

Edition 09/2025

OPERATING INSTRUCTIONS

SINAMICS

DCP

DC/DC Power Converter
www.siemens.com/drives

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SINAMICS DCP

Operating Instructions

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Firmware version V1.4 SP1

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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 persons are those who, because of their training and experience, are familiar with the installation, assembly, commissioning, operation, decommissioning and disassembly of the product and can recognize risks and avoid possible hazards.

Proper use of Siemens products

Note the following:

⚠ **WARNING**
Siemens products may only be used for the application described in the catalog and the associated usage information. 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.

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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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Introduction

1

1.1 About SINAMICS

Description

SINAMICS converters are the optimum solution for all drive applications extending from low voltage through to DC. All Siemens drive components, such as converters, motors, and controls, are matched to each other and can be integrated into your existing automation systems.

More information



You can find more information via the SINAMICS YouTube playlist:

YouTube playlist (https://www.youtube.com/playlist?list=PLw7lLwXw4H53rtHeTeifKtVMr2aXTYt0X)

1.2 About this manual

1.2.1 Content

Overview

This manual provides a summary of all of the information required to operate the converter under safe conditions.

The manual enables the target groups being addressed to mount, install, connect, and commission the converter safely and in the correct manner.

To illustrate possible application areas for our products, typical use cases are listed in this product documentation and in the online help. These are purely exemplary and do not constitute a statement on the suitability of the respective product for applications in specific individual cases. Unless explicitly contractually agreed, Siemens assumes no liability for such suitability. Suitability for a particular application in specific individual cases must be assessed by the user, taking into account all technical, legal, and other requirements on a case-by-case basis. Always observe the descriptions of the technical properties and the relevant constraints of the respective product provided in the product documentation.

1.2.2 Target group

Overview

This manual addresses the following target groups:

- Planning engineers
- Project engineers
- Technologists
- Installation personnel
- Programmers
- Commissioning engineers
- Machine operators
- Service and maintenance personnel

1.2.3 Standard scope

The functions of the system as delivered can only be found in the order documents.

Further functions may be executable in the system, which are not explained in this documentation. However, there is no entitlement to these functions in the case of a new delivery or service.

This documentation does not contain all detailed information on all types of the product. Furthermore, this documentation cannot take into consideration every conceivable type of installation, operation and service/maintenance.

The machine manufacturer must document any additions or modifications they make to the product themselves.

1.2.4 Use of third-party products in this documentation

This documentation contains recommendations relating to third-party products. Siemens accepts the fundamental suitability of these third-party products. You can use equivalent products from other manufacturers.

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

You can find details of our product partners here: website.

1.2.5 Websites of third-party companies

This document may contain hyperlinks to third-party websites. Siemens is not responsible for and shall not be liable for these websites and their content. Siemens has no control over the information which appears on these websites and is not responsible for the content and information provided there. The user bears the risk for their use.

1.3 Product documentation

Description

The product documentation for the converter can be found on the Internet:

SiePortal Sinamics DCP (https://support.industry.siemens.com/cs/ww/en/ps/13302/man)

You can display documents or download them in PDF and HTML5 formats.

The product documentation for the converter comprises the following documents:

Table 1-1 Product documentation

Information	Document	Content
Information about the converter	Operating Instructions for SINAMICS DCP	Installing, commissioning, and maintaining the converter
	List Manual for SINAMICS DCP	Meaning, setting options and dependencies of the parameters and messages of the converter
	Commissioning Manual for SINAMICS Free Function Blocks	General description, parameter list, function diagrams and the list of faults and alarms
General information	Industrial Cybersecurity Configuration Manual	Industrial Cybersecurity functions and safe operation of the SINAMICS product

More information

Generic station description file (GSD) for
PROFIBUS (https://support.industry.siemens.com/cs/ww/en/view/98206128)
PROFINET (https://support.industry.siemens.com/cs/ww/en/view/98207877)

1.4 Service and support

1.4.1 Siemens Online Support

You can find additional information about the product:

- using the Siemens Industry Online Support
  - Website: SIOS (https://support.industry.siemens.com/cs/ww/en/)
  - App Industry Online Support (for Apple iOS and Android)

Content of Siemens Online Support

- Product support
- Global forum for information and best practice sharing between users and specialists
- Local contact persons via the contact person database (→ Contact)

- Product information
- FAQs (frequently asked questions)
- Application examples
- Manuals
- Downloads
- Compatibility tool
- Newsletter with product selection
- Catalogs/brochures
- Certificates

1.4.2 Spare parts services

The online spare part service "Spares on Web (https://www.sow.siemens.com/)" offers spare parts for the product.

1.5 Important product information

1.5.1 Intended use

Requirement

⚠ WARNING

Death or serious injury if not used as intended

Not using as intended can result in hazardous states.

- Carefully observe the description of intended use

Note

It cannot be guaranteed that EMC emission limits are complied with if the products are connected to an isolated line supply grounded through a high ohmic connection or a line supply with grounded line conductor.

- Draw-up an EMC plan to comply with the EMC requirements of the intended application.

Description

Together with software, accessories and options, the products described in this manual are part of an electric drive system that is intended to supply low-voltage AC motors. The purpose of the described products in the drive system is to adjust the voltage/current from one side to the other.

The products are professional devices designed for stationary use indoors in industrial environments. The products must be correctly transported and stored and must be installed, commissioned and maintained by professionals who have adequate knowledge to implement the safety and EMC measures in accordance with the specifications described in this manual and recognized state-of-the-art engineering practice.

You must only use the products, carefully complying with the following conditions:

- All regulations and guidelines, which are applicable at the installation location, especially with respect to electrical safety, functional safety and electromagnetic compatibility.
- All instructions, notes, technical data and safety instructions that are included in this document and other supporting documents.

The products are part of a machine or system. They must guarantee the safety of persons and material assets as well as electromagnetic compatibility by applying suitable measures when designing the system.

Before using the product, you must to carry out a risk evaluation of the complete application (including products from third-party suppliers) and implement suitable measures for the system design.

Open type products (IP00 / IP20) are intended for installation in control cabinets, which offer the necessary protection.

Any use other than that expressly permitted is prohibited, and can result in unforeseen dangers.

1.5.2 Firmware updates and constraints

Description

As these Operating Instructions went to print, SINAMICS DCP devices were being supplied from the factory with the firmware release specified on the inside front page. However, these Operating Instructions can, in principle, also apply to other firmware releases.

- **Older firmware releases**
  It is possible that not all of the functions described here are actually available.
- **Newer firmware releases**
  It is possible that the SINAMICS DCP may feature additional functions that are not described in these Operating Instructions. Do not change any parameters that you cannot find in the List Manual from their factory setting, and do not give parameters any values that are not specified in the List Manual.
  The firmware release is displayed in r50060[6].
  Example:
  01040000 displayed on the BOP20 means 01.04.00.00 → Version 1.4, Service Pack 0, Hotfix 0
- You can download the firmware here: Download the firmware (https://support.industry.siemens.com/cs/de/en/ps/13302/dl)

1.5.3 Open-source software (OSS)

Description

The license conditions and copyright information of the open-source software components used by the device are saved on the device itself. You can download license and copyright information onto your PC via the support page of the integrated web server.

1.5.4 Compliance with the General Data Protection Regulation

Description

Siemens complies with the principles of the **General Data Protection Regulation (EU),** in particular the principle of data minimization ("privacy by design"). For this SINAMICS product, this means:

- **User management and access control (UMAC)**
  The product processes or stores the following personal data:
  - Login data for user management and access control:
    User name, group, password, role, rights.

  The data for user management and access control is stored in the converter and optionally on a memory card.
- **Support data (optional)**
  For optimal support in service cases, the end user or machine manufacturer (OEM) can optionally store contact data (header, email address, telephone number, homepage) in the converter.
  If this data is created, the author must give thought to data protection consent for this optional data. Siemens takes no responsibility for this data.
  This support contact data can be read and is freely accessible in, for example, the user interface as well as in the diagnostics report. This data is not encrypted.

This data is used for user management and access control (UMAC) and for the support function. The storage of this data is appropriate and limited to what is necessary, as it is essential to identify the authorized operators and service contact.

The personal data is also available as part of the backup system to ensure fast recovery of use cases.

The above-mentioned personal data cannot be stored anonymously or pseudonymized, as it serves the purpose of identifying the operating personnel. The anonymization or pseudonymization, e.g. of the login data, must be performed using suitable login names and contact data by the plant/machine operator.

Our product does not provide any functions for automatically deleting personal data. Individual UMAC data can be deleted manually by authorized personnel as soon as this is deemed recommended/required.

Fundamental safety instructions

2

2.1 General safety instructions

Note

SINAMICS DCP is a member of the SINAMICS series of devices. This series of devices mainly comprises components for electric drives. This is the reason that in these operating instructions in chapters which are applicable for several SINAMICS components (for example PROFIBUS), the terms "Drive", "Master/leading drive", "Drive unit" or "Drive system" are used. In these Operating Instructions, "drive", "drive unit" or "drive system" always refers to the SINAMICS DCP.



⚠ WARNING

Electric shock and danger to life due to other energy sources

Touching live components can result in death or serious injury.

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

Generally, the following six steps apply when establishing safety:

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

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



⚠ WARNING

Electric shock if there is no ground connection

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

- Ground the device in compliance with the applicable regulations.



⚠ WARNING

Electric shock due to connection to an unsuitable power supply

When equipment is connected to an unsuitable power supply, exposed components may carry a hazardous voltage that might result in serious injury or death.

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



⚠ WARNING

Electric shock due to equipment damage

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

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



⚠ WARNING

Electric shock due to unconnected cable shield

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

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



⚠ WARNING

Arcing when a plug connection is opened during operation

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

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



⚠ WARNING

Electric shock due to residual charges in power components

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

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

NOTICE

Damage to equipment due to unsuitable tightening tools.

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

- Be sure to only use screwdrivers which exactly match the heads of the screws.
- Tighten the screws with the torque specified in the technical documentation.
- Use a torque wrench or a mechanical precision nut runner with a dynamic torque sensor and speed limitation system.

NOTICE

Property damage due to loose power connections

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

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

⚠ WARNING

Spread of fire from built-in devices

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

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

⚠ WARNING

Active implant malfunctions due to electromagnetic fields

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment (for example, transformers, converters). Electromagnetic fields may interfere with active implants, e.g. pacemakers. People with active implants in the immediate vicinity of systems are at risk.

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

⚠ WARNING

Unexpected movement of machines caused by radio devices or mobile phones

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

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

⚠ WARNING

Fire due to inadequate ventilation clearances

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

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

⚠ WARNING

Unrecognized dangers due to missing or illegible warning labels

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

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

⚠ WARNING

Unexpected movement of machines caused by inactive safety functions

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

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

2.2 Equipment damage due to electric fields or electrostatic discharge

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



NOTICE

Equipment damage due to electric fields or electrostatic discharge

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

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

2.3 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment, or any eventuality which may arise. Application examples do not represent customer-specific solutions, but merely serve to provide assistance with typical tasks.

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

2.4 Cybersecurity information

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

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

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

For additional information on industrial cybersecurity measures that may be implemented, please visit
https://www.siemens.com/cybersecurity-industry.

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

To stay informed about product updates, subscribe to the Siemens Industrial Cybersecurity RSS Feed under
https://new.siemens.com/cert.

Further information is provided on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/ww/en/view/109975311)

⚠ WARNING

Unsafe operating states resulting from software manipulation

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

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

2.5 Residual risks of power drive systems

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

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

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

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

2.6 Notes on plant safety

Requirements

The operating company is responsible for the plant safety.

Verify that the following conditions are satisfied:

- Basic planning as well as all the work involved in transporting, assembling, installing, commissioning, maintaining repairing the equipment is only carried out by qualified personnel or by those skilled technicians responsible.
- The entire product documentation must always be available for all of the work that is performed.
- Technical data and specifications regarding the permissible installation, connection, environmental, and operating conditions are consequentially observed.
- All system-specific installation and safety regulations are observed and protective measures are taken to ensure personal safety.
- It is prohibited for unqualified persons to work on these devices or in their vicinity.

Note

Insulation resistance of the SINAMICS DCP 30 kW device

The insulation resistance of the SINAMICS DCP 30 kW device is approximately 500 kΩ.

Description

3

Area of application

A SINAMICS DCP is used to control the electrical power flow between two direct current systems in an electrical drive system. The device can be operated with current control or voltage control.

The main application of the SINAMICS DCP is to control the electrical power flow in the following directions:

- from a DC link (e.g. side 1, terminals P1 and N1) in an energy storage device (e.g. side 2, terminals P2 and N2).
- from an energy storage or energy generating device (e.g. side 2, terminals P2 and N2) into the DC link (e.g. side 1, terminals P1 and N1).

The power flow in both directions - from the DC link to the energy storage device or from the energy storage device into the DC link - is called bidirectional.

Controlled by a signed current setpoint or a voltage setpoint, electric power can be transferred in both directions, independent of the voltages of the two DC circuits (in the nominal range).

The integration of a SINAMICS DCP in a complete technical system is illustrated in Chapter "Block diagram with connection suggestion (Page 49)".

Protective measures for plants and systems equipped with SINAMICS DCP

The following warnings and/or notes must be carefully taken into consideration when implementing electrical systems in which a SINAMICS DCP is used.
Especially the requirements relating to protection against electric shock for the load or consumer side according to IEC 60364 must be strictly complied with.



⚠ WARNING

Electric shock when using SINAMICS DCP in plants and systems without adequate protective measures

The DCP alone does not provide protection against electric shock through basis protection (touch protection) and does not provide fault protection where the supply is automatically shut down (IEC 60364-4-41).

Using a SINAMICS DCP without adequate measures to protect against electric shock can result in death or severe injury.

- Ensure that there is sufficient basis protection (touch protection) by installing the equipment in a suitable control cabinet.
- Apply measures to automatically shut down the supply in the case of a fault (e.g. RCD, ground fault monitoring, short-circuit monitoring).
  For an automatic shutdown, all energy sources must be separated through all poles and at all sides.



⚠ WARNING

Electric shock as there is no electrical separation

SINAMICS DCP has no electrical separation between the power connections of side 1 and side 2, terminals N1 (side 1) and N2 (side 2) are internally directly connected with one another.

Further, a connection is established between terminals P1 (side 1) and P2 (side 2) as a result of the power semiconductors.

The DCP does not have any switching devices to disconnect the power connections.

As a consequence, it must always be assumed that there is hazardous voltage at both sides of the DCP. This is also true when the DCP is switched off.

As a consequence, serious injury or death can occur.

- Install the appropriate switching devices (e.g. contactors, circuit breakers) to electrically isolate the power connections.



⚠ WARNING

Electric shock if the insulation voltage is exceeded

An excessively high voltage will damage the insulation resulting in death or severe injury.

- Do not connect any voltage sources whose no-load voltage exceeds the permissible values of the device.
- To rule out any damage, route the cables so that they are protected



⚠ WARNING

Electric shock when using a SINAMICS DCP to provide SELV, FELV and PELV

The power circuit of the DCP is not suitable for generating a safety extra-low voltage in a non-grounded system (SELV), a functional extra-low voltage with protective separation (PELV) and a functional extra-low voltage (FELV).
This use can result in severe injury or death.

- Never use the power circuit of the SINAMICS DCP for generating a safety extra-low voltage in a non-grounded system (SELV), a functional extra-low voltage with protective separation (PELV) and a functional extra-low voltage (FELV).

Note

Test in accordance with safety standard IEC 61800-5-1

The safety requirements, including protection against electric shock, are tested for SINAMICS DCP at the device level according to IEC 61800-5-1 – where applicable.

Note

No validity for the manufacturer's declaration for SINAMICS DCP

The manufacturer's declaration issued by SIEMENS for SINAMICS converters is not applicable for SINAMICS DCP.
See under Manufacturer's declaration (https://support.industry.siemens.com/cs/ww/en/view/109476638)

Note

Polarity reversal is not possible

SINAMICS DCP only supports positive voltages at sides 1 and 2, i.e. the voltage at terminal P1 or P2 must always be higher than the voltage at terminals N1 or N2.

Polarity reversal is not possible.

Design

The SINAMICS DCP are compact devices and contain power units and open-loop/closed-loop control electronics.

The open-loop/closed-loop control electronics comprise several modules.

The module that is visible after removing the front panel is called the CUD (Control Unit DC). The connector board with interface X177 is plugged onto the CUD.

The power units are made up of semiconductor switches; the heat sink is grounded.

The negative polarity (minus) cable is routed from side 1 to side 2, the current is controlled in the positive polarity (plus) branch.

The devices are forced-ventilated, the air flow is from the bottom to the top.

The devices are only approved for installation in cabinets in the vertical mounting position.

Communication with the devices is via fieldbus (PROFIBUS or PROFINET) during normal operation and STARTER for the parameter assignment and diagnostics.

Additional components

- **CBE20 additional module**
  - The CBE20 additional module is inserted in the option module slot of the CUD. It allows the SINAMICS DCP to be connected as IO device to a PROFINET network.
- **Memory card**
  - The memory card enables the functions described in Chapter "Memory card functions (Page 161)".
- **For communication between two Control Units via DRIVE-CLiQ**
  see the OA Link Manual (https://support.industry.siemens.com/cs/ww/en/view/109477831)

Application planning

4

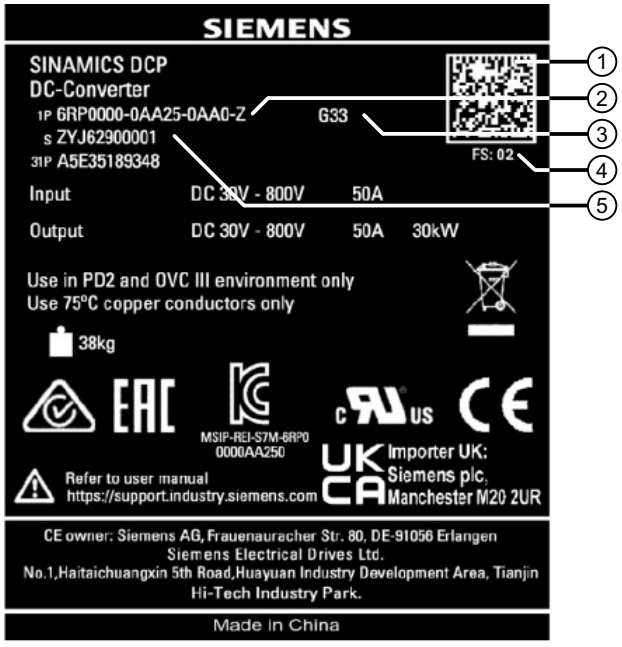
4.1 Device article numbers

Rated power	Rated direct current	Rated DC voltage	Article number
30 kW	50 A	600 V	6RP0000-0AA25-0AA0
120 kW	200 A	600 V	6RP0010-1AA32-0AA0
250 kW	250 A	1000 V	6RP0020-2AC32-5AA0

4.2 Rating plate

The rating plate contains the most important technical data and the serial number.

It is attached to the front cover.



① Data matrix code
② For options: "Z" after the article number
③ Order codes for options (according to ordering information for options) (order-specific)
④ Functional state
⑤ Serial number

Rating plate on the front cover

Note

Hazardous Voltage

There is a warning notice below the rating plate on the front cover about the hazardous voltage present at the device for up to 5 minutes after it has been disconnected from the power supply.



Figure 4-1 Symbolic illustration of the warning label

4.3 Ordering information for options and accessories

Ordering information for options with order codes

Table 4-1 Control Unit CUD options

Option	Order codes
Terminal Module Cabinet (TMC) can be snapped onto a 35 mm mounting rail. Enables the simple connection of the CUD standard signals (X177) via spring-loaded terminals in an easily accessible area of the control cabinet. The CUD is equipped with an adapter board. Terminal Module Cabinet and connecting cable (3 m) are supplied separately. Note: In the device version with option G63, the X177 terminal connections are no longer available directly on the CUD.	G63
CBE20 is required for communication via PROFINET, Modbus TCP, EtherNet/IP, SINAMICS Link	G33
Memory card is also required for firmware updates, communication via Modbus TCP and SINAMICS Link as well as diagnostic functions. See also Chapter "Memory card functions (Page 161)".	S03

Table 4-2 Further options

Option	Order codes
Coated modules Coated modules increase the robustness against climate influences: • Relative/absolute humidity 5 % to 95 % / 1 to 29 g/m³ for ambient or coolant temperature ≤30 °C. • ≤ 60 % when SO_2 and H_2S are present, and/or for ambient or coolant temperature 30 °C to 40 °C • Oil mist, salt mist, ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted.	M08 [1]
Extension of the warranty conditions by 12 months to a total of 24 months (2 years) after being delivered	Q80
Extension of the warranty conditions by 18 months to a total of 30 months (2½ years) after being delivered	Q81
Extension of the warranty conditions by 24 months to a total of 36 months (3 years) after being delivered	Q82
Extension of the warranty conditions by 30 months to a total of 42 months (3½ years) after being delivered	Q83
Extension of the warranty conditions by 36 months to a total of 48 months (4 years) after being delivered	Q84
Extension of the warranty conditions by 48 months to a total of 60 months (5 years) after being delivered	Q85
Power connections, top/bottom	M69 [2]
Power connections from below	M79 [2]

[1] Can be ordered as an option for 30 kW devices, included in the standard scope of delivery for 120 kW and 250 kW devices.

[2] Option can only be ordered with 120 kW and 250 kW devices.

Ordering information for accessories

Table 4-3 Article numbers for accessories

Item	Article number
CBE20 PROFINET	6SL3055-0AA00-2EB0
Memory card (corresponds to spare part for option S03)	6RX1800-0AS50
Terminal Module TM15	6SL3055-0AA00-3FA0
Terminal Module TM31	6SL3055-0AA00-3AA1
Terminal Module TM150	6SL3055-0AA00-3LA0
STARTER commissioning tool	6SL3072-0AA00-0AG0

4.4 Fault protection for the motor circuit

Description

The converter provides short-circuit protection at the motor output terminals.

The manufacturer's declaration describes the conditions regarding protection against electric shock in the event of an insulation failure in the motor circuit.

More information

You can find more information on the Internet: Manufacturer's declaration (https://support.industry.siemens.com/cs/ww/en/view/109476638)

Mounting

5

The SINAMICS DCP is only designed for cabinet mounting.

Note

Protection against the spread of fire

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

The device must be installed in a metal control cabinet or protected by another equivalent measure such that fire cannot spread and emissions outside of the control cabinet are prevented.

Note

Protection against condensation and electrically conductive dirt and pollution

To ensure that the device functions correctly, appropriately protect it for example by installing it in a control cabinet with degree of protection IP54 according to IEC 60529 or type 12 according to NEMA 250. Further measures may be necessary for particularly critical operating conditions.

A lower degree of cabinet protection is permissible, if condensation and conductive pollution can be excluded at the installation site.

SINAMICS DCP must be mounted in the vertical position to ensure that the required ventilation is guaranteed.

The mandatory cooling clearances are indicated by the dashed line.

The arrangement of the mounting positions is shown in the following drawings.

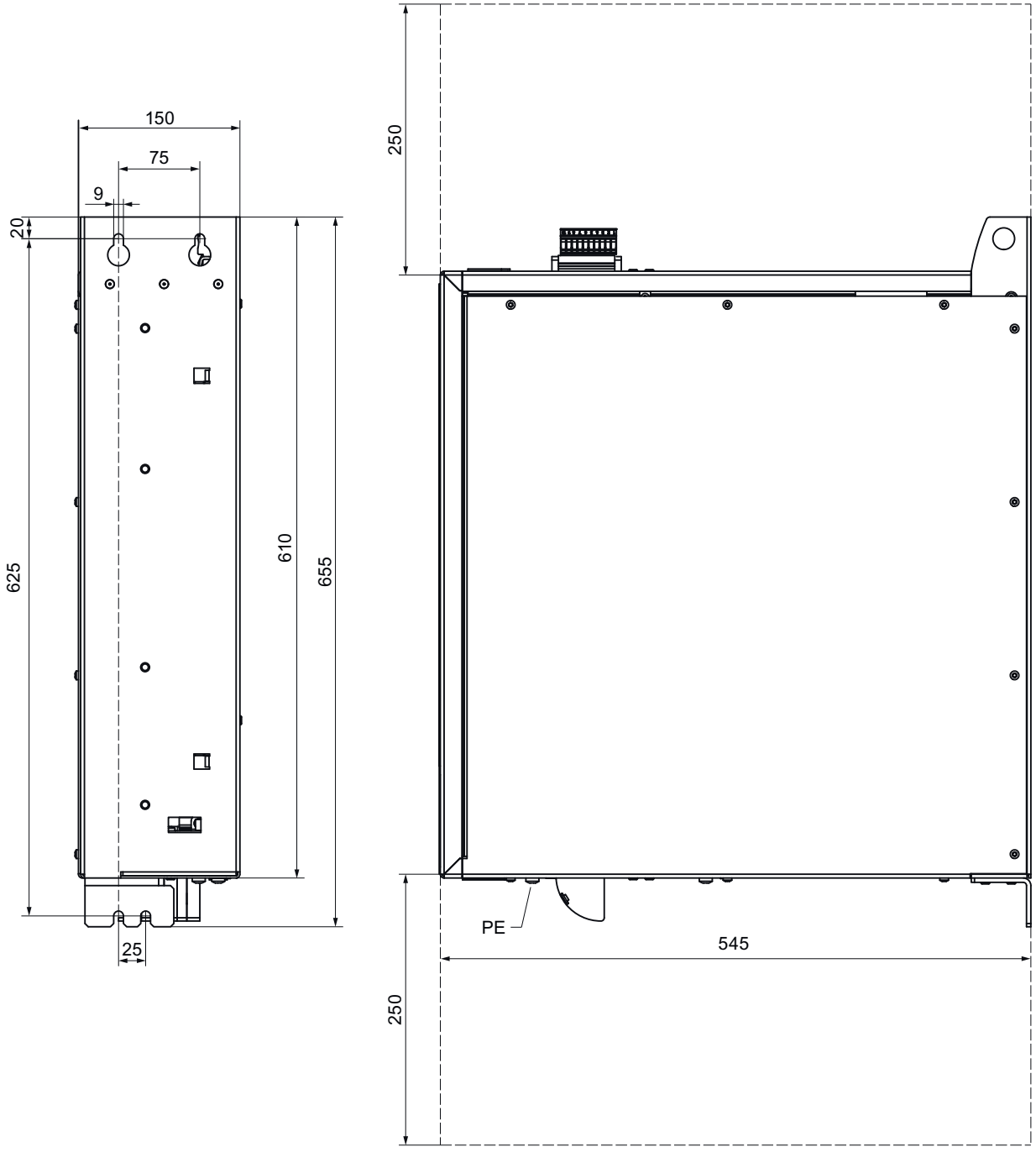


Figure 5-1 Dimensions and mounting positions for 30 kW devices; from functional state 02 (dimensions in mm), rear view, side view

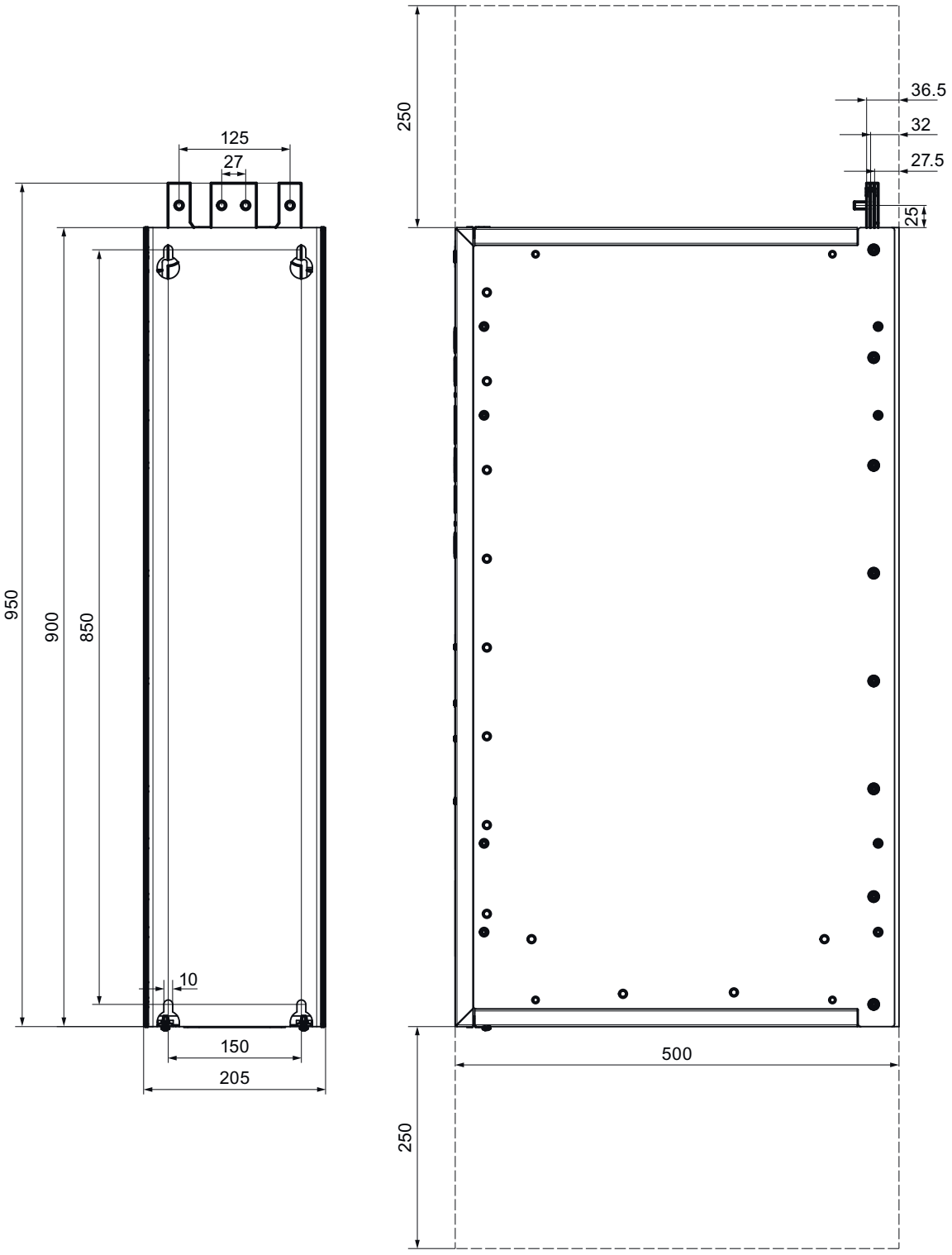


Figure 5-2 Dimensions and mounting positions for 120 kW and 250 kW devices (dimensions in mm), rear view, side view

The area below the device must be unobstructed and allow sufficient supply air.

The area above the device must allow the air outlet and the air outlet openings of the device must be unobstructed.

120 kW and 250 kW devices can be lined up directly next to one another.

For the 30 kW devices, as a result of the protruding screw heads, a clearance of approximately 5 mm is required on the right-hand side.

The customer must ensure that power cables are clamped no further than 300 mm from their termination.

Note

For cabinet designs with degree of protection greater than IP20, an additional fan is required if the power rating is fully utilized. This fan must be designed for the "fan air flow" (see Chapter "Device data (Page 434)") of the device in question.

Note

Using large shims when mounting 120 kW and 250 kW devices

When mounting 120 kW and 250 kW devices, it is recommended that ISO 7093-1-8-200HV shims (large series) are used to protect the mounting holes from excessive stress.

Transport aid

The 120 kW and 250 kW devices are supplied with 3 metal brackets, which are used as a transport aid (shown in red in the diagram above). These must be removed before mounting. The metal brackets can be disposed of as scrap metal.

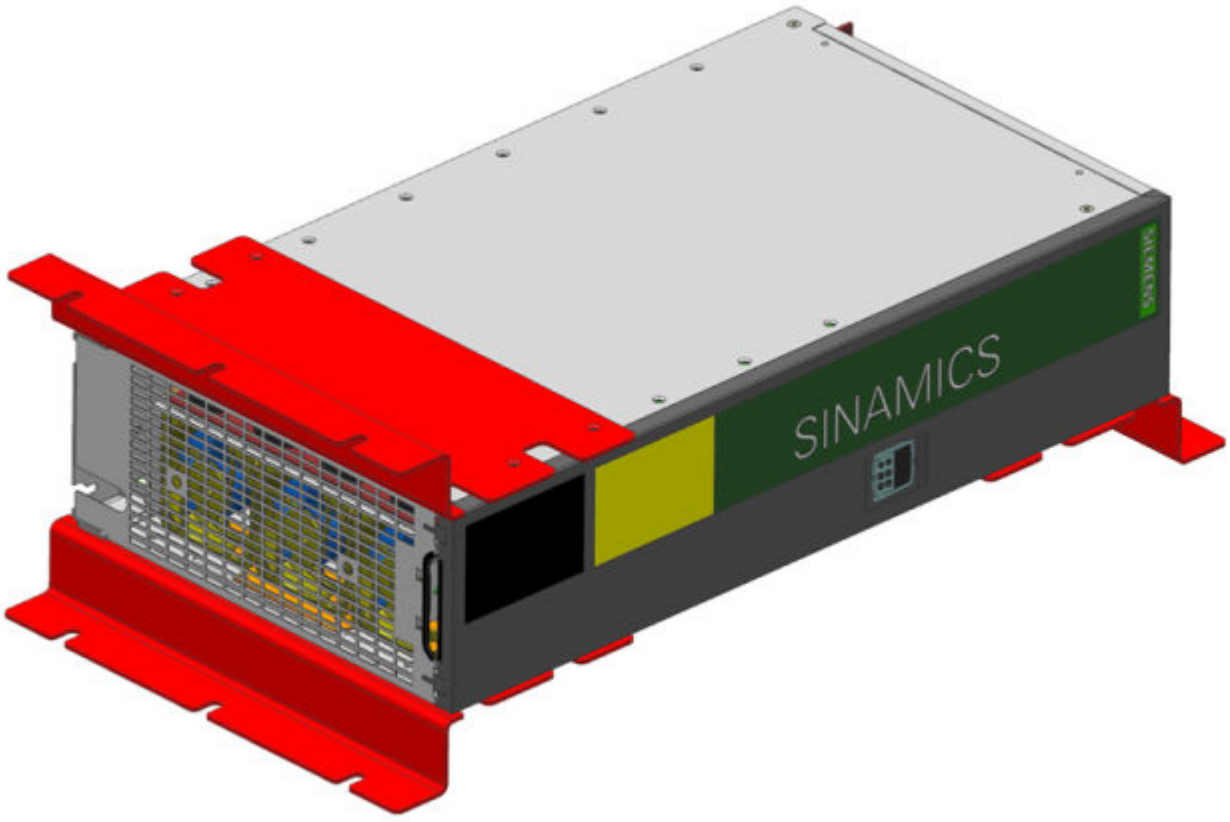


Figure 5-3 120 kW and 250 kW devices with mounted transport aid

Electrical connection

6

⚠ WARNING

Failure to observe general safety instructions and residual risks

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

- Observe the general safety instructions.
- Take into account residual risks when assessing risk.



⚠ WARNING

Electric shock due to the residual charge of the capacitors

Because of the capacitors, a hazardous voltage is still present for a period of time after the power supply has been switched off.

If live components are touched then this can result in severe injury or death.

- Open the unit only after the time specified on the warning label has elapsed.
- Before starting work, check that the device is in an absolutely no voltage condition by measuring all poles, also to ground.



⚠ WARNING

Electric shock or fire when using unsuitable residual current devices

In the case of a fault, a SINAMICS DCP can cause DC current to flow in the protective conductor (PE). In the case of a fault, this DC current can prevent residual current devices from tripping, which results in an electric shock or fire.

- Therefore, it is crucial that you only use universal current sensitive fault current protective devices (e.g. RCD type B).

The power and control terminals can be live (at a certain voltage) even when the SINAMICS DCP is switched off.

When handling the device while it is open, remember that live parts can be exposed.

The device may be operated if the front covers installed in the factory are attached.

When required, additional covers should be provided in the control cabinet (for example, in the area around the busbars).

When operating the SINAMICS DCP, all of screws fixing the front cover must be tight.

⚠ WARNING

Fire due to overheating when the required cable cross-sections of power cables is fallen below

Power cables with excessively low cross-sections can cause them to overheat. This can result in severe injury or death due to fire and smoke.

- Only use power cables with sufficiently large cross-sections. Take into account the routing type, ambient temperature and cable length.

NOTICE

Destruction of components as a result of high leakage currents

The CUD or other PROFIBUS and/or PROFINET nodes can be destroyed if significant leakage currents flow via the PROFIBUS or PROFINET cable.

- A functional equipotential bonding conductor with a cross-section of at least 10 mm² must be used between components in a system of a plant that are located at a distance from each other.



⚠ WARNING

Electric shock when connecting communication cables under voltage

The device cover must be removed when connecting communication cables (e.g. PROFIBUS, PROFINET). As a consequence, live components can be touched.

Touching live components can result in death or serious injury.

- Only connect up the communication cables when the device is in a no-voltage condition.

⚠ WARNING

Danger of injury caused by foreign objects in the device

Parts (e.g.: drilling chips, end sleeves) falling into the device can cause short circuits and damage the insulation. As a consequence, arcing, a loud bang or parts and components flying out of the device can cause severe injury.

- Only perform installation and other work when the devices are safely isolated from the power supply.
- Cover the ventilation slits during the installation of components in the cabinet and remove the cover before switching on.

6.1 EMC-compliant installation

6.1.1 Fundamental principles of EMC

What is EMC?

EMC stands for "electromagnetic compatibility" and describes the capability of a device to function satisfactorily in an electromagnetic environment without itself causing electromagnetic interference unacceptable for other devices in the environment. Therefore, the various units used should not cause interference to one another.

Within the context of the EMC Directive, the SINAMICS DCP units described in this document are not "units" at all, but are instead "components" that are intended to be installed in an overall system or overall plant. For reasons of clarity, however, the generic term "units" is used in many cases.

Interference emissions and interference immunity

EMC is dependent upon two properties demonstrated by the units involved in the system: interference emissions and interference immunity. Electrical units may be sources of interference (transmitter) and/or potentially susceptible equipment (receiver). Electromagnetic compatibility is ensured when the existing sources of interference do not impair the function of potentially susceptible equipment.

A unit may even be a source of interference and potentially susceptible equipment at the same time: For example, the power unit of a converter should be viewed as a source of interference and the control unit as potentially susceptible equipment.

Product standard IEC 61800-3

IEC 61800-3 defines different limits depending on the installation site of the system, referred to as the first and second environments.

Residential buildings or locations at which the system is directly connected to a public low-voltage network without an intermediate transformer are defined as the **first environment**.

The term **second environment** refers to all locations outside residential areas. These are basically industrial areas that have their own medium-voltage supply via their own transformers.

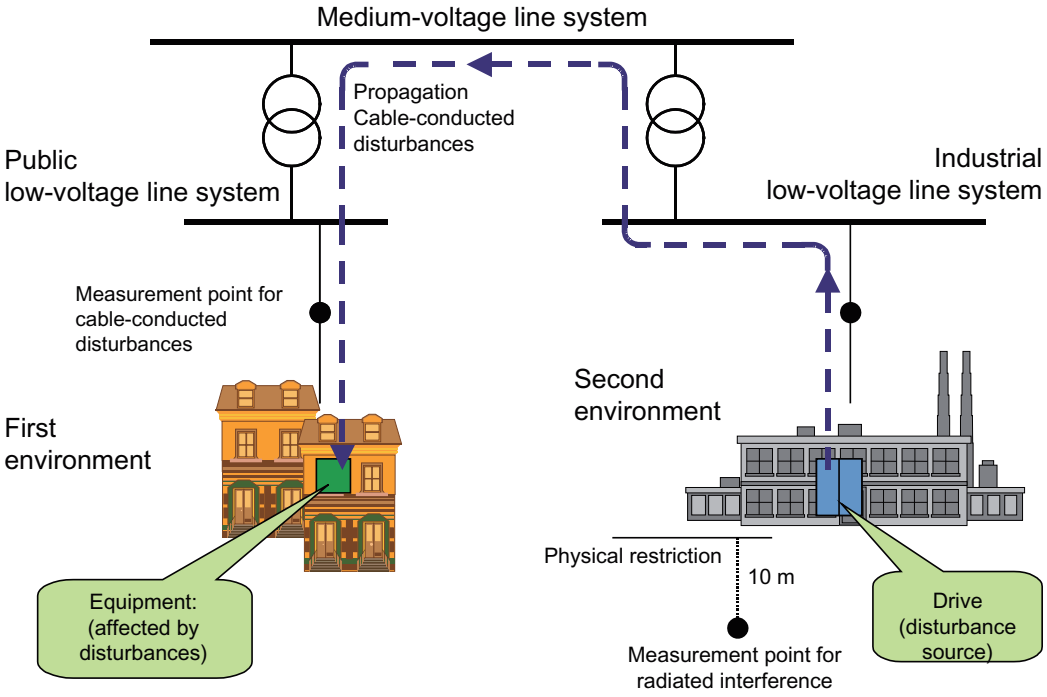


Figure 6-1 Definition of the first and second environments

Depending on the installation location and the power rating, four different categories are defined in IEC 61800-3:

Category C1: Systems for rated voltages < 1000 V for unlimited use in the first environment

Category C2: Stationary systems for rated voltages < 1000 V for use in the second environment. Use in the first environment is possible if the system is operated and installed by qualified personnel. The warning information and installation instructions supplied by the manufacturer must be observed.

