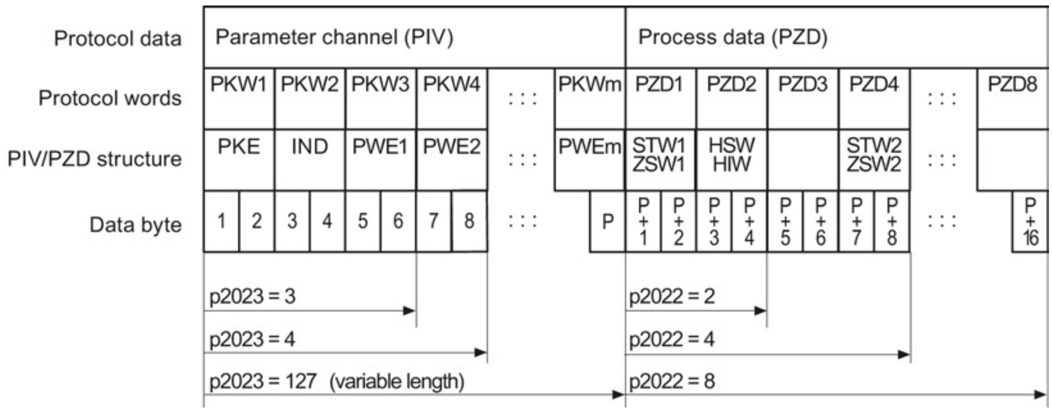


Figure 6-14 USS telegram - user data structure

Parameter channel

In parameter p2023 specify the parameter channel length.

Parameter channel with fixed and variable length

- p2023 = 0
  With this setting, no parameter values are transferred.
- p2023 = 3
  You can select this setting if you only want to read or write 16-bit data or alarm signals.
- p2023 = 4:
  If you want to read or write 32-bit values (for example indexed parameters or bit parameters, e.g. r0722.2), then this setting is required. In this case, the send or receive telegram always contains four words, even if only three would be required. The values are entered right-justified in the 4th word.
- p2023 = 127:
  If you set p2023 = 27 (variable length), the send and response telegrams are as long as the task actually requires.

Process data

Parameter p2022 defines the length for the process data. You can transfer up to eight process data items in one telegram (p2022 = 0 … 8). For p2022 = 0, no process data is transferred.

6.8.2.4 USS parameter channel (PIV)

Structure of the parameter channel

Depending on the setting in p2023, the parameter channel has a fixed length of three or four words, or a variable length, depending on the length of the data to be transferred.

The 1st and 2nd words contain the parameter number, the index and the type of job (read or write). The other words of the parameter channel contain parameter contents. The parameter contents can be 8-bit values, 16-bit values (e.g. baud rate) or 32-bit values (e.g. CO parameters). The parameter contents are entered right-justified in the word with the highest number. Words that are not required are assigned 0.

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

The diagram shows a parameter channel that is four words long.

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

You can find examples of telegrams at the end of this section.

Request and response IDs

Bits 12 to 15 of the 1st word of the parameter channel contain the request and response identifier.

Table 6- 14 Request identifiers, controller → inverter

Request identifier	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- 15 Response identifiers, inverter → controller

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1)]
4	Transfer parameter value (field, word) [2)]
5	Transfer parameter value (field, double word) [2)]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the controller, refer to the following table.
8	No master control 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- 16 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)

No.	Description
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 closed-loop controller that is enabled** (operating state of the inverter prevents a parameter change)
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)

Parameter number

Parameter numbers < 2000 — PNU = parameter number.
Write the parameter number into the PNU (PKE bit 10 ... 0).

Parameter numbers ≥ 2000 — PNU = parameter number - offset.
Write the parameter number minus the offset into the PNU (PKE bit 10 … 0).
Write the offset in the page index (IND bit 15 … 8).

Table 6- 17 Offset and page index of the parameter numbers

Parameter number	Offset	Page index								
		Hex	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as hex value into the subindex (IND bit 7 … 0).

Parameter contents

Parameter contents can be parameter values or connector parameters. You require two words for connector parameters. For interconnecting connector parameters refer to BICO technology: Interconnecting signals (Page 172).

Enter the parameter value in the parameter channel right-justified as follows:

- 8-bit values: Low word, bit 0 ... 7, bits 8 … 15 are zero.
- 16-bit values: Low word, bits 0 … 15,
- 32-bit values: Low word and high word

Enter a connector parameter right-justified as follows:

- Number of the connector parameter: High word
- Drive object of the connector parameter: Low word, bits 10 … 15
- The index or bit field number of the connector parameter: Low word, bits 0 … 9

Telegram examples, length of the parameter channel = 4

Read request: Read out serial number of the Power Module (r7841[2])

To obtain the value of the indexed parameter r7841, 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 (page index): = 90 hex** (offset 6000 ≙ 90 hex)
- **IND, bit 0 … 7 (subindex): = 2** (index of the parameter)
- 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	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	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 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 6-15 Telegram for a read request from r7841[2]

Write request: Changing the automatic 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 hex** (change, parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 4BA hex** (1210 = 4BA hex, no offset, as 1210 < 1999)
- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **IND, bit 0 … 7 (subindex): = 0 hex** (parameter is not indexed)
- **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	Page index	Subindex	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 6-16 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 fill 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 (page index): = 0 hex** (offset 0 ≙ 0 hex)
- **IND, bit 0 … 7 (subindex): = 1 hex** (command data set, CDS1 = index1)
- **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 or bit number of the parameter: DI 2 = r0722.2)

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	Page index	Subindex	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 0	0 0 0 0 0 0 0 1	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 6-17 Telegram to assign DI 2 with ON/OFF1

6.8.2.5 USS process data channel (PZD)

Description

The process data channel (PZD) contains the following data depending on the transmission direction:

- Control words and setpoints for the slave
- Status words and actual values for the master

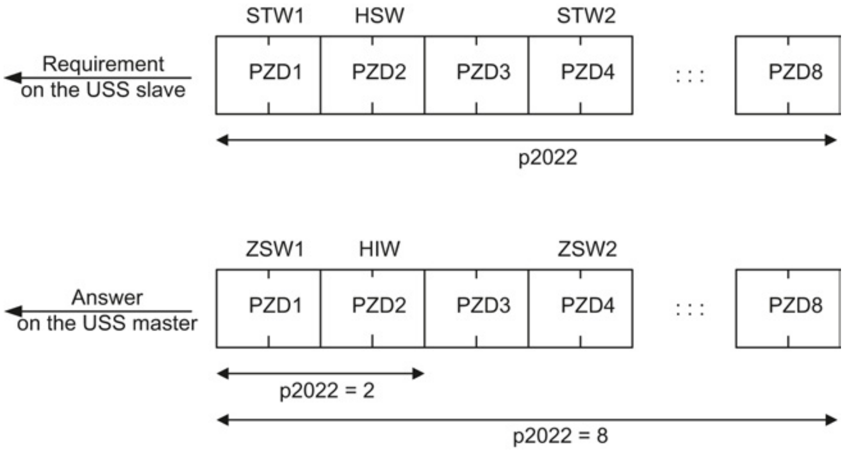


Figure 6-18 Process data channel

The first two words are:

- Control 1 (STW1) and main setpoint (HSW)
- Status word 1 (ZSW1) and main actual value (HIW)

If p2022 is greater than or equal to 4, then the inverter receives the additional control word (STW2).

You define the sources of the PZD using parameter p2051.

For further information, please refer to the List Manual.

6.8.2.6 Time-out and other errors

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

Table 6- 18 Character runtime

Baud rate in bit/s	Transmission time per bit	Character run time (= 11 bits)
9600	104.170 µs	1.146 ms
19200	52.084 µs	0.573 ms
38400	26.042 µs	0.286 ms
115200	5.340 µs	0.059 ms

The telegram runtime is longer than just purely adding all of the character runtimes (=residual runtime). You must also take into consideration the character delay time between the individual characters of the telegram.

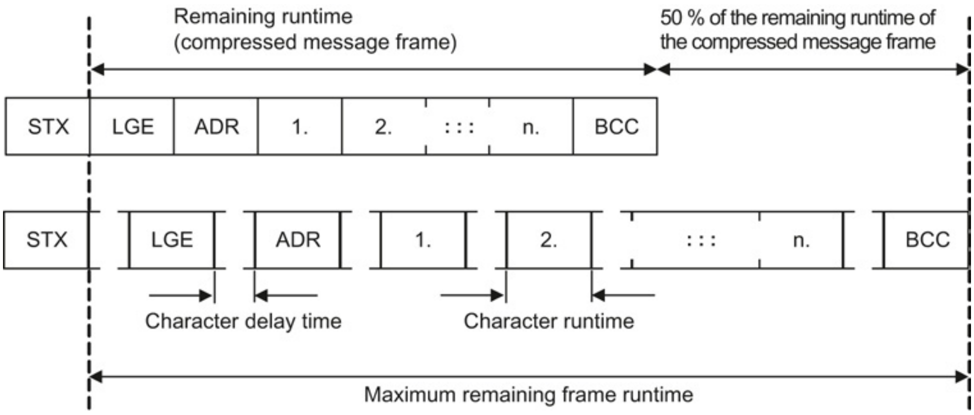


Figure 6-19 Telegram runtime as the sum of the residual runtime and character delay times

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

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

The slave only responds after the response delay has expired.

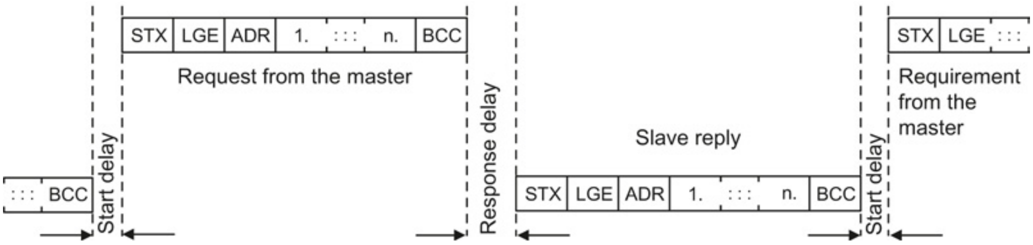


Figure 6-20 Start delay and response delay

The duration of the start delay must at least be as long as the time for two characters and depends on the baud rate.

Table 6- 19 Duration of the start delay

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

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

Telegram monitoring of the master

With your USS master, we recommend that the following times are monitored:

- Response delay: Response time of the slave to a request from the master
  The response delay must be < 20 ms, but longer than the start delay
- Telegram runtime: Transmission time of the response telegram sent from the slave

Telegram monitoring of the inverter

The inverter monitors the time between two requests of the master. Parameter p2040 defines the permissible time in ms. If a time p2040 ≠ 0 is exceeded, then the inverter interprets this as telegram failure and responds with fault F01910.

150% of the residual runtime is the guide value for the setting of p2040, i.e. the telegram runtime without taking into account the character delay times.

For communication via USS, the inverter checks bit 10 of the received control word 1. If the bit is not set when the motor is switched on ("Operation"), the inverter responds with fault F07220.

6.8.3 Communication over Modbus RTU

Overview of communication using Modbus

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

Modbus offers three transmission modes:

- **Modbus ASCII**
  Data in ASCII code. The data throughput is lower compared to RTU.
- **Modbus RTU (RTU: Remote Terminal Unit)**
  Data in binary format. The data throughput is greater than in ASCII code.
- **Modbus TCP**
  Data as TCP/IP packets. TCP port 502 is reserved for Modbus TCP. Modbus TCP is currently undergoing definition as a standard (IEC PAS 62030 (pre-standard)).

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

1 Bit Start	8-bit data	1 Bit P-even	1 Bit stop

Communication settings

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

Note

It is not permitted to change over the units

The "Unit changeover (Page 374)" function is not permissible with this bus system!

6.8.3.1 Basic settings for communication

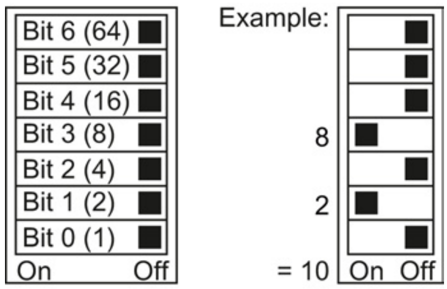
You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Using parameter p2021 (factory setting: 1) or using STARTER, you can only set the address, if all address switches are set to "OFF" (0).

Valid address range: 1 … 247

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 1) will not be able to be changed.

The positions of the address switches are described in Section: CU230P-2 HVAC Control Unit (option K98) (Page 89).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – Using the address switches
   – With the IOP using p2021
   – In STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list in parameter p2021.
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

Additional settings

Parameters	Description
p0015 = 21	**Drive device macro** Select the I/O configuration (USS fieldbus)
p0791[0 … 1]	**Fieldbus analog outputs** Parameter to interconnect the analog outputs for control via the fieldbus
p2030 = 2	**Fieldbus telegram selection** 2: Modbus RTU
p2020	**Baud rate** Factory setting = 19200 bit/s
p2024[0 … 2]	**Modbus timing** (see Section "Baud rates and mapping tables (Page 231)") • **p2024[0]: Maximum slave telegram processing time:** The time after which the slave must have sent a response to the master. • **p2024[1]: Character delay time:** Character delay time: Maximum permissible delay time between the individual characters in the Modbus frame (Modbus standard processing time for 1.5 bytes). • **p2024[20]: Inter-telegram delay:** Maximum permissible delay time between Modbus telegrams (Modbus standard processing time for 3.5 bytes).
r2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface.
p2040	**Fieldbus monitoring time** 0 ms … 1999999 ms, factory setting = 100 ms. The more slaves that are connected in the network, the longer the fieldbus monitoring time must be. If process data is not transferred within one cycle of the fieldbus monitoring time, then the inverter shuts down with fault F01910. p2040 = 0 ⇒ bus monitoring deactivated.

6.8.3.2 Modbus RTU telegram

Description

For Modbus, there is precisely one master and up to 247 slaves. The master always starts the communication. The slaves can only transfer data at the request of the master. Slave-to-slave communication is not possible. The Control Unit always operates as slave.

The following figure shows the structure of a Modbus RTU telegram.

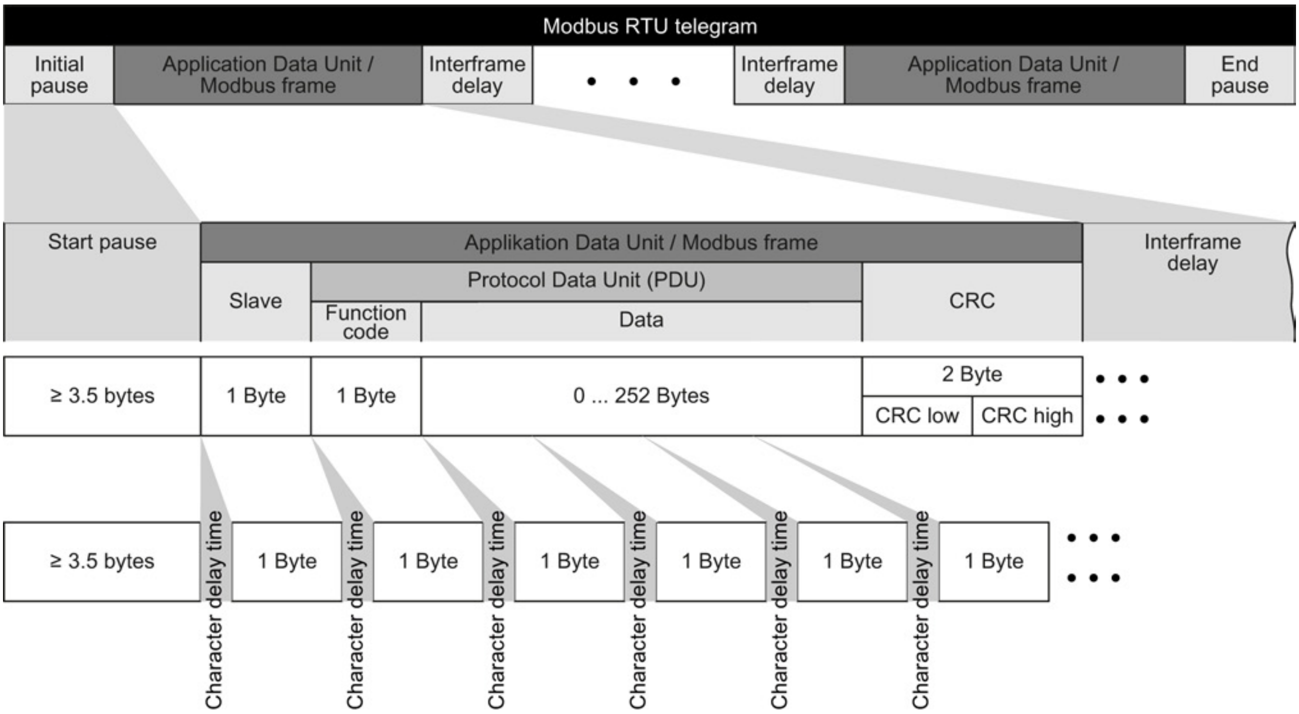


Figure 6-21 Modbus with delay times

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

6.8.3.3 Baud rates and mapping tables

Permissible baud rates and telegram delay

The Modbus RTU telegram requires pauses for the following cases:

- Start detection
- Between the individual frames
- End detection

Minimum duration: Processing time for 3.5 bytes (can be set via p2024[2]).

A character delay time is also permitted between the individual bytes of a frame.
Maximum duration: Processing time for 1.5 bytes (can be set via p2024[1]).

Table 6- 20 Baud rates, transmission times, and delays

Baud rate in bit/s (p2020)	Transmission time per character (11 bits)	Minimum pause between two telegrams (p2024[2])	Maximum pause between two bytes (p2024[1])
4800	2.292 ms	≥ 8.021 ms	≤ 3.438 ms
9600	1.146 ms	≥ 4.010 ms	≤ 1.719 ms
19200 (factory setting)	0.573 ms	≥ 1.75 ms	≤ 0.859 ms
38400	0.286 ms	≥ 1.75 ms	≤ 0.75 ms
57600	0.191 ms	≥ 1.75 ms	≤ 0.556 ms
76800	0.143 ms	≥ 1.75 ms	≤ 0.417 ms
93750	0.117 ms	≥ 1.75 ms	≤ 0.341 ms
115200	0.095 ms	≥ 1.75 ms	≤ 0.278 ms
187500	0.059 ms	≥ 1.75 ms	≤ 0.171 ms

Note

The factory setting for p2024[1] and p2024[2] is 0. The inverter specifies the associated values depending on the protocol selection (p2030) or the baud rate.

Modbus register and Control Unit parameters

The Modbus protocol contains register or bit numbers for addressing memory. You must assign the appropriate control words, status words and parameters to these registers in the slave.

The inverter supports the following addressing ranges:

Addressing range	Remark
40001 … 40065	Compatible with Micromaster MM436
40100 … 40522	

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

The registers 40100 to 40111 are described as process data.

Note

"R"; "W"; "R/W" in the "Modbus access" column stands for read (with FC03); write (with FC06); read/write.

Table 6- 21 Assigning the Modbus register to the parameters of the Control Unit

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
Process data							
Control data							
40100	Control word	R/W	--	1			Process data 1
40101	Main setpoint	R/W	--	1			Process data 2
Status data							
40110	Status word	R	--	1			Process data 1
40111	Main actual value	R	--	1			Process data 2
Parameter data							
Digital outputs							
40200	DO 0	R/W	--	1	HIGH	LOW	p0730, r747.0, p748.0
40201	DO 1	R/W	--	1	HIGH	LOW	p0731, r747.1, p748.1
40202	DO 2	R/W	--	1	HIGH	LOW	p0732, r747.2, p748.2
Analog outputs							
40220	AO 0	R	%	100	-100.0 … 100.0		r0774.0
40221	AO 1	R	%	100	-100.0 … 100.0		r0774.1
Digital inputs							
40240	DI 0	R	--	1	HIGH	LOW	r0722.0
40241	DI 1	R	--	1	HIGH	LOW	r0722.1
40242	DI 2	R	--	1	HIGH	LOW	r0722.2
40243	DI 3	R	--	1	HIGH	LOW	r0722.3
40244	DI 4	R	--	1	HIGH	LOW	r0722.4
40245	DI 5	R	--	1	HIGH	LOW	r0722.5
Analog inputs							
40260	AI 0	R	%	100	-300.0 … 300.0		r0755 [0]
40261	AI 1	R	%	100	-300.0 … 300.0		r0755 [1]
40262	AI 2	R	%	100	-300.0 … 300.0		r0755 [2]
40263	AI 3	R	%	100	-300.0 … 300.0		r0755 [3]
Inverter identification							
40300	Powerstack number	R	--	1	0 … 32767		r0200
40301	Inverter firmware	R	--	0.0001	0.00 … 327.67		r0018
Inverter data							
40320	Rated power of the power unit	R	kW	100	0 … 327.67		r0206
40321	Current limit	R/W	%	10	10.0 … 400.0		p0640
40322	Ramp-up time	R/W	s	100	0.00 … 650.0		p1120
40323	Ramp-down time	R/W	s	100	0.00 … 650.0		p1121
40324	Reference speed	R/W	RPM	1	6.000 … 32767		p2000
Inverter diagnostics							
40340	Speed setpoint	R	RPM	1	-16250 … 16250		r0020
40341	Actual speed value	R	RPM	1	-16250 … 16250		r0022

Modbus Reg. No.	Description	Modbus access	Unit	Scaling factor	On/Off text or value range		Data / parameter
40342	Output frequency	R	Hz	100	- 327.68 … 327.67		r0024
40343	Output voltage	R	V	1	0 … 32767		r0025
40344	DC-link voltage	R	V	1	0 … 32767		r0026
40345	Actual current value	R	A	100	0 … 163.83		r0027
40346	Actual torque value	R	Nm	100	- 325.00 … 325.00		r0031
40347	Actual active power	R	kW	100	0 … 327.67		r0032
40348	Energy consumption	R	kWh	1	0 … 32767		r0039
40349	Control priority	R	--	1	MANUAL	AUTO	r0807
Fault diagnostics							
40400	Fault number, index 0	R	--	1	0 … 32767		r0947 [0]
40401	Fault number, index 1	R	--	1	0 … 32767		r0947 [1]
40402	Fault number, index 2	R	--	1	0 … 32767		r0947 [2]
40403	Fault number, index 2	R	--	1	0 … 32767		r0947 [3]
40404	Fault number, index 3	R	--	1	0 … 32767		r0947 [4]
40405	Fault number, index 4	R	--	1	0 … 32767		r0947 [5]
40406	Fault number, index 5	R	--	1	0 … 32767		r0947 [6]
40407	Fault number, index 6	R	--	1	0 … 32767		r0947 [7]
40408	Alarm number	R	--	1	0 …32767		r2110 [0]
40499	PRM ERROR code	R	--	1	0 …99		--
Technology controller							
40500	Technology controller enable	R/W	--	1	0 … 1		p2200, r2349.0
40501	Technology controller MOP	R/W	%	100	-200.0 … 200.0		p2240
Technology controller adjustment							
40510	Time constant for actual-value filters of the technology controller	R/W	--	100	0.00 … 60.0		p2265
40511	Scaling factor for actual value of the technology controller	R/W	%	100	0.00 … 500.00		p2269
40512	Proportional amplification of the technology controller	R/W	--	1000	0.000 … 65.000		p2280
40513	Integral time of the technology controller	R/W	s	1	0 … 60		p2285
40514	Time constant D-component of the technology controller	R/W	--	1	0 … 60		p2274
40515	Max. limit of technology controller	R/W	%	100	-200.0 … 200.0		p2291
40516	Min. limit technology controller	R/W	%	100	-200.0 … 200.0		p2292
PID diagnostics							
40520	Effective setpoint acc. to internal technology controller MOP ramp-function generator	R	%	100	-100.0 … 100.0		r2250
40521	Actual value of technology controller after filter	R	%	100	-100.0 … 100.0		r2266
40522	Output signal technology controller	R	%	100	-100.0 … 100.0		r2294

6.8.3.4 Write and read access via FC 03 and FC 06

Function codes used

For data exchange between the master and slave, predefined function codes are used for communication via Modbus.

The Control Unit uses the Modbus function code 03, FC 03 (read holding registers) for reading, and the Modbus function code 06, FC 06 (preset single register) for writing.

Structure of a read request via Modbus function code 03 (FC 03)

Any valid register address is permitted as the start address.

The controller can use the FC 03 to access more than one register with one request. The number of addressed registers is contained in bytes 4 and 5 of the read request.

Table 6- 22 Invalid read requests

Read request	Inverter response
Invalid register address	Exception code 02 (invalid data address)
Read a write-only register	Telegram in which all values are set to 0.
Read a reserved register	
Controller addresses more than 125 registers	Exception code 03 (invalid data value)
The start address and the number of registers of an address are located outside of a defined register block	Exception code 02 (invalid data address)

Table 6- 23 Structure of a read request for slave number 17

Example		
	Byte	Description
11 h	0	Slave address
03 h	1	Function code
00 h	2	Register start address "High" (register 40110)
6D h	3	Register start address "Low"
00 h	4	Number of registers "High" (2 registers: 40110; 40111)
02 h	5	Number of registers "Low"
xx h	6	CRC "Low"
xx h	7	CRC "High"

The response returns the corresponding data set:

Table 6- 24 Slave response to the read request

Example		
	Byte	Description
11 h	0	Slave address
03 h	1	Function code
04 h	2	Number of bytes (4 bytes are returned)
11 h	3	Data of first register "High"
22 h	4	Data of first register "Low"
33 h	5	Data of second register "High"
44 h	6	Data of second register "Low"
xx h	7	CRC "Low"
xx h	8	CRC "High"

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

Start address is the holding register address.

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

Table 6- 25 Write request and response of the inverter

Write request	Inverter response
Incorrect address (a holding register address does not exist)	Exception code 02
Write to a "read-only" register	Modbus error telegram (exception code 04 - device failure)
Write to a reserved register	

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

Table 6- 26 Structure of a write request for slave number 17

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

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

Table 6- 27 Slave response to the write request

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

6.8.3.5 Communication procedure

Procedure for communication in a normal case

Normally, the master sends a telegram to a slave (address range 1 ... 247). The slave sends a response telegram to the master. This response telegram mirrors the function code; the slave enters its own address in the telegram and so the slave identifies itself with the master.

The slave only processes orders and telegrams which are directly addressed to it.

Communication error

If the slave detects a communication error on receipt (parity, CRC), it does not send a response to the master (this can lead to "setpoint timeout").

Logical error

If the slave detects a logical error within a request, it responds to the master with an "exception response". In this case, the slave sets the highest bit in the function code to 1 in the response. If, for example, it receives an unsupported function code from the master, the slave responds with an "exception response" with code 01 (illegal function code).

Table 6- 28 Overview of exception codes

Exception code	Modbus name	Remark
01	Illegal function code	An unknown (unsupported) function code was sent to the slave.
02	Illegal Data Address	An invalid address was requested.
03	Illegal data value	An invalid data value was detected.
04	Server failure	Slave has terminated during processing.

Maximum processing time, p2024[0]

The slave-response time is the time in which the Modbus master expects a response to a request. Set the same slave-response time (p2024 [0] in the inverter) in the master and slave.

Process data monitoring time (setpoint timeout), p2040

"Setpoint timeout" (F1910) is issued by the Modbus if p2040 is set to a value > 0 ms and no process data is requested within this time period.

The "Setpoint timeout" only applies for access to process data (40100, 40101, 40110, 40111). The "Setpoint timeout" is not generated for parameter data (40200 … 40522).

Note

Adjust the time (factory setting = 100 ms) depending on the number of slaves and the baud rate set on the bus.

6.8.4 Communication via BACnet MS/TP

BACnet properties

In BACnet, components and systems are considered to be black boxes which contain a number of objects. BACnet objects only stipulate the behavior outside the device, BACnet sets no internal functions.

A range of object types and their instances represent one component.

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

Data exchange with the client

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

Communication settings

- The Control Unit supports BACnet via RS485 (BACnet MS/TP)
- Communication supports Unicode, coded with the character set UTF-8
- The maximum cable length is 1200 m (3281 ft).

Protocol Implementation Conformance Statement

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

Note

It is not permitted to change over the units

The "Unit changeover (Page 374)" function is not permissible with this bus system!

6.8.4.1 Basic settings for communication

Setting the address

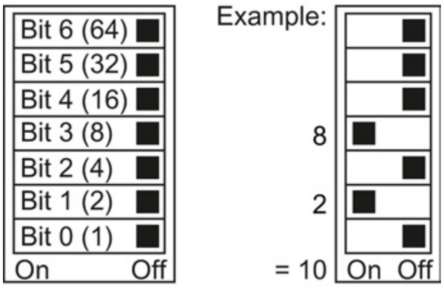
You set the MAC address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Valid address range: 0 … 127.

For address 0, the inverter responds to a broadcast.

If you have specified a valid address ≠ 0 using the address switches, this address will always be the one that takes effect and parameter p2021 cannot be changed.

The positions of the address switches are described in Section: CU230P-2 HVAC Control Unit (option K98) (Page 89).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – Using the address switches
   – With the IOP using p2021
   – In STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list in parameter p2021.
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

Additional settings

P no.	Parameter name
p0015 = 21	**Drive device macro** Select the I/O configuration (USS fieldbus)
p0791[0 … 1]	**Fieldbus analog outputs** Parameter to interconnect the analog outputs for control via the fieldbus
p2030 = 5	**Fieldbus telegram selection** 5: BACnet
p2020	**Baud rate** Factory setting = 9600 bit/s
p2024[0 … 2]	**Processing times** p2024 [0]: 0 ms … 10000 ms, maximum processing time (APDU timeout), factory setting = 1000 ms, p2024[1 … 2]: No significance for BACnet
p2025[0 … 3]	**BACnet communication parameter** • p2025 [0]: 0 … 4194303: Device object instance number, Factory setting = 1 • p2025 [1]: 1 … 10: Maximum Info Frames, factory setting = 1 • p2025 [2]: 0 … 39: Number of APDU Retries (repeated attempts after fault telegrams), factory setting = 3 • p2025 [3]: 1 … 127: Maximum Master address, factory setting = 127
p2026[0 … 74]	**Setting of the COV_Increment** (COV = change of values) 0 … 4194303, factory setting = 1 COV_Increment: Changes the value of the "present value" of an object instance for which the server transfers an UnConfirmedCOV_Notification or ConfirmedCOV_Notification. You can use these parameters to set for which inverter value changes an UnConfirmedCOV_Notification or ConfirmedCOV_Notification result is sent. The factory setting 1 means that the inverter sends an UnConfirmedCOV_Notification or ConfirmedCOV_Notification if the considered value, e.g. for a range of 0 … 10 V, changes by ≥ 1 absolute. This requires an active SubscribeCOV_Service to send the relevant object instance. You can also set the COV_Increment via the object property "COV_Increment" of the relevant analog input, analog output or analog value.
p2027	**BACnet language selection** German/English - only becomes effective after power off/on
r2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface
p2040	**Fieldbus monitoring time** 0 ms … 1999999 ms, factory setting = 100 ms The more slaves that are connected in the network, the longer the fieldbus monitoring time must be. If process data is not transferred within one cycle of the fieldbus monitoring time, then the inverter shuts down with fault F01910. p2040 = 0 ⇒ bus monitoring deactivated.

6.8.4.2 Supported services and objects

BIBBs used by the inverter

The BIBBs (BIBB: **B**ACnet **I**nteroperability **B**uilding **B**lock) are a collection of one or several BACnet services. The BACnet services are subdivided into A and B devices. An A device operates as client and a B device as server.

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

The CU230P-2 HVAC uses the BIBBs listed below.

Overview of the BIBBs used by CU230P-2 HVAC and associated services

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

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

SubscribeCOV monitors the property changes of the following objects:

- Analog Input (AIxx),
- Analog Output (AOxx),
- Analog Value (AVxx),
- Binary Value (BVxx) and
- Multi-state Input (MSIxx)

Note

SubscribeCOV services are not retentive; i.e. the master must re-initiate the SubscribedCOV services when restarting the CU.

Code numbers of the object types supported in BACnet

Object type	Code number for BACnet object type		Object type	Code number for BACnet object type
Device Object	8		Analog Input Object	0
Binary Input Object	3		Analog Output Object	1
Binary Output Object	4		Analog Value Object	2
Binary Value Object	5		Multi-State Input Object	13

Object properties of the "Device" object type

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

1) Length = 480
2) Not supported

Object properties of other object types

Object property	Object type						
	Binary Input	Binary Output	Binary Value	Analog Input	Analog Output	Analog Value	Multi-State Input
Object_Identifier	X	X	X	X	X	X	X
Object_Name	X	X	X	X	X	X	X
Object_Type	X	X	X	X	X	X	X
Present_Value	X	X	X	X	X	X	X
Description	X	X	X	X	X	X	X
Status_Flags	X	X	X	X	X	X	X
Event_State	X	X	X	X	X	X	X
Out_Of_Service	X	X	X	X	X	X	X
Units				X	X	X	
Priority_Array		X	X*		X	X*	
Relinquish_Default		X	X*		X*	X	
Polarity	X	X					

Object property	Object type						
	Binary Input	Binary Output	Binary Value	Analog Input	Analog Output	Analog Value	Multi-State Input
Active_Text	X	X	X				
Inactive_Text	X	X	X				
COV_Increment				X	X	X	
State_Text							X
Number_of_States							X

* for command values only (access type C)

Note

Access types are available in the following versions:

- C: Executable
- R: Readable
- W: Writable

Binary Input Objects

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

Binary Output Objects

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

Binary value Objects

Instance ID	Object name	Description	Possible values	Text active	Text inactive	Access type	Parameter
BV0	RUN/ STOP ACT	Inverter status regardless of command source	RUN / STOP	STOP	RUN	R	r0052.2
BV1	FWD / REV	Direction of rotation regardless of command source	REV / FWD	FWD	REV	R	r0052.14
BV2	FAULT ACT	Inverter fault	FAULT / OK	FAULT	OK	R	r0052.3
BV3	WARN ACT	Inverter warning	WARN / OK	WARN	OK	R	r0052.7
BV4	MANUAL/ AUTO ACT	Indicates the source of the manual/auto inverter control	AUTO / MANUAL	AUTO	LOCAL	R	r0052.9
BV7	CTL OVERRIDE ACT	ACT displays the inverter's control from the BACnet override control via BV93. Note that the operator panel's "Manual" operating mode has a higher priority than the BACnet override control.	ON/OFF	0	1	R	r2032[10]
BV8	AT SET-POINT	Setpoint reached	YES / NO	YES	NO	R	r0052.8
BV9	AT MAX FREQ	Maximum speed reached	YES / NO	YES	NO	R	r0052.10
BV10	DRIVE READY	Inverter ready	YES / NO	YES	NO	R	r0052.1
BV15	RUN COM ACT	ACT indicates the status of the ON command, regardless of the source	YES / NO	0	1	R	r2032[0]
BV16	HIB MOD ACT	ACT means that the inverter is operating in energy-saving mode	ON/OFF	0	1	R	r2399[1]
BV17	ESM MOD	ACT means that the inverter is operating in the essential service mode	ON/OFF	0	1	R	r3889[0]
BV20	RUN/ STOP CMD	ON command for the inverter (when controlling via BACnet)	RUN / STOP	0	1	C	r0054.0
BV21	FWD/ REV CMD	Reverse direction of rotation (when controlling via BACnet)	REV / FWD	0	1	C	r0054.11

Instance ID	Object name	Description	Possible values	Text active	Text inactive	Access type	Parameter
BV22	FAULT RESET	Acknowledge fault (when controlling via BACnet)	RESET / NO	0	1	C	r0054.7
BV24	CDS	Local / Remote	Local / Remote	YES	NO	C	r0054.15
BV26	RUN ENA CMD	Enable inverter operation		ENABLED	DISABLED	C	r0054.3
BV27	OFF2	OFF2 status	RUN / STOP	0	1	C	r0054.1
BV28	OFF3	OFF3 status Note: BV28 sets the r0054.4, r0054.5, and r0054.6 bits	RUN / STOP	0	1	C	r0054.2
BV50	ENABLE PID	Enable technology controller	ENABLED / DISABLED	ENABLED	DISABLED	C	p2200
BV51	ENABLE PID 0	Enable technology 0 controller	ENABLED / DISABLED	ENABLED	DISABLED	C	p11000
BV52	ENABLE PID 1	Enable technology 1 controller	ENABLED / DISABLED	ENABLED	DISABLED	C	p11100
BV53	ENABLE PID 2	Enable technology 2 controller	ENABLED / DISABLED	ENABLED	DISABLED	C	p11200
BV90	LOCAL LOCK	Use MANUAL (operator panel) to lock inverter control		LOCK	UNLOCK	C	p0806
BV93	CTL OVERRIDE CMD	Inverter control using BACnet override control	ON/OFF	0	1	C	r0054.10

Analog Input Objects

Instance ID	Object name	Description	Unit	Range	Access type	Parameter
AI0	ANALOG INPUT 0	AI0 input signal	V/mA	inverter-dependent	R	r0752[0]
AI1	ANALOG INPUT 1	AI1 input signal	V/mA	inverter-dependent	R	r0752[1]
AI2	ANALOG INPUT 2	AI2 input signal	V/mA	inverter-dependent	R	r0752[2]
AI3	ANALOG INPUT 3	AI3 input signal	V/mA	inverter-dependent	R	r0752[3]
AI10	ANALOG INPUT 0 SCALED	Scaled AI 0 input signal	%	inverter-dependent	R	r0755[0]
AI11	ANALOG INPUT 1 SCALED	Scaled AI 1 input signal	%	inverter-dependent	R	r0755[1]
AI12	ANALOG INPUT 2 SCALED	Scaled AI 2 input signal	%	inverter-dependent	R	r0755[2]
AI13	ANALOG INPUT 3 SCALED	Scaled AI 3 input signal	%	inverter-dependent	R	r0755[3]

Analog Output Objects

Instance ID	Object name	Description	Unit	Range	Access type	Parameter
AO0	ANALOG OUTPUT 0	AI0 value	%	inverter-dependent	C	p0791.0
AO1	ANALOG OUTPUT 1	AI1 value	%	inverter-dependent	C	p0791.1

Analog Value Objects

Instance ID	Object name	Description	Unit	Range	Access type	Parameter
AV0	OUTPUT FREQ_Hz	Output frequency (Hz)	Hz	inverter-dependent	R	r0024
AV1	OUTPUT FREQ_PCT	Output frequency (%)	%	inverter-dependent	R	HIW
AV2	OUTPUT SPEED	Motor speed	RPM	inverter-dependent	R	r0022
AV3	DC BUS VOLT	DC-link voltage	V	inverter-dependent	R	r0026
AV4	OUTPUT VOLT	Output voltage	V	inverter-dependent	R	r0025
AV5	CURRENT	Motor current	A	inverter-dependent	R	r0027
AV6	TORQUE	Motor torque	Nm	inverter-dependent	R	r0031
AV7	POWER	Motor power	kW	inverter-dependent	R	r0032
AV8	DRIVE TEMP	Heat sink temperature	°C	inverter-dependent	R	r0037
AV9	MOTOR TEMP	Measured or calculated motor temperature	°C	inverter-dependent	R	r0035
AV10	KWH (NR)	Cumulative inverter energy consumption (cannot be reset!)	kWh	inverter-dependent	R	r0039
AV12	INV RUN TIME (R)	Motor's operating hours (is reset by entering "0")	h	0 … 4294967295	W	p0650
AV13	INV Model	Code number of Power Module	---	inverter-dependent	R	r0200
AV14	INV FW VER	Firmware version	---	inverter-dependent	R	r0018
AV15	INV POWER	Rated power of the inverter	kW	inverter-dependent	R	r0206
AV16	RPM STPT 1	Reference speed of the inverter	RPM	6.0 … 210000	W	p2000
AV17	FREQ STPT PCT	Setpoint 1 (when controlling via BACnet)	%	-199.99 … 199.99	C	HSW
AV18	ACT FAULT	Number of the fault due to be dealt with	---	inverter-dependent	R	r0947[0]
AV19	PREV FAULT 1	Number of the last fault	---	inverter-dependent	R	r0947[1]
AV20	PREV FAULT 2	Number of the fault before last	---	inverter-dependent	R	r0947[2]
AV21	PREV FAULT 3	Number of the fault third from last	---	inverter-dependent	R	r0947[3]
AV22	PREV FAULT 4	Number of the fault fourth from last	---	inverter-dependent	R	r0947[4]
AV25	Select Setpoint Source	Command to select the setpoint source	---	0 … 32767	W	p1000
AV28	AO1 ACT	Signal from AO 1	mA	inverter-dependent	R	r0774.0
AV29	AO2 ACT	Signal from AO 1	mA	inverter-dependent	R	r0774.1
AV30	MIN SPEED	Minimum speed	RPM	0.000 – 19500.000	W	p1080

Instance ID	Object name	Description	Unit	Range	Access type	Parameter
AV31	MAX FREQ	Maximum speed	RPM	0.000 … 210000.000	W	p1082
AV32	ACCEL TIME	Ramp-up time	s	0.00 … 999999.0	W	p1120
AV33	DECEL TIME	Ramp-down time	s	0.00 … 999999.0	W	p1121
AV34	CUR LIM	Current limit	A	inverter-dependent	R	p0640
AV39	ACT WARN	Indication of a pending alarm	---	inverter-dependent	R	r2110[0]
AV40	PREV WARN 1	Indication of the last alarm	---	inverter-dependent	R	r2110[1]
AV41	PREV WARN 2	Indication of the last but one alarm	---	inverter-dependent	R	r2110[2]
AV5000	RAMP UP TIME	Technology controller ramp-up time	s	0 … 650	W	p2257
AV5001	RAMP DOWN TIME	Technology controller ramp-down time	s	0 … 650	W	p2258
AV5002	FILTER TIME	Technology controller actual value filter time constant	s	0 … 60	W	p2265
AV5003	DIFF TIME	Technology controller differentiation time constant	s	0 … 60	W	p2274
AV5004	PROP GAIN	Technology controller proportional gain	s	0 … 1000	W	p2280
AV5005	INTEG TIME	Technology controller integral time	s	0 … 1000	W	p2285
AV5006	OUTPUT MAX	Technology controller maximum limiting	%	- 200 … 200	W	p2291
AV5007	OUTPUT MIN	Technology controller minimum limiting	%	- 200 … 200	W	p2292
AV5100	RAMP UP TIME 0	Technology controller 0 ramp-up time	s	0 … 650	W	p11057
AV5101	RAMP DOWN TIME 0	Technology controller 0 ramp-down time	s	0 … 650	W	p11058
AV5102	FILTER TIME 0	Technology controller 0 actual value filter time constant	s	0 … 60	W	p11065
AV5103	DIFF TIME 0	Technology controller 0 differentiation time constant	s	0 … 60	W	p11074
AV5104	PROP GAIN 0	Technology controller 0 proportional gain	s	0 … 1000	W	p11080
AV5105	INTEG TIME 0	Technology controller 0 integral time	s	0 … 1000	W	p11085
AV5106	OUTPUT MAX 0	Technology controller 0 maximum limiting	%	- 200 … 200	W	p11091
AV5107	OUTPUT MIN	Technology controller 0 minimum limiting	%	- 200 … 200	W	p11092
AV5200	RAMP UP TIME 1	Technology controller 1 ramp-up time	s	0 … 650	W	p11157
AV5201	RAMP DOWN TIME 1	Technology controller 1 ramp-down time	s	0 … 650	W	p11158
AV5202	FILTER TIME 1	Technology controller 1 actual value filter time constant	s	0 … 60	W	p11165
AV5203	DIFF TIME 1	Technology controller 1 differentiation time constant	s	0 … 60	W	p11174

Instance ID	Object name	Description	Unit	Range	Access type	Parameter
AV5204	PROP GAIN 1	Technology controller 1 proportional gain	s	0 … 1000	W	p11180
AV5205	INTEG TIME 1	Technology controller integral time	s	0 … 1000	W	p11185
AV5206	OUTPUT MAX 1	Technology controller 1 maximum limiting	%	- 200 … 200	W	p11191
AV5207	OUTPUT MIN 1	Technology controller 1 minimum limiting	%	- 200 … 200	W	p11192
AV5300	RAMP UP TIME 2	Technology controller 2 ramp-up time	s	0 … 650	W	p112257
AV5301	RAMP DOWN TIME 2	Technology controller 2 ramp-down time	s	0 … 650	W	p11258
AV5302	FILTER TIME 2	Technology controller 2 actual value filter time constant	s	0 … 60	W	p11265
AV5303	DIFF TIME 2	Technology controller 2 differentiation time constant	s	0 … 60	W	p11274
AV5304	PROP GAIN 2	Technology controller 2 proportional gain	s	0 … 1000	W	p11280
AV5305	INTEG TIME 2	Technology controller 2 integral time	s	0 … 1000	W	p11285
AV5306	OUTPUT MAX 2	Technology controller 2 maximum limiting	%	- 200 … 200	W	p11291
AV5307	OUTPUT MIN 2	Technology controller 2 minimum limiting	%	- 200 … 200	W	p11292

Multi-State Input Objects

Instance ID	Object name	Description	Possible values	Access type	Parameter
MSI0	FAULT_1	Fault number 1	See List Manual "List of faults and alarms"	R	r0947[0]
MSI1	FAULT_2	Fault number 2		R	r0947[1]
MSI2	FAULT_3	Fault number 3		R	r0947[2]
MSI3	FAULT_4	Fault number 4		R	r0947[3]
MSI4	FAULT_5	Fault number 5		R	r0947[4]
MSI5	FAULT_6	Fault number 6		R	r0947[5]
MSI6	FAULT_7	Fault number 7		R	r0947[6]
MSI7	FAULT_8	Fault number 8		R	r0947[7]
MSI8	WARNING_1	Warning number 1		R	r2110[0]
MS9	WARNING_2	Warning number 2		R	r2110[1]
MSI10	WARNING_3	Warning number 3		R	r2110[2]
MSI11	WARNING_4	Warning number 4		R	r2110[3]
MSI12	WARNING_5	Warning number 5		R	r2110[4]
MSI13	WARNING_6	Warning number 6		R	r2110[5]
MSI14	WARNING_7	Warning number 7		R	r2110[6]
MSI15	WARNING_8	Warning number 8		R	r2110[7]

6.8.5 Communication via P1

P1 is an asynchronous master-slave communication between what is known as a Field Cabinet (master) and the FLN devices (slaves). FLN stands for "Floor level network".

The master individually addresses the various slaves. A slave responds only if the master addresses it. Communication between the slaves is not possible.

A Field Cabinet can have several FLN ports. You can connect up to 32 FLN devices to each FLN port (slaves).

Settings in the controller

In the Field Cabinet, for each slave you must install what is known as a "Logical controller (LCTR) point". In addition, in the Field Cabinet you must define the "Point numbers" for communication.

An overview of the "Point Numbers" is provided on the following pages.

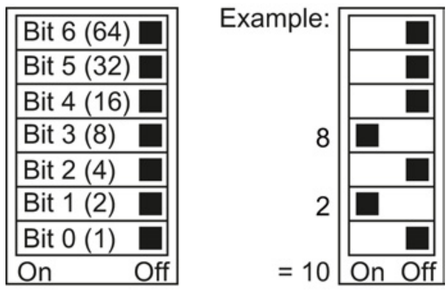
Setting the address

You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Valid address range: 1 … 99

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 99) will not be able to be changed.

The positions of the address switches are described in Section: CU230P-2 HVAC Control Unit (option K98) (Page 89).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   – Using the address switches
   – With the IOP using p2021
   – In STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list in parameter p2021.
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

Settings in the inverter

After you have completed the basic commissioning, you must set the following P1-specific parameters in the inverter:

Parameter	Description
p2030 = 8	**Communication protocol for P1.** With this setting, the inverter sets parameters p2020 and p2021 as follows: • p2020 = 5: Baud rate 4800 bit/s • p2021 = 1 … **99:** Slave address (factory setting = 99).
p0840 = 2090.0	Wire **ON/OFF1** to control word 1 bit 0
p0852 = 2090.3	Wire the signal for **Enable operation** to control word 1 bit 3
p1070 = 2050.1	Connect the signal for the **main setpoint** to the communication interface
p2103.0 = 2090.7	Connect the first signal source for **acknowledgment** to the communication interface
p2051.0 = 52.0	Send status word via the communication interface
p2051.1 = 63.0	Send actual speed value via the communication interface
p0971 = 1	Permanently save the settings in the inverter

Note

Address 99 (to all)

No matter their address, all FLN devices answer telegrams with address 99.

Overview

The subsequently listed "Point Numbers" for communication are defined using P1 in the converter. The values listed in the tables refer to SI units.

Point No.	Descriptor	Default/ factory	Units	Slope	Inter-cept	Subpt. Type	IO Type	On Text	Off Text	CU Param / Word Type
								Range		
1	CTLR ADDRESS	99	--	1	0	2	LAO_255	0 ... 255		p2021
2	APPLICATION	2767	--	1	0	2	LAO_32k	0 ... 32767		p8998[0]
3	FREQ OUTPUT	0	HZ	0.04	-650	1*)	LAI_32k	-650 ... 650		r0024
5	SPEED	0	RPM	1	-16250	1*)	LAI_32k	-16250 ... 16250		r0022
6	CURRENT	0	A	0.05	0	1*)	LAI_32k	0 ... 1638.4		r0027
7	TORQUE	0	NM	0.2	-3250	1*)	LAI_32k	-3250 ... 3250		r0031
8	ACTUAL PWR	0	KW	0.01	0	1	LAI_32k	0 ... 327.67		r0032
9	TOTAL KWH	0	KWH	1	0	1	LAI_32k	0 ... 32767		r0039
13	DC BUS VOLTS	0	V	1	0		LAI_32k	0 ... 32767		r0026
14	REFERENCE	0	HZ	0.04	-650		LAI_32k	-650 ... 650		r0020
16	RATED PWR	0	KW	0.01	0		LAI_32k	0 ... 327.67		r0206
17	OUTPUT VOLTS	0	V	1	0		LAI_32k	0 ... 32767		r0025
20	OVRD TIME	1	HRS	1	0	2	LAO_255	0 ... 255		p8998[1]
21	AR MAX FREQ	0	--	1	0	1	LDI	MAX	NO	ZSW:10
22	CMD FWD REV	0	--	1	0	1	LDO	REV	FWD	STW:11
23	FWD REV	0	--	1	0	1	LDI	FWD	REV	ZSW:14
24	CMD START	0	--	1	0	1	LDO	START	STOP	STW:0
25	STOP RUN	0	--	1	0	1	LDI	RUN	STOP	ZSW:2
26	CONTROL MODE	1	--	1	0	1	LDI	SERIAL	LOCAL	ZSW:9
28	READY TO RUN	0	--	1	0	1	LDI	READY	OFF	ZSW:1
29	DAY NIGHT	0	--	1	0	1	LDO	NIGHT	DAY	p8998[2]
30	CURRENT LMT	0.0	PCT	0.1	10.0	2	LAO_4k	0 ... 400		p0640
31	ACCEL TIME 1	10.00	SEC	0.02	0	2	LAO_32k	0 ... 650.00		p1120
32	DECEL TIME 1	10.00	SEC	0.02	0	2	LAO_32k	0 ... 650.00		p1121
34	HAND AUTO	0	--	1	0	2	LDI	HAND	AUTO	r0807.0

Point No.	Descriptor	Default/ factory	Units	Slope	Inter- cept	Subpt. Type	IO Type	On Text	Off Text	CU Param / Word Type
								Range		
35	RUN ENABLE	1	--	1	0	1	LDO	ENABLE	OFF	STW:3
36	ENABLED	0	--	1	0	1	LDI	ON	OFF	ZSW:0
40	DIGITAL OUT 1	0	--		0	2	LDO	ON	OFF	p0730 / r747.0
41	DIGITAL OUT 2	0	--	1	0	2	LDO	ON	OFF	p0731 / r747.1
42	DIGITAL OUT 3	0	--	1	0	2	LDO	ON	OFF	p0732 / r747.2
45	ANALOG IN 1	0	PCT	0.1	-300.0	1*)	LAI_32k	-300 … 300		r0755[0]
46	ANALOG IN 2	0	PCT	0.1	-300.0	1*)	LAI_32k	-300 … 300		r0755[1]
47	ANALOG OUT 1	0	PCT	0.1	-100.0	1	LAI_32k	-100 … 100		r0774[0]
48	ANALOG OUT 2	0	PCT	0.1	-100.0	1	LAI_32k	-100 … 100		r0774[1]
51	FREQ REF	0	PCT	0.006103515	0	1*)	LAO_32k	0 … 100		HSW
52	FREQ ACTUAL	0	PCT	0.012207031	-100.0	1*)	LAI_32k	-100.0 … 100.0		HIW
53	FREQ MAX	3000.00	HZ	0.02	1.00	1	LAO_32k	0.10 … 650.00		p2000 1/min à Hz
55	PID SP REF	0	PCT	0.024414063	-200.0	1	LAO_32k	-200.0 … 200.0		p2240
56	PID SP OUT	0	PCT	0.012207031	-100.0	1	LAI_32k	-100.0 … 100.0		r2250
57	PID UP LMT	100.0	PCT	0.024414063	-200.0	1	LAO_32k	-200.0 … 200.0		p2291
58	PID LO LMT	0	PCT	0.024414063	-200.0	1	LAO_32k	-200.0 … 200.0		p2292
59	PID OUTPUT	0	PCT	0.012207031	0	1	LAI_32k	-100.0 … 100.0		r2294
60	PI FEEDBACK	0	PCT	0.012207031	-100.0	1*)	LAI_32k	-100.0 … 100.0		r2266
61	P GAIN	1.000	--	0.01	0	2	LAO_32k	0 … 100.00		p2280
62	I GAIN	0	SEC	0.002	0	2	LAO_32k	0 … 60.00		p2285
63	D GAIN	0	--	0.002	0	2	LAO_32k	0 … 60.00		p2274
64	ENABLE PID	0	--	1	0	2	LDO	ON	OFF	p2200
66	FEEDBK GAIN	100.0	PCT	0.02	0	2	LAO_32k	0 … 500.00		p2269
68	LOW PASS	0	--	0.01	0	2	LAO_32k	0 … 60.00		p2265
71	DIGITAL IN 0	0	--	1	0	1	LDI	ON	OFF	r0722.0

Point No.	Descriptor	Default/ factory	Units	Slope	Inter-cept	Subpt. Type	IO Type	On Text	Off Text	CU Param / Word Type
								Range		
72	DIGITAL IN 1	0	--	1	0	1	LDI	ON	OFF	r0722.1
73	DIGITAL IN 2	0	--	1	0	1	LDI	ON	OFF	r0722.2
74	DIGITAL IN 3	0	--	1	0	1	LDI	ON	OFF	r0722.3
75	DIGITAL IN 4	0	--	1	0	1	LDI	ON	OFF	r0722.4
76	DIGITAL IN 5	0	--	1	0	1	LDI	ON	OFF	r0722.5
80	WDOG TIME	100	MS	10	0	2	LAO_8k	0 … 65530		p2040
83	INVERTER VER	Apr 50	--	0.01	0	2	LAI_32k	00.00 … 99.99		r0018
84	DRIVE MODEL	0	--	1	0	2	LAI_32k	0 … 32767		r0200
85	1st USER PARAMETER	0	--	1	0	2	LAO_32k	0 … 32767		p0013[0]
86	2nd USER PARAMETER	0	--	1	0	2	LAO_32k	0 … 32767		p0013[1]
87	3rd USER PARAMETER	0	--	1	0	2	LAO_32k	0 … 32767		p0013[2]
88	4th USER PARAMETER	0	--	1	0	2	LAO_32k	0 … 32767		p0013[3]
89	Finish of USER PARAMETER transfer	0	--	1	0	2	LDO	START	READY	p0016
90	ACTIVE FAULT	0	--	1	0	1*)	LAI_32k	0 … 32767		r0947[0]
91	1ST FAULT	0	--	1	0	1*)	LAI_32k	0 … 32767		r0947[1]
92	2ND FAULT	0	--	1	0	1*)	LAI_32k	0 … 32767		r0947[2]
93	3RD FAULT	0	--	1	0	1*)	LAI_32k	0 … 32767		r0947[3]
94	FAULT	0	--	1	0	1	LDI	FAULT	OK	ZSW:3
95	FAULT ACK	0	--	1	0	1	LDO	ON	OFF	STW:7
96	WARNING	0	--	1	0	1	LDI	WARN	OK	ZSW:7
97	ACTIVE WARNING	0	--	1	0	1*)	LAI_32k	0 … 32767		r2110[0]
98	RAM TO ROM	0	--	1	0	1	LDO	SAVE	DONE	p971/ p10=30
99	ERROR STATUS	0	--	1	0	1*)	LAI_255	0 … 255		r947[0]

1*): For reasons of compatibility, these type 1 subpoints can save COV area information. Point Number 98 RAM TO ROM was implemented in order to be able to save these in a non-volatile fashion.

6.9 Communication over CANopen

General information on CAN

You can find general information on CAN in the CAN Internet pages (http://www.can-cia.org); you can obtain an explanation of CAN terminology in the CANdictionary under CAN downloads (http://www.can-cia.org/index.php?id=6).

Integrating a inverter in a CANopen network

To integrate an inverter in a CANopen network, we recommend the EDS file on the Internet (http://support.automation.siemens.com/WW/view/en/48351511). This file is the description file of the SINAMICS G120 inverter for CANopen networks. In this way, you can use the objects of the DSP 402 device profile.

6.9.1 CANopen functions of the converter

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

There are two ways you can setup the communication between the inverter and the controller:

- Via the Predefined connection set (Page 267)
- Via Free PDO mapping (Page 269)

Communication objects (COB)

The inverter operates with communication objects from the following profiles:

- CANopen communication profile CiA 301
- Device profile CiA 402 (Drives And Motion Control)
- Indicator profile DR 303-3

Specifically, these are:

- NMT Network management (NMT service) (Page 255)
  Network management objects for controlling CANopen communication and for monitoring the individual nodes on the basis of a master-slave relationship
- SDO SDO services (Page 258)
  Service data objects for reading and changing parameters
- PDO PDO and PDO services (Page 263)
  Process data objects to transfer process data; TPDO to send, RPDO to receive
- SYNC
  Synchronization objects
- EMCY
  Time stamp and fault messages

COB ID

A communication object contains the data to be transferred and a unique 11-bit COB ID. The COB ID also defines the priority for processing the communication objects. The communication object with the lowest COB ID always has the highest priority.

COB ID for individual communication objects

You will find the specifications for the COB IDs of the individual communication objects below:

- **COB ID$_{NMT}$ = 0** — Cannot be changed
- **COB ID$_{SYNC}$ = free** — Pre-assigned with 80 hex
- **COB ID$_{EMCY}$ = free** — 80 hex + node ID = COB ID $_{EMCY}$
- **COB ID$_{TPDO}$ = free** — In the free PDO mapping *)
- **COB ID$_{RPDO}$ = free** — In the free PDO mapping *)
- **COB ID$_{TSDO}$** = 580 + node ID
- **COB ID$_{RSDO}$** = 600 + node ID
- **COB ID$_{Node\ Guarding/Heartbeat}$** = 700 + node ID

*) In the "Predefined Connection Set", see Section Predefined connection set (Page 267).

6.9.1.1 Network management (NMT service)

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

The NMT services can be used to initialize, start, monitor, reset, or stop nodes. Two data bytes follow each NMT service. All NMT services have the fixed COB ID = 0.

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

- Initializing
  The inverter initializes itself after power on. In the factory setting, the inverter then enters the "Pre-Operational" state, which also corresponds to the CANopen standard.
  Using p8684, you can set that after the bus has booted, the inverter does not go into the "Pre-Operational" state, but instead, into the "Stopped" or "Operational" state.
- Pre-Operational
  In this state, the node cannot process any process data (PDO). However, the controller can use SDO parameters to change or operate the inverter, which means that you can also enter setpoints via SDO.
- Operational
  In this state, the node can process both SDO and PDO.

- Stopped
  In this state, the node can process neither PDO nor SDO. The "Stopped" state terminates one of the following commands:
  - Enter Pre-Operational
  - Start Remote Node
  - Reset Node
  - Reset Communication

The NMT recognizes the following transitional states:

- Start Remote Node:
  Command for switching from the "Pre-Operational" communication state to "Operational". The drive can only send and receive process data (PDO) in "Operational" state.
- Stop Remote Node:
  Command for switching from "Pre-Operational" or "Operational" to "Stopped". The node only processes NMT commands in the "Stopped" state.
- Enter Pre-Operational:
  Command for switching from "Operational" or "Stopped" to "Pre-Operational". In this state, the node cannot process any process data (PDO). However, the controller can use SDO parameters to change or operate the inverter, which means that you can also enter setpoints via SDO.
- Reset Node:
  Command for switching from "Operational", "Pre-Operational" or "Stopped" to "Initialization". When the Reset Node command is issued, the inverter resets all the objects (1000 hex - 9FFF hex) to the state that was present after "Power On".
- Reset Communication:
  Command for switching from "Operational", "Pre-Operational" or "Stopped" to "Initialization". When the Reset Communication command is issued, the inverter resets all the communication objects (1000 hex - 1FFF hex) to the state that was present after "Power On".

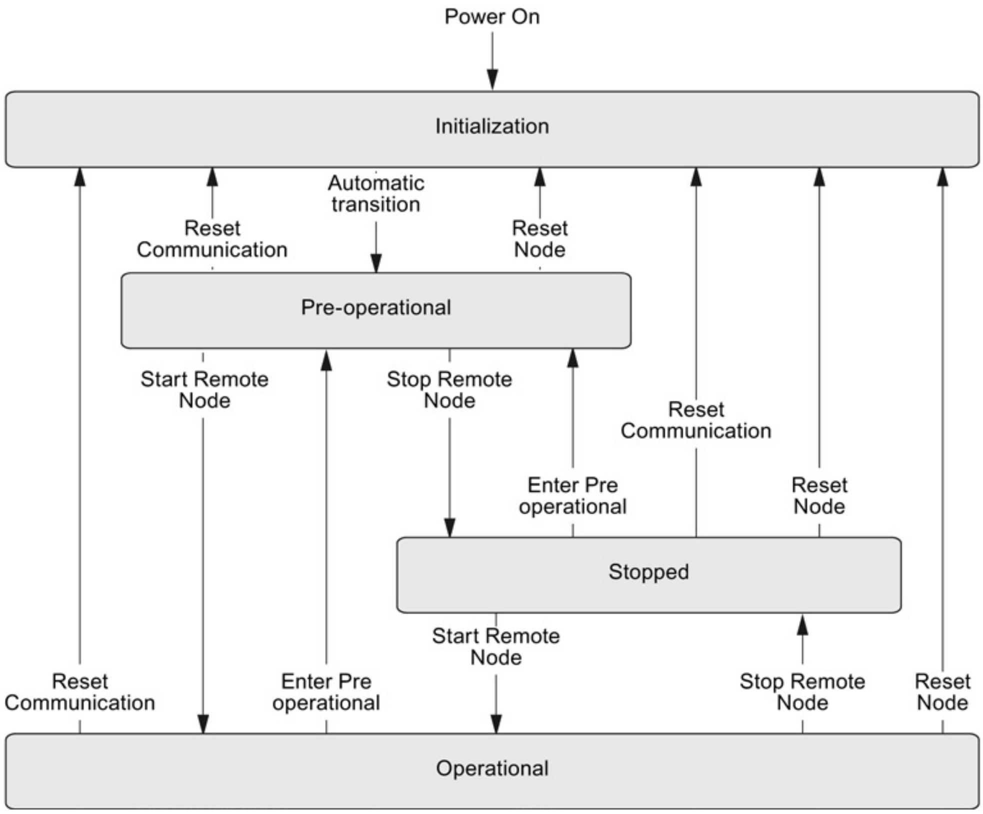


Figure 6-22 CANopen state diagram

Command specifier and Node_ID indicate the transition states and addressed nodes:

Overview of NMT commands

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

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

- Requirement of a slave:
  The controller accesses the slave with its node ID (1 - 127).
- Requirement for all slaves:
  Node ID = 0

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

- p8685 = 0 Initializing (display only)
- p8685 = 4 Stopped
- p8685 = 5 Operational
- p8685 = 127 Pre-Operational (factory setting)
- p8685 = 128 Reset Node
- p8685 = 129 Reset Communication

You can also change the NMT state in STARTER via "Control_Unit / Communication / CAN" under the "Network-Management" tab.

6.9.1.2 SDO services

You can access the object directory of the connected drive unit using the SDO services. An SDO connection is a peer-to-peer coupling between an SDO client and a server.

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

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

Receiving:	Server ⇐ client:	COB ID = 600 hex + node ID
Sending:	Server ⇒ client:	COB ID = 580 hex + node ID

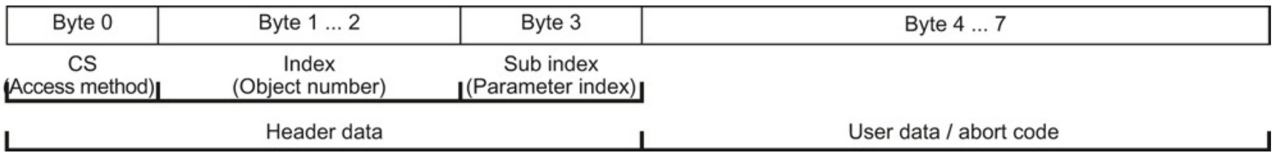
Properties

The SDOs have the following properties:

- An SDO connection exists only in the Pre-Operational and Operational states
- Transmission is confirmed
- Asynchronous transmission (matches the acyclical communication via PROFIBUS DP)
- Transmission of values > 4 bytes (normal transfer)
- Transmission of values ≤ 4 bytes (expedited transfer)
- All drive unit parameters can be addressed via SDO

Structure of the SDO protocols

The basic structure of the SDO protocols is shown below:



Byte 0 (CS = command specifier) contains the access type of the protocol:

- 2F hex: Write 4 bytes
- 2B hex: Write 3 bytes
- 27 hex: Write 2 bytes
- 23 hex: Write 1 byte
- 40 hex: Read request
- 4F hex: Read 4 bytes
- 4B hex: Read 3 bytes
- 47 hex: Read 2 bytes
- 43 hex: Read 1 byte
- 60 hex: Write confirmation
- 80 hex: Error

6.9.1.3 Access to SINAMICS parameters via SDO

If you wish to change inverter parameters in CANopen using the controller, use the SDO service.

You also configure RPDO and TPDO telegrams via SDO. You can find the objects that are available to do this in Section Object directories (Page 273).

Object numbers for SDO jobs

In CAN, access the inverter parameters with the SDO service via manufacturer-specific objects in the range from 2000 hex to 470F hex of the CANopen object directory.

Because you cannot directly address all of the parameters using this area, you require for an SDO job always the parameter number itself and the offset dependent on the parameter number.

Selection of parameter range and the associated offset

Parameter range	Offset	Offset value
0 < parameter number < 10000	p8630[2] = 0	0
10000 ≤ parameter number < 20000	p8630[2] = 1	10000
20000 ≤ parameter number < 20000	p8630[2] = 2	20000
30000 ≤ parameter number < 20000	p8630[2] = 3	30000

Calculate object number for an SDO job

The object number for the SDO job is calculated as follows:
object number hex = (number of the inverter parameter - offset value) hex + 2000 hex

Examples of object numbers

Parameter	Number of the inverter parameter - offset value		Object number
	Decimal	Hexadecimal	
• p0010:	10 dec	A hex	⇒ 200A hex
• p11000:	1000 dec	3E8 hex	⇒ 23E8 hex
• r20001:	1 dec	1 hex	⇒ 2001 hex
• p31020:	1020 dec	3FC hex	⇒ 23FC hex

Selection, index range

A CANopen object can contain a maximum of 255 indexes. For parameters with more than 255 indexes, you must create additional CANopen objects via p8630[1]. Overall, 1024 indexes are possible.

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

Switch-on access to objects of the inverter parameters

Access to objects of the inverter parameters is activated via p8630[0], where:

- p8630[0] = 0: only access to CANopen objects (SDO, PDO, ...)
- p8630[0] = 1: access to virtual CANopen objects (inverter parameters)

A selection of important manufacturer-specific objects is included in the EDS file.

6.9.1.4 Access PZD objects via SDO

Access to mapped PZD objects

When you access objects mapped via send or receive telegrams, you can access the process data without additional settings.

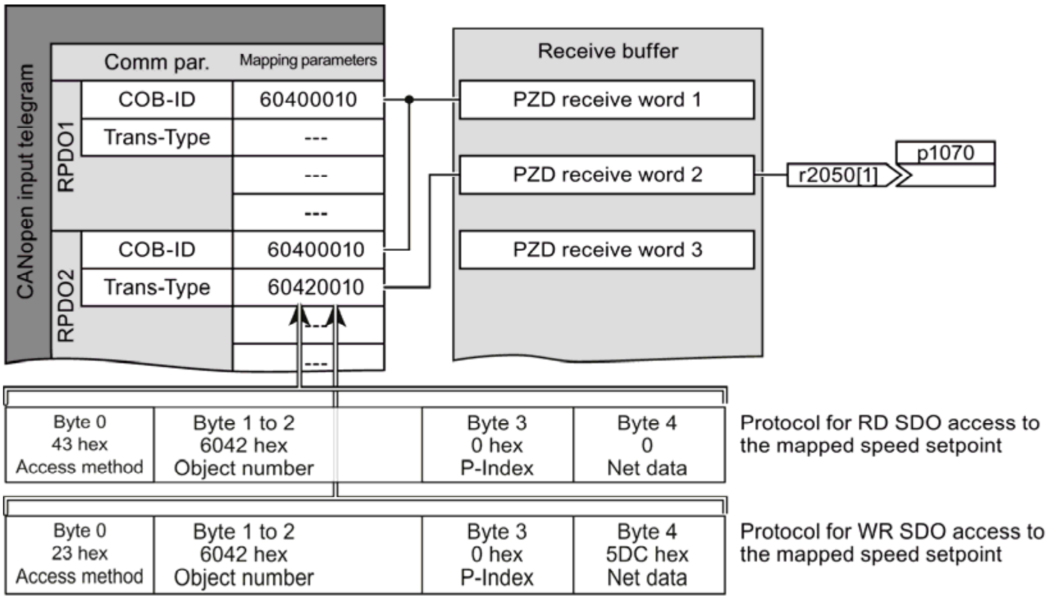


Figure 6-23 Access to the process data

Access to non-mapped PZD objects

When you access objects that are not interconnected via the receive or send telegram, you must also establish the interconnection with the corresponding CANopen parameters.

There follows an example for switching the control word with the CANopen parameters:

ON/OFF1	p840[0] = r8795.0
No coast down activated	p0844[0] = r8795.1
No fast stop activated	p0848[0] = r8795.2
Enable operation	p0852[0] = r8795.3
Enable ramp-function generator	p1140[0] = r8795.4
Continue ramp-function generator	p1141[0] = r8795.5
Enable speed setpoint	p1142[0] = r8795.6
Acknowledge fault	p2103[0] = r8795.7
Stop	p8791 = r8795.8

SDO abort codes

Abort code	Description
0503 0000 hex	Toggle bit not alternated.
0504 0000 hex	SDO protocol timed out.
0504 0001 hex	Client/server command specifier not valid or unknown.
0504 0002 hex	Invalid block size (block mode only).
0504 0003 hex	Invalid sequence number (block mode only).
0504 0004 hex	CRC error (block mode only).
0504 0005 hex	Out of memory.
0601 0000 hex	Unsupported access to an object.
0601 0001 hex	Attempt to read a write only object.
0601 0002 hex	Attempt to write a read only object.
0602 0000 hex	Object does not exist in the object dictionary.
0604 0041 hex	Object cannot be mapped to the PDO.
0604 0042 hex	The number and length of the objects to be mapped would exceed PDO length.
0604 0043 hex	General parameter incompatibility reason.
0604 0047 hex	General internal incompatibility in the device.
0606 0000 hex	Access failed due to an hardware error.
0607 0010 hex	Data type does not match, length of service parameter does not match.
0607 0012 hex	Data type does not match, length of service parameter too high.
0607 0013 hex	Data type does not match, length of service parameter too low.
0609 0011 hex	Subindex does not exist.
0609 0030 hex	Value range of parameter exceeded (only for write access).
0609 0031 hex	Value of parameter written too high.

Abort code	Description
0609 0032 hex	Value of parameter written too low.
0609 0036 hex	Maximum value is less than minimum value.
060A 0023 hex	Resource not available: SDO connection. SDO connection
0800 0000 hex	General error.
0800 0020 hex	Data cannot be transferred or stored to the application.
0800 0021 hex	Data cannot be transferred or stored to the application because of local control.
0800 0022 hex	Data cannot be transferred or stored to the application because of the current device state.
0800 0023 hex	Object dictionary dynamic generation failed or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error).

6.9.1.5 PDO and PDO services

Process data objects (PDO)

CANopen transfers the process data using "Process Data Objects" (PDO). There are send PDOs (TDPO) and receive PDOs (RPDO). CAN controller and inverter each exchange eight TPDOs and RPDOs.

PDO communication parameters and PDO mapping parameters define a PDO.

Link the PDO with the elements of the object directory that contain the process data. You can use Free PDO mapping (Page 269) or the Predefined connection set (Page 267) to do this.

Parameter area for PDO	RPDO		TPDO	
	In the inverter	In CANopen	In the inverter	In CANopen
Communication parameters	p8700 … p8707	1400 hex … 1407 hex	p8720 … p8727	1800 hex … 1807 hex
Mapping parameters	p8710 … p8717	1600 hex … 1607 hex	p8730 … p8737	1A00 hex …1A07 hex

Structure of the PDO

A PDO consists of communication and mapping parameters. Examples for the structure of the TPDO and RPDO follow.

The values for communication parameters can be found in the tables in Section Object directories (Page 273)

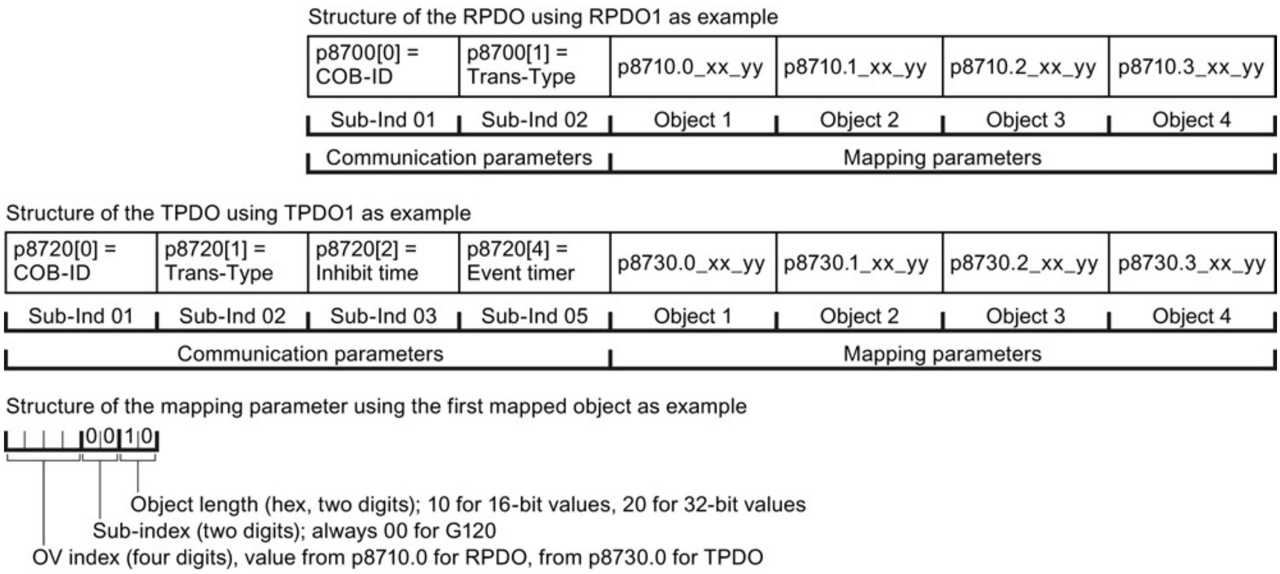


Figure 6-24   Structure of the RPDO and TPDO communication objects

COB ID

An overview of the COB IDs can be found in Section CANopen functions of the converter (Page 254). Section Predefined connection set (Page 267) explains how the COB IDs are calculated.

Transmission type

For process data objects, the following transmission types are available, which you set in index 1 of the communication parameter (p8700[1] … p8707[1] / p8720[1] … p8727[1]) in the inverter:

- Cyclic synchronous (value range: 1 … 240)
  - TPDO after each n-th SYNC
  - RPDO after each n-th SYNC
- Acyclic synchronous (value: 0)
  - TPDO when a SYNC is received and a process data has changed in the telegram.
- Cyclic asynchronous (values: 254, 255 + event time)
  - TPDO when a process data has changed in the telegram.
- Acyclic asynchronous (values: 254, 255)
  - TPDO when a process data has changed in the telegram.
  - The controller accepts the RPDO immediately.

Inhibit time

The inhibit time defines the minimum interval between two transmissions.

Synchronous data transmission

A periodic synchronization object (SYNC object) ensures that the devices on the CANopen bus remain synchronized during transmission.

Each PDO transferred as synchronization object must include a "transmission type" 1 ... n:

- Transmission type 1: PDO in each SYNC cycle
- Transmission type n: PDO in every n-th SYNC cycle

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

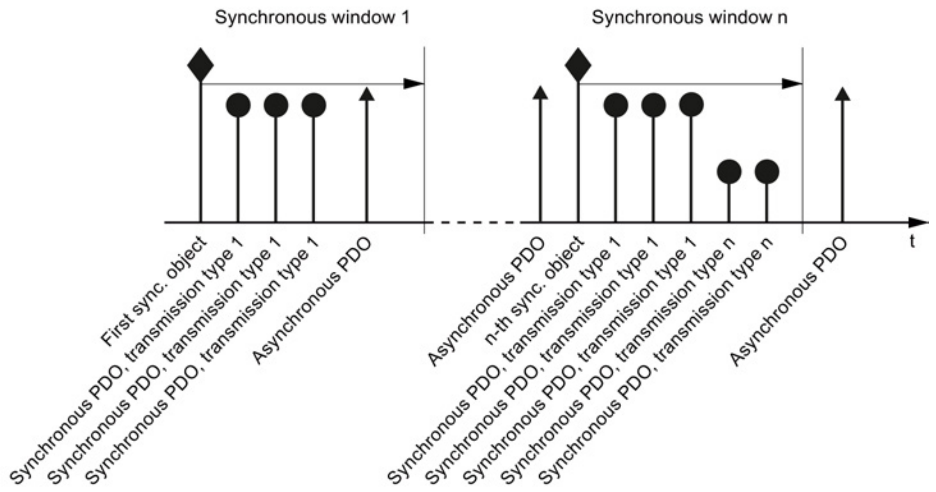


Figure 6-25 Principle of synchronous and asynchronous transmission

For synchronous TPDOs, the transmission mode also identifies the transmission rate as a factor of the SYNC object transmission intervals.

The CAN controller transfers data from synchronous RPDOs that it received after a SYNC signal only after the next SYNC signal to the inverter.

Note

The SYNC signal synchronizes only the communication on the CANopen bus and not functions in the inverter, e.g. the clock times of the speed control.

PDO services

The PDO services can be subdivided as follows:

- Write PDO
- Read PDO
- SYNC service

Write PDO

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

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

Read PDO

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

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

SYNC service

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

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

Note

Set the COB ID of the SYNC object to the same value for all nodes of a bus that should respond to the SYNC telegram from the master.

The COB ID of the SYNC object is defined in object 1005h (p8602).

6.9.1.6 Predefined connection set

If you integrate the inverter using the factory setting in CANopen, the inverter receives the control word and the speed setpoint from the controller. The inverter returns the status word and the actual speed value to the controller. These are the settings stipulated in the Predefined Connection Set.

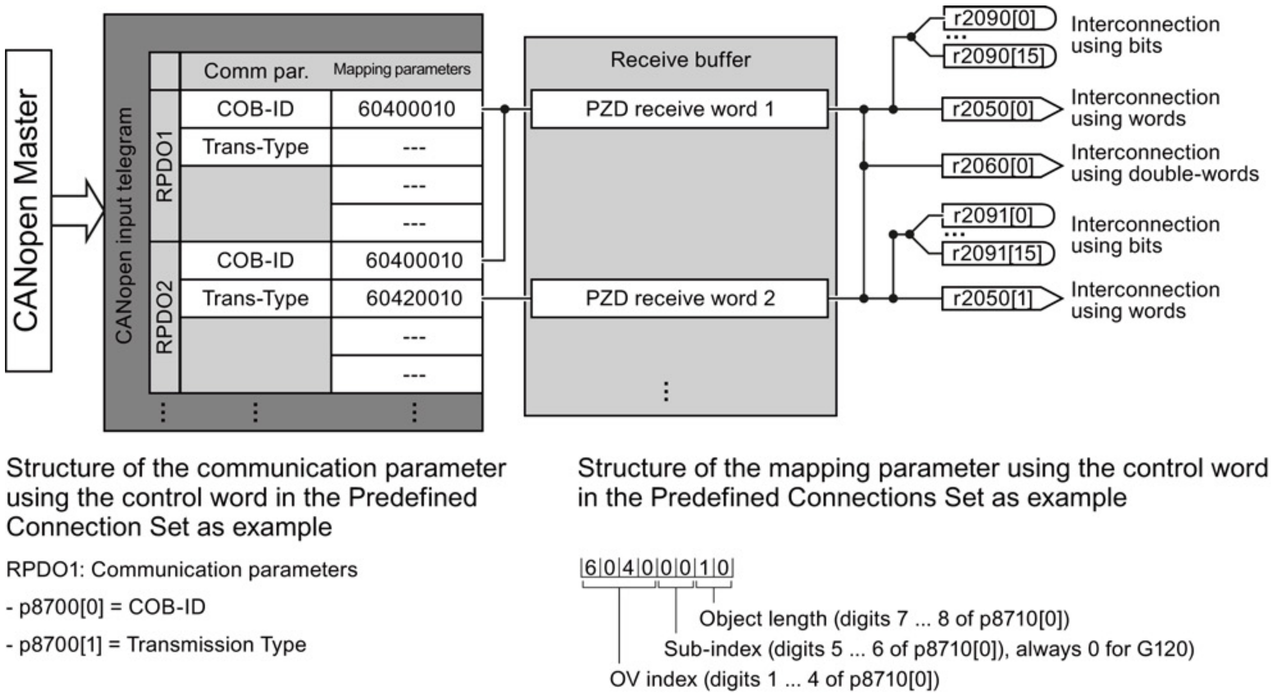


Figure 6-26 RPDO mapping with the Predefined Connection Set

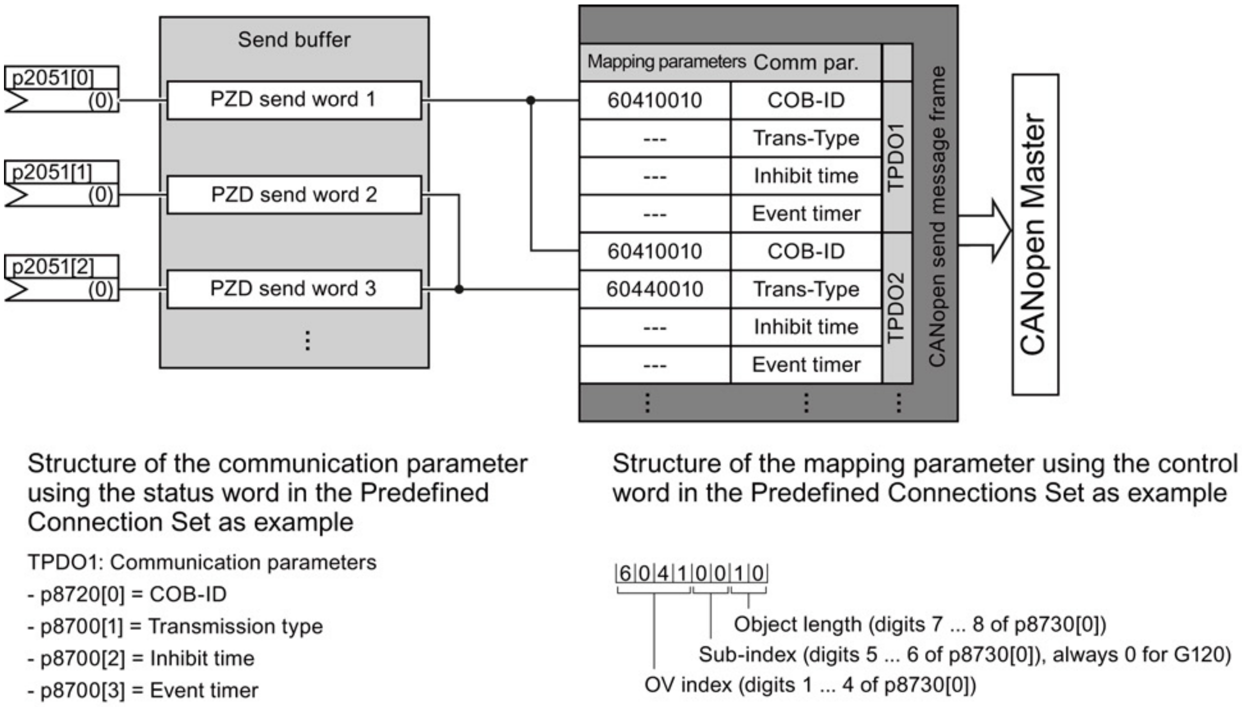


Figure 6-27 TPDO mapping with the Predefined Connection Set

Calculate the COB IDs using the following formula and enter the results in the p8700, p8701, p8720 and p8721 parameters.

COB ID for TPDO and RPDO in the Predefined Connection Set

- **COB ID**$_{TPDO}$ = 180 hex + node ID + ((TPDO no. - 1) * 100 hex)

  Example:

  – For p8721[0] = COB ID of TPDO 2, this gives with Node ID = C hex the following value:
  180 hex + C hex + ((2 - 1)*100 hex) = 18C hex + 100 hex = 28C hex

- **COB ID**$_{RPDO}$ = 200 hex + node ID + ((RPDO no. - 1) * 100 hex)

  Example:

  – For p8700[0] = COB ID of RPDO 1, this gives with Node ID = C hex the following value:
  200 hex + C hex + ((1 - 1) * 100 hex) = 20C hex + 0 hex = 20C hex

6.9.1.7 Free PDO mapping

Using the free PDO mapping, you configure and interconnect any process data as required as follows:

- As free objects or
- As objects of drive profile CiA 402, corresponding to the requirements of your system for the PDO service

This requires that the inverter is set to a free PDO mapping (p8744 = 2) (factory setting).

Interconnecting process data via a free PDO mapping

Procedure

To interconnect process data, proceed as follows:

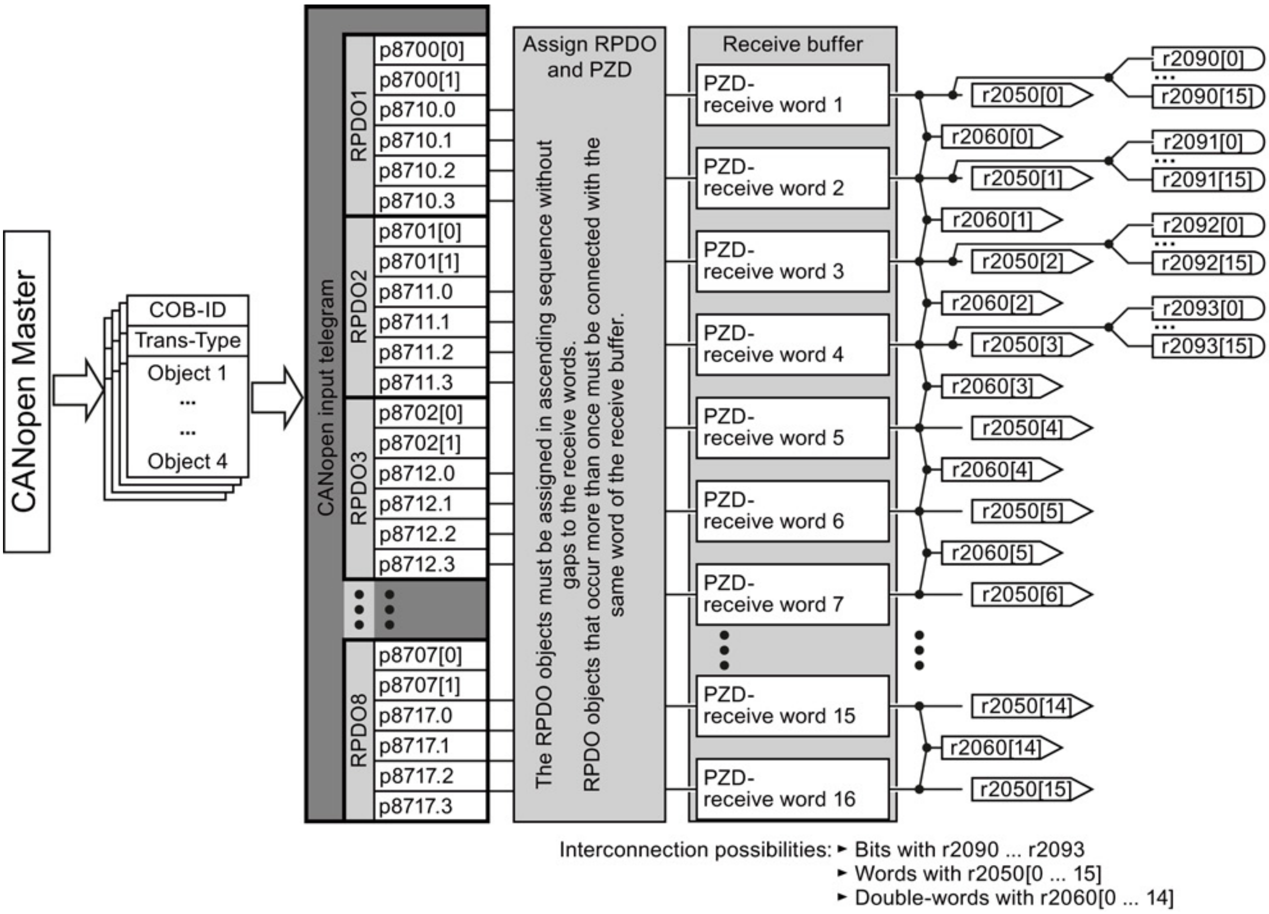
1. Define process data,
   examples:
   - Send actual current value (r0068) from the inverter to the controller (TPDO - Transmit Process Data Object)
   - Send additional speed setpoint from the controller to the inverter (RPDO - Receive Process Data Object) and write in p1075
2. Specify objects for transmission of the process data
   - TPDO1 for the actual current value
   - RPDO1 for additional speed setpoint
3. Set communication parameters for RPDO and TPDO
   - Define the communication parameters for RPDO, see RPDO communication parameters (Page 276)
   - Define the communication parameters for TPDO, see TPDO communication parameters (Page 279)
4. Select the OD index for the mapping parameters:
   - Mapping parameters for RPDO, see RPDO mapping parameters (Page 277)
   - Mapping parameters for TPDO, see TPDO mapping parameters (Page 280)
5. Write OV index into the SINAMICS mapping parameters
   - p8710 … p8717 for RPDO
   - p8730 … p8737 for TPDO
   - You will find the OD index in the free objects (Page 282) or in the objects of the CiA 402 drive profile (Page 273)

Note

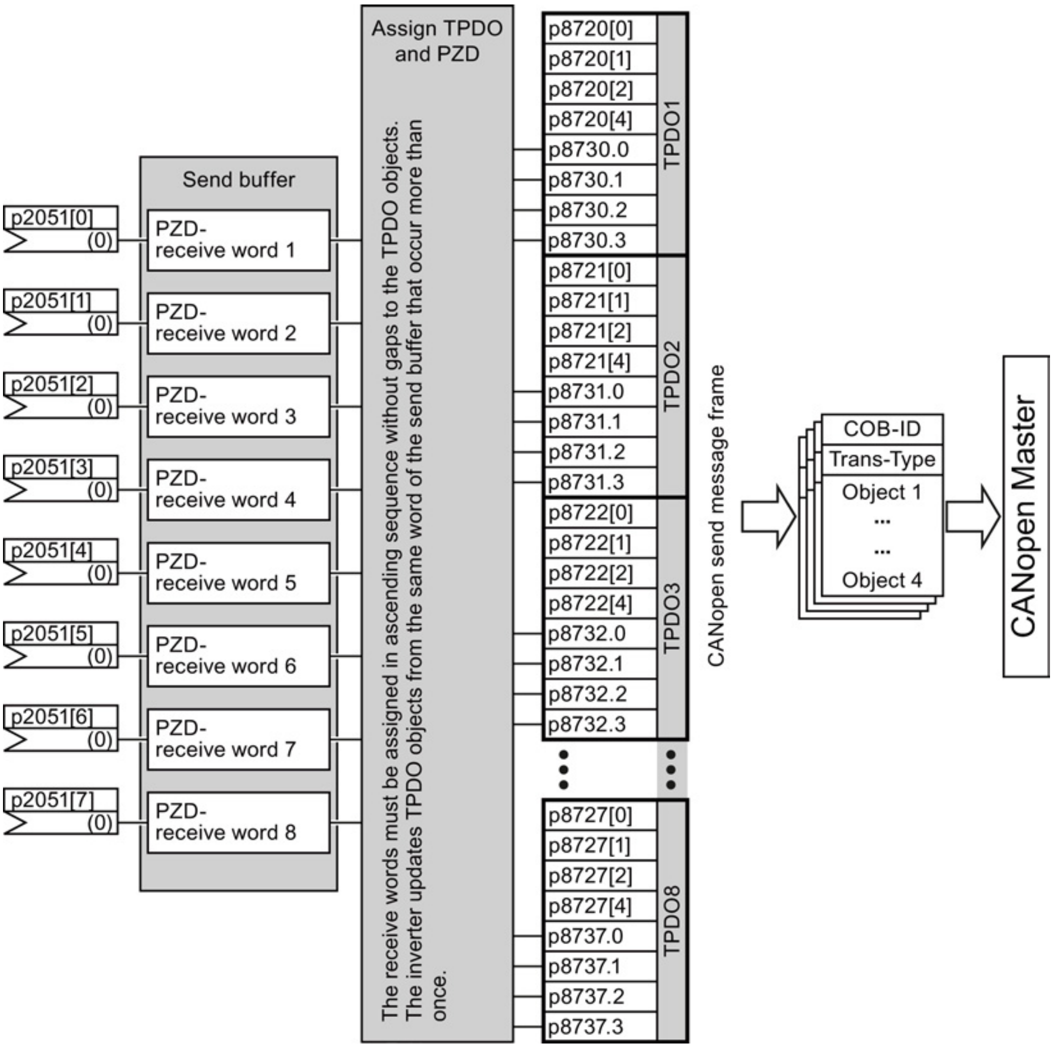
Requirement for changing the OD indexes of the SINAMICS mapping parameters

To allow you to change the values of the mapping parameters, you must set the COB ID of the corresponding parameter to invalid. Add the value 80000000 hex to the COB ID. If you have changed the mapping parameter, you must reset the COB ID to the valid value.

Free RPDO mapping - Overview



Free TPDO mapping - Overview



6.9.1.8 Interconnect objects from the receive and transmit buffers

Procedure

Proceed as follows to configure the CANopen PDO:

1. Create a telegram:
   Create a PDO (parameterize the PDO Com. Parameters and PDO mapping parameters), see Predefined connection set (Page 267) and Free PDO mapping (Page 269)
2. Interconnect the parameters:
   Interconnect the parameters of the PZD buffer (p2050/p2060, p2051) corresponding to the mapping of point "Create telegram" using the mapping table r8750/r8760 or r8751/r8761. The mapping table indicates the position of a mapped CANopen object in the PZD buffer.

Interconnecting the receive buffer

The inverter writes the received data in the receive buffer:

- PZD receive word 1 … PZD receive word 12 double word in r2060[0] … r2060[10].
- PZD receive word 1 … PZD receive word 12 word in r2050[0] … r2050[11].
- PZD 1 … PZD 4 bit-by-bit in r2090.0 … r2090.15 to r2093.0 … r2093.15

The position of the mapped objects in the receive buffer is displayed in:

- r8760 for double word switching
- r8750 for word switching

Examples

Object	Mapped receive objects	Receive word r2050	
Control word	r8750[0] = 6040 hex (PZD1)	Interconnect r2050[0] (PZD1) with control word [1)]	p0840.0 = 2090.0 p0844.0 = 2090.1 p0844.0 = 2090.2 p0852.0 = 2090.3 p2130.0 = 2090.7
Torque limit	r8750[1] = 5800 hex (PZD2)	Link r2050[1] (PZD2) with torque limit:	p1522 = 2050[1]
Speed setpoint	r8750[2] = 6042 hex (PZD3)	Link r2050[2] (PZD3) with speed setpoint:	p1070 = 2050[2]

1) see also p8790, "Automatic CAN control word interconnection"

Interconnecting the send buffer

The inverter sends the data from the send buffer as follows:

- p2051[0] … p2051[13] in PZD 1 … PZD 14 (indication of the actual link in r2053[0 … 13])
- p2061[0] … p2061[12] in PZD 1 … PZD 14 (indication of the actual link in r2063[0 … 12])

Examples

Object	Mapped send objects	Send word p2051	
Status word	r8751[0] = 6041 hex (PZD1)	Interconnect p2051[0] with PZD1	p2051[0] = r8784
Actual current value	r8751[1] = 5810 hex (PZD2)	Link PZD2 with actual current value	p2051[1] = r68[1]
Actual speed value	r8751[2] = 6044 hex (PZD3)	Link PZD3 with actual speed value	p2051[2] = r63[0]

6.9.1.9 CANopen operating modes

The converter works with the "Velocity Mode" CANopen operating mode. "Velocity Mode" is a simple velocity control with ramps and the objects intended for this purpose. It is preferably used for converters with V/f and I/f control.

6.9.2 Object directories

6.9.2.1 General objects from the CiA 301 communication profile

Overview

The following table lists the drive-independent communication objects. The "SINAMICS parameters" column shows the parameter numbers assigned in the inverter.

Table 6- 29 Drive-independent communication objects

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmission	Data type	Default values	Can be read/ written
1000		Device type	r8600	SDO	U32	–	r
1001		Error register	r8601	SDO	U8	–	r
1003	0...52 hex	Predefined error field	p8611[0...82]	SDO	U32	0	r/w
	0	Number of errors	p8611.0	SDO	U32	0	rw
	1	Number of module	p8611.1	SDO	U32	0	r
	2	Number of errors: module 1	p8611.2	SDO	U32	0	r
	3-A	Standard error field: module 1	p8611.3- p8611.10	SDO	U32	0	r
	B	Number of errors: module 2	p8611.11	SDO	U32	0	r
	C-13	Standard error field: module 2	p8611.12- p8611.19	SDO	U32	0	r
	14	Number of errors: module 3	p8611.20	SDO	U32	0	r
	15-1C	Standard error field: module 3	p8611.21- p8611.28	SDO	U32	0	r
	1D	Number of errors: module 4	p8611.29	SDO	U32	0	r
	1E-25	Standard error field: module 4	p8611.30-p8611.37	SDO	U32	0	r
	26	Number of errors: module 5	p8611.38	SDO	U32	0	r
	27-2E	Standard error field: module 5	p8611.39-p8611.46	SDO	U32	0	r

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmis sion	Data type	Default values	Can be read/ written
	2F	Number of errors: module 6	p8611.47	SDO	U32	0	r
	30-37	Standard error field: module 6	p8611.48-p8611.55	SDO	U32	0	r
	38	Number of errors: module 7	p8611.56	SDO	U32	0	r
	39-40	Standard error field: module 7	p8611.57-p8611.64	SDO	U32	0	r
	41	Number of errors: module 8	p8611.65	SDO	U32	0	r
	42-49	Standard error field: module 8	p8611.66-p8611.73	SDO	U32	0	r
	4A	Number of Control Unit errors	p8611.74	SDO	U32	0	r
	4B-52	Standard error field: Control Unit	p8611.75-p8611.82	SDO	U32	0	r
1005		SYNCH COB ID	p8602	SDO	U32	128	rw
1008		Manufacturer device name		SDO			
100A		Manufacturer software version	r0018	SDO	U32	–	r
100C		Guard time	p8604.0	SDO	U16	0	rw
100D		Lifetime factor	p8604.1	SDO	U16	0	rw
1010		Store parameters	p0977	SDO	U16	0	rw
	0	Largest subindex supported		SDO			
	1	Save all parameters	p0977	SDO	U16	0	rw
	2	Save communication parameters (0x1000-0x1fff)	p0977	SDO	U16	0	rw
	3	Save application-related parameters (0x6000-0x9fff)	p0977	SDO	U16	0	rw
1011		Restore default parameters	p0976	SDO	U16	0	rw
	0	Largest subindex supported		SDO			
	1	Restore all default parameters	p0976	SDO	U16	0	rw
	2	Restore communication default parameters (0x1000-0x1fff)	p0976	SDO	U16	0	rw
	3	Restore application default parameters (0x6000-0x9fff)	p0976	SDO	U16	0	rw
1014		COB ID emergency	p8603	SDO	U32	0	rw

OD index (hex)	Subindex (hex)	Object name	SINAMICS parameters	Transmis sion	Data type	Default values	Can be read/ written
1017		Producer heartbeat time	p8606	SDO	U16	0	rw
1018		Identy Object	r8607[0...3]		U32	–	r
	0	Number of entries		SDO			
	1	Vendor ID	r8607.0	SDO	U32	–	r
	2	Product code	r8607.1	SDO	U32	–	r
	3	Revision number	r8607.2	SDO	U32	–	r
	4	Serial number	r8607.3	SDO	U32	0	r
1027		Module list					
	0	Number of entries	r0102	SDO	U16	–	r
	1-8	Module ID	p0107[0...15]	SDO	I16	0	rw
1029		Error behavior					
	0	Number of error classes		SDO			
	1	Communication error	p8609.0	SDO	U32	1	rw
	2	Device profile or manufacturer-specific error	p8609.1	SDO	U32	1	rw
1200		1st server SDO parameter					
	0	Number of entries		SDO			
	1	COB ID client -> server (rx)	r8610.0	SDO	U32	–	r
	2	COB ID server -> client (tx)	r8610.1	SDO	U32	–	r

RPDO configuration objects

The following tables list the communication and mapping parameters together with the indexes for the individual RPDO configuration objects. The configuration objects are established via SDO. The "SINAMICS parameters" column shows the parameter numbers assigned in the inverter.

Table 6- 30 RPDO configuration objects - communication parameters

OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1400		**Receive PDO 1 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8700.0	U32	200 hex + node ID	r/w
	2	Transmission type	p8700.1	U8	FE hex	r/w
1401		**Receive PDO 2 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8701.0	U32	300 hex + node ID	r/w
	2	Transmission type	p8701.1	U8	FE hex	r/w
1402		**Receive PDO 3 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8702.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8702.1	U8	FE hex	r/w
1403		**Receive PDO 4 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8703.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8703.1	U8	FE hex	r/w
1404		**Receive PDO 5 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8704.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8704.1	U8	FE hex	r/w
1405		**Receive PDO 6 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8705.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8705.1	U8	FE hex	r/w
1406		**Receive PDO 7 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8706.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8706.1	U8	FE hex	r/w
1407		**Receive PDO 8 communication parameter**				
	0	Largest subindex supported		U8	2	r
	1	COB ID used by PDO	p8707.0	U32	8000 06DF hex	r/w
	2	Transmission type	p8707.1	U8	FE hex	r/w

Table 6- 31 RPDO configuration objects - mapping parameters

OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1600		**Receive PDO 1 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	1	r
	1	PDO mapping for the first application object to be mapped	p8710.0	U32	6040 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8710.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8710.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8710.3	U32	0	r/w
1601		**Receive PDO 2 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	2	r
	1	PDO mapping for the first application object to be mapped	p8711.0	U32	6040 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8711.1	U32	6042 hex	r/w
	3	PDO mapping for the third application object to be mapped	p8711.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8711.3	U32	0	r/w
1602		**Receive PDO 3 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8712.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8712.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8712.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8712.3	U32	0	r/w
1603		**Receive PDO 4 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8713.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8713.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8713.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8713.3	U32	0	r/w
1604		**Receive PDO 5 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r

OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	1	PDO mapping for the first application object to be mapped	p8714.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8714.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8714.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8714.3	U32	0	r/w
1605		**Receive PDO 6 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8715.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8715.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8715.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8715.3	U32	0	r/w
1606		**Receive PDO 7 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8716.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8716.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8716.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8716.3	U32	0	r/w
1607		**Receive PDO 8 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8717.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8717.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8717.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8717.3	U32	0	r/w

TPDO configuration objects

The following tables list the communication and mapping parameters together with the indexes for the individual TPDO configuration objects. The configuration objects are established via SDO. The "SINAMICS parameters" column shows the parameter numbers assigned in the inverter.