Category C3: Systems for rated voltages < 1000 V for exclusive use in the second environment

Category C4: Systems for rated voltages ≥ 1000 V or for rated currents ≥ 400 A for use in complex systems in the second environment.

The figure below shows how the four categories are assigned to the first and second environments:

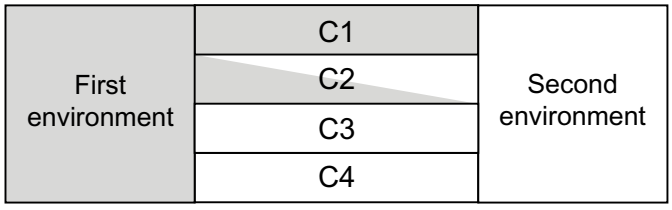


Figure 6-2 Definition of categories C1 to C4

SINAMICS DCP devices comply with requirements of the second environment and Category C3 of IEC 61800-3.

⚠ CAUTION

SINAMICS DCP not to be used in a residential environment

The device is not intended for use in a residential environment, and cannot ensure appropriate protection of radio reception in environments such as these.

- Do not use this device in the first environment (residential area).

6.1.2 Electromagnetic fields at the workplace

6.1.2.1 Preliminary remarks

Protection of workers from electromagnetic fields is specified in the European EMF Directive 2013/35/EU. This directive is implemented in national law in the European Economic Area (EEA). Employers are obligated to design workplaces in such a way that workers are protected from impermissibly strong electromagnetic fields. To this end, assessments and/or measurements must be performed for workplaces.

General conditions for correct assessment or measurement

1. The laws for protection from electromagnetic fields in force in individual EU member states can go beyond the minimum requirements of the EMF Directive 2013/35/EU and always take precedence.
2. The ICNIRP 2010 limits for the workplace are the basis for the assessment.
3. The 100 µT (RMS) mentioned below for assessment of active implants comes from the 26th BImSchV (Bundesimmissionsschutz Verordnung der Bundesrepublik Deutschland [German Federal Emission Protection Regulation]).
   According to Directive 2013/35/EU, 500 µT (RMS) at 50 Hz is applicable here.
4. Compliance with the limit values was checked for the following frequencies:
   – Line frequency 47 ... 63 Hz (related to the line frequency of a SINAMICS converter system)
   – Pulse frequency 20 kHz and multiples thereof, assessed up to a maximum of 400 kHz
5. The routing of power cables has a significant impact on the electromagnetic fields that occur. More detailed information is provided in the subsequent installation notes.

6.1.2.2 Measurements/evaluations for SINAMICS DCP

Note

Validity

The following information regarding electromagnetic fields relates solely to products and components supplied by Siemens. As specified in the documentation, the precondition is that the components are installed and operated inside metal cabinets and shielded motor cables are used. More detailed information on this is provided in Chapter "EMC-compliant installation of SINAMICS DCP (installation instructions) (Page 44)".

The components are normally used in machines.

Table 6-1 Information for frequency range 0 Hz to 300 GHz

Frequency range	0 Hz ... 100 kHz	100 kHz ... 300 GHz
Electric field strength	Limits not exceeded	Limits not exceeded
Magnetic flux density	For assessment, see the following table	Limits not exceeded

Table 6-2 Minimum clearances to SINAMICS DCP at 0 Hz ... 100 kHz

Power	Generally		Individuals with active implants	
	Control cabinet closed	Control cabinet open	Control cabinet closed	Control cabinet open
P ≤ 250 kW	15 cm	15 cm	Must be separately assessed depending on the active implant.	Must be separately assessed depending on the active implant.

Note

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

6.1.3 EMC-compliant installation of SINAMICS DCP (installation instructions)

General information

In order to ensure electromagnetic compatibility (EMC) in rugged electrical environments and adhere to the standards required by the relevant legislating body, the EMC rules listed below should be followed during the construction and installation stages.

Rules for EMC-compliant installation

1 All metallic parts of the cabinet must be connected with one another through a large surface area with a good electrical connection (not paint on paint!). Use contact or serrated washers if necessary. The cabinet door must be connected to the cabinet using the shortest possible ground strips (at the top, center, and bottom).

2 Contactors, relays, solenoid valves, electromechanical operating hours counters, etc., in the cabinet and - where applicable - in neighboring cabinets - must be provided with quenching combinations such as RC elements, varistors, and diodes. These must be connected directly at the appropriate coil.

3 Wherever possible, signal cables should only be routed[1)] into the cabinet at one side/level.

4 Unshielded cables in the same circuit (supply/return conductors) must be twisted where possible, or the area between them must be minimized, to avoid creating loop antennas unnecessarily.

5 Connect spare wires to the cabinet ground [2)] at both ends. This achieves an additional shielding effect.

6 Avoid unnecessary cable lengths This keeps coupling capacitances and inductances low.

7 Crosstalk is generally reduced if the cables are laid close to the control cabinet ground. Therefore, do not route cables freely around the cabinet, but lay them as close as possible to the cabinet enclosure / mounting plates. This also applies to spare cables.

8 Signal and power cables must be physically separated (to prevent coupling paths). Minimum clearance: 20 cm should be aimed at. If it is not possible to physically separate the signal cable and electric power cable, the signal cable must be decoupled either using a partition or by routing it in a metal conduit. The partition or metal conduit must be grounded at several points. If it is not possible to avoid signal and power cables crossing, carefully ensure that they only cross at right angles.

9 Ground the shields of digital signal cables at both ends (source and destination), ensuring maximum contact area and good conductivity. In the event of poor equipotential bonding between the shield connections, run an additional equalizing conductor with a cross-section of at least 10 mm^2 parallel to the shield for the purpose of reducing the shield current. Generally speaking, the shields may also be connected to the cabinet enclosure (ground) [2)] at several points. The shields can be connected several times even outside the control cabinet. Foil shields should be avoided, as they are at least 5 times less effective than braided shields.

10 Shields for analog signal cables may be connected to ground at both ends if equipotential bonding is good (this must be done over a large area with good conductivity). It can be assumed that equipotential bonding is good if all metal parts are well interconnected and the electronics components are supplied from a single source.

Footnotes

[1)] Signal cables are defined as:
Digital signal cables, e.g. cables for incremental encoders
Analog signal cables, e.g. ±10 V setpoint cable
Communication interfaces: e.g. PROFIBUS and PROFINET

[2)] Generally speaking, "ground" refers to all metallic conductive parts that can be connected to a protective conductor, such as the cabinet enclosure, motor enclosure, or foundation ground.

To prevent coupling external interference into the cabinet, the shields of the cables used must be grounded through the largest possible surface area as close as possible to the point of entry into the cabinet.

This is achieved by using the appropriate shield bars or comb-type bars.
These bars must be connected to the cabinet housing through largest possible surface area to establish a good electrical connection.

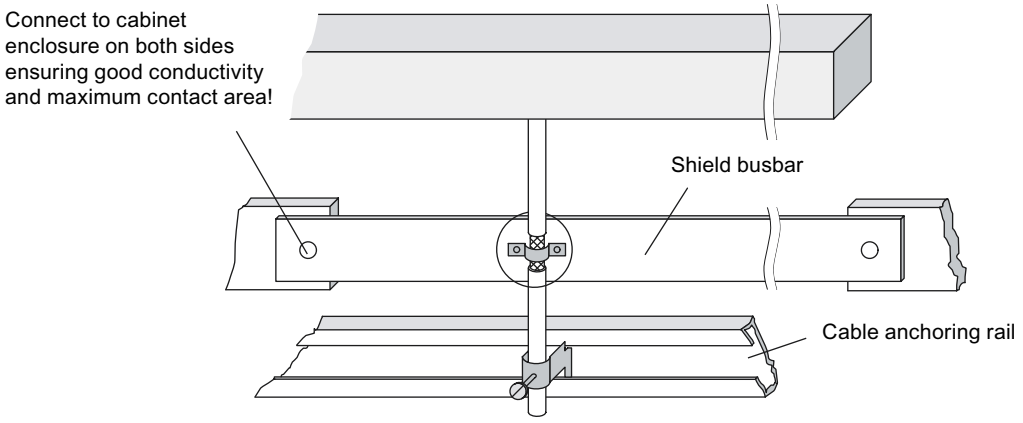


Figure 6-3 Connecting the shield of a power cable at the cabinet entry

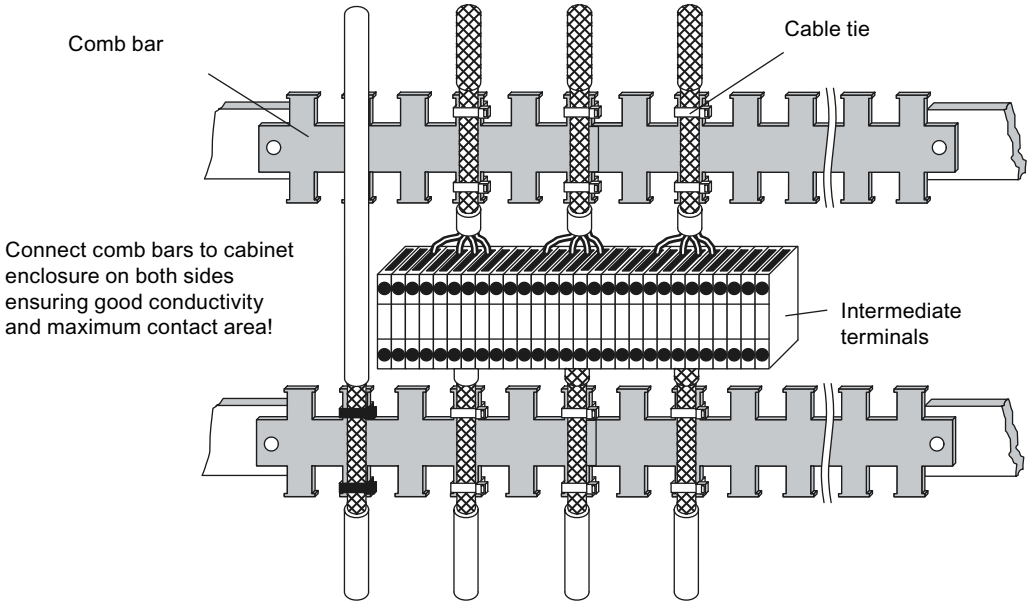


Figure 6-4 Shield connection for the signal cables in the cabinet

The following rules apply for the connection cables:

- All cables that leave the cabinet system must be "shielded".
- Cables inside the cabinet do not have to be "shielded".

Mounting on bare metal backplane

The SINAMICS DCP devices must be mounted on a bare metal and corrosion-resistant backplane.

The rear panel must have a good RF connection to the control cabinet, e.g. by using fabric tapes.

Limit values for SINAMICS DCP

The applied limit values at the DC output are not configured with a filter, as this may have to be adapted to the specific application.

An exemplary graph with typical values is shown below (setup SINAMICS DCP 250 kW in combination with a typical SINAMICS drive assembly).
This shows the conducted interference emission, based on the limits according to CISPR 11 Class A for DC interfaces.

The corresponding measures for compliance with the EMC standards / regulations (e.g. use of shielded cables, filters, ...) must be ensured by the user.

The following diagram represents the DC output compared to the limits according to CISPR 11 Class A.

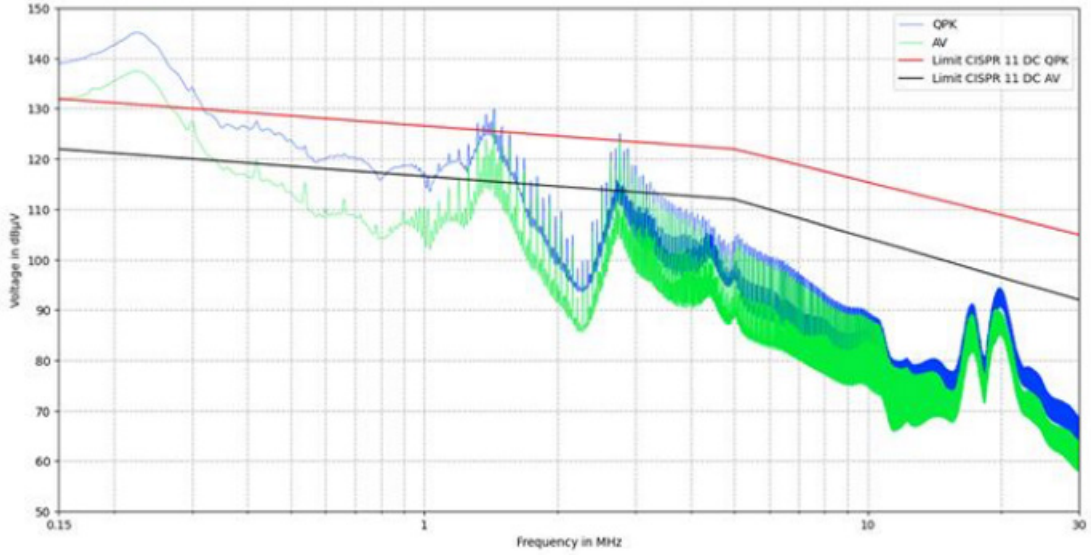


Figure 6-5 DC output of the SINAMICS DCP compared to the limits according to CISPR 11 Class A

If the SINAMICS DCP is directly integrated into a system via a network interface, appropriate measures for compliance with EMC are also required at this interface (use of shielding, potential-free optical transformers, ...).

The basis for these limits are those of CISPR 32 Class A.

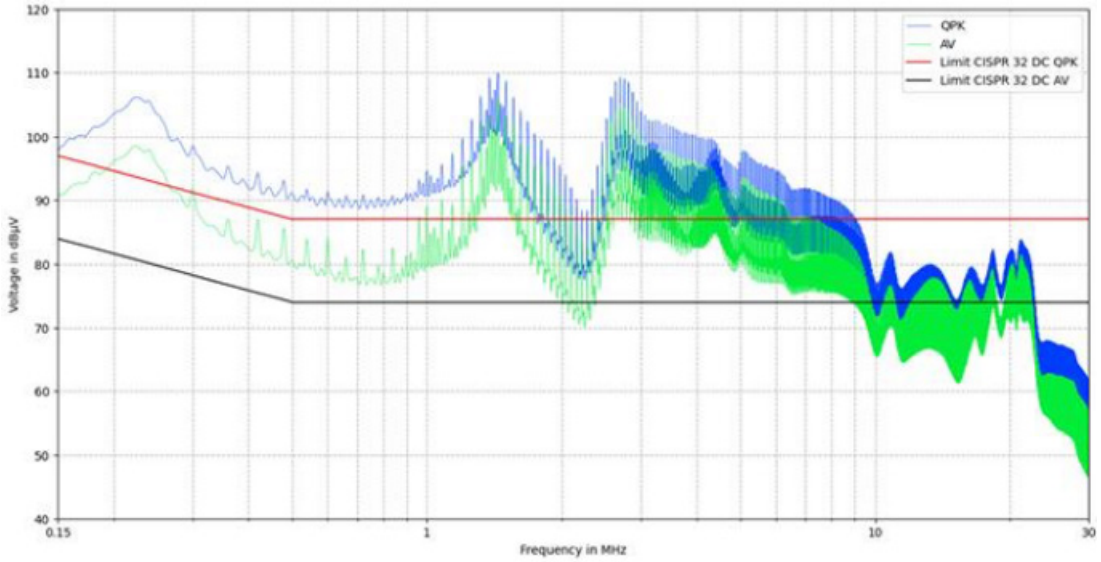


Figure 6-6 Network interface of the SINAMICS DCP compared to the limits according to CISPR 32 Class A

6.2 Block diagram with connection suggestion

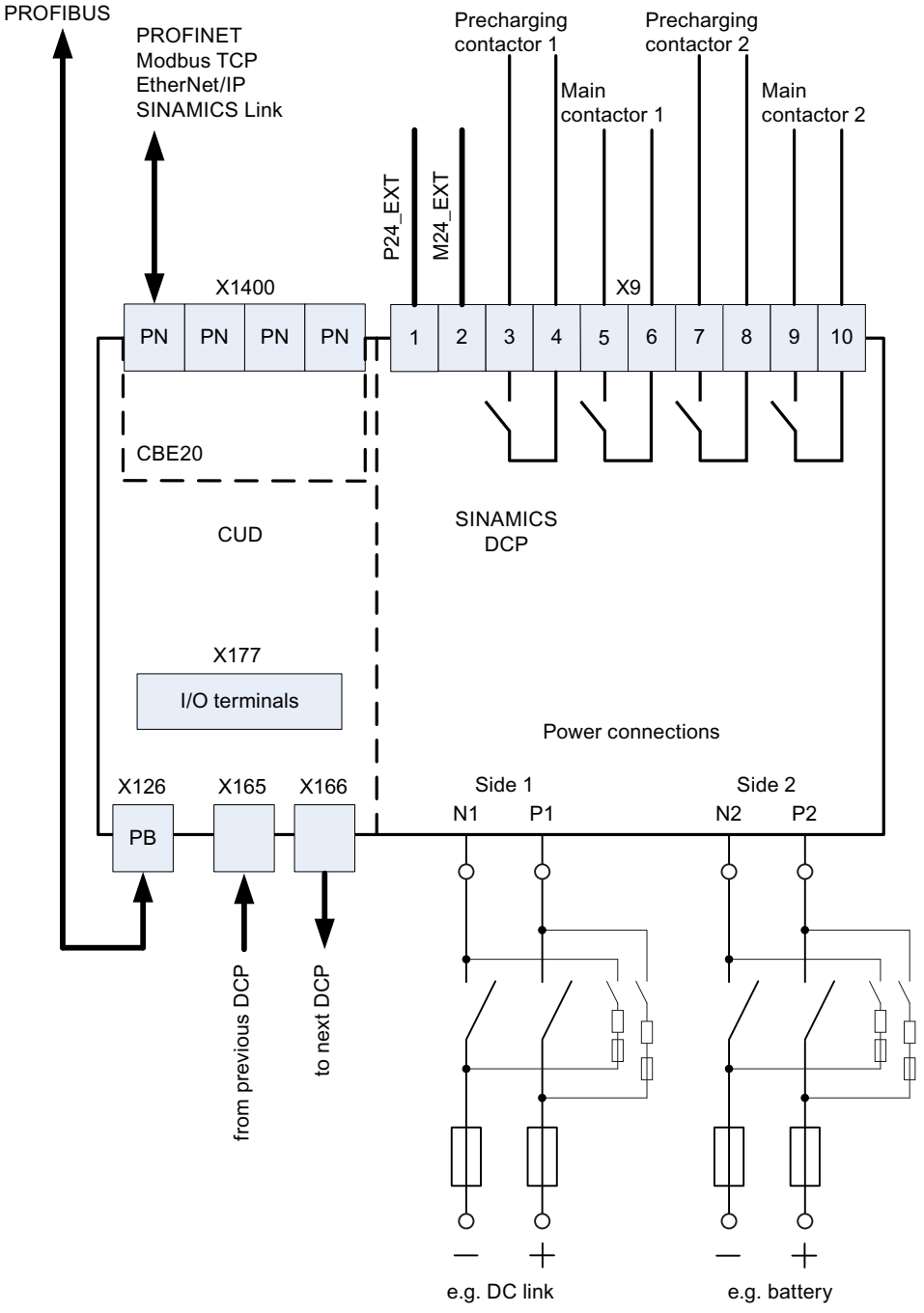


Figure 6-7 Block diagram with connection suggestion

The previous block diagram shows a (maximum) configuration for the SINAMICS DCP together with possible interfaces to a higher level control system. This configuration can be modified according to the requirements of the intended application.

- Fuses: see Chapter "Components (Page 50)".
- Precharging (precharging interface: precharging resistors, precharging contactors, precharging fuses): see Chapter "Precharging DC links (Page 351)".
- Main contactors: see Chapter "Components (Page 50)".
- The connections "from the previous DCP" and "to the next DCP" are only required if several SINAMICS DCPs are connected in parallel and the parallel interface is used, see Chapter "Connecting several SINAMICS DCPs in parallel (Page 397)".

6.3 Components

⚠ WARNING

Danger when using unsuitable components

Using unsuitable components can result in death or severe injury.

- Check the suitability of the recommended types and devices in the context of the particular system or application - and if required make the appropriate adaptations.

Fuses

On side 1 and side 2 of the device, the P and N connections must be individually protected using a DC fuse (see Figure 6-7 Block diagram with connection suggestion (Page 49)).

The fuse must be selected depending on the following parameters of the application:

- The expected short-circuit current
  This defines the tripping characteristic and the nominal interruption capability of the fuse required.
  - Applications with defined minimum short-circuit current: aR fuses (ultra-fast acting)
  - Applications with undefined short-circuit current: gR fuses (fast acting)
- Operating current
- DC rated voltage
- Time constant of the short circuit current

⚠ WARNING

Electric shock or fire due to missing or unsuitable overcurrent protective devices

Overcurrent protective devices that trip too late or not all can result in electric shock or fire. This can result in severe injury or death.

- Only connect the power connections at both sides of the SINAMICS DCP using the appropriate overcurrent protective devices.
- To guarantee protection for persons and against fire, the overcurrent protective devices must be dimensioned for the short-circuit currents expected. This means that the currents that flow can be appropriately handled, interrupted in plenty of time – therefore guaranteeing safe and reliable shutdown.

Main fuses

The following types are suggested for operation at rated current:

- Use in systems with a high short-circuit current:
  - 30 kW device:
    Eaton Bussmann fuse cartridge 63 A with designation 170E3583
  - 120 kW device:
    Siemens SITOR fuse cartridge 250 A with designation 3NB1128-4KK11
  - 250 kW device:
    Siemens SITOR fuse cartridge 315 A with designation 3NB1231-4KK11

Precharging circuit fuses

When dimensioning the precharging fuses, the precharging resistors and the precharging capacitance must be taken into careful consideration.

Fuses with gS or gR characteristic are suitable for protecting the precharging circuit.

Possible types, 4 A / 1500 V DC:

- Siemens cylindrical fuse cartridge 3NW6604-4

⚠ WARNING

Fire and device damage as a result of ground fault/short-circuit

Inadequate installation of the cables to the precharging circuit of the SINAMICS DCP can result in a ground fault/short-circuit and place persons at risk as a result of the associated fire and smoke.

- Comply with local installation regulations, which allow this fault to be ruled out.
- Protect the cables from mechanical damage.
- In addition, apply one of the following measures:
  - Using cables with double insulation.
  - Observe adequate clearances, e.g. through the use of spacers.
  - Route the cables in separate cable ducts or pipes.

Line contactors

The following criteria must be used as basis when selecting the main contactors:

- DC contactors must be used.
- Rated voltage and rated current must be selected corresponding to the specific requirements of the application.
- Contact rating of the "NO contact for the contactor control": 2 A at 30 V AC/DC resistive. See Chapter "Terminal block for the 24 V DC power supply and switching contacts (Page 60)".

Precharging contactors

Recommended type:

- High-voltage relay: RL 42
  Coil voltage: 24 V
  Manufacturer: SPS Electronic

Precharging resistors

Recommended type

CAV K 150 C 47 R 800, manufacturer: Danotherm company

Note

Precharging resistors must be installed in both precharging circuit cables.

The precharging times must be taken into consideration when parameterizing the system (p55355).

When using function "flying restart", generally resistors with values lower than 47 Ω are required, see Chapter "Flying restart (Page 348)".

6.4 Terminals and connectors

6.4.1 Connection overview for the 30 kW device

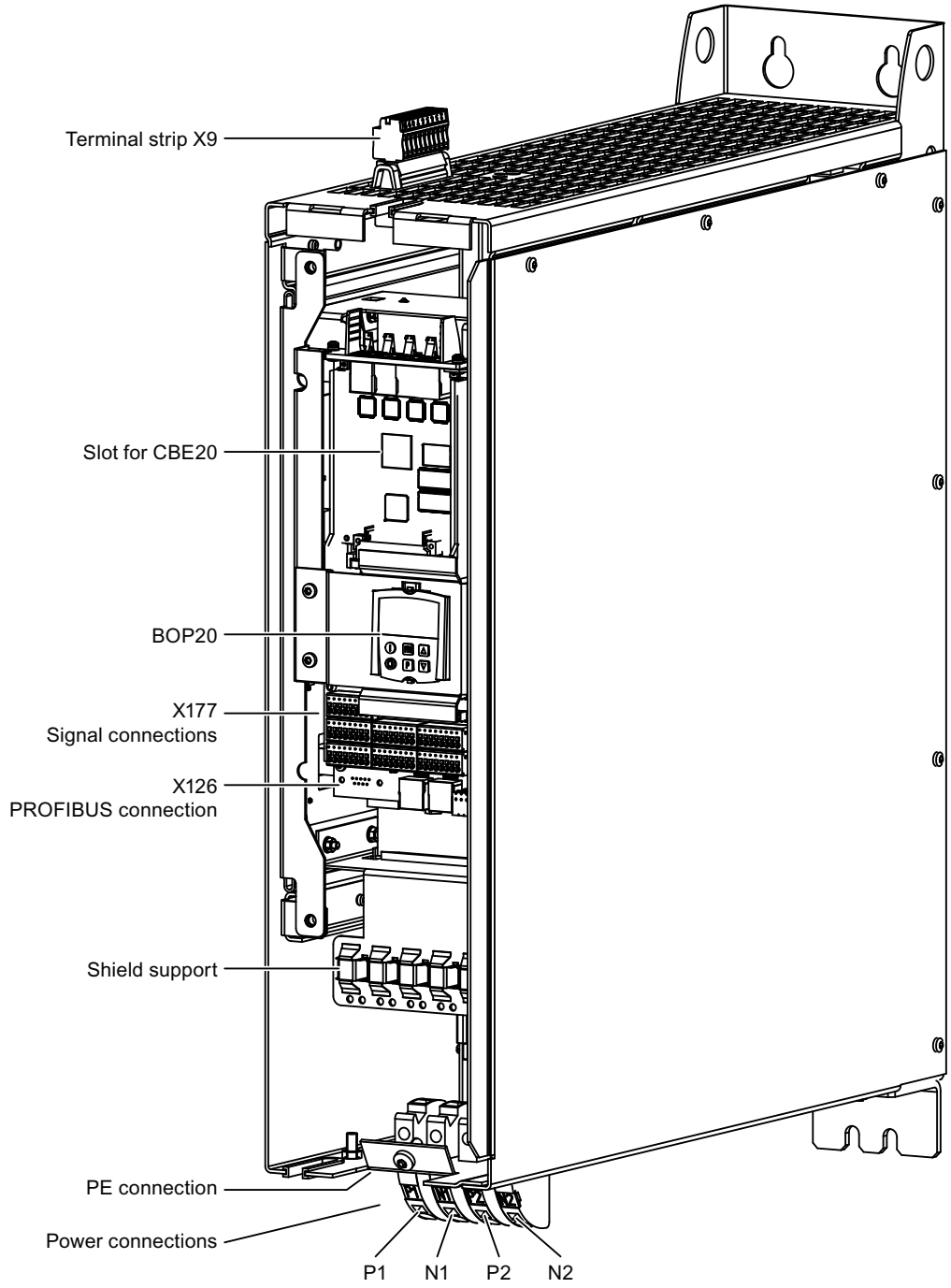


Figure 6-8 Connection overview for the 30 kW device

6.4.2 Connection overview for the 120 kW and 250 kW devices

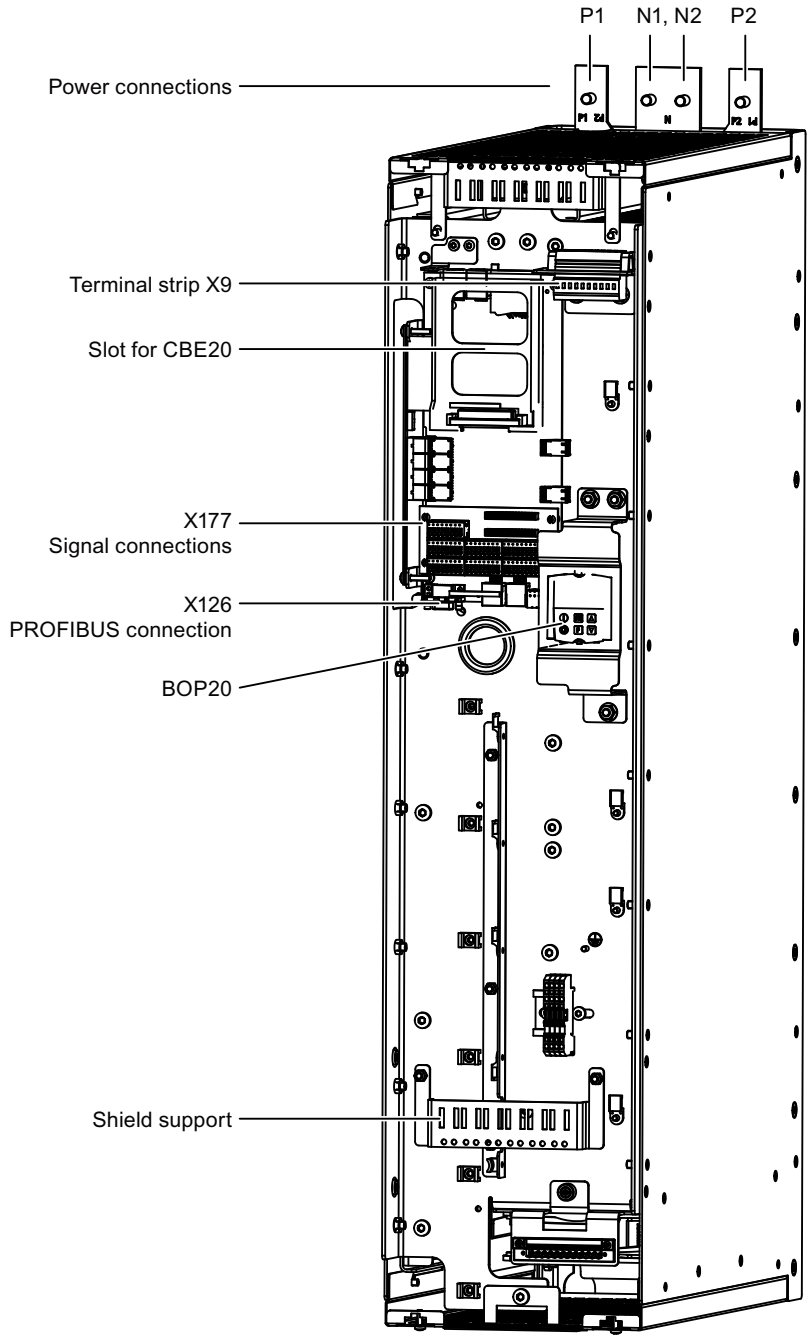


Figure 6-9 Connection overview for the 120 kW and a 250 kW devices (without options M69, M79)

6.4.3 Power connections

The power connections are defined as follows:

P1	Side 1: Plus cable
N1	Side 1: Minus cable
P2	Side 2: Plus cable
N2	Side 2: Minus cable

NOTICE
High frequency interference as a result of using an unshielded connecting cable outside the control cabinet If unshielded cables for the power connections are routed outside the control cabinet, then these can cause high-frequency interference. • Use shielded cables for the power connections if these are routed outside the control cabinet. • Observe the rules listed in Chapter "EMC-compliant installation of SINAMICS DCP (installation instructions) (Page 44)".

Power connections at the 30 kW device

- The DC power connection, side 1 (P1, N1) is located at the lower left of the device.
- The DC power connection, side 2 (P2, N2) is located at the lower right of the device.
- The ground connection is located at the bottom left of the device.

See Chapter "Connection overview for the 30 kW device (Page 53)".

Power connections at 120 kW and 250 kW devices

- The DC power unit connections, side 1 (P1, N1) and side 2 (P2, N2) are located at the top of the device (see connection overview).
  For option M69 (power connections, top/bottom), the connections are located at the top of the device (P1, N1) and at the bottom of the device (P2, N2).
  For option M79 (power connections from the bottom), the connections are located at the bottom of the device.
- The ground connection is located at the top and bottom of the device

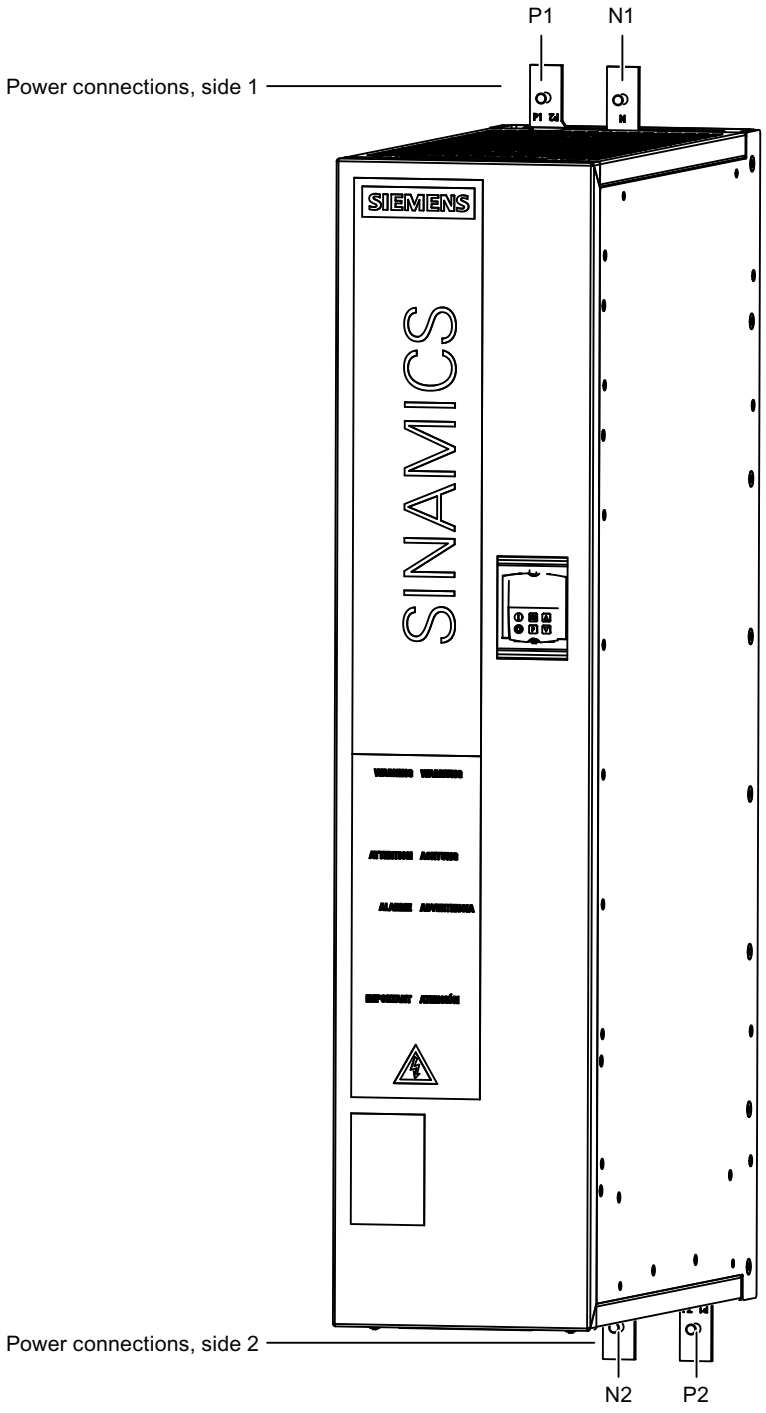


Figure 6-10 Power connections for 120 kW and 250 kW devices for option M69 (power connections at the top/bottom)

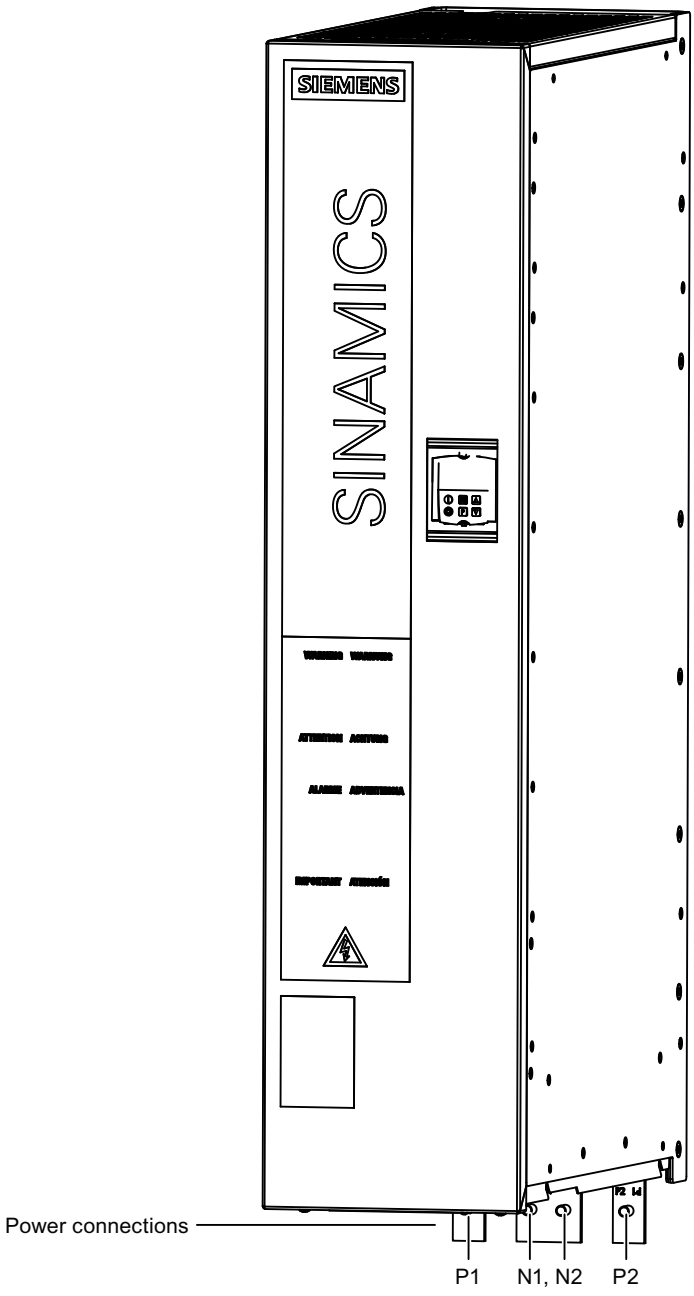


Figure 6-11 Power connections for 120 kW and 250 kW devices for option M79 (power connections at the bottom)

Note:
For 120 kW and 250 kW devices, connections N1 and N2 are combined to form a busbar with designation N.

Power connection designations stamped upside down should be ignored.

Tightening torque of the nuts for the power connections: 13 Nm.

NOTICE
Multiple use of the power connections is not permitted For reasons of safety, multiple use of the power connections is not permitted. This means that it is not permissible to place several cable lugs on top of each other and screw them together. If it is necessary to loop through the power connections (for example, when connecting several SINAMICS DCP devices in parallel), then you must use suitable distribution terminals, which you mount in the cabinet.

6.4.4 Connection cables

The following cross-sections are suggested for connection cables connected to the cable connections:

30 kW device

16 mm² copper

Note

The sheath diameter of the cable must not exceed 10 mm.

120 kW device

95 mm² copper

250 kW device

120 mm² copper

Cable types

Use shielded cables for the connections that are led out of the control cabinet.

Usable cable types

- Helukabel "MULTISPEED® 600-C-PUR -J/-O"
- LAPP "OLFLEX® CHAIN 809 SC CY"
- SBA "SABIX BL 409 C FRNC"

The maximum permissible cable length is 100 m.

6.4.5 PE connection

The device must be grounded. The device has a PE connection, identified by a grounding symbol.

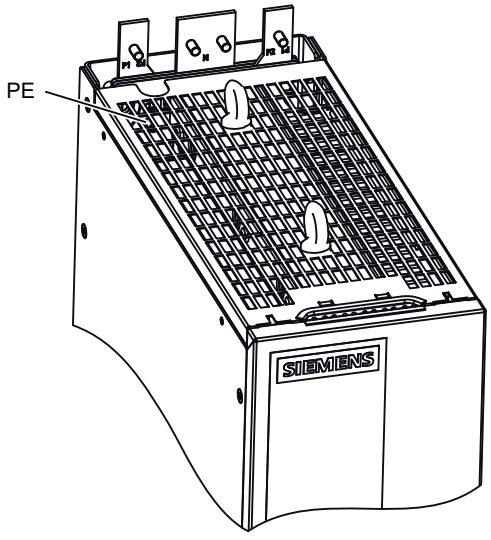
Connection overview for the 30 kW device

The PE connection is located at the lower side of the device next to the power connections, see Chapter "Connection overview for the 30 kW device (Page 53)".

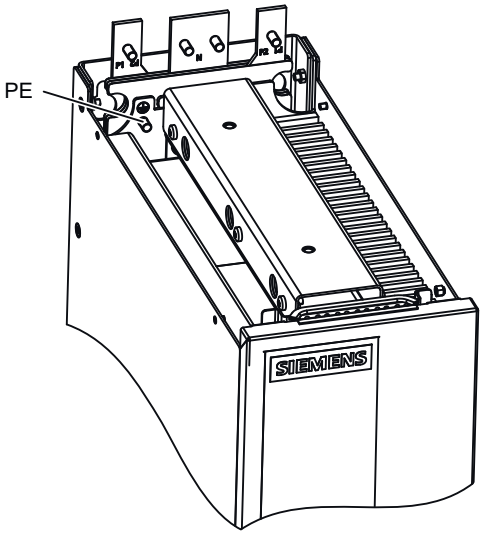
Screw tightening torque: 6 Nm.