Table 6- 32 TPDO configuration objects - communication parameters

OD index (hex)	Sub-index (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1800		**Transmit PDO 1 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8720.0	U32	180 hex + node ID	r/w
	2	Transmission type	p8720.1	U8	FE hex	r/w
	3	Inhibit time	p8720.2	U16	0	r/w
	4	Reserved	p8720.3	U8	---	r/w
	5	Event timer	p8720.4	U16	0	r/w
1801		**Transmit PDO 2 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8721.0	U32	280 hex + node ID	r/w
	2	Transmission type	p8721.1	U8	FE hex	r/w
	3	Inhibit time	p8721.2	U16	0	r/w
	4	Reserved	p8721.3	U8	---	r/w
	5	Event timer	p8721.4	U16	0	r/w
1802		**Transmit PDO 3 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8722.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8722.1	U8	FE hex	r/w
	3	Inhibit time	p8722.2	U16	0	r/w
	4	Reserved	p8722.3	U8	---	r/w
	5	Event timer	p8722.4	U16	0	r/w
1803		**Transmit PDO 4 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8723.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8723.1	U8	FE hex	r/w
	3	Inhibit time	p8723.2	U16	0	r/w
	4	Reserved	p8723.3	U8	---	r/w
	5	Event timer	p8723.4	U16	0	r/w
1804		**Transmit PDO 5 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8724.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8724.1	U8	FE hex	r/w

OD index (hex)	Sub-index (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	3	Inhibit time	p8724.2	U16	0	r/w
	4	Reserved	p8724.3	U8	---	r/w
	5	Event timer	p8724.4	U16	0	r/w
1805		**Transmit PDO 6 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8725.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8725.1	U8	FE hex	r/w
	3	Inhibit time	p8725.2	U16	0	r/w
	4	Reserved	p8725.3	U8	---	r/w
	5	Event timer	p8725.4	U16	0	r/w
1806		**Transmit PDO 7 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8726.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8726.1	U8	FE hex	r/w
	3	Inhibit time	p8726.2	U16	0	r/w
	4	Reserved	p8726.3	U8	---	r/w
	5	Event timer	p8726.4	U16	0	r/w
1807		**Transmit PDO 8 communication parameter**				
	0	Largest subindex supported		U8	5	r
	1	COB ID used by PDO	p8727.0	U32	C000 06DF hex	r/w
	2	Transmission type	p8727.1	U8	FE hex	r/w
	3	Inhibit time	p8727.2	U16	0	r/w
	4	Reserved	p8727.3	U8	---	r/w
	5	Event timer	p8727.4	U16	0	r/w

Table 6- 33 TPDO configuration objects - mapping parameters

OD index (hex)	Sub-index (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1A00		**Transmit PDO 1 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	1	r/w
	1	PDO mapping for the first application object to be mapped	p8730.0	U32	6041 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8730.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8730.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8730.3	U32	0	r/w

OD index (hex)	Sub-index (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
1A01		**Transmit PDO 2 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	2	r/w
	1	PDO mapping for the first application object to be mapped	p8731.0	U32	6041 hex	r/w
	2	PDO mapping for the second application object to be mapped	p8731.1	U32	6044 hex	r/w
	3	PDO mapping for the third application object to be mapped	p8731.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8731.3	U32	0	r/w
1A02		**Transmit PDO 3 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8732.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8732.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8732.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8732.3	U32	0	r/w
1A03		**Transmit PDO 4 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8733.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8733.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8733.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8733.3	U32	0	r/w
1A04		**Transmit PDO 5 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8734.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8734.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8734.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8734.3	U32	0	r/w
1A05		**Transmit PDO 6 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r/w
	1	PDO mapping for the first application object to be mapped	p8735.0	U32	0	r/w

OD index (hex)	Sub-index (hex)	Object name	SINAMICS parameters	Data type	Predefined connection set	Can be read/ written
	2	PDO mapping for the second application object to be mapped	p8735.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8735.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8735.3	U32	0	r/w
1A06		**Transmit PDO 7 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8736.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8736.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8736.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8736.3	U32	0	r/w
1A07		**Transmit PDO 8 mapping parameter**				
	0	Number of mapped application objects in PDO		U8	0	r
	1	PDO mapping for the first application object to be mapped	p8737.0	U32	0	r/w
	2	PDO mapping for the second application object to be mapped	p8737.1	U32	0	r/w
	3	PDO mapping for the third application object to be mapped	p8737.2	U32	0	r/w
	4	PDO mapping for the fourth application object to be mapped	p8737.3	U32	0	r/w

6.9.2.2 Free objects

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

Scaling the process data of the free objects:

- 16-bit (word): 4000 hex ≙ 100%
- 32-bit (doubleword) 4000000 hex ≙ 100%
- For temperature values: 16-bit (word): 4000 hex ≙ 100° C
- For temperature values: 32-bit (doubleword): 4000000 hex ≙ 100° C

The "SINAMICS parameters" column shows the parameter numbers assigned in the inverter. The assignment applies to the case in which an object which is not mapped in any PDO is to be accessed via SDO.

OD index (hex)	Description	Data type per PZD	Default values	Can be read/ written	SINAMICS parameters
5800 … 580F	16 freely-interconnectable receive process data	I16	0	r/w	r8745[0 … 15]
5810 … 581F	16 freely-interconnectable transmit process data	I16	0	r	r8746[0 … 15]
5820 … 5827	8 freely-interconnectable receive process data	I32	0	r/w	r8747[0 … 7]
5828 … 582F	Reserved				
5830 … 5837	8 freely-interconnectable transmit process data	I32	0	r	r8748[0 … 7]
5828 … 582F	Reserved				

6.9.2.3 Objects from the CiA 402 drive profile

The following table lists the object directory with the index of the individual objects for the drives. The "SINAMICS parameters" column shows the parameter numbers assigned in the inverter.

OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Trans-mission	Data type	Default setting	Can be read/ written
Predefinitions							
67FF		Single device type		SDO	U32		r
Common entries in the object dictionary							
6007		Abort connection option code	p8641	SDO	I16	3	r/w
6502		Supported drive modes		SDO	I32		r
6504		Drive manufacturer		SDO	String	SIEMENS	r
Device control							
6040		Controlword	r8795	PDO/SDO	U16	–	r/w
6041		Status word	r8784	PDO/SDO	U16	–	r
605D		Halt option code	p8791	PDO/SDO	I16	–	r/w
6060		Modes of operation	p1300	SDO	I8	–	r/w
6061		Modes of operation display	p1300	SDO	I8	–	r
Factor group							
6094		Velocity encoder factor		SDO	U8	-	r
	01	Velocity encoder factor numerator	p8798[1]	SDO	U32	1	r/w
	02	Velocity encoder factor denumerator	p8798[2]	SDO	U32	1	r/w
Profile Velocity Mode 3)							
6063		Actual position value	r0482	SDO/PDO	I32	–	r

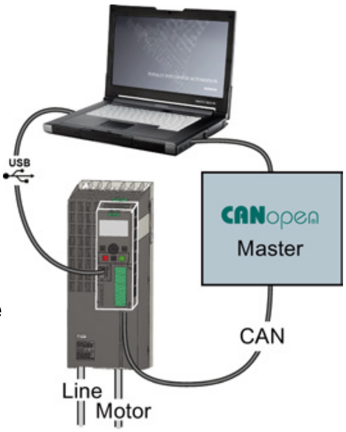
OD index (hex)	Sub-index (hex)	Name of the object	SINAMICS parameters	Trans-mission	Data type	Default setting	Can be read/ written
6069		Velocity sensor actual value	r0061	SDO/PDO	I32	–	r
606B		Velocity demand value	r1170	SDO/PDO	I32	–	r
606C		Velocity actual value Actual velocity	r0063	SDO/PDO	I32	–	r
6083		Profile acceleration	p1082/p1120	SDO	I32	–	r/w
6084		Profile deceleration	p1082/p1121	SDO	I32	0	r/w
6085		Quick stop deceleration	p1082/p1135	SDO	I32	0	r/w
6086		Motion profile type	p1115/p1134	SDO	I32	0	r/w
60FF		Target velocity Set velocity	p1155[0] 1) p1072 2)	SDO/PDO	I32	0	r/w
Profile Torque Mode 3)							
6071		Target torque torque setpoint	r8797	SDO/PDO	I16	–	r/w
6072		Max torque	p1520	SDO	0	0	
6074		Torque demand value overall torque setpoint	r0079	SDO/PDO	I16	–	r
6077		Torque actual value	r0080	SDO/PDO	I16	–	r
Velocity mode							
6042		vl target velocity	r8792	SDO/PDO	I16	–	r/w
6043		vl velocity demand	r1170	SDO/PDO	I16	–	r
6044		vl velocity actual value	r0063	SDO/PDO	I16	–	r
6046	0	vl velocity min./max. amount		SDO	U8	–	r
	1	vl velocity min. amount	p1080	SDO	U32	–	r/w
	2	vl velocity max. amount	p1082	SDO	U32	–	r/w
6048	0	vl velocity acceleration		SDO	U8	–	r
	1	Delta speed	p1082	SDO	U32	–	r/w
	2	Delta time	p1120	SDO	U16	–	r/w

1) Without ramp-function generator
2) With ramp-function generator
3) The inverter processes the objects of profile velocity mode and profile torque mode. But they cannot be set nor selected in inverters.

6.9.3 Integrating the converter into CANopen

Commissioning

Precondition



- STARTER ≥ version 4.2, is installed on the computer used to commission the system.
- The inverter is connected to a CANopen master.
- The EDS (Electronic Data Sheet) (http://support.automation.siemens.com/WW/view/en/48351511) is installed on your CANopen master.
- In the basic commissioning you have set the inverter interfaces to the CANopen fieldbus.

  This means that the following signals in the inverter are interconnected corresponding to the Predefined Connection Sets:
  - Speed setpoint and control word
  - Actual speed value and status word

Procedure

Proceed as follows to commission the CANopen interface:

1. Connecting inverter to CAN bus (Page 286)
2. Set the node ID, baud rate and the monitoring of the communication.
   Also see "Setting the node ID and baud rate (Page 286)" as well as "Setting the monitoring of the communication (Page 287)"
3. Interconnect additional process data
   Set p8744 = 2. You can now interconnect additional process data.

   See also "Free PDO mapping (Page 269)"
4. Signal interconnection of the links created in free PDO mapping.

   See also Interconnect objects from the receive and transmit buffers (Page 271).
5. Exit commissioning
   Select the "Operational" status in the "Network management" tab in the "Control Unit/Communication/CAN" STARTER screen form and exit the commissioning.

More information about configuring the communication is provided in Sections Object directories (Page 273) and CANopen functions of the converter (Page 254).

6.9.3.1 Connecting inverter to CAN bus

Connect the converter to the fieldbus via the 9-pin SUB-D pin connector.

The connections of this pin connector are short-circuit proof and isolated. If the converter forms the first or last slave in the CANopen network, then you must switch-in the bus-terminating resistor.

For additional information on the SUB-D pin connector and on the bus-terminating resistor, please refer to Section CU230P-2 CAN Control Unit (option K99) (Page 95).

6.9.3.2 Setting the node ID and baud rate

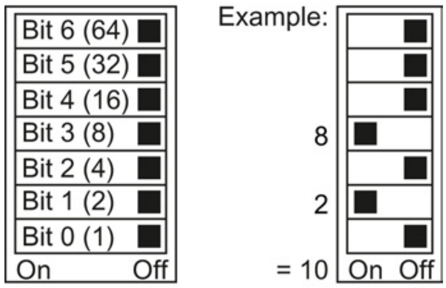
Setting the node ID

You set the node ID of the inverter using the address switches on the Control Unit, using parameter p8620 or in STARTER.

Valid address range: 1 … 127

If you have specified a valid node ID using the address switches, this node ID will always be the one that takes effect, and parameter p8620 (factory setting: 126) will not be able to be changed.

The positions of the address switches are described in Section: CU230P-2 CAN Control Unit (option K99) (Page 95).



Procedure

To change the bus address, proceed as follows:

1. Set the address using one of the subsequently listed options:
   - using the address switches
   - with the IOP using p8620
   - in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list with p8620
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

Setting the data transfer rate

You set the data transfer rate using parameter p8622 or in the STARTER "Control Unit/Communication/CAN" screen form under the "CAN interface" tab.

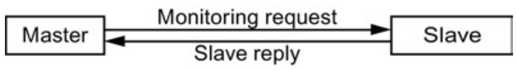
Setting range: 10 kbit/s … 1 Mbit/s (factory setting: 20 kbit/s). The maximum permitted cable length for 1 Mbit/s is 40 m.

In order that a newly set or modified data transfer rate becomes effective, switch on the inverter power supply and, if being used, the 24 V supply for the Control Unit. Switch on the voltages again after all LEDs at the inverter have gone dark.

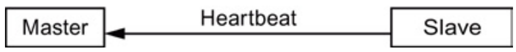
6.9.3.3 Setting the monitoring of the communication

To monitor the communication, use one of the following methods:

- Node guarding / life guarding



- Heartbeat



Node guarding / life guarding

Principle of operation

- Node guarding:
  Is always active if heartbeat is not activated (p8606 = 0). Node guarding means the master sends monitoring queries to the inverter which then answers.

  The inverter does not monitor the communication. Set the responses to a bus failure in the master.
- Life guarding:
  Is active if you use p8604[0] and p8604[1] to set a Life Time ≠ 0.
  Life Guarding means that the inverter monitors the master's monitoring query and reports fault F8700 (A) with fault value 2, if a life guarding protocol (life guarding event) is not received within the lifetime. Set additional responses to a bus failure in the master.

  Calculate value for life time

  Life Time = Guard Time in milliseconds (p8604[0]) x Life Time Factor (p8604[1])

Heartbeat

Principle of operation

The slave periodically sends heartbeat messages. Other slaves and the master can monitor this signal. In the master, set the responses for the case that the heartbeat does not come.

Setting value for heartbeat

Set in p8606 the cycle time for the heartbeat in milliseconds.

Inverter behavior with a bus fault

With a bus fault, the CAN master goes to the "Bus OFF" status. In the inverter set the response via the p8641 parameter. Factory setting: p8641 = 3 (OFF3). When you have resolved the bus fault, you can confirm the fault as follows:

- Via OFF/ON: this enables you to remove the "Bus OFF" state and restart the communication.
- Via DI 2 or directly via p3981: the inverter remains in the "Bus OFF" state. To restart the communication, set p8608[1] = 1.

WARNING

Stopping the motor after a bus fault

If, in the event of a fault, the inverter does not set a bus fault (p8641 = 0), the motor cannot be stopped via the controller.

For this case, wire an additional OFF command via terminals.

To stop the motor via the controller, you must resolve the bus fault and restart the communication via p8608[1] = 1.

6.9.4 Free PDO mapping for example of the actual current value and torque limit

You integrate the actual current value and torque limit into the communication via the free PDO mapping.

The actual current value and the torque setpoint are transferred in TPDO1 and RPDO1, respectively. TPDO1 and RPDO1 have already been specified by the Predefined Connection Set.

Mapping the actual current value (r0068) with TPDO1

Procedure

Proceed as follows to accept the actual current value as send object in the communication:

1. Set the OV index for the actual current value:
   first free OV index from the send data from the "Free objects" 5810 table
2. Map the OV index for the actual current value with PZD2:
   – Set the COB-ID of TPDO1 to "invalid":
     p8720[0] = 800001B2 hex
   – Link the mapping parameter object 2 of TPDO1 (p8730[1]) with the OV index for the actual current value:
     p8730[1] = 58100010 hex (5810 = OV index, 00 = fixed value, 10 ≙ 16-bit value)
   – Set the COB-ID of TPDO1 to "valid":
     p8720[0] = 400001B2 hex

   r8751 shows which object is matched to which PZD:
   PZD2 (r8751[1]) = 5810 (actual current value)
3. Link the PZD send word 2 in the send word (p2051) with the actual current value:
   p2051[1] = r0068[0]

Mapping the torque limit (p1520) with RPDO1

Procedure

Proceed as follows to accept the torque limit value in the communication:

1. Set the OV index for the torque limit:
   first free OV index from the receive data from the "Free objects" 5800 table
2. Map the OV index for the torque limit with PZD2
   – Set the COB-ID of RPDO1 to "invalid":
     p8700[0] = 80000232 hex
   – Link the mapping parameter object 2 of RPDO1 (p8710[1]) with the OV index for the torque limit:
     p8710[1] = 58000010 hex (5800 = OV index, 00 = fixed value, 10 ≙ 16-bit value)
   – Set the COB-ID of RPDO1 to "valid":
     p8700[0] = 40000232 hex

   r8750 shows which object is mapped to which PZD:
   PZD2 (r8750[1]) = 5800 (torque limit)
3. Link the PZD receive word 2 in the receive word (p2050) with the torque limit:
   p2050[1] = p1520[0]

6.10 Operation with the IOP

6.10.1 Overview

6.10.1.1 Introduction

Introduction

The Intelligent Operator Panel (IOP) optimizes the interface and communications options of the SINAMICS inverter.

The IOP is connected to the inverter using an RS 232 interface.

The IOP supports (in conjunction with a PC with USB port) the following functions:

- Download wizards
- Download additional languages
- Download IOP firmware updates

The downloads can be found on the Siemens Service and Support website:

Service & Support website (http://support.automation.siemens.com)

6.10.1.2 Screen icons

Screen symbols

A series of symbols showing different states appears in the upper right area of the IOP display. These symbols are explained in the table below.

Table 6- 34 Screen symbols

Function	State	Symbol	Remark
Command source	Auto		
	JOG	JOG	Displayed when the JOG function is activated.
	Manual		
Inverter state	Ready		
	In operation		Symbol rotates when the motor is running.
Fault pending	Fault		
Alarm pending	Alarm		
Save in the RAM	Active		Specifies that all data is currently saved in the RAM. If the power supply is interrupted, all data will be lost.
PID autotuning	Active		
Hibernation mode	Active		Energy-saving mode.
Write protection	Active		Parameters cannot be changed.
Know-how protection	Active		Parameters cannot be displayed or changed.
ESM	Active		Essential Service Mode (emergency operation).

Function	State	Symbol	Remark
Battery state	Fully charged		The battery state is displayed only when the IOP hand-held unit is used.
	¾ charged		
	½ charged		
	¼ charged		
	Not charged		
	Being changed		

6.10.1.3 Menu structure

Menu structure

The IOP is a menu-driven device and has the following menu structure:

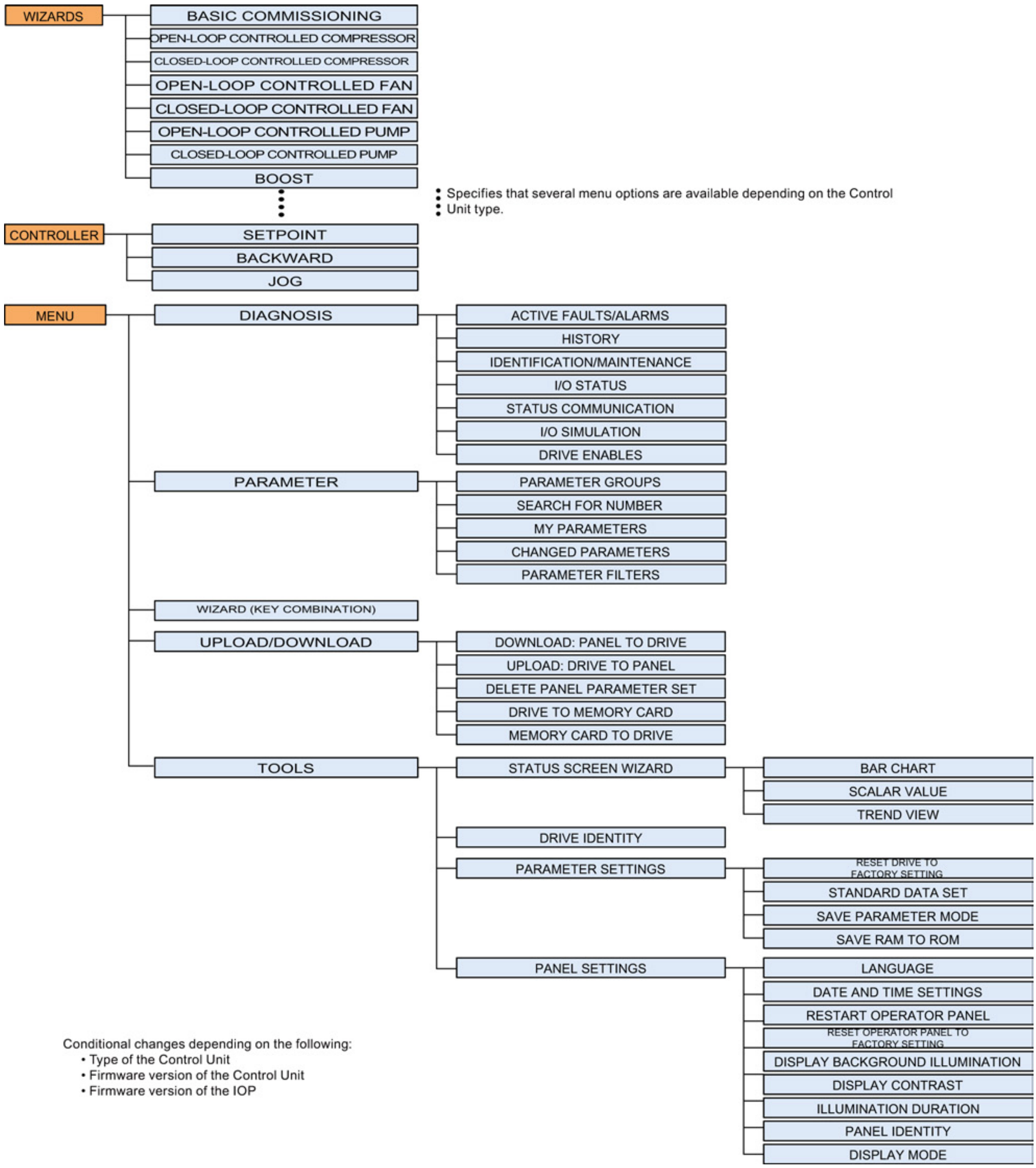


Figure 6-28 IOP menu structure

6.10.2 Wizards

Wizards

Various wizards are available for the function definition and the commissioning of the inverter. The various wizard types are listed below:

- Basic commissioning
- Open-loop controlled compressor
- Closed-loop controlled compressor
- Open-loop controlled fan
- Closed-loop controlled fan
- Fan activation via PID
- Open-loop controlled pump
- Closed-loop controlled pump
- Boost
- PID wizard

The various wizards are described briefly below; the appropriate circuit diagrams can be found in Wiring diagrams (Page 301).

Note

Wizards

The actual menu structure and the function scope of the IOP depend on the following factors:

- Software version and type of the Control Unit to which the IOP is connected
- Firmware and software version of the IOP

NOTICE
Data sets
The wizards use the standard data sets (DDS0 and CDS0). If other available data sets are used rather than these standard data sets, the wizards may possibly not function correctly.

Calling the IOP wizards

The wizards are called in the "Wizards" menu in the lower area of the "Status" screen.

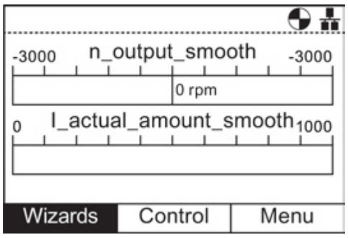


Figure 6-29 Status screen – "Wizard" menu marked

Prerequisites

Note

Restoring the factory setting

Every wizard provides an option that allows you to restore the factory settings. It is recommended to accept this option.

Before the IOP application wizards are used, the following must be ensured:

- All required units are available and have been installed correctly in accordance with the circuit diagram of the associated application wizard.
- The inverter, motor and the other units of the application have been wired in accordance with the circuit diagrams (refer to the appropriate section of this manual).
- All components of the system have been checked for their correctness and proper installation.

Required information for the wizards

The IOP wizards require during the setting task detailed technical information that must always be available. The following information is available:

- **Motor data** – this data is contained on the motor type plate (see figure below).
- **Sensor data** – details for the sensor types that can be used for the inverter, e.g. temperature and pressure sensors. The required information can normally be find on the sensor type plate.

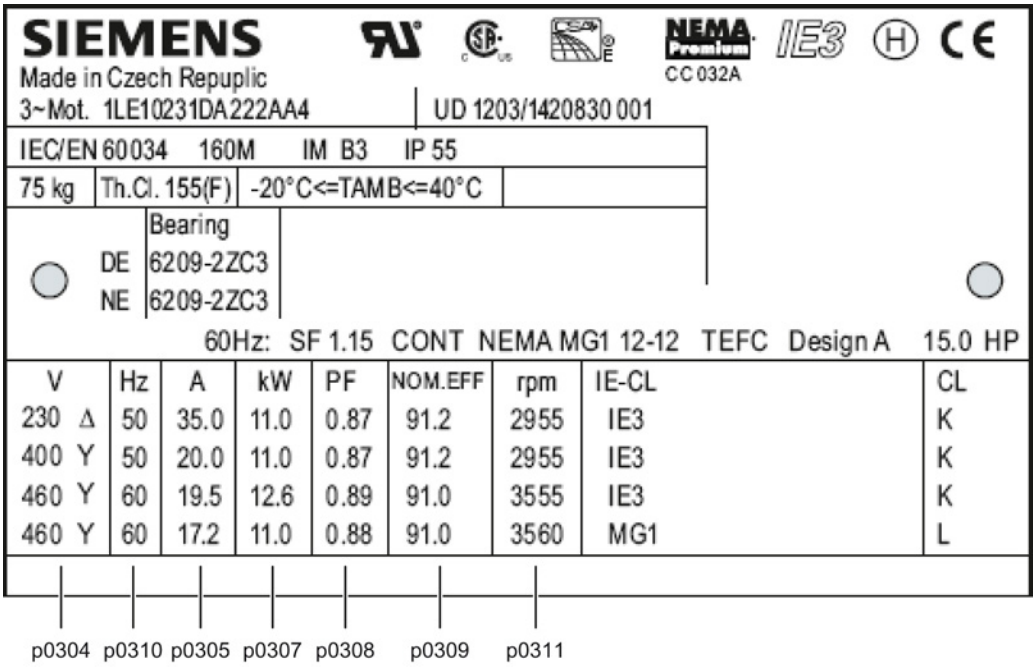


Figure 6-30 Example of a motor type plate

Basic commissioning

The basic commissioning of the inverter and motor includes the following processes:

- Selection of the closed-loop control type
- Selection of the motor type and input of the motor data
- Input of the data for the ramp-function generator
- Selection of the sensor for the motor temperature
- Calculation of the motor and closed-loop control data

The wizard prompts the user through the basic commissioning and displays various associated screens in which the options and values required for the commissioning can be set. The data in the inverter can be saved after completion of the basic commissioning.

Open-loop controlled compressor

The inverter regulates the output pressure of a compressor in accordance with the varying gas volumes to be compressed.

To compress the gas, the volume is reduced and the pressure in the container is increased.

The setpoint is specified using the analog inputs.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Compressor
- Motor temperature sensor (optional)

Closed-loop controlled compressor

A constant pressure must be maintained in a system with minimum energy consumption.

The system pressure is monitored by the PID closed-loop controller. When the pressure remains constant, the inverter operates the system with minimum frequency.

The setpoints are specified using analog input 0.

The actual value of the system is received using analog input 1 of the pressure sensor. The inverter uses this actual value in order to respond to changes of the system pressure.

The ON/OFF and reset commands are controlled using digital input 0 or 1.

The general monitoring of the inverter state is performed using digital output 0 (inverter fault), 1 (inverter ready) and 2 (inverter running).

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Compressor
- Pressure sensor
- Motor temperature sensor (optional)

Open-loop controlled fan

This is a basic fan application in which the fan is controlled by the inverter.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Fan
- Belt monitoring sensor (optional)
- Motor temperature sensor (optional)

Closed-loop controlled fan

For this application, a constant air flow within a ventilation system should be maintained while consuming as little energy as possible.

A fixed air flow and pressure for the fan system are specified in the inverter. These values are monitored directly by the PID closed-loop controller. The inverter modifies the fan speed appropriately when the pressure changes.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Fan
- Actual value encoder
- Motor temperature sensor (optional)

Fan activation via PID

This application is used to operate several parallel-switched fans depending on the actual air flow requirements.

One fan is controlled and monitored directly with the other fans being switched on and off as required. A feedback from these other fans is not required. The monitoring is done using pressure sensors together with the PID closed-loop controller.

The analog inputs are used to set the setpoint and to receive the feedbacks from the various sensors to which the PID closed-loop controller then responds. The digital outputs are used to control the fans.

When switched on, each fan runs with minimum frequency. This achieves a consistent increase of the pressure and the air flow without producing an overpressure in the system.

Because all fans can be switched on and off by the inverter, the fans can be used with different frequencies. This ensures that no fan runs continually and the workload is distributed equally.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Several fans
- Pressure sensors
- Temperature sensor (optional)

Open-loop controlled pump

For this application, a constant liquid level should be maintained in a pump system. If liquid is removed from the system, refilling is made to a specified level.

The frequency setpoint is specified using the analog input.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Pump
- Motor temperature sensor (optional)
- Filling level sensor (dry-run protection – optional)

Closed-loop controlled pump

The closed-loop control can be used to directly monitor the liquid level in a tank using the PID closed-loop control function.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Pump
- Actual value encoder
- Filling level sensor (dry-run protection – optional)
- Motor temperature sensor (optional)

Boost

At low output frequencies, V/f characteristic curve control achieves only a low output voltage. This means that the output voltage can be too low to:

- Magnetize an induction motor
- Maintain the load
- Compensate for losses in the system
- Generate a tensioning, acceleration or braking torque

The boost function can be used to increase (boost) the output voltage of the inverter.

The "boost" wizard prompts the user though the correct setting of the boost function.

PID closed-loop controller

In industrial applications, closed-loop control is deployed in many processes. A simple closed-loop control is based on an actual value signal of the process (e.g. temperature, pressure or speed) and a predefined value or setpoint. The closed-loop control system compares these two values from which it derives a planned-actual difference. This planned-actual difference is used to regulate the inverter and the motor so that the difference is reduced.

System delays can make the processing of the planned-actual difference very complex. The planned-actual difference is processed by a PID closed-loop controller (proportional, integral, differential) whose parameters can be adapted to achieve an optimum system performance and stability.

The "PID closed-loop controller" wizard prompts the user though the PID setup process.

Pump staging with PID

This application is used to operate several parallel-switched pumps depending on the required water requirement. This allows the system to respond to the requirements in real-time with minimum hardware effort.

Several pumps are operated in parallel with a water supply system. One of the pumps is controlled directly by the inverter. The other pumps operate at a fixed speed as required.

The system consists of the following components:

- Control Unit
- Power Module
- Motor
- Geared motor
- Pumps
- Pressure sensor
- Flow sensor
- Filling level sensor
- Temperature sensor (optional)

6.10.2.1 Wiring diagrams

Overview

Because the IOP wizards prompt the user through the setting and commissioning of applications, a certain technical competency, qualification and practical experience of the user is assumed.

The user must be a qualified and experienced drive technician because the commissioning of an application requires comprehensive knowledge.

The technician must also be familiar with all technologies and protocols of the following components/elements:

- PLC - setting, programming and communication
- Inverter - setup, wiring and commissioning
- All relevant international and local safety regulations

The provided information applies to the wiring of the application (inverter inputs/outputs and communications connections).

Prerequisites

Before the IOP wizards are used, the following must be ensured:

- All required units are available and have been installed correctly in accordance with the relevant circuit diagram of the associated application wizard.
- The inverter, motor and the other units of the application have been wired in accordance with the attached circuit diagrams.
- All required information (e.g. motor type data) is available.
- All components of the system have been checked for their correctness and proper installation.

Information about the IOP wizards

The IOP shows the user a menu system in which the appropriate wizard for the associated application can be selected. A list with application-specific questions is displayed on completion. Questions concerning the ports, inputs/outputs and their functions can be answered using the circuit diagrams.

This section shows an appropriate circuit diagram for each application.

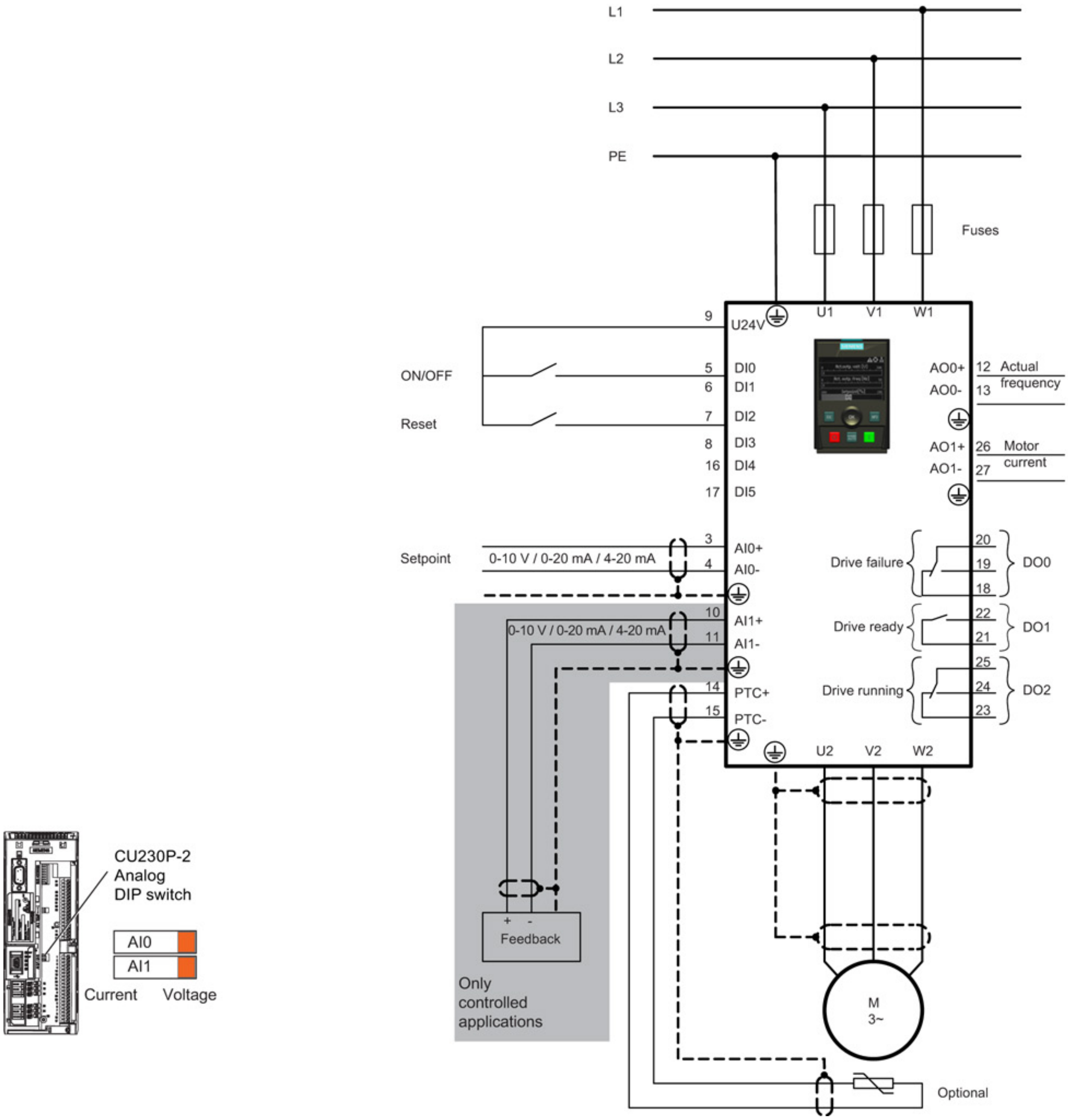


Figure 6-31 "Compressor" circuit diagram

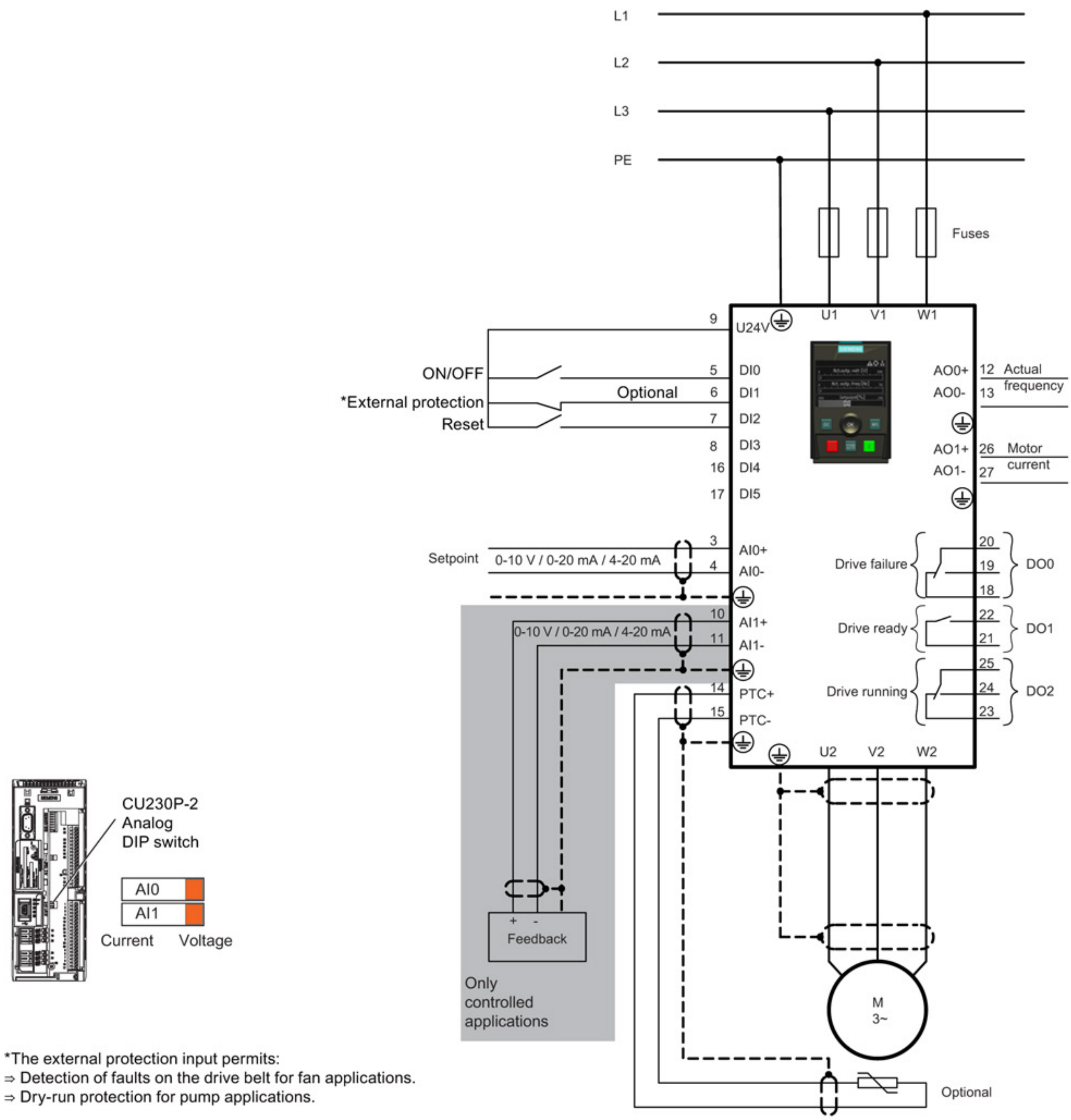
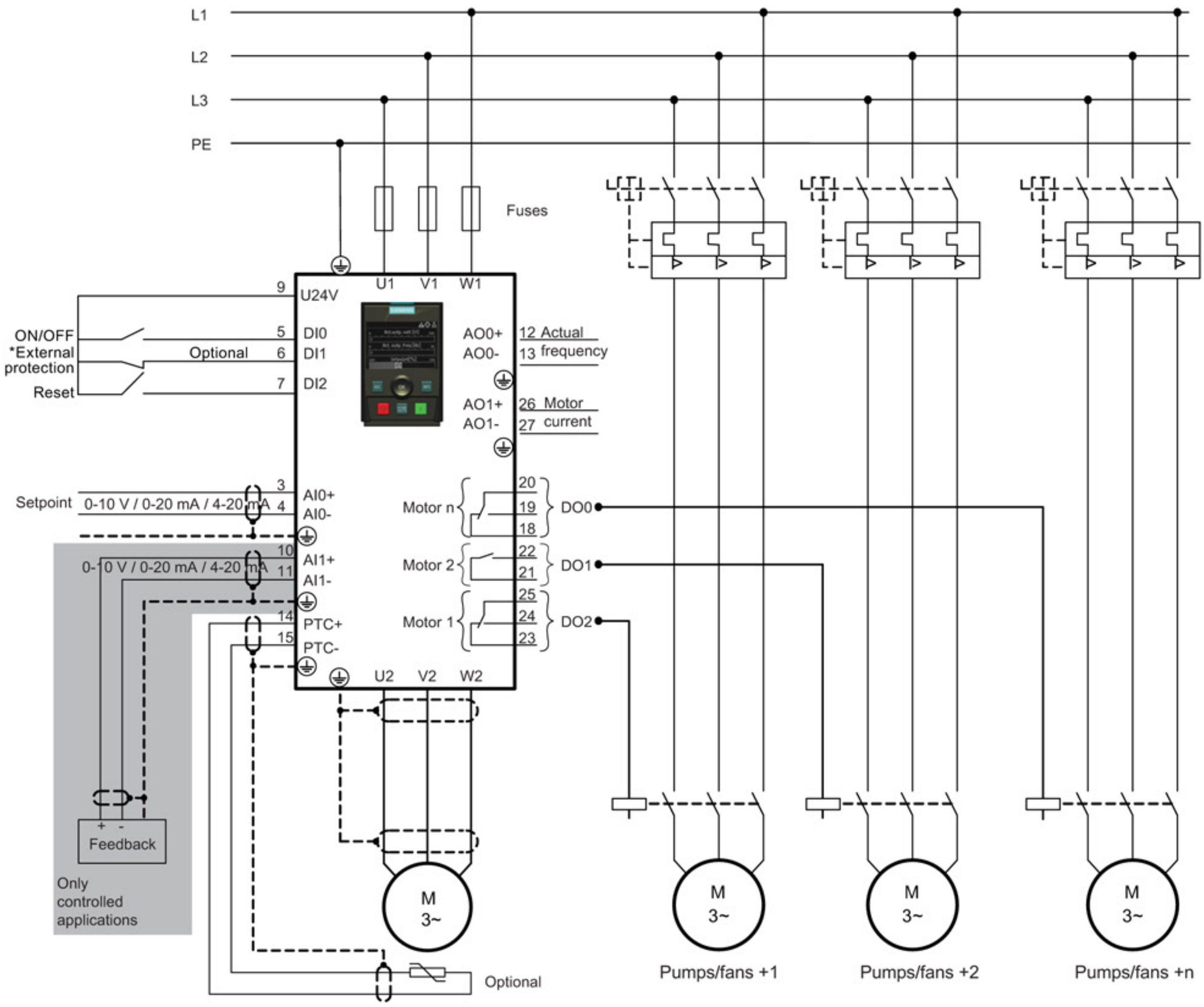


Figure 6-32 "Pumps and fans" circuit diagram



*The external protection input permits:
⇒ Detection of faults on the drive belt for fan applications.
⇒ Dry-run protection for pump applications.

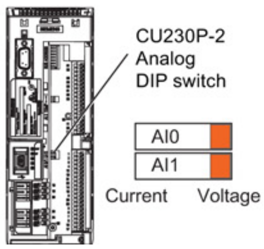


Figure 6-33 "Pump and fan staging" circuit diagram

6.10.3 Control

Overview

The following settings can be changed online in the "Control" menu:

- Setpoint
- Backward
- Jog

The "Control" menu is accessed using the center button in the lower area of the "Status" screen.

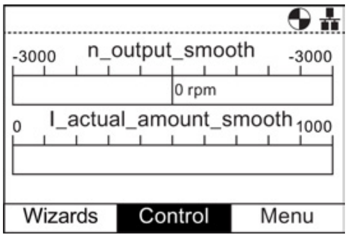


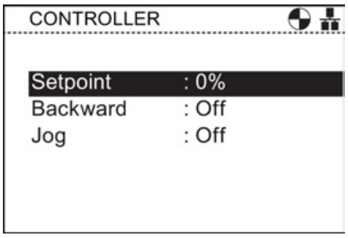
Figure 6-34 Status screen – "Control" menu marked

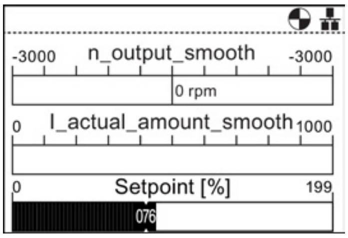
Setpoint

The setpoint is used to specify the motor speed as percentage of the complete speed range.

To change the setpoint, proceed as follows:

1. Turn the **navigation wheel** and select "**Control**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Control**" screen appears.
4. The "**setpoint**" entry is already selected.
5. Press the **navigation wheel** to select the "**setpoint**" entry.
6. The "**Setpoint**" screen appears.
7. Turn the **navigation wheel** to change the setpoint.
8. Confirm the new setpoint by pressing the **navigation wheel**. The setpoint is also changed when you press the "**Esc**" key.
9. The "**Control**" screen appears.
10. Press the "**Esc**" key to return to the "**Status**" screen.





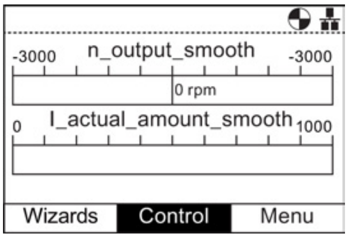
The setpoint can be changed using the IOP only when the inverter runs in MANUAL operation. The setpoint is reset when a switch is made from MANUAL mode back to AUTO mode.

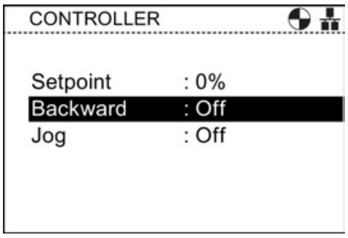
Backward

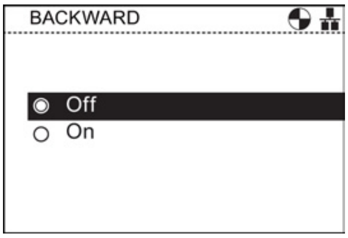
The Backward command changes the rotational direction of the motor from forward to backward.

Proceed as follows to reverse the rotational direction of the motor:

1. Turn the **navigation wheel** and select "**Control**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Control**" screen appears.
4. Turn the **navigation wheel** and select "**Backward**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Backward**" screen appears.
7. Turn the **navigation wheel** and select "**On**" or "**Off**".
8. Confirm the selection by pressing the **navigation wheel**.
9. The IOP returns to the "**Control**" screen.
10. Press the "**Esc**" key to return to the "**Status**" screen.





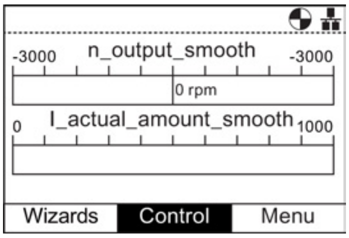


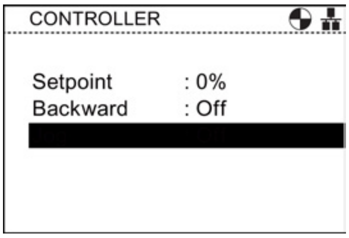
Jogging

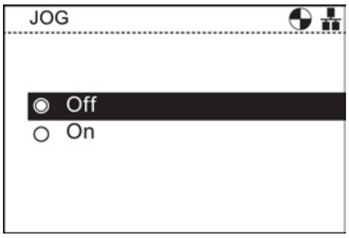
If the JOG function is activated, the motor is brought manually to a specified speed when the key is pressed. If the is held pressed, the motor turns until the key is released again.

Proceed as follows to activate or deactivate the JOG function:

1. Turn the **navigation wheel** and select "**Control**".
2. Confirm the selection by pressing the **navigation wheel**.
3. The "**Control**" screen appears.
4. Turn the **navigation wheel** and select "**Jog**".
5. Confirm the selection by pressing the **navigation wheel**.
6. The "**Jog**" screen appears.
7. Turn the **navigation wheel** and select "**On**" or "**Off**".
8. Confirm the selection by pressing the **navigation wheel**.
9. The IOP returns to the "**Control**" screen.
10. Press the "**Esc**" key to return to the "**Status**" screen.







Note

Selection of the jog speeds

The jog parameters p1058 (jog speed 1) and p1059 (jog speed 2) must be set to the appropriate speeds. The default jog speeds are 150 rpm and -150 rpm.

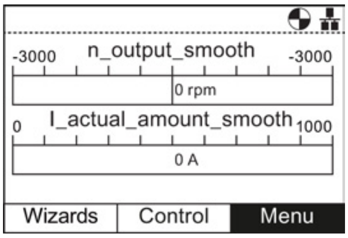
Once jog speed 1 and jog speed 2 have been set, pressing the "INFO" key for a longer time switches between the two jog speeds.

6.10.4 Menu

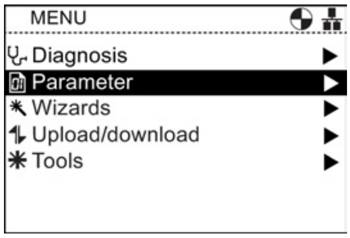
6.10.4.1 Overview

Overview

The "Menu" screen is selected from the three menu options in the lower area of the IOP screen. If the menu options are not displayed, press the navigation wheel once to display them.



Menu selection



Menu screen

If the "Menu" option is selected, the following functions are displayed:

- Diagnosis
- Parameters
- Wizards
- Upload/download
- Tools

Mark the desired function by turning the navigation wheel. Press the navigation wheel to confirm the selection. Further submenus will be displayed. Press the "**Esc**" key briefly to return to the previous screen. If the key is pressed for a longer time, the "Status" screen will be displayed.

Note

IOP function support

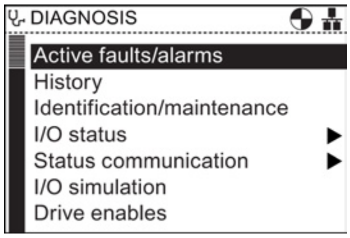
The actual menu structure and the function scope of the IOP depend on the following factors:

- Software version and type of the Control Unit to which the IOP is connected
- Firmware and software version of the IOP
- Selected function group filtering of the parameters

6.10.4.2 Diagnostics

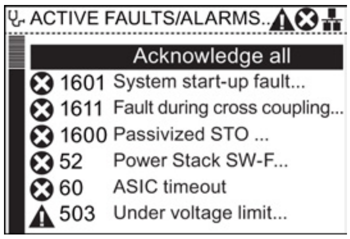
"Diagnosis" menu

If the "Diagnosis" function is selected, the following options are displayed:



- Active faults/alarms (failures and warnings)
- History
- Identification/maintenance
- I/O status
- Status communication
- I/O simulation
- Drive enables

Active faults/alarms

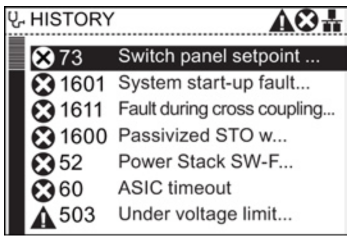


If this option is selected, all active faults/alarms that have not yet been confirmed will be displayed.

The individual faults and alarms can be selected. When the **INFO** or **OK** key is pressed, an explanation of the relevant fault or alarm is displayed.

If the **INFO**, **OK** or **Esc** key is pressed again, the list of faults or alarms is displayed.

History



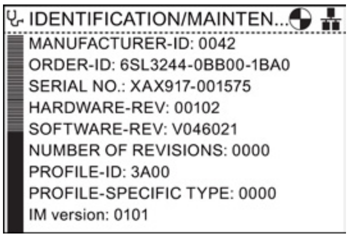
When this option is selected, a list of all previous faults and alarms as well as the associated time of occurrence is displayed.

The individual faults and alarms can be selected. When the **INFO** or **OK** key is pressed, an explanation of the relevant fault or alarm is displayed.

If the **INFO**, **OK** or **Esc** key is pressed again, the list of faults or alarms is displayed.

Identification/maintenance

When this option is selected, technical information about the Control Unit and the Power Module to which the IOP is connected is displayed. The actual displayed information depends on the associated Control Unit and Power Module.



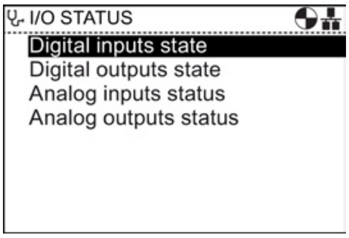
I/O status

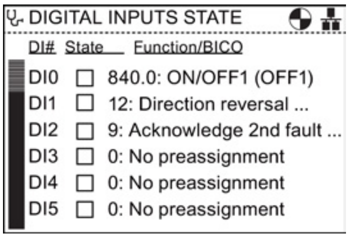
When this option is selected, a list of the digital and analog inputs and outputs of the inverter as well as their current status is displayed.

This is only an information screen in which no changes can be made.

Pressing the **Esc** key displays the previous menu again.

In the example shown on the right-hand side, the status of the digital inputs is displayed.

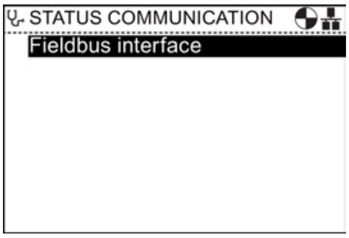


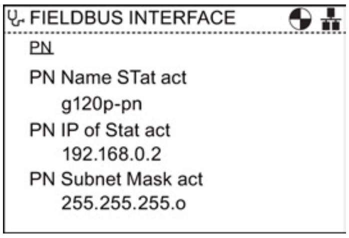


Status communication

When this option is selected, the status of the fieldbus interface as well as details for the data transfer settings (e.g. length of the status and control words) are displayed.

In the example shown on the right-hand side, the status of the PROFINET fieldbus interface is displayed.





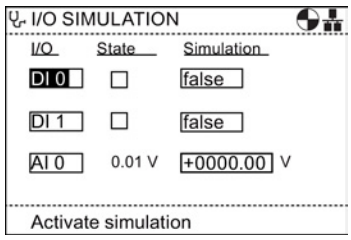
I/O simulation

WARNING

Loss of the inverter control

If the inverter is started via the I/O simulation and the IOP of the inverter is removed, the inverter, and thus the motor, cannot be stopped. When I/O simulation is active, the inverter can only be stopped via this simulation.

Digital and analog inputs/outputs without external signals can be simulated in the "I/O simulation" screen. This function is extremely useful, especially during commissioning and troubleshooting since any situation can be simulated without wiring, tools or external devices.



Example:

- A digital input can be set without requiring terminal wiring to "High".
- An analog input or output can be set to any value without requiring terminal wiring.
- A digital output can be set to "High".

This screen offers the following options:

- I/O – three I/Os can be simulated (two digital I/Os and one analog I/O).
- State – the state of the input or output is displayed in real time. If the square is displayed dark, the input or output signal is available. No changes can be made in this screen area.
- Simulation – the current state of the input or output is displayed in this screen area. These states can be changed.

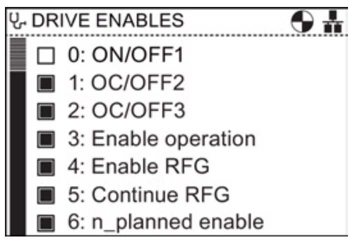
Proceed as follows to perform an I/O simulation:

1. Turn the **navigation wheel** until the desired digital input or output is displayed in the first field.
2. Press **OK**.
3. The appropriate control field is marked.
4. Turn the **navigation wheel** until the desired control signal is displayed.
5. Press **OK**.
6. Repeat this action until all fields contain the desired settings.
7. The "**Activate simulation**" entry is then marked.
8. Press **OK**. The simulation starts.
9. "**Deactivate simulation**" is marked while the simulation is running – press **OK** to stop the simulation.

Drive enables

The "Drive enables" screen shows a list of all current enable signals of the inverter. If the enable signal is present and active, it will be selected ■. If the enable signal is not present and not active, the selection will be removed □.

This is only an information screen in which no changes can be made.



6.10.4.3 Parameters

"Parameters" menu

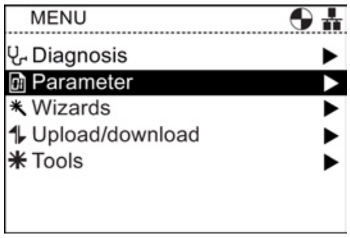
Note

IOP function support

- The actual menu structure and the function scope of the IOP depend on the following factors:
  - Software version and type of the Control Unit to which the IOP is connected
  - Firmware and software version of the IOP
  - Selected function group filtering of the parameters
- When parameters or search values are changed, it is possible to change individual digits or the complete value. Pressing the **navigation wheel** for a longer time (> 3 seconds) switches between the two different change modes.

The "Parameters" menu gives the user access to all inverter parameters and so associated comprehensive functions. When this option is selected, parameter-based functions are performed. These are grouped as follows:

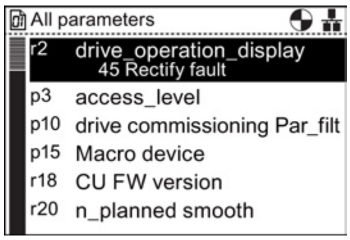
- Parameter groups
- Search for number
- My parameters
- Changed parameters
- Parameter filter



Parameter groups

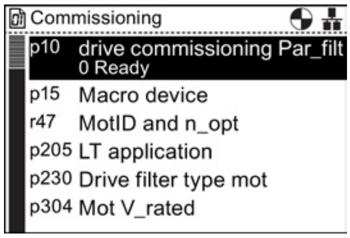
All parameters

This option gives the user access to the individual inverter parameters. The default filter setting is "Standard". This gives the user access to the most frequently used parameters. The standard filter settings can be changed in the Parameters menu with "Parameter filter" under the "Parameter settings" option in the "Tools" menu.



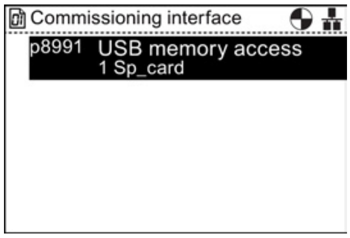
Commissioning

This screen shows a complete list of all parameters required for the commissioning. The parameters are listed in numeric sequence. Set values can be confirmed or changed (e.g. for the fine configuration of the application or to correct false parameter values).



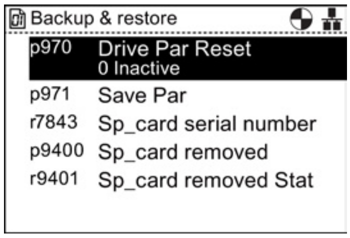
Commissioning interface

This screen shows the parameters relevant for commissioning the commissioning interface. The parameters are listed in numeric sequence. Set values can be confirmed or changed (e.g. for the fine configuration of the application or to correct false parameter values).



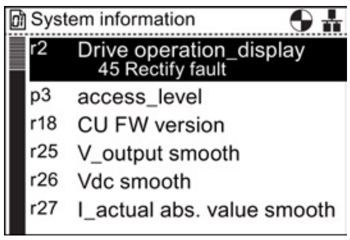
Backup and restore

This option gives the user access to all parameters relevant for the backup and restore functions of the inverter. Each current parameter value is displayed. It can be changed.



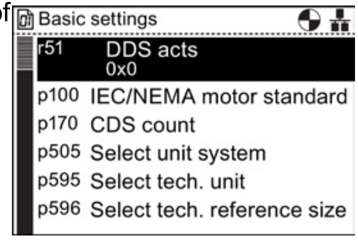
System information

This screen shows all parameters that contain system information of the inverter. Most of these parameters are displayed only as information and cannot be changed.



Basic settings

This screen shows all parameters that contain base settings of the inverter. These include, for example, parameters for data sets and unit systems.

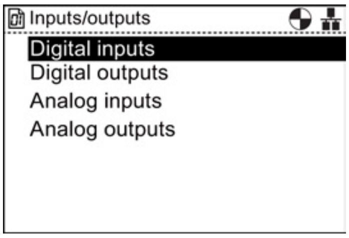


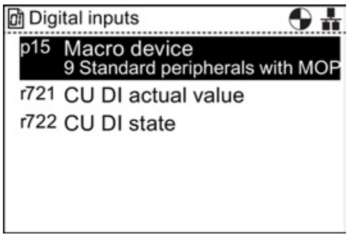
Inputs/outputs

This option gives the user access to all parameters required for configuring the following signals:

- Digital inputs
- Digital outputs
- Analog inputs
- Analog outputs

The user can navigate through the various inputs/outputs and display their current configuration. If required, the parameter values can also be changed directly. In the example shown on the right-hand side, the parameters of the digital inputs are displayed.

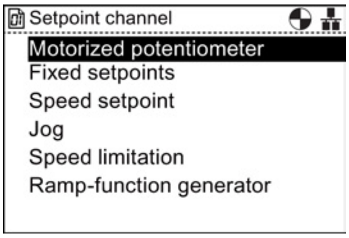




Setpoint channel

The user can use this option to display and change the following setpoint parameters:

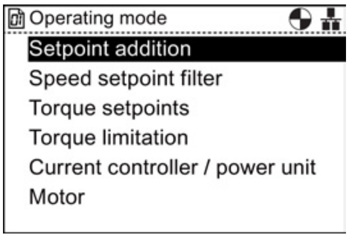
- Motorized potentiometer
- Fixed setpoints
- Speed setpoint
- Jog
- Speed limitation
- Ramp-function generator



Operating mode

This option gives the user direct access to the parameters for the following modes:

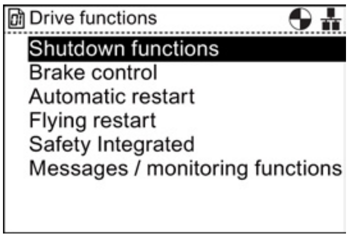
- Setpoint addition
- Speed setpoint filter
- Torque setpoints
- Torque limitation
- Current controller / power unit
- Motor



Drive functions

This option gives the user direct access to the parameters for the following drive functions:

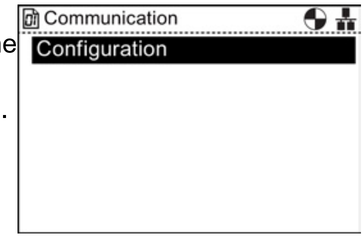
- Shutdown functions
- Brake control
- Automatic restart
- Flying restart
- Safety Integrated
- Messages / monitoring functions

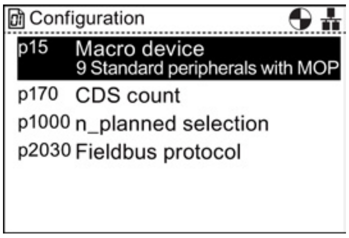


Before parameters with reference to the functions listed above can be changed, the inverter/motor system must be in a safe state.

Communication

This option gives the user direct access to the control and configuration parameters for the fieldbus communication of the inverter. The parameters can be displayed for confirmation of their settings and values, and in specific cases, also changed.



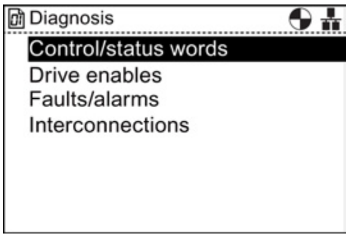


Diagnosis

This option gives the user direct access to the parameters for the system status monitoring. Parameters are subdivided into the following function groups:

- Control/status words
- Drive enables
- Interconnections
- Faults/alarms

All parameters in these groups can only be displayed but not changed.

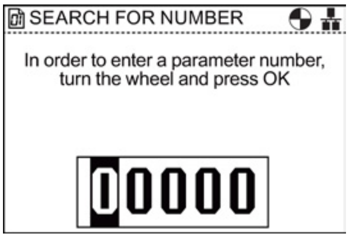


Search for number

The user can use this option to search for specific parameter numbers. If the entered parameter number does not exist, the parameter whose number is nearest to the entered number is displayed.

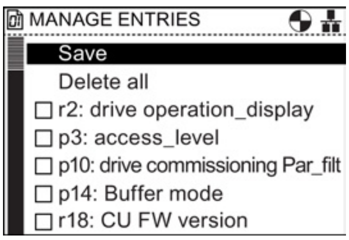
Turn the **navigation wheel** to change the individual digit values; turn the **navigation wheel** to confirm the selection. The next digit is selected automatically. Repeat the process as described above. Once all fields have been completed, the IOP shows the parameter. If you have selected a wrong number, press **Esc** to go back one position.

If the parameter number does not exist, the screen allows a choice between "Select new number" and "Go to the next parameter number".



My parameters

The user can use this option to select the parameters to be listed. A list with all selectable parameters that specify those parameters to be displayed with the "My parameters" option is displayed. There are further options used to manage this parameter list.

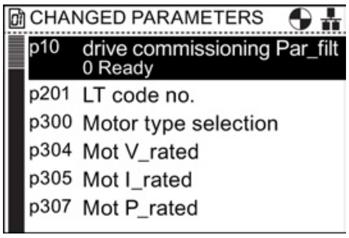


Changed parameters

When the "Changed parameters" option is selected, the IOP searches the list of the inverter parameters for those parameters whose settings differ from the factory settings.

When the search completes, a list of the parameters with their changed values is displayed on the screen.

The individual parameters can be fetched in order to display and possibly change their values.



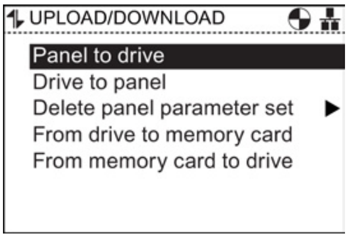
6.10.4.4 Up/Download

Overview

The upload/download options allow the user to save parameter sets in the various available system memories.

The following options are available:

- Panel to drive
- Drive to panel
- Delete panel parameter set
- From drive to memory card
- From memory card to drive



WARNING

Unexpected inverter behavior

During the data transfer to and from the inverter, the process must not be interrupted and the transfer must be allowed to finish, otherwise the data may be damaged and an unexpected system behavior can result. If the transfer process is interrupted, we recommend that the inverter is reset to the factory settings before it is further parameterized or assumes control of the application.

Fault display during the upload/download

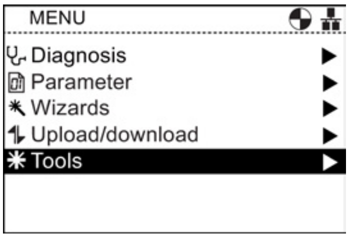
If a fault occurs during the upload/download process and a fault display appears, press **Esc** to continue the upload/download process. Pressing OK aborts the upload/download process.

6.10.4.5 Extras

Overview

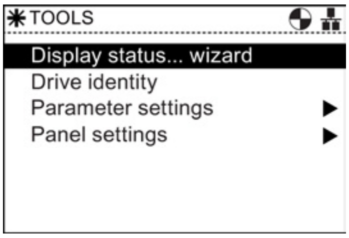
The following options for configuring the IOP are available in the "Tools" menu:

- Display status wizard
- Drive identity
- Parameter settings
- Panel settings



"Display status" wizard

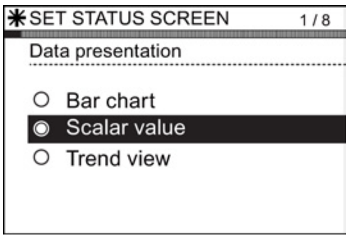
This wizard supports the user for configuring the information displayed in the screen. By default, the output voltage and speed of the inverter are displayed. The wizard can be used to display other physical values of the inverter. Known conversion factors and offset values can be used to match the displayed dimension units to the associated requirements.



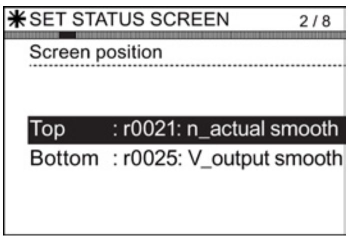
Scalar value

The bar chart (status screen) and the scalar value are defined using a similar process. The following example shows how the status screen is defined for the scalar value.

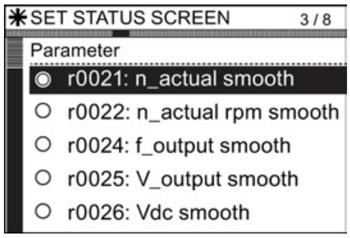
1. In the "Set status screen" menu, select the "Scalar value" option.



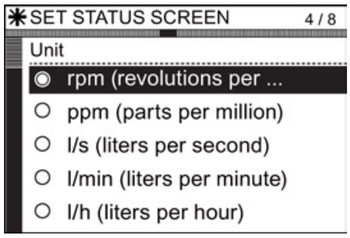
2. Select the screen position of the displayed values.



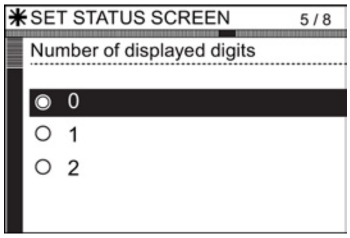
3. Select the parameter values to be displayed on the status screen.



4. Select the required dimension units to be displayed on the status screen.

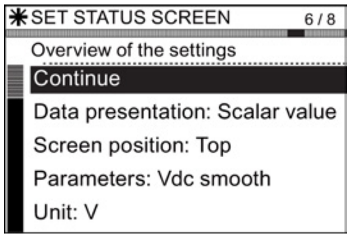


5. Select the required number of decimal places to be displayed on the status screen.



6. A summary of the settings is displayed when the user selection is completed.

   If the settings are correct, select "Continue" to continue with the next step.

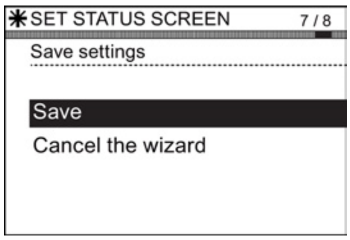


7. The option to save the settings is displayed.

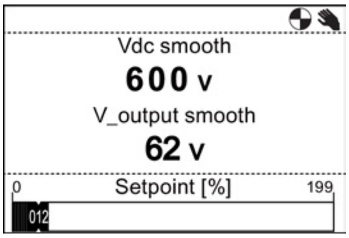
   Select "Save" to save the settings or "Abort wizard" to terminate the wizard.

   If "Abort wizard" is selected, no changes are saved and the status screen remains configured as previously.

   If "Save" is selected, all changes will be saved.



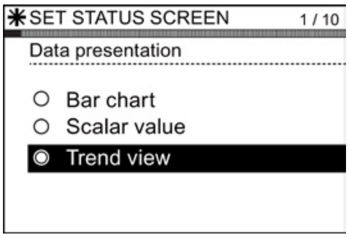
8. When the save process completes successfully, the screen returns automatically to the new status screen as configured in the wizard.



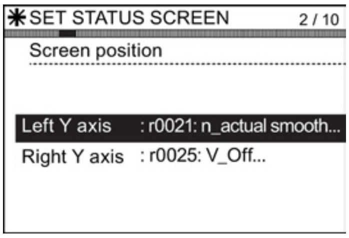
Trend view

The user can configure the real-time monitoring of the inverter and display the desired values as a diagram in the trend view. To define the trend view, perform the following steps:

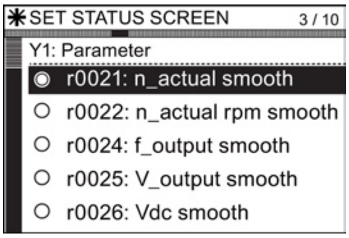
1. In the "Set status screen" menu, select the "Trend view" option.



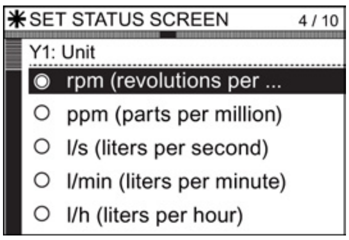
2. Select the screen position of the displayed values.



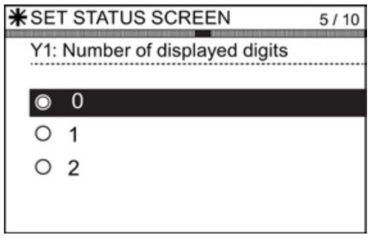
3. Select the parameter values to be displayed on the status screen.



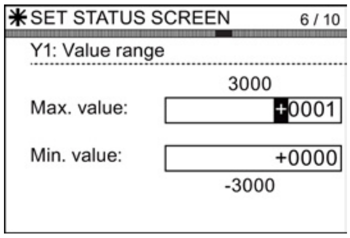
4. Select the dimension unit to be displayed on the status screen.



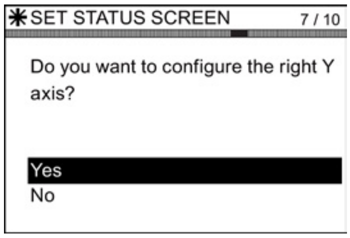
5. Select the number of decimal places to be displayed on the status screen.



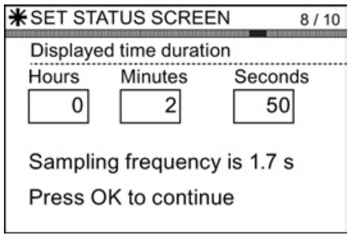
6. Determine the value range of the Y1 axis.



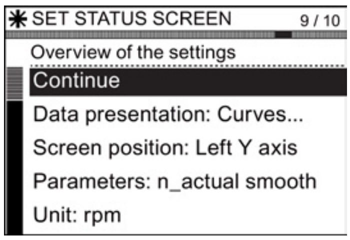
7. If required, the other axis (right Y axis) can be configured.



8. Specify the desired time interval for the displayed trend view.

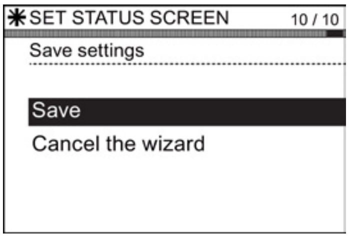


9. A summary of the settings is displayed. If they are correct, select "Continue".

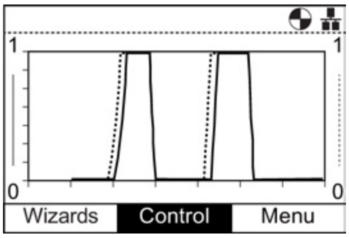


10. Select "Save" to save the settings or "Abort wizard" to terminate the wizard.

    If "Abort wizard" is selected, all changes are discarded and the status screen is reset to the most recently configured settings.



When the save process completes successfully, the screen returns automatically to the new status screen.



Pressing the **INFO** key longer, writes the diagram data in a curve information file on the IOP. The following figure shows an example of the curve information file and its storage location.

```
Trend Information
---------------------
Template:
Axis:Param Number<index>:<bit>:Param Name

Left axis (Y1): r0021     : - : n_act smooth
Right axis(Y2): r0025     : - : U_outp smooth

Time period: 150 Secs.
Sample rate: 1.5 Secs.

Sample     Y1(Hz)          Y2(V)
-----------------------------------
  1          0.000        17.920
  2          0.000        20.233
  3          0.000        20.234
  4          0.954        27.541
  5          3.240        43.577
  6          3.497        44.495
  7          5.325        58.811
  8          6.497        65.728
  9          4.832        50.322
 10          0.000        20.143
 11          0.000        20.240
 12          0.000        20.240
 13          3.046        42.973
 14          6.772        70.384
 15         10.342        94.288
 16         13.492       116.783
 17         13.998       120.530
 18         13.998       120.532
 19         13.998       120.533
 20         13.998       120.535
 21          9.169        82.063
 22          0.000         0.000
 23          0.000         0.0
 24          0.000
```

To access the Trend Information file, select the following directory on the IOP:

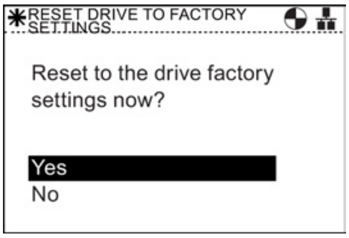
/efs/health/TrendSample.txt

Figure 6-35 Curve information file

Parameter settings

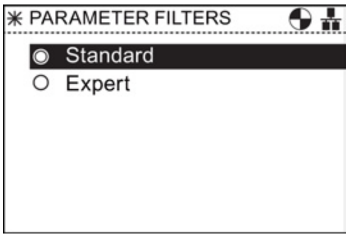
Reset drive to the factory setting

This option allows the user to reset the inverter to the factory settings.



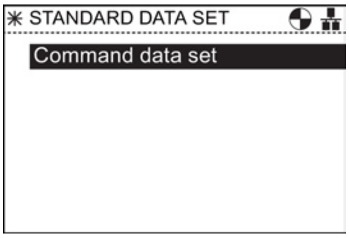
Parameter filter

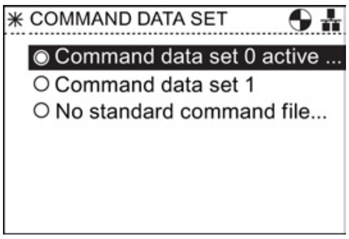
The user can use this option to select the parameters to be listed. The default setting is "Standard". This gives the user access to the most frequently used parameters. The selection of the "Expert" access level allows access to all available parameters.



Standard data set

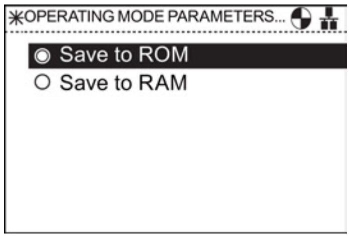
This option allows the user to specify the standard command data set used to display or select a new standard data set from the available options.





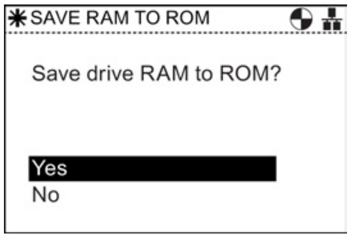
Save Parameter mode

This option allows the user to specify the standard storage location for all storage functions performed on the inverter.



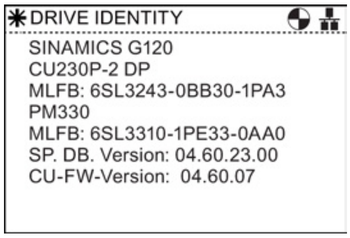
Save RAM to ROM

This option allows the user to manually transfer all drive data from the internal memory of the inverter to the internal non-volatile memory so that the data remains stored on the inverter until it is overwritten.



Drive identity

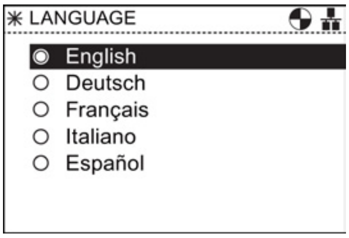
This option can be used to display the technical data of the components that belong to the inverter system. This also includes the data of the Control Unit and the Power Module. This is an information screen in which no changes can be made.



Panel settings

Language

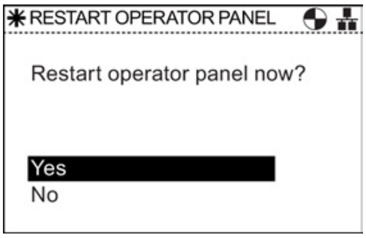
The user can use this option to select the language used to display the information and text of the IOP. This option has already been explained in more detail in the "Initial setting" section. A PC with USB port can be used to add additional languages to or delete languages from the IOP.



For more information about selecting this function, refer to Initial setting (Page 153).

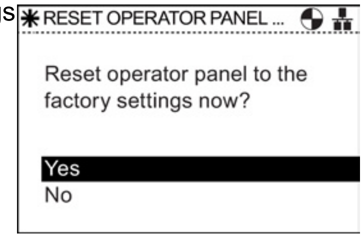
Restart operator panel

This option permits a restart of the IOP without losing the settings.



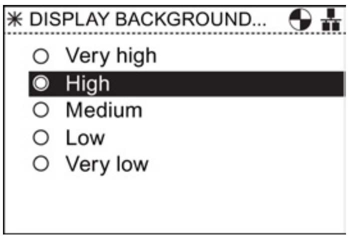
Reset operator panel to the factory setting

This option resets the IOP to the factory settings. All settings stored previously on the IOP are lost. The parameter sets stored on the IOP are not deleted.



Display background illumination

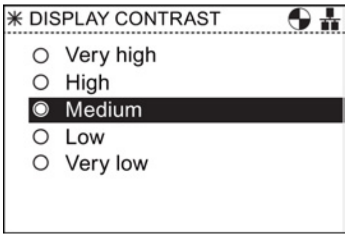
The user can use this option to set the brightness of the display background illumination.



For more information about selecting this function, refer to Initial setting (Page 153).

Display contrast

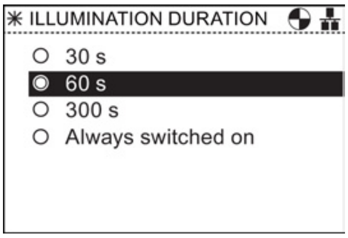
The user can use this option to set the black-white contrast of the display.



For more information about selecting this function, refer to Initial setting (Page 153).

Illumination duration

By default, the display background illumination is switched off automatically 60 seconds after the last pressing of a key. This setting can be changed to 30 seconds, 60 seconds, 300 seconds or continuous illumination.

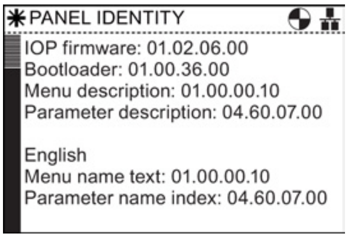


For more information about selecting this function, refer to Initial setting (Page 153).

Panel identity

This screen shows the following technical information about the IOP:

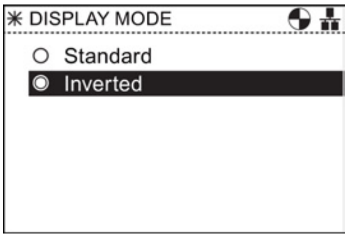
- Version of the IOP firmware
- Version of the menu description
- Version of the parameter description
- Text version of the menu names
- Index version of the parameter names
- Version of the wizard description



Display mode

The display mode allows the user to select how text is displayed.

- "Normal" causes black text to be displayed on a white background.
- "Inverse" causes white text to be displayed on a black background.



For more information about selecting this function, refer to Initial setting (Page 153).

6.10.4.6 Write Protection

Introduction

The write protection function is provided to prevent inadvertent changes of the settings on the inverter. No password is required for activating the write protection function.

A list of the adjustable parameters that can be changed in spite of activated write protection can be found in the List Manual.

The list has the designation "WRITE_NO_LOCK".

Note

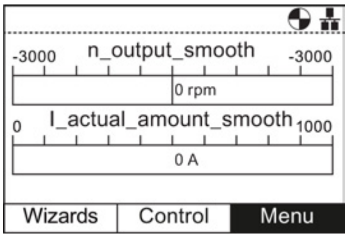
Fieldbus communication using CAN, BACnet and MODBUS

When these fieldbus communication protocols are used, the factory settings for parameters can be changed even when the write protection function is active. To ensure that the write protection function is active for communication via fieldbus, if required, parameter p7762 must be set to 1.

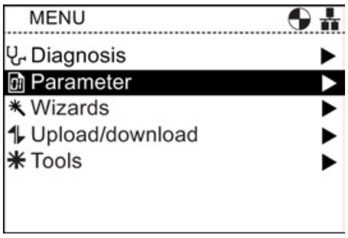
Activate/deactivate write protection function

Proceed as follows to activate or deactivate the write protection function:

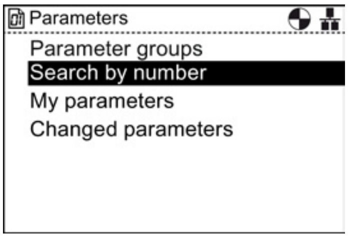
1. Select "Menu" on the main screen.



2. Select the "Parameters" entry in the menu.

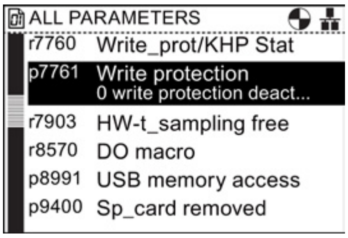


3. Select the "Search for number" entry in the "Parameters" menu.



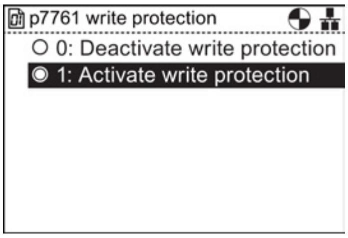
4. Enter "07761" and press "OK".

5. The parameter from the "All parameters" menu is displayed automatically on the screen. The parameter for the write protection is emphasized. Note that the current status of the write protection function is displayed under the parameter name. Press "OK" to select the parameter.



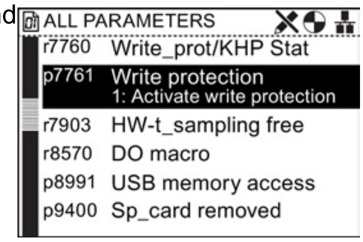
6. Select "1: Activate write protection" to activate the write protection function.

   Press "OK" to confirm your selection.



7. The display returns to the "All parameters" screen and the parameter for the write protection is emphasized to specify the status of the function as active.

   Press the "Esc" key twice to return to the "Status" screen.



To deactivate the write protection function, perform the same procedure as above but select "0: Deactivate write protection".

Functions 7

7.1 Section content

This section provides information on:

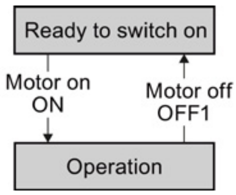
- Inverter control procedure
- Setpoint sources and setpoint preparation
- V/f control and vector control
- Protection functions:
  Power module protection, thermal monitoring functions and overload responses, anti-stall protection, stall protection, thermal motor protection, Vdc control.
- Application-specific functions:
  Unit changeover, energy-saving display for fluid flow machines, braking functions, flying restart, efficiency optimization, quick magnetization for induction motors, automatic restart, simple process control functions, real-time clock and time switch, emergency operation, multi-zone closed-loop controller, cascade control, bypass, energy-saving mode, logical and arithmetic functions using freely switchable function blocks.

7.2 Inverter control

7.2.1 Switching the motor on and off

After switching the supply voltage on, the inverter normally goes into the "Ready to switch on" 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.
- The inverter brakes the motor after the OFF1 command. The inverter switches off the motor once standstill has been reached. The inverter is again "ready to start".



Inverter states and commands for switching the motor on and off

In addition to the OFF1 command, there are other commands that are used to switch off the motor:

- OFF2 - the inverter immediately switches off the motor without first braking it.
- OFF3 - this command means "quick stop". After OFF3, the inverter brakes the motor with the OFF3 ramp-down time. After reaching standstill, the inverter switches off the motor. The command is frequently used for exceptional operating situations where it is necessary to brake the motor especially quickly. Collision protection is a typical application for this function.

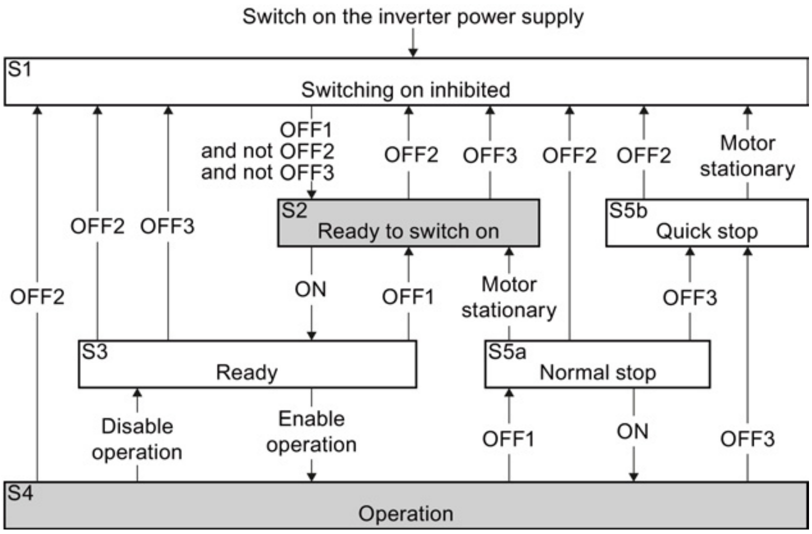


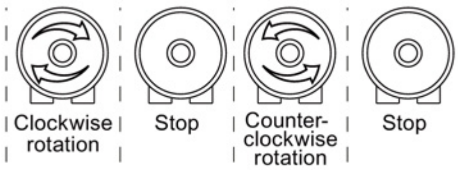
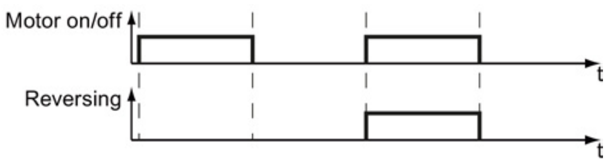
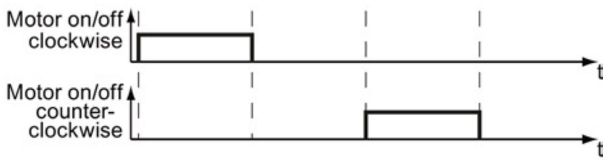
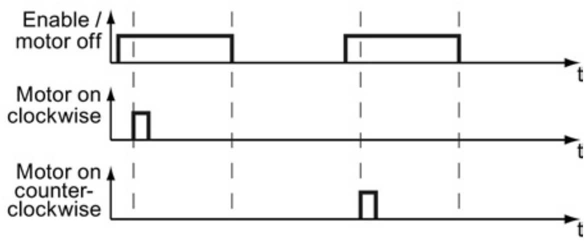
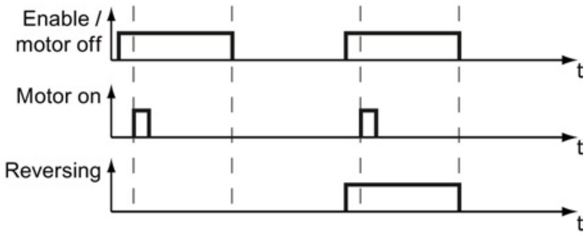
Figure 7-1 Internal sequence control of the inverter when the motor is switched on and off

The abbreviations S1 … S5b to identify the inverter states are defined in the PROFIdrive profile.

Inverter status	Explanation
S1	In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions: • ON was active when switching the inverter on. Exception: When the automatic restart function is active, ON must be active after switching the power supply on. • OFF2 or OFF3 is selected.
S2	This state is required to switch on the motor.
S3	The inverter waits for the operating enable. If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit. If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.
S4	The motor is switched on.
S5a	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
S5b	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time.

Five different methods are available for controlling the motor via digital inputs.

Table 7- 1 Two-wire control and three-wire control

Behavior of the motor		
	**Control commands**	**Typical application**
	**Two-wire control, method 1** 1. Switch the motor on and off (ON/OFF1). 2. Reverse the motor direction of rotation.	Local control in conveyor systems.
	**Two-wire control, method 2 and two-wire control, method 3** 1. Switch the motor on and off (ON/OFF1), clockwise rotation. 2. Switch the motor on and off (ON/OFF1), counter-clockwise rotation.	Traction drives with control via joystick
	**Three-wire control, method 1** 1. Enable signal for switching the motor on and off (OFF1). 2. Switch the motor on (ON), clockwise rotation. 3. Switch the motor on (ON), counter-clockwise rotation.	Traction drives with control via joystick
	**Three-wire control, method 2** 1. Enable signal for switching the motor on and off (OFF1). 2. Switch the motor on (ON). 3. Reverse the motor direction of rotation.	-

Note

Reversing is disabled in the factory setting. To use the "Reverse" function, you must release the negative rotational direction, see Section Enable direction of rotation (Page 350).

7.2.2 Two-wire control: method 1

You switch the motor on and off using a control command (ON/OFF1) while the other control command reverses the motor direction of rotation.

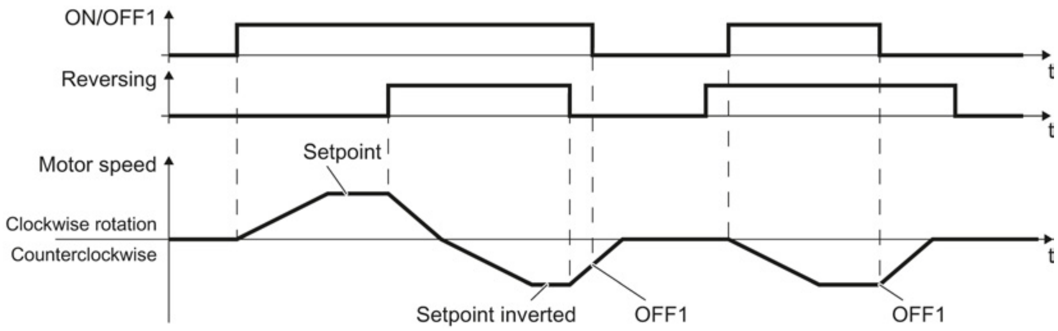


Figure 7-2 Two-wire control, method 1

Table 7- 2 Function table

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

<table>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 12</td><td colspan="3">Drive unit macro (factory setting for inverters with CU230P-2 HVAC and CU230P-2 CAN)</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1</td><td>Reversing</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 1 (ON/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 2 (reversing)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p3330[0 … n] = 722.3</td><td colspan="3">DI 3: ON/OFF1</td></tr>
</table>

7.2.3 Two-wire control, method 2

You switch the motor on and off using a control command (ON/OFF1) and at the same time select clockwise motor rotation. You also use the other control command to switch the motor on and off, but in this case you select counter-clockwise rotation for the motor.

The inverter only accepts a new control command when the motor is at a standstill.

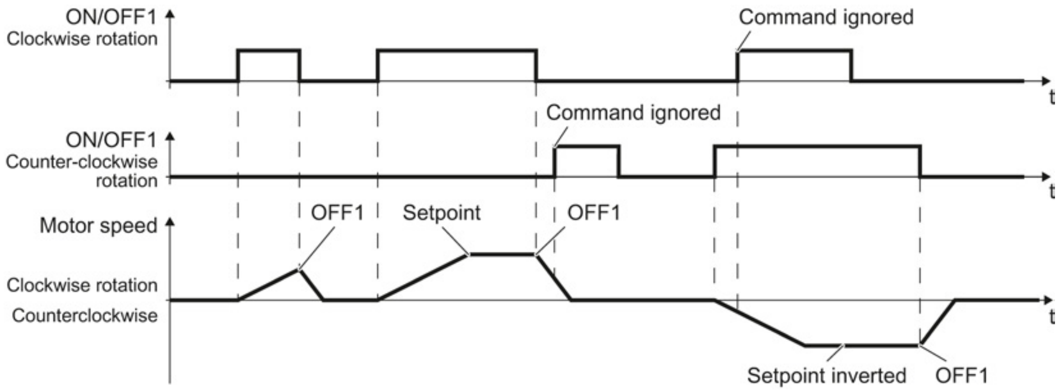


Figure 7-3 Two-wire control, method 2

Table 7- 3 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 based on the signal that assumes status "1" first.

Parameter	Description		
p0015 = 17	**Macro drive unit**		
	Controlling the motor using the digital inputs of the inverter:	DI 0	DI 1
		ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation
Advanced setting Interconnecting control commands with digital inputs of your choice (DI x).			
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[0 … n] = 722.0	DI 0: ON/OFF1 counter-clockwise rotation		

7.2.4 Two-wire control, method 3

You switch the motor on and off using a control command (ON/OFF1) and at the same time select clockwise motor rotation. You also use the other control command to switch the motor on and off, but in this case you select counter-clockwise rotation for the motor.

Unlike method 2, the inverter will accept the control commands at any time, regardless of the motor speed.

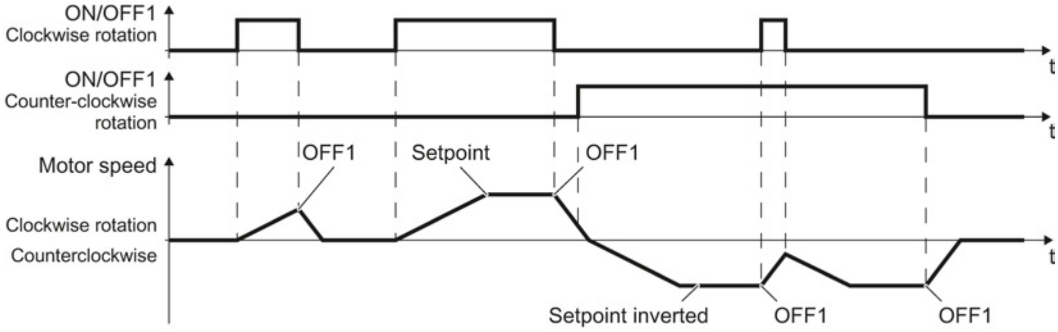


Figure 7-4 Two-wire control, method 3

Table 7- 4 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>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">p0015 = 18</td><td colspan="3">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td></tr>
<tr><td>ON/OFF1 clockwise rotation</td><td>ON/OFF1 counter-clockwise rotation</td></tr>
<tr><td colspan="4">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 1 (ON/OFF1 clockwise rotation)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="3">BI: 2/3 wire control command 2 (ON/OFF1 counter-clockwise rotation)</td></tr>
<tr><td colspan="4">Example</td></tr>
<tr><td>p3331[0 … n] = 722.2</td><td colspan="3">DI 2: ON/OFF1 counter-clockwise rotation</td></tr>
</table>

7.2.5 Three-wire control, method 1

With one control command, you enable the two other control commands. You switch the motor off by withdrawing the enable (OFF1).

You switch the motor's direction of rotation to clockwise rotation with the positive edge of the second control command. If the motor is still switched off, switch it on (ON).

You switch the motor's direction of rotation to counter-clockwise rotation with the positive edge of the third control command. If the motor is still switched off, switch it on (ON).

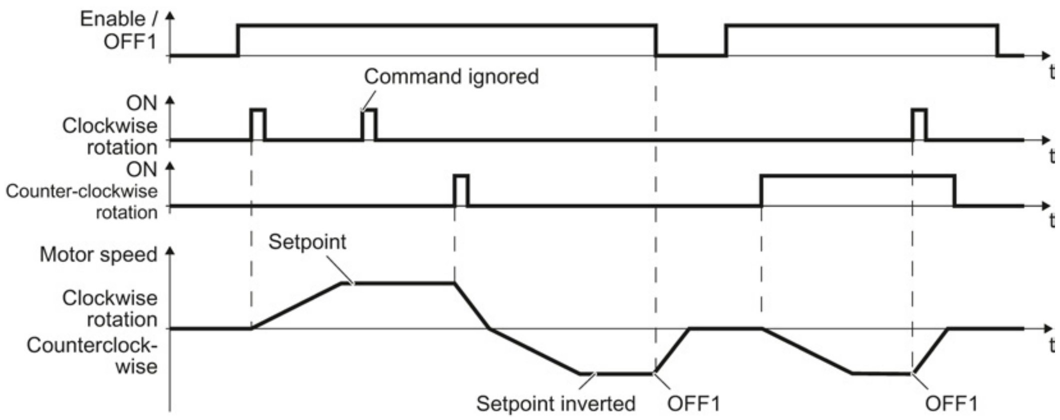


Figure 7-5 Three-wire control, method 1

Table 7- 5 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>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 19</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON clockwise rotation</td><td>ON counter-clockwise rotation</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 2 (ON clockwise rotation)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 3 (ON counter-clockwise rotation)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3332[0 … n] = 722.0</td><td colspan="4">DI 0: ON counter-clockwise rotation</td></tr>
</table>

7.2.6 Three-wire control, method 2

With one control command, you enable the two other control commands. You switch the motor off by withdrawing the enable (OFF1).

You switch the motor on with the positive edge of the second control command (ON).

The third control command defines the motor's direction of rotation (reversing).

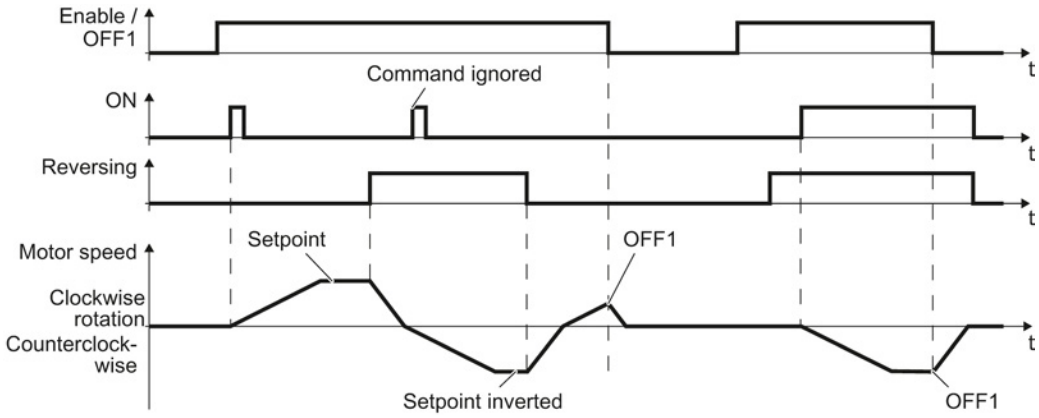


Figure 7-6 Three-wire control, method 2

Table 7- 6 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>
<tr><th>Parameter</th><th colspan="4">Description</th></tr>
<tr><td rowspan="3">p0015 = 20</td><td colspan="4">Macro drive unit</td></tr>
<tr><td rowspan="2">Controlling the motor using the digital inputs of the inverter:</td><td>DI 0</td><td>DI 1</td><td>DI 2</td></tr>
<tr><td>Enable / OFF1</td><td>ON</td><td>Reversing</td></tr>
<tr><td colspan="5">Advanced setting
Interconnecting control commands with digital inputs of your choice (DI x).</td></tr>
<tr><td>p3330[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 1 (enable/OFF1)</td></tr>
<tr><td>p3331[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 2 (ON)</td></tr>
<tr><td>p3332[0 … n] = 722.x</td><td colspan="4">BI: 2/3 wire control command 3 (reversing)</td></tr>
<tr><td colspan="5">Example</td></tr>
<tr><td>p3331[0 … n] = 722.0</td><td colspan="4">DI 0: ON</td></tr>
</table>

7.3 Setpoints

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

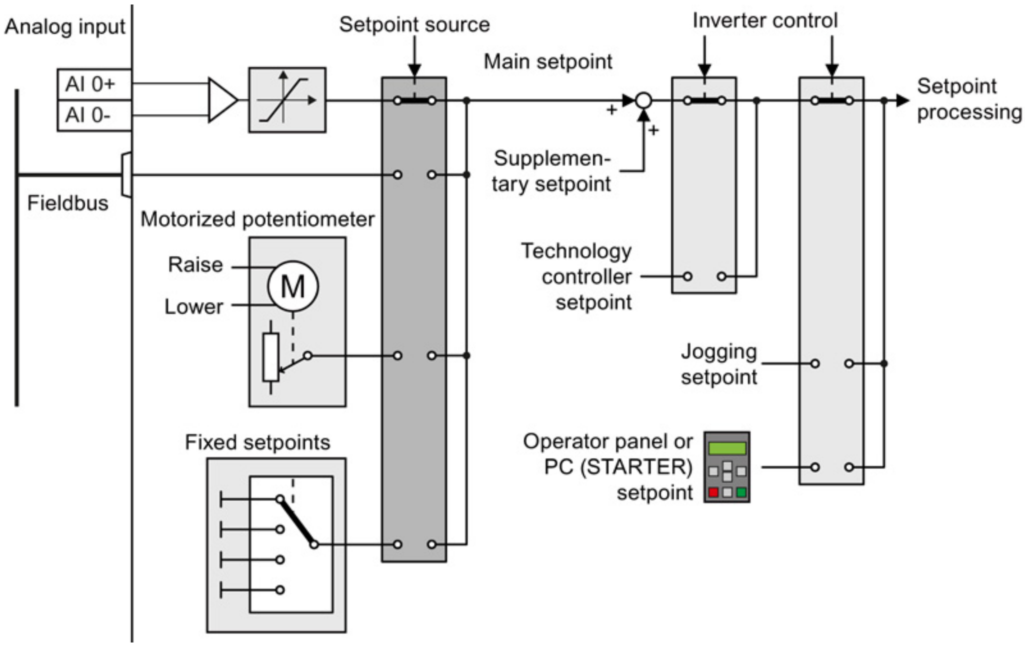


Figure 7-7 Setpoint sources for the inverter

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

- Inverter analog input.
- Inverter fieldbus interface.
- 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 closed-loop controller is active and appropriately interconnected, its output specifies the motor speed.
- When jogging is active.
- When controlling from the IOP or the STARTER PC tool.

7.3.1 Analog input as setpoint source

Interconnecting an analog input

If you have selected a pre-assignment without a function of the analog input, then you must interconnect the parameter of the main setpoint with an analog input.

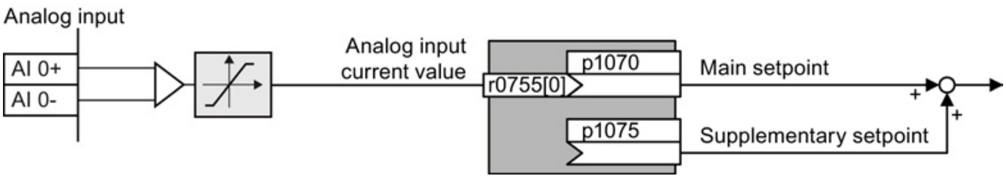


Figure 7-8 Example: Analog input 0 as setpoint source

Table 7- 7 Setting with analog input 0 as setpoint source

Parameter	Remark
p1070 = 755[0]	**Main setpoint** Interconnects the main setpoint with analog input 0
p1075 = 755[0]	**Additional setpoint** Interconnects the additional setpoint with analog input 0

You must adapt the analog input to the connected signal, e.g. ± 10 V or 4 … 20 mA.