Position of the PE connections for 120 kW and 250 kW devices

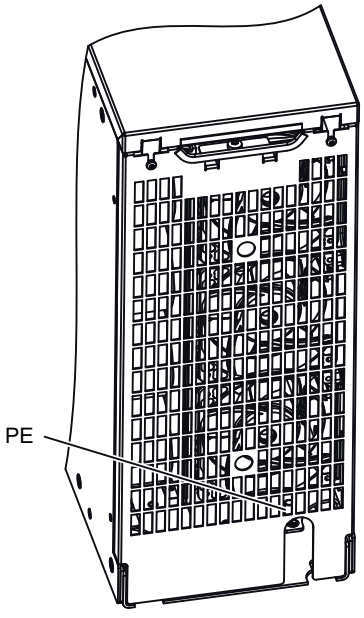
To access the PE connections for 120 kW and 250 kW devices, the corresponding covers at the top and bottom must be removed.



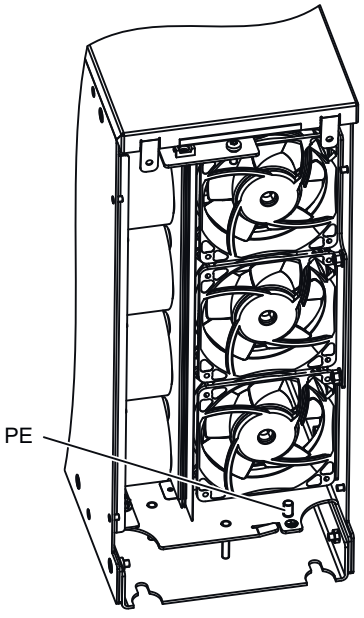
Upper ground connection with attached cover



Upper ground connection with cover removed



Lower ground connection with attached cover



Lower ground connection with cover removed

Nut tightening torque: 13 Nm.

6.4.6 Terminal block for the 24 V DC power supply and switching contacts

Terminal block X9 with 10 terminals is provided at or in the device (see connection overviews).

For 120 kW and 250 kW devices, the terminal block for the power supply and switching contacts is only accessible after first removing the front panel.

Table 6-3 Terminal arrangement X9

Terminal	Designation	Meaning	Technical specifications
1	P24_EXT	External power supply	24 V DC plus cable
2	M24_EXT	External power supply	24 V DC minus cable
3	VLSE1	NO contact for contactor control [1)]	Precharging contactor, side 1
4	VLSE2	NO contact for contactor control [1)]	Precharging contactor, side 1
5	HLSE1	NO contact for contactor control [1)]	Main contactor, side 1
6	HLSE2	NO contact for contactor control [1)]	Main contactor, side 1
7	VLSA1	NO contact for contactor control [1)]	Precharging contactor, side 2
8	VLSA2	NO contact for contactor control [1)]	Precharging contactor, side 2
9	HLSA1	NO contact for contactor control [1)]	Main contactor, side 2
10	HLSA2	NO contact for contactor control [1)]	Main contactor, side 2

- Terminal type: Spring-loaded terminal
- Type: PELV 24 V circuit
- Voltage tolerance of the P24 V ext: 18 V to 30 V
- Current consumption:
  - 30 kW device: In = 5 A
  - 120 kW device: In = 20 A
  - 250 kW device: In = 20 A
- Conductor cross-sections: 1.5 to 2.5 mm²
  For 120 kW and 250 kW devices, for connections "P24_EXT" and "M24_EXT", a cross-section of 2.5 mm² must be used.

[1)] Contact rating of the "NO contact for the contactor control": 2 A at 30 V AC/DC resistive.

NOTICE

Material damage when the maximum voltage rating of the NO contact for the contactor control is exceeded

When the maximum voltage rating is exceeded, the NO contact for the contactor control can be damaged.

- Do not apply a voltage higher than 30 V to the NO contact for the contactor control.

NOTICE

Damage to other loads as a result of overvoltage

Overvoltage of switched inductances (contactors, relays) can damage connected loads.

- Install suitable overvoltage protection circuits and devices.

Note

Grounding the 24 V electronics power supply

In SINAMICS DCP, the electronics ground M is permanently connected to the protective conductor potential.

Note

Malfunction because the 24 V supply voltage is too low

A malfunction can occur if the 24 V supply voltage falls below the specified minimum value.

- Select the 24 V supply voltage so that it is high enough to ensure that all SINAMICS DCP devices have adequate voltage. Do not exceed the maximum value supply voltage.

6.4.7 Communication connections

The cables for PROFIBUS or PROFINET must be connected inside the device. The front cover must be removed to do this.



⚠ WARNING

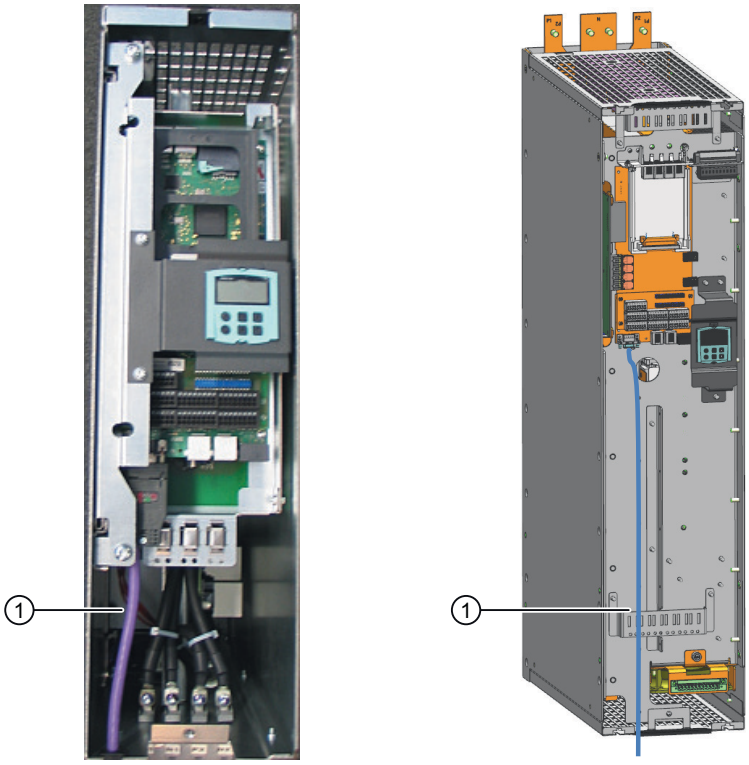
Electric shock when connecting communication cables under voltage

The device cover must be removed when connecting communication cables (e.g. PROFIBUS, PROFINET). As a consequence, live components can be touched.

Touching live components can result in death or serious injury.

- Only connect up the communication cables when the device is in a no-voltage condition.

- The PROFIBUS connector X126 is on the CUD module. The cable can be led out at the bottom through the intended aperture.
- The PROFINET connector X1400 is on the CBE20 module. The cable can be brought out at the top through the opening provided for this purpose.



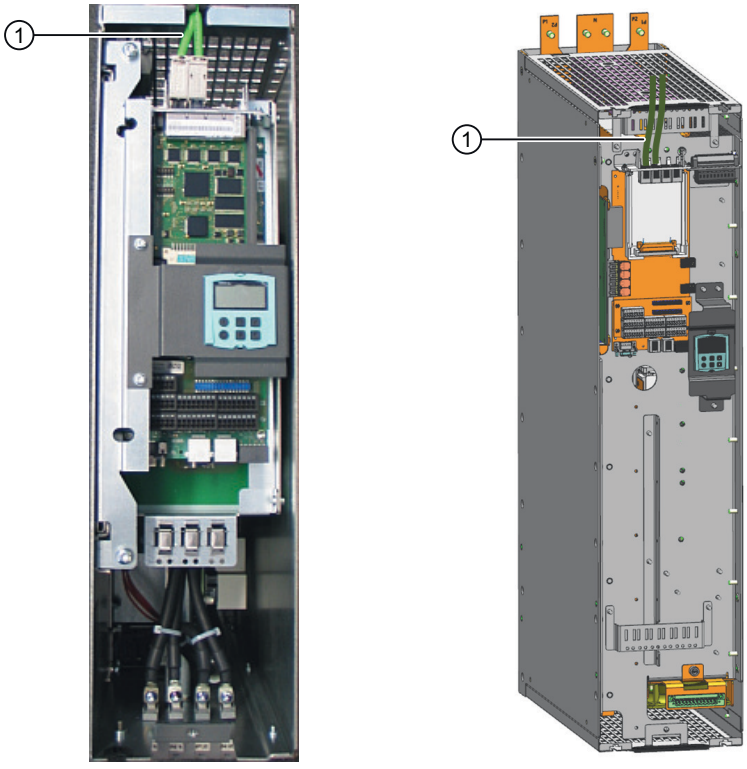
① PROFIBUS cable

Figure 6-12 PROFIBUS connection for 30 kW device or for 120 kW and 250 kW devices

Note

PROFIBUS plug connector

To connect the SINAMICS DCP, only straight PROFIBUS plug connectors must be used (e.g. Article No. 6GK1500-0FC10).
It is not possible to use angled PROFIBUS plug connectors.



① PROFINET cable

Figure 6-13 PROFINET connection for 30 kW device or for 120 kW and 250 kW devices

6.5 Terminals on the CUD and connector board

In the standard version, the SINAMICS DCP is shipped with a connector board plugged onto the CUD. This provides interface X177.

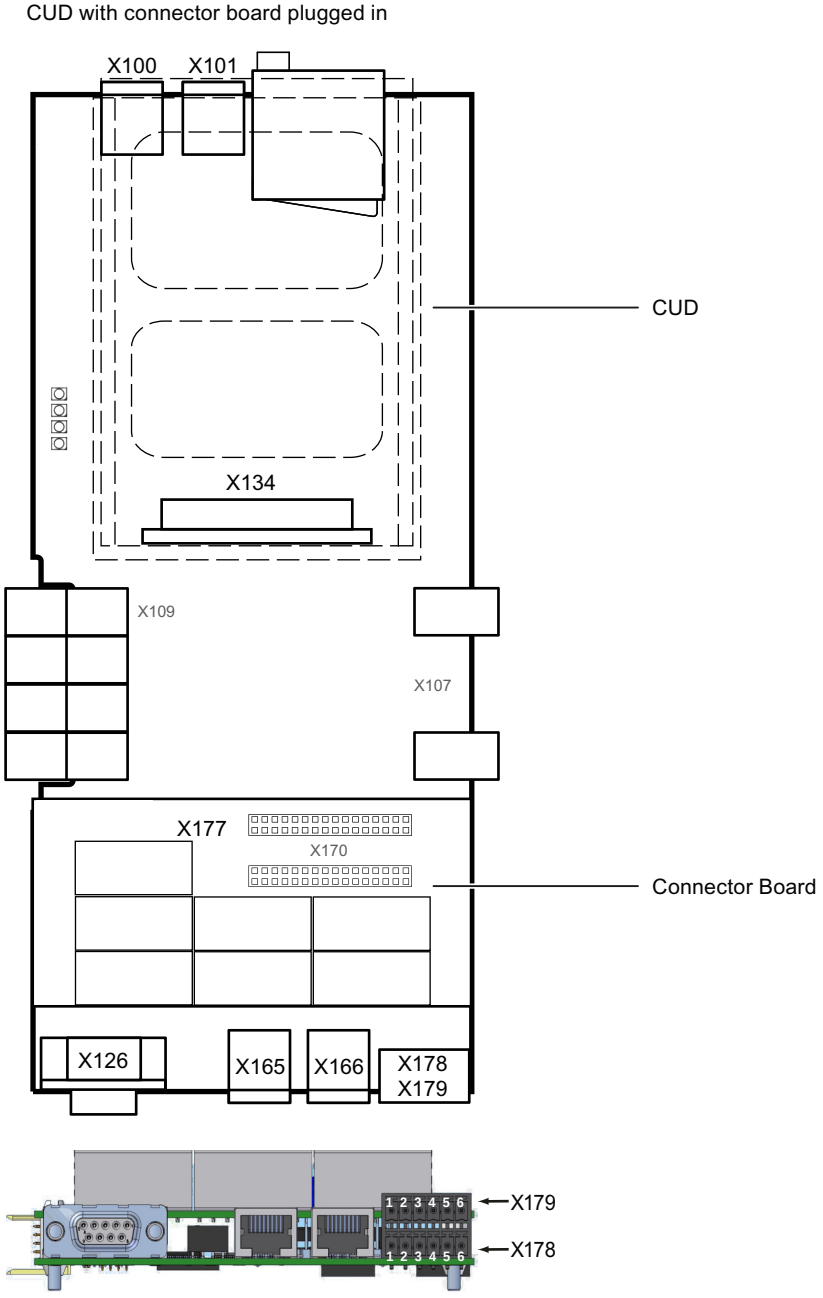


Figure 6-14 Terminal/connector arrangement of the CUD and connector board

Terminals on the CUD

The CUD terminals are usually not required for the operation of the SINAMICS DCP.

Table 6-4 Terminals of the CUD

-X178, -X179: Reserved, do not use	
-X126: PROFIBUS connection	
Type	Submin D, 9-pin
-X100, -X101: DRIVE-CLiQ sockets for Terminal Modules and OALINK	
Type	Modular jack 8/4 (RJ45)

Note

Function equipotential bonding for DRIVE-CLiQ nodes

Integrate all of the components that are connected via DRIVE-CLiQ into the function equipotential bonding concept. You can establish equipotential bonding with a conductor (min. 6 mm^2), which is routed as far as possible in parallel to the DRIVE-CLiQ cable.

Terminals on the connector board

See also "Table 8-8 Overview of inputs and outputs (Page 182)".

Note

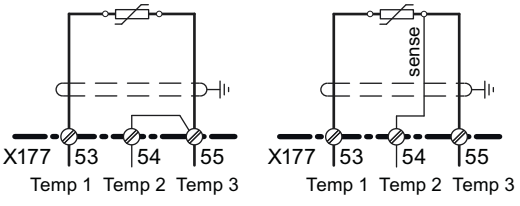
No ground connection using terminal strip X9

The terminal ground connections are electrically isolated from terminal strip X9.

Table 6-5 Assignment, terminal -X177

Terminal -X177	**Function**		**Technical specifications**
Analog inputs (assignable inputs)			
1 2	AI 3 + AI 3 -	Analog input 3	Bipolar voltage inputs - differential input ±10 V - input resistance 150 kΩ - resolution, approximately 5.4 mV (±11 bit) - common mode controllability: ±15 V
3 4	AI 4 + AI 4 -	Analog input 4	
5 6	AI 5 + AI 5 -	Analog input 5	
7 8	AI 6 + AI 6 -	Analog input 6	
Digital inputs (assignable inputs)			
9 10	24 V DC	24 V supply (output)	24 VDC, short-circuit proof Max. load 200 mA (terminals 9 and 10 combined), internal supply in relation to internal ground

Terminal -X177	**Function**		**Technical specifications**
11	DI 0	Digital input 0	H signal: +15 V to +30 V L signal: – 30 V to +5 V or terminal open circuit 8.5 mA at 24 V
12	DI 1	Digital input 1	
13	DI 2	Digital input 2	
14	DI 3	Digital input 3	
Digital inputs/outputs (assignable inputs/outputs)			
15	DI/DO 4	Digital input/output 4	Digital inputs or outputs that can be parameterized Input characteristics: H signal: +15 V to +30 V L signal: 0 V to +5 V or terminal open 8.5 mA at 24 V Output characteristics: H signal: +20 V to +26 V L signal: 0 to +2 V short-circuit proof; max. current carrying capacity: 100 mA per DO; max. total load of all DO (-X177:15-22): 800 mA Internal protection circuit (free-wheeling diode) If overload occurs: Alarm A60018
16	DI/DO 5	Digital input/output 5	
17	DI/DO 6	Digital input/output 6	
18	DI/DO 7	Digital input/output 7	
19	DO 0	Digital output 0	Digital outputs H signal: +20 V to +26 V L signal: 0 to +2 V short-circuit proof; max. current carrying capacity: 100 mA per DO; max. total load of all DO (-X177:15-22): 800 mA Internal protection circuit (free-wheeling diode) If overload occurs: Alarm A60018
20	DO 1	Digital output 1	
21	DO 2	Digital output 2	
22	DO 3	Digital output 3	
23, 24	M	Ground, digital	
35, 36	M	Ground, digital	
Analog inputs, setpoint inputs (assignable inputs)			
25 26	AI 0 + AI 0 -	Analog input 0	Input type (signal type) can be parameterized: • Bipolar voltage input 0...10 V - differential input ±10 V - input resistance: 150 kΩ • Bipolar current input 0...20 mA - current input -20 mA...20 mA - input resistance: 300 Ω • Unipolar current input 4...20 mA - current input 4...20 mA - input resistance: 300 Ω - wire break monitoring Resolution: approx. 0.66 mV (±14 bit) Common mode controllability: ±15 V
27 28	AI 1 + AI 1 -	Analog input 1	
29 30	AI 2 + AI 2 -	Analog input 2	Bipolar voltage input 0...10 V - differential input ±10 V - input resistance: 150 kΩ - resolution: approx. 0.66 mV (±14 bit) - common mode controllability: ±15 V

Terminal -X177	**Function**		**Technical specifications**
Reference voltage			
31	P10	Reference voltage ±10 V (output)	Tolerance ±1% at 25° C Stability 0.1% per 10° K 10 mA short-circuit proof
32	N10		
33, 34	M	Ground, analog	
Terminals not used			
37	Reserved, do not use		
38	Reserved, do not use		
39	Reserved, do not use		
40	Reserved, do not use		
41	Reserved, do not use		
42	Reserved, do not use		
43	Reserved, do not use		
44	Reserved, do not use		
45	Reserved, do not use		
46	Reserved, do not use		
47	Reserved, do not use		
48	Reserved, do not use		
Analog outputs (assignable outputs)			
49	AO 0	Analog output 0	±10 V, max. 2 mA short-circuit proof, resolution ±15 bits
50	M	Ground, analog	
51	AO 1	Analog output 1	
52	M	Ground, analog	
Connections for temperature sensors			
53	Temp 1		Connect the sensor according to p50490 (see SINAMICS DCP List Manual). The cable to the temperature sensor must be shielded, the shield must be connected to ground at both ends. The cables for the Temp 1 and Temp 3 connections to the temperature sensor must be approximately the same length. The sense line (Temp 2) is used to compensate cable resistances; if a sense line is not used, then terminals 54 and 55 must be directly connected at the CUD. Connection with/without sense line: 
54	Temp 2 (sense line)		
55	Temp 3		
56	M	Ground, analog	

Memory card slot

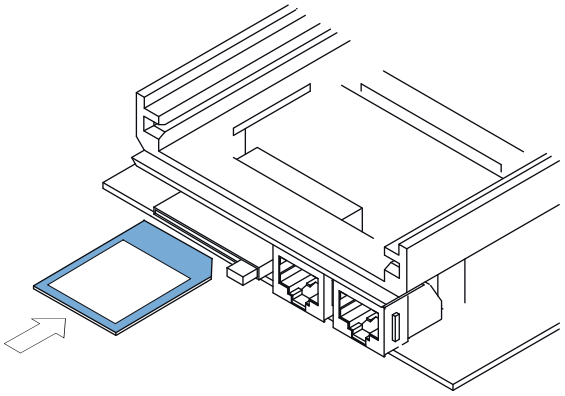


Figure 6-15 "Control Unit (CUD)" module, memory card slot

Note

Using the memory card

Using the memory card, see Chapter "Memory card functions (Page 161)".

6.6 Additional system components

6.6.1 Option Board: Communication Board EtherNet CBE20

6.6.1.1 Description

The SINAMICS DCP can be connected to PROFINET using the Communication Board CBE20 interface module. The module supports PROFINET IO with Isochronous Realtime Ethernet (IRT) and PROFINET IO with RT. Mixed operation is not permissible. PROFINET CBA is not supported.

The Communication Board has an Ethernet interface with 4 ports for communication. It is inserted into the option slot of the CUD.

The Communication Board CBE20 allows SINAMICS Link connections to be established, and connection to Modbus TCP and EtherNet/IP.

Note

By inserting the CBE20 (X1400), the IF1 communication channel switches over from PROFIBUS to PROFINET. PROFIBUS can be switched back to IF1 by setting parameter p8839 = 1 (see Chapter "Parallel operation of communication interfaces (Page 201)").

6.6.1.2 Safety instructions

NOTICE
Damage or malfunctions of the Option Board by inserting and withdrawing during operation Withdrawing and inserting the Option Board during operation can damage it or cause it to malfunction. • Only withdraw or insert the Option Board when the Control Unit is in a no-voltage condition.

NOTICE
Qualified personnel The CBE20 must only be operated by qualified personnel. The ESD information must be observed.

6.6.1.3 Interface description

Overview

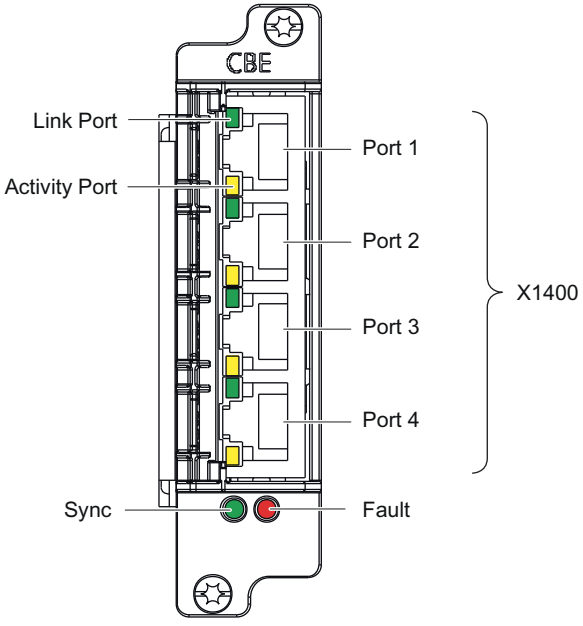


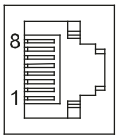
Figure 6-16 Interface description CBE20

MAC address

The MAC address of the module is printed on the CBE20. The adhesive label is located next to the adhesive label with the article number. It can be read from the front when installed in the DCP.

X1400 Ethernet interface

Table 6-6 X1400 Ethernet, ports 1-4

	Pin	Signal name	Technical specifications
	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	
	Screened back-shell	M_EXT	Screen, permanently connected
Connector type: RJ45 socket			

Note

The Ethernet interfaces support Auto MDI(X). It is therefore possible to use both crossover and straight through cables to connect the devices.

For diagnostic purposes, each port has one green and one yellow LED.

Cable type: Industrial Ethernet
Max. cable length: 100 m

6.6.1.4 Meaning of the LEDs

Note

The LEDs are only visible when the front cover of the SINAMICS DCP is opened.

Table 6-7 Meaning of the LEDs at ports 1 to 4 of the X1400 interface

LED	Color	State	Description
Link port	-	Off	Electronics power supply is missing or outside permissible tolerance range (link missing or defective).
	Green	Continuous light	A different device is connected to port x and a physical connection exists.

LED	Color	State	Description
Activity port	-	Off	Electronics power supply is missing or outside permissible tolerance range (no activity).
	Yellow	Flashing light	Data is being received or sent at port x.

Table 6-8 Meaning of the Sync and Fault LEDs on the CBE20

LED	Color	State	Description
Fault	–	Off	If the link port LED is green: The CBE20 is operating normally, data is being exchanged with the configured IO Controller.
	Red	Flashing	• The response monitoring interval has elapsed. • Communications is interrupted. • The IP address is incorrect. • Incorrect or no configuration. • Incorrect parameter settings. • Incorrect or missing device name. • IO controller not connected/switched off, although an Ethernet connection has been established. • Other CBE20 errors
		Continuous light	CBE20 bus error • No physical connection to a subnet/switch. • Incorrect transmission rate. • Full duplex transmission is not activated.
Sync	–	Off	If the link port LED is green: Control Unit task system is not synchronized with the IRT clock. An internal substitute clock is generated.
	Green	Flashing light	Control Unit task system is synchronized with the IRT clock and data is being exchanged.
		Continuous light	Task system and MC-PLL are synchronized with the IRT clock.

Table 6-9 Meaning of the OPT LED on the Control Unit

LED	Color	State	Description, cause	Remedy
OPT	–	OFF	Electronics power supply is missing or outside permissible tolerance range. Communication Board either defective or not inserted.	–
	Green	Continuous light	Communication Board is ready and cyclic communication is taking place.	–
		0.5 Hz flashing light	The Communication Board is ready, but cyclic communications is not running. Possible causes: • At least one fault is present. • Communication is being established.	–
	Red	Continuous light	Cyclic communication via PROFINET has not yet been established. However, non-cyclic communication is possible. SINAMICS is waiting for a parameterization/configuration telegram.	–
		0.5 Hz flashing light	The firmware update into the CBE20 has been completed with an error. Possible causes: • The CBE20 is defective. • The memory card for the Control Unit is defective. CBE20 cannot be used in this state.	Replace the memory card or the CBE20.
		2 Hz flashing light	There is a communications error between the Control Unit and the CBE20. Possible causes: • The board was withdrawn after booting. • The board is defective.	Correctly insert the board, if required, replace.
	Orange	0.5 Hz flashing light	Firmware of the CBE20 currently being updated.	–

6.6.1.5 Assembling the 30 kW device

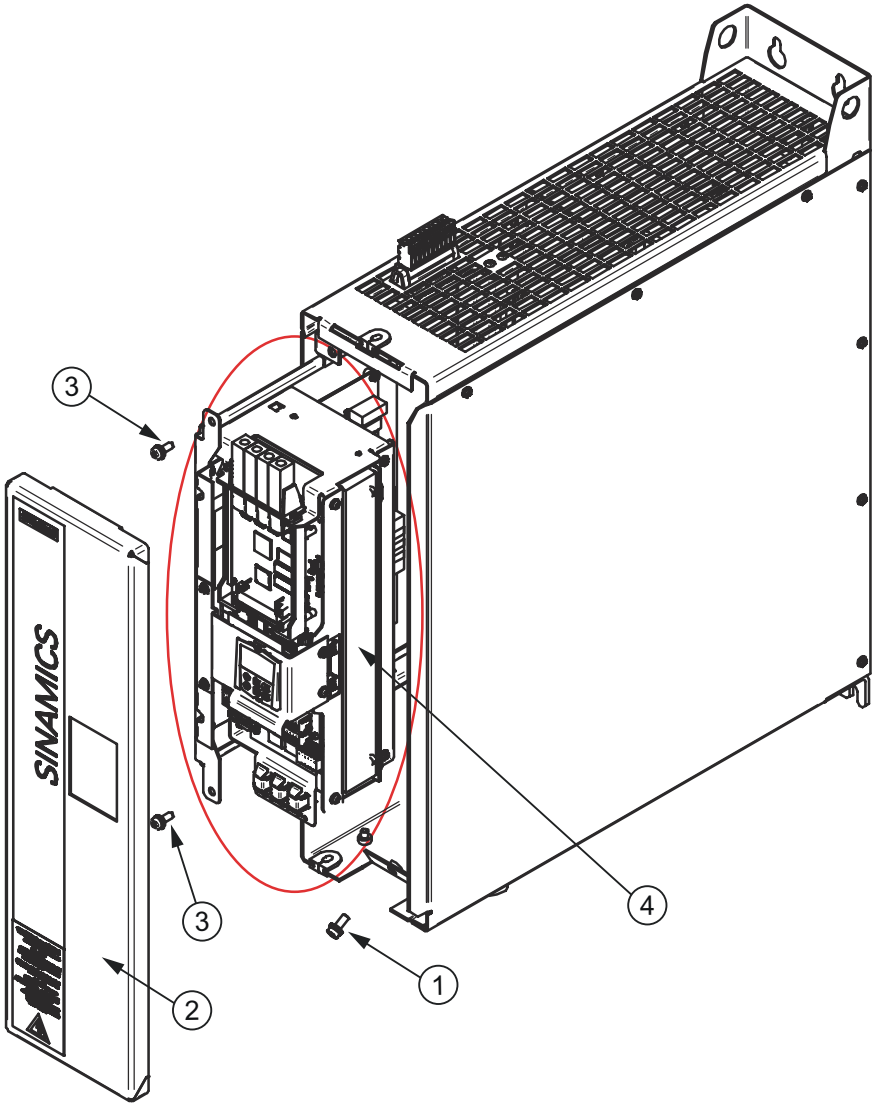
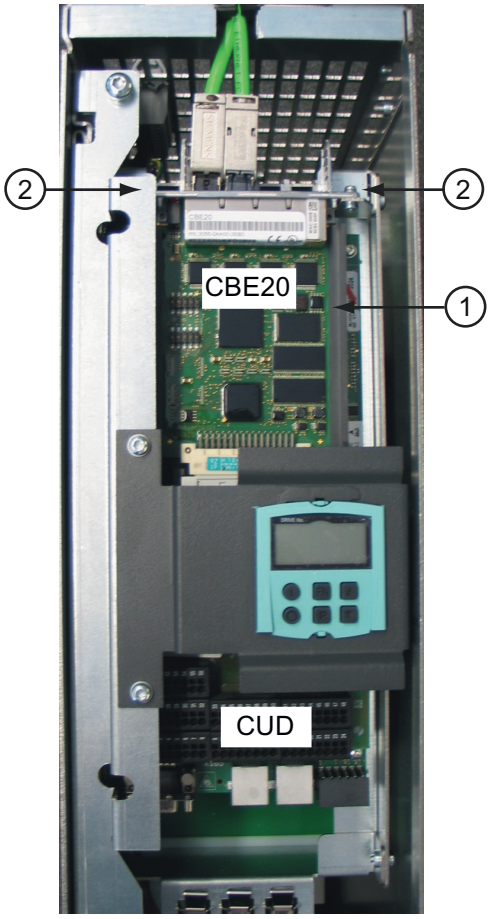


Figure 6-17 Assembling the CBE20

1. Loosen the screw ①
2. Detach and remove the front plate ②
3. Loosen the screws ③
4. Pull out the electronics rack unit ④
5. Push the CBE20 into the option module interface (see the following diagram)
6. Reinsert the electronics unit ④
7. Tighten the screws ③ again
8. Attach the front plate ② again
9. Tighten the screw ③ again



Push the CBE20 into the option module interface ① on the CUD from above, and tighten the screws ②.
Tool: Torx T10 screwdriver tightening torque 1 Nm.

Figure 6-18 Assembling the CBE20

6.6.1.6 Mounting 120 kW and 250 kW devices

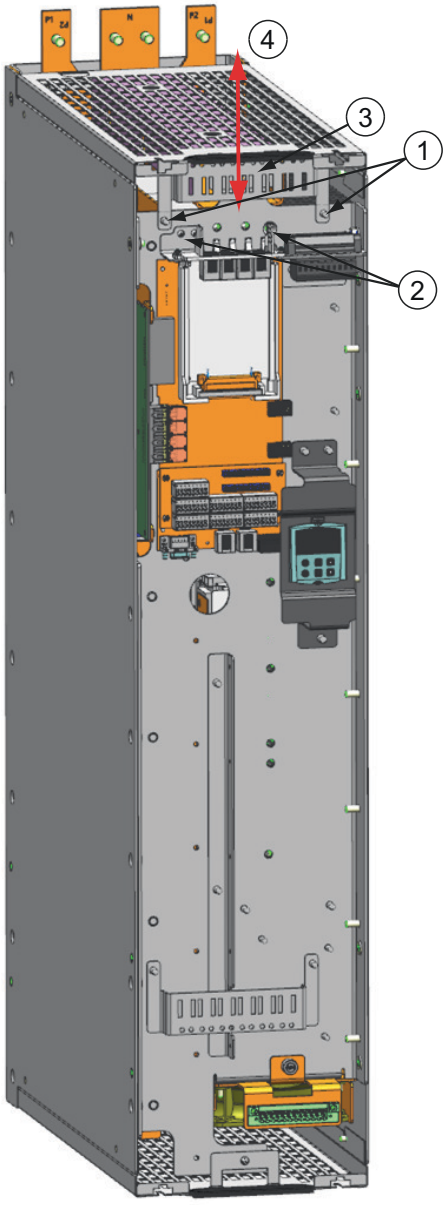


Figure 6-19 Installing the CBE20

1. Release the two screws at the lower side of the device and remove the front panel
2. Release the nuts ①, remove the bracket
3. Loosen the screws ③
4. Remove the cover plate ③ (screw)
5. Push in the CBE20 ④
6. Tighten the screws ③ again
7. Fasten the cover plate ③

8. Attach the bracket and fasten with ① nuts
9. Re-attach the front panel and tighten the two screws at the lower side of the device

6.6.1.7 Technical data

Table 6-10 Technical data

Communication Board CBE20 **6SL3055-0AA00-2EBx**	**Unit**	**Value**
Max. current requirements (at 24 V DC)	A_{DC}	0.1
Power loss	W	2.4
Weight	kg	< 0.1

6.6.2 Terminal Module Cabinet TMC (option G63)

The Terminal Module Cabinet (TMC) enables the simple connection of the CUD standard signals (X177) via spring-loaded terminals in an easily accessible area of the control cabinet.

See Chapter "Ordering information for options and accessories (Page 30)" for ordering data.



Figure 6-20 Terminal Module Cabinet

The CUD is equipped with a "Cabinet Board".

During installation, connectors X1 and X2 on the adapter board must be connected to connectors X1 and X2 on the TMC with the supplied cables (3 m). The cables must be laid in a cable duct.

Terminal block assignment, see "Terminal arrangement, option G63 (Page 77)".

6.6.2.1 Terminal arrangement, option G63

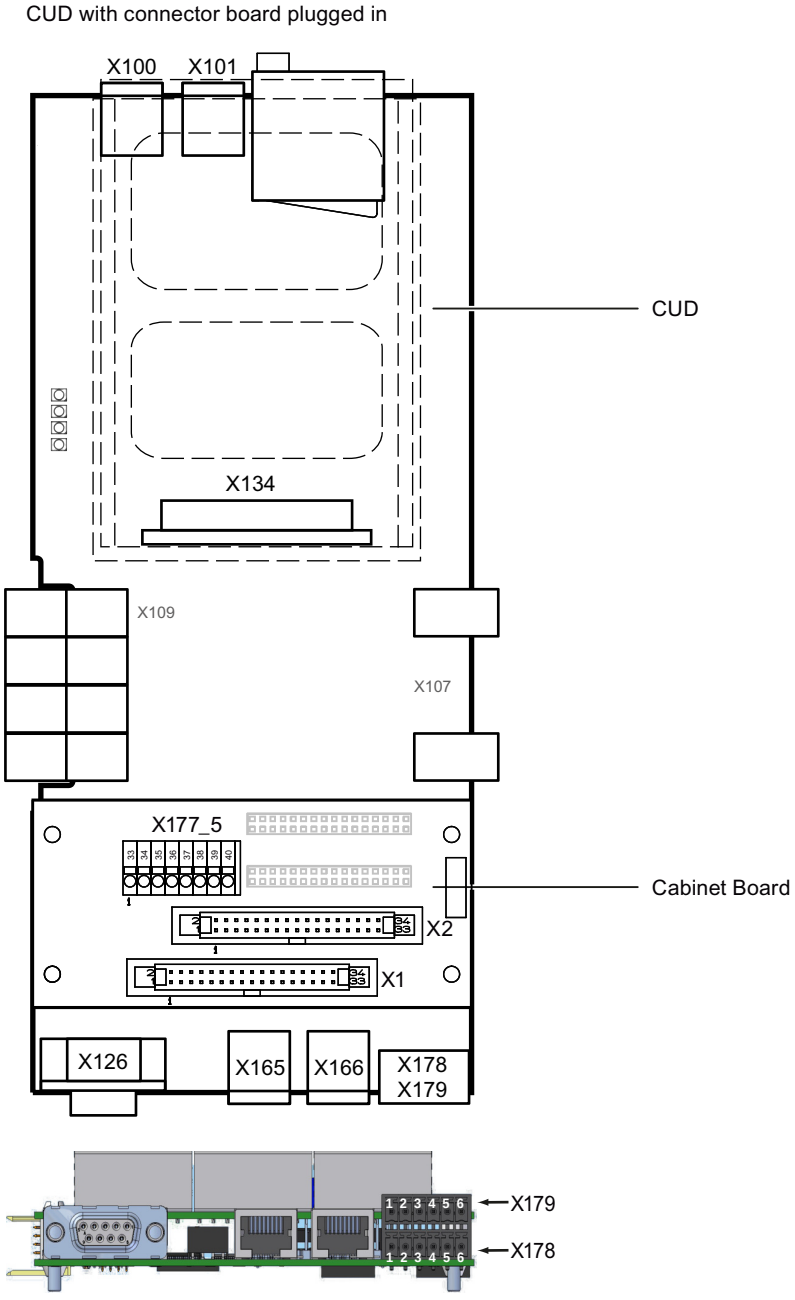


Figure 6-21 CUD terminal/connector arrangement and Cabinet Board – option G63

Modules for option G63

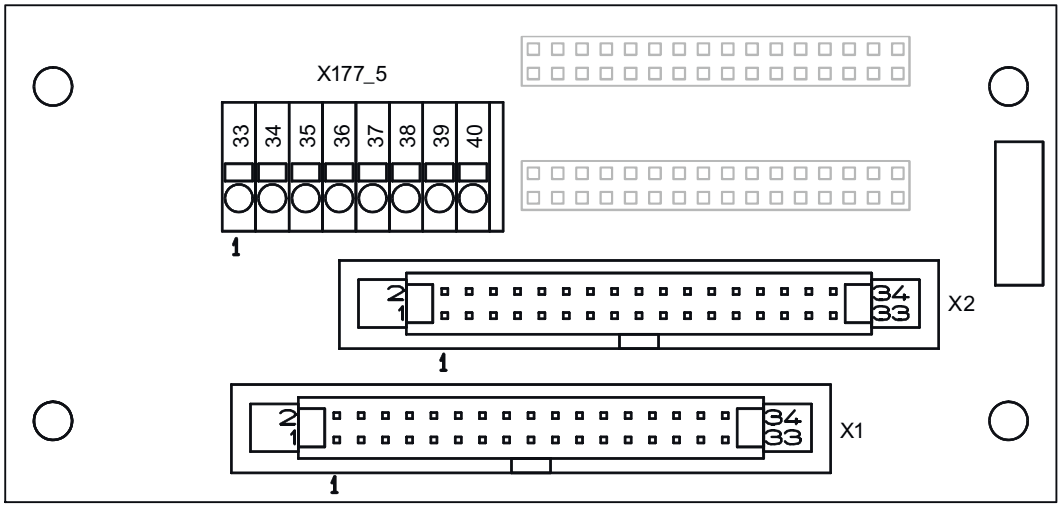


Figure 6-22 Terminal/connector arrangement on the "Cabinet Board"

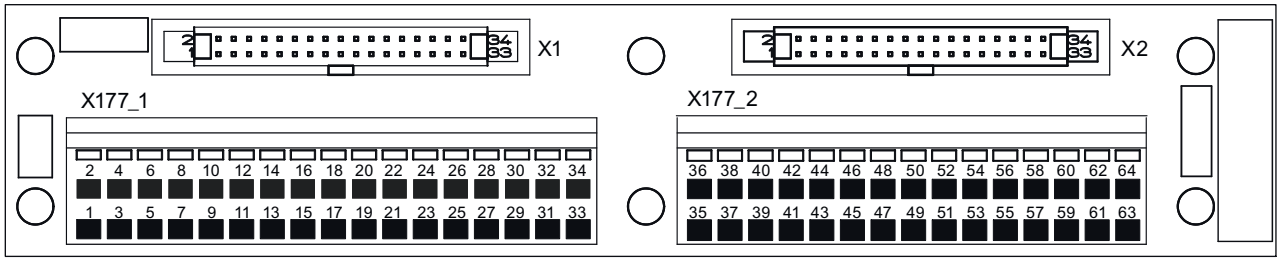


Figure 6-23 Terminal arrangement on the "Terminal Module Cabinet (TMC)"

Terminal assignment for option G63

The technical data for terminals X177_1, X177_2 and X177_5 corresponds to the specifications for terminal X177 on the Connector Board in the version without option G63, see Table 6-5 Assignment, terminal -X177 (Page 65).