7.3.2 Specifying the setpoint via the fieldbus

Interconnecting the fieldbus with the main setpoint

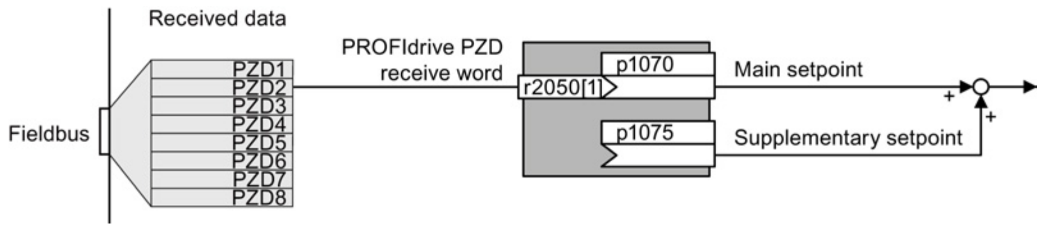


Figure 7-9 Fieldbus as setpoint source

Most standard telegrams receive the speed setpoint as a second process data PZD2.

Table 7- 8 Setting the fieldbus as setpoint source

Parameter	Remark
p1070 = 2050[1]	**Main setpoint** Interconnects the main setpoint with process data PZD2 from the fieldbus.
p1075 = 2050[1]	**Additional setpoint** Interconnects the additional setpoint with process data PZD2 from the fieldbus.

7.3.3 Motorized potentiometer as setpoint source

The "Motorized potentiometer" function emulates an electromechanical potentiometer. The output value of the motorized potentiometer can be continually set using the "up" and "down" control signals.

Interconnecting the motorized potentiometer (MOP) with the setpoint source

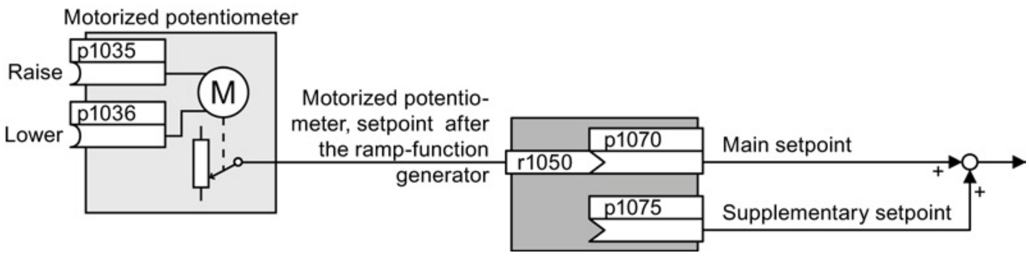


Figure 7-10 Motorized potentiometer as setpoint source

Table 7- 9 Basic setup of motorized potentiometer

Parameter	Description
p1047	**MOP ramp-up time** (factory setting 10 s)
p1048	**MOP ramp-down time** (factory setting 10 s)
p1040	**MOP start value** (factory setting 0 rpm) Defines the start value [rpm], which is effective when first switching the motor on.

Table 7- 10 Setting the MOP as setpoint source

Parameter	Remark
p1070 = 1050	**Main setpoint** Interconnects the main setpoint with MOP.
p1035	**Motorized potentiometer, increase setpoint** Interconnects this signal, for example with a digital input of your choice: p1035 = 722.1 (digital input 1)
p1036	**Motorized potentiometer, decrease setpoint** Interconnects this signal, for example with a digital input of your choice.

Adapting the behavior of the motorized potentiometer

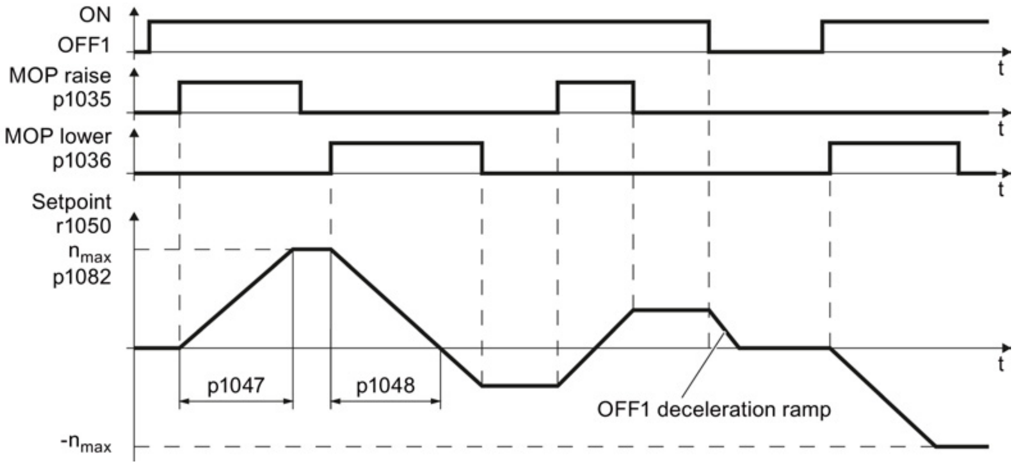


Figure 7-11 Function chart of motorized potentiometer

Table 7- 11 Extended setup of motorized potentiometer

Parameter	Description
p1030	**MOP configuration** (factory setting 00110 bin) **Parameter value with five independently adjustable bits 00 … 04** **Bit 00:** Save setpoint after switching the motor off 0: After the motor is switched on, p1040 is specified as the setpoint 1: Setpoint is saved after the motor is switched off and set to the saved value once it is switched on **Bit 01:** Configure ramp-function generator in automatic mode (1-signal via BI: p1041) 0: Without ramp-function generator in the automatic mode (ramp-up/ramp-down time = 0) 1: With ramp-function generator in the automatic mode In manual mode (0-signal via BI: p1041) the ramp-function generator is always active **Bit 02:** Configure initial rounding 0: Without initial rounding 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes **Bit 03:** Store setpoint in power-independent manner 0: No power-independent saving 1: Setpoint is saved in the event of a power failure (bit 00 = 1) **Bit 04:** Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: Setpoint is calculated independent of the pulse enable.
p1037	**MOP maximum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1038	**MOP minimum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning

Parameter	Description
p1043	**Motorized potentiometer, accept setting value** (factory setting 0) Signal source for accepting the setting value. The setting value in p1044 acts for a 0/1-edge at p1043.
p1044	**MOP setting value** (factory setting 0) Signal source for the setting value.

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

7.3.4 Fixed speed as setpoint source

In many applications after switching the motor on, all that is needed is to run the motor at a constant speed or to switch between different speeds.

Example: After it has been switched on, a conveyor belt only runs with two different velocities.

Interconnecting the fixed speeds with a main setpoint

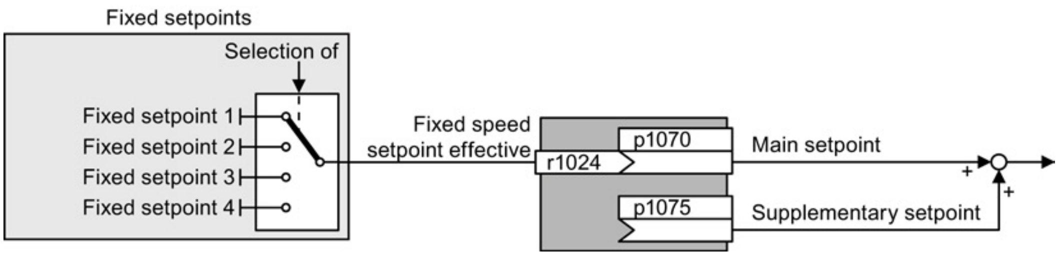


Figure 7-12 Fixed speeds as setpoint source

Table 7- 12 Setting the fixed speed as a setpoint source

Parameter	Remark
p1070 = 1024	**Main setpoint** Interconnects the main setpoint with fixed speeds
p1075 = 1024	**Additional setpoint** Interconnects the additional setpoint with fixed speeds

Select direct or binary fixed setpoint

The inverter has up to 16 different fixed setpoints. The higher-level controller selects the appropriate fixed setpoints via digital inputs or the fieldbus.

The inverter distinguishes between two methods for selecting the fixed setpoints:

1. Direct selection:
   You set four different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.
   Direct selection is the most suitable method for controlling the inverter via the digital inputs.

   Additional information about direct selection can be found in function diagram 3011 in the List Manual.
2. Binary selection:
   You set 16 different fixed setpoints. You precisely select one of these fixed setpoints by a combination of four selection bits.
   The binary selection is the suitable method of controlling the inverter via a fieldbus.
   Additional information about binary selection can be found in function diagram 3010 of the List Manual.

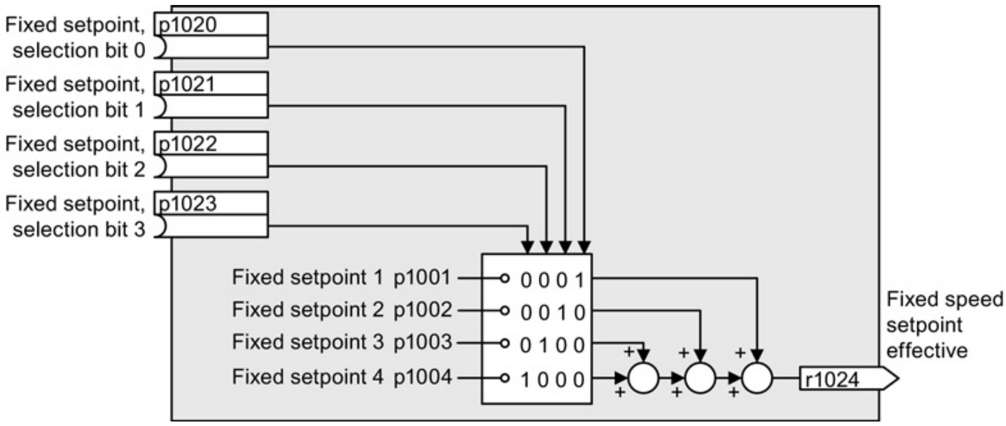


Figure 7-13 Simplified function diagram for directly selecting fixed setpoints

Example: Select two fixed setpoints directly

The motor should operate at different speeds as follows:

- The signal at digital input 0 switches the motor on and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.
- The signals at the two digital inputs accelerate the motor to 2300 rpm.

Table 7- 13 Settings for the example

Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** [rpm]
p0840 = 722.0	**ON/OFF1:** Switch on motor with digital input 0
p1070 = 1024	**Main setpoint:** Interconnects the main setpoint with the fixed speed setpoint.
p1020 = 722.0	**Fixed speed setpoint selection bit 0:** Interconnects fixed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnects fixed setpoint 2 with digital input 1 (DI 1).
p1016 = 1	**Fixed speed setpoint mode:** Selects direct selection of the fixed setpoints.

Table 7- 14 Resulting fixed setpoints for the example

Fixed setpoint selected by	Resulting setpoint
DI 0 = LOW and DI 1 = LOW	Motor stops
DI 0 = HIGH and DI 1 = LOW	300 rpm
DI 0 = LOW and DI 1 = HIGH	2000 rpm
DI 0 = HIGH and DI 1 = HIGH	2300 rpm

7.4 Setpoint calculation

7.4.1 Overview of setpoint processing

The setpoint can be modified as follows using the setpoint processing:

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Minimum speed to avoid standstill when the motor is switched on.
- Skip frequency bands to prevent mechanical resonance effects at specific speeds.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

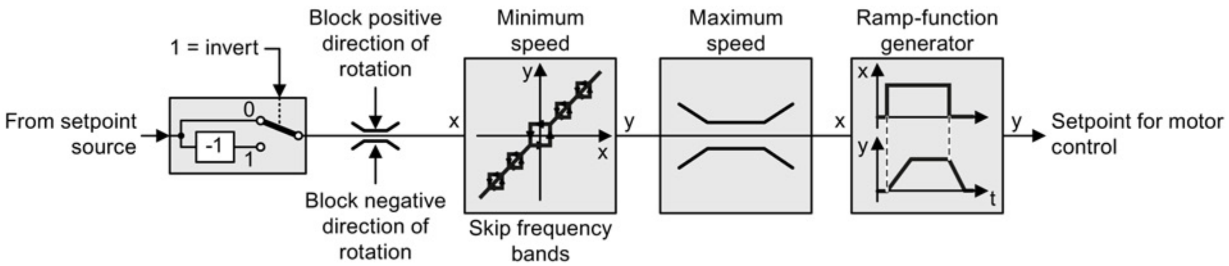


Figure 7-14 Setpoint processing in the inverter

7.4.2 Invert setpoint

Proceed as follows to invert the setpoint:

Interconnect parameter p1113 with a binary signal, e.g. digital input 1.

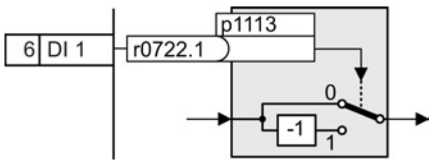


Table 7- 15 Examples of settings to invert the setpoint

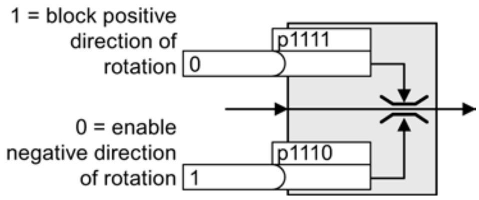
Parameter	Remark
p1113 = 722.1	**Setpoint inversion** Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Setpoint is inverted.
p1113 = 2090.11	Invert setpoint via control word 1, bit 11.

7.4.3 Enable direction of rotation

In the factory setting of the inverter, the negative direction of rotation of the motor is inhibited.

Proceed as follows to enable the negative direction of rotation:

Set parameter p1110 to a value = 0.



The positive direction of rotation is enabled in the factory setting; you can inhibit this direction of rotation using p1111 = 1.

Table 7- 16 Examples of settings to inhibit the direction of rotation

Parameter	Remark
p1110 = 1	**Inhibit negative direction** Negative direction is permanently inhibited.
p1110 = 722.3	**Inhibit negative direction** Digital input 3 = 0: Negative direction of rotation is enabled. Digital input 3 = 1: Negative direction of rotation is inhibited.

7.4.4 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 when accelerating or braking.

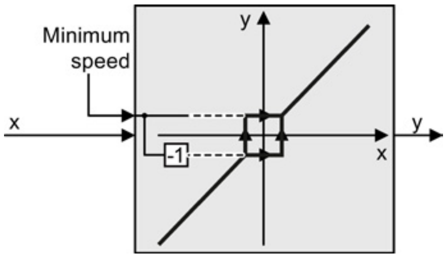


Table 7- 17 Setting the minimum speed

Parameter	Description
p1080	Minimum speed
p1106	CI: Minimum speed signal source

The minimum speed is formed from the parameters p1080 and p1106, where the larger value determines the effective minimum speed.

7.4.5 Skip frequency bands

The inverter prevents continuous motor operation at speeds in the suppression-speed range.

This can prevent speeds from being approached stationary that, for example, cause excitation of resonancy vibrations of the drive train.

To ensure that the speed does not constantly increase and decrease in the suppression bandwidth (speeds), the bands are assigned a hysteresis.

The suppression speeds apply in the positive and negative direction of rotation.

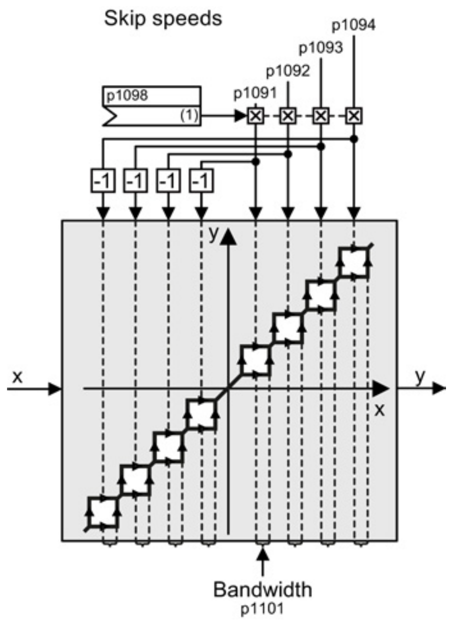


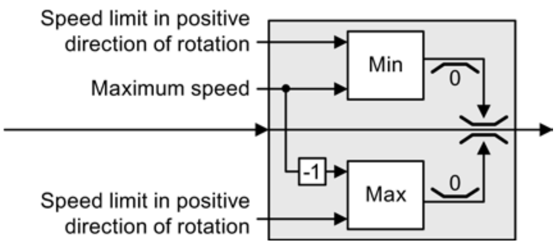
Table 7- 18 Setting skip frequency bands

Parameter	Description
p1091	Suppression speed 1
p1092	Suppression speed 2
p1093	Suppression speed 3
p1094	Suppression speed 4
p1098	Suppression speed scaling
p1101	Suppression speed bandwidth

7.4.6 Speed limitation

The maximum speed limits the speed setpoint range for both directions of rotation.

The inverter 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 7- 19 Parameters for the speed limitation

Parameter	Description
p1082	**Maximum speed**, pre-assigned for the automatic calculation of the control parameters
p1083	**Speed limit, positive direction of rotation** (factory setting: 210000 rpm)
p1085	**CI: Speed limit, positive direction of rotation** (factory setting: p1083)
p1086	**Speed limit, negative direction of rotation** (factory setting: -210000 rpm)
p1088	**CI: Speed limit, negative direction of rotation** (factory setting: p1086)

7.4.7 Ramp-function generator

The ramp-function generator in the setpoint channel limits the rate that the speed setpoint changes. As a consequence the motor accelerates and brakes more softly, reducing the stress on the mechanical system of the driven machine.

The ramp-function generator is not active if the technology closed-loop controller in the inverter specifies the speed setpoint.

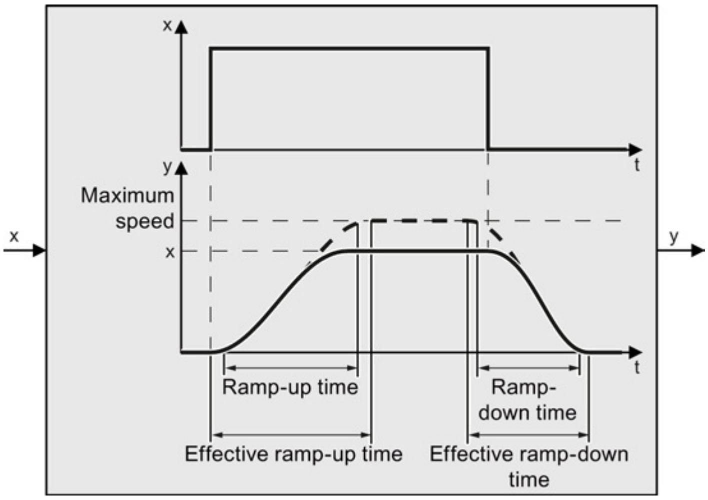
Simple ramp-function generator

This inverter always uses the extended ramp-function generator. Consequently, the simple ramp-function generator is not described in this manual.

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).

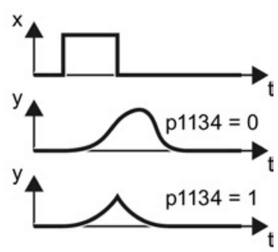
Initial and final rounding permit smooth, jerk-free acceleration and braking.



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 7- 20 Additional parameters to set the extended ramp-function generator

Parameters	Description	
p1120	**Ramp-function generator, ramp-up time** (factory setting: 20 s) Accelerating time in seconds from zero speed up to the maximum speed p1082	
p1121	**Ramp-function generator, ramp-down time** (factory setting: 30 s) Braking time in seconds from the maximum speed down to standstill	
p1130	**Ramp-function generator initial rounding time** (factory setting: 2 s) Initial rounding for the extended ramp-function generator. The value applies to ramp up and ramp down.	
p1131	**Ramp-function generator final rounding time** (factory setting: 2 s) Final rounding for the extended ramp-function generator. The value applies to 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 depending on the Power Module 3 s) The quick stop (OFF3) has its own ramp-down time.	
p1136	**OFF3 initial rounding time** (factory setting: 0.5 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

Proceed as follows to set the extended ramp-function generator:

1. Enter the highest possible speed setpoint.
2. Switch the motor on.
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.
   - We recommend that you set the final rounding to the same value as the initial rounding.
4. Switch the motor off.
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. Depending on the inverter setting, the real braking time exceeds the set ramp-down time, or the inverter goes into a fault condition when braking.
   - Extend the ramp-down time if the motor is braked too quickly or the inverter goes into a fault condition when braking.
     Another possibility is to limit the maximum DC-link voltage, see Limiting the maximum DC link voltage (Page 369)
6. Repeat steps 1 … 5 until the drive behavior matches the requirements.

7.5 Motor control

7.5.1 Vector control or V/f control

Criteria for selecting either V/f control or vector control

Motors should preferably be operated in vector control.

When compared to V/f control, vector control offers the following advantages because of the sensoress actual speed acquisition:

- 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.
- Full torque is possible at standstill.

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

- If the motor is too small in comparison to the inverter (the rated motor power must not be less than one quarter of the rated inverter power).
- If you operate several motors on one inverter.
- If a power contactor is used between the inverter and motor, and is opened while the motor is powered up.

7.5.2 Closed-loop speed control

7.5.2.1 Properties of the sensorless vector control

Using a motor model, the speed control calculates the load and the motor slip. As a result of this calculation, the inverter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Speed control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

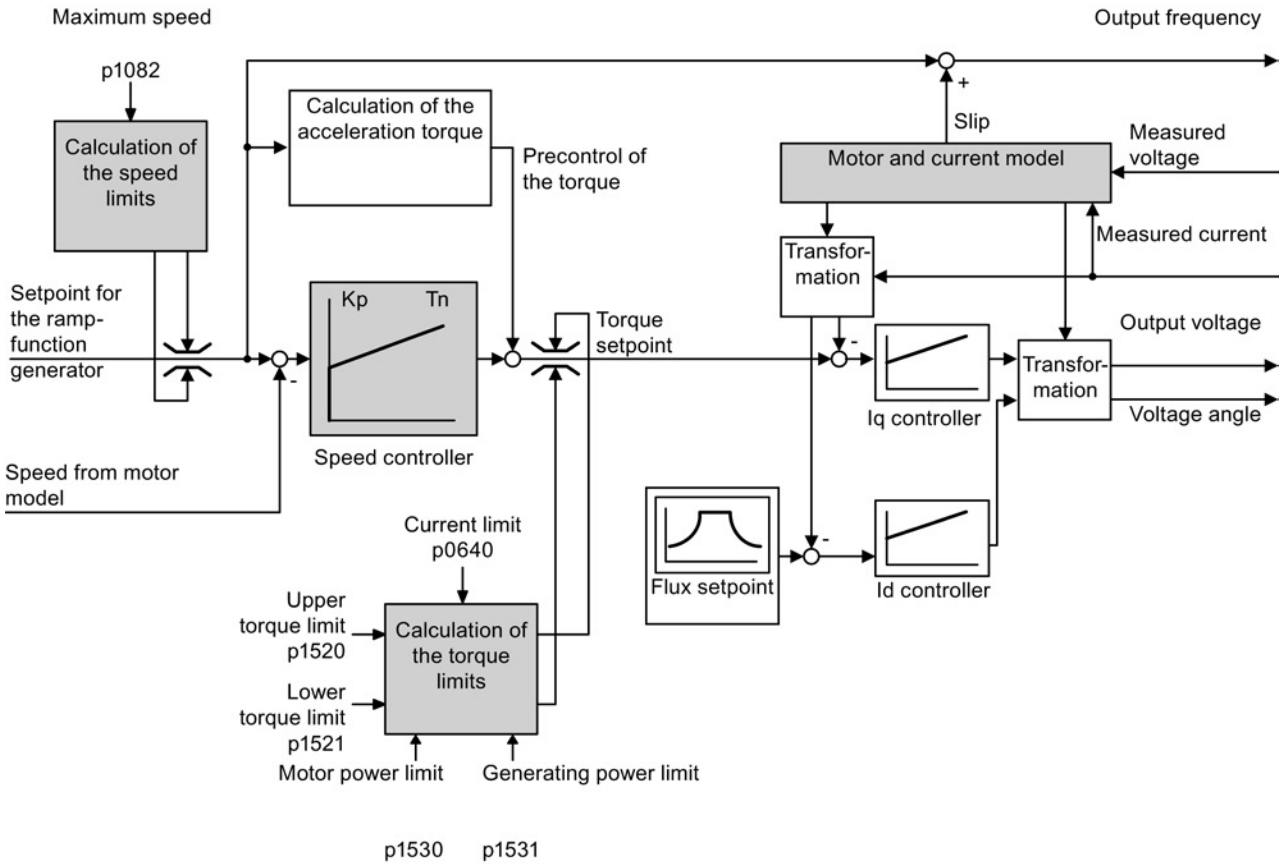


Figure 7-15 Simplified function diagram of sensorless vector control

You can find additional information on speed control in the function diagrams 6020 ff. of the List Manual.

7.5.2.2 Select motor control

Speed control is already preset

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

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter corresponds to the motor data on the type plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.
- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of the limit, you can also set additional positive and negative torque limits or limit the power of the motor.

- The motor identification (MotID) is mandatory (default setting); the automatic closed-loop speed controller optimization is recommended (in addition, the magnetization current is determined and the closed-loop speed controller optimized).
- Read the description later in this section if you want to further optimize these settings.

7.5.2.3 Optimizing the closed-loop speed controller

Recommendation

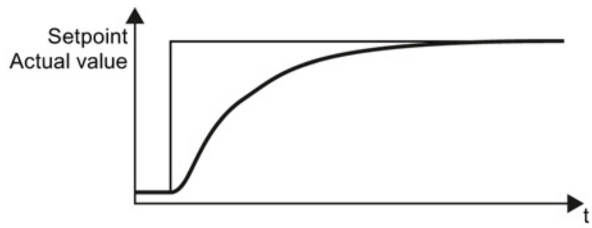
Automatic closed-loop speed controller optimization is recommended (p1900 = 3).

Optimum control response - post optimization not required

You do not have to manually adapt the speed closed-loop controller if, after the speed controller self optimization, the motor manifests the following acceleration response:

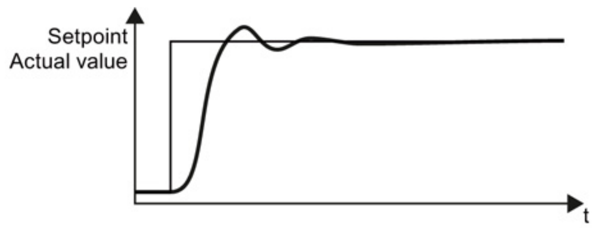
Optimum control response for applications that do not permit any overshoot.

The actual value approaches the setpoint without any significant overshoot.



Optimum control response for fast correction and quick compensation of noise components.

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).



Control optimization required

In some cases, the self optimization result is not satisfactory, or the inverter cancels the self-optimization routine with a fault. Further, self optimization is not permissible in plants and systems in which the motor cannot freely rotate.

In these cases you must manually optimize the closed-loop speed controller.

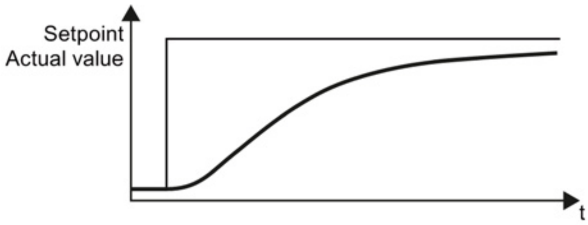
The examples listed below show you which variables you can use to adapt the control response.

The basic procedure is described in the following section for STARTER and IOP.

- K_P (p1470) Proportion share
- T_N (p1472) Integration time

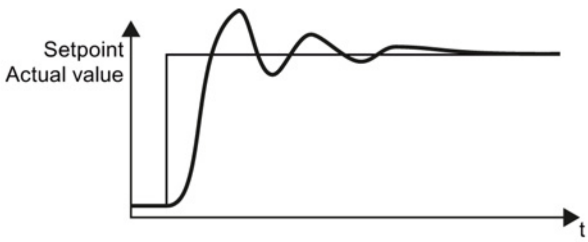
The actual value only slowly approaches the setpoint.

- Increase the proportional component K_P and reduce the integration time T_N.



The actual value quickly approaches the setpoint, but overshoots too much.

- Decrease the proportional component K_P and increase the integration time T_N.



Optimizing the closed-loop speed controller with STARTER and IOP

Procedure

To manually optimize the closed-loop speed controller with STARTER, proceed as follows:

1. Go online, and in the "Ramp-function generator" screen form, set the times = 0.
2. Set pre-control = 0 in the "Closed-loop speed controller" screen form.
3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER.
4. Optimize the closed-loop controller in the "Closed-loop speed controller" screen form by adjusting the closed-loop controller parameters K_P and T_N.
5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.
6. Set the pre-control of the closed-loop speed controller back to 100%.

To manually optimize the closed-loop speed controller with the IOP, proceed as follows:

1. Set the ramp-up and ramp-down times of the ramp-function generator p1120 = 0 and p1121 = 0.
2. Set the pre-control of the closed-loop speed controller p1496 = 0.
3. Enter a setpoint step and observe the associated actual value.
4. Optimize the closed-loop speed controller by changing the closed-loop controller parameters K_P and T_N until the drive runs optimally.
5. Set the ramp-up and ramp-down times of the ramp-function generator p1120 and p1121 back to their original value.
6. Set the pre-control of the closed-loop speed controller p1496 = 100%.

7.5.3 V/f control

V/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

The inverter provides the two most important characteristics (linear and square-law).

V/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

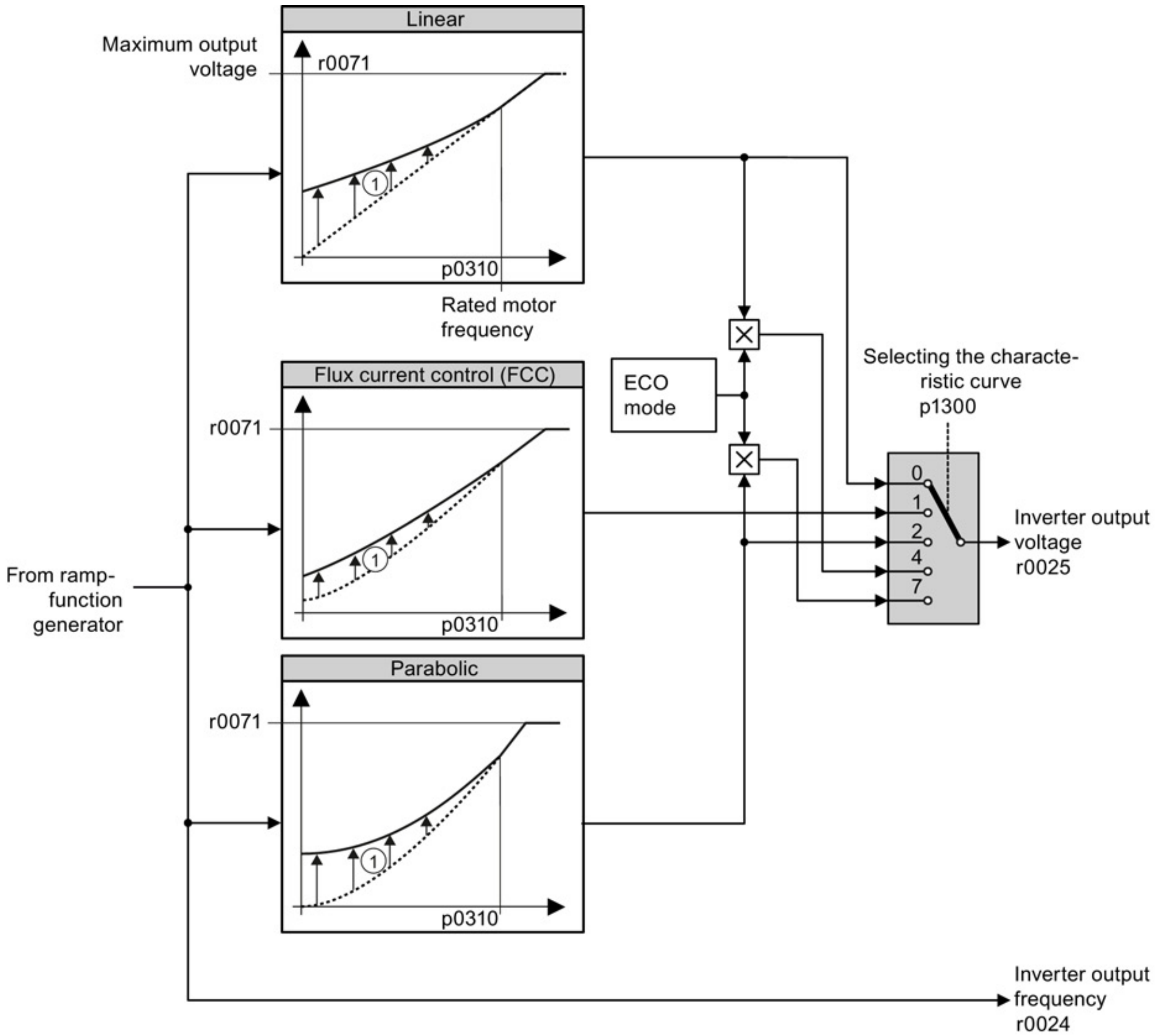
If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

The V/f control can also be used in the test mode.

Parameter p1300 sets the characteristic curve.

7.5.3.1 Characteristics of V/f control

The inverter has several V/f characteristics. Based on the characteristic, as the frequency increases, the inverter increases the voltage at the motor.



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

Figure 7-16 V/f characteristics of the inverter

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

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

The value of the motor 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

7.5.3.2 Selecting the V/f characteristic

Procedure

Proceed as follows to select a V/f characteristic in STARTER:

1. Go online.
2. Select the V/f characteristic curve in one of the screen forms "Speed closed-loop controller" or "V/f control".

Proceed as follows to select a V/f characteristic with the IOP:

1. Select the "Parameters" menu.
2. Select "Expert" as parameter filter.
3. Select parameter p1300.
4. Set p1300 to the appropriate value.

Table 7- 21 Linear and parabolic characteristics

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Eccentric-worm pump, compressor	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Precondition: You have set the motor data according to the type plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans, compressors	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 7- 22 Characteristics for special applications

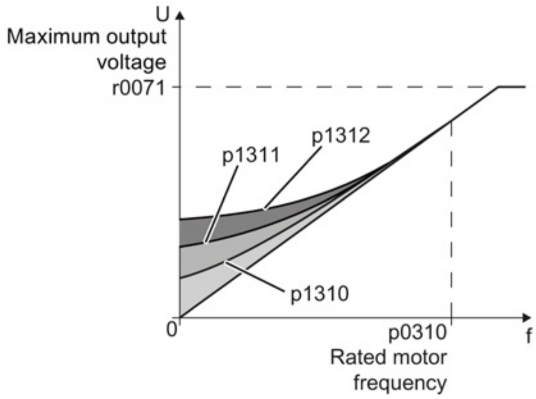
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage.	ECO mode	p1300 = 4 (linear ECO characteristic curve) or p1300 = 7 (parabolic ECO characteristic curve)

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

7.5.3.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for V/f control

The voltage boost acts on every V/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.



Procedure

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.
3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.

5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**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").

7.6 Protection functions

The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter and the motor. Further, the frequency inverter protects itself against an excessively high DC-link voltage when the motor is regenerating. In addition, the inverter can use the kinetic energy of the motor to prevent a reduction of the DC-link voltage in the event of a brief power failure.

7.6.1 Inverter temperature monitoring

The inverter protects itself against overtemperature with different monitoring functions:

- I^2t monitoring (alarm A07805, fault F30005)
  The I^2t monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a percentage value. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
- Inverter monitoring (alarm A05000, fault F30004)
  The inverter monitors the module sensor temperatures of the Power Module. The values are in r0037[0] [°C].
- Monitoring the barrier junction temperatures of the Power Unit (alarm A05006, fault F30024)
  The inverter calculates the difference in temperature between the chip (IGBT) and the module sensor. Together with the measured module sensor temperatures, this produces the chip temperatures. The values are in r0037[1] [°C].

Inverter response

The inverter temperature is determined primarily by the feed-through and switching losses of the IGBTs.

The inverter reacts to an excessive temperature by reducing the output current and the pulse frequency (for vector control) or pulse frequency and the speed (for V/f control).

The temperature alarm threshold can be set using p0292[0] (heat sink, factory setting 5° C) and p0292[1] (power semiconductor, factory setting 15° C).

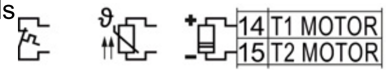
7.6.2 Motor temperature monitoring using a temperature sensor

Connecting the temperature sensor

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

- Temperature switch (e.g. bimetallic switch)
- PTC sensor
- KTY84 sensor

Connect the temperature sensor of the motor to terminals 14 and 15 of the Control Unit.



Set response to excess motor temperature

If you use a temperature switch or PTC sensor, set the response to excess motor temperature via P0610 as follows:

- p0610 = 0
  - Warning A07910,
  - No shutdown
- p0610 = 1, p0610 = 2, p0610 = 12
  - Warning A07910
  - Shutdown with fault F07011

If you use a KTY84 sensor, set the temperature for the warning or fault threshold via p0604 or p0605.

- Monitoring via p0604: Response as per the setting in p0610
- Monitoring via p0605: Shutdown with fault as soon as the set threshold is exceeded.

For details, please refer to the List Manual.

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.

KTY84 sensor

Use a KTY sensor to monitor the motor temperature and the sensor itself for wire-break or short-circuit.

WARNING
Danger to life due to fire caused by overheating as the result of thermal overloading of the motor If a KTY sensor is connected with the incorrect polarity, this can destroy the motor due to overheating and so cause fire, because the inverter cannot detect a motor overtemperature condition. • Connect the KTY sensor with the correct polarity.

- 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 switches off with 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.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Natural cooling - with fan on the motor shaft (factory setting) 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 (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130° C)
p0605	**Motor temperature fault threshold** (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.
p0610	**Motor overtemperature response** Determines the response when the motor temperature reaches the alarm threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); current limit is reduced and timer is started. Shutdown with fault (F07011). 2: Alarm (A07910); timer is started. Shutdown with fault (F07011). 12: As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0640	**Current limit** (input in A)

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

7.6.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode (p1300 = 20) and functions by calculating a thermal motor model.

Table 7- 23 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description
p0621= 1	**Motor-temperature acquisition after restart** 0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on
p0622	**Magnetization time of the motor for temperature measurement after starting** *(set automatically as the result of motor data identification)*
p0625	**Ambient motor temperature** Enter the ambient motor temperature in °C at the instant that the motor data is acquired (factory setting: **20° C**). The difference between the motor temperature and motor environment (p0625) must lie within a tolerance range of approx. ± 5° C.

7.6.4 Overcurrent protection

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

During V/f control, the maximum current controller (I-max controller) protects the motor and inverter against overload by limiting the output current.

I-max controller operation

If an overload situation occurs, the speed and stator voltage of the motor are reduced until the current is within the permissible range. If the motor is in regenerative mode, i.e. it is being driven by the connected machine, the I-max controller increases the speed and stator voltage of the motor to reduce the current.

Note

The inverter load is only reduced if the motor torque decreases at lower speeds, e.g. for fans.

In the regenerative mode, the current only decreases if the torque decreases at a higher speed.

Settings

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 7- 24 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 block diagrams 1690 and 6714 in the List Manual.

7.6.5 Limiting the maximum DC link voltage

How does the motor generate overvoltage?

An induction motor operates as a generator if it is driven by the connected load. A generator converts mechanical power into electrical power. The electrical power flows back into the inverter and causes V_{DC} in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before the voltage can reach critical levels, however, the inverter switches the motor off with the fault message "DC-link overvoltage".

Protecting the motor and inverter against overvoltage

To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Braking functions of the converter (Page 379).

Parameters of the Vdc_max control

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

Parameter for V/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**Vdc_max control Vdc monitoring configuration** (factory setting: 1) 1: Enable Vdc_max control
r1282	r1242	**Vdc_max control activation level** Shows the value of the DC-link voltage above which the Vdc_max control is active
p1283	p1243	**Vdc_max control dynamic factor** (factory setting: 100 %) Scaling closed-loop control parameters p1290, p1291 and p1292
p1284	---	**Vdc_max controller time threshold** Setting for the monitoring time of the Vdc_max controller.
p1290	p1250	**Vdc_max control proportional gain** (factory setting: 1)
p1291	p1251	**Vdc_max control integral time** (factory setting p1291: 40 ms, factory setting p1251: 0 ms)
p1292	p1252	**Vdc_max control rate time** (factory setting p1292: 10 ms, factory setting p1252: 0 ms)
p1294	p1254	**Vdc_max control automatic sensing ON level** (factory setting p1294: 0, factory setting p1254: PM330/PM240 = 1, PM230 = 0) Activates or deactivates automatic detection of the switch-on levels of the Vdc_max control. 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 block diagrams 6320 and 6220).

7.6.6 Minimum DC-link voltage limit

With this function, the kinetic energy of the motor is used for buffering the DC-link voltage in the event of a momentary power failure, thereby decelerating the drive.

Typical cause: Line voltage failure

Remedy: Specify a regenerative torque for the rotating drive to compensate the existing losses, thereby stabilizing the voltage in the DC link. This process is known as kinetic buffering.
Kinetic buffering is only possible as long as energy is generated by the movement of the drive.

Description

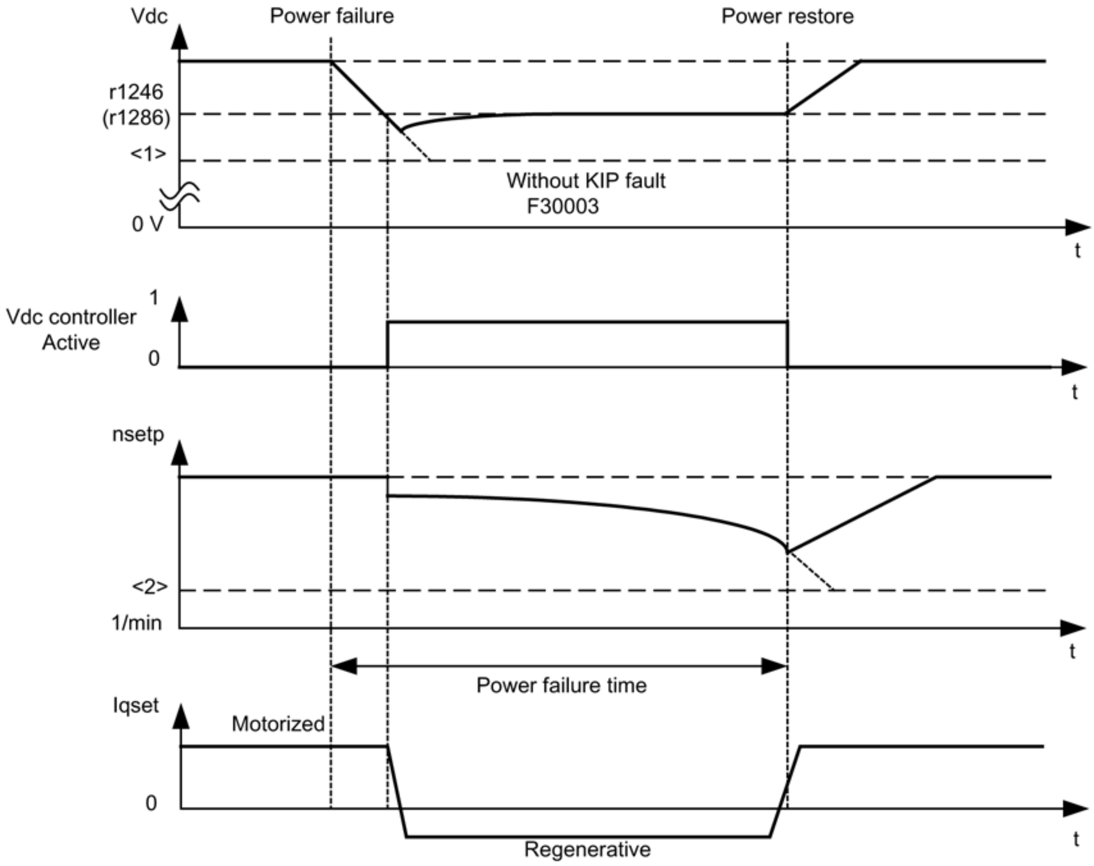


Figure 7-17 Switching Vdc_min control on/off (kinetic buffering)

When Vdc_min control is enabled with p1240 = 2.3 (p1280), it is activated if the power fails when the Vdc_min switch-in level (r1246 (r1286)) is undershot. In general, the regenerative power (braking energy) of the drive machine generated when the motor speed is reduced is used to buffer the DC-link voltage of the drive; in other words, when Vdc_min control is active, the motor speed no longer follows the main setpoint and can be reduced to zero. The drive continues operating until the shutdown threshold of the DC-link voltage is undershot (see "Switching Vdc_min control on/off" <1>).

Note

Parameter specifications in brackets

All parameter specifications in parentheses refer to V/f control.

Distinction between V/f control and speed control:

- V/f control
  The Vdc_min controller acts on the speed setpoint channel. When Vdc_min control is active, the drive setpoint speed is reduced so that the drive becomes regenerative.
- Speed control
  The Vdc_min controller acts on the speed closed-loop controller output and affects the torque-generating current setpoint. When Vdc_min control is active, the torque-generating current setpoint is reduced so that the drive becomes regenerative.

If the power fails, the DC-link voltage decreases due to the lack of power from the supply system. When the DC-link voltage threshold set via parameter p1245 (p1285) is reached, the Vdc_min controller is activated. Due to the PID properties of the closed-loop controller, the motor speed is reduced to the extent that the regenerative drive energy maintains the DC-link voltage at the level set in p1245 (p1285). The kinetic energy of the drive governs the dropout characteristic of the motor speed and, in turn, the buffering duration. In centrifugal mass drives (e.g. fans), buffering can last a few seconds. In drives with a low centrifugal mass (e.g. pumps), however, buffering can last just 100 to 200 ms. When the power is restored, the Vdc_min controller is deactivated and the drive is ramped up to its setpoint speed at the ramp-function generator ramp. As long as the Vdc_min controller is active, an alarm A7402 (drive: DC-link voltage minimum controller active) will be issued.

If the drive can no longer generate any regenerative energy (because, for example, it is almost at a standstill), the DC-link voltage continues to drop. If the minimum DC-link voltage is undershot (see "Switching Vdc_min control on/off" <1>), the drive will shut down with fault F30003 (power unit: DC-link undervoltage).

If, during active Vdc_min control, a speed threshold set with parameter p1257 (p1297) (see "Switching Vdc_min control on/off" <2>) is undershot, the drive will shut down with F7405 (kinetic buffering minimum speed not reached).

If a shutdown with undervoltage in the DC link (F30003) occurs without the drive first coming to a standstill despite the fact that Vdc_min control is active, the closed-loop controller may have to be optimized via dynamic factor p1247 (p1287). Increasing the dynamic factor in p1247 (p1287) causes the closed-loop controller to intervene more quickly. The default setting for this parameter, however, should be sufficient for most applications.

Parameter p1256 = 1 (p1296) can be used to activate time monitoring for kinetic buffering. The monitoring time can be set in parameter p1255 (p1295). If buffering (i.e., the power failure) lasts longer than the time set here, the drive will shut down with fault F7406 (drive: kinetic buffering maximum time exceeded). The standard fault response for this fault is OFF3, which means that this function can be used for controlled drive deceleration in the event of a power failure. In this case, excess regenerative energy can only be dissipated via an additional braking resistor.

7.7 Application-specific functions

The inverter offers a series of functions that you can use depending on your particular application, e.g.:

- Switching over units
- Energy savings indicator for pumps, fans, and compressors
- Braking functions
- Flying restart
- Efficiency optimization
- Quick magnetization for induction motors
- Automatic restart
- Basic process control functions
- Real-time clock and time switch
- Essential service mode
- Multi-zone controller
- Cascade control
- Bypass
- Energy-saving mode
- Write and know-how protection
- Logical and arithmetic functions using function blocks that can be freely interconnected

Refer to the following sections for detailed descriptions.

7.7.1 Unit changeover

Description

Parameters and process variables for input and output can be switched to a suitable unit system (SI units, US units or referenced variables (%)) with the using the unit switchover function.

Specifically, you have the following options:

- Changing over the motor standard (Page 375) IEC/NEMA
- Changing over the unit system (Page 375)
- Changing over process variables for the technology controller (Page 376)

Note

The motor standard, the unit system as well as the process variables can only be changed offline.

Restrictions for the unit switchover function

- The values on the type plate of the inverter or motor cannot be displayed as percentage values.
- Using the unit switchover function several times (for example, percent → physical unit 1 → physical unit 2 → percent) may lead to the original value being changed by one decimal place as a result of rounding errors.
- If the unit is switched to percentage and the reference value is then changed, the percentage values relate to the new reference value.
  Example:
  – For a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a speed of 1200 rpm.
  – If the reference speed is changed to 3000 rpm, then the value of 80% is kept and now means 2400 rpm.

Switching units

The units can be switched via the IOP and via STARTER.

- Unit switchover via IOP is always performed immediately. Once the corresponding parameters have been changed, the values affected are displayed in the new selected unit.
- If STARTER is used, unit switchover can only take place in offline mode in the configuration screen of the "Units" tab. The new units are not displayed until after the download ("Load project to target system") and subsequent upload ("Load project to PG") have been completed.

Reference variables for unit switchover

p2000 Reference speed reference frequency

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

p2006 Reference temperature

7.7.1.1 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the switchover.

Table 7- 25 Variables affected by switching over the motor standard

P no.	Designation	Unit for p0100 =		
		0 *)	1	2
r0206	Rated power module power	kW	HP	kW
p0219	Braking resistor braking power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
p0341	Motor moment of inertia	kgm^2	lb ft^2	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r0394	Rated motor power	kW	HP	kW
r1493	CO: Moment of inertia, total	kgm^2	lb ft^2	kgm^2
r1969	Speed_cont_opt moment of inertia determined	kgm^2	lb ft^2	kgm^2

*) Factory setting

7.7.1.2 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units
- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

Note

Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which switchover to % is not possible, 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.

Note

Parameters affected by switchover

The parameters affected by switching over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

7.7.1.3 Changing over process variables for the technology controller

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Note

We recommend that the units and reference values of the technology controller are coordinated and harmonized with one another during commissioning.

Subsequent modification in the reference variable or the unit can result in incorrect calculations or displays.

Note

Groups of units

For details concerning unit groups, please refer to the section titled "Unit group and unit choice" in the List Manual.

SwitchIng over process variables of the technology controller

You change over the process variables of the technology controller using p0595. For physical values, you define the reference variable in p0596.

Parameters affected by the unit switchover of the technology controller belong to unit group 9_1.

Switching the process variables of the additional technology controller 0

The process variables of the additional technology controller 0 switch over via p11026. You define the reference variable for absolute units in p11027.

Parameters affected by the unit switchover of the additional technology controller 0 belong to unit group 9_2.

Switching the process variables of the additional technology controller 1

The process variables of the additional technology controller 1 switch over via p11126. You define the reference variable for absolute units in p11127.

Parameters affected by the unit switchover of the additional technology controller 1 belong to unit group 9_3.

Switching the process variables of the additional technology controller 2

The process variables of the additional technology controller 2 switchover via p11226. You define the reference variable for absolute units in p11227.

Parameters affected by the unit switchover of the additional technology controller 2 belong to unit group 9_4.

7.7.2 Energy-saving display

Background

Conventionally-controlled fluid flow machines control the flow rate using valves or throttles. In so doing, the drive operates constantly at the rated speed. The efficiency of the system decreases if the flow rate is reduced using valves or throttles. The efficiency is the lowest when valves or throttles are completely closed. Further, undesirable effects can occur, e.g. the formation of vapor bubbles in liquids (cavitation) or the temperature rise of the medium being pumped increases.

The inverter controls the flow rate or the pressure by varying the speed of the fluid flow machine. As a consequence, over its complete operating range, a fluid-flow machine operates close to its maximum efficiency – and especially in partial load operation, uses less energy than for valve and throttle-based closed-loop control.

Function

The energy-saving display calculates the energy saved when operating fluid-flow machines, e.g. centrifugal pumps, fans, radial and axial compressors. The energy-saving display compares inverter operation with direct line operation and throttle control.

The inverter indicates the energy saved in parameter r0041 in kWh, referred to the last 100 operating hours.

For less than 100 operating hours, the inverter interpolates the energy saving to 100 operating hours.