Table 6-11 Assignment of the terminals on the Terminal Module Cabinet (TMC) (overview)

Terminal X177_1, X177_2	**Function**		**Description**
1st terminal block (X177_1)			
1, 2	AI 3 +, AI 3 -	Analog input 3	See X177.1 and 2
3, 4	AI 4 +, AI 4 -	Analog input 4	See X177.3 and 4
5, 6	AI 5 +, AI 5 -	Analog input 5	See X177.5 and 6
7, 8	AI 6 +, AI 6 -	Analog input 6	See X177.7 and 8
9, 10	24 V DC	24 V supply (output)	24 VDC, short-circuit proof Max. load 200 mA (terminals 9, 10, 57, 58, 59 and 60 combined), internal supply to digital ground and analog ground

Terminal X177_1, X177_2	**Function**		**Description**
11, 12, 13, 14	DI 0, 1, 2, 3	Digital input 0, 1, 2, 3	See X177.11, 12, 13, 14
15, 16, 17, 18	DI/DO 4, 5, 6, 7	Digital input/output 4, 5, 6, 7	See X177.15, 16, 17, 18
19, 20, 21 22	DO 0, 1, 2, 3	Digital output 0, 1, 2, 3	See X177.19, 20, 21, 22, 23, 24
23, 24	M	Ground, digital	
25, 26	AI 0 +, AI 0 -	Analog input 0	See X177.25 and 26
27, 28	AI 1 +, AI 1 -	Analog input 1	See X177.27 and 28
29, 30	AI 2 +, AI 2 -	Analog input 2	See X177.29 and 30
31, 32	P10, N10	Reference voltage ±10 V (output)	See X177.31, 32, 33, 34
33, 34	M	Ground, analog	
2nd terminal block (X177_2)			
35, 36	M	Ground, digital	See X177.35 and 36
37, 38	Reserved, do not use		-
39, 40	Reserved, do not use		-
41, 42	Reserved, do not use		-
43, 44	Reserved, do not use		-
45, 46	Reserved, do not use		-
47, 48	Reserved, do not use		-
49, 50	AO 0, M	Analog output 0, analog ground	See X177.49 and 50
51, 52	AO 1, M	Analog output 1, analog ground	See X177.51 and 52
53, 54, 55	Temp 1, 2, 3	Temperature sensor, motor interface 1	See X177.53, 54, 55
56	M	Ground, analog	See X177.56
57, 58, 59, 60	24 V DC	24 V supply (output)	24 VDC, short-circuit proof Max. load 200 mA (terminals 9, 10, 57, 58, 59 and 60 combined), internal supply to digital ground and analog ground
61, 62, 63, 64	M	Ground, digital	-
"Terminal Module Cabinet (TMC)" module			

Table 6-12 Assignment of the terminals on the Cabinet Board (overview)

Terminal X177_5	**Function**		**Description**
33, 34	M	Ground, analog	-
35, 36	M	Ground, digital	See X177.35 and 36
37, 38	Reserved, do not use		See X177.37 and 38

Terminal X177_5	Function	Description
39, 40	Reserved, do not use	See X177.39 and 40
"Cabinet Board" module		

Note:
The terminals on X177_5 are connected in parallel to the terminals with the same name on the Terminal Module Cabinet (TMC).

Open-loop and closed-loop control section

Table 6-13 Terminal type, open-loop and closed-loop control section

X177, X177_5 (for option G63):	
Type	SPT 1.5 spring-loaded terminal
Connection capacity	Rigid/flexible/conductor sizes (mm^2/mm^2/AWG): 0.2-1.5 / 0.2-1.5 / 24-16 flexible with conductor end sleeve with/without plastic sleeve: 0.25-1.5 / 0.25-0.75 mm^2 (stripped length 8 mm)
Stripped length	10 mm
X177_1, X177_2 (for option G63):	
Type	Two-tier terminal with spring-loaded terminal PK 68
Connection capacity	Rigid/flexible 0.5-2.5 mm^2

6.6.3 Terminal Module TM15

6.6.3.1 Description

The TM15 is a terminal expansion module for snapping onto a mounting rail according to IEC 60715. The number of available digital inputs and outputs within a drive system can be expanded with the TM15.

Table 6-14 Interface overview of the TM15

Type	Number
DRIVE-CLiQ interfaces	2
Bidirectional digital inputs/outputs	24 (electrical isolation in three groups each with eight DI/DO)

6.6.3.2 Safety instructions

⚠ WARNING

Non-observance of the safety instructions

If the safety instructions in Chapter 1 are not observed, accidents can occur involving severe injuries or death.

- Make sure that the safety instructions are observed.

⚠ WARNING

Fire through overheating due to insufficient ventilation clearances

Inadequate ventilation clearances cause overheating with a risk for personnel due to smoke and fire. This can also result in more downtimes and reduced service lives of the Terminal Module.

- For this reason, it is imperative that you maintain the 50 mm clearances above and below the Terminal Module.

NOTICE

Damage through the use of incorrect DRIVE-CLiQ cables

Damage or malfunctions can occur on the devices or system when incorrect or unreleased DRIVE-CLiQ cables are used.

- Only use suitable DRIVE-CLiQ cables that have been released by Siemens for the respective application.

Note

Malfunctions due to polluted DRIVE-CLiQ interfaces

Malfunctions can occur in the system through the use of polluted DRIVE-CLiQ interfaces.

- Cover unused DRIVE-CLiQ interfaces with the supplied blanking covers.

6.6.3.3 Interface description

Overview

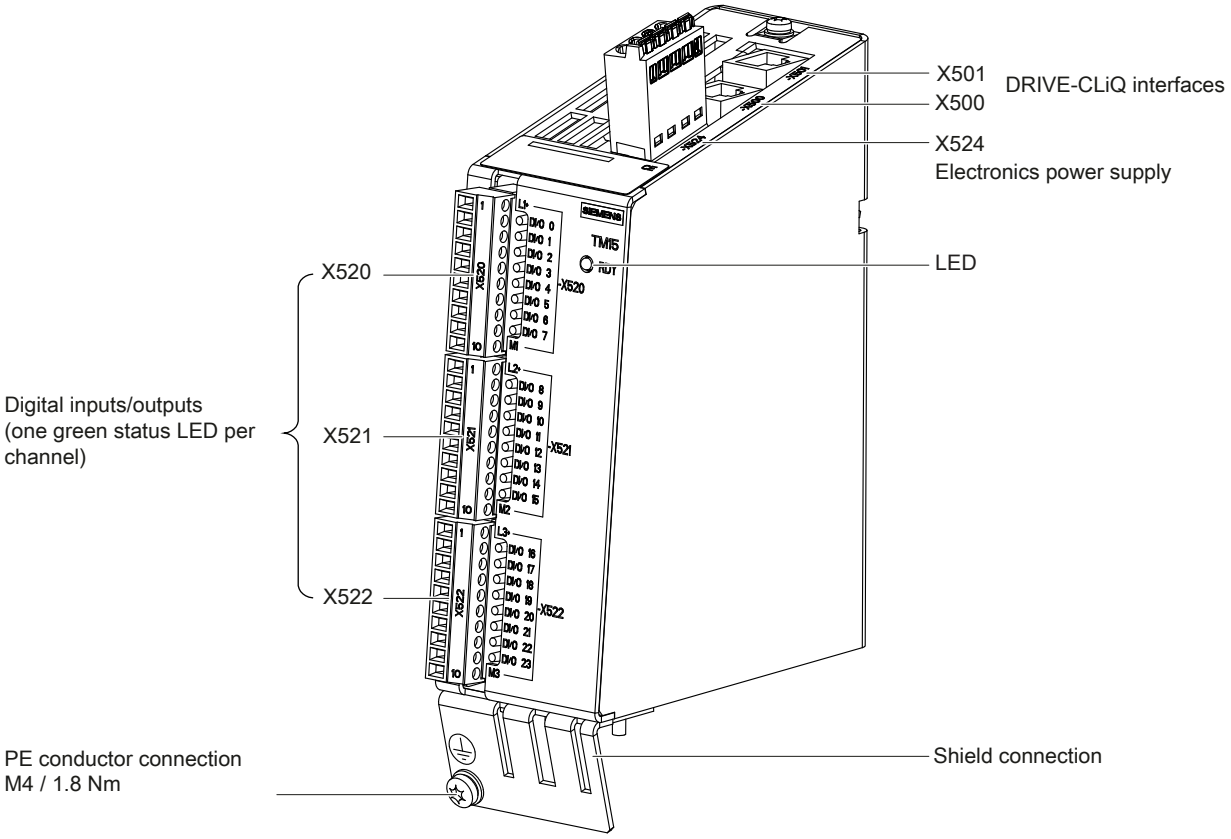


Figure 6-24 TM15 interface overview

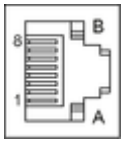
Terminal type

X520, X521, X522		
Terminal type	Screw terminal	
Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.08 ... 1.5 mm^2 0.25 ... 1.5 mm^2 0.25 ... 0.5 mm^2 28 ... 14
Stripped length	7 mm	
Tool	0.4 × 2.0 mm screwdriver	
Tightening torque	0.22 ... 0.25 Nm	
X524		
Terminal type	Spring-loaded terminal	

Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.2 ... 2.5 mm^2 0.25 ... 2.5 mm^2 0.25 ... 1.5 mm^2 24 ... 12
Stripped length	8 mm	

X500/X501 DRIVE-CLiQ interfaces

Table 6-15 X500/X501: DRIVE-CLiQ interfaces

Connector	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground

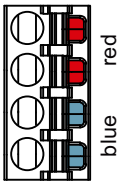
The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.
Blanking covers (50 x) Article No.: 6SL3066-4CA00-0AA0

Note

The maximum DRIVE-CLiQ cable length is 100 m.

X524 electronic power supply

Table 6-16 X524: Electronics power supply

Connector	Terminal	Designation	Technical specifications
	+	Electronics power supply	Voltage: 24 VDC (20.4 ... 28.8 V) Current consumption: max. 0.6 A [1] Max. current via jumper in connector: 20 A (15 A according to UL/CSA)
	+	Electronics power supply	
	M	Electronics ground	
	M	Electronics ground	

[1] Including the current consumption for the digital outputs

The maximum cable length that can be connected is 30 m.

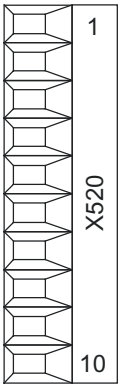
Note

The two "+" or "M" terminals are jumpered in the connector. This ensures that the supply voltage is looped through.

The digital outputs are supplied via terminals X520, X521, and X522.

X520 bidirectional digital inputs/outputs

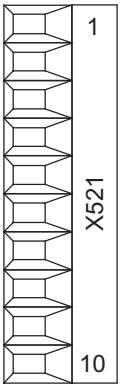
Table 6-17 X520: Bidirectional digital inputs/outputs

Connector	Terminal	Designation [1]	Technical specifications
	1	L1+	See Section "Technical specifications"
	2	DI/DO 0	
	3	DI/DO 1	
	4	DI/DO 2	
	5	DI/DO 3	
	6	DI/DO 4	
	7	DI/DO 5	
	8	DI/DO 6	
	9	DI/DO 7	
	10	M1 (GND)	

[1] L1+: A 24 V DC power supply for DI/DO 0 to 7 (first potential group) must always be connected if at least one DI/DO of the potential group is used as an output.
M1: A ground reference for DI/DO 0 to 7 (first potential group) must always be connected if at least one DI/DO of the potential group is used as either an input or output.
DI/DO: Bidirectional digital input/output

X521 bidirectional digital inputs/outputs

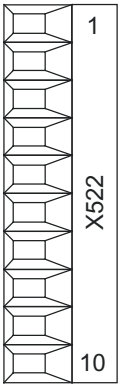
Table 6-18 X521: Bidirectional digital inputs/outputs

Connector	Terminal	Designation [1)]	Technical specifications
	1	L2+	See Section "Technical specifications"
	2	DI/DO 8	
	3	DI/DO 9	
	4	DI/DO 10	
	5	DI/DO 11	
	6	DI/DO 12	
	7	DI/DO 13	
	8	DI/DO 14	
	9	DI/DO 15	
	10	M2 (GND)	

1) L2+: A 24 V DC power supply for DI/DO 8 to 15 (second potential group) must always be connected if at least one DI/DO of the potential group is used as output.
M2: A ground reference for DI/DO 8 to 15 (second potential group) must always be connected if at least one DI/DO of the potential group is used as either input or output.
DI/DO: Bidirectional digital input/output

X522 bidirectional digital inputs/outputs

Table 6-19 X522: Bidirectional digital inputs/outputs

Connector	Terminal	Designation [1)]	Technical specifications
	1	L3+	See Section "Technical specifications"
	2	DI/DO 16	
	3	DI/DO 17	
	4	DI/DO 18	
	5	DI/DO 19	
	6	DI/DO 20	
	7	DI/DO 21	
	8	DI/DO 22	
	9	DI/DO 23	
	10	M3 (GND)	

1) L3+: A 24 V DC power supply for DI/DO 16 to 23 (third potential group) must always be connected if at least one DI/DO of the potential group is used as output.
M3: A ground reference for DI/DO 16 to 23 (third potential group) must always be connected if at least one DI/DO of the potential group is used as either input or output.
DI/DO: Bidirectional digital input/output

6.6.3.4 Connection example

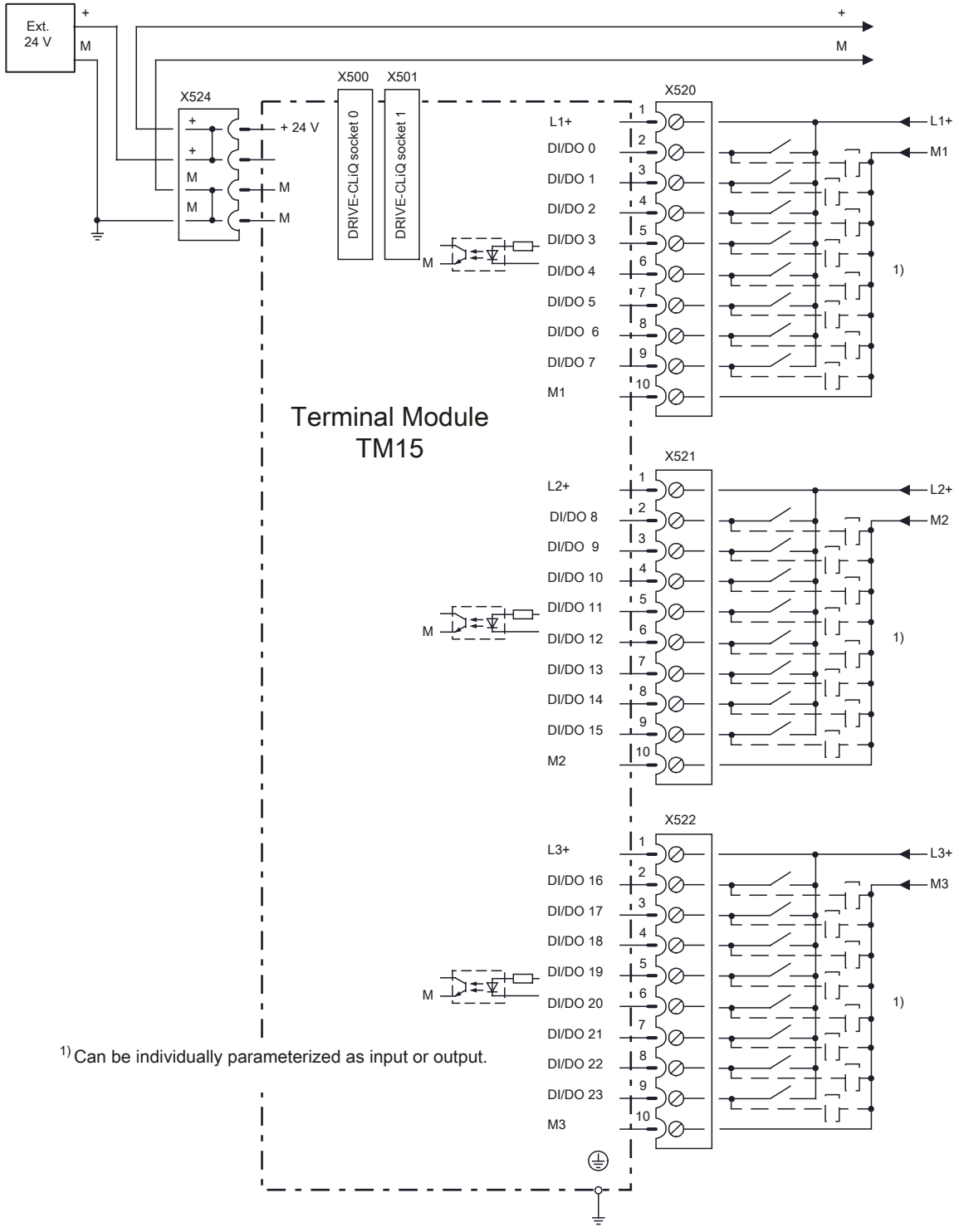


Figure 6-25 Example connection of TM15

6.6.3.5 Meaning of the LEDs on the Terminal Module TM15

Table 6-20 Meanings of the LEDs on the Terminal Module TM15

LED	Color	Status	Description, cause	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
	Green	Continuous light	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	Continuous light	DRIVE-CLiQ communication is being established.	–
	Red	Continuous light	This component has at least one fault. **Note:** The LED is activated irrespective of whether the corresponding messages have been reconfigured.	Remove and acknowledge the fault.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.	–
		2 Hz flashing light	Firmware download has been completed. The system waits for POWER ON.	Carry out a POWER ON.
	Green/orange or Red/orange	Flashing light	Component recognition via LED is activated[1]. **Note:** Both options depend on the LED status when component recognition is activated.	–

[1] See SINAMICS DCP List Manual for the parameters to activate the recognition of components via LED

Cause and rectification of faults

The following documents contain information about the cause of faults and how they can be rectified:

SINAMICS DCP List Manual

6.6.3.6 Dimension drawing

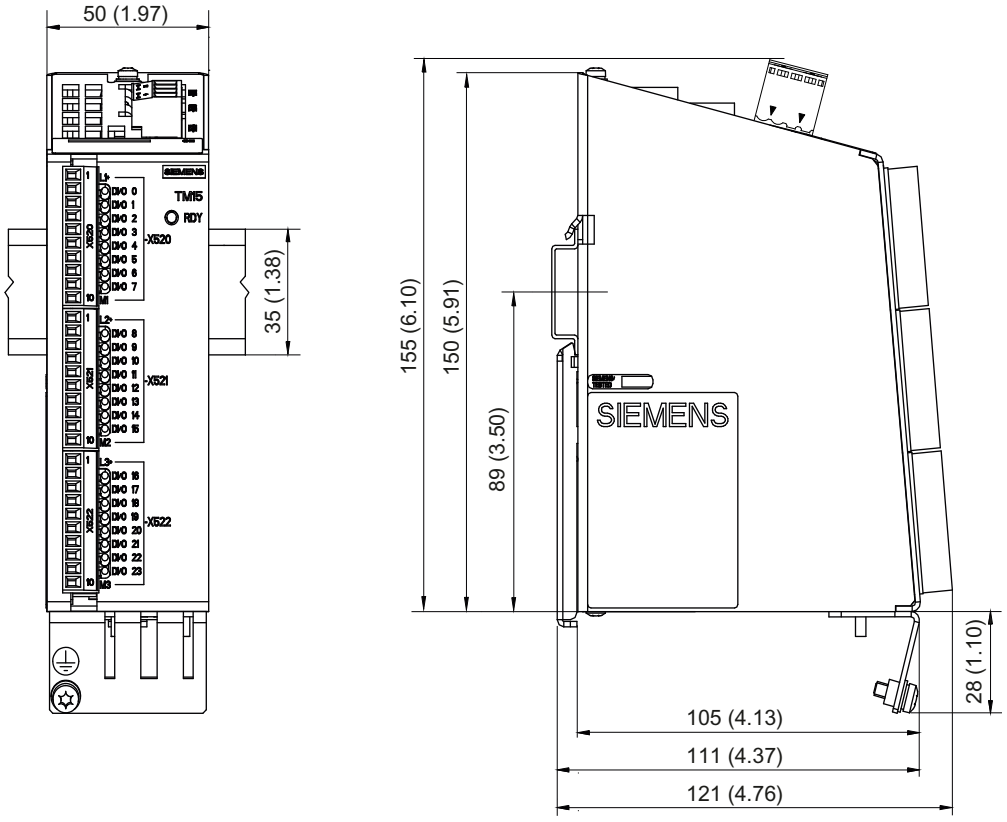


Figure 6-26 Dimension drawing of Terminal Module TM15, all data in mm and (inches)

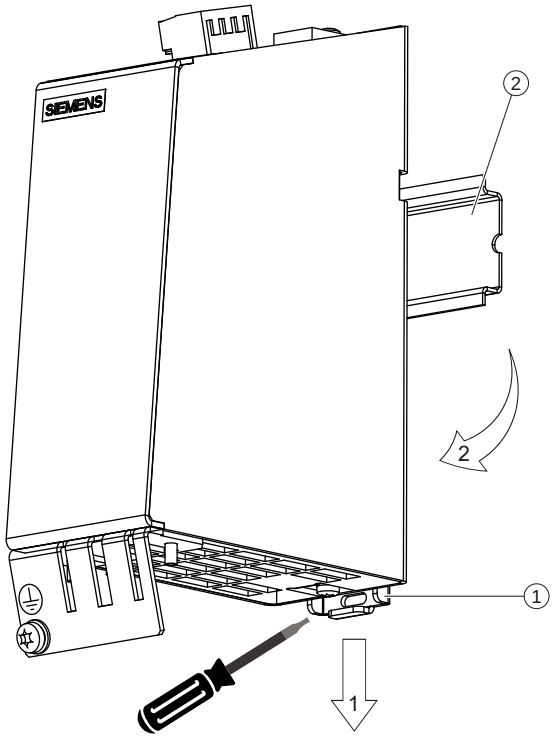
6.6.3.7 Installation

Installation

1. Tilt the component backwards slightly and attach it to the DIN rail using the hooks.
2. Swivel the component onto the DIN rail until you hear the mounting slide at the rear latch into position.
3. Slide the components along the mounting rail to either the left or right up to their final position.

Disassembly

1. First shift the mounting slide downwards at the lug to release the interlocking with the mounting rail.
2. Swivel the component to the front and withdraw it upwards from the DIN rail.



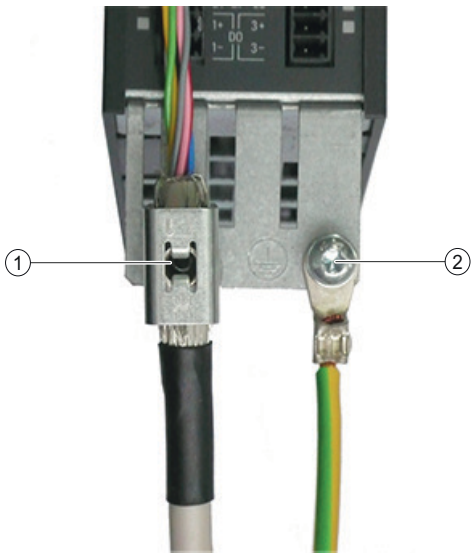
① Mounting slide
② Standard mounting rail

Figure 6-27 Removing from a mounting rail

6.6.3.8 Protective conductor connection and shield support

It is always advisable to shield the digital I/O wiring.

The following diagrams show typical Weidmüller shield connection terminals for the shield supports.



① Shield connection terminal, Weidmüller company, type: KLBUE CO1, Article number: 1753311001
② Protective conductor connection with M4 screw / 1.8 Nm

Figure 6-28 Shield supports and protective conductor connection

NOTICE
Damage or faulty operation due to incorrect shielding or inadmissible cable lengths If the correct shielding procedures and the permissible cable lengths are not observed, the machine can be damaged or may malfunction. • Only use shielded cables. • Do not exceed the cable lengths stated in the technical data.

Note

Only use screws with a permissible insertion depth of 4 - 6 mm.

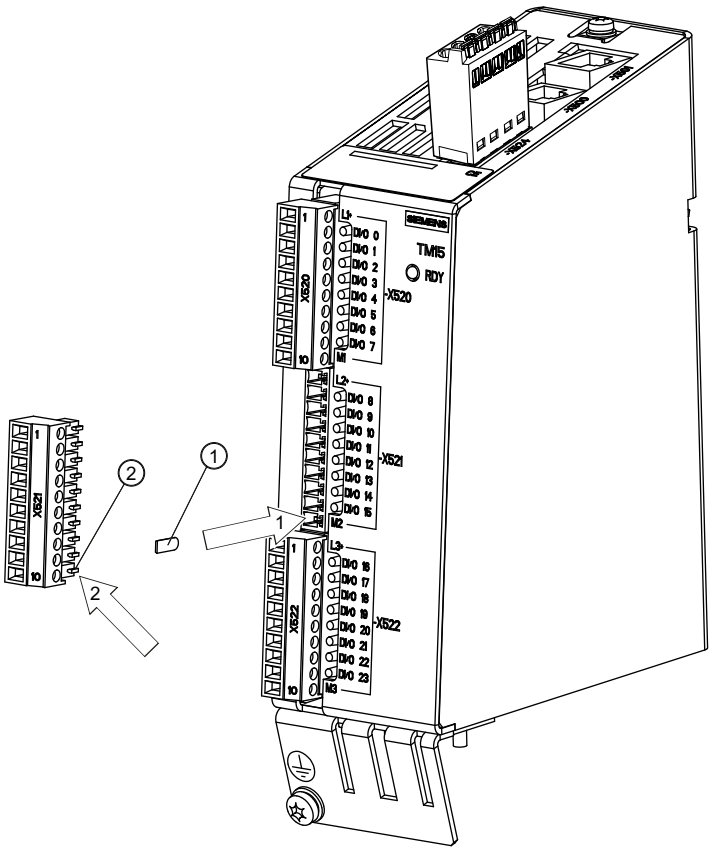
The TM15 enclosure is connected to the ground terminal of the module supply (terminal X524). If the ground terminal is actually grounded, then the enclosure is also grounded. An additional ground connection using the M4 screw is especially necessary if high potential bonding currents can flow (e.g. through the cable shield).

6.6.3.9 Connector coding

A series of coding elements ("coding sliders") are supplied with each Terminal Module TM15.

Connector coding

1. Insert at least one coding slider at the required position.
2. Remove the associated coding lug at the connector.



① Insert a coding slider.
② Cut off the coding lug on the connector.

Figure 6-29 Procedure for encoding a connector

To avoid wiring errors, unique coding patterns must be defined for the connectors X520, X521 and X522.

Possible patterns:

- 3 connectors on one component are encoded differently (i.e. X520, X521 and X522).
- Different component types are encoded differently.
- Otherwise identical components are encoded differently on the same machine, (e.g. several TM15-type components).

6.6.3.10 Technical data

Table 6-21 Technical data

6SL3055-0AA00-3FAx	Unit	Value
Electronics power supply		
Voltage	V_{DC}	24 V DC (20.4 ... 28.8)
Current (without DRIVE-CLiQ or digital outputs)	A_{DC}	≤0.15
Power loss	W	≤3
Max. cable length	m	30

6SL3055-0AA00-3FAx	Unit	Value
Peripherals		
Digital inputs/outputs	Can be parameterized as either DI or DO	
Number of digital inputs/outputs	24	
Electrical isolation	Yes, in groups of 8	
Digital inputs		
Voltage	V_{DC}	-30 ... +30
Low level (an open digital input is interpreted as "low")	V_{DC}	-30 ... +5
High level	V_{DC}	15 ... 30
Input impedance	kΩ	2.8
Input current, typical (at 24 V DC)	mA	9
Max. voltage in OFF state	V_{DC}	5
Current in OFF state	mA	0.0 to 1.0 (per channel)
Typical input delay of the digital inputs	µs	"0" → "1": 50 "1" → "0": 100
Digital outputs (continuously short-circuit proof)		
Voltage	V_{DC}	24
Max. load current per digital output	A_{DC}	0.5
Output delay (resistive load)		
Typical	µs	"0" → "1": 50 "1" → "0": 150
Maximum	µs	"0" → "1": 100 "1" → "0": 225
Min. output pulse (100% amplitude, 0.5 A with resistive load)	µs	125 (typ.) 350 (max.)
Switching frequency For resistive load For inductive load For lamp load Max. lamp load	 Hz Hz Hz W	 max. 100 max. 0.5 max. 10 5
Max. switching frequency (100% amplitude, 50%/50% duty cycle; with 0.5 A and a resistive load)	kHz	1 (typ.)
Voltage drop in ON state	V_{DC}	0.75 (max.) for maximum load in all circuits
Leakage current in OFF state	µA	Max. 10 per channel
Voltage drop, output (I/O power supply to the output)	V_{DC}	0.5
Max. total current of outputs (per group) up to 60° C up to 50° C up to 40° C	 A_{DC} A_{DC} A_{DC}	 2 3 4

6SL3055-0AA00-3FAx	Unit	Value
Response time	The response time for the digital inputs/outputs (TM15 DI/DO) consists of the following elements: • Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle). • Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle). • Evaluation on the Control Unit (see function diagram) For more information: SINAMICS DCP List Manual, Chapter "Function block diagrams"	
Weight	kg	1.0
Protective conductor connection	At the housing with M4/1.8 Nm screw	
Approvals	UL and cULus, http://www.ul.com (www.ul.com) File: E164110, Vol. 2, Sec. 9	

6.6.4 Terminal Module TM31

6.6.4.1 Description

The TM31 is a terminal expansion module for snapping onto a mounting rail according to IEC 60715. The TM31 Terminal Module can be used to increase the number of available digital and analog inputs and outputs within a drive system.

The TM31 contains the following interfaces:

Table 6-22 Interface overview of the TM31

Type	Quantity
DRIVE-CLiQ interfaces	2
Digital inputs	8
Bidirectional digital inputs/outputs	4
Analog inputs	2
Analog outputs	2
Relay outputs	2
Temperature sensor input	1

Supported types

SINAMICS DCP only supports one version of the Terminal Module TM31:

Table 6-23 TM31 types

Article number TM31	Use with SINAMICS DCP
6SL3055-0AA00-3AA0	Not possible
6SL3055-0AA00-3AA1	Possible

6.6.4.2 Safety instructions

⚠ WARNING

Non-observance of the safety instructions

If the safety instructions in Chapter 1 are not observed, accidents can occur involving severe injuries or death.

- Make sure that the safety instructions are observed.

⚠ WARNING

Fire through overheating due to insufficient ventilation clearances

Inadequate ventilation clearances cause overheating with a risk for personnel due to smoke and fire. This can also result in more downtimes and reduced service lives of the Terminal Module.

- For this reason, it is imperative that you maintain the 50 mm clearances above and below the Terminal Module.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to temperature sensors

Unshielded or incorrectly routed cables to temperature sensors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables as temperature sensor cables.
- If temperature sensor cables are routed together with the motor cable, use separately shielded cables twisted in pairs.
- Connect the cable shield at both ends to ground potential over a large surface area.

NOTICE

Damage through the use of incorrect DRIVE-CLiQ cables

Damage or malfunctions can occur on the devices or system when incorrect or unreleased DRIVE-CLiQ cables are used.

- Only use suitable DRIVE-CLiQ cables that have been released by Siemens for the respective application.

Note

Malfunctions due to polluted DRIVE-CLiQ interfaces

Malfunctions can occur in the system through the use of polluted DRIVE-CLiQ interfaces.

- Cover unused DRIVE-CLiQ interfaces with the supplied blanking covers.

6.6.4.3 Interface description

Overview

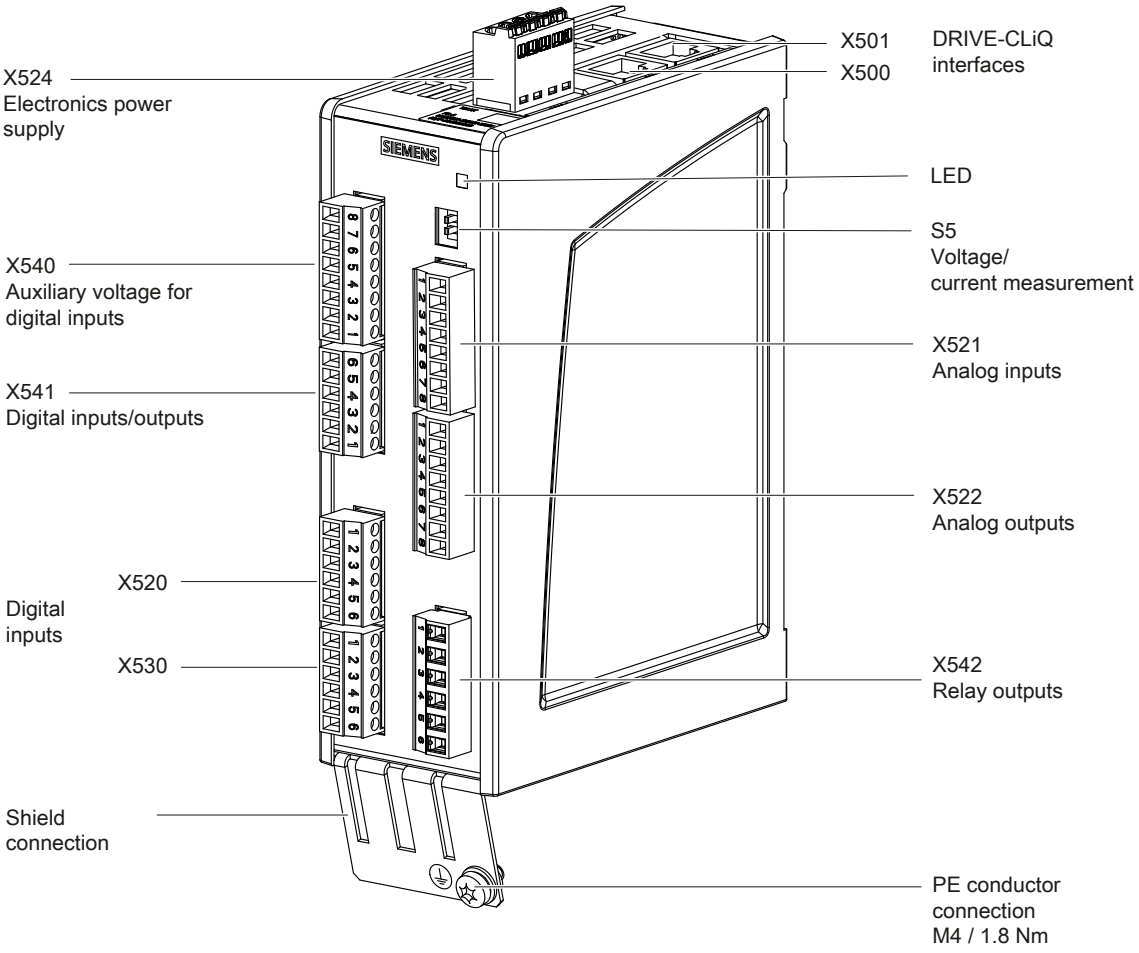


Figure 6-30 Interface description TM31

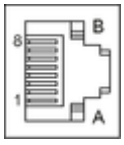
Terminal type

X520, X521, X522, X530, X540, X541		
Terminal type	Screw terminal	
Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.08 ... 1.5 mm^2 0.25 ... 1.5 mm^2 0.25 ... 0.5 mm^2 28 ... 14
Stripped length	7 mm	
Tool	0.4 × 2.0 mm screwdriver	
Tightening torque	0.22 ... 0.25 Nm	

X542		
Terminal type	Screw terminal	
Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.2 ... 2.5 mm^2 0.25 ... 1 mm^2 0.25 ... 1 mm^2 22 ... 12
Stripped length	9 mm	
Tool	0.6 × 3.5 mm screwdriver	
Tightening torque	0.5 ... 0.6 Nm	
X524		
Terminal type	Spring-loaded terminal	
Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.2 ... 2.5 mm^2 0.25 ... 2.5 mm^2 0.25 ... 1.5 mm^2 24 ... 12
Stripped length	8 mm	

X500/X501 DRIVE-CLiQ interfaces

Table 6-24 X500/X501: DRIVE-CLiQ interfaces

Connector	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	M (0 V)	Electronics ground

The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.

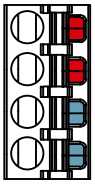
Blanking covers (50 x) Article No.: 6SL3066-4CA00-0AA0

Note

The maximum DRIVE-CLiQ cable length is 100 m.

X524 electronic power supply

Table 6-25 X524: Electronics power supply

Connector	Terminal	Designation	Technical specifications
	+	Electronics power supply	Voltage: 24 VDC (20.4 ... 28.8 V) Current consumption: max. 1.7 A [1] Max. current via jumper in connector: 20 A (15 A according to UL/CSA)
	+	Electronics power supply	
	M	Electronics ground	
	M	Electronics ground	

[1] Including the current consumption for the digital outputs and for supplying the sensor

The maximum cable length that can be connected is 30 m.

Note

The two "+" or "M" terminals are jumpered in the connector. This ensures that the supply voltage is looped through.

The current consumption increases by the value for the DRIVE-CLiQ node and digital outputs.

X520, X530 digital inputs

Table 6-26 X520: Digital inputs

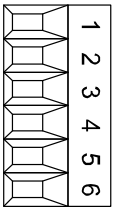
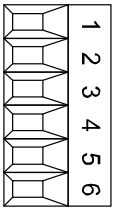
Connector	Terminal	Designation [1]	Technical specifications
	1	DI 0	Voltage: -3 ... +30 V Electrical isolation: Yes Reference potential: M1 Input characteristic acc. to IEC 61131-2, type 1 Input voltage (including ripple) "1" signal: 15 ... 30 V "0" signal: -3 ... +5 V Input current at 24 V DC: typ. 9 mA at < 0.5 mA: "0" signal reliably detected Input delay: For "0" → "1": typ. 50 µs/max. 100 µs for "1" → "0": typ. 130 µs, max. 150 µs
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	
	6	M	

Table 6-27 X530: Digital inputs

Connector	Terminal	Designation [1]	Technical specifications
	1	DI 4	Voltage: -3 ... +30 V Electrical isolation: Yes Reference potential: M2 Input characteristic acc. to IEC 61131-2, type 1 Input voltage (including ripple) "1" signal: 15 ... 30 V "0" signal: -3 ... +5 V Input current at 24 V DC: typ. 9 mA at < 0.5 mA: "0" signal reliably detected Input delay: For "0" → "1": typ. 50 µs/max. 100 µs for "1" → "0": typ. 130 µs, max. 150 µs
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	
	6	M	

[1] DI: Digital input; M: Electronics ground; M1, M2: Ground reference

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

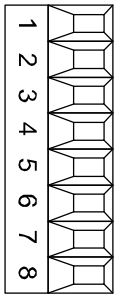
Terminal M1 or M2 must be connected in order that digital inputs (DI) can function.

This is achieved through one of the following measures:

1. Provide the ground reference of the digital inputs
2. A jumper to terminal M
   Note:: This removes isolation for these digital inputs.

X521 analog inputs

Table 6-28 X521: Analog inputs

Connector	Terminal	Designation [1]	Technical specifications
	1	AI 0+	The analog inputs can be switched over between current and voltage input using switches S5.0 and S5.1 **As voltage input** : -10 ... +10 V; R_i > 100 kΩ Resolution: 11 bits + sign **As current input**: -20 ... +20 mA; R_i = 250 kΩ Resolution: 10 bits + sign
	2	AI 0-	
	3	AI 1+	
	4	AI 1-	
	5	P10	**Auxiliary voltage**: P10 = 10 V N10 = -10 V Current-carrying capacity: max. 3 mA Sustained short-circuit-proof
	6	M	
	7	N10	
	8	M	

[1] AI: Analog inputs; P10/N10: Auxiliary voltage; M: Ground reference

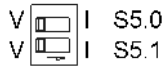
NOTICE
Damage or malfunctions through impermissible voltage values If a current exceeding ±35 mA flows through the analog current input, the component could be destroyed. The common mode range must not be violated in order to avoid incorrect analog-digital conversion results. • The input voltage may only be in the range between -30 V and +30 V (destruction limit). • The common mode voltage may only be in the range between -10 V and +10 V (error limit). • The back EMF (electromotive force) at the auxiliary voltage outputs may only be in the range between -15 V and +15 V.

Note

The power supply for the analog inputs can be taken internally or from an external power supply unit

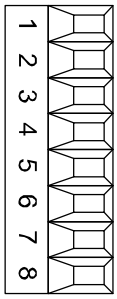
Analog inputs current/voltage switch

Table 6-29 Current/voltage selector switch S5

	Switch	Function
	S5.0	Switchover of voltage (V)/current (I) AI0
	S5.1	Switchover of voltage (V)/current (I) AI1

X522 analog outputs/temperature sensor

Table 6-30 X522: Analog outputs/temperature sensor

Connector	Terminal	Designation [1]	Technical specifications
	1	AO 0V+	You can set the following output signals using parameters: **Voltage:** -10 V ... 10 V (max. 3 mA) **Current 1**: 4 ... 20 mA (max. load resistance ≤ 500 Ω) **Current 2**: -20 ... 20 mA (max. load resistance ≤ 500 Ω) **Current 3**: 0 ... 20 mA (max. load resistance ≤ 500 Ω) Resolution: 11 bits + sign Sustained short-circuit-proof
	2	AO 0-	
	3	AO 0C+	
	4	AO 1V+	
	5	AO 1-	
	6	AO 1C+	
	7	+ Temp [2]	Temperature sensor PT1000 / PTC / KTY84-1C130 Measuring current via temperature sensor connection: 2 mA
	8	- Temp [2]	

[1] AO xV: Analog output voltage; AO xC: Analog output current

[2] Accuracy of the temperature measurement (including evaluation):
- PT1000: ±5 °C (PT1000 tolerance class B. acc. to IEC 60751
- PTC: ±5 °C
- KTY: ±7 °C

NOTICE

Damage or malfunctions through impermissible voltage values

If the back EMF is impermissible then damage and malfunctions may occur on the components.

- The back EMF at the outputs may only be in the range between -15 V and +15 V.

NOTICE

Motor damage due to incorrectly connected KTY temperature sensor

If a KTY temperature sensor is connected with incorrect polarity, it is not possible to detect when the motor overheats. Overheating can cause damage to the motor.

- Connect a KTY temperature sensor with the correct polarity.