The inverter calculates the energy-saving based on the operating characteristic that has been saved.

Table 7- 26 Operating characteristic set in the factory

	Point 1	Point 2	Point 3	Point 4	Point 5
Power	p3320 = 25%	p3322 = 50%	p3324 = 77%	p3326 = 92%	p3328 = 100%
Speed	p3321 = 0%	p3323 = 25%	p3325 = 50%	p3327 = 75%	p3329 = 100%

If you require a precise value for the energy saving, then you must adapt the operating characteristic set in the factory.

Additional parameters for the energy consumption display:

r0039[0]: Energy consumption since the last reset.

r0039[1]: Energy drawn since the last reset.

r0039[2]: Energy fed back since the last reset.

p0040: Parameter to reset parameters r0039 and r0041.

r0041: Displays the saved energy since the last reset, referred to the operating characteristic, defined by parameters p3320 …p3329.

Adapting the operating characteristic

Precondition

You require the following data to calculate the system-specific operating characteristic:

- Operating characteristics of the manufacturer
  - for pumps: Delivery height and power as a function of the flow rate
  - for fans: Total pressure increase and power as a function of the flow rate
- System characteristics for five different flow rates.

Procedure

Proceed as follows to adapt the operating characteristic:

1. For the five different flow rates, calculate the delivery height requirement, referred to a pump, which is directly connected to the line supply (n = 100%).

   To do this, set the formula for the system characteristic the same as the formula for the operating characteristic of the delivery height.

   For a correspondingly lower delivery height, you only require a correspondingly low speed.
2. Enter the speeds into parameters p3321, p3323, p3325, p3327 and p3329.

3. Based on the flow rates and the associated operating characteristic of the manufacturer, calculate the power that the pump requires for the various flow rates when connected directly to the line supply.
4. Enter the values into parameters p3320, p3322, p3324, p3326 and p3328.

7.7.3 Braking functions of the converter

7.7.3.1 Electrical braking methods

Regenerative power

If an induction motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it operates as a generator. The motor converts mechanical power into electrical power.
Examples of applications, in which regenerative operation briefly occurs, include:

- Fans that in no-load operation turn backwards because of a draft must be braked before the start up.

For certain applications, the motor can operate in the regenerative mode for longer periods of time.

The inverter offers the following options to convert the regenerative power of the motor into heat:

- DC braking (Page 379)
- Dynamic braking (Page 383)

A comparison with the main features of the individual braking functions is listed in the following paragraphs.

7.7.3.2 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Function

> ⚠ **WARNING**
>
> Danger to life due to fire caused by overheating as the result of thermal overloading of the motor
>
> The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor and even cause fire.
>
> - Monitor the motor temperature.
> - If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

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.

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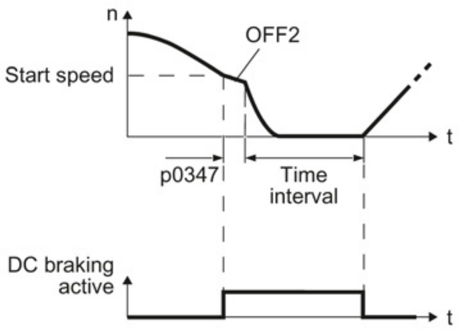
<tr>
<td>

DC braking when falling below a start speed
Precondition: p1230 = 1 and p1231 = 14



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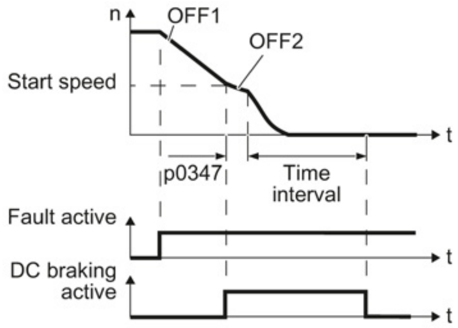
DC braking when a fault occurs
Precondition: Fault number and fault response are assigned using p2100 and p2101



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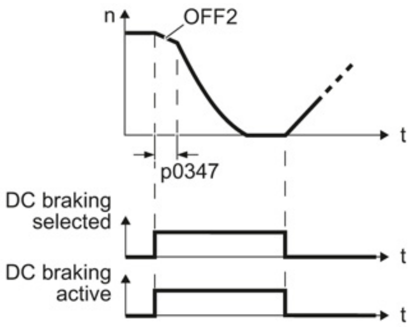
DC braking initiated using a control command
Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)



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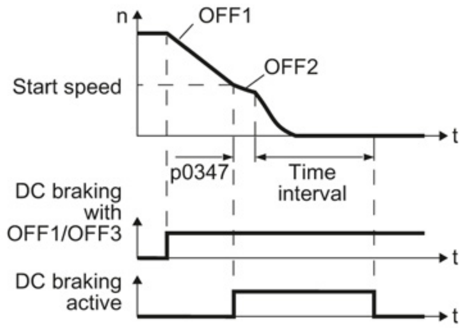
DC braking when switching off the motor
Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14



</td>
</tr>
</table>

DC braking when falling below a starting speed

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

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

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

If the higher-level controller 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

1. The higher-level controller switches the motor off (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 the basic 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: DC braking deactivated • 1 signal: DC braking activated	
p1231	**Configuring DC braking** (factory setting: 0)	
	0 4 5 14	No DC braking General release for DC braking DC braking for OFF1/OFF3 DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)	
p1233	**DC braking duration** (factory setting 1 s)	
p1234	**DC braking start speed** (factory setting: 210000 rpm)	
r1239	**DC braking status word**	
	.08 .10 .11 .12 .13	DC braking active DC braking ready DC braking selected DC braking selection internally locked DC braking for OFF1/OFF3

Table 7- 27 Configuring DC braking when faults occur

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. The "DCBRAKE" entry means that DC braking can be set as response for this particular fault.	

7.7.3.3 Dynamic braking

Typical applications for dynamic braking are fans that in no-load operation turn backwards because of a draft must be braked before the start up.

Principle of operation

⚠ CAUTION
Burns when touching a hot braking resistor
A braking resistor reaches high temperatures during operation. Touching the braking resistor may result in burns. • Do not touch a braking resistor during operation.

The braking chopper controls the braking resistor depending on its DC-link voltage. The DC-link voltage increases as soon as the inverter absorbs the regenerative power when braking the motor. The braking chopper converts this power into heat in the braking resistor. This prevents the DC-link voltage from increasing above the limit value $U_{DC\ link,\ max}$.

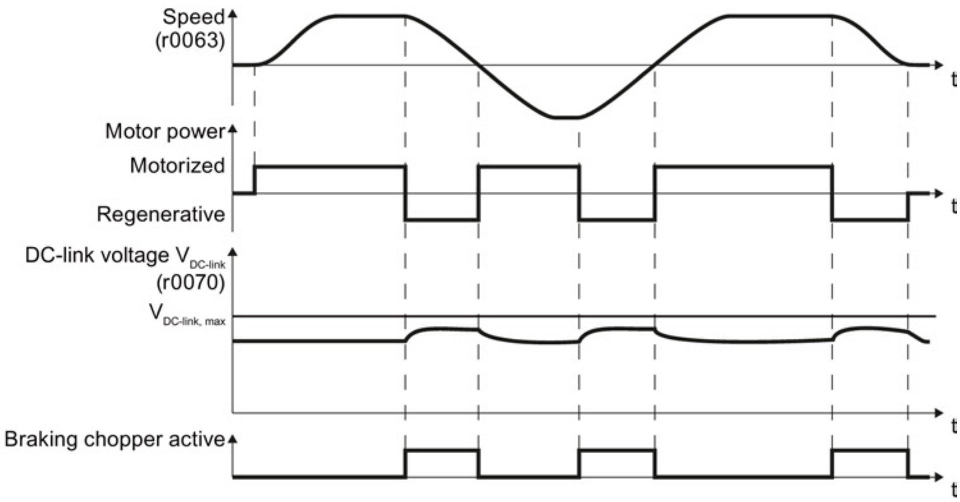


Figure 7-18 Simplified representation of dynamic braking with respect to time

Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 7- 28 Parameter

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0219</td><td colspan="2">Braking power of the braking resistor (factory setting: 0 kW)
Set the maximum braking power that the braking resistor must handle in your particular application.
Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor.
Example: In your particular application, the motor brakes every 90 seconds. In so doing, the braking resistor must handle a braking power of 50 kW for 20 s. Set the maximum braking power to: p0219 = 50 (kW).
Note: As a consequence, the Vdc max controller is automatically deactivated (p1240 = 0), the minimum ramp-down time (p1127) and the regenerative power limit (p1531) adapted</td></tr>
<tr><td rowspan="2">p0844</td><td colspan="2">No coast down / coast down (OFF2) signal source 1</td></tr>
<tr><td>p0844 = 722.x</td><td>Monitor the overtemperature of the braking resistor with digital input x of the Control Unit.
This requires that the thermoswitch of the braking resistor is connected to digital input x of the Control Unit.</td></tr>
</table>

7.7.4 Flying restart

If you switch the motor on while it is still running, then with a high degree of probability, a fault will occur due to overcurrent (F30001 or F07801). Examples of applications involving an unintentionally rotating motor directly before switching on:

- The motor rotates after a brief line interruption.
- A flow of air turns the fan impeller.
- A load with a high moment of inertia drives the motor.

After the ON command, the "flying restart" function initially synchronizes the inverter output frequency to the motor speed and then accelerates the motor up to the setpoint.

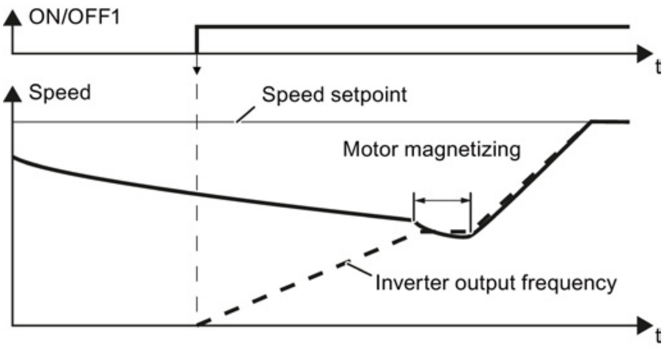


Figure 7-19 Principle of operation of the "flying restart" function

Setting "flying restart" function

If the inverter simultaneously drives several motors, then you must only use the "flying restart" function if the speed of all of the motors is always the same (group drive with a mechanical coupling).

Table 7- 29 Basic setting

Parameter	Description	
p1200	**Flying restart operating mode** (factory setting: 0)	
	0	Flying restart is locked
	1	Flying restart is enabled, search for the motor in both directions, start in direction of setpoint
	4	Flying restart is enabled, only search in direction of setpoint

Table 7- 30 Advanced settings

Parameter	Description
p1201	**Flying restart enable signal source** (factory setting: 1) Defines a control command, e.g. a digital input, through which the flying restart function is enabled.
p1202	**Flying restart search current** (factory setting: 100 %) Defines the search current with respect to the magnetizing current (r0331), which flows in the motor during the flying restart.
p1203	**Flying restart search speed factor** (Factory setting: 100 %) The value influences the speed with which the output frequency is changed during the flying restart. A higher value results in a longer search time. If the inverter does not find the motor, reduce the search speed (increase p1203).

7.7.5 Efficiency optimization

The following can be achieved when optimizing efficiency using p1580:

- Lower motor losses in the partial load range
- Minimization of noise in the motor

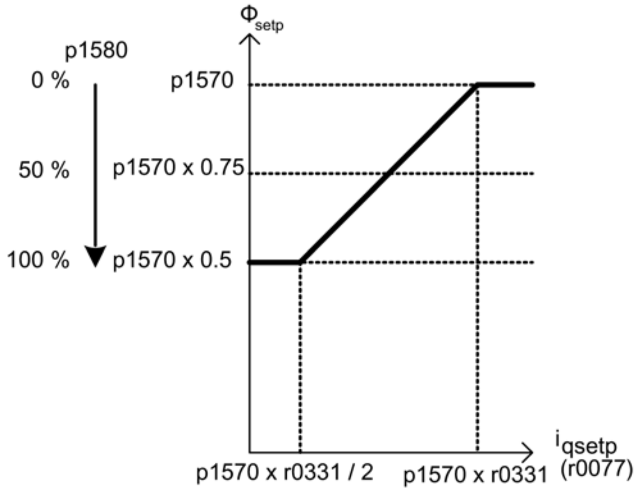


Figure 7-20 Efficiency optimization

It only makes sense to activate this function if the dynamic response requirements of the speed controller are low (e.g. pump and fan applications).

For p1580 = 100%, the flux in the motor under no-load operating conditions is reduced to half of the setpoint (reference flux) (p1570/2). As soon as load is connected to the drive, the setpoint (reference) flux increases linearly with the load, and reaches the setpoint set in p1570 at approx. r0077 = r0331 x p1570.

In the field-weakening range, the final value is reduced by the actual degree of field weakening. The smoothing time (p1582) should be set to approx. 100 to 200 ms. Flux differentiation (see also p1401.1) is automatically deactivated internally following magnetization.

For more information, refer to the parameter descriptions and the function block diagrams 6722 and 673 of the List Manual.

7.7.6 Quick magnetization for induction motors

Description

Fast magnetization for induction motors is used to reduce delay time during magnetization.

Features

- Rapid flux build-up by impressing a field-producing current at the current limit, which considerably reduces the magnetization time.
- If the "Flying restart" function is activated, the excitation build-up time set in p0346 is still used.

Commissioning

Parameter setting p1401.6 = 1 is necessary to activate fast magnetization.

This setting initiates the following sequence during motor starting:

- The field-producing current setpoint jumps to its limit value: 0.9 x r0067 (I_{max}).
- The flux increases as fast as physically possible with the specified current.
- The flux setpoint r0083 is made to follow accordingly.
- Excitation ceases and the speed setpoint is enabled when the flux setpoint is reached.
- The flux is increased further until the flux setpoint in p1570 has been reached.

For more information, refer to the parameter descriptions and the function block diagrams 6491, 6722 and 673 of the List Manual.

Notes

When quick magnetization is selected (p1401.6 = 1), smooth starting is deactivated internally and alarm A07416 displayed.

When the stator resistance identification function is active (see p0621 "Identification of stator resistance after restart"), quick magnetization is deactivated internally and alarm A07416 displayed.

The parameter does not work when combined with the "flying restart" function (see p1200), i.e. flying restart is performed without quick magnetization.

7.7.7 Automatic restart

The automatic restart includes two different functions:

- The inverter automatically acknowledges faults.
- After a fault occurs or after a power failure, the inverter automatically switches the motor on again.

The inverter interprets the following events as power failure:

- The inverter signals fault F30003 (DC-link undervoltage), as the line supply voltage of the inverter has briefly failed.
- The inverter power supply has failed for a long enough time so that the inverter has been switched-off.

⚠ WARNING
Danger to life due to the automatic machine restart When the "automatic restart" function is active (p1210 > 1), the motor automatically starts after a power failure. The movements that the machine executes may result in serious injuries. • Block the machine to prevent unintentional access. • Before working on the machine switch the automatic restart mechanism off.

Commissioning the automatic restart

Proceed as follows to commission the automatic restart:

1. If it is possible that the motor is still rotating for a longer period of time after a power failure or after a fault, then in addition, you must activate the "flying restart" function, see Flying restart (Page 384).
2. Using p1210, select the automatic restart mode that best suits your application.

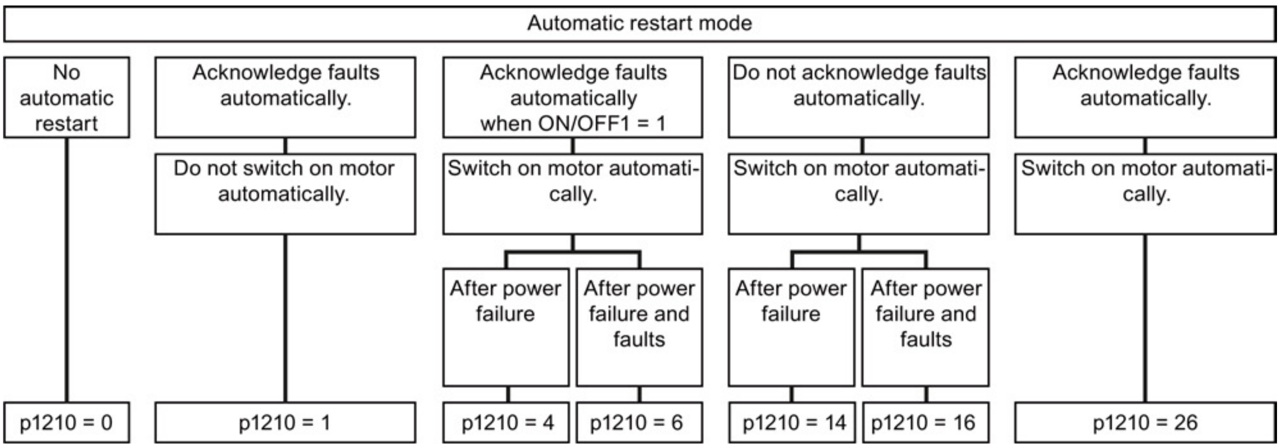
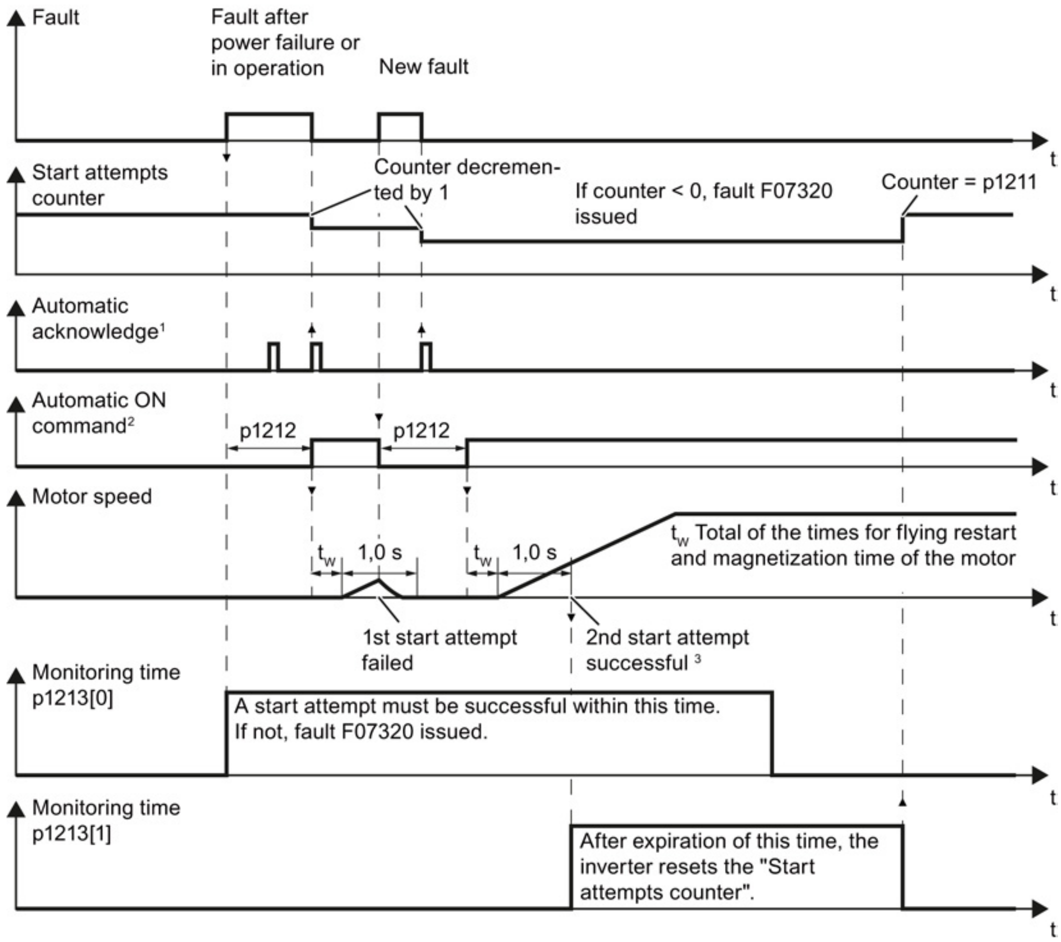


Figure 7-21 Selecting the automatic restart mode

3. Set the parameters of the automatic restart function.
   The method of operation of the parameters is explained in the following diagram and in the table.



[1] The inverter automatically acknowledges faults under the following conditions:

- p1210 = 1 or 26: Always.
- p1210 = 4 or 6: If the command to switch the motor on is available at a digital input or via the fieldbus (ON/OFF1 = 1).
- p1210 = 14 or 16: Never.

[2] The inverter attempts to automatically switch the motor on under the following conditions:

- p1210 = 1: Never.
- p1210 = 4, 6, 14, 16, or 26: If the command to switch the motor on is available at a digital input or via the fieldbus (ON/OFF1 = 1).

[3] If no fault has occurred one second after flying restart and magnetizing (r0056.4 = 1), the start attempt was successful.

Figure 7-22 Time response of the automatic restart

Parameters for setting the automatic restart

<table>
<tr><th>Parameter</th><th>Explanation</th></tr>
<tr><td>p1210</td><td>Automatic restart mode (factory setting 0)
0: Disable automatic restart.
1: Acknowledge all faults without restarting.
4: Restart after power failure without further restart attempts.
6: Restart after fault with further restart attempts.
14: Restart after power failure after manual acknowledgement.
16: Restart after fault after manual acknowledgement.
26: Acknowledgement of all faults and restart with ON/OFF1 = 1 command.</td></tr>
<tr><td>p1211</td><td>Automatic restart start attempts (factory setting 3)
This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.
You define the maximum number of start attempts using p1211. After each successful acknowledgement, the inverter decrements its internal counter of start attempts by 1.
For p1211 = n, up to n + 1 start attempts are made. Fault F07320 is output after n + 1 unsuccessful start attempts.
The inverter sets the start attempt counter back again to the value of p1211, if one of the following conditions is fulfilled:
• After a successful start attempt, the time in p1213[1] has expired.
• After fault F07320, switch the motor off (OFF1) and acknowledge the fault.
• You change the start value p1211 or the mode p1210.</td></tr>
<tr><td>p1212</td><td>Automatic restart wait time start attempt (factory setting 1.0 s)
This parameter is only effective for the settings p1210 = 4, 6, 26.
Examples for setting this parameter:
1. After a power failure, a certain time must elapse before the motor can be switched-on, e.g. because other machine components are not immediately ready. In this case, set p1212 longer than the time, after which all of the fault causes have been removed.
2. In operation, the inverter develops a fault condition. The lower you select p1212, the sooner the inverter attempts to switch the motor on again.</td></tr>
<tr><td>p1213[0]</td><td>Automatic restart monitoring time
for restart (factory setting 60 s)
This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26.
With this monitoring function, you limit the time in which the inverter may attempt to automatically switch the motor on again.
The monitoring function starts when a fault is identified and ends with a successful start attempt. If the motor has not successfully started after the monitoring time has expired, fault F07320 is signaled.
Set the monitoring time longer than the sum of the following times:
+ p1212
+ Time that the inverter requires to start the motor on the fly.
+ Motor magnetizing time (p0346)
+ 1 second
You deactivate the monitoring function with p1213 = 0.</td></tr>
</table>

Parameter	Explanation
p1213[1]	**Automatic restart monitoring time to reset the start-up counter** (factory setting: 0 s) This parameter is only effective for the settings p1210 = 4, 6, 14, 16, 26. Using this monitoring time, you prevent that faults, which continually occur within a certain time period, are automatically acknowledged each time. The monitoring function starts with a successful start attempt and ends after the monitoring time has expired. If the inverter has made more than (p1211 + 1) successful start attempts within monitoring time p1213[1], the inverter cancels the automatic restart function and signals fault F07320. In order to switch the motor on again, you must acknowledge the fault and set ON/OFF1 = 1.

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

Advanced settings

If you wish to suppress the automatic restart function for certain faults, then you must enter the appropriate fault numbers in p1206[0 … 9].

Example: p1206[0] = 07331 ⇒ No restart for fault F07331.

Suppressing the automatic restart only functions for the setting p1210 = 6, 16 or 26.

⚠WARNING

Danger to life caused by unexpected movement of motors due to incorrect parameterization of the field bus

In the case of communication via the fieldbus interface, the motor restarts with the setting p1210 = 6 even if the communication link is interrupted. This causes an automatic restart of the motor with the danger of injury.

- Enter the fault number of the communication error in parameter p1206.

Example: A communication failure via PROFIBUS is signaled using fault F01910. You should therefore set p1206[n] = 1910 (n = 0 … 9).

7.7.8 Technology controller

Description

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

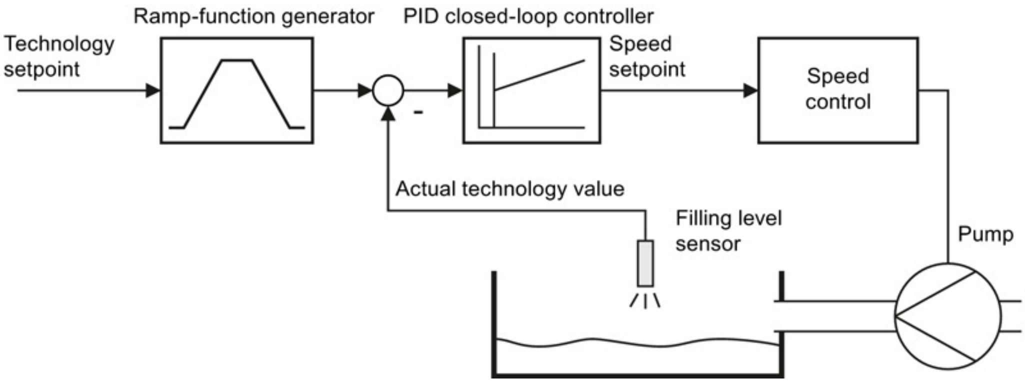


Figure 7-23 Example: Technology controller as a level controller

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- Separate fixed values
- Separate motorized potentiometer
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched to the system deviation or actual value channel.
- The motorized potentiometer of the technology controller is only active when the drive pulses are enabled.

Simplified representation of the technology controller

The technology controller is implemented as PID controller (controller with proportional, integral and differential component) which means that it can be very flexibly adapted.

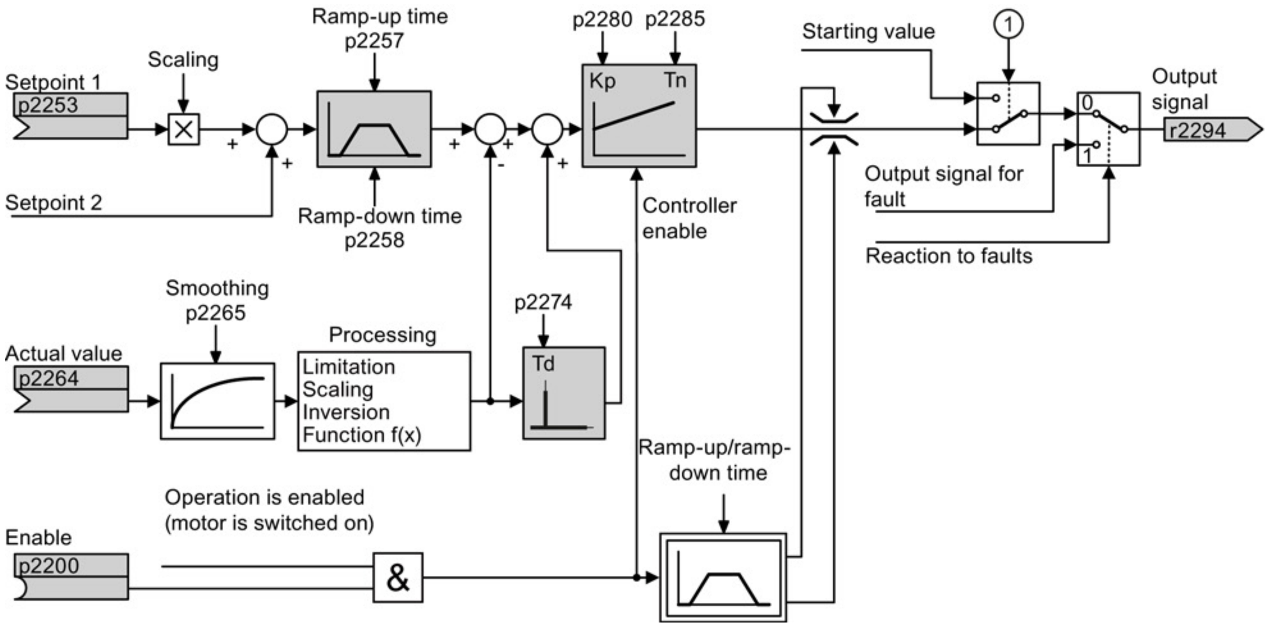


Figure 7-24 Simplified representation of the technology controller

① The inverter uses the start value when all the following conditions are 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.

For more information, refer to the parameter descriptions and the function block diagrams 7950 - 7958 of the List Manual.

Optimizing a closed-loop controller

You optimize the technology controller as described in Section Optimizing the closed-loop speed controller (Page 358).

7.7.9 Free technology controllers

Additional technology controllers

The inverter has 3 additional technology controllers in the following parameter ranges:

- p11000 … p11099: free technology controller 0
- p11100 … p11199: free technology controller 1
- p11200 … p11299: free technology controller 2

For more information, refer to the parameter descriptions and the function block diagram 7030 in the List Manual.

7.7.10 Monitor the load torque (system protection)

In many applications, it is advisable to monitor the motor torque:

- Applications where the load speed can be indirectly monitored by means of the load torque. For example, in fans and conveyor belts with too low a torque indicates that the drive belt is torn.
- Applications that are to be protected against overload or locking (e.g. extruders or mixers).
- Applications in which no-load operation of the motor represents an impermissible situation (e.g. pumps).

Load torque monitoring functions

The inverter monitors the motor torque in different ways:

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

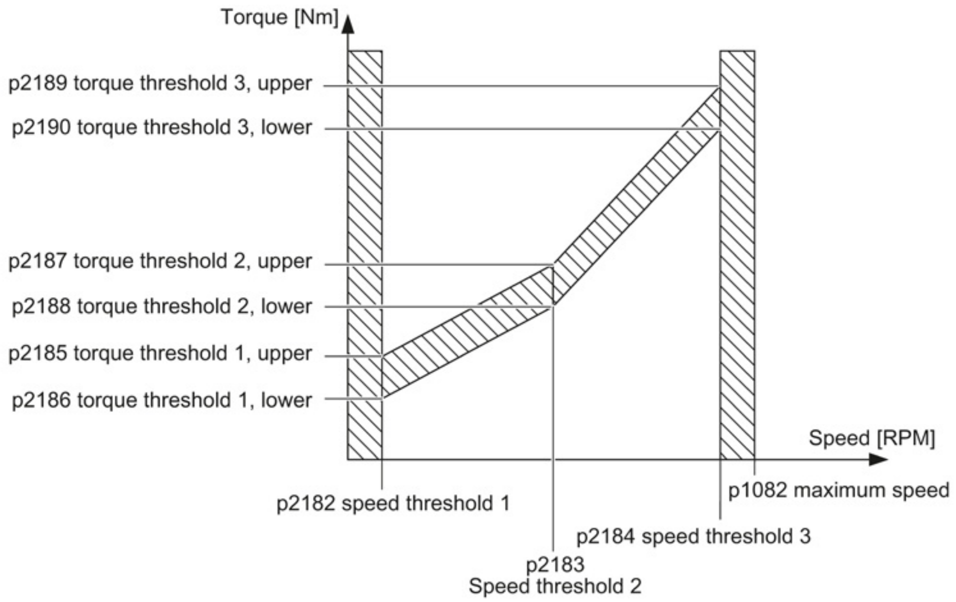


Figure 7-25 Load torque monitoring

Table 7- 31 Parameterizing the monitoring functions

Parameter	Description
No-load monitoring	
3% x p0305	**Current limit for no-load detection** If the inverter current is below this value, the message "no load" is output.
p2180	**Delay time for the "no load" message**
Blocking protection	
p2177	**Delay time for the "motor locked" message**
Stall protection	
p2178	**Delay time for the "motor stalled" message**
p1745	**Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated** This parameter is only evaluated as part of encoderless vector control.
Speed-dependent torque monitoring	
p2181	**Load monitoring, response** Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
p2182	**Load monitoring, speed threshold 1**
p2183	**Load monitoring, speed threshold 2**
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**
p2193	**Load monitoring configuration** 0: Monitoring switched off 1: Monitoring torque and load drop 2: Monitoring speed and load drop 3: Load failure monitoring

For more information about these functions, see the List Manual (function block diagrams 8012, 8013, and 8020 as well as the parameter list).

7.7.11 Load failure monitoring

Using this function, the inverter monitors the speed or velocity of a machine component. The inverter evaluates whether an encoder signal is present. If the encoder signal fails for a time that can be adjusted, then the inverter signals a fault.

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

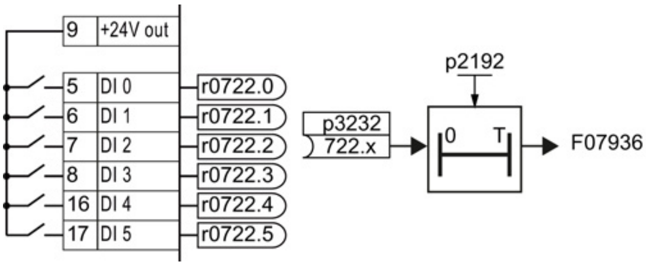


Figure 7-26 Load failure monitoring using a digital input

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 = 1…3	**Load monitoring configuration** (factory setting: 1) 0: Monitoring is deactivated 1: Torque monitoring (see Monitor the load torque (system protection) (Page 394)) and load failure 2: Speed deviation monitoring (see below) and load failure 3: Load failure monitoring
p3232 = 722.x	**Load monitoring failure detection** (factory setting: 1) Interconnect the load monitoring with a digital input of your choice.

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

7.7.12 Real time clock (RTC)

The real-time clock (RTC) is the basis for time-dependent process controls, e.g.:

- To reduce the temperature of a heating control during the night
- Increase the pressure of a water supply at certain times during the day

Real-time clock: Format and commissioning

The real-time clock starts as soon as the Control Unit power supply is switched on for the first time. The real-time clock comprises the time in 24-hour format and the date in "day, month, year" format.

After a Control Unit power supply interruption, the real-time clock continues to run for approx. five days.

If you wish to use the real-time clock, you must set the time and date once when commissioning. If you restore the inverter factory setting, the real-time clock parameters are not reset.

Parameter	Real-time clock (RTC)
p8400[0]	**RTC time**, hour (0 … 23)
p8400[1]	**RTC time**, minute (0 … 59)
p8400[2]	**RTC time**, second (0 … 59)
p8401[0]	**RTC date**, day (1 … 31)
p8401[1]	**RTC date**, month (1 … 12)
p8401[2]	**RTC date**, year (1 … 9999)
r8404	**RTC weekday** 1: Monday 2: Tuesday 3: Wednesday 4: Thursday 5: Friday 6: Saturday 7: Sunday
p8405	**RTC activate/deactivate alarm A01098** Sets whether the real-time clock issues an alarm if the time is not running in synchronism (e.g. after a longer power supply interruption). 0: Alarm A01098 deactivated 1: Alarm A01098 activated (factory setting)

Accept the real-time clock in the alarm and fault buffer

Using the real-time clock, you can track the sequence of alarms and faults over time. When an appropriate message occurs, the real-time clock is converted into the UTC time format (Universal Time Coordinated):

Date, time ⇒ 01.01.1970, 0:00 + d (days) + m (milliseconds)

The number "d" of days and the number "m" of milliseconds is transferred into the alarm and fault times of the alarm or fault buffer, see Section Alarms, faults and system messages (Page 439).

Converting UTC into RTC

An RTC can again be calculated from the UTC.

Proceed as follows to calculate a date and time from a fault or alarm time saved in the UTC format:

1. Calculate the number of seconds of UTC:
   Number of seconds = ms / 1000 + days × 86400
2. In the Internet, you will find programs to convert from UTC into RTC, e.g.:
   UTC to RTC (http://unixtime-converter.com/)
3. Enter the number of seconds in the corresponding screen and start the calculation.

Example:

Saved as alarm time in the alarm buffer:

r2123[0] = 2345 [ms]
r2145[0] = 15920 [days]

Number of seconds = 2345 / 1000 + 15920 × 86400 = 1375488023
Converting this number of seconds in RTC provides the date: 03.08.2013, 02:00:23.

7.7.13 Time switch (DTC)

The "time switch" (DTC) function, along with the real-time clock in the inverter, offers the option of controlling when signals are switched on and off.

Examples:

- Switching temperature control from day to night mode.
- Switching a process control from weekday to weekend.

Principle of operation of the time switch (DTC)

The inverter has three independently adjustable time switches. The time switch output can be interconnected with every binector input of your inverter, e.g. with a digital output or a technology controller's enable signal.

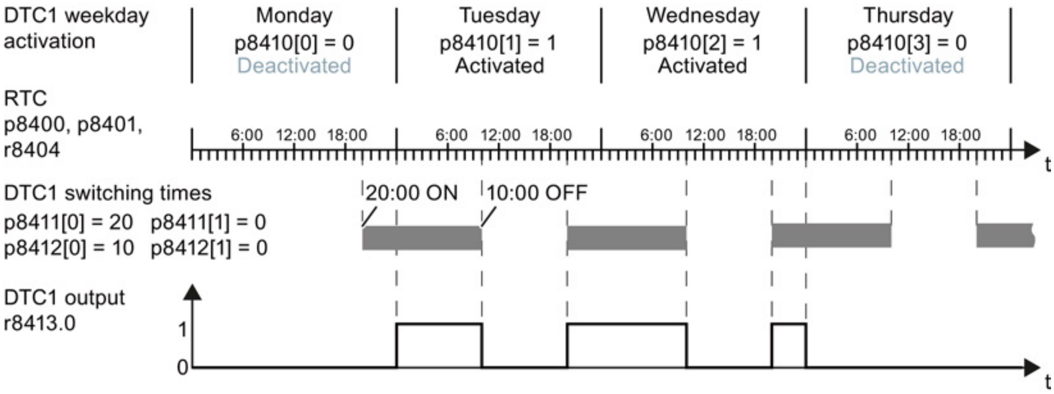


Figure 7-27 Time behavior of the time switch using example DTC1

Setting the time switch

- Enable parameterization of the DTC: p8409 = 0.
  As long as DTC parameterization is enabled, the inverter keeps the output of all three DTC (r84x3, x = 1, 2, 3) at LOW.
- Set the activation of the weekdays; the switching on and off times.
- Enable the setting: p8409 = 1.
  The inverter enables the DTC output once more.

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

7.7.14 Acquire temperature using temperature sensors

Analog input AI 2

Via the DIP switch and parameter p0756[2] , set the function of the analog input AI 2:

- p0756[2] = 2 or 3→ options for setting as current input
- p0756[2] = 6, 7 or 8 → options for setting as temperature sensor

Analog input AI 3

Analog input AI 3 is designed as a resistance input for a temperature sensor.

Setting options:

- p0756[3] = 6, 7 or 8 → options for setting as temperature sensor

Permissible temperature sensors

The temperature-dependent resistances Pt1000 or LG-Ni1000 are permissible as temperature sensors. If you want to use the temperature signal as the actual value of the temperature closed-loop controller, set p2264 = 755[2] or 755[3].

Connect the temperature sensor as follows:

- AI 2 (terminals 50, 51)
- AI 3 (terminals 52, 53)

Measuring ranges and alarm thresholds for LG-Ni1000

The measuring range of the LG-Ni1000 sensor extends from – 88° C … 165° C. For values outside this range, the inverter outputs alarm A03520 "Temperature sensor fault". The fault type is displayed in r2124.

Measuring ranges and alarm thresholds for Pt1000

The measuring range of the Pt1000 sensor extends from –88° C … 240° C. For values outside this range, the inverter outputs alarm A03520 "Temperature sensor fault". The fault type is displayed in r2124.

Fault values for temperature sensing via AI 2

- r2124 = 33: Wire break or sensor not connected
- r2124 = 34: Short-circuit

Fault values for temperature sensing via AI 3

- r2124 = 49: Wire break or sensor not connected
- r2124 = 50: Short-circuit

Note

If you use a temperature sensor as the input for the technology controller, you have to modify the scaling of the analog input.

- Scaling example for LG-Ni1000:
  0° C (p0757[x]) = 0% (p0758[x]); 100° C (p0759[x]) = 100% (p0760[x])
- Scaling example for Pt1000:
  0° C (p0757[x]) = 0% (p0758[x]); 80 % C (p0759[x]) = 100% (p0760[x])

Please refer to the parameter list as well as the 2252 and 2270 function block diagrams for further details.

7.7.15 Essential service mode

In the **E**ssential **S**ervice **M**ode (ESM), the motor must operate for as long as possible, for example in the case of a fire, to keep the evacuation routes open by extracting smoke.

Contrary to normal operation, when faults develop, the inverter does not shut down, but responds as follows

- Faults that do not immediately result in the destruction of the inverter or the motor:
  The inverter ignores these faults, and continues to operate in the "essential service mode"
- Faults/errors, which cannot be ignored, and demand a restart, for example software errors:
  The inverter automatically restarts and attempts to acknowledge the existing fault/error using this function.
- Faults, which also cannot be resolved after a restart:
  In this case, there is the option of activating the bypass function and to directly operate the motor from the line supply.

⚠ WARNING

Danger to life due to fire in essential service mode

In essential service mode, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter. Fire and smoke development can cause severe injury or material damage.

- Use essential service mode only when the named restrictions are satisfied.

Note

Loss of warranty for an inverter operated in the essential service mode

If you activate the essential service mode, then all warranty claims are null and void with reference to the inverter.

The essential service mode is an exceptional state, and is not suitable for continuous operation.

The inverter logs the essential service mode, and the faults that occur while in essential service mode in a password-protected memory. This data is only accessible for the service and repair organization.

Special features of essential service mode

Priority

The essential service mode has priority over all other operating modes (e.g. hibernation or energy-saving mode).

Starting and ending the essential service mode

The essential service mode is started via a digital input, and remains active as long as the signal is available.

If the signal is withdrawn via the digital input, then the inverter reverts to normal operation and its behavior depends on the pending commands and setpoints.

Automatic restart in the essential service mode

In the essential service mode, the inverter operates with the "Restart after fault with additional start attempts" setting (p1210 = 6). We recommend that you set the automatic restart function, also for normal operation, to a value p1210 ≠ 0.

In the essential service mode, the inverter ignores the settings in p1206 (faults without automatic restart).

The inverter carries out the maximum number of restart attempts set in p1211 corresponding to the settings in p1212 and p1213. If these attempts are not successful, then the inverter goes into a fault condition with F07320.

Speed setpoint and direction of rotation in the essential service mode

The essential service mode has its own setpoint source (p3881), and if this source is lost, an alternative setpoint (p3882).

For the case that it is not possible to define the direction of rotation of the essential service mode setpoint when configuring the system, then the direction of rotation can be inverted using a digital input.

If the technology controller is active as setpoint source for the essential service mode setpoint, then the direction of rotation cannot be changed via the digital input.

Bypass and essential service mode

- If, when activating the essential service mode, bypass operation is active, inverter operation is selected internally in order to ensure that the setpoint is entered via the source intended for the essential service mode.
- If faults are still present after the number of start attempts parameterized in p1211, then the inverter goes into a fault condition with F07320. In this case, there is an option of switching over to bypass operation and then directly connecting the motor to the line supply.

Application example

To improve the air circulation in the stairwells, the ventilation control creates a slight underpressure in the building. With this control, a fire would mean that smoke gases enter into the stairwell. This would then mean that the stairs would be blocked as escape or evacuation route.

Using the essential service mode function, the ventilation switches over to the control of an overpressure. This prevents the propagation of smoke in the stairwell, thereby keeping the stairs free as an evacuation route.

Settings for the essential service mode

Procedure

Proceed as follows in order to be able to use the essential service mode:

1. **Interconnect a free digital input as source for the essential service mode.**
   Example DI3: Set p3880 = 722.3.
   Ensure that this digital input is not interconnected with other functions.
2. **Using p3881, set the setpoint source for the essential service mode**
   Option 1:
   - P3881 = 0: Last recognized setpoint (factory setting) or
   - p3881 = 1: Fixed setpoint 15, or
   - p3881 = 2: Analog setpoint, or
   - p3881 = 3: Fieldbus

   Option 2:
   - p3881 = 4: Technology loop controller
   - Using p3884, set the source for the essential service mode setpoint.
     If you cannot connect a setpoint in p3884, then the inverter takes technology setpoint 1 that has been connected (p2253).
3. **Using p3882, set the source for the alternative setpoint.**
   - P3882 = 0: Last recognized setpoint (factory setting)

     p3882 = 1: Fixed speed setpoint which is defined in p1015

     p3882 = 2: Maximum speed (value of p1082)
4. **Parameterize the source to select the direction of rotation for the essential service mode.**
   Option 1: Emergency setpoint using p3881 = 0, 1, 2, 3:
   Using p3883, invert the direction of rotation for the essential service mode. To do this, interconnect p3883 with a digital input, e.g. with digital input 4 (DI4): Set p3883 = 722.4
   The following applies:
   - p3883 = 0 → normal direction of rotation in the essential service mode,
   - p3883 = 1 → inverted direction of rotation in the essential service mode,

   Option 2: Essential service mode via technology controller (p3881 = 4)
   If you enter the setpoint for the essential service mode via the technology controller, then the direction of rotation of the essential service mode setpoint is always valid.

5. **Switchover to bypass operation - option**
   If the inverter is not in a position to acknowledge pending faults using the automatic restart, then it goes into a fault condition with fault F07320.

   In order to also be able to operate the motor in this case, you have the option of directly connecting the motor to the line supply using the bypass operation function.

   For this, you must observe the following items:

   – Start the script described in this FAQ http://support.automation.siemens.com/WW/view/en/66936543 (http://support.automation.siemens.com/WW/view/en/66936543). This means that you enable the "Bypass in the essential service mode" function.

   – Ensure that the direction of rotation does not change when switching over to bypass operation.

   – Set that the bypass is activated via a signal (p1267 = 0).

   – Make other settings for "Switch over to bypass (Page 413)".

Application example

An application example for the essential service mode can be found on the Internet at the following address: http://support.automation.siemens.com/WW/view/en/63969509 (http://support.automation.siemens.com/WW/view/en/63969509)

7.7.16 Multi-zone control

Multi-zone control is used to control quantities such as pressure or temperature via the technology setpoint deviation. The setpoints and actual values are fed in via the analog inputs as current (0 … 20 mA) or voltage (0 … 10 V) or as a percentage via temperature-dependent resistances (LG-Ni1000 / Pt1000, 0° C = 0%; 100° C= 100%).

Control variants for multi-zone control

There are three control variants for multi-zone control, which are selected via p31021:

- **One setpoint and one, two or three actual values**

  The actual value for the control can be calculated as mean value, maximum value or minimum value by the inverter. You can find all of the setting options in the parameter list in parameter p31022.

  – Average value: The deviation from the setpoint of the average value of two or three actual values is controlled.

  – Minimum value: The deviation from the setpoint of the smallest actual value is controlled.

  – Maximum value: The deviation from the setpoint of the highest actual value is controlled.

- **Two setpoint / actual value pairs as maximum value control (cooling)**

  The maximum value control compares two setpoint / actual value pairs and controls the actual value which has the largest deviation upwards from its associated setpoint. No control takes place if both actual values lie below their setpoints.

  In order to avoid frequent switchover, the inverter only switches over if the deviation of the controlled setpoint / actual value pair is more than two percent lower than the deviation of the uncontrolled value pair.

- **Two setpoint / actual value pairs as minimum value control (heating)**

  The maximum value control compares two setpoint / actual value pairs and controls the actual value which has the largest deviation upwards from its associated setpoint. No control takes place if both actual values lie above their setpoints.

  In order to avoid frequent switchover, the inverter only switches over if the deviation of the controlled setpoint / actual value pair is more than two percent lower than the deviation of the uncontrolled value pair.

Switching from day to night mode

You can modify the setpoints for day and night mode individually. You have the following opportunities to switch from day to night mode:

- Signal via a digital input, e.g. DI 4
- via p31025 with the aid of free components and the real-time clock

---

Note

If you activate the multi-zone control, the inverter switches its analog inputs as sources for the setpoint and current value of the technology controller (refer to table).

Table 7- 32 Parameters to set the multi-zone control:

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p2200</td><td colspan="2">Technology controller enable</td></tr>
<tr><td>p2251</td><td colspan="2">Set technology controller as main setpoint</td></tr>
<tr><td rowspan="3">p31020</td><td colspan="2">Multi-zone control interconnection
(factory setting = 0)
A subsequent parameterization is performed by activating or deactivating the multi-zone control.</td></tr>
<tr><td>Subsequent connection for p31020 = 1 (activate multi-zone control)</td><td>Subsequent connection for p31020 = 0 (deactivate multi-zone control)</td></tr>
<tr><td>p31023[0] = 0755[0] (AI0)
p31023[2] = 0755[1] (AI1)
p31026[0] = 0755[2] (AI2)
p31026[1] = 0755[3] (AI3)
p2253[0] = 31024 (setpoint output, technology controller)
p2264[0] = 31027 (actual value output, technology controller)</td><td>p31023[0] = 0
p31023[2] = 0
p31026[0] = 0
p31026[1] = 0
p2253[0] = 0
p2264[0] = 0</td></tr>
<tr><td>31021</td><td colspan="2">Configuration of multi-zone control
• 0 = Setpoint 1 / several actual values (factory setting)
• 1 = Two zones / maximum value setting
• 2 = Two zones / minimum value setting</td></tr>
<tr><td>p31022</td><td colspan="2">Processing of actual values for multi-zone control (only for p31021 = 0)
Possible values: 0 … 11 (factory setting = 0)</td></tr>
<tr><td>p31023[0 … 3]</td><td colspan="2">Setpoints for multi-zone control
Selection of the source for setpoints in multi-zone control (factory setting = 0)</td></tr>
<tr><td>r31024</td><td colspan="2">Multi-zone control setpoint output for the technology controller</td></tr>
<tr><td>p31025</td><td colspan="2">Switching from day to night mode for multi-zone control
Selection of the source for switching between day and night operation by the multi-zone control (default setting = 0)</td></tr>
<tr><td>p31026[0 … 2]</td><td colspan="2">Actual values for multi-zone control
Selection of the source for actual values of the multi-zone control (factory setting = 0)</td></tr>
<tr><td>r31027</td><td colspan="2">Multi-zone control actual value output for the technology controller</td></tr>
</table>

Note

If you deactivate the multi-zone control, the inverter resets the interconnection of its analog inputs to the default setting.

Example

In an open plan office, temperature sensors (Lg-Ni1000) are installed in three different places. The inverter receives the measured values and temperature setpoint via its analog inputs. Temperature setpoints between 8° C … 30° C are permissible. Overnight the average temperature should be 16° C.

Settings

p2200 = 1	Technology controller enable
p2251 = 0	Set technology controller as main setpoint
p2900 = 16	Temperature setpoint overnight (16° C) as a fixed percentage value
p31020 = 1	Activate multi-zone control
p31021 = 0	Select multi-zone control with one setpoint and three actual values
p31022 = 7	Three actual values, one setpoint. The average value of the three actual values is used for the control.
p31023[0] = 755[0]	Temperature setpoint via analog input 0
p0756[0] = 0	Select analog input type (voltage input 0 … 10 V)
p0757[0] = 0 / p0758[0] = 8	Set the lower value to 8° C (0 V ≙ 8° C)
p0759[0] = 10 / p0760[0] = 30	Set the upper value to 30° C (10 V ≙ 30° C)
p31023[1] = 2900	Link p31023[1] with the value written in p2900 to reduce the temperature overnight
p31026[0] = 755[2]	Temperature actual value 1 via analog input 2 as a percentage value
p0756[2] = 6	Select analog input type (temperature sensor LG-Ni1000)
p0757[2] = 0 / p0758[2] = 0	Set lower value of the scaling characteristic
p0759[2] = 100 / p0760[2] = 100	Set upper value of the scaling characteristic
p31026[1] = 755[3]	Temperature actual value 2 via analog input 3 as a percentage value
p0756[3] = 6	Select analog input type (temperature sensor LG-Ni1000)
p0757[3] = 0 / p0758[3] = 0	Set lower value of the scaling characteristic
p0759[3] = 100 / p0760[3] = 100	Set upper value of the scaling characteristic
p31026[2] = 755[1]	Temperature actual value 3 via temperature sensor with current output (0 mA … 20 mA) via analog input 1
p0756[1] = 2	Select analog input type (current input 0 … 20 mA)
p0757[1] = 0 / p0758[1] = 0	Set lower value of the scaling characteristic (0 mA ≙ 0° C)
p0759[1] = 20 / p0760[1] = 100	Set upper value of the scaling characteristic (20 mA ≙ 100%)
p31025 = 722[4]	Switchover from day to night via digital input 4

You will find more information about this multi-zone control in the parameter list and in function block diagram 7032 of the List Manual.

7.7.17 Cascade control

Cascade control is suitable for applications that require simultaneous operation of up to four motors as a function of the load. Here, for example, significantly fluctuating pressures or flow rates are equalized.

Depending on the PID variance, the inverter's cascade control switches up to three other motors on or off via contactors or motor starters.

Note

Technology closed-loop controller as main setpoint

For cascade control switch the main setpoint with the output of the technology closed-loop controller (p2251 = 0, p2200 =1)

Operating principle

- **Connecting external motors**

  If the main drive is run at maximum speed and the deviation on the technology closed-loop controller input continues to increase, the controller also switches the external motors on the line system. At the same time, the main drive is ramped down to the switch-on/switch-off speed (p2378) to keep the total output power as constant as possible. The technology closed-loop controller is deactivated while ramping down to the switch-on/switch-off speed.

- **Disconnecting external motors**

  If the main drive is running at minimum speed and the deviation on the technology closed-loop controller input continues to decrease, the controller disconnects the external motors M1 to M3 from the line system. The main drive is simultaneously ramped-up to the switch-on/switch-off speed to keep the total output power as constant as possible.

To avoid frequent activation/deactivation of the uncontrolled motors, you must specify a time in p2377 which must have elapsed before the inverter can switch a further motor on or off. After the time set in p2377 has elapsed, a further motor will be activated immediately if the PID deviation is greater than the value set in p2376. If, after p2377 has elapsed, the PID deviation is less than p2376 but greater than 2373, the timer p2374 is started before the uncontrolled motor is activated.

The motors are deactivated in the same way.

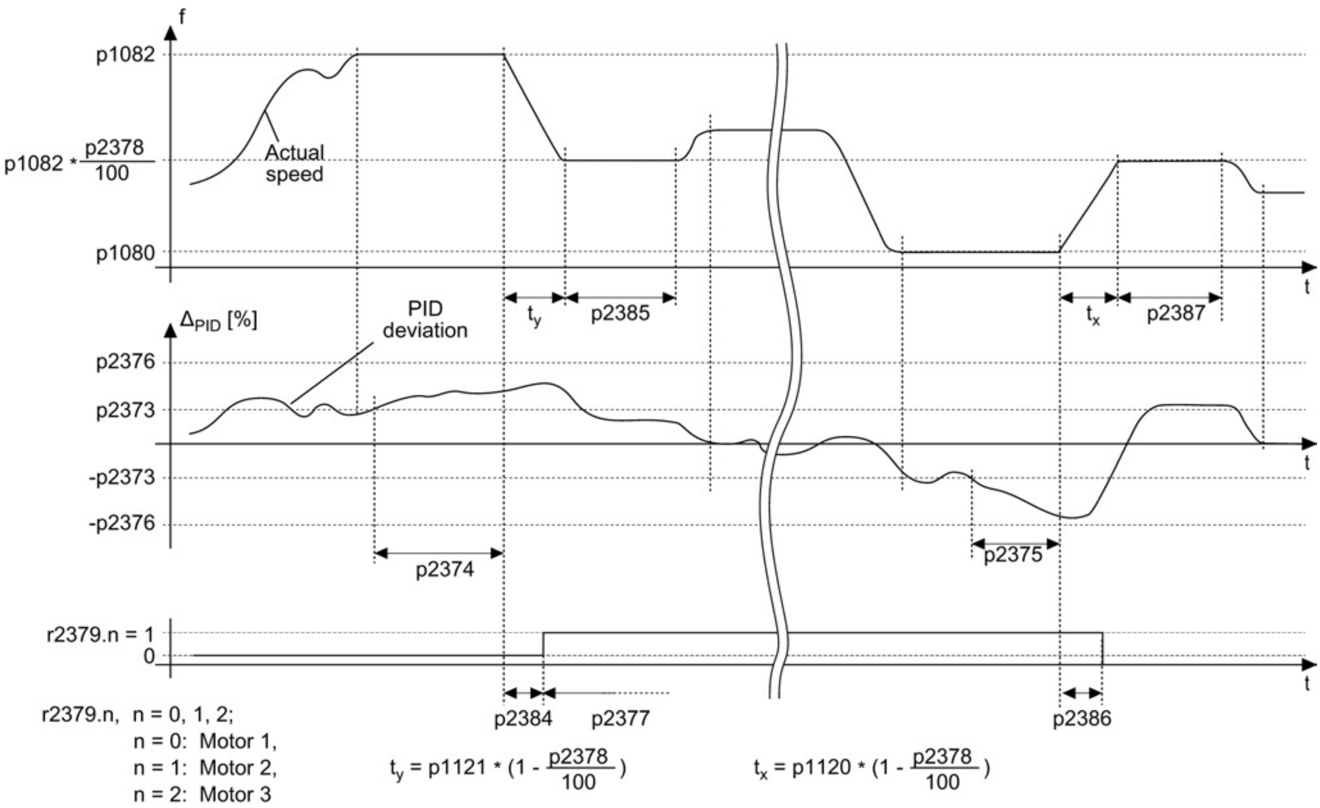


Figure 7-28 Conditions for activating/deactivating an uncontrolled motor

Controlling the activation and deactivation of motors

Use p2371 to determine the order of activation/deactivation for the individual external motors.

Table 7- 33 Order of activation for external motors depending on setting in p2371

p2371	Significance	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
0	Cascade control deactivated	---					
1	One motor can be activated	M1					
2	Two motors can be activated	M1	M1+M2				
3	Two motors can be activated	M1	M2	M1+M2			
4	Three motors can be activated	M1	M1+M2	M1+M2+M3			
5	Three motors can be activated	M1	M3	M1+M3	M1+M2+M3		
6	Three motors can be activated	M1	M2	M1+M2	M2+M3	M1+M2+M3	
7	Three motors can be activated	M1	M1+M2	M3	M1+M3	M1+M2+M3	
8	Three motors can be activated	M1	M2	M3	M1+M3	M2+M3	M1+M2+M3

Table 7- 34 Order of deactivation for external motors depending on setting in p2371

p2371	Activated motors	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
1	M1	M1					
2	M1+M2	M1+M2	M1				
3	M1+M2	M1+M2	M2	M1			
4	M1+M2+M3	M1+M2+M3	M1+M2	M1			
5	M1+M2+M3	M1+M2+M3	M3+M1	M3	M1		
6	M1+M2+M3	M1+M2+M3	M3+M2	M2+M1	M2	M1	
7	M1+M2+M3	M1+M2+M3	M3+M1	M3	M2+M1	M1	
8	M1+M2+M3	M1+M2+M3	M3+M2	M3+M1	M3	M2	M1

If you are using motors of the same power rating, you can use p2372 to define whether the motors are to be activated/deactivated following the setting specified in p2371 (p2372 = 0) or based on the operating hours (p2372 = 1, 2 ,3. Details see parameter list).

Parameters to set and activate the cascade control

p0730 = r2379.0	**Signal source for digital output 0** Control external motor 1 via DO 0
p0731 = r2379.1	**Signal source for digital output 1** Control external motor 2 via DO 1
p0732 = r2379.2	**Signal source for digital output 2** Control external motor 3 via DO 2
p2200 = 1	**Technology closed-loop controller release** Activate technology closed-loop controller
p2251 = 0	**Technology closed-loop controller mode** Technology closed-loop controller as main speed setpoint
p2370 = 1	**Cascade control enable**
p2371	**Cascade control - configuration** Define activation sequence
p2372	**Cascade control - motor selection mode** Define automatic motor switch-on
p2373	**Cascade control - switch-in threshold** Define switch-on threshold
p2374	**Cascade control - switch-in delay** Define delay time
p2375	**Cascade control switch-off delay** Define delay time for de-staging
p2376	**Cascade control - overcontrol threshold** Define overcontrol threshold
p2377	**Cascade control - interlock time** Define interlock time
p2378	**Cascade control - connect/disconnect speed** Define the speed for the main drive after connecting/disconnecting a motor
r2379	**Cascade control - status word**
p2380[0...2]	**Cascade control - operating hours** Operating hours of the individual uncontrolled motors
p2381	**Cascade control - maximum time for continuous mode**
p2382	**Cascade control - absolute operating time limit**
p2383	**Cascade control - switch-off sequence** Define switch-off sequence for an OFF command
p2384	**Cascade control - motor switch-on delay** Define motor switch-on delay
p2385	**Cascade control - connect hold time** Define speed hold time after connecting an external motor
p2386	**Cascade control - motor switch-off delay** Define motor switch-off delay
p2387	**Cascade control - switch-off speed hold time** Define speed hold time after disconnecting an external motor

For more information, refer to the parameter descriptions and the function block diagram 7036 in the List Manual.

7.7.18 Bypass

The bypass function switches the motor from inverter operation to line system operation. The following options are possible:

- Bypass function when activating via a control signal (p1267.0 = 1)
- Bypass function depending on the speed (p1267.1 = 1)

The inverter controls two contactors via its digital outputs. The inverter analyses the feedback signals from the contactors via its digital inputs. If using direct connection logic (high level = ON), both contactors should be NO contacts.

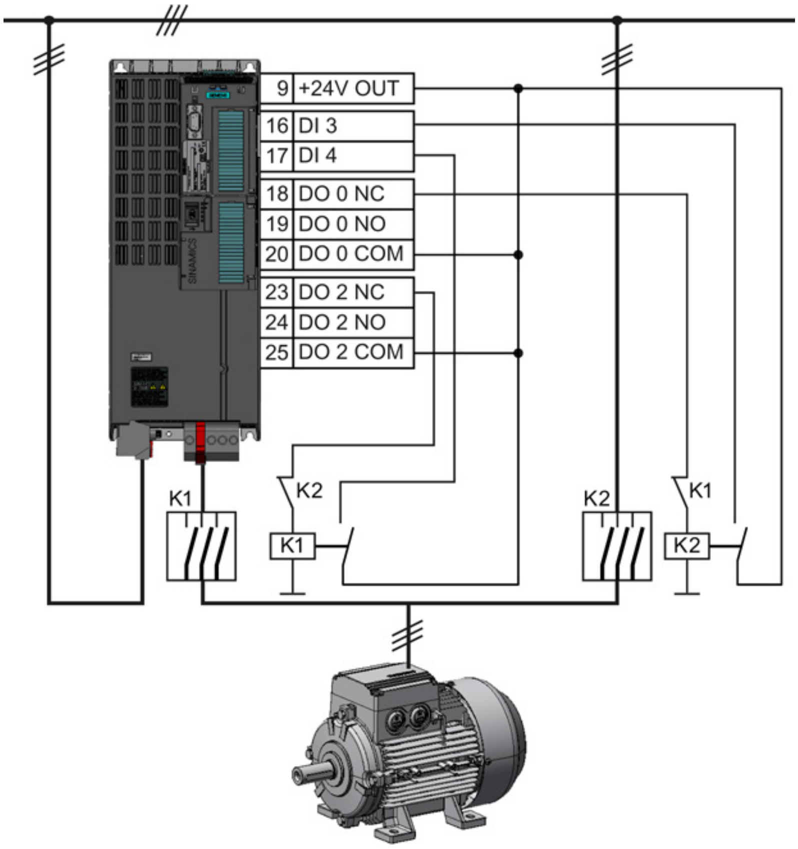


Figure 7-29 Bypass circuit for control using the inverter

Note

Flying restart must be activated for the bypass function (p1200 = 1 or 4).

Note

Bypass mode in the essential service mode

The special features for bypass mode in the essential service mode are described in Section Essential service mode (Page 402).

Switchover procedure between line and inverter operation

When switching over to line operation, contactor K1 is opened after the inverter pulses have been inhibited. The system then waits for the de-energization time of the motor and then contactor K2 is closed so that the motor is connected directly to the line supply.

When the motor is switched to the line supply, an equalizing current flows that must be taken into account when the protective equipment is selected and dimensioned.

When switching over to inverter operation, initially contactor K2 must be opened and after the de-excitation time, contactor K1 is closed. The inverter then captures the rotating motor and the motor is operated on the inverter.

Bypass function when activating via a control signal (p1267.0 = 1)

The state of the bypass contactors is evaluated when the inverter is switched on. If the automatic restart function is active (p1210 = 4) and an ON command (r0054.0 = 1) as well as the bypass signal (p1266 = 1) are still present at power up, then after power up, the inverter goes into the "ready and bypass" state (r899.0 = 1 and r0046.25 = 1) and the motor continues to run directly connected to the line supply.

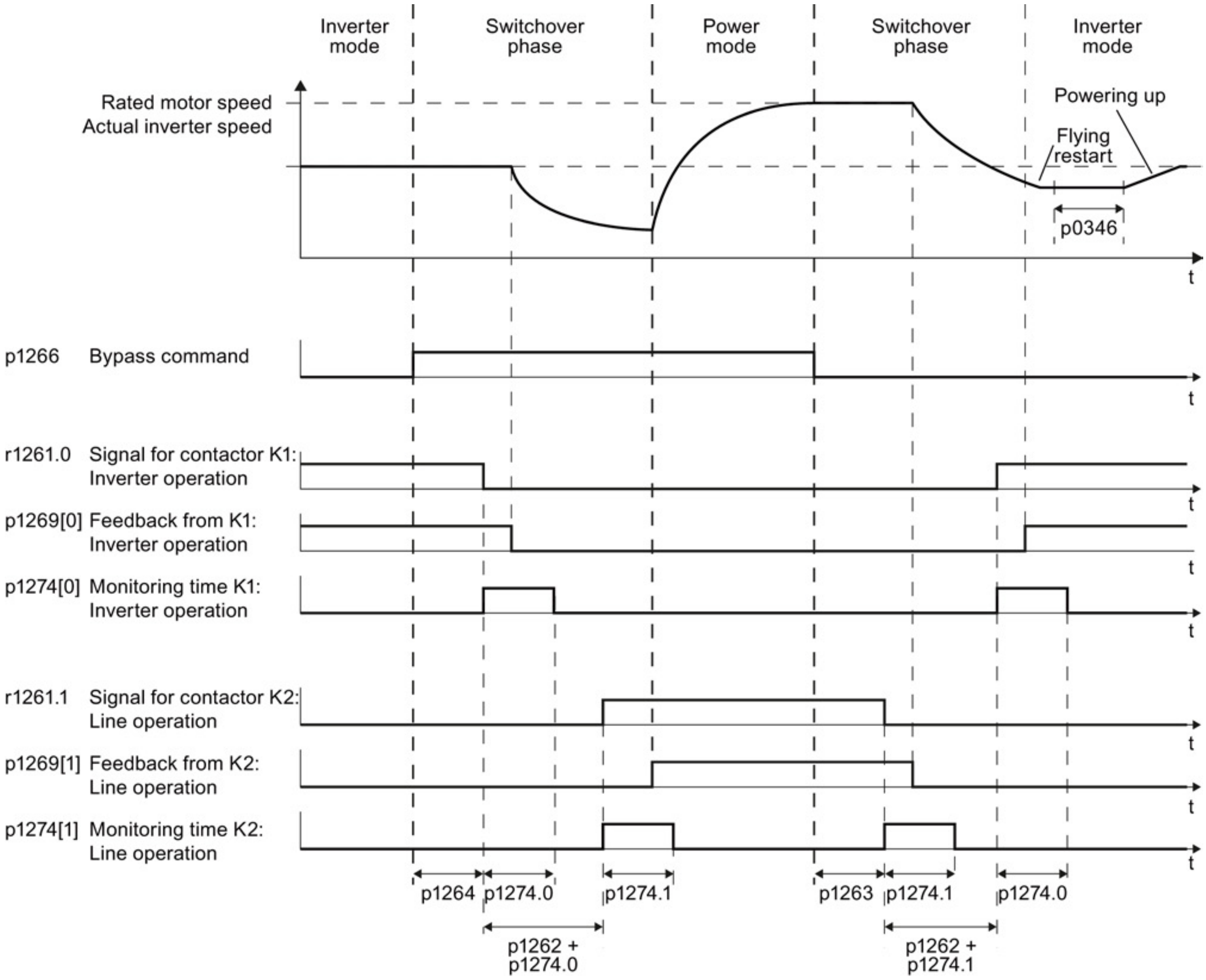


Figure 7-30 Bypass control independent of the speed via a control signal (p1267.0 = 1)

Bypass function depending on the speed (p1267.1 = 1)

With this function, switchover to line operation is realized corresponding to the following diagram, if the setpoint lies above the bypass threshold.

If the setpoint falls below the bypass threshold, the motor is captured by the inverter and operates in inverter operation.

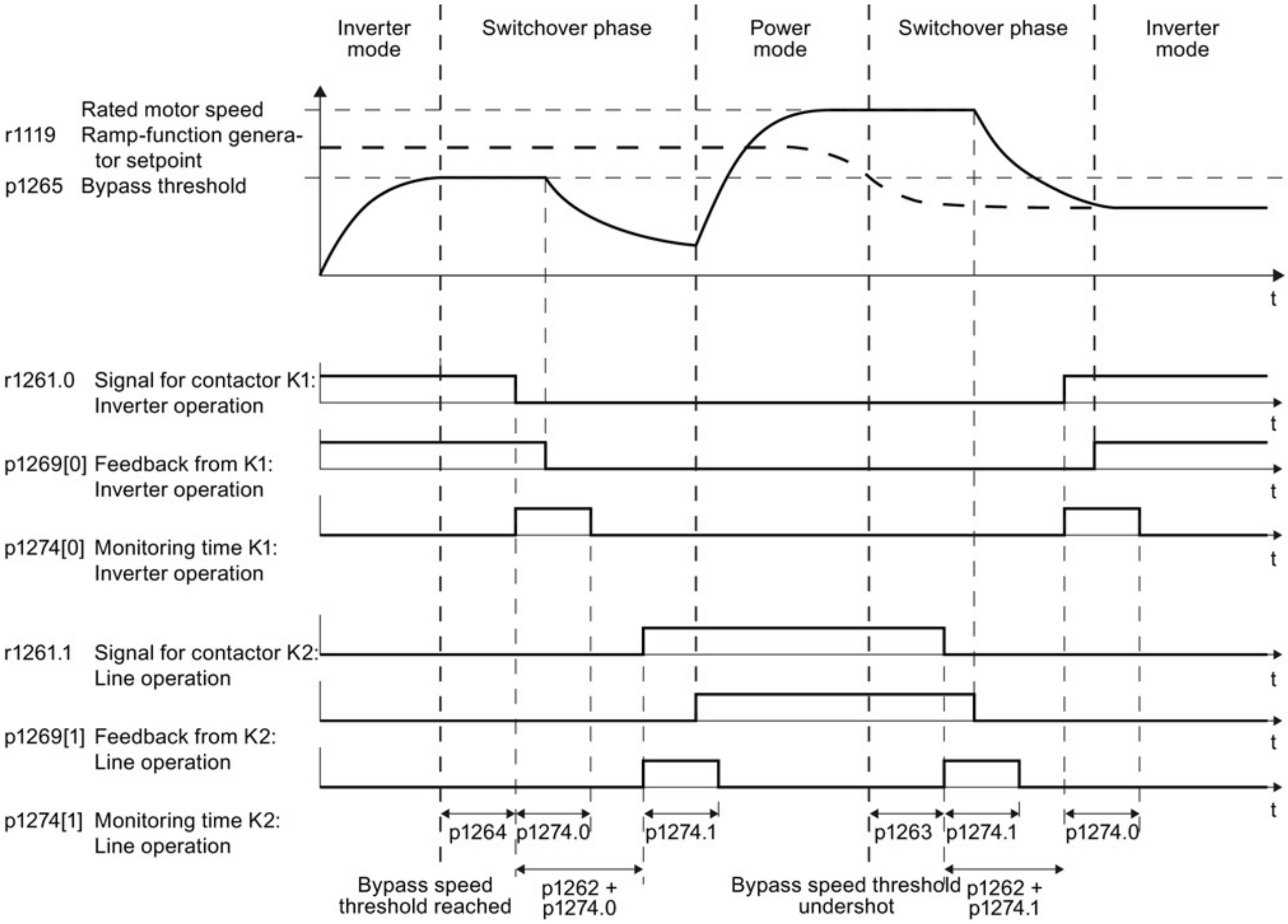


Figure 7-31 Switchover behavior from inverter to line operation dependent on the speed

General properties of the bypass function

- The two motor contactors must be designed for switching under load.
- Contactor K2 must be designed for switching an inductive load.
- Contactors K1 and K2 must be mutually interlocked so that they cannot close at the same time.

Switch off motor in bypass mode

- In bypass mode the motor no longer responds to the OFF1 command, but rather only to OFF2 and OFF3.
- If you cut off power to the inverter in bypass mode, the bypass contactor opens and the motor coasts down. If you want to operate the motor even when the inverter is switched off, the signal for the bypass contactor must come from the higher-level controller.

Temperature monitoring and overload protection in bypass mode

- If the motor is running in bypass mode, while the inverter is in the "ready and bypass" state (r899.0 = 1 and r0046.25 = 1), then the motor temperature monitoring via the temperature sensor is active.
- Install the overload protection for the motor bypass mode.

Parameters for setting the bypass function

Parameter	Description
p1260	**Bypass configuration** Activate the bypass function.
r1261	**Bypass control/status word** Control and feedback signals for the bypass function.
p1262	**Bypass dead time** Switchover time for contactors. This should be longer than the motor's de-magnetizing time!
p1263	**Debypass delay time** Delay time for switching back to inverter operation.
p1264	**Bypass delay time** Delay time for switching to bypass mode.
p1265	**Bypass speed threshold** Speed threshold for switching to bypass mode.
p1266	**Bypass control command** Signal source for switching to bypass mode.
p1267	**Bypass switchover source configuration** Switch to bypass mode using speed threshold or control signal.
p1269	**Bypass switch feedback** Signal source for contactor feedback for bypass mode.
p1274	**Bypass switch monitoring time** Monitoring time setting for bypass contactors.

For more information, refer to the parameter descriptions and the function block diagram 7035 in the List Manual.

7.7.19 Energy-saving mode

The energy-saving mode is especially suitable for pumps and fans. Typical applications include pressure and temperature controls.

The energy-saving mode offers the advantages of energy saving, lowering mechanical wear and reduced noise.

Note

If a motorized potentiometer in the inverter delivers the setpoint in energy-saving mode, you have to set p1030.4 and p2230.4 = 1.

Additional setting options are provided in the List Manual in function block diagram 7088 and in the associated parameter descriptions.

Function

In energy-saving mode the inverter switches the motor off if the device conditions permit this and back on again if required.

The energy-saving mode starts as soon as the motor speed drops below the energy-saving mode start speed. The inverter switches the motor off only after an adjustable amount of time has elapsed. If, during this time, the speed setpoint increases above the energy-saving mode start speed due to pressure or temperature changes, the energy-saving mode is exited and the inverter goes into normal operation.

In energy-saving mode the motor is switched off but the inverter continues to monitor the speed setpoint or technology closed-loop controller variation.

- **For an external setpoint setting (without technology closed-loop controller) the speed setpoint is monitored** and the motor is switched-on again as soon as the setpoint increases above the restart speed. The restart speed is calculated as follows: Restart speed = p1080 + p2390 + p2393.

  In the factory setting, the positive speed setpoint is monitored, i.e. the motor is switched on as soon as the setpoint exceeds the restart speed.

  If you also want to monitor the negative speed setpoint, you have to monitor the setpoint amount. This can be set using p1110 = 0.

Additional setting options are described in the List Manual, in function block diagrams 3030 and 3040 as well as in the associated parameter descriptions.

- **When the setpoint setting is entered from the technology controller, the technology controller deviation (r2273) is monitored** and the motor is switched on if the deviation of the technology closed-loop controller exceeds the energy-saving mode restart value (p2392).

  In the factory setting, only the positive deviation of the technology closed-loop controller is monitored, i.e. the motor is switched on as soon as the technology closed-loop controller deviation is greater than the energy-saving mode restart value (p2392).

  To switch the motor back on for negative technology closed-loop controller deviation, the value of the deviation must be monitored.

  Set p2298 = 2292 and set the minimum threshold in p2292.

Note

Energy-saving mode after switching the inverter on

After switching the inverter on, a waiting period starts in the inverter. The waiting period is at most the following times:

- p1120 (ramp-up time)
- p2391 (energy-saving mode delay time)
- 20 s

If the motor does not reach the energy-saving mode start speed within this waiting period, the inverter activates energy-saving mode and switches the motor off.

Additional setting options are provided in the List Manual in function block diagram 7958 and in the associated parameter descriptions.

If you want to prevent frequent activation and deactivation, before deactivation you still have to set a short speed boost. The boost is deactivated with p2394 = 0.

To avoid tank deposits, particularly where liquids are present, it is possible to exit the energy-saving mode after an adjustable time (p2396) has expired and switch to normal operation.

The settings required for the respective variant can be found in the following tables.

Activate energy-saving mode with setpoint setting using the internal technology closed-loop controller

With this operating mode you have to set the technology closed-loop controller as the setpoint source (p2200) and use the output of the technology closed-loop controller as the main setpoint (p2251). The boost can be deactivated.

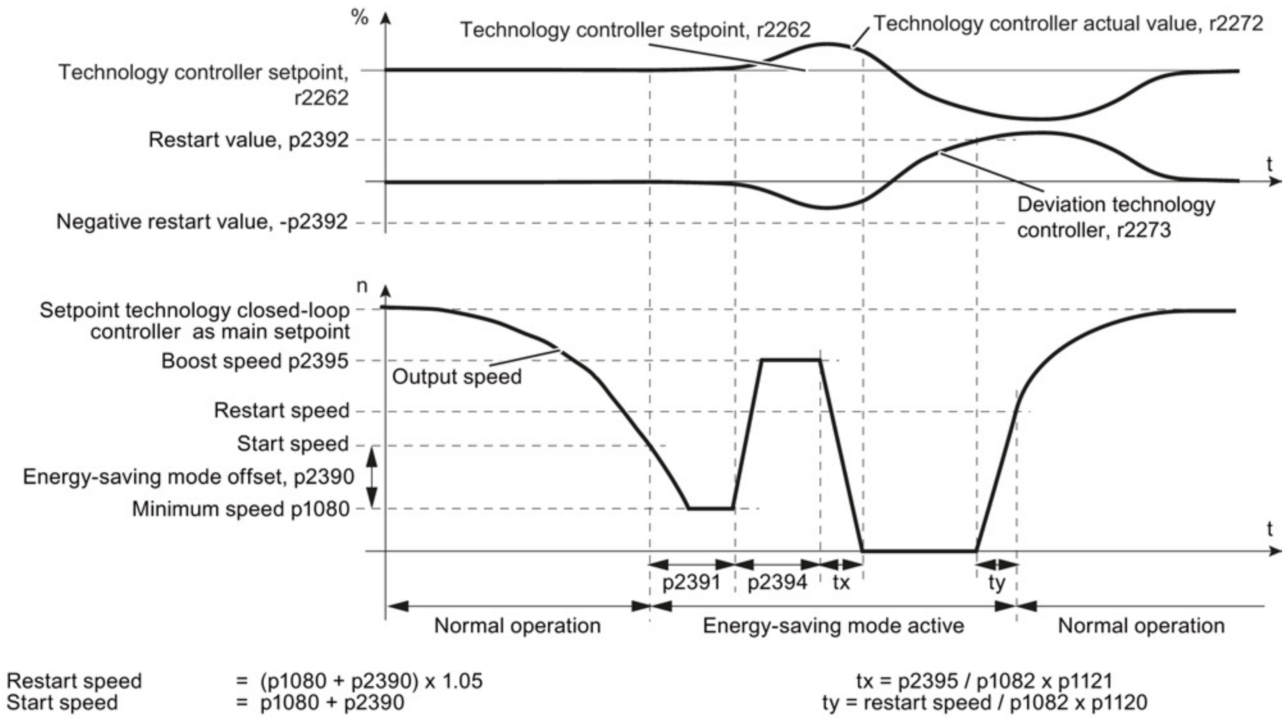


Figure 7-32 Energy-saving mode using the technology setpoint as the main setpoint with boost

Activate energy-saving mode with external setpoint setting

In this operating mode, the setpoint is specified by an external source (e.g. a temperature sensor); the technology setpoint can be used here as a supplementary setpoint.

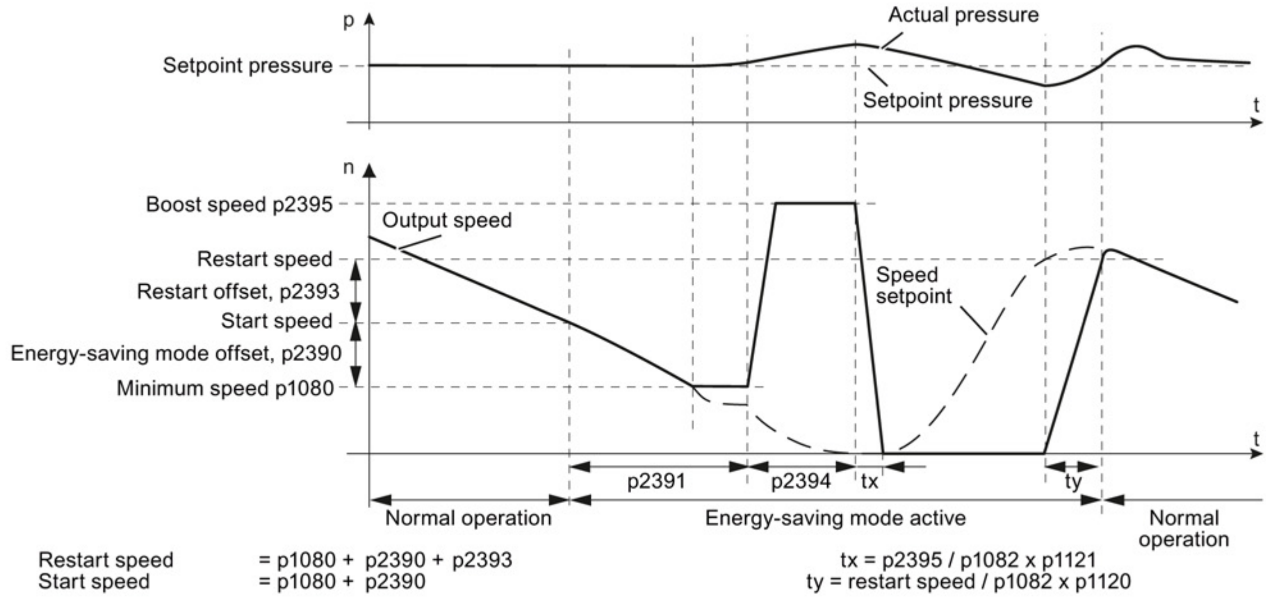


Figure 7-33 Energy-saving mode using an external setpoint with boost

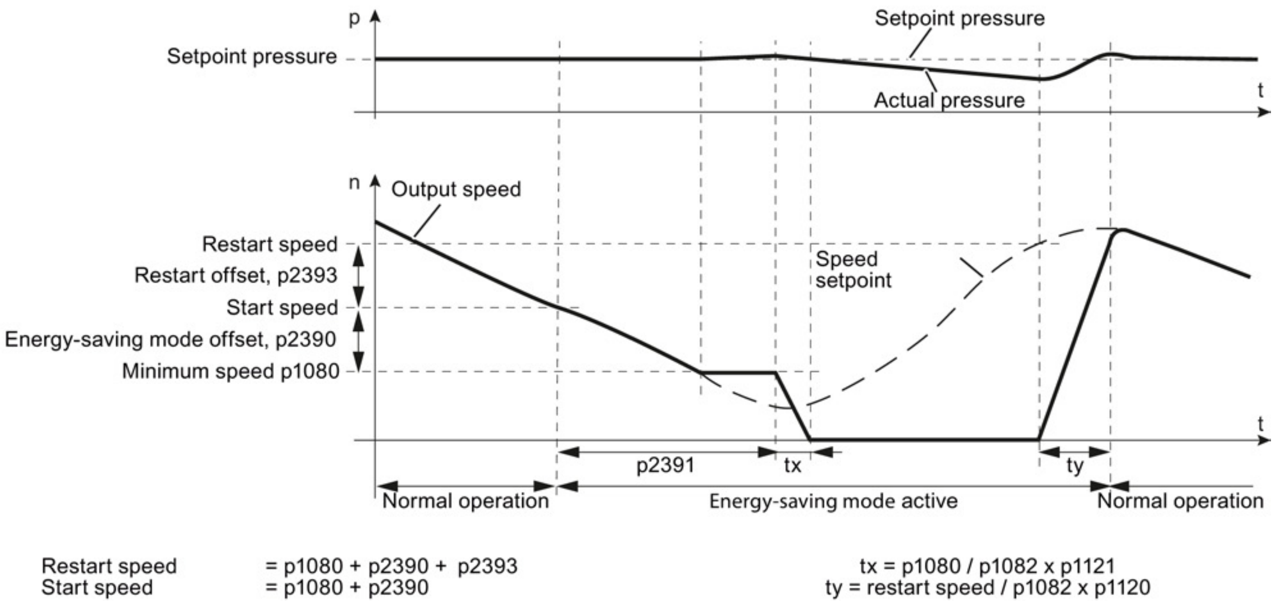


Figure 7-34 Energy-saving mode using an external setpoint without boost

Set energy-saving mode

Parameter	Description	Via tech. setpoint	Via external setpoint
p1080	**Minimum speed** 0 (factory setting) … 19500 rpm. Lower limit of the motor speed is independent of the speed setpoint.	x	x
p1110	**Block negative direction** Parameter to block the negative direction.	-	x
p2200	**Technology controller enable** 0: Technology controller deactivated (factory setting) 1: Technology controller activated	x	-
p2251 = 1	**Technology controller mode** 0: Technology controller as main setpoint (factory setting) 1: Technology controller as supplementary setpoint	x	-
p2298	**Technology controller minimum limiting** Parameter for the minimum limiting of the technology closed-loop controller.	x	-
p2398	**Energy-saving operating mode** 0: Energy-saving mode inhibited (factory setting) 1: Energy-saving mode enabled	x	x
p2390	**Energy-saving mode start speed** 0 (factory setting) … 21000 rpm. As soon as this speed is fallen below, the energy-saving mode delay time starts and switches off the motor once it expires. The energy-saving mode start speed is calculated as follows: Start speed = p1080 + p2390 p1080 = minimum speed p2390 = energy-saving mode start speed	x	x
p2391	**Energy-saving mode delay time** 0 ... 3599 s (factory setting 120). The energy-saving mode delay time starts as soon as the output frequency of the inverter drops below the energy-saving mode start speed p2390. If the output frequency increases above this threshold during the delay time, the energy-saving mode delay time is interrupted. Otherwise, the motor is switched off after the delay time has expired (if necessary, after a short boost).	x	x
p2392	**Energy-saving mode restart value (percentage)** Is required if the technology closed-loop controller is used as the main setpoint. As soon as the technology closed-loop controller deviation (r2273) exceeds the energy-saving mode restart value, the inverter switches to normal operation and the motor starts with a setpoint of 1.05 * (p1080 + p2390). As soon as this value is reached, the motor continues to operate with the setpoint of the technology closed-loop controller (r2260).	x	-
p2393	**Energy-saving mode restart speed (rpm)** Is required for external setpoint setting. The motor starts as soon as the setpoint exceeds the restart speed. The restart speed is calculated as follows: Restart speed = p1080 + p2390 + p2393 p1080 = minimum speed p2390 = energy-saving mode start speed p2393 = energy-saving mode restart speed	-	x

Parameter	Description	Via tech. setpoint	Via external setpoint
p2394	**Energy-saving mode boost duration** 0 (factory setting) … 3599 s. Before the inverter switches over into the energy-saving mode, the motor is accelerated for the time set in p2394 according to the acceleration ramp, but not to more than the speed set in P2395.	x	x
p2395	**Energy-saving mode boost speed** 0 (factory setting) … 21000 rpm. Before the inverter switches over into the energy-saving mode, the motor is accelerated for the time set in p2394 according to the acceleration ramp, but not to more than the speed set in p2395. **Caution:** The boost must not result in any overpressure or overflow.	x	x
p2396	**Maximum energy-saving mode shutdown time** 0 (factory setting) … 863999 s. At the latest when this time expires, the inverter switches to normal operation and is accelerated up to the start speed (p1080 + p2390). If the inverter is switched to normal operation in advance, the shutdown time is reset to the value set in this parameter. With p2396 = 0, automatic switchover to normal operation after a certain time is deactivated.	x	x

Status of the energy-saving mode

Parameter	Description
r2273	**Display of the setpoint/actual value deviation of the technology closed-loop controller**
r2397	**Actual energy-saving mode output speed** Actual boost speed before the pulses are inhibited or the actual start speed after restart.
r2399	**Energy-saving mode status word** 00 Energy-saving mode enabled (p2398 <> 0) 01 Energy-saving mode active 02 Energy-saving mode delay time active 03 Energy-saving mode boost active 04 Energy-saving mode motor switched off 05 Energy-saving mode motor switched off, cyclic restart active 06 Energy-saving mode motor restarts 07 Energy-saving mode supplies the total setpoint of the ramp-function generator 08 Energy-saving mode bypasses the ramp-function generator in the setpoint channel

7.7.20 Write and know-how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

7.7.20.1 Write protection

Write protection prevents inverter settings from being inadvertently changed. No password is required for write protection, your settings remain unencrypted.

The following functions are excluded from the write protection:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Access to service parameters (p3950) - only for service personnel, a password is required
- Restoring the factory setting
- Upload
- Acknowledging alarms and faults
- Switching over to the control panel
- Trace
- Function generator
- Measuring functions
- Reading out diagnostic buffer

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Activate and deactivate write protection

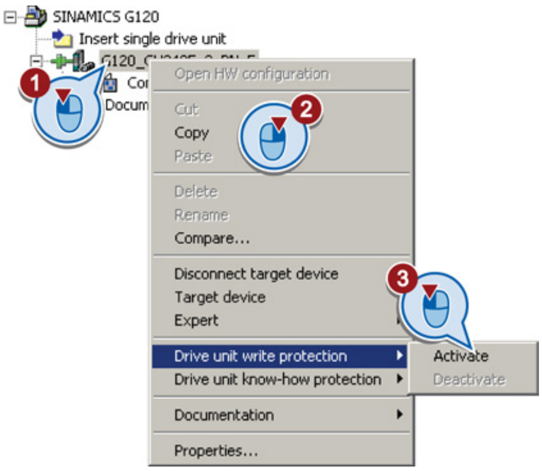
Precondition

You are online with STARTER.

Procedure

Proceed as follows to activate or deactivate the write protection:

1. Select the inverter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate or deactivate write protection.
4. Click the "Copy RAM to ROM" button . Otherwise, your settings will be lost when the inverter is switched off.



Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.

The confirmation prompt is not issued if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

7.7.20.2 Know-how protection

The know-how protection is used to encrypt configuring/engineering know-how, and protect it against being changed or copied.

In the case of active know-how protection, support by technical support personnel is only possible with the consent of the machine manufacturer.

The know-how protection is available in the following versions:

- **Know-how protection without copy protection** (possible with or without memory card)
- **Know-how protection with copy protection** (possible only with recommended Siemens memory card)

A password is required for the know-how protection.

In case of active know-how protection, the STARTER dialog screens are locked. The expert list in STARTER shows only display parameters.

Note

OpenSSL

This product contains software that has been developed by the OpenSSL project for use in the OpenSSL toolkit.

http://www.openssl.org

Actions that are also possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Displaying the alarm history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters that are accessible even though know-how protection is active)

Actions that are not possible during active know-how protection

- Download
- Export/import
- Trace
- Function generator
- Measuring functions
- Automatic controller setting
- Stationary/rotating measurement
- Deleting the alarm history

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Commissioning the inverter with know-how protection

Procedure - overview

Proceed as follows to commission an inverter with know-how protection:

1. Commission the inverter.
2. Create the exception list (Page 430).
3. Activate the know-how protection (Page 428).
4. Save the settings in the inverter by copying RAM to ROM with or via p0971 = 1.
5. Save the project with on the PG/PC. Also back up any other project-related data (machine type, password, etc.) that may be required for the support of the end customer.

Settings for the know-how protection

Activate know-how protection

Prerequisites

- You are online with STARTER.

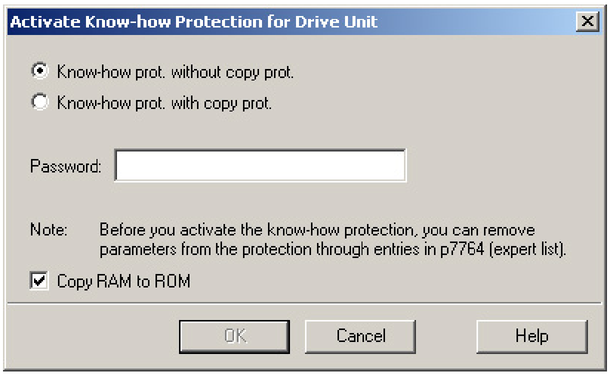
  If you have created a project offline on your computer, you must download it to the inverter and go online.
- You have inserted the recommended Siemens card.

Procedure

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 424)).
2. Enter your password. Length of the password: 1 … 30 characters.

   For the password, we recommend that you only use characters from the ASCII character set. If you use any character for the password, then if changes are made to the Windows language settings after activating know-how protection, errors can occur when subsequently checking the password.



3. In this screen form, click the "Copy RAM to ROM" button. This allows you to save your settings so that they are protected against power failure.

Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

Deactivate know-how protection, delete password

Prerequisites

- You are online with STARTER.
- You have inserted the recommended Siemens card.

Procedure

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
   - Temporary status: Know-how protection is active again after switching the power supply off and on.

   - Final status: If you select "Copy RAM to ROM", the inverter immediately deletes the password. If you do not select "Copy RAM to ROM", the inverter deletes the password the next time the supply voltage is switched off.
3. Enter the password and exit the screen form with OK.

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload () on the PC/PG and go offline ()
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.
4. Go online and load the project into the inverter ().
5. Now make the additional settings in p7764.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer deactivate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

Replacing devices with active know-how protection

Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the inverter settings can be transferred to another inverter using a memory card.

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the Control Unit cannot be simply replaced.

However, to allow the inverter to be replaced, you must use a Siemens memory card, and the machine manufacturers must have an identical machine that they use as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

- 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 Control Unit?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection
  - enters the serial number of the new Control Unit in p7759
  - enters the serial number of the inserted memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!)
  - writes the configuration with p0971 = 1 to the memory card
  - sends the memory card to the end customer
- The end customer inserts the memory card in the Control Unit and switches the inverter on.

When powering up, the inverter checks the serial numbers of the card and the Control Unit, and the inverter goes into the "ready to start" state when they match.

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 Control Unit and the serial number of the memory card

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the Control Unit be replaced?
  - What is the serial number (r7758) of the new Control Unit?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection
  - enters the serial number of the new Control Unit in p7759
  - enters the serial number of the customer's memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the Control Unit and switches the inverter on.

When powering up, the inverter checks the serial numbers of the card and the Control Unit, and the inverter goes into the "ready to start" state when they match.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

7.7.21 Free function blocks

The free function blocks permit additional signal processing inside the inverter. In order to use the free function blocks, you must interconnect the inputs and outputs of the function blocks with the appropriate signals.

The following free function blocks are available:

- Logic AND, OR, XOR, NOT
- Arithmetic ADD, SUB, MUL, DIV, AVA (absolute value), NCM (comparison), PLI (polyline)
- Timers MFP (pulse generator), PCL (pulse shortening), PDE (ON delay), PDF (OFF delay), PST (pulse stretching)
- RSR (RS flip-flop), DSR (D flip-flop)
- Switches BSW (binary) NSW (numeric)
- Closed-loop controllers LIM (limiters), PT1 (smoothing), INT (integrators), DIF (differentiators)
- Monitoring LVM (limit value monitor)

Activating and interconnecting free function blocks

None of the free function blocks in the inverter are active in the factory setting.

Procedure

Proceed as follows to activate a free function block and interconnect it with signals:

1. Select the required function block in the List Manual. You can find the parameters to set the free function blocks in function block diagrams 7200 ff.
2. Use the IOP or expert list in STARTER to set the parameters that define the runtime group of the block to the required value.

   The block is now active.
3. If you have assigned several function blocks to the same runtime group, set the parameter that defines the execution sequence within the runtime group.
4. Interconnect the inputs and outputs of the function block with the required signals in the inverter.

Runtime groups and time slices

The inverter computes runtime groups 1 … 6 in different time slices.

Table 7- 35 Runtime groups, time slices and assignment of the free function blocks

Free function blocks	Runtime groups 1 … 6 with associated time slices					
	1	2	3	4	5	6
	8 ms	16 ms	32 ms	64 ms	128 ms	256 ms
Logic AND, OR, XOR, NOT	✓	✓	✓	✓	✓	✓
Arithmetic ADD, SUB, MUL, DIV, AVA, NCM, PLI	-	-	-	-	✓	✓
Timers MFP, PCL, PDE, PDF, PST	-	-	-	-	✓	✓
Memories RSR, DSR	✓	✓	✓	✓	✓	✓
Switches NSW	-	-	-	-	✓	✓
Switches BSW	✓	✓	✓	✓	✓	✓
Closed-loop controllers LIM, PT1, INT, DIF	-	-	-	-	✓	✓
Monitoring LVM	-	-	-	-	✓	✓

✓: The inverter can compute the free function block in this runtime group
-: A free function block is not possible in this runtime group

Scaling the analog signals

If you interconnect a physical quantity, e.g. speed or voltage to the input of a free function block, then the inverter automatically scales the signal to a value of 1. The analog output signals of the free function blocks are also scaled (0 ≙ 0 %, 1≙ 100 %).

As soon as you have interconnected the scaled output signal of a free function block to functions that require physical input quantities, then the inverter converts the signal into the physical quantity. An example of this is the signal source for the main setpoint (p1070).

Scaling parameters of physical quantities:

Speed	p2000 Reference speed	(≙100 %)
Voltage	p2001 Reference voltage	(≙100 %)
Current	p2002 Reference current	(≙100 %)
Torque	p2003 Reference torque	(≙100 %)
Power	r2004 Reference power	(≙100 %)
Temperature	p2006 Reference temperature	(≙100 %)

The assignments to the reference parameters are in the parameter description in the List Manual.

Examples

- Speed:
  Reference speed p2000 = 3000 rpm, actual speed 2100 rpm. As a consequence, the following applies to the scaled input quantity: 2100 / 3000 = 0.7.
- Temperature:
  Reference quantity is 100° C. For an actual temperature of 120° C, the input value is obtained from 120° C / 100° C = 1.2.

Limits

Enter limits within the function blocks as scaled values.

Scaled limit = physical limit value / value of the reference parameter.

Example: OR logic combination of two digital inputs

You want to switch the motor on via digital input 0 and also via digital input 1.

Procedure

Proceed as follows to logically interconnect digital inputs 0 and 1:

1. Activate a free OR block by assigning it to a runtime group, and define the run sequence.
2. Interconnect the status signals of the two digital inputs DI 0 and DI 1 with the two inputs of the OR block.
3. Finally, interconnect the OR block output with the internal ON command (p0840).

Parameter	Description
p20048 = 1	**Assignment of block OR 0 to runtime group 1** The block OR 0 is calculated in the time slice with 8 ms
p20049 = 60	Definition of run sequence within runtime group 1 Within one runtime group, the block with the smallest value is calculated first.
p20046[0] = 722.0	**Interconnection of the first OR 0 input** The first OR 0 input is linked to digital input 0 (r0722.0)
p20046[1] = 722.1	**Interconnection of the second OR 0 input** The second OR 0 input is linked to digital input 1 (r0722.1)
p0840 = 20047	**Interconnection of the OR 0 output** The OR 0 output (r20047) is connected with the motor's ON command

8 Application examples

Siemens Industry Online Support provides examples of standard applications for the communication:

1. Control using PROFIBUS/PROFINET
   - Configuring with STEP 7:
     http://support.automation.siemens.com/WW/view/en/58820849
   - Configuring with STEP 7≥ V11 (TIA Portal):
     http://support.automation.siemens.com/WW/view/en/60140921
2. Cross data traffic configuring with STEP 7 V5:
   http://support.automation.siemens.com/WW/view/en/74455218

Alarms, faults and system messages 9

The inverter has the following diagnostic types:

- LED

  The LED at the front of the Control Unit provides information about the most important inverter states.

- Alarms and faults

  The inverter signals alarms and faults via

  – The fieldbus

  – The terminal strip with the appropriate setting

  – The IOP

  – STARTER

  Alarms and faults have a unique number.

9.1 Operating states indicated on LEDs

The LED RDY (Ready) is temporarily orange after the power supply voltage is switched-on. As soon as the color of the LED RDY changes to either red or green, the LEDs signal the inverter state.

Signal states of the LED

In addition to the signal states "on" and "off" there are two different flashing frequencies:

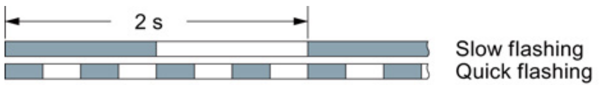


Table 9- 1 Inverter diagnostics

LED		Explanation
RDY	BF	
GREEN - on	---	There is presently no fault
GREEN - slow	---	Commissioning or reset to factory settings
GREEN - fast	---	Inverter writes data to the memory card
RED - slow	---	Inverter waits until the power supply is switched off and switched on again after a firmware update
RED - fast	---	There is presently a fault
RED - fast	RED - fast	Incorrect memory card or unsuccessful firmware update
Green / Red - slow	---	Licensing is not sufficient, for details, see List of alarms and faults (Page 451)

Table 9- 2 Communication diagnostics via PROFINET

LNK LED	Explanation
GREEN - on	The communication via PROFINET is in order.
GREEN - slow	Device naming is active.
Off	No communication via PROFINET.

Table 9- 3 Communication diagnostics via RS485

LED BF	Explanation
On	Receive process data
RED - slow	Bus active - no process data
RED - fast	No bus activity
YELLOW - variable frequency	Firmware update in progress

Table 9- 4 Communication diagnostics via PROFIBUS DP

LED BF	Explanation
off	Cyclic data exchange (or PROFIBUS not used, p2030 = 0)
RED - slow	Bus fault - configuration fault
RED - fast	Bus fault - no data exchange - baud rate search - no connection
YELLOW - variable frequency	Firmware update in progress

LED BF display for CANopen

In addition to the signal states "on" and "off" there are three different flashing frequencies:

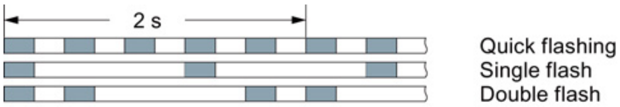


Table 9- 5 Communication diagnostics via CANopen

BF LED	Explanation
GREEN - on	Bus state "Operational"
GREEN - fast	Bus state "Pre-Operational"
GREEN - single flash	Bus state "Stopped"
RED - on	No bus
RED - single flash	Alarm - limit reached
RED - double flash	Error event in control (Error Control Event)
YELLOW - variable frequency	Firmware update in progress

9.2 System runtime

By evaluating the system runtime of the inverter, you can decide when you should replace components subject to wear in time before they fail - such as fans, motors and gear units.

Principle of operation

The system runtime is started as soon as the Control Unit power supply is switched-on. The system runtime stops when the Control Unit is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

If r2114[0] has reached a value of 86,400,000 ms (24 hours), r2114[0] is set to the value 0 and the value of r2114[1] is increased by 1.

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

You cannot reset the system runtime.

9.3 Alarms

Alarms have the following properties:

- They do not have a direct effect in the converter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - At the Operator Panel with a Axxxxx
  - Via STARTER, if you click on TAB  at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

Alarm buffer

For each incoming alarm, the converter saves the alarm, alarm value and the time that the alarm was received.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
		I32	Float	Days	ms	Days	ms

Figure 9-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).
The converter uses an internal time calculation to save the alarm times. More information on the internal time calculation can be found in Chapter Real time clock (RTC) (Page 398).

As soon as the alarm has been removed, the converter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 9-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value		Alarm time received		Alarm time removed	
1. Alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2. Alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3. Alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4. Alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5. Alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6. Alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7. Alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 9-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the converter shifts all alarms that have been removed from the alarm buffer into the alarm history. In the alarm history, alarms are also sorted according to the "alarm time received", however, when compared to the alarm buffer, in the inverse sequence:

- The youngest alarm is in index 8
- The second youngest alarm is in index 9
- etc.