⚠ WARNING

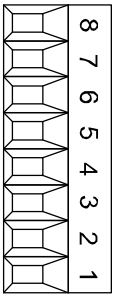
Electric shock when the motor temperature sensor insulation fails

When connecting temperature sensors which are not isolated from the motor power circuit according to safe electrical separation, arcing to the signal electronics may occur.

- Use motors whose temperature sensors have safe electrical separation.
- Use only connecting cables and connectors with safe electrical separation between the insulated conductors of the temperature sensor and the insulated conductors of the power circuit.

X540 auxiliary voltage for the digital inputs

Table 6-31 X540: Auxiliary voltage for the digital inputs

Connector	Terminal	Designation	Technical specifications
	8	+24 V	Voltage: +24 VDC Max. total load current of +24 V auxiliary voltage for terminals X540 and X541 combined: 150 mA
	7	+24 V	
	6	+24 V	
	5	+24 V	
	4	+24 V	
	3	+24 V	
	2	+24 V	
	1	+24 V	

Note

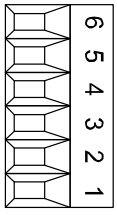
This power supply is only used for powering the digital inputs.

Note

If the 24 V supply is briefly interrupted, the auxiliary voltage for the digital inputs is deactivated for this time.

X541 bidirectional digital inputs/outputs

Table 6-32 X541: Bidirectional digital inputs/outputs

Connector	Terminal	Designation [1]	Technical specifications
	6	M	**As input:** Voltage: -3 ... 30 V Electrical isolation: no Reference potential: M Input characteristic acc. to IEC 61131-2, type 1 Input voltage (including ripple) "1" signal: 15 ... 30 V "0" signal: -3 ... +5 V Input current at 24 V DC: typ. 9 mA at < 0.5 mA: "0" signal reliably detected Input delay: For "0" → "1": typ. 50 µs -for "1" → "0" typ. 100 µs **As output:** Voltage: 24 V DC Electrical isolation: no Reference potential: M Output voltage "1" signal, with load: > X524.+ -2 V Output current for each output: ≤ 0.5 A Sum of all 4 outputs: ≤ 0.1 A (when parameter p4046 = 0) ≤ 1.0 A (when parameter p4046 = 1) Residual current for "0" signal: < 0.5 mA Short-circuit protection, automatic restart after a short-circuit Load types: ohmic, capacitive, inductive Output delay for "0" → "1": typ. 150 µs / max. 500 µs (ohmic load) for "1" → "0": typ. 50 µs (ohmic load) Switching frequency For ohmic load: Max. 100 Hz For inductive load: Max. 0.5 Hz For lamp load: max. 10 Hz Lamp load: max. 5 W
	5	DI/DO 11	
	4	DI/DO 10	
	3	DI/DO 9	
	2	DI/DO 8	
	1	+24 V	Auxiliary voltage: Voltage: +24 V DC Max. total load current of +24 V auxiliary voltage for terminals X540 and X541 combined: 150 mA

[1] DI/DO: Bidirectional digital input/output; M: Electronics ground

Note

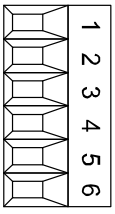
An open input is interpreted as "low".

Note

If a the 24 V supply is briefly interrupted, the digital outputs are deactivated during this time.

X542 relay outputs

Table 6-33 X542: Relay outputs

Connector	Terminal	Designation [1]	Technical specifications
	1	DO 0.NC	Contact type: Two-way contact max. load current: 8 A Max. switching voltage: 250 V_{AC}. 30 V_{DC} Max. switching capacity at 250 V_{AC}: 2000 VA (cosφ = 1) Max. switching capacity at 250 $V_{AC:}$ 750 VA (cosφ = 0.4) Max. Switching capacity at 30 V_{DC}: 240 W (resistive load) Required minimum current: 100 mA Output delay: ≤ 20 ms [2] Overvoltage category: Class II according to IEC 61800-5-1
	2	DO 0.COM	
	3	DO 0.NO	
	4	DO 1.NC	
	5	DO 1.COM	
	6	DO 1.NO	

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

[2] Depending on the parameterization and the supply voltage (P24) of the TM31

6.6.4.4 Connection example

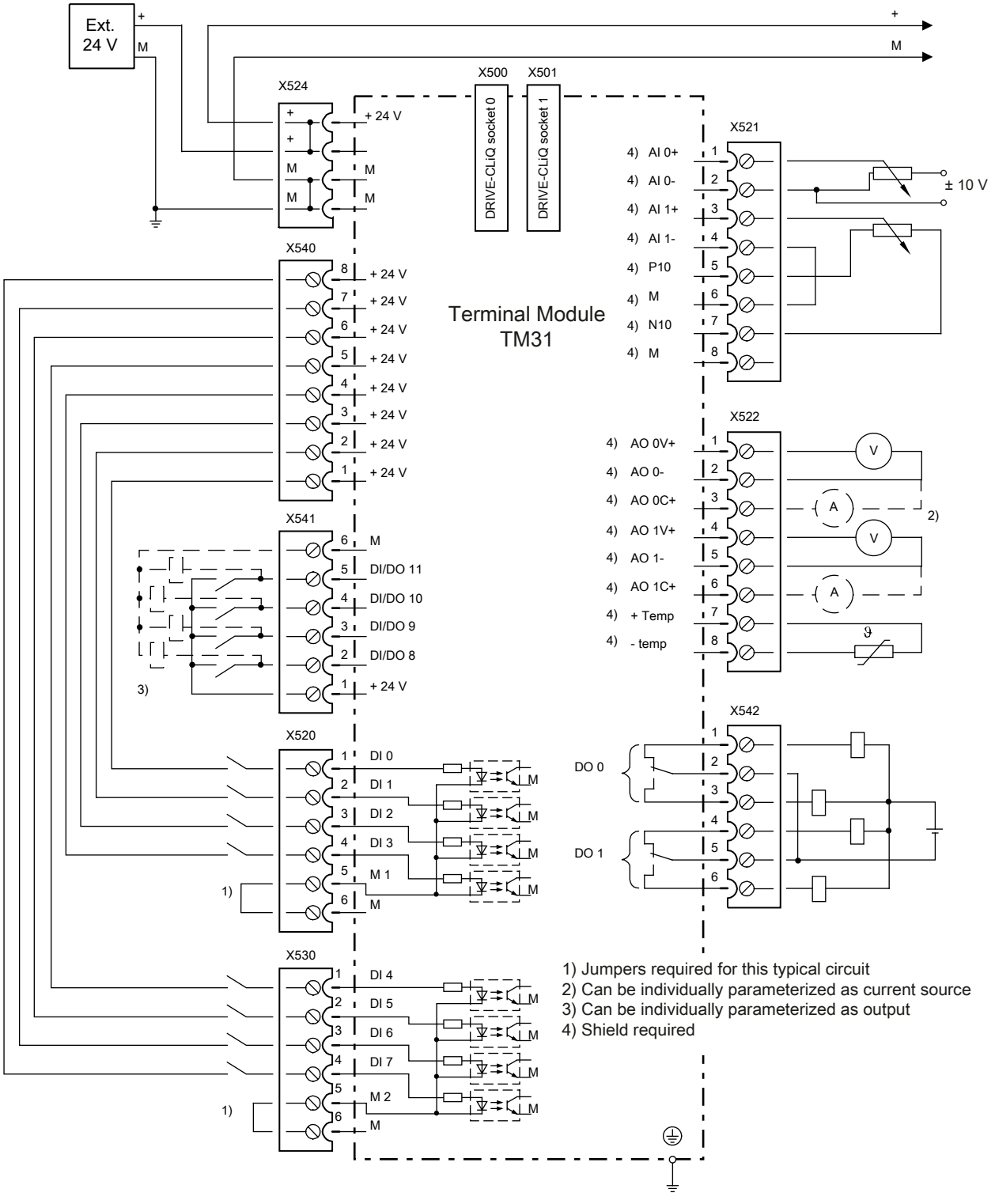


Figure 6-31 TM31 connection example

6.6.4.5 Meaning of the LEDs on the Terminal Module TM31

Table 6-34 Meanings of the LEDs on the Terminal Module TM31

LED	Color	Status	Description, cause	Remedy
READY	-	Off	The electronics power supply is missing or outside the permissible tolerance range.	–
	Green	Continuous light	The component is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	Continuous light	DRIVE-CLiQ communication is being established.	–
	Red	Continuous light	This component has at least one fault. **Note:** The LED is activated irrespective of whether the corresponding messages have been reconfigured.	Remove and acknowledge the fault.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.	–
		2 Hz flashing light	Firmware download has been completed. The system waits for POWER ON.	Carry out a POWER ON.
	Green/orange or Red/orange	Flashing light	Component recognition via LED is activated[1]. **Note:** Both options depend on the LED status when component recognition is activated.	–

[1] See SINAMICS DCP List Manual for the parameters to activate the recognition of components via LED

Cause and rectification of faults

The following documents contain information about the cause of faults and how they can be rectified:

SINAMICS DCP List Manual

6.6.4.6 Dimension drawing

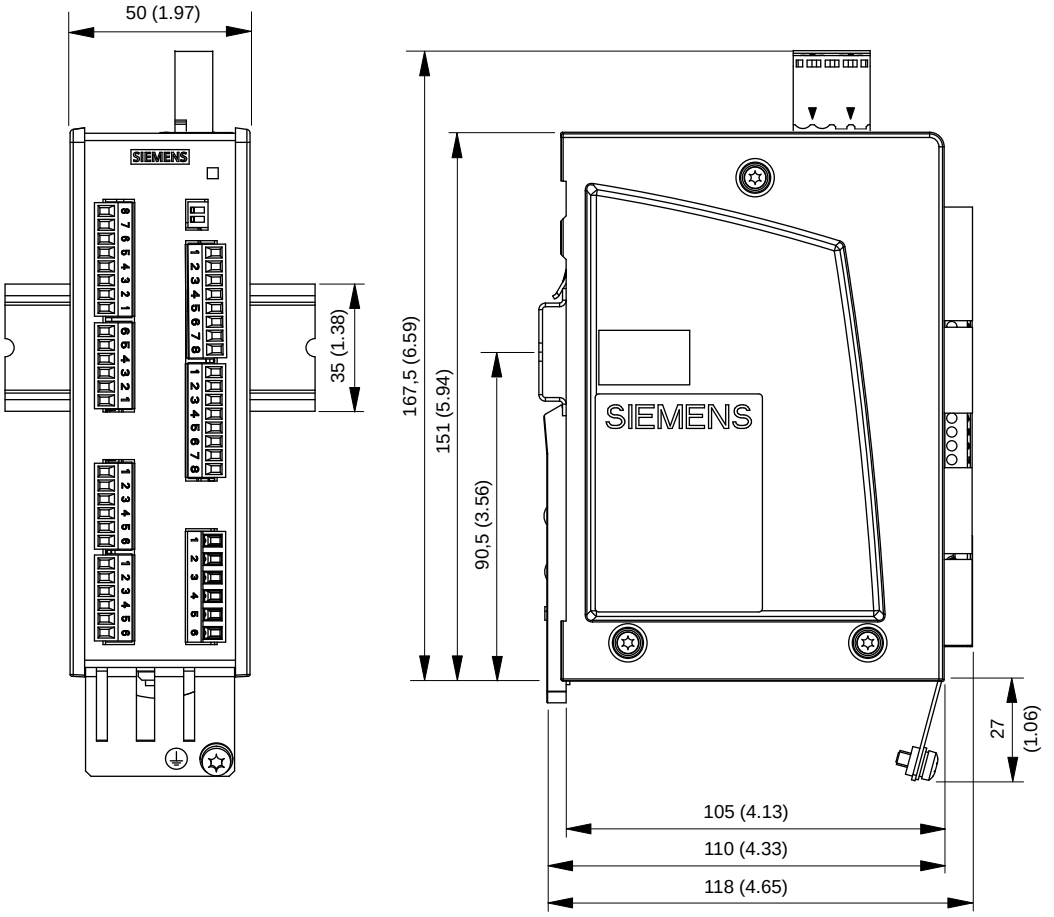


Figure 6-32 Dimension drawing of Terminal Module TM31, all data in mm and inches

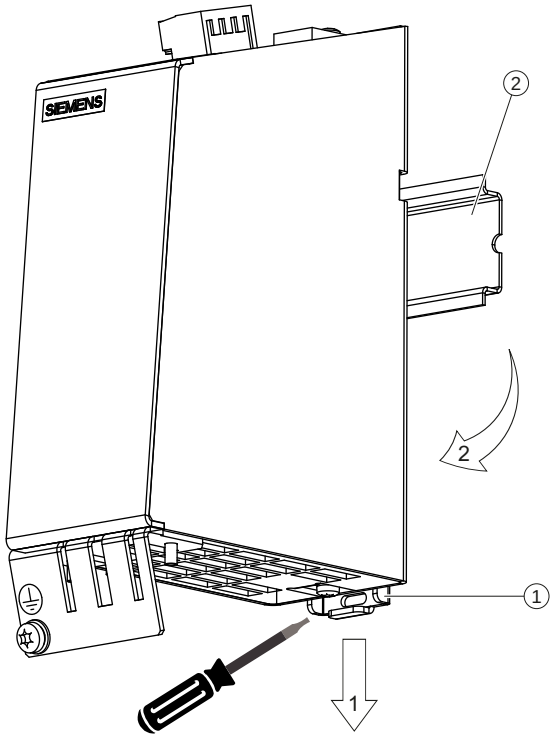
6.6.4.7 Installation

Installation

1. Tilt the component backwards slightly and attach it to the DIN rail using the hooks.
2. Swivel the component onto the DIN rail until you hear the mounting slide at the rear latch into position.
3. Slide the components along the mounting rail to either the left or right up to their final position.

Disassembly

1. First shift the mounting slide downwards at the lug to release the interlocking with the mounting rail.
2. Swivel the component to the front and withdraw it upwards from the DIN rail.



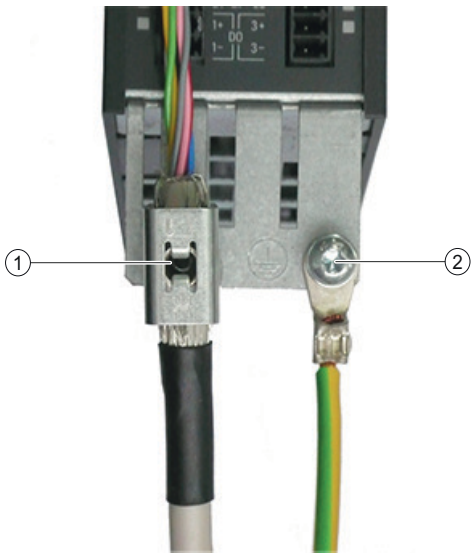
① Mounting slide
② Standard mounting rail

Figure 6-33 Removing from a mounting rail

6.6.4.8 Protective conductor connection and shield support

It is always advisable to shield the digital input/output wiring.

The following diagrams show typical Weidmüller shield connection terminals for the shield supports.



① Shield connection terminal, Weidmüller company, type: KLBUE CO1, Article number: 1753311001

② Protective conductor connection M4 / 1.8 Nm

Figure 6-34 Shield supports

NOTICE
Damage or faulty operation due to incorrect shielding or inadmissible cable lengths If the correct shielding procedures and the permissible cable lengths are not observed, the machine can be damaged or may malfunction. • Only use shielded cables. • Do not exceed the cable lengths stated in the technical data.

6.6.4.9 Connector coding

To ensure that identical connectors are assigned correctly on the TM31, the connectors are coded as shown in the diagram below.

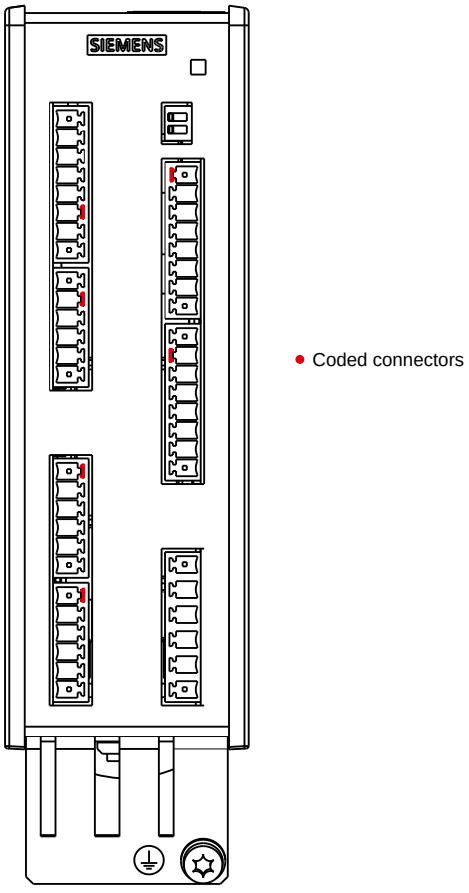


Figure 6-35 Example of connector coding at the TM31

The bending radii of the cables must be observed (see MOTION-CONNECT description).

6.6.4.10 Technical data

Table 6-35 Technical data

6SL3055-0AA00-3AA1	Unit	Value
Electronics power supply		
Voltage	V_{DC}	24 V DC (20.4 ... 28.8)
Current (without DRIVE-CLiQ, digital outputs and auxiliary voltages)	A_{DC}	≤0.2
Power loss	W	≤5
PE/ground connection	At the housing with M4/1.8 Nm screw	

6SL3055-0AA00-3AA1	Unit	Value
Response time	The response time for the digital inputs/outputs and the analog inputs/outputs consists of the following elements: • Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle). • Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle) • Evaluation on the Control Unit (see function diagram) Further information: SINAMICS DCP List Manual, Chapter "Function diagrams".	
Maximum cable lengths: Electronics power supply DRIVE-CLiQ cables inputs/outputs	 m m m	 30 100 30
Weight	kg	0.49

6.6.5 Terminal Module TM150

6.6.5.1 Description

The terminal module TM150 is a DRIVE-CLiQ component for temperature evaluation. The temperature is measured in a temperature range from -99 °C to +250 °C for the following temperature sensors:

- PT100 (with monitoring for wire breakage and short-circuit)
- PT1000 (with monitoring for wire breakage and short-circuit)
- KTY84 (with monitoring for wire breakage and short-circuit)
- PTC (with short-circuit monitoring)
- Bimetallic NC contact (without monitoring)

For the temperature sensor inputs, for each terminal block the evaluation can be parameterized for 1x2-wire, 2x2-wire, 3-wire or 4-wire conductors. There is no galvanic isolation in the TM150.

The TM150 is mounted in the control cabinet and can be snapped on to a standard mounting rail (IEC 60715).

The TM150 contains the following interfaces:

Table 6-36 Overview of the TM150 interfaces

Type	Quantity
DRIVE-CLiQ interfaces	2
Temperature sensor inputs	12
Electronics power supply	1

6.6.5.2 Safety instructions

⚠ WARNING

Non-observance of the safety instructions

If the safety instructions in Chapter 1 are not observed, accidents can occur involving severe injuries or death.

- Make sure that the safety instructions are observed.

⚠ WARNING

Fire through overheating due to insufficient ventilation clearances

Inadequate ventilation clearances cause overheating with a risk for personnel due to smoke and fire. This can also result in more downtimes and reduced service lives of the Terminal Module.

- For this reason, it is imperative that you maintain the 50 mm clearances above and below the Terminal Module.

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to temperature sensors

Unshielded or incorrectly routed cables to temperature sensors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables as temperature sensor cables.
- If temperature sensor cables are routed together with the motor cable, use separately shielded cables twisted in pairs.
- Connect the cable shield at both ends to ground potential over a large surface area.

NOTICE

Damage through the use of incorrect DRIVE-CLiQ cables

Damage or malfunctions can occur on the devices or system when incorrect or unreleased DRIVE-CLiQ cables are used.

- Only use suitable DRIVE-CLiQ cables that have been released by Siemens for the respective application.

Note

Malfunctions due to polluted DRIVE-CLiQ interfaces

Malfunctions can occur in the system through the use of polluted DRIVE-CLiQ interfaces.

- Cover unused DRIVE-CLiQ interfaces with the supplied blanking covers.

6.6.5.3 Interface description

Overview

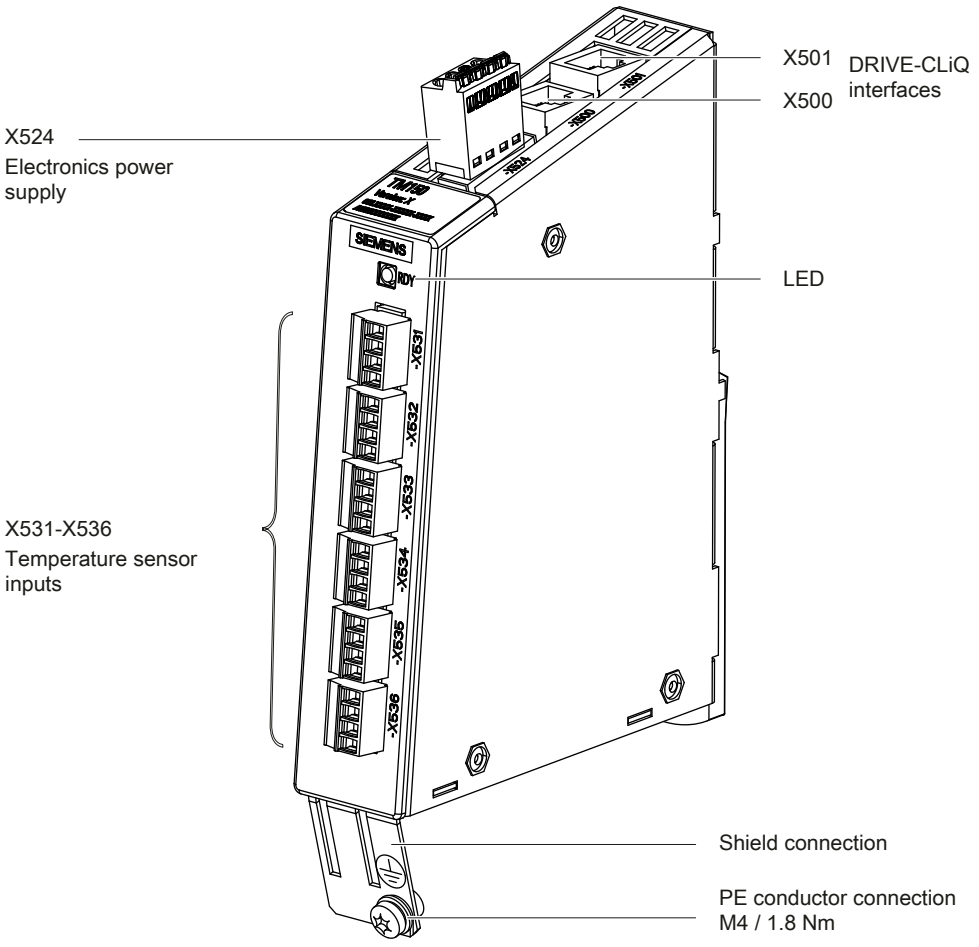


Figure 6-36 Interface overview of Terminal Module TM150

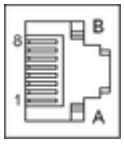
Terminal type

X524		
Terminal type	Spring-loaded terminal	
Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.2 ... 2.5 mm^2 0.25 ... 2.5 mm^2 0.25 ... 1.5 mm^2 24 ... 12
Stripped length	8 mm	
X531 - X536		
Terminal type	Spring-loaded terminal	

Connectable cable cross-sections	Rigid, flexible Flexible with conductor end sleeve without plastic sleeve Flexible with conductor end sleeve with plastic sleeve AWG / kcmil	0.2 ... 1.5 mm^2 0.25 ... 1.5 mm^2 0.25 ... 0.75 mm^2 24 ... 16
Stripped length	10 mm	

X500/X501 DRIVE-CLiQ interfaces

Table 6-37 X500/X501: DRIVE-CLiQ interfaces

Connector	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply, max. 450 mA
	B	M (0 V)	Electronics ground

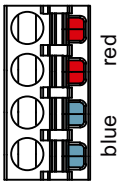
The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.
Blanking covers (50 x) Article No.: 6SL3066-4CA00-0AA0

Note

The maximum DRIVE-CLiQ cable length is 100 m.

X524 Electronics power supply

Table 6-38 X524: Electronics power supply

Connector	Terminal	Designation	Technical specifications
	+	Electronics power supply	Voltage: 24 VDC (20.4 ... 28.8 V) Current consumption: max. 0.5 A [1] Max. current via jumper in connector: 20 A (15 A according to UL/CSA)
	+	Electronics power supply	
	M	Electronics ground	
	M	Electronics ground	

[1] Including DRIVE-CLiQ

The maximum cable length that can be connected is 30 m.

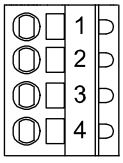
Note

The two "+" or "M" terminals are jumpered in the connector. This ensures that the supply voltage is looped through.

The current consumption increases by the value for the DRIVE-CLiQ node.

X531-X536 temperature sensor inputs

Table 6-39 X531-X536: Temperature sensor inputs

Connector	Terminal	Function 1x2- / 2x2-wire	Function 3 and 4-wire	Technical specifications
	1	+ Temp (channel x)	+ (Channel x)	Temperature sensor connection for sensors with 1x2 wires Connection of the 2nd measurement cable for sensors with 4-wires
	2	- Temp (channel x)	- (Channel x)	Temperature sensor connection for sensors with 1x2 wires Connection of the 1st measurement cable for sensors with 3 and 4-wires.
	3	+ Temp (channel y)	+ I_c (constant current, positive channel x)	Temperature sensor connection for sensors with 2x2, 3 and 4-wires
	4	- Temp (channel y)	- I_c (constant current, negative channel x)	
Measuring current via temperature sensor connection: Approx. 0.83 mA				

When connecting temperature sensors with three wires, a jumper must be inserted between X53x.2 and X53x.4.

Table 6-40 Channel assignment

Terminal	Channel number [x] for 1x2, 3 and 4-wires	Channel number [y] for 2x2 wires
X531	0	6
X532	1	7
X533	2	8
X534	3	9
X535	4	10
X536	5	11

NOTICE

Motor damage due to incorrectly connected KTY temperature sensor

A KTY temperature sensor connected with incorrect polarity cannot detect if the motor overheats. Overheating can cause damage to the motor.

- Connect a KTY temperature sensor with the correct polarity.

NOTICE

Overheating of the motor through jumpering the temperature sensor connections

Jumpering of the temperature sensor connections "+ Temp" and "- Temp" results in incorrect measurement results. Damage to the motor can result if the overheating is not detected.

- When using several temperature sensors, separately connect the individual sensors to "+ Temp" and "- Temp".

NOTICE

Device failure as a result of unshielded or incorrectly routed cables to temperature sensors

Unshielded or incorrectly routed cables to temperature sensors can result in interference being coupled into the signal processing electronics from the power side. This can result in significant disturbance of all signals (fault messages) up to failure of individual components (destruction of the devices).

- Only use shielded cables as temperature sensor cables.
- If temperature sensor cables are routed together with the motor cable, use separately shielded cables twisted in pairs.
- Connect the cable shield at both ends to ground potential over a large surface area.

Note

Incorrect temperature measured values as a result of cables with an excessively high resistance

An excessively long cable length or an excessively small cable cross-section can falsify the temperature measurement (for a PT100, 10 Ω cable resistance can falsify the measurement result by 10%). As a consequence, excessively high measured values are output, which could lead to the motor being unnecessarily tripped prematurely.

- Use only cable lengths ≤ 300 m.
- For cable lengths >100 m, use cables with a cross-section of ≥1 mm^2.

6.6.5.4 Connection examples

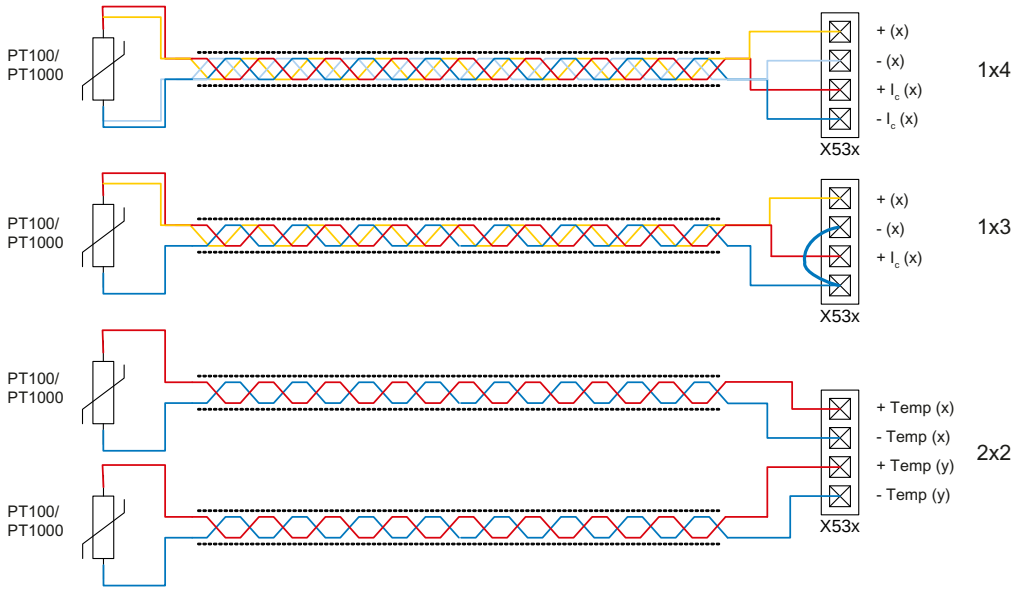


Figure 6-37 Connecting a PT100/PT1000 with 2x2, 3 and 4-wires to the temperature sensor inputs X53x of Terminal Module TM150

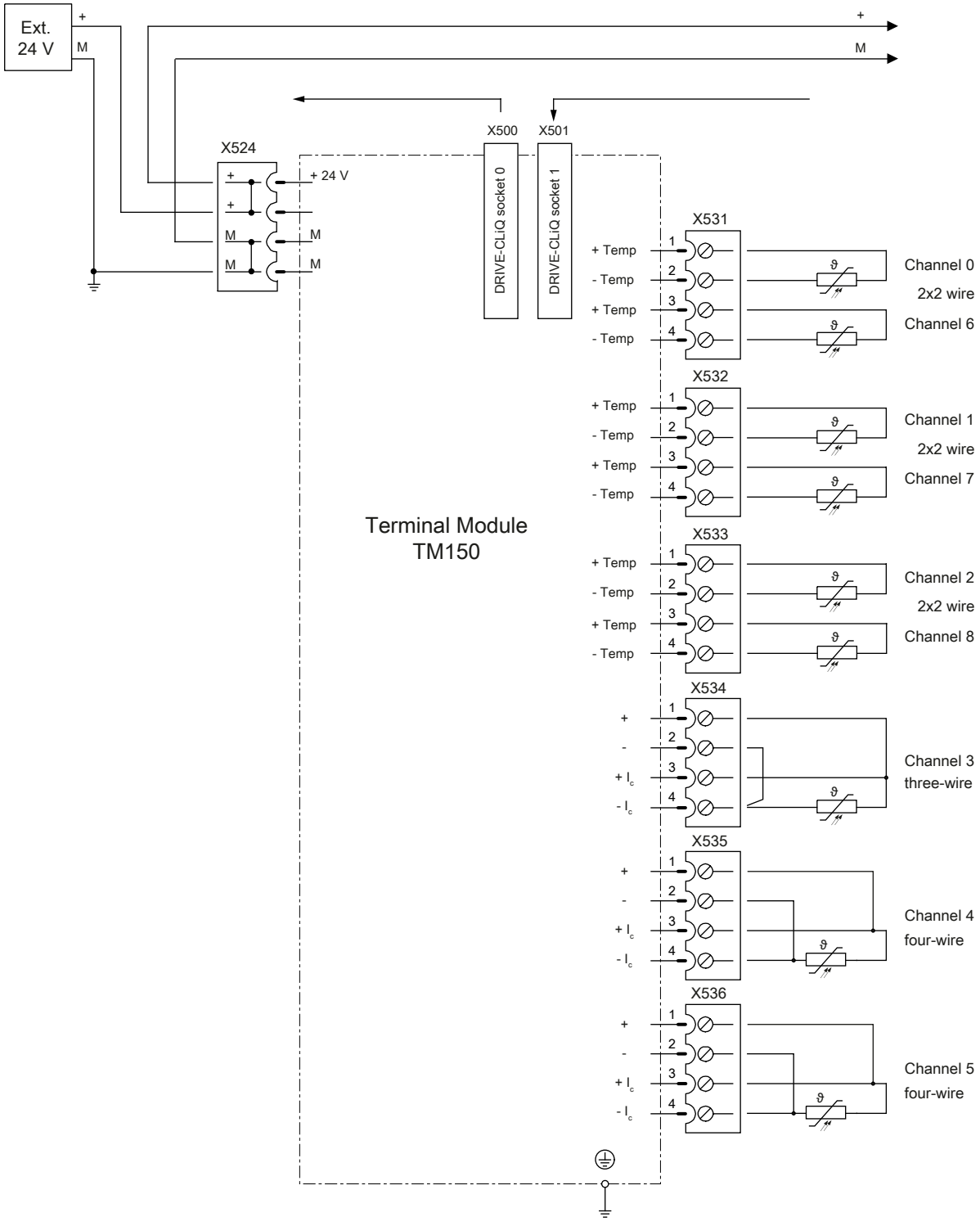


Figure 6-38 Connection example for a Terminal Module TM150

6.6.5.5 Meaning of the LEDs on the Terminal Module TM150

Table 6-41 Meaning of the LEDs at the Terminal Module TM150

LED	Color	State	Description, cause	Remedy
READY	–	Off	Electronics power supply is missing or outside permissible tolerance range.	Check power supply
	Green	Continuous light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	Continuous light	DRIVE-CLiQ communication is being established.	–
	Red	Continuous light	At least one fault is present in this component. **Remark:** LED is controlled irrespective of the corresponding messages being reconfigured.	Remedy and acknowledge fault
	Green/ Red	0.5 Hz flashing light	Firmware is being downloaded.	–
		2 Hz flashing light	Firmware has been downloaded. Wait for POWER ON.	Carry out a POWER ON
	Green/ orange or red/ orange	2 Hz flashing light	Component recognition via LED is activated (p0154). **Remark:** Both options depend on the LED status when module recognition is activated via p0154 = 1.	–

Cause and rectification of faults

The following documents contain information about the cause of faults and how they can be rectified:

SINAMICS S120 Commissioning Manual with STARTER

SINAMICS DCP List Manual

6.6.5.6 Dimension drawing

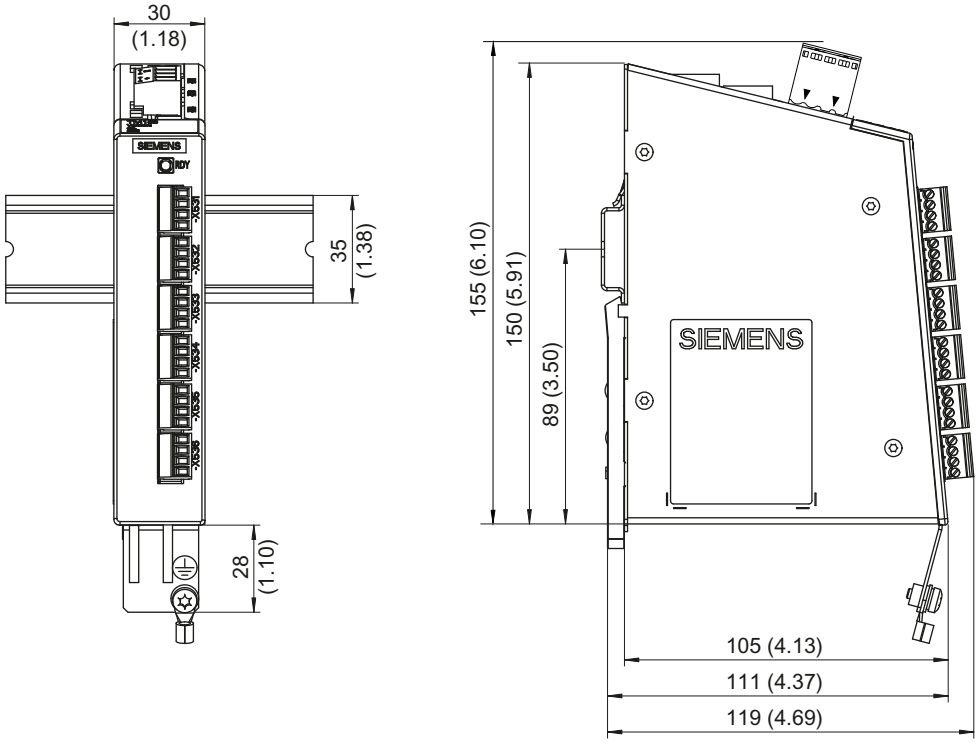


Figure 6-39 Dimension drawing of Terminal Module TM150, all data in mm and (inches)

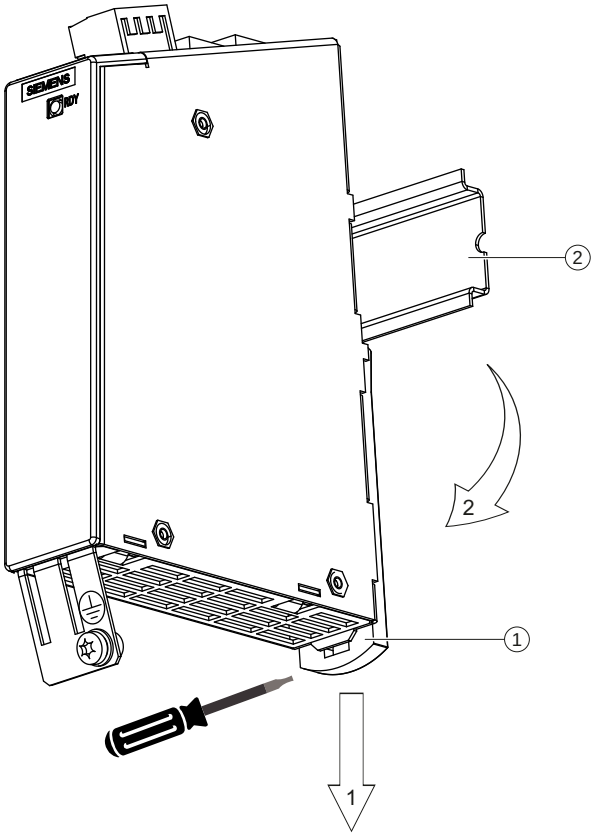
6.6.5.7 Installation

Installation

1. Tilt the component backwards slightly and attach it to the DIN rail using the hooks.
2. Swivel the component onto the DIN rail until you hear the mounting slide at the rear latch into position.
3. Slide the components along the mounting rail to either the left or right up to their final position.

Disassembly

1. First shift the mounting slide downwards at the lug to release the interlocking with the mounting rail.
2. Swivel the component to the front and withdraw it upwards from the DIN rail.

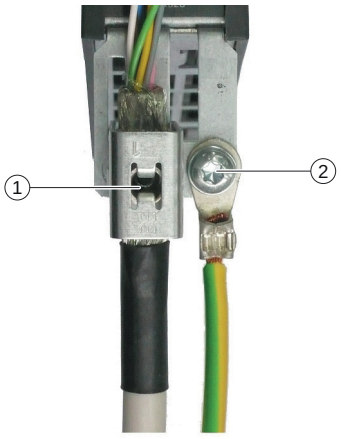


① Mounting slide
② Standard mounting rail

Figure 6-40 Removing a TM150 from a mounting rail

6.6.5.8 Protective conductor connection and shield support

The following diagram shows a typical Weidmüller shield connection clamp for the shield supports.



① Shield connection terminal, Weidmüller company, type: KLBUE CO1, Article number: 1753311001

② Protective conductor connection M4 / 1.8 Nm

Figure 6-41 Shield support and protective conductor connection

NOTICE
Damage or faulty operation due to incorrect shielding and inadmissible cable lengths If the correct shielding procedures and the permissible cable lengths are not observed, the machine can be damaged or may malfunction. • Only use shielded cables. • Do not exceed the cable lengths stated in the technical data.

6.6.5.9 Technical data

Table 6-42 Technical data

6SL3055-0AA00-3LA0	Unit	Value
Voltage Current (without DRIVE-CLiQ) Power loss	V_{DC} A_{DC} W	24 V DC (20.4 ... 28.8) ≤0.1 ≤2
PE/ground connection	At the housing with M4 / 1.8 Nm screw	
Maximum cable length	m	30
Weight	kg	0.4

Commissioning

7

⚠ WARNING

Not observing fundamental safety instructions and residual risks

Not observing fundamental safety instructions and residual risks listed in Chapter 1 can result in accidents with severe injuries or death.

- Comply with the fundamental safety instructions.
- Take into account residual risks when assessing risk.

7.1 Switching on

After the device is switched on (POWER ON, i.e. switching on the 24 V power supply), the SINAMICS DCP powers up. Running up to operating state o7.1 in the SINAMICS DCP with the saved parameters ("Copy from RAM to ROM" is performed) takes approx. 45 seconds. Running up without the saved parameters (first commissioning) takes approx. 60 seconds.

Table 7-1 SINAMICS DCP ramp-up times

BOP20 display	CUD status LED [1]	Run-up time [2]
Backlighting at the BOP20	RDY: Red DP1: Red	POWER ON
-	RDY: orange DP1: -	15 s
Display "run up"	RDY: orange DP1: -	35 s
Operating state 12.4	RDY: Green DP1: -	40 s
Operating state 7.1	RDY: Green DP1: -	45 s

[1] The status of the LEDs on the CUD (see also Chapter "Description of the LEDs on the CUD (Page 362)") can only be seen when the device cover is open.

[2] Running up with saved parameters ("Copy from RAM to ROM" was performed).

Note

If options are being used and in the case of certain device configurations, the duration of start-up increases.

Note

If an external memory card with previously saved data is plugged into the SINAMICS DCP while running up, the device runs up based on the parameter assignments saved on the card (see also Chapter "Memory card functions (Page 161)").

7.1.1 BOP20 status display during ramp-up

While running up, the status of the run-up is briefly displayed on the BOP20.

Displayed value	Meaning
0	Operation
10	Ready
20	Waiting for ramp-up
25	Waiting for automatic firmware update of DRIVE-CLiQ components
31	Commissioning software download active
33	Correcting/acknowledging topology error
34	Terminating commissioning mode
35	Performing first commissioning
70	Initialization
80	Reset active
99	Internal software error

The previously listed states are automatically run through during the commissioning and are normally not visible.

In the following exceptional cases, ramp-up is interrupted with display value 33. In this state, the device can be parameterized via BOP20 and via STARTER:

- Differences have been identified between the reference and actual topology.
  - Correct the topology (e.g. re-insert the TM component).
  - Accept the actual topology into the reference topology by setting p9905 = 1 or p9905 = 2. Run-up is continued.
- A memory card with a parameter data set which comes from a SINAMICS DCP with a different Article number, is inserted in the device.
  - Accept the parameter data set by setting p9906 = 3. Run-up is continued.
    or
  - Switch off the device and use the correct memory card and then switch it on again.

7.2 Commissioning using the BOP20 operator panel

7.2.1 Requirements

SINAMICS basics

If you are not yet familiar with SINAMICS basics (parameters, drive objects, BICO technology, etc.), please read Chapter "Basics (Page 157)" before starting commissioning.

BOP20 operator panel

If you are not yet familiar with the BOP20 operator panel, please read Chapter "Parameter assignment via the BOP20 (Basic Operator Panel 20) (Page 173)" before starting commissioning.

Notation of the parameters

Expressed in full, a parameter consists of
the drive object + parameter number + index, with the following notation:

(oo)pxxxxx[ii]	for indexed parameters
(oo)pxxxxx	for non-indexed parameters

To make these easier to read, in this chapter the drive object specification has been omitted from all parameters belonging to the "Drive control" drive object (= drive object 2).
For example, the specification p50076[1] refers to parameter (2)p50076[1] (= drive object 2, parameter 50076, index 1).

7.2.2 Commissioning steps

〈1〉 Access level and parameter filter

(1) p0003 = 3 (expert)

(2) p0010 = 0 (no filter)

〈2〉 Setting the installation altitude

p55100, installation altitude

Setting the installation altitude of the device above sea level.
With installation altitudes above 2000 m, the current and voltage are derated.

See Chapter "Derating (Page 358)".

〈3〉 Setting the source for the control word

p0840 signal source for starting/stopping

Recommended setting: p0840 = r2090.0 (bit 0 in the 1st receive word from the fieldbus)

See function diagrams 2460, 2580 and 2650 in the SINAMICS DCP List Manual.

p0852 signal source for enabling operation

Recommended setting: p0852 = 1

See function diagrams 2580 and 2650 in the SINAMICS DCP List Manual.

〈4〉 Setting the type of precharging

See also Chapter "Precharging DC links (Page 351)".

p55350, type of precharging

1 Resistance precharging on side 1, pulsing up on side 2
2 Resistance precharging on side 2, pulsing up on side 1
3 Resistance precharging on both sides (first side 1, then side 2)
4 Resistance precharging on both sides (first side 2, then side 1)

p55352 signal source for precharging the target value

This signal source must be interconnected at p55350 = 1 or 2.

Recommended setting: p55352 = r2050[2] (3rd receive word from the fieldbus)

See function diagram 6835 in the SINAMICS DCP List Manual.

p55355[0] and [1] maximum duration of precharging on side 1 or side 2

Factory setting: 100 ms

p55356[0] and [1] maximum switching time of the main contactor on side 1 or side 2

Factory setting: 100 ms

NOTICE
Malfunctions or damage if the delay times are incorrectly set Incorrectly set delay times can result in malfunctions or damage to the system. • Set the delay times (p55355[0,1], p55356[0,1]) so that they are suitable for your particular system.

〈5〉 Entering data for undervoltage/overvoltage protection

- Protecting side 1 against undervoltage
  - p55130: Lower threshold of the undervoltage protection
  - p55131: Upper threshold of the undervoltage protection
- Protecting side 1 against overvoltage
  - p55132: Lower threshold of the overvoltage protection
  - p55133: Upper threshold of the overvoltage protection
  - p55182: Upper threshold of the dynamic overvoltage protection
- Protecting side 2 against undervoltage
  - p55140: Lower threshold of the undervoltage protection
  - p55141: Upper threshold of the undervoltage protection
- Protecting side 2 against overvoltage
  - p55142: Lower threshold of the overvoltage protection
  - p55143: Upper threshold of the overvoltage protection
  - p55187: Upper threshold of the dynamic overvoltage protection

Note

The factory settings allow the 250 kW devices to operate in their full voltage range.

For the 30 kW and 120 kW devices, while commissioning, the voltage limits must be reduced to values within the permitted voltage range (see Chapter "Technical specifications (Page 433)").

The subsequent settings are suggested for the individual device types.

Parameter		Suggested settings		
		DCP 30 kW	DCP 120 kW	DCP 250 kW (factory setting)
p55132	Limitation side 1 overvoltage lower	800 V	800 V	1200 V
p55133	Limitation side 1 overvoltage upper	1000 V	1000 V	1220 V
p55142	Limitation side 2 overvoltage lower	800 V	800 V	1200 V
p55143	Limitation side 2 overvoltage upper	1000 V	1000 V	1220 V
p55182	Voltage limitation dynamic overvoltage side 1	1000 V	1000 V	1220 V
p55187	Voltage limitation dynamic overvoltage side 2	1000 V	1000 V	1220 V

〈6〉 Settings for current control

p55050 signal source for the current setpoint (WE = r2050[1], 2nd receive word from the fieldbus)

p55060 meaning of the current setpoint (11 = current on side 1, 12 = current on side 2)

p55220[0] and [1] current controller gain Kp for positive or negative current (factory setting = 0.200)

p55221[0] and [1] current controller integral time Tn for positive or negative current (factory setting = 5.000 ms)

〈7〉 Settings for voltage control

p54145 signal source to enable the voltage controller (WE = 1)

p54105 signal source to activate the voltage control (WE = 0)

p54100 signal source for the voltage setpoint (WE = 100%)

p54141 signal source for the positive current limit (WE = r52002 = 200 %)

p54142 signal source for the negative current limit (WE = r52004 = -200 %)

p54125 voltage controller gain Kp (WE = 2.000)

p54126 voltage controller integral time Tn (WE = 0.30 ms)

Notes on commissioning

Note

The closed-loop voltage control is available from firmware version V1.2.

The overvoltage and undervoltage limits (p55130 ... p55143, function diagram 6812) are only active in the closed-loop current controlled mode, but not in the closed-loop voltage control mode.

The dynamic voltage limiting (step <5>, p55181 ... p55187, function diagram 6817) is available in the closed-loop voltage control mode from firmware version V1.3.

The current limits of the closed-loop voltage control refer to the reactor current, see Chapter "Voltage control (Page 342)".

7.3 Commissioning using the STARTER commissioning tool

7.3.1 STARTER commissioning tool

7.3.1.1 Description

Description

You can use the STARTER commissioning tool to configure and commission SINAMICS drives or drive systems as well as the SINAMICS DCP. The drive configuration can be performed with the aid of the STARTER wizard for drive configuration.

To commission the DCP with firmware V1.4 SP1, you require STARTER from V4.5.1 and the SSP "DCP 1.4 SP1".
You can download the SSP "DCP 1.4 SP1" here: SSP SINAMICS DCP V1.4 SP1 (https://support.industry.siemens.com/cs/us/en/view/109474935).

Note

In this chapter, "drive", "drive unit" or "drive system" always refers to the SINAMICS DCP.

Note

This chapter describes how to commission with STARTER. STARTER has a comprehensive online help that explains in detail all of the sequences and setting options in the system. This is the reason why this chapter is restricted to the individual commissioning steps.

Prerequisites for installing STARTER

STARTER is installed on a PG/PC. The hardware and software preconditions are described in the readme file for STARTER.

Note

The SIMOTION SCOUT engineering tool includes the STARTER functionality to commission drives.

As of version V4.2, SCOUT has also been released for commissioning the SINAMICS DCP.

7.3.1.2 Installing the STARTER commissioning tool

Download STARTER here: STARTER download (https://support.industry.siemens.com/cs/de/en/ps/13437/dl).

STARTER is installed using the "setup" file. When you double-click the "Setup" file, the installation wizard guides you through the process of installing STARTER.

7.3.1.3 Layout of the STARTER user interface

STARTER provides the following four operating areas:

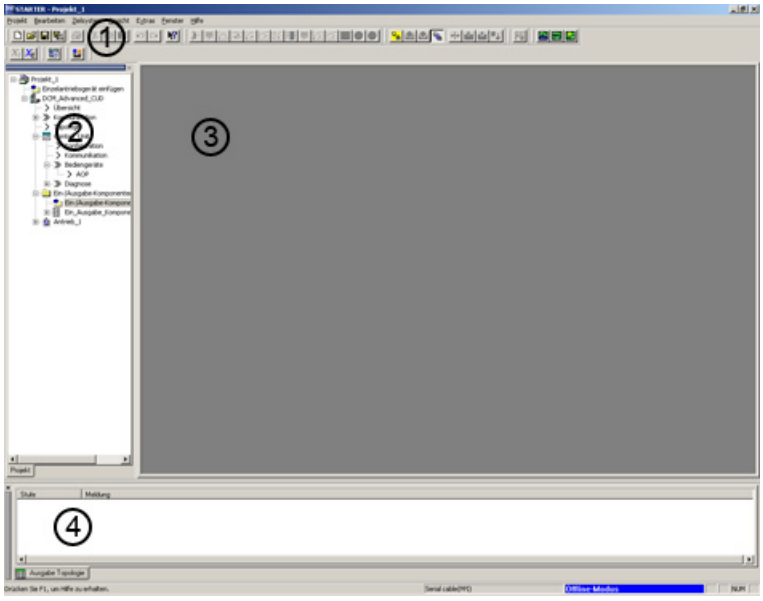


Figure 7-1 STARTER operating areas

Operating area	Explanation
① Toolbars	In this area, you can access frequently used functions by clicking icons.
② Project navigator	The elements and objects contained in the project are displayed in this area.
③ Working area	Changes to the drive units are made in this area.
④ Detail view	This area displays detailed information, for instance about faults and alarms.

7.3.2 Procedure for commissioning with STARTER

7.3.2.1 Basic procedure when using STARTER

STARTER uses a series of interactive screens to enter the data required for the drive unit.

Note

The interactive screens are pre-assigned defaults that you need to adapt to your application and configuration under certain circumstances.

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).

7.3.2.2 Creating the project

Click the STARTER icon on the desktop or select the menu command Start > All Programs > STARTER in the Microsoft Windows start menu to start the STARTER commissioning tool.

The first time you run the software, the main screen shown below appears with the dialog screen forms:

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below as numbered step sequences.

Accessing the STARTER project wizard

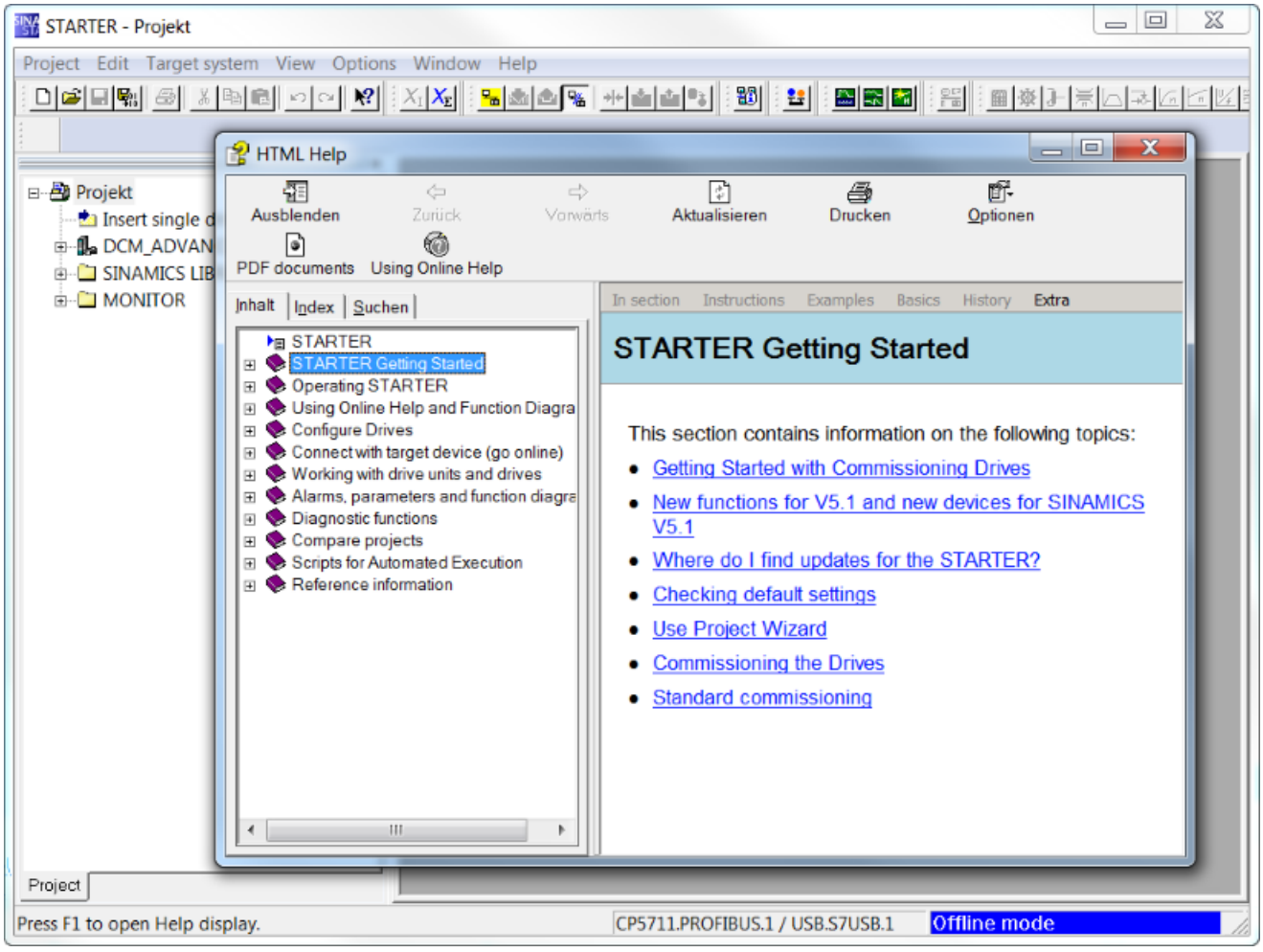


Figure 7-2 Main screen of the STARTER parameterizing and commissioning tool

⇒ Close the "STARTER Getting Started Drive Commissioning" screen by selecting **HTML Help > Close**.

Note

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

You can bring up the project wizard by selecting **Project > New with wizard**.

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

You can call up the online help at any time by selecting **Help > Getting Started**.

STARTER features a detailed online help system.

7.3.2.3 The STARTER project wizard

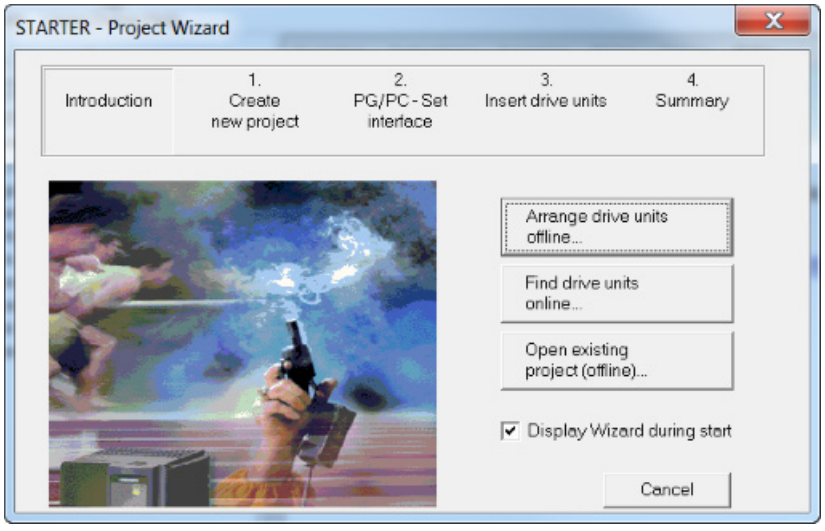


Figure 7-3 STARTER project wizard

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

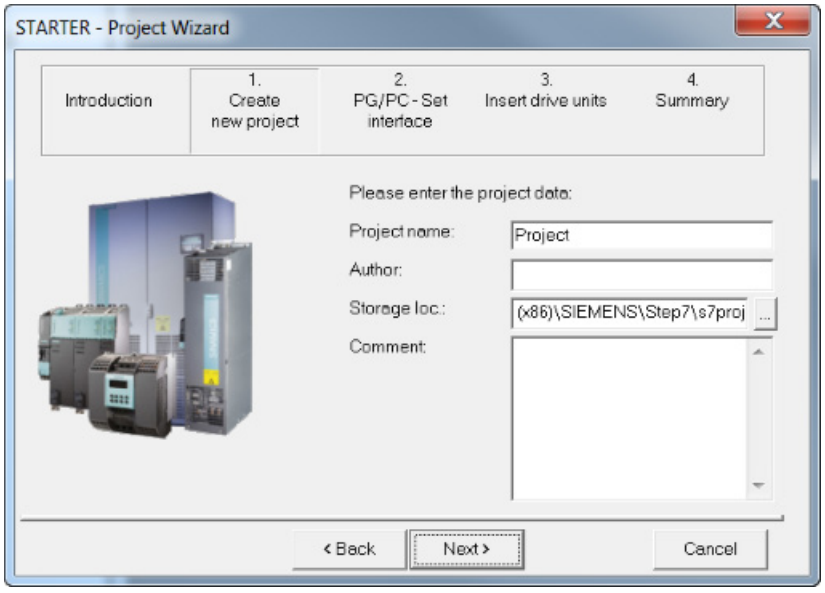


Figure 7-4 Create a new project

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

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

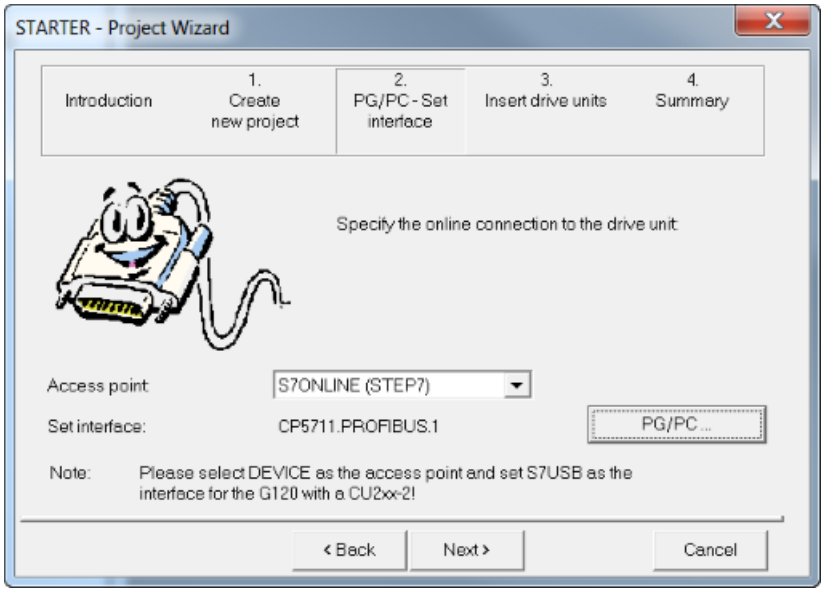


Figure 7-5 Setting up the interface

⇒ Click **PG/PC...** and set up the interface according to your device configuration.

Buttons **Properties...**, **Diagnostics...** and **Copy...** are now available.

Set S7ONLINE as access point.

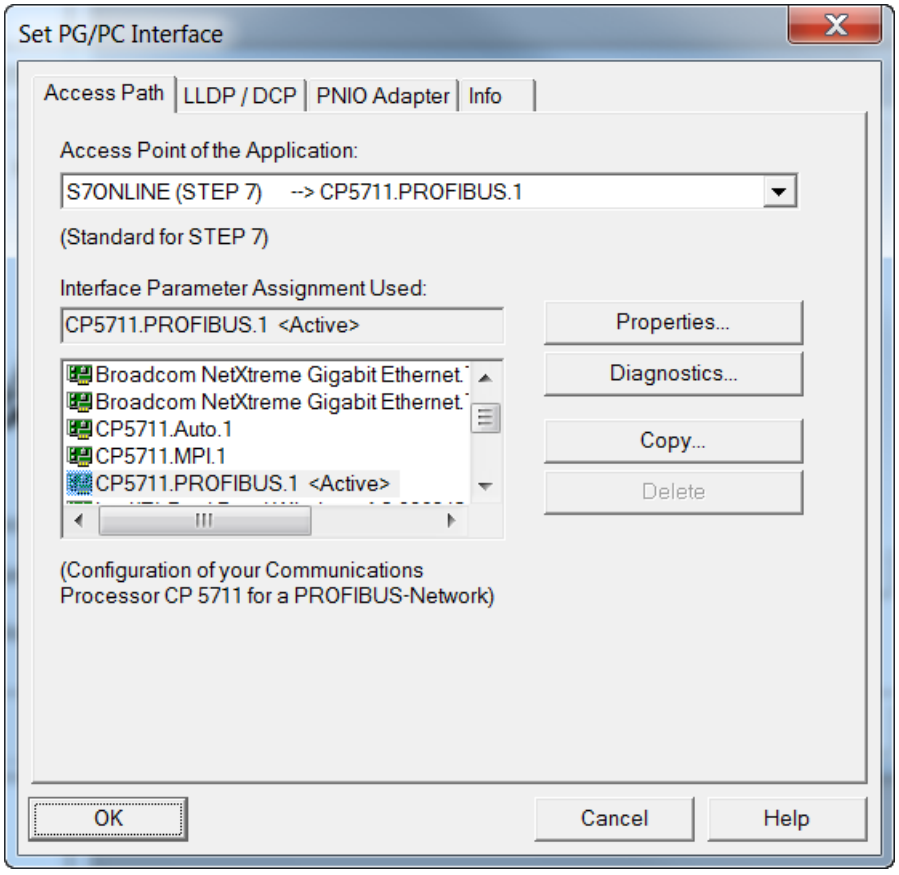


Figure 7-6 Setting the interface

Note

To parameterize the interface, you must install the appropriate interface card (e.g.: PC Adapter (PROFIBUS)).

We recommend that the Siemens USB PROFIBUS CP5711 adapter is used, Article number 6GK1571-1AA00.

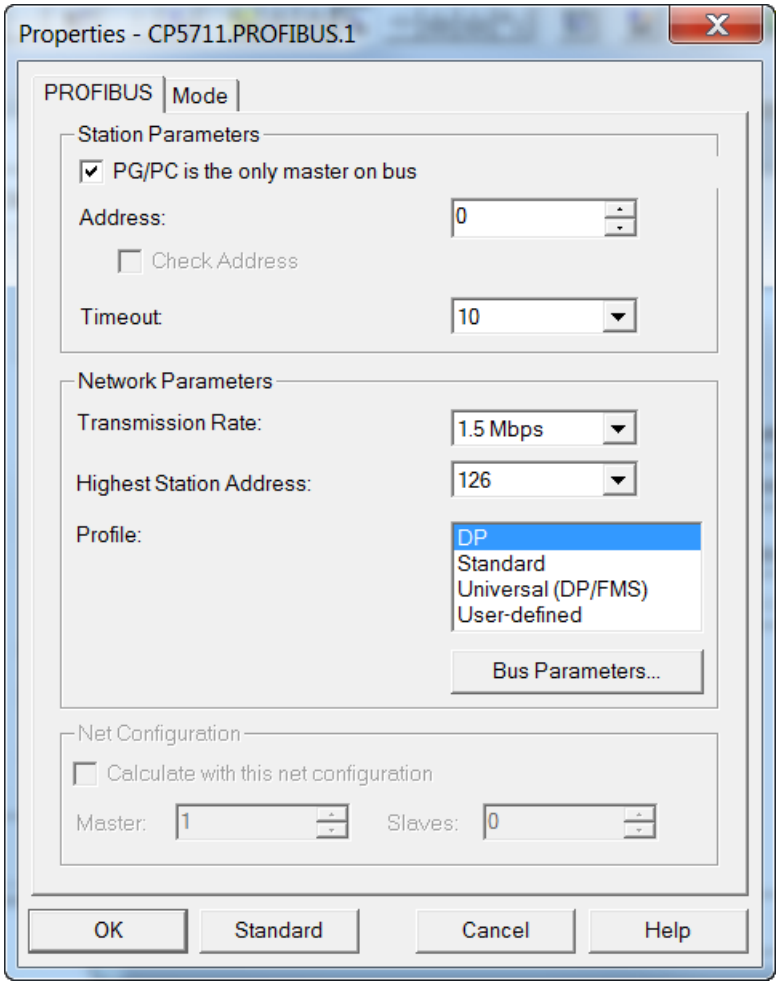


Figure 7-7 Setting up the interface - properties

Note

PG/PC is the only master on bus must be activated if no other masters (PC, S7, etc.) are available on the bus.

Note

Even if no PROFIBUS interface is installed in the PC, projects can be generated and PROFIBUS addresses for the drive objects can be assigned.

Only the bus addresses available in the project will be offered. That prevents double bus address assignments.

⇒ After completion, click **OK** to confirm the setup and to return to the project wizard.

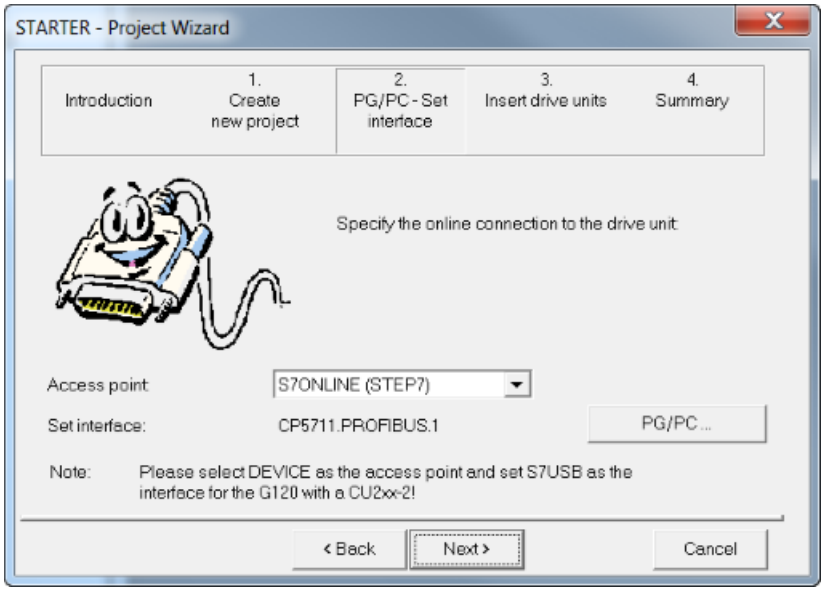


Figure 7-8 Setting the interface - ready

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

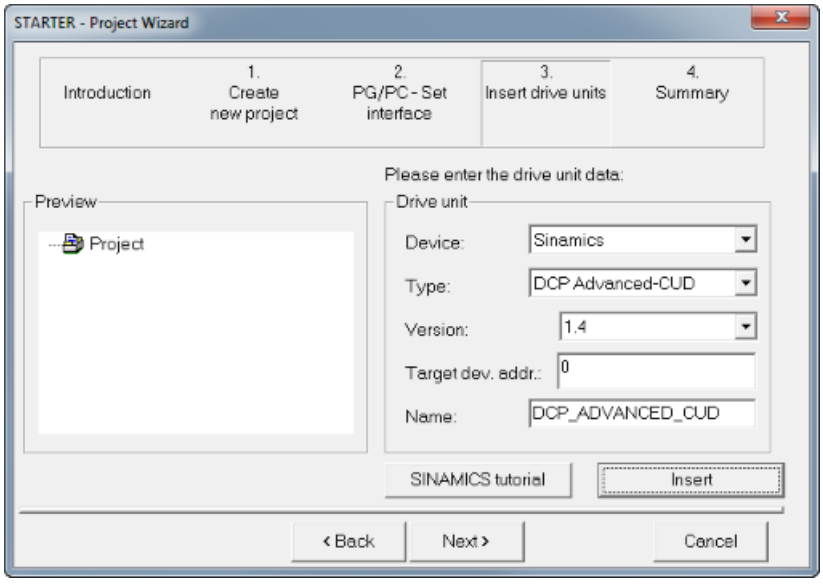


Figure 7-9 Inserting the drive unit

⇒ Select the following data from the list fields:

Unit: SINAMICS DCP
Type: DCP Advanced CUD
Version: Current version
Bus address: The corresponding drive bus address (the default setting is 0)
Name: Any desired name can be entered in the name box

Note

For a download, the bus address assigned here is transferred to the device, but is not transferred to parameter p0918 (bus address).

To keep p0918 consistent with the project, after a "Load to target device" a "Load to PG" must still be performed – and must be repeated after every change to p0918 using BOP20.

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

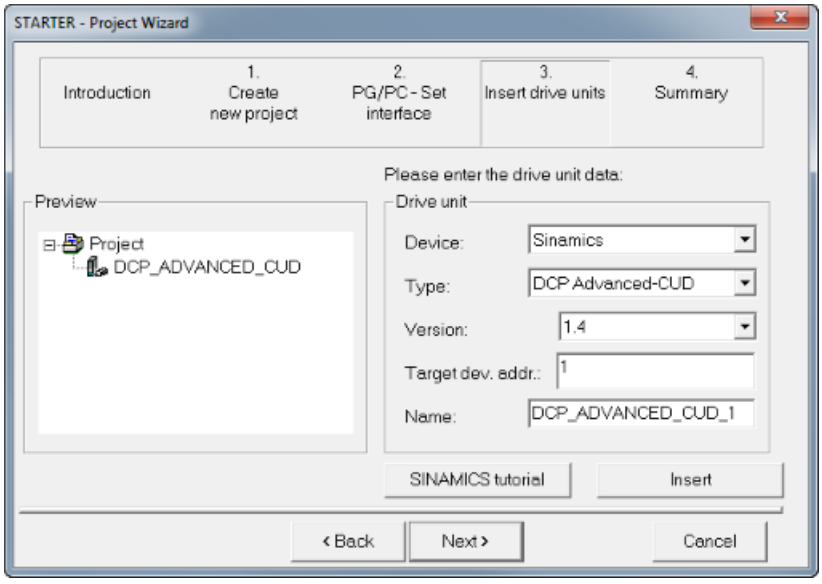


Figure 7-10 Inserting the drive unit - ready

⇒ Click **Next >**
A summary of the project is displayed.

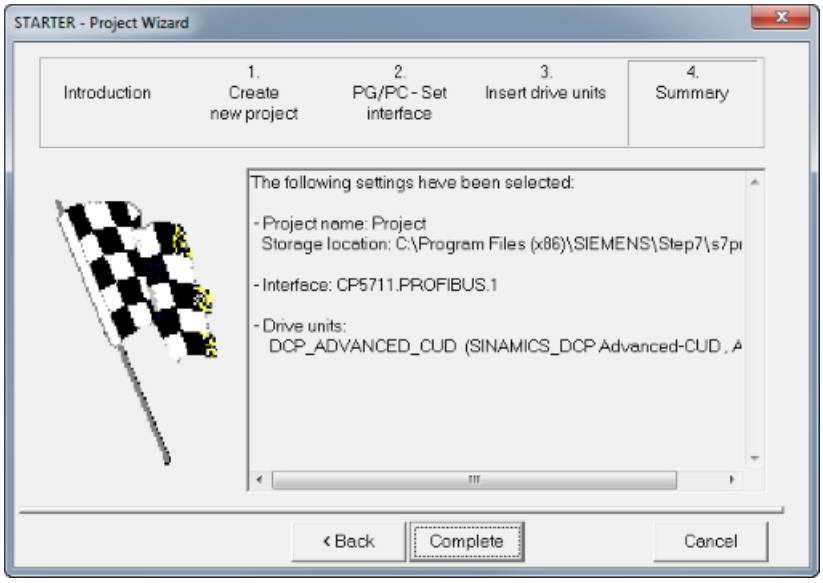


Figure 7-11 Summary

⇒ Click **Finish** to complete the creation of a new project for the drive unit.

7.3.2.4 Configuring a drive unit

Note: STARTER must be offline.

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

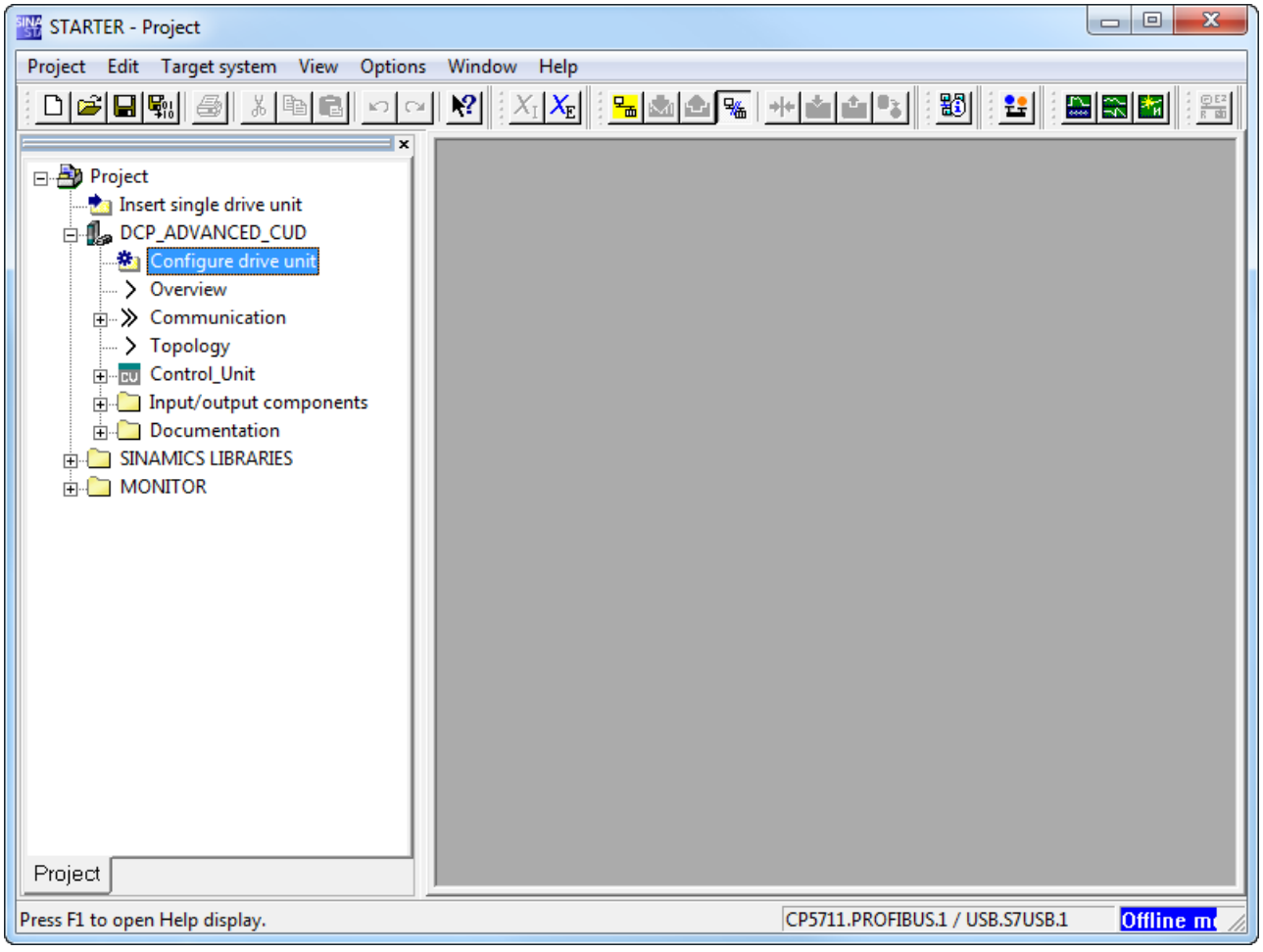


Figure 7-12 Configuring the project navigator drive unit

⇒ In the project navigator, click the plus sign next to the drive unit that you want to configure. The plus sign changes into a minus sign and the options for configuring the drive unit appear as a directory tree under the drive unit.

⇒ Double click **Configure drive unit**

Selecting an option module

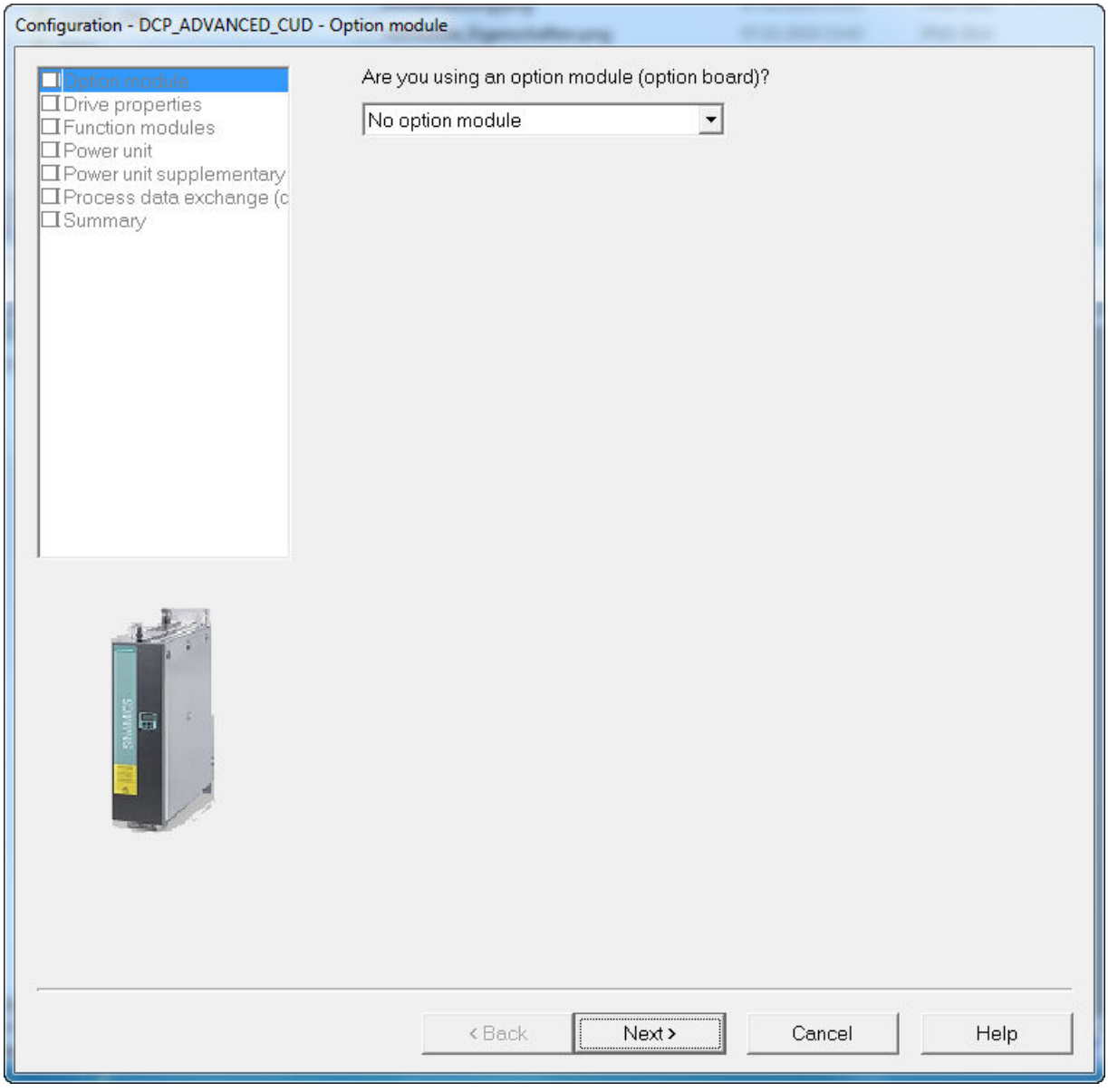


Figure 7-13 Selecting an option module

⇒ If you have inserted a CBE20 option module (option G33), then the module needs to be activated here

⇒ Click **Next >**

Entering drive properties

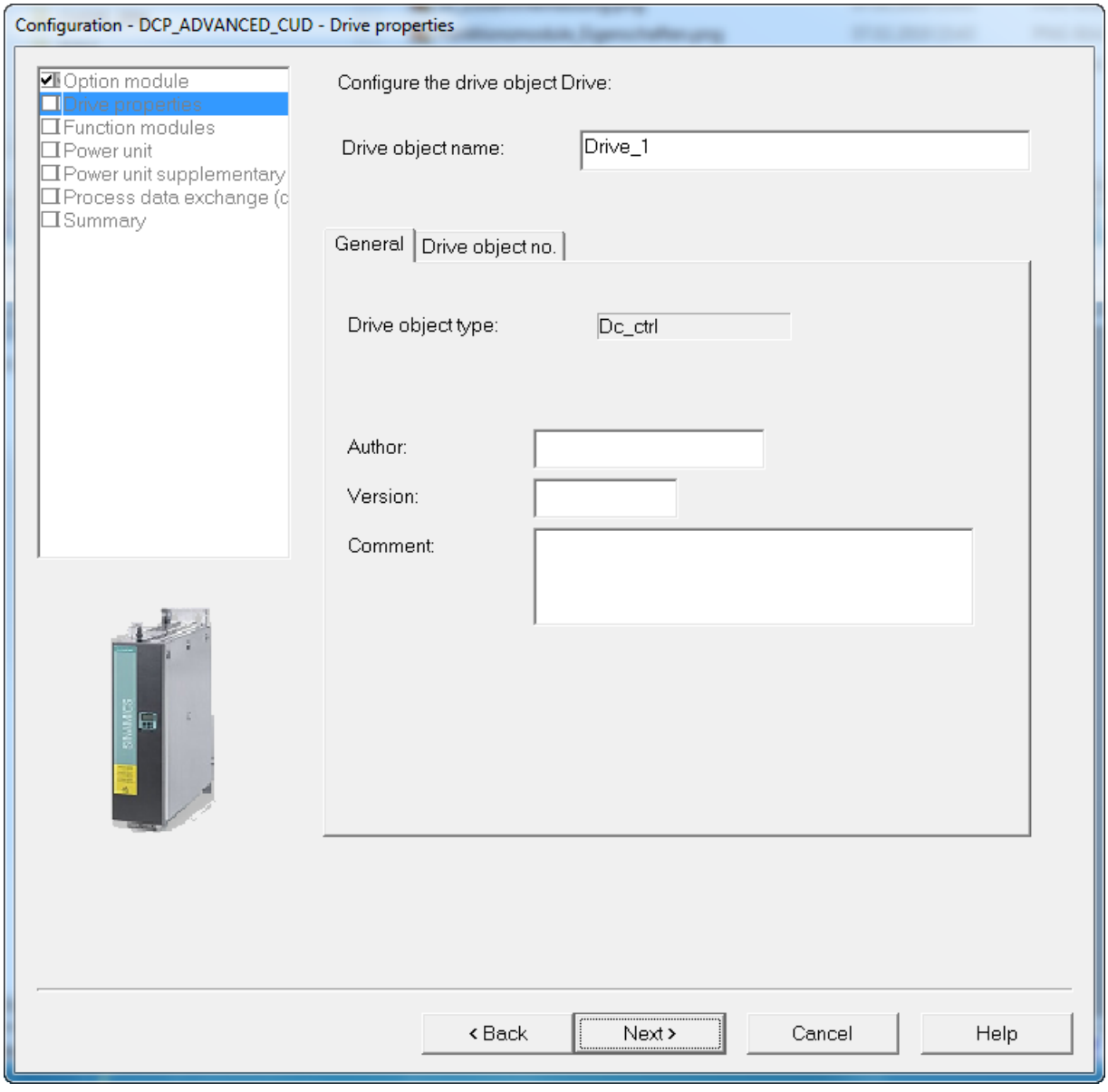


Figure 7-14 Entering drive properties

Under **Drive properties**, you can enter optional information about the drive/project.