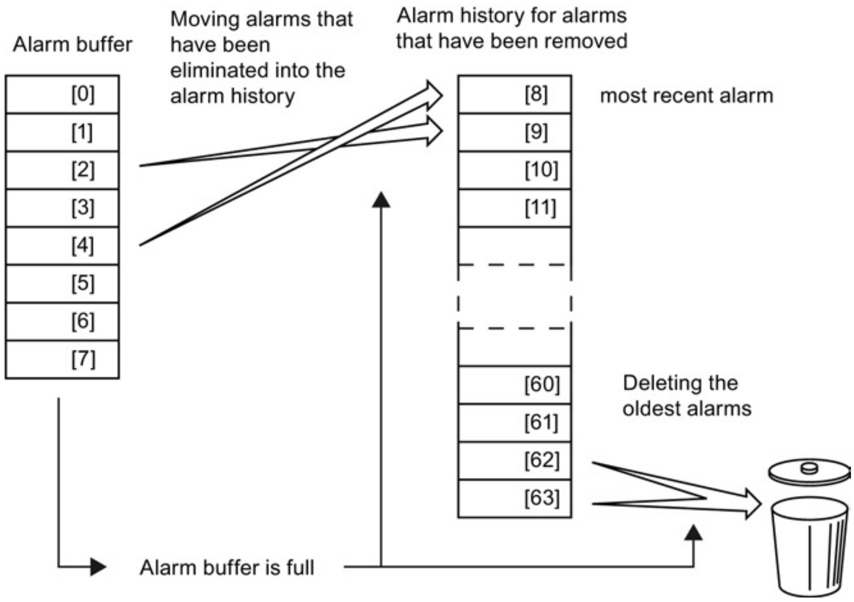


Figure 9-4 Shifting alarms that have been removed into the alarm history

Any alarms that have not been removed remain in the alarm buffer. The converter sorts the alarms and closes gaps between the alarms.

If the alarm history is filled up to index 63, each time a new alarm is accepted in the alarm history, the oldest alarm is deleted.

Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	**Alarm code** Displays the numbers of alarms that have occurred
r2123	**Alarm time received in milliseconds** Displays the time in milliseconds when the alarm occurred
r2124	**Alarm value** Displays additional information about the alarm
r2125	**Alarm time removed in milliseconds** Displays the time in milliseconds when the alarm was removed
p2111	**Alarm counter** Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118	**Setting the message number for the message type** Selection of the alarms for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

9.4 Faults

A fault indicates a severe fault during inverter operation.

The inverter signals a fault as follows:

- At the operator panel with Fxxxxx
- At the inverter using the red LED RDY
- In bit 3 of status word 1 (r0052)
- Via STARTER

To delete a message, you must remedy the cause of the fault and acknowledge the fault.

Every fault has a unique fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0] I32	r2133[0] Float	r2130[0] Days	r0948[0] ms	r2136[0] Days	r2109[0] ms

Figure 9-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written to parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times. More information on the internal time calculation can be found in Chapter Real time clock (RTC) (Page 398).

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 9-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 9-7 Complete fault buffer

Acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch-off the inverter power supply and switch-on again.
- Press the acknowledgement button on the operator panel
- Acknowledgement signal at digital input 2
- Acknowledgement signal in bit 7 of control word 1 (r0054) for Control Units with fieldbus interface

Faults detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again. The list of faults in the List Manual contains a note on this limited acknowledgement possibility.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The acknowledgement has no effect as long as none of the causes for the faults in the buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

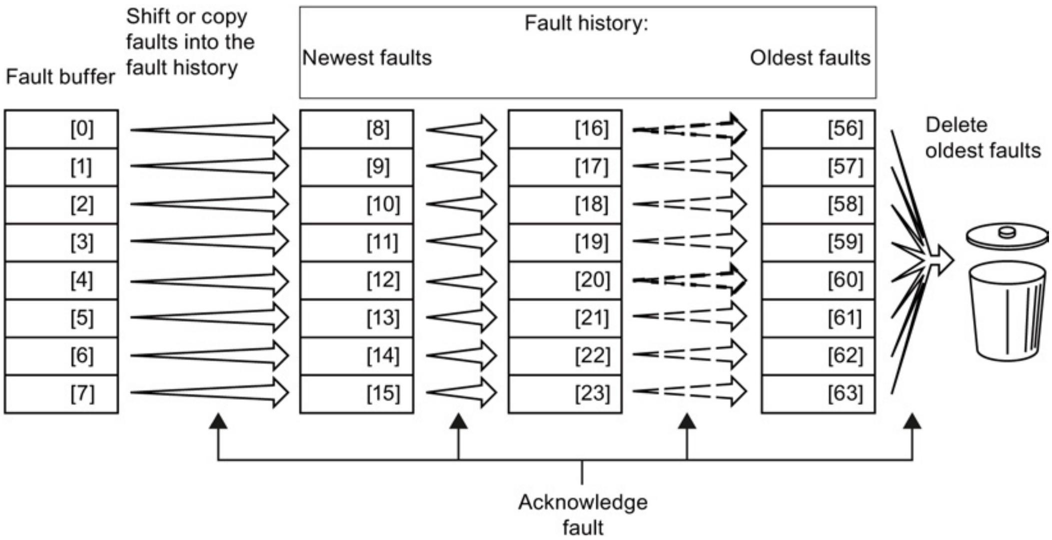


Figure 9-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history. For these faults, the "fault time coming" remains unchanged and the "fault time removed" remains empty.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indexes remain empty.

The inverter shifts the values previously saved in the fault history by eight indexes. Faults, which were saved in indexes 56 … 63 before the acknowledgement, are deleted.

Deleting the fault history

If you wish 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 faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgement. The fault buffer is deleted with p0952 = 0.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	**Setting the fault number for fault response** Selection of the faults for which the fault response applies
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgement mode** Selection of the faults for which the acknowledgement type should be changed
p2127	**Setting, acknowledgement mode** Setting the acknowledgement type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgement after removing the fault cause
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	**Setting the message number for the message type** Selection of the message for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

9.5 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 9- 6 Faults that can be acknowledged only by switching the inverter off and on again (POWER ON)

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	After this fault is output, the inverter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the inverter.
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.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F1257	Firmware obsolete	Upgrade the firmware in the CU.
F01512	An attempt has been made to establish a conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring V_{CE}	Check or replace Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact 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.
F30950	Software fault in Power Module	Replace Power Module or contact technical support.

Table 9- 7 The most important alarms and faults

Number	Cause	Remedy
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 inverter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB). Check the module parameters and recommission if necessary.
F01033	Switching over units: 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	Switching over units: 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).
F01054	System limit exceeded	The maximum computing power of the Control Unit was exceeded. The following measures reduce the load on the Control Unit: • Use only one data record (CDS and DDS) • Only use the safety features of the basic functions • Deactivate the technology closed-loop controller • Use the simple ramp-function generator rather than the extended ramp-function generator • Do not use any free function components • Reduce the sampling time of the free function blocks
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.
F01910	Fieldbus timeout setpoint	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 wiring for interruptions. Check the level of the injected signal. The input current measured by the analog input can be read out in r0752.

Number	Cause	Remedy
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 set	Check the set supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check the 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 the thermal time constant p0611. Check the overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the motor temperature sensor fault evaluation (p0607 = 0).
F07086 F07088	Switching over units: Parameter limit violation	Check the adapted parameter values and if required correct them.
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 the search current (p1202), check the motor connection.
A07400	DC-link voltage maximum controller active	If it is not desirable that the closed-loop controller intervenes: • Increase the ramp-down times. • Deactivate the Vdc_max control (p1240 = 0 for vector control, p1280 = 0 for V/f control).

Number	Cause	Remedy
A07409	V/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the ramp-ups 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 the current limits (p0640). Vector control: Check the current controller (p1715, p1717). V/f control: Check the current limiting controller (p1340 … p1346). Increase the acceleration ramp (p1120) or reduce the load. Check the motor and motor cables for short-circuit and ground fault. Check the motor regarding the star/delta connection and type plate parameterization. Check the power unit / motor combination. Select the flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
F07806	Regenerative power limit exceeded	Increase the deceleration ramp. Reduce the driving load. Use a power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short-circuit detected	• Check the inverter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: 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 the precontrol for the speed limiting controller (p1401 bit 7 = 1). Increase the hysteresis for overspeed signal p2162.

Number	Cause	Remedy
F07902	Motor stalled	Check whether the motor data has been set correctly and perform a motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor identification activated	Switch on the motor and identify the motor data.
F08501	PROFINET: Setpoint timeout	• Check the PROFINET connection. • Set the controller into the RUN mode. • If the fault occurs repeatedly, check the monitoring time set p2044.
F08502	PROFINET: Monitoring time, sign-of-life expired	• Check the PROFINET connection.
F08510	PROFINET: Send configuration data not valid	• Check the PROFINET configuration
A08511	PROFINET: Receive configuration data not valid	
A08526	PROFINET: No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	PROFINET: 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.

Number	Cause	Remedy
F08700	CAN: Communications error	A CAN communications error has occurred. Check the following: • Bus cable • Baud rate (p8622) • Bit timing (p8623) • Master Start the CAN controller manually with p8608 = 1 after the cause of the fault has been resolved!
A8800	PROFIenergy energy-saving mode active	Not required
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred when checking the memory card. • Insert a suitable memory card and switch the inverter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • V/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • V/f operation: Increase the acceleration ramp • Reduce the load • Replace the power 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	Inverter overtemperature	Check whether the inverter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.

Number	Cause	Remedy
F30005	I2t inverter overload	Check the rated currents of the motor and Power Module. Reduce the current limit p0640. When operating with V/f characteristic: Reduce p1341.
F30011	Line phase failure	Check the inverter's input fuses. Check the motor feeder cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
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.
A30042	Fan has reached its maximum number of operating hours	• Replace the fan. • Reset the operating hours counter.
A30049	Internal fan defective	Check the internal fan and if required replace.
F30059	Internal fan defective	Check the internal fan and if required replace.
A30502	DC-link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.
A50010	PROFINET name of station invalid	Correct the name of station (p8920) and activate (p8925 = 2).

For further information, please refer to the List Manual.

10 Maintenance and servicing

10.1 Section content

This section provides information on the following:

- Maintenance and servicing procedures that have to be carried out on a regular basis to ensure the availability of the cabinet units.
- Exchanging device components when the unit is serviced.
- Forming the DC-link capacitors
- Load the firmware or language packages for the IOP.

WARNING
Danger to life due to improper maintenance and repairs
Improper repairs and/or the deployment of not approved spare parts can cause death or severe injury. • Allow only qualified personnel to perform maintenance work. • Only use spare parts that have been approved by the manufacturer. • For repairs, contact the Technical Support.

NOTICE
Material damage caused by contamination in the device
Contamination can cause material damage in the device due to overheating or voltage flash-overs. • Visually inspect the equipment at least once per year. • Remove dust accumulations from inside the cabinet unit in regular intervals (at least once per year).

10.2 Maintenance

The cabinet unit mainly comprises electronic components. Apart from the fan(s), the unit contains very few components that are subject to wear or require maintenance or servicing. Maintenance aims to preserve the specified condition of the cabinet unit. Dirt and contamination must be removed regularly and parts subject to wear replaced.

The following points must generally be observed.

10.2.1 Cleaning

Dust deposits

Dust deposits inside the cabinet unit must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached.

Ventilation

The ventilation openings in the cabinet must never be obstructed. The fan must be checked to make sure that it is functioning correctly.

Cable and screw terminals

Cable and screw terminals must be checked regularly to ensure that they are secure in position, and if necessary, retightened. Cabling must be checked for defects. Defective parts must be replaced immediately.

Note

Maintenance intervals

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions (cabinet environment) and the operating conditions.

Siemens offers its customers support in the form of a service contract. For further details, contact your regional office or sales office.

10.3 Maintenance

Servicing involves activities and procedures for maintaining and restoring the specified condition of the device.

Required tools

The following tools are required for replacing components:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench 5 Nm to 50 Nm
- Screwdriver, size 2
- T20 torx screwdriver
- T25 torx screwdriver
- T30 torx screwdriver

A socket wrench kit with two long extensions is recommended.

Tightening torques for screw connections

The following tightening torques apply when tightening connections of operating current-conducting parts (DC link / motor connections, general busbars), non-operating current-conducting parts (ground connections, ground terminal connections), and general steel threaded connections.

Table 10- 1 Tightening torques for screw connections

Thread	Ground connections, protective conductor connections, steel threaded connections (fault current-conducting)	Plastic, busbars (operating current-conducting)
M3	1.3 Nm	0.8 Nm
M4	3 Nm	1.8 Nm
M5	6 Nm	3 Nm
M6	10 Nm	6 Nm
M8	25 Nm	13 Nm
M10	50 Nm	25 Nm
M12	88 Nm	50 Nm

NOTICE
Screw connections for protective covers
The threaded connections for the protective covers made of Makrolon must only be tightened with 2.5 Nm.

10.3.1 Transport Power Modules

Crane lifting lugs

The Power Modules are fitted with crane lifting lugs for transportation on a lifting harness in the context of replacement.

NOTICE
Material damage caused by improper transporting with a crane
The crane transport with non-vertical ropes or chains can cause bending with subsequent damage to the housing. • Use a lifting harness to ensure that the ropes or chains run vertically.

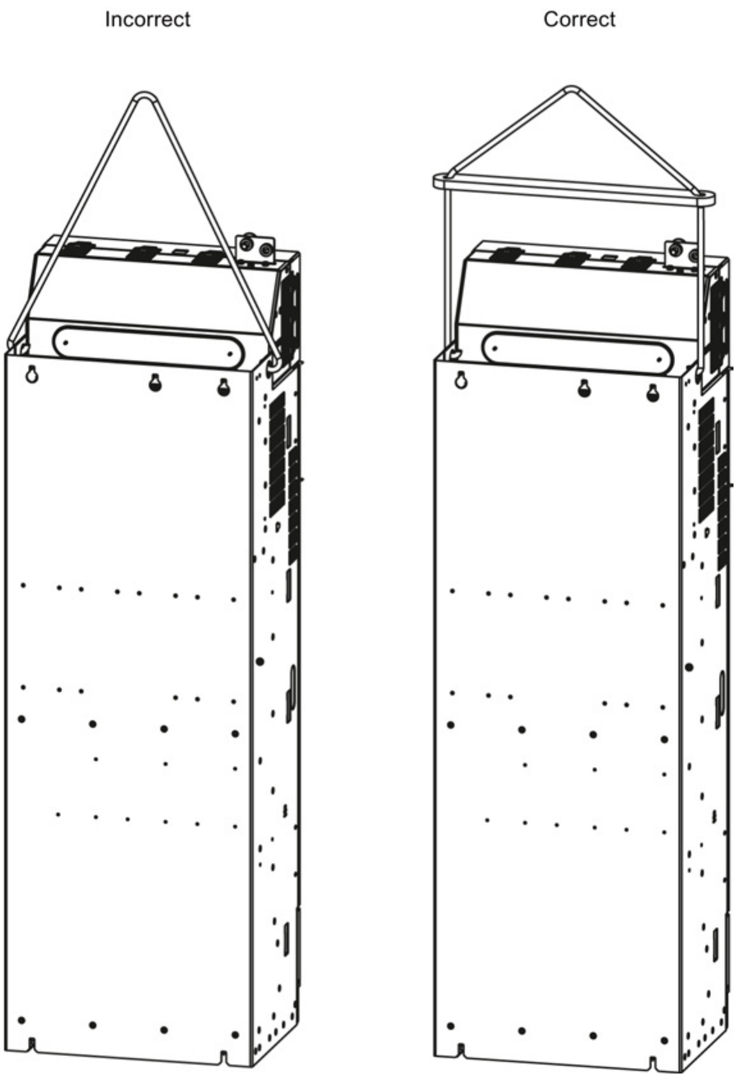


Figure 10-1 Lifting Power Modules

10.4 Replacing components

10.4.1 Replacing the filter mats

The filter mats must be checked at regular intervals. If the mats are too dirty to allow the air supply to flow normally, they must be replaced.

Note

Replacing the filter mats

Filter mat replacement is only relevant for options M23, M43 and M54.

Not replacing contaminated filter mats can cause premature drive shutdown.

10.4.2 Replacing the fan, frame size GX

Replacing the fan

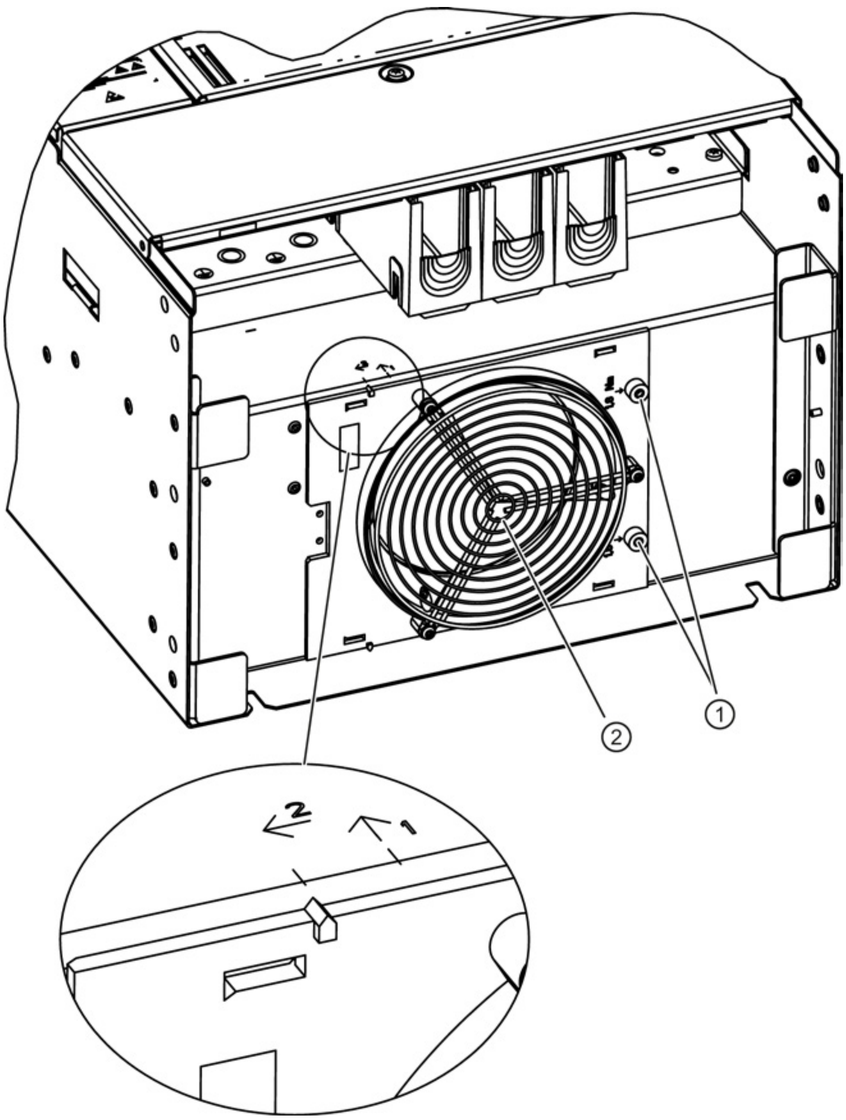


Figure 10-2 Replacement of the fan, frame size GX, view from below

Description

The average service life of the fan is 50.000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the cabinet unit.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

1. Switch the converter off.
2. Release the retaining screws (①). The screws are captive.
3. Shift the fan unit to the right, from position "2" to position "1" (this is marked on the housing).
   The connector is simultaneously released.
4. Remove the fan unit from the inverter (②).

Installation steps

For re-installation, carry out the above steps in reverse order.

Tightening torque for the captive fixing screws: 1.8 Nm

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

10.4.3 Replacement of the cabinet fan for type A

Cabinet fan replacement

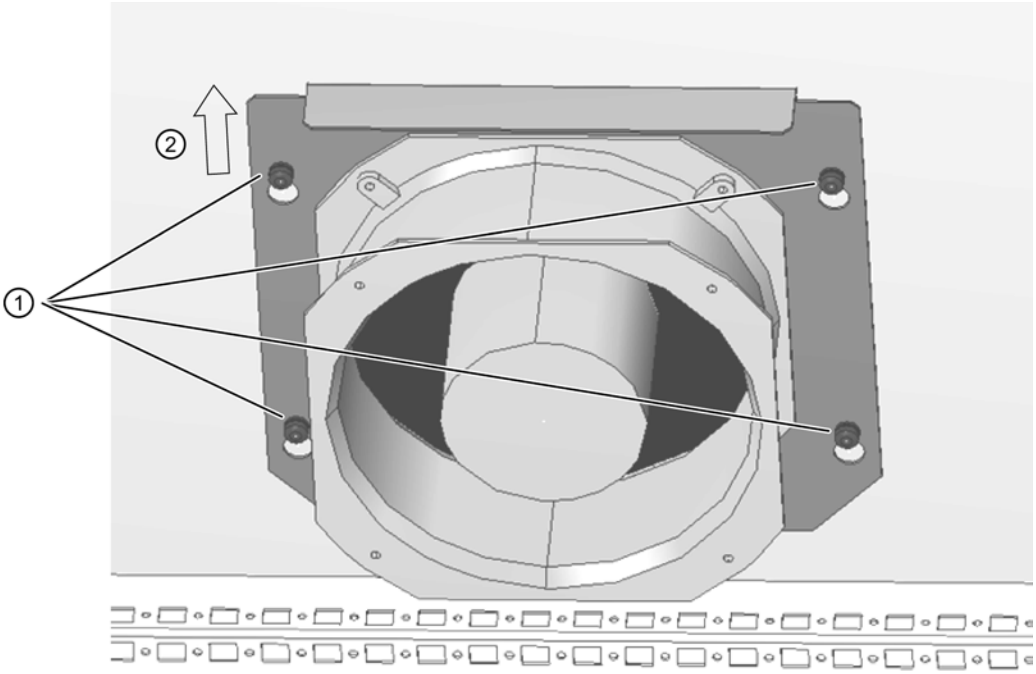


Figure 10-3 Replacing the cabinet fan

Description

The average service life of the fan is 50.000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the cabinet unit.

Preparatory steps

- Disconnect the cabinet unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

1. Remove the power supply to the cabinet fan.
2. Release the retaining screws (①).
3. Push the fan unit forwards (②).
4. Remove the fan unit from the inverter.

Installation steps

For re-installation, carry out the above steps in reverse order.

Note

Fan replacement together with the fan in the Power Module

The cabinet fan should be replaced together with the fan in the Power Module.

10.4.4 Replacing cylindrical fuses

The following fuses are cylindrical fuses:

- Fan fuses (-F101, -F102)
- Fuses for auxiliary power supply (-F11, -F12)
- Fuse for the internal 230 VAC supply (-F21)

Figure 10-4   Fuse holder

Order numbers for replacing fuses that have blown can be found in the spare parts list.

⚠ WARNING
Danger to life due to electric shock when using unsuitable fuses
If unsuitable fuses are used, an electric shock can cause severe injury or death.
• Use only fuses specified in the spare parts list.

10.4.5 Replacing the LV HRC fuses

Description

NH fuses (low-voltage high-breaking-capacity fuses), also called knife fuses, are used, for example, in the on/off switches of the power supplies.

Figure 10-5 NH fuse

Preparatory steps

- Have the fuse equipment ready: NH fuse puller with forearm protection for NH fuse-links
- National safety regulations must be followed.

Figure 10-6 NH fuse puller with forearm protection for NH fuses

Note

The NH fuse puller can be ordered from Siemens with order number 3NX1 if required.

Removal steps

The NH fuse is removed in the following steps:

1. Switch the main switch to OFF.
2. Remove the front shock protection cover of the cabinet in front of the fuses,

WARNING

Danger to life through electric shock due to removed cover above the power connections

Line voltage is present even for opened main switch when the lower cover is removed (above the power connections). Contact with the connections can result in death or serious injury.

- Do not remove the cover (shock protection) over the line connections.

3. Put the NH fuse puller with forearm protection for NH fuse-links over the fuse.
4. Remove the defective fuse.

Note

Replacing all NH fuses at the same time

After one NH fuse trips, always replace all NH fuses at the same time.

Installation steps

The NH fuse is installed in the following steps:

1. Attach the new fuse onto the NH fuse grip.
2. Insert the fuse into the fuse holder.
3. Press the release button on the NH fuse puller to release the grip from the new fuse.
4. Attach the front shock protection cover.

The power switch can then be closed.

WARNING

Danger to life due to electric shock when using unsuitable fuses

If unsuitable fuses are used, an electric shock can cause severe injury or death.

- Use only fuses specified in the spare parts list.

10.4.6 Replacing the IOP

1. Switch the unit into a no-voltage condition.
2. Open the cabinet.
3. Disconnect the power supply and communications line on the operator panel.
4. Release the fastenings on the operator panel.
5. Remove the operator panel.
6. Install the new operator panel.
7. Carry out any other work by reversing the sequence.

10.5 Forming the DC-link capacitors

Description

If the device is kept in storage for more than two years, the DC-ink capacitors have to be formed. If this is not done, the unit could be damaged when it is operated under load.

If the cabinet is commissioned within two years of its date of manufacture, the DC-link capacitors do not need to be formed. The date of manufacture is indicated in the serial number on the type plate (see Type plate (Page 28)).

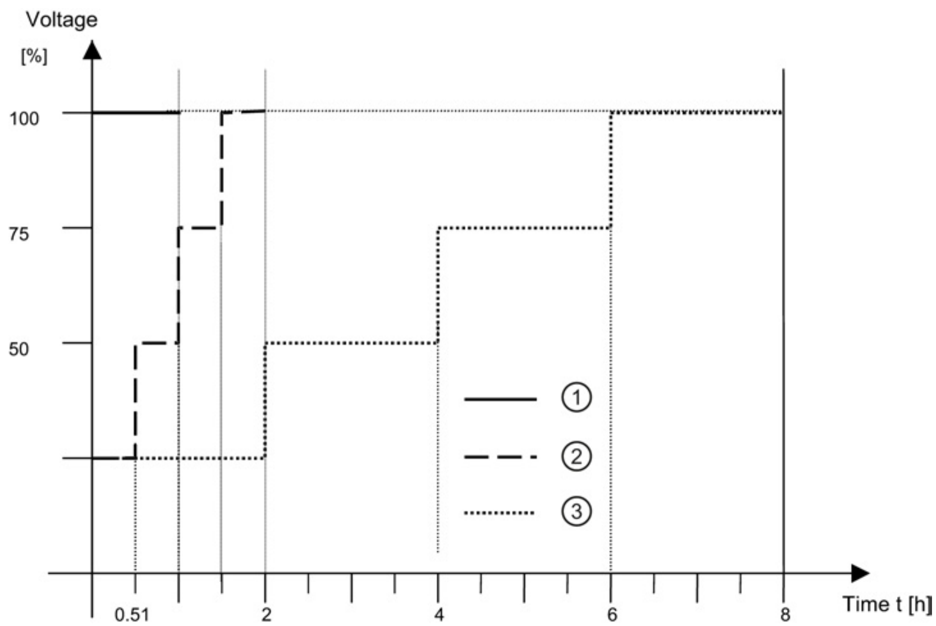
Note

Storage period

It is important that the storage period is calculated from the date of manufacture and not from the date when the equipment was shipped.

Procedure

You can take the details about the measures required when forming from the following diagram.



Storage times less than 1 year: No measures required

① Storage times of between 1 and 2 years: Connect voltage for one hour before switching on

② Storage times of between 2 and 3 years: Form corresponding to the curve before switching on

③ Storage times of 3 and more years: Form corresponding to the curve before switching on

Figure 10-7 Measures when forming the DC-link capacitors

10.6 Load the firmware or language packages for the IOP

The loading of the firmware or language packages for the IOP is described at the following link:
http://support.automation.siemens.com/WW/view/en/30563514/133100

11 Technical specifications

11.1 Section content

This chapter provides information on the following:

- General and specific technical specifications for the devices.
- Information on restrictions that apply when the devices are used in unfavorable ambient conditions (derating)

11.2 General data

Table 11- 1 General technical data

Electrical data	
Line system configurations	Grounded TN/TT systems and non-grounded IT systems
Line frequency	47 ... 63 Hz
Output frequency	0 ... 100 Hz
Displacement factor cosφ	0.96
Power factor λ	0.75 ... 0.93
Converter efficiency	> 98 %
Overvoltage category	III according to EN 61800-5-1
Mechanical data	
Degree of protection	IP20 (higher degrees of protection up to IP54 optional)
Class of protection	I according to EN 61800-5-1
Touch protection	EN 50274 and BGV A3 when used as intended
Cabinet system	Schäfer industrial housing IS-1, doors with double-barb lock, three-section base plates for cable entry
Paint finish	RAL 7035 (indoor requirements)
Sound pressure level L_{pA} (1 m)	• for 50 Hz line frequency: ≤ 66 dB(A) • for 60 Hz line frequency: ≤ 66 dB(A)
Cooling method	Forced air cooling AF according to EN 60146
Compliance with standards	
Standards	EN 60146-1, EN 61800-2, EN 61800-3, EN 61800-5-1, EN 60204-1, EN 60529 [2)]
CE mark	In accordance with EMC Directive No. 2004/108/EC and Low-Voltage Directive No. 2006/95/EC and Machinery Directive No. 2006/42/EC
RI suppression	In accordance with the EMC product standard for variable-speed drives EN 61800-3, "second environment." Application in "first environment" possible with line filters (option L00) [1)].

Ambient conditions	Storage	Transport	Operation
Ambient temperature	-25 ... +55° C	-25 ... +70° C above *–40° C* for 24 hours	*0* ... +40° C up to 50° C with derating
Humidity range [2)] (non-condensing) corresponds to class	*5 to 95%* 1K4 according to EN 60721-3-1	*5* ... 95% at 40° C 2K3 according to EN 60721-3-2	5 ... *95%* 3K3 according to EN 60721-3-3
Environmental class/harmful chemical substances [2)]	1C2 according to EN 60721-3-1	2C2 according to EN 60721-3-2	3C2 according to EN 60721-3-3
Organic/biological influences [2)]	1B1 according to EN 60721-3-1	2B1 according to EN 60721-3-2	3B1 according to EN 60721-3-3 Restriction: No conductive dust particles permitted
Degree of pollution	2 according to EN 61800-5-1		
Installation altitude	Up to 1000 m above sea level without derating, > 1000 m above sea level with derating (see "Derating data")		
Mechanical strength	**Storage**	**Transport**	**Operation**
Vibrational load [2)] - Displacement - Acceleration corresponds to class	 1.5 mm at *5* to 9 Hz 5 m/s² at > 9 to 200 Hz 1M2 according to EN 60721-3-1	 2M2 according to EN 60721-3-2	 0.075 mm at 10 to 58 Hz 10 m/s² at > 58 to 200 Hz 3M2 according to EN 60721-3-2
Shock load [2)] - Acceleration corresponds to class	 40 m/s² at 22 ms 1M2 according to EN 60721-3-1	 150 m/s² at 11 ms 2M2 according to EN 60721-3-2	 *50 m/s²* at 30 ms *150 m/s²* at 11 ms 3M4 according to EN 60721-3-3

Deviations from the defined classes are shown in *italics*.

1) Applies to cable lengths of up to 100 m.

2) The EN standards specified are the European editions of the international IEC standards with the same designations.

11.2.1 Derating data

11.2.1.1 Permissible output current as a function of the ambient temperature

The cabinet units and the associated system components are dimensioned for an ambient temperature of 40° C. The output current must be reduced if the cabinet devices are operated at ambient temperatures above 40° C. Ambient temperatures above 50° C are not permissible.

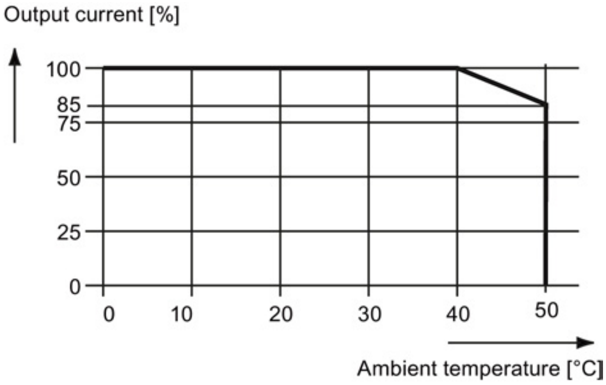


Figure 11-1 Permitted output current depending on the ambient temperature (inlet air temperature at the air inlet of the cabinet unit)

11.2.1.2 Derating values for installation altitudes between 1000 m and 4000 m above sea level

If the SINAMICS G120P Cabinet units are operated at an installation altitude >1000 m above sea level, it must be taken into account that the air pressure and, consequently, the air density decreases. The lower air density also reduces the cooling efficiency and the insulation capacity of the air.

Installation altitudes between 1000 m and 4000 m can be achieved by applying the following measures.

Reduction of the output current as a function of the installation altitude

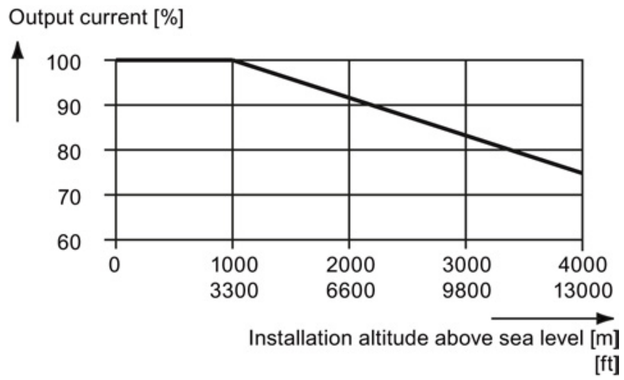


Figure 11-2 Reduction of the output current as a function of the installation altitude

Using an isolating transformer to reduce transient overvoltages according to IEC 61800-5-1

This drops overvoltage category III to overvoltage category II, thereby reducing the requirements for insulation capacity of the air. Additional voltage derating (reduction of the input voltage) is not required if the following framework conditions are observed:

- The isolating transformer must be fed from a low-voltage or medium-voltage network and must not be powered directly from a high-voltage supply system.
- The isolating transformer may be connect to one or more cabinet units.
- The cables between the isolating transformer and the cabinet unit(s) must be routed in such a manner as to rule out direct lightening strike, i.e. overland lines must not be used.
- The following types of system are permissible:
  – TN systems with grounded star point (no grounded outer conductor).
  – IT systems (operation with a ground fault must be restricted to the shorted possible time).

11.2.1.3 Derating factor of the output current as a function of the line voltage

Table 11- 2 Derating factor of the output current as a function of the line voltage

Order number	Rated output current I_N at 380 V/400 V	380 V	400 V	415 V	460 V	480 V
6SL3710-1PE32-1_A0	205 A	100 %	100 %	95.9 %	83.5 %	78 %
6SL3710-1PE32-5_A0	245 A	100 %	100 %	95.3 %	81.3 %	75 %
6SL3710-1PE33-0_A0	300 A	100 %	100 %	96.6 %	86.2 %	81.6 %
6SL3710-1PE33-7_A0	370 A	100 %	100 %	96.9 %	87.8 %	83.7 %

Current derating as a function of the pulse frequency

In the factory setting, the drive starts with a pulse frequency of 4 kHz and reduces automatically the pulse frequency to the associated required frequencies when loaded. When the load decreases, the pulse frequency is increased automatically up to 4 kHz.

The values of the rated current apply to a pulse frequency of 2 kHz at 40° C ambient temperature and are reached at any time by the automatic adaptation of the output pulse frequency.

11.2.2 Overload capability

The converter is equipped with an overload reserve to deal with breakaway torques, for example.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The overloads apply under the precondition that the converter is operated at its base-load current before and after the overload (a duty cycle duration of 300 s is used as a basis here).

Duty cycles

The base load current for low overload (I_L) is based on a load duty cycle of 110% for 60 s or 135% for 3 s.

The base load current I_H for a high overload is based on a duty cycle of 150% for 60 s.

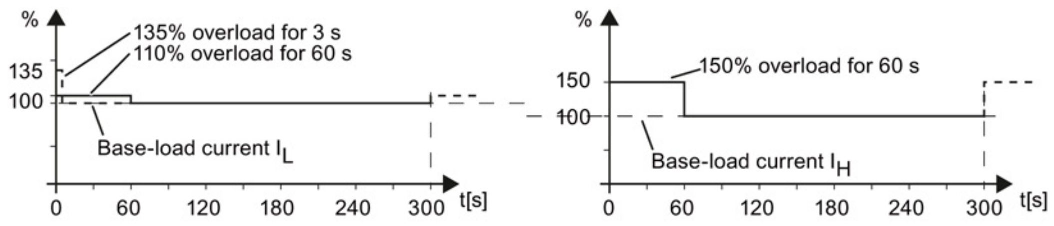


Figure 11-3   Overload curves

11.3 Technical specifications

Note

Notes on the technical data

Current, voltage and power figures in these tables are rated values.

The cables to the device are protected by fuses of operating class gG.

The cable cross-sections have been determined for three-core copper cables routed horizontally in air at 40° C ambient temperature (according to DIN VDE 0276-1000 and IEC 60364-5-52) with a permissible operating temperature of 70° C (e.g. Protodur NYY or NYCWY) and the recommended conductor protection according to DIN VDE 0100 section 430 and IEC 60364-4-43.

Note

Cable cross-sections

When the conditions differ from the above stated (cable routing, cable grouping, ambient temperature), the following instructions for routing the cables must be taken into account:

The required cable cross-section depends on the amperage which flows through the cable. The permissible current loading of cables is defined, for example, in DIN VDE 0276-1000 and IEC 60364-5-52. It depends partly on ambient conditions such as temperature and partly on the type of routing. If the cables are routed individually, they will be cooled relatively well. If several cables are routed together, they may heat each other up. Please note the corresponding derating factors for these supplementary conditions in DIN VDE 0276-1000 and IEC 60364-5-52.

11.3.1 Cabinet unit type A, 3-phase 380 - 480 VAC

Table 11- 3 Type A, 3-phase 380 ... 480 VAC, Part 1

Order number	6SL3710-	1PE32-1AA0	1PE32-5AA0	1PE33-0AA0
Rated power				
- For I_L at 50 Hz 400 V 1)	kW	110	132	160
- For I_L at 60 Hz 460 V 2)	hp	125	150	200
- For I_H at 50 Hz 400 V 1)	kW	90	110	132
- For I_H at 60 Hz 460 V 2)	hp	100	100	150
Output current				
- Rated current I_N (400 V ±10%)	A	205	245	300
- Rated current I_N (480 V ±10%)	A	160	184	245
- Base load current I_L (400 V ±10%) 3)	A	200	240	290
- Base load current I_L (480 V ±10%) 3)	A	156	180	240
- Base load current I_H (400 V ±10%) 4)	A	164	196	240
- Base load current I_H (480 V ±10%) 4)	A	125	138	200
Input current				
- Rated input current (400 V ±10%) 5	A	218	262	317
- Rated input current (480 V ±10%) 5	A	171	197	262
- Base load current I_L (400 V ±10%) 3)	A	213	257	307
- Base load current I_L (480 V ±10%) 3)	A	167	193	257
- Base load current I_H (400 V ±10%) 4)	A	175	210	254
- Base load current I_H (480 V ±10%) 4)	A	134	147	214
- Input current, max.	A	288	347	415
- Power requirement for the 24 VDC auxiliary supply	A	1.0	1.0	1.0
Supply voltages				
- Line voltage	V_{ACrms}	3-phase 380 VAC -10% to 3-phase 480 VAC +10% (-15% < 1 min)		
- Line frequency	Hz	47 to 63 Hz		
- Electronic power supply	V_{DC}	24 (20.4 to 28.8)		
Heat loss, for I_N and 40° C	kW	2.98	3.54	4.14
Coolant requirements	m^3/s	0.21	0.21	0.21
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	66/66	66/66	66/66
Line connection				
- Recommended: IEC 6)	mm^2	2 x 70	2 x 95	2 x 120
- Maximum: IEC	mm^2	2 x 240	2 x 240	2 x 240
- Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Motor connection				
- Recommended: IEC 6)	mm^2	2 x 50	2 x 70	2 x 95
- Maximum: IEC	mm^2	2 x 240	2 x 240	2 x 240
- Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Maximum DC-link voltage: IEC				
- Fixing screw	mm^2	2 x 240	2 x 240	2 x 240
		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)
Maximum protective conductor connection: IEC	mm^2	3 x 240	3 x 240	3 x 240
Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)

Order number	6SL3710-	1PE32-1AA0	1PE32-5AA0	1PE33-0AA0
Motor cable length, max. shielded/unshielded - with observance of Categories C3 and C2 - without observance of the limit values for radio interference suppression	 m m	 100/200 300/450	 100/200 300/450	 100/200 300/450
Dimensions (standard version) - Width - Height - Depth	 mm mm mm	 1000 2000 600	 1000 2000 600	 1000 2000 600
Power Module frame size		GX	GX	GX
Weight (without options), approx.	kg	360	360	370
Recommended protection - Line protection (with option L26) Rated current Frame size according to IEC 60269 - Line and semiconductor protection (without option L26) Rated current Frame size according to IEC 60269	 A A 	 3NA3144 250 1 3NE1230-2 315 1	 3NA3252 315 2 3NE1331-2 350 2	 3NA3260 400 2 3NE1333-2 450 2
Short-circuit current rating per IEC 7)	kA	65	65	65
Minimum short-circuit current 8) - For 3NE1 fuses - For 3NA3 fuses	 A A	 3000 5800	 3600 7300	 4400 9500

1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 400 VAC 50 Hz.
2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 460 VAC 60 Hz.
3) The base-load current I_L is based on a duty cycle of 110% for 60 s or 135% for 3 s with a duty cycle duration of 300 s (see "Overload capability").
4) The base-load current I_H is based on a duty cycle of 150% for 60 s with a duty cycle duration of 300 s (see "Overload capability").
5) The current values given here are based on the rated output current.
6) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.
7) In conjunction with the specified fuses or circuit breakers.
8) Current required for reliable triggering of the protective devices.

Table 11- 4 Type A, 3-phase 380 ... 480 VAC, Part 2

Order number	6SL3710-	1PE33-7AA0		
Rated power - For I_L at 50 Hz 400 V [1)] - For I_L at 60 Hz 460 V [2)] - For I_H at 50 Hz 400 V [1)] - For I_H at 60 Hz 460 V [2)]	 kW hp kW hp	 200 250 160 200		
Output current - Rated current I_N (400 V ±10%) - Rated current I_N (480 V ±10%) - Base load current I_L (400 V ±10%) [3)] - Base load current I_L (480 V ±10%) [3)] - Base load current I_H (400 V ±10%) [4)] - Base load current I_H (480 V ±10%) [4)]	 A A A A A A	 370 308 360 302 296 257		
Input current - Rated input current (400 V ±10%) [5] - Rated input current (480 V ±10%) [5] - Base load current I_L (400 V ±10%) [3)] - Base load current I_L (480 V ±10%) [3)] - Base load current I_H (400 V ±10%) [4)] - Base load current I_H (480 V ±10%) [4)] - Input current, max. - Power requirement for the 24 VDC auxiliary supply	 A A A A A A A A	 375 314 365 308 300 262 493 1.0		
Supply voltages - Line voltage - Line frequency - Electronic power supply	 V_{ACrms} Hz V_{DC}	 3-phase 380 VAC -10% to 3-phase 480 VAC +10% (-15% < 1 min) 47 to 63 Hz 24 (20.4 to 28.8)		
Heat loss, for I_N and 40° C	kW	5.28		
Coolant requirements	m^3/s	0.21		
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	66/66		
Line connection - Recommended: IEC [6)] - Maximum: IEC - Fixing screw	 mm^2 mm^2	 2 x 120 2 x 240 M12 (2 holes)		
Motor connection - Recommended: IEC [6)] - Maximum: IEC - Fixing screw	 mm^2 mm^2	 2 x 95 2 x 240 M12 (2 holes)		
Maximum DC-link voltage: IEC - Fixing screw	 mm^2	 2 x 240 M12 (2 holes)		
Maximum protective conductor connection: IEC Fixing screw	 mm^2	 3 x 240 M12 (2 holes)		

Order number	6SL3710-	1PE33-7AA0		
Motor cable length, max. shielded/unshielded - with observance of Categories C3 and C2 - without observance of the limit values for radio interference suppression	 m m	 100/200 300/450		
Dimensions (standard version) - Width - Height - Depth	 mm mm mm	 1000 2000 600		
Power Module frame size		GX		
Weight (without options), approx.	kg	380		
Recommended protection - Line protection (with option L26) Rated current Frame size according to IEC 60269 - Line and semiconductor protection (without option L26) Rated current Frame size according to IEC 60269	 A A	 3NA3365 500 3 3NE1334-2 500 2		
Short-circuit current rating per IEC 7)	kA	65		
Minimum short-circuit current 8) - For 3NE1 fuses - For 3NA3 fuses	 A A	 5200 14000		

1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 400 VAC 50 Hz.

2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 460 VAC 60 Hz.

3) The base-load current I_L is based on a duty cycle of 110% for 60 s or 135% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) The base-load current I_H is based on a duty cycle of 150% for 60 s with a duty cycle duration of 300 s (see "Overload capability").

5) The current values given here are based on the rated output current.

6) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.

7) In conjunction with the specified fuses or circuit breakers.

8) Current required for reliable triggering of the protective devices.

11.3.2 Cabinet unit type C, 3-phase 380 - 480 VAC

Table 11- 5 Type C, 3-phase 380 ... 480 VAC, Part 1

Order number	6SL3710-	1PE32-1CA0	1PE32-5CA0	1PE33-0CA0
Rated power				
- For I_L at 50 Hz 400 V [1)]	kW	110	132	160
- For I_L at 60 Hz 460 V [2)]	hp	125	150	200
- For I_H at 50 Hz 400 V [1)]	kW	90	110	132
- For I_H at 60 Hz 460 V [2)]	hp	100	100	150
Output current				
- Rated current I_N (400 V ±10%)	A	205	245	300
- Rated current I_N (480 V ±10%)	A	160	184	245
- Base load current I_L (400 V ±10%) [3)]	A	200	240	290
- Base load current I_L (480 V ±10%) [3)]	A	156	180	240
- Base load current I_H (400 V ±10%) [4)]	A	164	196	240
- Base load current I_H (480 V ±10%) [4)]	A	125	138	200
Input current				
- Rated input current (400 V ±10%) [5]	A	218	262	317
- Rated input current (480 V ±10%) [5]	A	171	197	262
- Base load current I_L (400 V ±10%) [3)]	A	213	257	307
- Base load current I_L (480 V ±10%) [3)]	A	167	193	257
- Base load current I_H (400 V ±10%) [4)]	A	175	210	254
- Base load current I_H (480 V ±10%) [4)]	A	134	147	214
- Input current, max.	A	288	347	415
- Power requirement for the 24 VDC auxiliary supply	A	0.5	0.5	0.5
Supply voltages				
- Line voltage	V_{ACrms}	3-phase 380 VAC -10% to 3-phase 480 VAC +10% (-15% < 1 min)		
- Line frequency	Hz	47 to 63 Hz		
- Electronic power supply	V_{DC}	24 (20.4 to 28.8)		
Heat loss, for I_N and 40° C	kW	2.43	2.86	3.50
Coolant requirements	m³/s	0.21	0.21	0.21
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	63/63	63/63	63/63
Line connection				
- Recommended: IEC [6)]	mm²	2 x 70	2 x 95	2 x 120
- Maximum: IEC	mm²	2 x 240	2 x 240	2 x 240
- Fixing screw		M12 (1 hole)	M12 (1 hole)	M12 (1 hole)
Motor connection				
- Recommended: IEC [6)]	mm²	2 x 50	2 x 70	2 x 95
- Maximum: IEC	mm²	2 x 240	2 x 240	2 x 240
- Fixing screw		M12 (1 hole)	M12 (1 hole)	M12 (1 hole)
Maximum DC-link voltage: IEC				
- Fixing screw	mm²	2 x 240	2 x 240	2 x 240
		M12 (1 hole)	M12 (1 hole)	M12 (1 hole)
Maximum protective conductor connection: IEC	mm²	3 x 240	3 x 240	3 x 240
Fixing screw		M12 (2 holes)	M12 (2 holes)	M12 (2 holes)

Order number	6SL3710-	1PE32-1CA0	1PE32-5CA0	1PE33-0CA0
Motor cable length, max. shielded/unshielded - with observance of Categories C3 and C2 - without observance of the limit values for radio interference suppression	 m m	 100/200 300/450	 100/200 300/450	 100/200 300/450
Dimensions (standard version) - Width - Height - Depth	 mm mm mm	 600 2000 600	 600 2000 600	 600 2000 600
Power Module frame size		GX	GX	GX
Weight (without options), approx.	kg	290	290	290
Recommended protection - Line and semi-cond. protection Rated current Frame size according to IEC 60269	 A 	 3NE1230-2 315 1	 3NE1331-2 350 2	 3NE1333-2 450 2
Short-circuit current rating per IEC [7]	kA	65	65	65
Minimum short-circuit current [8] - For 3NE1 fuses	 A	 3000	 3600	 4400

1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 400 VAC 50 Hz.
2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 460 VAC 60 Hz.
3) The base-load current I_L is based on a duty cycle of 110% for 60 s or 135% for 3 s with a duty cycle duration of 300 s (see "Overload capability").
4) The base-load current I_H is based on a duty cycle of 150% for 60 s with a duty cycle duration of 300 s (see "Overload capability").
5) The current values given here are based on the rated output current.
6) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.
7) In conjunction with the specified fuse-elements.
8) Current required for reliable triggering of the protective devices.

Table 11- 6 Type C, 3-phase 380 ... 480 VAC, Part 2

Order number	6SL3710-	1PE33-7CA0		
Rated power - For I_L at 50 Hz 400 V 1) - For I_L at 60 Hz 460 V 2) - For I_H at 50 Hz 400 V 1) - For I_H at 60 Hz 460 V 2)	 kW hp kW hp	 200 250 160 200		
Output current - Rated current I_N (400 V ±10%) - Rated current I_N (480 V ±10%) - Base load current I_L (400 V ±10%) 3) - Base load current I_L (480 V ±10%) 3) - Base load current I_H (400 V ±10%) 4) - Base load current I_H (480 V ±10%) 4)	 A A A A A A	 370 308 360 302 296 257		
Input current - Rated input current (400 V ±10%) 5 - Rated input current (480 V ±10%) 5 - Base load current I_L (400 V ±10%) 3) - Base load current I_L (480 V ±10%) 3) - Base load current I_H (400 V ±10%) 4) - Base load current I_H (480 V ±10%) 4) - Input current, max. - Power requirement for the 24 VDC auxiliary supply	 A A A A A A A A	 375 314 365 308 300 262 493 0.5		
Supply voltages - Line voltage - Line frequency - Electronic power supply	 V_{ACrms} Hz V_{DC}	 3-phase 380 VAC -10% to 3-phase 480 VAC +10% (-15% < 1 min) 47 to 63 Hz 24 (20.4 to 28.8)		
Heat loss, for I_N and 40° C	kW	4.38		
Coolant requirements	m^3/s	0.21		
Sound pressure level L_{pA} (1 m) at 50/60 Hz	dB(A)	63/63		
Line connection - Recommended: IEC 6) - Maximum: IEC - Fixing screw	 mm^2 mm^2	 2 x 120 2 x 240 M12 (1 hole)		
Motor connection - Recommended: IEC 6) - Maximum: IEC - Fixing screw	 mm^2 mm^2	 2 x 95 2 x 240 M12 (1 hole)		
Maximum DC-link voltage: IEC - Fixing screw	 mm^2	 2 x 240 M12 (1 hole)		
Maximum protective conductor connection: IEC Fixing screw	 mm^2	 3 x 240 M12 (2 holes)		

Order number	6SL3710-	1PE33-7CA0		
Motor cable length, max. shielded/unshielded - with observance of Categories C3 and C2 - without observance of the limit values for radio interference suppression	 m m	 100/200 300/450		
Dimensions (standard version) - Width - Height - Depth	 mm mm mm	 600 2000 600		
Power Module frame size		GX		
Weight (without options), approx.	kg	300		
Recommended protection - Line and semi-cond. protection Rated current Frame size according to IEC 60269	 A	 3NE1334-2 500 2		
Short-circuit current rating per IEC 7)	kA	65		
Minimum short-circuit current 8) - For 3NE1 fuses	 A	 5200		

1) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 400 VAC 50 Hz.

2) Rated output of a typical 6-pole standard induction motor based on I_L or I_H at 3-phase 460 VAC 60 Hz.

3) The base-load current I_L is based on a duty cycle of 110% for 60 s or 135% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) The base-load current I_H is based on a duty cycle of 150% for 60 s with a duty cycle duration of 300 s (see "Overload capability").

5) The current values given here are based on the rated output current.

6) The recommendations for the North American market in AWG or MCM must be taken from the appropriate NEC (National Electrical Code) or CEC (Canadian Electrical Code) standards.

7) In conjunction with the specified fuse-elements.

8) Current required for reliable triggering of the protective devices.

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Additional information

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