⇒ Click **Next >**

Selecting the function module

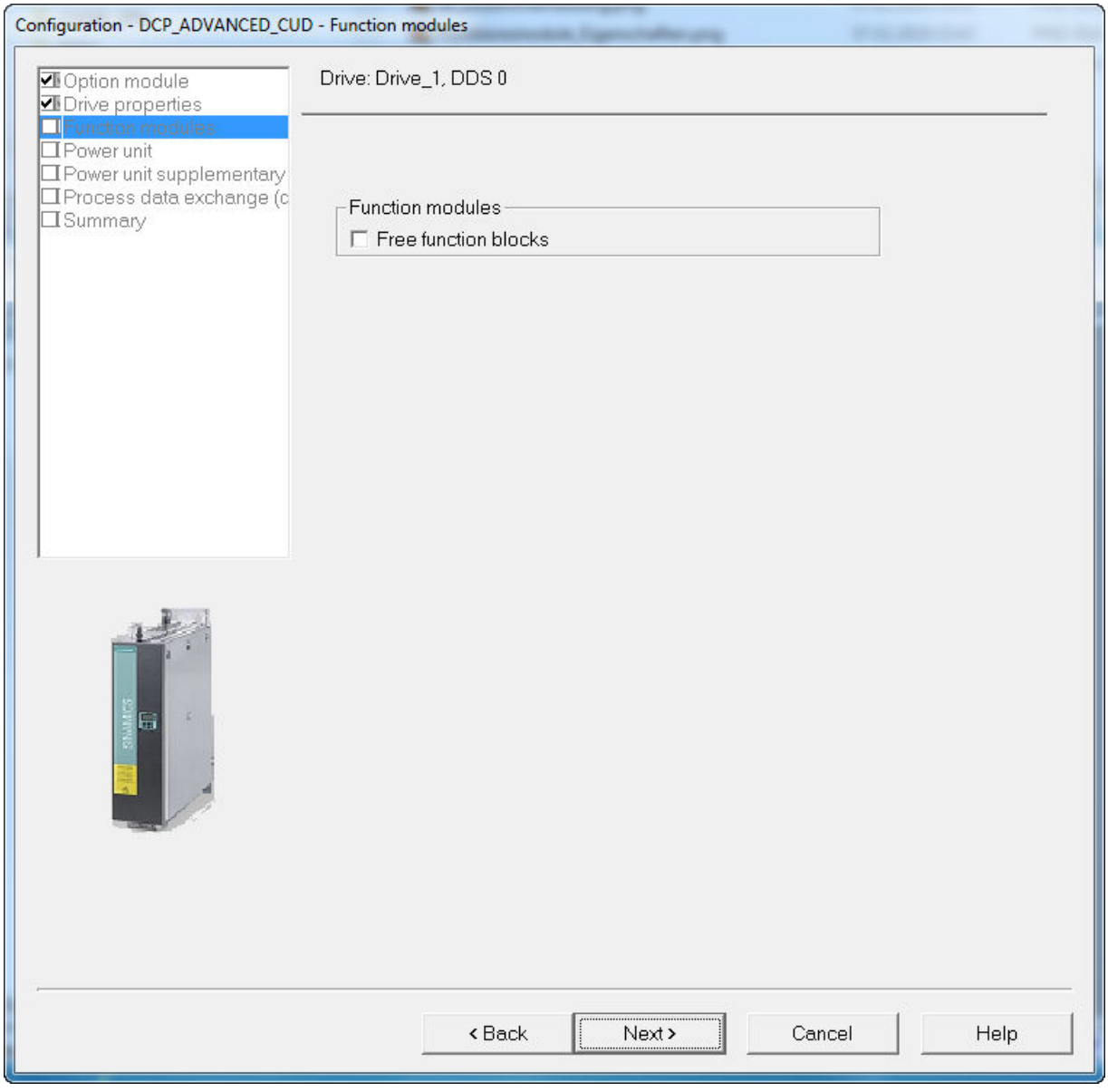


Figure 7-15 Selecting the function module

⇒ If you want to use the free function blocks, you can activate them here. If required, this can be subsequently done.

⇒ Click **Next >**

Selecting a power unit

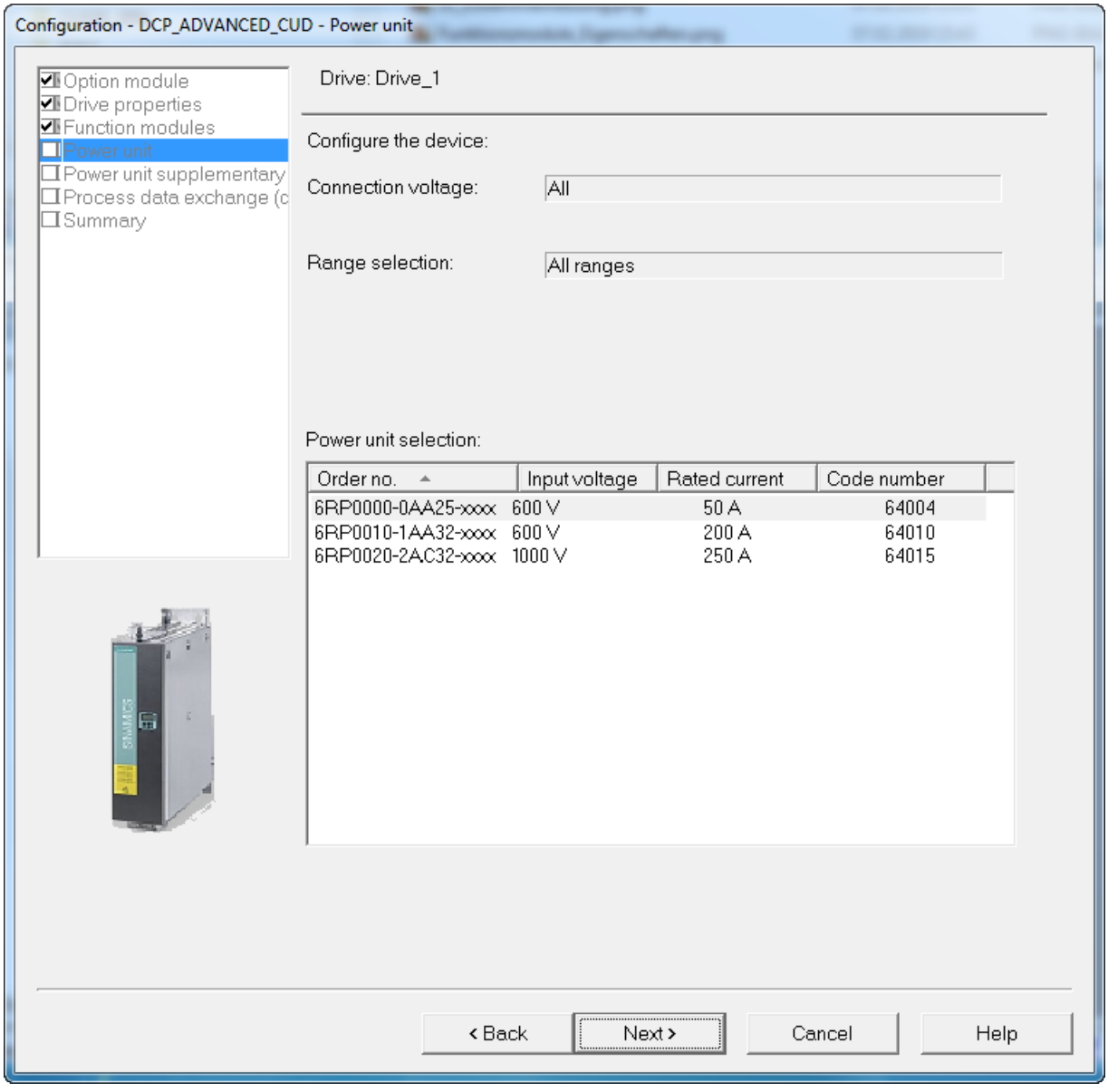


Figure 7-16 Selecting a power unit

⇒ Select the corresponding device according to the Article No. on the rating plate.

⇒ Click **Next >**

Entering additional power unit data

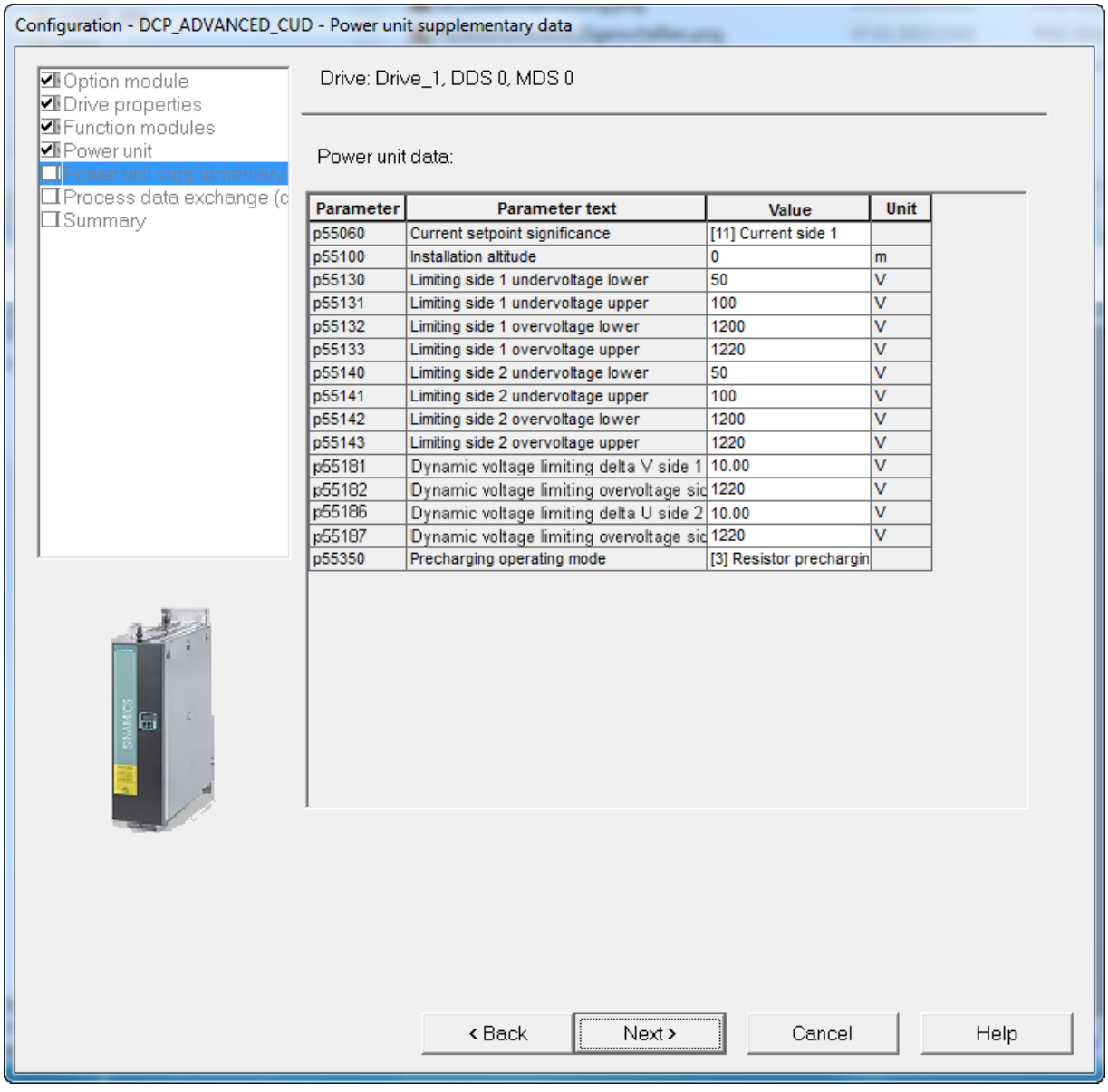


Figure 7-17 Entering additional power unit data

⇒ Enter the required parameter values.

Note

The factory settings allow the 250 kW devices to operate in their full voltage range.

For the 30 kW and 120 kW devices, while commissioning, the voltage limits must be reduced to values within the permitted voltage range (see Chapter "Technical specifications (Page 433)").

The subsequent settings are suggested for the individual device types.

Parameter		Suggested settings		
		DCP 30 kW	DCP 120 kW	DCP 250 kW (factory setting)
p55132	Limitation side 1 overvoltage lower	800 V	800 V	1200 V
p55133	Limitation side 1 overvoltage upper	1000 V	1000 V	1220 V
p55142	Limitation side 2 overvoltage lower	800 V	800 V	1200 V
p55143	Limitation side 2 overvoltage upper	1000 V	1000 V	1220 V
p55182	Voltage limitation dynamic overvoltage side 1	1000 V	1000 V	1220 V
p55187	Voltage limitation dynamic overvoltage side 2	1000 V	1000 V	1220 V

Note

The closed-loop voltage control is available from firmware version V1.2.

The overvoltage and undervoltage limits (p55130 ... p55143, function diagram 6812) are only active in the closed-loop current controlled mode, but not in the closed-loop voltage control mode.

The dynamic voltage limiting (step <5>, p55181 ... p55187, function diagram 6817) is available in the closed-loop voltage control mode from firmware version V1.3.

The current limits of the closed-loop voltage control refer to the reactor current, see Chapter "Voltage control (Page 342)".

⇒ Click **Next >**

Selecting a telegram

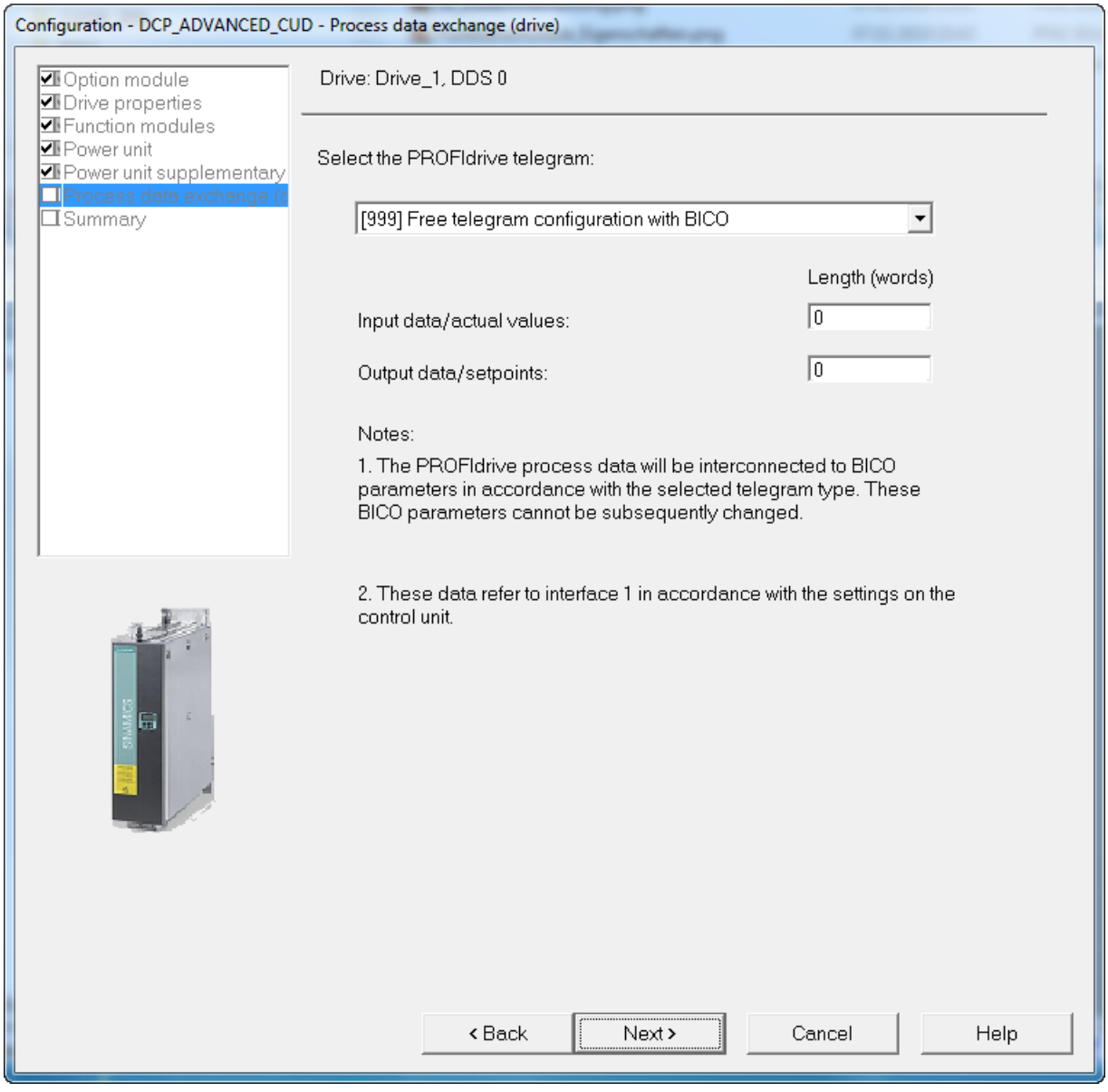


Figure 7-18 Selecting a telegram

⇒ Select "[999] Free telegram configuration with BICO".

Note

"Free telegram configuration with BICO" is now available for the DCP, see Chapter "Telegrams and process data (Page 194)".

⇒ Click **Next >**

Summary

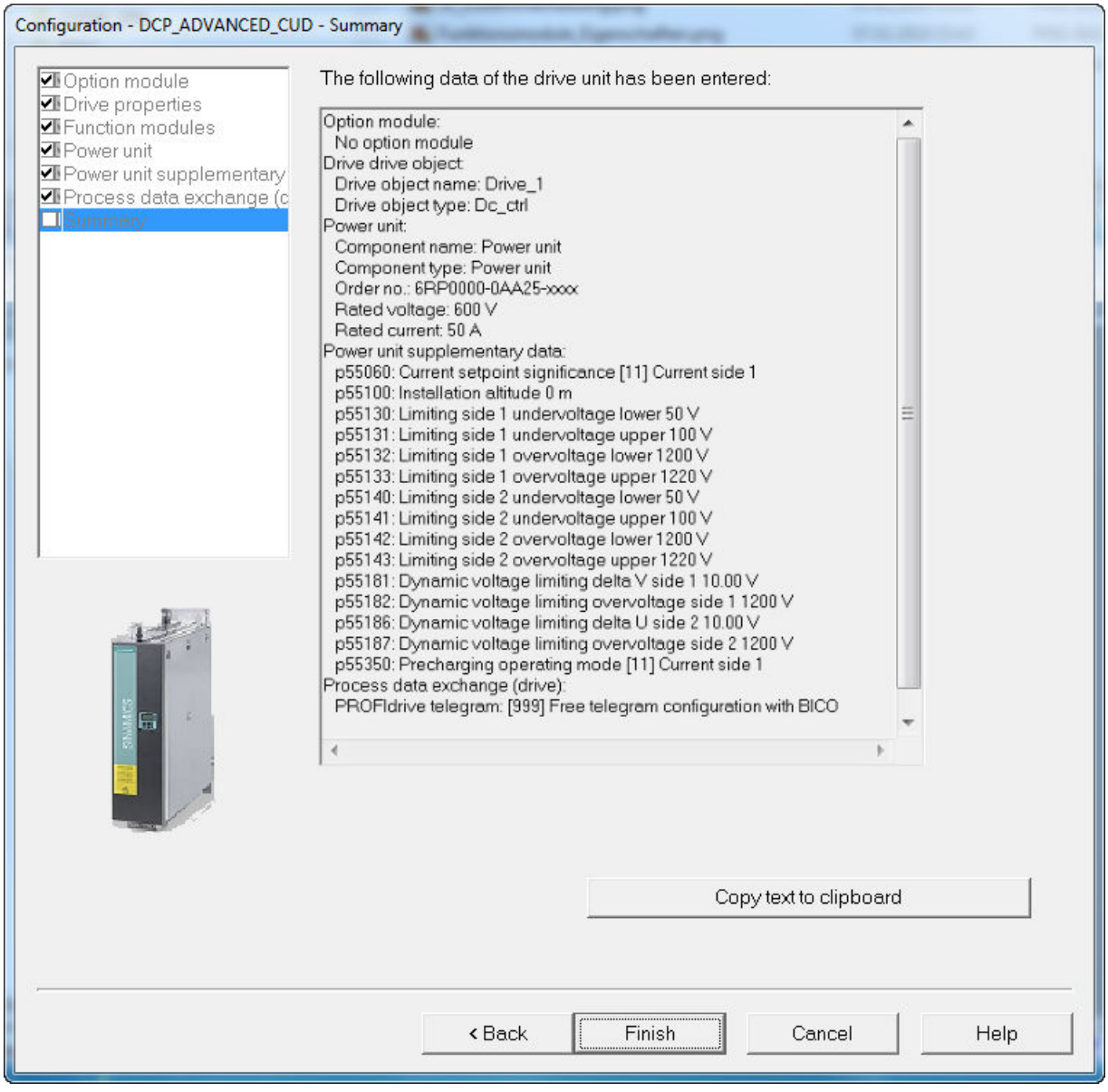


Figure 7-19 Summary

⇒ 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 subsequent use.

⇒ Click **Finish**.

⇒ Save your project on the hard disk via **Project > Save**.

7.3.2.5 Starting the drive project

You have generated a project and saved it to your hard disk. The next step is to transfer your project configuration data to the drive unit.

Transferring a STARTER project to the drive unit

The following steps are required to transfer the STARTER project created offline to the drive unit:

- **Step 1**
  Select the menu command **Project > Connect to target system**
  Selection in the toolbar:

- **Step 2**
  Select SINAMICS_DCP as the target device in the following screen and confirm with OK:

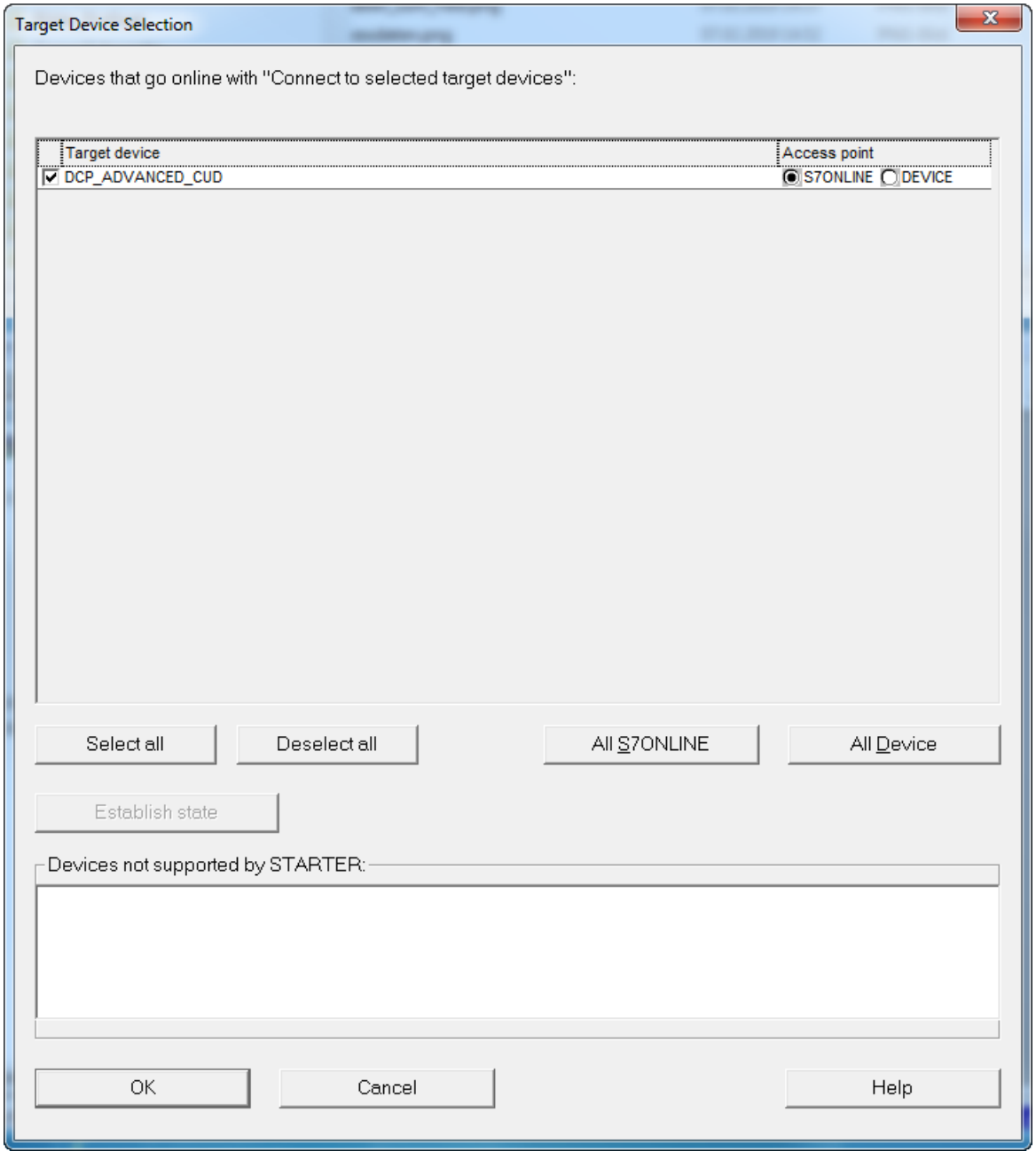


Figure 7-20 Target device selection

- **Step 3**
  Select menu command **Download to target device**

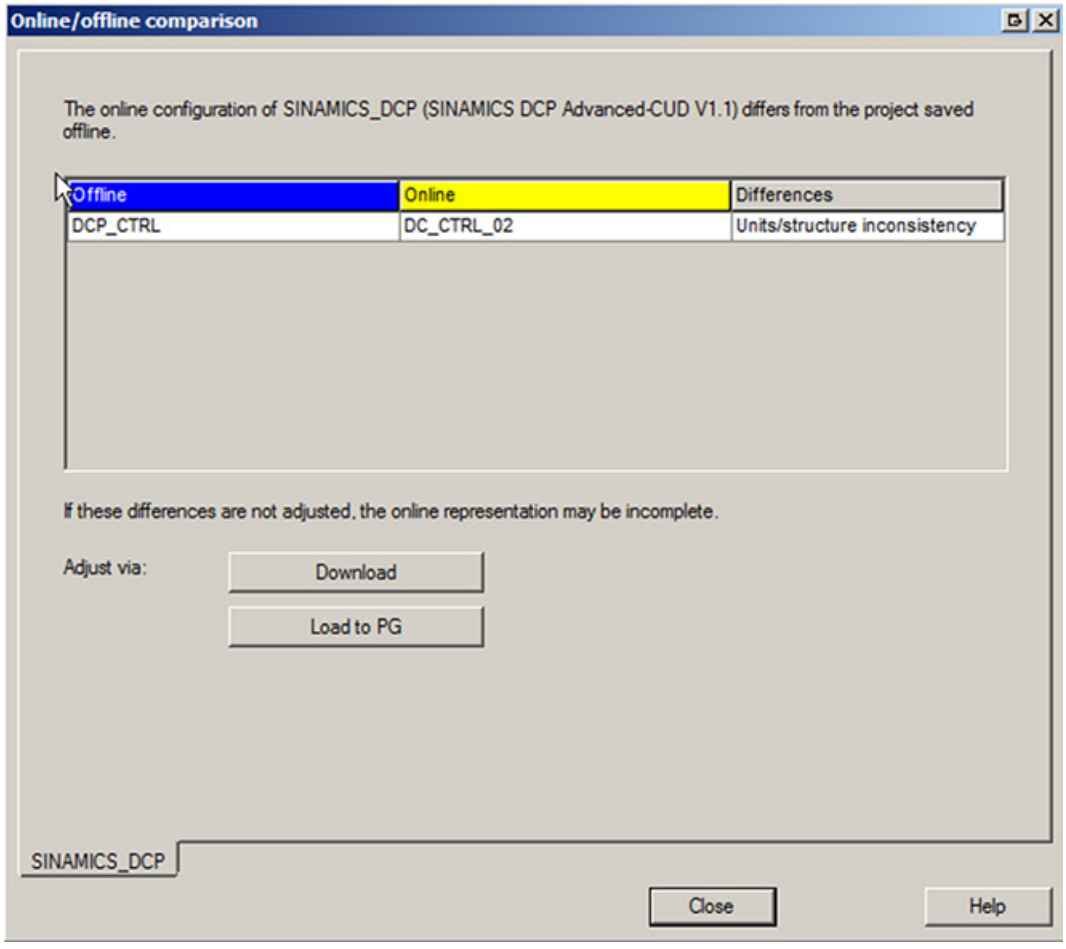


Figure 7-21 Online-offline comparison

- **Step 4**
  Activate the checkbox to select that "Copy RAM to ROM" should be performed after the download.

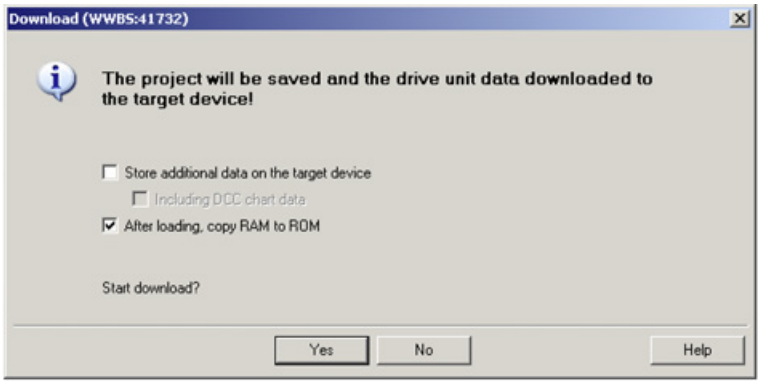


Figure 7-22 Download to target device

Alternatively, the download to the target system can also be performed as follows:

- **Step 1**
  Select the menu command **Target system > Download > Project to target system**
  Selection in the toolbar



Note

Your project data has now been transferred to the drive unit. Presently, this data is only in the volatile memory (RAM) of the drive unit, however, neither saved in the non-volatile memory (ROM) nor on an optionally inserted memory card (see also "Memory card functions (Page 161)").

To save your project data in the ROM and on the optionally available memory card of your drive unit so that it is protected against power failure, carry out the following steps.

- **Step 2**
  Select the menu command **Target system > Target system > Copy RAM to ROM**
  Selection in the toolbar



Note

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

Results of the preceding steps

- You have generated a project for your drive unit using the STARTER offline
- You have saved your project data to your PC hard drive
- You have transferred your project data to the drive unit
- You have saved your project data in your drive unit's FLASH memory so that it is backed up in the event of a power failure

7.4 Activating function modules

For SINAMICS drives, extended functions can be activated as function modules.

Through activation, the parameters of the corresponding functionalities are also displayed.

Function modules can be individually activated/deactivated on every drive object.

For SINAMICS DCP, the following subfunctions are available as function modules.

- Free function blocks
- PROFINET interface

7.4.1 Activating offline via STARTER

Function modules can be defined for all DOs by using the properties dialog (activate by right-clicking the DO in the project navigator). Example shown for the closed-loop control DO "Drive_1":

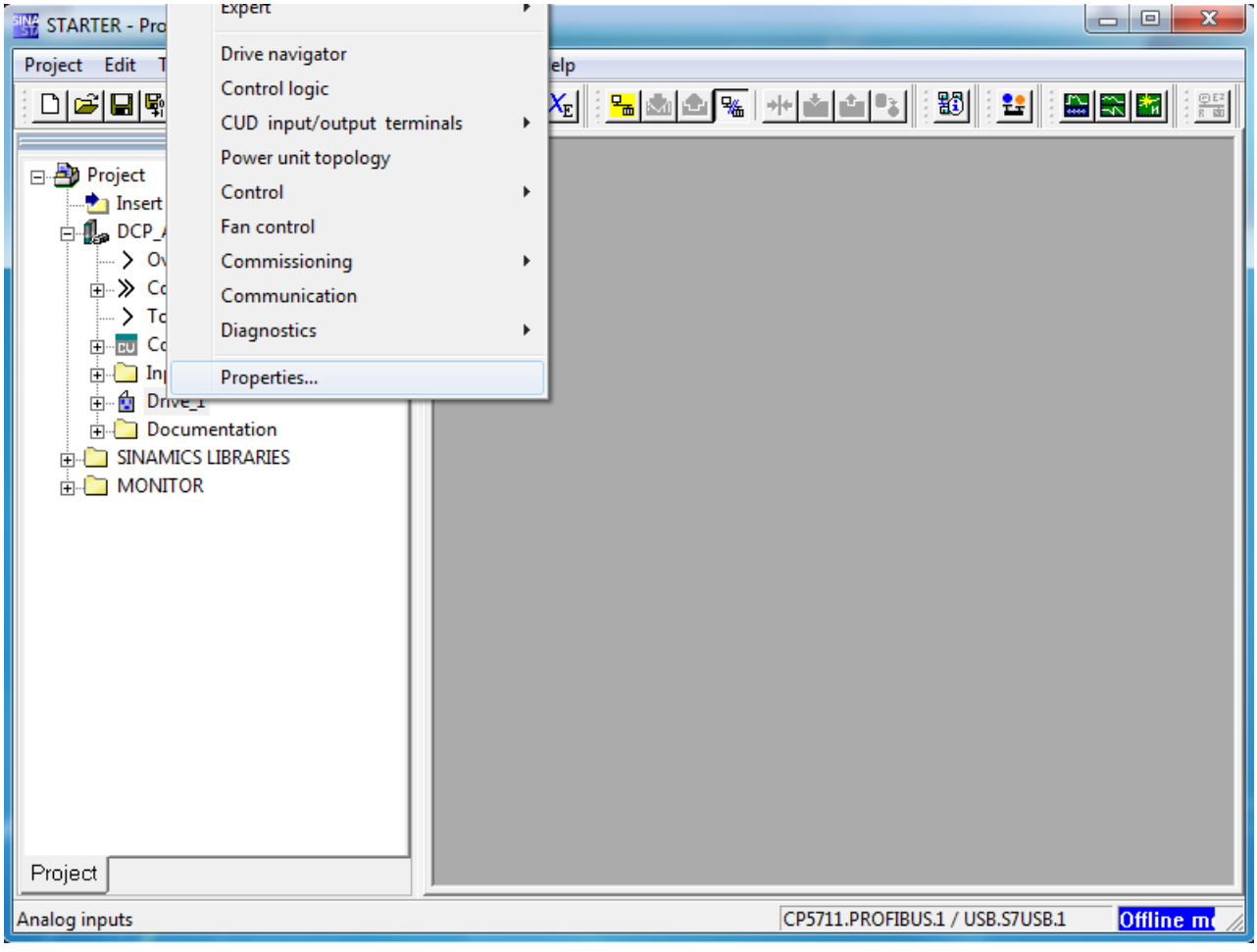


Figure 7-23 Drive object properties

The function modules can be accessed in the "Function modules" tab in the opening dialog.

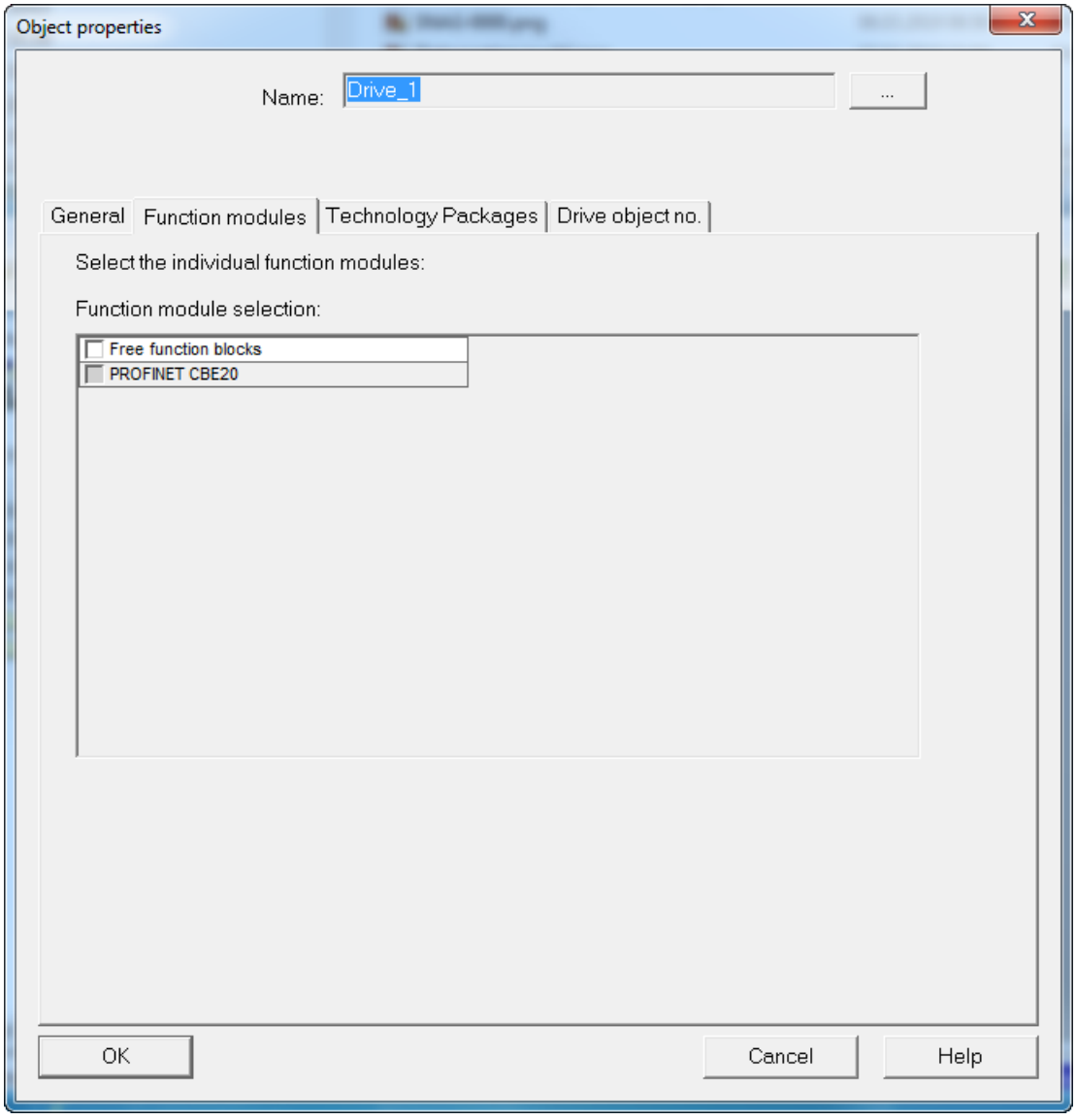


Figure 7-24 Selecting the function modules

Accept the settings by clicking **OK**.

The function modules are also correspondingly set in the SINAMICS DCP by connecting online and downloading.

7.4.2 Activating online via parameters

Note

This process is not supported by STARTER because it uses its own mechanisms.

Activation is through p0108. r0108 and is available at each DO as a display parameter for the activated function modules.

The setting is made on p0108[i] in the Control Unit. The index corresponds to the DO.
Index 0 stands for the CU_DCP,
index 1 for the first DO – the default is the closed loop control DO DCP_CTRL,
index 2 optionally the first TMxx, etc.

Subfunction	p0108 bit
Free function blocks	18
PROFINET interface	31

The function modules are activated/deactivated by setting the bits to 1 or 0.

At the BOP20 parameter assignment is made at DO1 (CU_DCP)

- p0009 = 2
- Correspondingly set or delete p0108[i] bits
- p0009 = 0

This triggers the firmware to reboot, therefore activating the function modules that have been set – together with the associated parameters.

7.5 Commissioning optional additional modules

Additional modules can be connected via DRIVE-CLiQ or OMI slot (CBE20).

The components must be logged in to the firmware when the system is commissioned for the first time.

That can be done:

- Offline by inserting the components into the project in STARTER and loading the project into the SINAMICS DCP
- By adding the components through the parameter assignments on the BOP20

PROFINET module (CBE20)

Adding online in the SINAMICS DCP

The CBE20 is automatically detected when inserted into the slot and is integrated into the system.

Before the module can also be addressed in the network, an IP address and device name must be assigned, see Chapter "Communication via PROFINET IO (Page 252)".

Note

If PROFINET is to be used only as a commissioning interface but process control is through PROFIBUS, after commissioning the CBE20, the process data interface needs to be set back to PROFIBUS (p8839 = 1).

Adding offline in STARTER

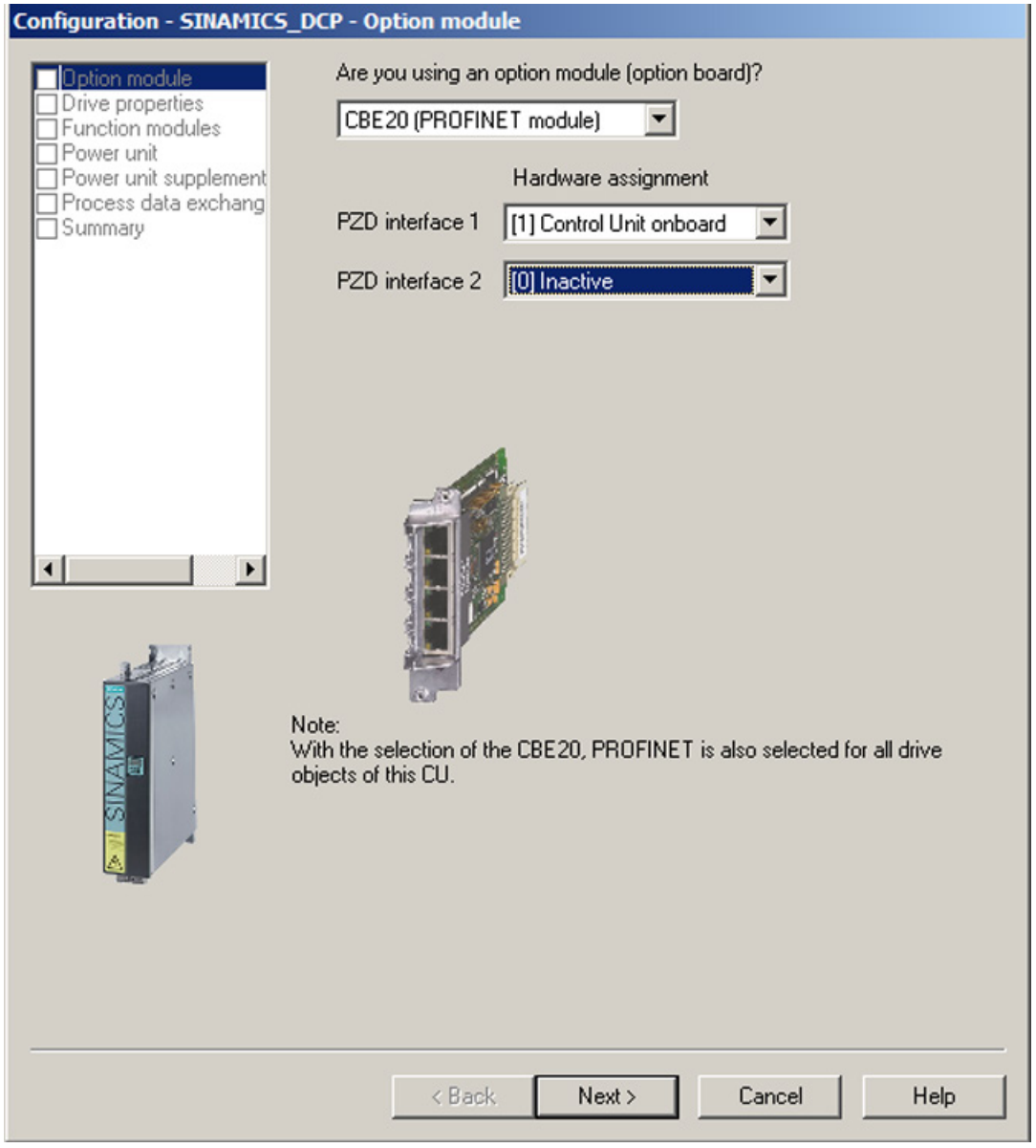


Figure 7-25 Configuration

Removing online in the SINAMICS DCP

Removing a CBE20 without STARTER always leads to the loss of the parameter assignments which are replaced by the factory settings.

p0009 = 30
p0976 = 1
(recent commissioning)

Removing offline with STARTER

In STARTER, the Control Unit configuration wizard can also be used to subsequently add or remove a CBE20 (see Section Adding offline in STARTER).

After deleting in the wizard, the project needs to be saved, loaded into the SINAMICS DCP and permanently saved with RAM → ROM.

Operation

8

8.1 Operation

8.1.1 Basics

8.1.1.1 Parameters

Parameter types

The following adjustable and display parameters are available:

- Adjustable parameters (can be written and read)
  These parameters have a direct effect on how a function responds.
  Example: Ramp-up and ramp-down time of the setpoint ramp
- Display parameters (can only be read)
  These parameters are used to display internal variables.
  Example: Current voltage on side 1 and side 2

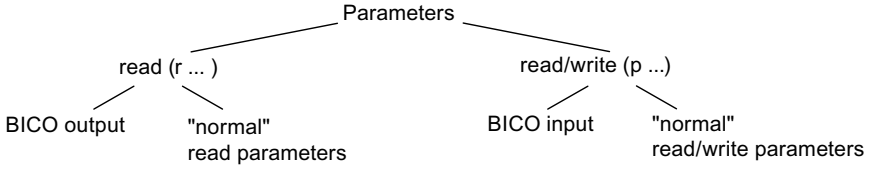


Figure 8-1 Parameter types

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

Parameter categories

The parameters of the individual drive objects are categorized into 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 for each drive object and can be addressed via the parameter index for reading and writing. A distinction is made between different data set types:
  - CDS: Command Data Set
    By parameterizing several command data sets and switching between them, the SINAMICS DCP can be operated with different preconfigured 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.

Note

With the SINAMICS DCP, the parameters of the closed-loop control are not implemented as DDS parameters.

Saving parameters in a non-volatile memory

The modified parameter values are stored in the volatile RAM. When the SINAMICS DCP is switched off, this data is lost.

The data must be saved in the non-volatile memory, as described below, so that the changes are available the next time the drive is switched on.

- Saving parameters with STARTER
  See "Copy RAM to ROM" function
- Saving parameters
  p0977 = 1; automatically reset to 0

Note

The power supply for the SINAMICS DCP may only be switched off after saving has finished (i.e. after saving has started, wait until the parameter has the value 0 again).

Reset parameters

The parameters can be reset to the factory setting as follows:

p0009 = 30	Parameter reset
p0976 = 1	Start restoring all parameters to their factory settings

After this has been done, p0976 is automatically set to 0 and p0009 is set to 1.

Deleting all user data

In addition to the actual parameter data set which saves the parameter assignment of the unit in a non-volatile memory (ROM) of the device and which can be deleted using p0976 = 1 (restore factory settings), the following data also belongs to the non-volatile user data:

- DCC charts
- The DCC block library
- Additional parameter data sets (see p0802, p0803, p0804)

Note

DCC is not supported in firmware version V1.1.

This data is also saved in the non-volatile memory (ROM). All user data is deleted from the ROM as follows:

p0009 = 30 Parameter reset
p0976 = 200 Start to delete all user data

The operation may take several minutes. The unit automatically powers up during this time. As a result, the unit in STARTER goes offline. Re-connect with the drive. After this has been done, p0976 is automatically set to 0 and p0009 is set to 0.

Note

Data on the memory card is not deleted by setting p0976 = 200. In spite of this, when deleting all user data, it is not permissible that a memory card is inserted. An inserted memory card would mean that for an automatic run-up after p0976 = 200, as usual, the data would be read from the memory card (see also Chapter "Memory card functions (Page 161)"). The device would ramp-up with the parameter assignment from the memory card.

Access level

The parameters are subdivided into access levels. The SINAMICS DCP List Manual specifies the access level at which the parameter can be displayed and modified. The required access levels 0 to 4 can be set in p0003.

Table 8-1 Access levels

Access level	Remark
0 User-defined	Parameters from the user-defined list (p0013)
1 Standard	Parameters for the simplest possible operations
2 Extended	Parameters for handling the basic functions of the unit
3 Expert	Expert knowledge is already required for these parameters (e.g. knowledge of assigning BICO parameters).
4 Service	Expert knowledge is also required for these parameters. The access level is password-protected. These must be entered in the STARTER expert list or CUD parameter p3950.

Note

Parameter p0003 is only available on drive object CU_DCP (Control Unit).

8.1.1.2 Drive objects

A drive object is a self-contained software function with its own parameters and potentially its own faults and alarms. Drive objects can be provided as standard (e.g. drive control), or can be created individually or also created several times.

Properties of a drive object:

- Separate parameter space
- Separate fault/alarm system
- Separate PROFIdrive telegram for process data

Drive objects in the SINAMICS DCP

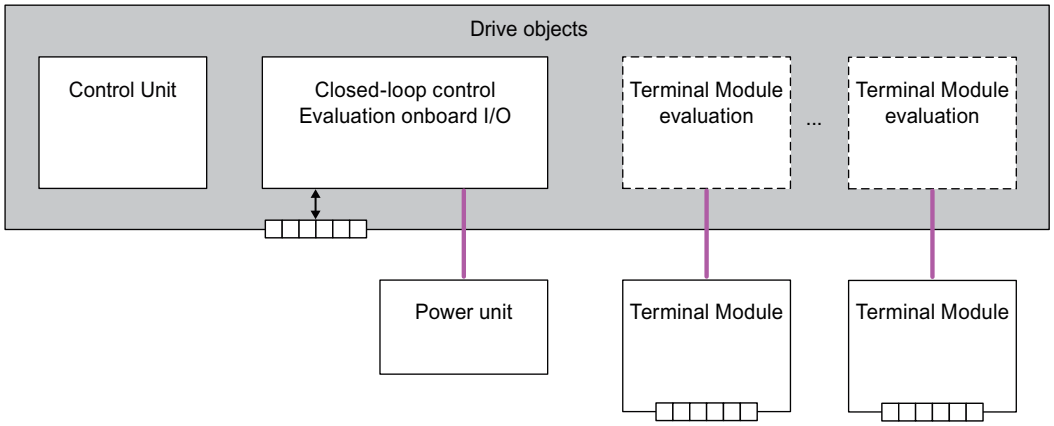


Figure 8-2 Drive objects

- Drive control (DCP_CTRL)
  The drive control performs the closed-loop control of the SINAMICS DCP. The I/Os on the CUD are evaluated within this drive object.
- Control Unit (CU_DCP)
  This drive object is, for example, responsible for communication – and includes various system parameters.
- Evaluation of optional Terminal Modules
  An independent drive object handles evaluation of each optional Terminal Module.

Configuring drive objects

If, after first commissioning, additional drive objects are configured or deleted, they must be added or deleted in STARTER or activated using the appropriate parameters (see Chapter "Commissioning optional additional modules (Page 154)").

Note

Each installed drive object is allocated a number between 0 and 63 during first commissioning so that it can be identified internally.

Overview of important parameters (see the SINAMICS DCP List Manual)

Adjustable parameters

- p0101 Drive object numbers
- p0107 Drive object type
- p0108 drive objects, function module

Display parameters

- r0102 Number of drive objects

8.1.1.3 Memory card functions

This chapter describes the basic functions of the memory card in the SINAMICS DCP.

Basics

The CUD (Control Unit for the SINAMICS DCP) manages three memory areas:

- A volatile memory, the **RAM**, also called work memory
- A non-volatile memory, the **flash EPROM**. The flash EPROM is known as flash memory or as **ROM**.
  Note: The designation ROM does not completely correspond to the functionality of a flash EPROM; however, it is used in this way over the complete series of SINAMICS products.
- An optionally available portable memory card

  Note

  Memory cards can be ordered as an option (S03) or as accessories, see Chapter "Ordering information for options and accessories (Page 30)".

  The functionality with SINAMICS DCP is not guaranteed for memory cards from other manufacturers.

The work memory receives all project information and application programs while the device is being operated. To save the actual data of the work memory, you must copy it to non-volatile memory **before** shutting down, see Chapter "Commissioning (Page 123)", "Copy RAM to ROM" function.

An optional memory card is used:

- For saving various parameter data sets
- For transferring the parameter data sets to additional SINAMICS DCPs
- For series commissioning

The memory card is needed:

- For installing firmware updates
- For loading the DCC block library to the SINAMICS DCP
- For reading-out the diagnostic trace
- For communication via Modbus TCP
- For communication via SINAMICS Link

NOTICE
Undesirable response or data loss if the memory card is improperly handled For disturbance-free operation of the control electronics (CUD), the memory card recommended by Siemens must only be inserted in the device when the SINAMICS DCP is switched-off and in a no voltage condition. Inserting the card when operational can result in undefined states of the device with the corresponding effects. Ideally, the memory card is ordered when purchasing the DCP, and is installed before commissioning. If the memory card is not inserted from the very beginning, and is only inserted after being requested to do so, for example by Technical Support, then it must first be completely emptied. This prevents that data possibly saved on the memory card overwrites the actual parameter assignment of the DCP. To avoid data loss when removing the memory card, it must be logged off from the device as described in Section "Safely removing the memory card".

Note

The memory card supplied from Siemens as option S03 includes, when supplied, a dump of the internal device firmware. These files are required to update the firmware. These files can be deleted for other applications.

Before you use the card for the functions described in this chapter, copy these files to a local folder of your PG/PC and delete the files on the memory card.

Parameter data sets

Parameter data sets represent all of the parameters of a project - including the DCC charts and the project itself. The parameter data sets differ depending on configuration and application.

Different data volumes can be saved in the three memory areas:

- ROM: Four parameter data sets with the indices 0, 10, 11, and 12
- The parameter data set with the index 0 is active in the RAM
- Memory card: Depending on the free storage space, up to 101 parameter data sets (indices 0 to 100)

Note

The DCC library itself is not saved as a part of the parameter data set.

Copying parameter data sets from non-volatile memory to the memory card

There are three ways of copying parameter data sets from non-volatile memory (ROM) to the memory card:

The system is switched off

1. Insert a memory card into the CUD (the memory card must be empty as otherwise the system will boot from the card)
2. Switch on the system
3. The system is commissioned by the firmware in the ROM.
4. Then the complete updated parameter data set with the index 0 is automatically copied from the "ROM" to the memory card **without a prompt appearing**.

The system is switched on

- Execute command "Copy RAM to ROM" (p0977 = 1). The updated parameter data set is copied automatically, first to the "ROM" and then as a data set to the memory card with index 0. If the memory card already contains a parameter data set with the index 0, this will be overwritten without a prompt appearing.

The system is switched on

By the user, utilizing the parameter data transfer from ROM to the memory card:
p0804 = 2, p0802 = (0..100) as target on the memory card and p0803 = (0/10/11/12) as source from the ROM.

Note

While saving (BOP20 flashes, RDY LED flashes), the device must NOT be switched off. Switching off the device while saving leads to the loss of the most recently performed and not yet saved device parameterization.

Note

When options are being used and with certain device configurations, the saving operation can take several minutes.

Note

When a memory card is inserted, the "Copy RAM to ROM" command (p0977 = 1) copies parameter data set with index 0 from the ROM to the memory card. A parameter data set that might have been previously saved on the memory card is overwritten.

Copying parameter data sets from the memory card to non-volatile memory

There are two ways of copying parameter data sets from the memory card to non-volatile memory:

The system is switched off

1. Insert a memory card containing a parameter data set with the index 0 into the CUD.
2. Switch on the system. The new parameter data set will be copied to the ROM automatically. The parameter data set with the index 0 which was previously in the ROM will be overwritten.
3. The system will then boot with the new parameter data set.

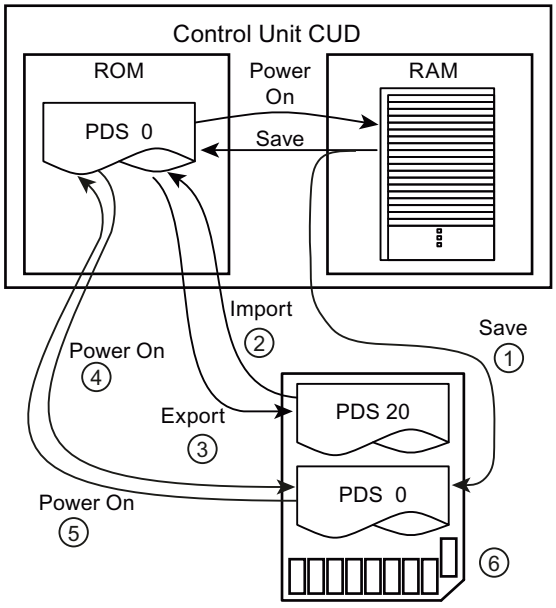
The system is switched on

The user starts data transmission from the memory card to the ROM with parameters p0802, p0803 and p0804:

- p0804 = 1
- p0802 = (0 ... 100) as source from the memory card and p0803 = (0/10/11/12) as target to the ROM.

Note

The parameter data set in the ROM is overwritten during system start-up. If a memory card with a parameter data set is inserted when the system is switched on, the parameter data set with the index 0 in the ROM will be overwritten by the new one with the index 0 on the memory card.



① Memory card available: PDS 0 is copied to the card in parallel
② p0802 = 20; p0803 = 0; p0804 = 1
③ p0802 = 20; p0803 = 0; p0804 = 2
④ For POWER ON, no PDS 0 on the card: PDS 0 is copied from the ROM to the memory card
⑤ At POWER ON, PDS 0 on the card: PDS 0 is copied to the ROM
⑥ Memory card

PDS = parameter data set

Figure 8-3 Copying parameter data sets

Using the memory card for series commissioning

The memory card can also be used for series commissioning of several units with the same parameter assignment.

Procedure:

1. Completely commission a "sample" SINAMICS DCP. As soon as all of the parameters have been correctly set, carry out "Copy RAM to ROM".
2. Switch off the system and insert a memory card into the CUD. Switch on the system.
3. The parameter assignment is saved on the memory card. If DCC charts are activated in the system, then these as well as the DCC library are also saved on the memory card.
4. Remove the card (p9400).
5. Insert the card into a CUD that is switched-off and has still not been parameterized. Switch on the system (POWER ON).

6. During ramp-up, the parameter assignment is transferred to the CUD and copied to the ROM as well as to the RAM. If DCC charts and the DCC library were saved on the memory card, then these are also copied.
7. The card can be removed once the system has run-up (p9400). The CUD that was still not parameterized now has the same parameter assignment as the original "sample" SINAMICS DCP.

Note

The article number of the device from which the parameter data set originated is also saved in a parameter data set. If the parameter data set is loaded to a device with another article number (POWER ON with the memory card inserted), then the device signals an inconsistent topology (ramp-up stops with display "33" on the BOP, alarm A01420 is output). This occurs, if e.g. a parameter set that was created in a 30 kW device is subsequently loaded into a 120 kW device. In this state, the user can accept the parameter set by setting p9906 = 3. Run-up is continued.

Important parameters

p0977: Save all parameters (for details, see the SINAMICS DCP List Manual).

p0802: Data transfer of parameters [0, 10, 11, 12], memory card as source or target

p0803: Data transfer of parameters [0...100], non-volatile device memory as source or target

p0804: Start of parameter data transfer and specification of transfer direction:

- p0804 = 1: Transfer from the memory card to non-volatile device memory
- p0804 = 2: Transfer from non-volatile device memory to memory card

Safely removing a memory card

Removing the memory card must be requested using p9400.

Procedure:

p9400 = 2	Request to "safely remove" the memory card
p9400 = 3	Feedback: "You can safely remove the memory card" Remove the memory card
p9400 = 100	Feedback: "It is not possible to safely remove the memory card" The SINAMICS DCP is accessing the memory card. Leave the memory card in the unit and try again later.
p9400 = 0	Message: No memory card inserted

Note

If the memory card is removed without a request being made, this can destroy the file system on the memory card.

8.1.1.4 BICO technology: Interconnecting signals

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

The SINAMICS DCP can be adapted to a wide range of requirements using BICO technology (Binector Connector Technology).

Digital and analog signals, which can be interconnected as required 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

The STARTER commissioning tool is recommended when using BICO technology.

Binectors, BI: Binector input, BO: Binector output

A binector is a unitless digital (binary) signal that can assume a value of 0 or 1.

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

Table 8-2 Binectors

Abbreviation	Symbol	Name	Description
BI		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 (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).

Table 8-3 Connectors

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

Interconnecting signals with 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 to connect a binector/connector input to a binector/connector output:

- Binectors: Parameter number, bit number and drive object ID
- Connectors without an index: Parameter number and drive object No.
- Connectors with an index: Parameter number, index and drive object No.
- Data type (signal source for connector output parameter)

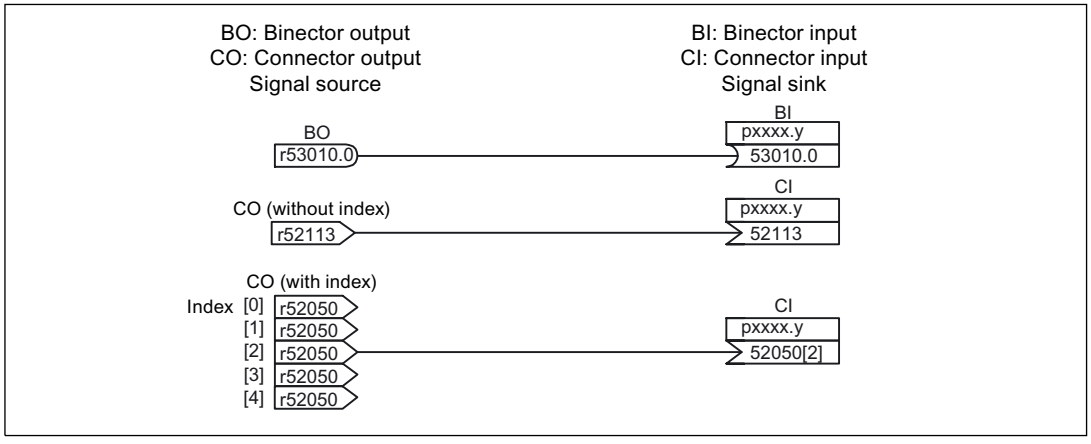


Figure 8-4 Interconnecting signals with BICO technology

Note

A connector input (CI) cannot be interconnected to any connector output (CO, signal source). The same applies for a 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:

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

The possible interconnections between the BICO input (signal sink) and BICO output (signal source) are listed in the table titled "Possible combinations for BICO interconnections", which can be found in the "Explanations on the parameter list" chapter of the SINAMICS DCP List Manual.

The BICO parameter interconnection can be implemented in different command data sets (CDS). The different interconnections are activated by switching data sets. Interconnections across drive objects are also possible.

Note

Process data is transferred between SINAMICS DCP and a higher-level control system in a standardized form via the fieldbus.

More detailed information is provided in Chapter "Telegrams and process data (Page 194)" in Section "Scaling BICOs".

Internal coding of the binector/connector output parameters

Internal coding is required for writing BICO input parameters via PROFIBUS, for example.

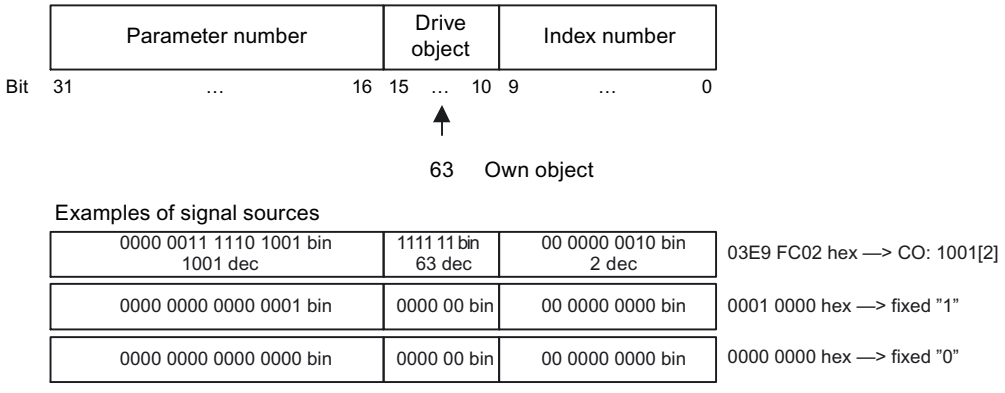


Figure 8-5 Internal coding of the binector/connector output parameters

Example: Interconnecting digital signals

A drive is to be traversed via terminals DI 0 and DI 3 on the CUD with ON/OFF1 and "Enable operation".

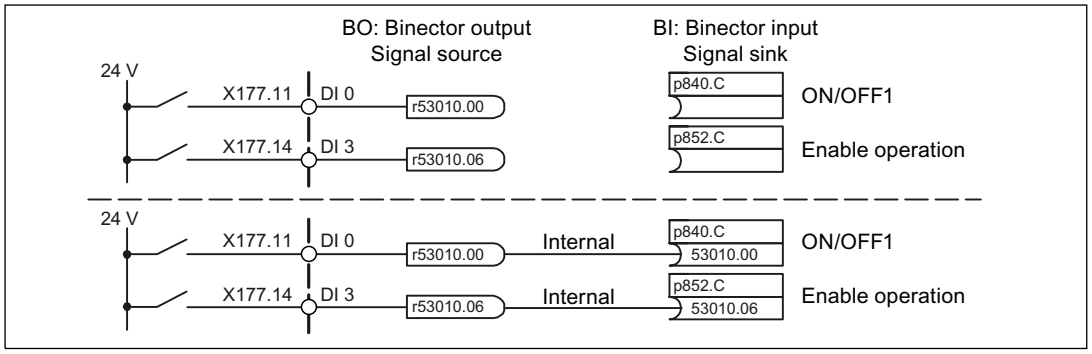


Figure 8-6 Interconnecting digital signals (example)

Binector-connector converters and connector-binector converters

Binector-connector converters

- Several digital signals are converted to a 32-bit integer double word or to a 16-bit integer word.
- p2080[0...15] BI: PROFIdrive PZD send bit-by-bit

Connector-binector converters

- A 32-bit integer double word or a 16-bit integer word is converted to individual digital signals.
- p2099[0...1] CI: PROFIdrive PZD selection receive bit-by-bit

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 [%]
- p2902[0...n] CO: Fixed values [%]
- p50401 CO: Fixed value 1
- p50402 CO: Fixed value 2
- p50403 CO: Fixed value 3
- p50421 ... p50428 BO: Fixed bit 0...7
- r52000 ... r52008 CO: Fixed values

These parameters can be used for test purposes.

8.1.1.5 Data sets

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 SINAMICS DCP.

By parameterizing several command data sets and switching between them, the SINAMICS DCP can be operated with different preconfigured signal sources.

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
  - ON/OFF, enable signals (p0844, etc.)

A drive object can manage two command data sets.
The following parameters are available for selecting command data sets and for displaying the currently selected command data set:

- Binector input p0810 BI: Command data set (CDS) selection
- r0836: Displays the selected data set

Example: Switchover between command data set 0 and 1

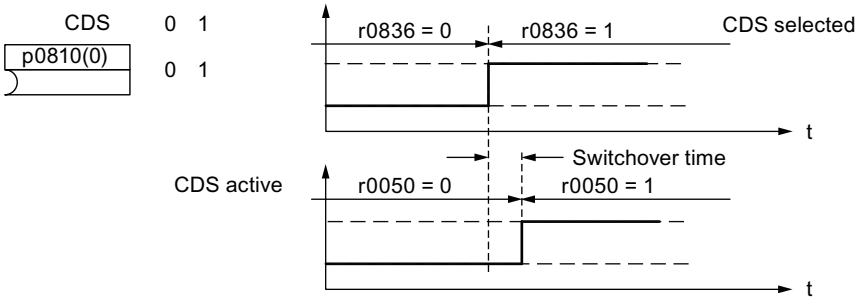


Figure 8-7 Switching over the command data set (example)

Copying a command data set

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

Copying is started.

Copying is completed when p0809[2] = 0.

DDS: Drive data set

A command data set contains various adjustable parameters:

- Fixed values (p2900, p2901)
- Scalings (p50701, p50711, p50721, p50741)

The parameters that are grouped together in the drive data set are identified in the SINAMICS DCP List Manual by "DDS" and are assigned an index [0...n].

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

A drive object can manage 4 drive data sets.
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 the 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

Copy drive data set

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

Copying is started.

Copying is finished when p0819[2] = 0.

Function diagrams (see SINAMICS DCP List Manual)

- 8560 Command Data Sets (CDS)
- 8565 Drive Data Sets (DDS)

Overview of important parameters (see the SINAMICS DCP List Manual)

- p0170 Command data set (CDS) number
- p0809 Copy Command Data Set (CDS)
- p0810 BI: Command Data Set, CDS bit 0
- p0819 copy Drive Data Set (DDS)
- p0820 BI: Drive Data Set selection DDS bit 0
- p0821 BI: Drive Data Set selection DDS bit 1

8.1.2 Parameter assignment via the BOP20 (Basic Operator Panel 20)

8.1.2.1 General information on the BOP20

Using the BOP20, the SINAMICS DCP can be switched on and off for commissioning purposes and parameters can be displayed and modified. Faults can be diagnosed as well as acknowledged.

Overview of the displays and keys

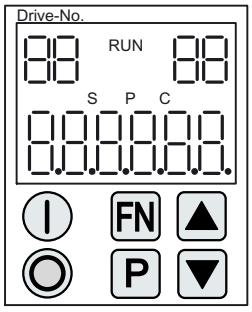


Figure 8-8 Overview of the displays and keys

Information on the displays

Table 8-4 Displays

Display	Meaning
Top left 2 digits	The active drive object of the BOP is displayed here. The displays and key operations always refer to this drive object.
RUN	Is displayed when the SINAMICS DCP is in the RUN state (operation). RUN is also displayed via bit r0899.2.
Top right 2 digits	The following is displayed in this field: • More than 6 digits: Characters that are still present but invisible (e.g. "r2" –> 2 characters to the right are invisible, "L1" –> 1 character to the left is invisible) • Designation of BICO inputs (bi, ci) • Designation of BICO outputs (bo, co) • Source object of a BICO interconnection to a drive object different than the active one.
S	Is displayed if at least one parameter was changed and the value was not transferred into the non-volatile memory.
P	Is displayed if, for a parameter, the value only becomes effective after pressing the P key.
C	Is displayed if at least one parameter was changed and the calculation for consistent data management has still not been initiated.
Bottom 6 digits	Displays parameters, indices, faults and alarms.

For certain user actions (e.g. restore factory setting) a two-digit number is displayed on the BOP20. This number provides information about the SINAMICS DCP state. The meaning of these numbers is provided in Chapter "BOP20 status display during ramp-up (Page 124)".

Information on the keys

Table 8-5 Keys

Key	Name	Meaning
	ON	Switching on Binector output r0019.0 is set using this key.
	OFF	Switching off The binector outputs r0019.0, .1 and .2 are simultaneously reset when this key is pressed. After the key has been released, binector outputs r0019.1 and .2 are again set to a "1" signal. **Note**: The effectiveness of these keys can be defined via BICO parameterization.
	Functions	The meaning of these keys depends on the current display. **Note**: The effectiveness of this key to acknowledge faults can be defined via BICO parameterization.
	Parameters	The meaning of these keys depends on the current display. If this key is pressed for 3 s, the "Copy RAM to ROM" function is executed. The "S" displayed on the BOP disappears.
	Higher	The keys depend on the current display and are used to either increase or decrease values.
	Lower	

BOP20 functions

Table 8-6 Functions

Name	Description
Backlight	The backlight can be set using p0007 in such a way that it switches itself off automatically after the set time if no actions are carried out.
Switch active drive	From the BOP perspective, the active drive is defined using p0008 or using the keys "FN" and "Arrow up".
Units	The units are not displayed on the BOP.
Access level	The access level for the BOP is defined using p0003. The higher the access level, the more parameters can be selected via the BOP.
Parameter filter	The parameter filter in p0004 can be used to filter the available parameters in accordance with their particular function.
Select status display	Actual values and setpoints are displayed on the operating display. The status display can be set via p0006.
User parameter list	Using the user parameter list in p0013, parameters can be selected for access.

Name	Description
Hot swapping	The BOP can be unplugged and plugged while energized. • The ON and OFF buttons have a function: Unplugging the BOP causes the drives to coast to a standstill. When the BOP is plugged in again, the drives must be switched on again. • The ON and OFF buttons have no function: Unplugging and plugging the BOP in again has no effect on the drives.
Actuate keys	The following applies to the "P" and "FN" keys: When used in a combination with another key, "P" or "FN" must be pressed first and then the other key.

Overview of important parameters (see the SINAMICS DCP List Manual)

All drive objects

- p0005 BOP operating display selection
- p0006 BOP operating display mode
- p0013 BOP user-defined list
- p0971 Drive object, save parameters

Drive object, Control Unit (CU_DCP)

- r0002 Control Unit status display
- p0003 BOP access level
- p0004 BOP display filter
- p0007 BOP background lighting
- p0008 BOP drive object after running up
- p0009 Device commissioning, parameter filter
- p0011 BOP password input (p0013)
- p0012 BOP password confirmation (p0013)
- r0019 CO/BO: Control word, BOP
- p0977 Save all parameters

Note

During a data save operation initiated by the user, the electronics power supply for the SINAMICS DCP must not be interrupted.

An active data save operation is indicated by the following actions:

- The RDY-LED flashes (see Chapter "Description of the LEDs on the CUD (Page 362)")
- The BOP20 flashes

Interrupting the electronics power supply while saving can lead to the loss of the current device parameter assignment. See also Chapter "Memory card functions (Page 161)".

Drive object (DCP_CTRL)

- p0010 Drive commissioning parameter filter

8.1.2.2 Display and operation with the BOP20

Characteristics

- Status display
- Changing the active drive object
- Displaying/changing parameters
- Displaying/acknowledging faults and alarms
- SINAMICS DCP controlled by the BOP20

Status display

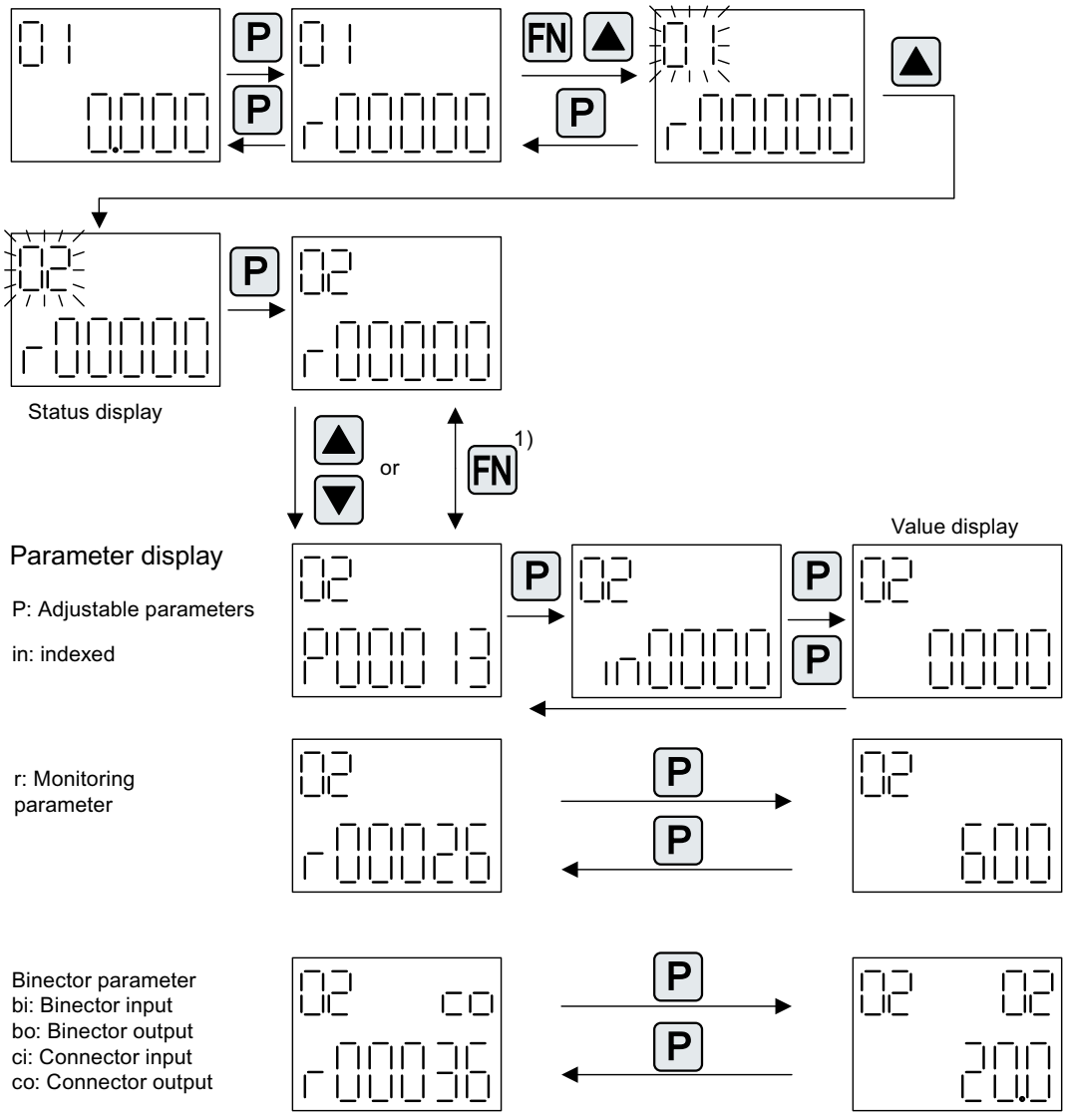
The status display for each drive object can be set using p0005 and p0006.

Using the status display, you can switch to the parameter display or to a different drive object. The following functions are supported:

- Changing the active drive object
  - Press the "FN" and "Arrow up" keys -> the drive object number at the top left flashes
  - Select the required drive object using the arrow keys
  - Confirm with the "P" key
- Parameter display
  - Press the "P" key
  - The required parameter can be selected using the arrow keys
  - Press the "FN" key -> parameter r0000 is displayed
  - Press the "P" key -> returns to the status display

Parameter display

The parameters are selected in the BOP20 using the number. To call up the parameter display from the status display, press the "P" key. You can search for the parameters you require using the arrow keys. To display the parameter value, press the "P" key again. You can toggle between the drive objects by simultaneously pressing the "FN" key and an arrow key. You can toggle between r0000 and the parameter that was last displayed by pressing the "FN" key in the parameter display.



1) You can switch between "r00000" and the parameter that was last displayed by pressing the FN key in the parameter display.

Figure 8-9 Parameter display

Value display

To switch from the parameter display to the value display, press the "P" key. In the value display, the values of the adjustable parameters can be increased and decreased using the arrow. The cursor can be selected using the "FN" key.

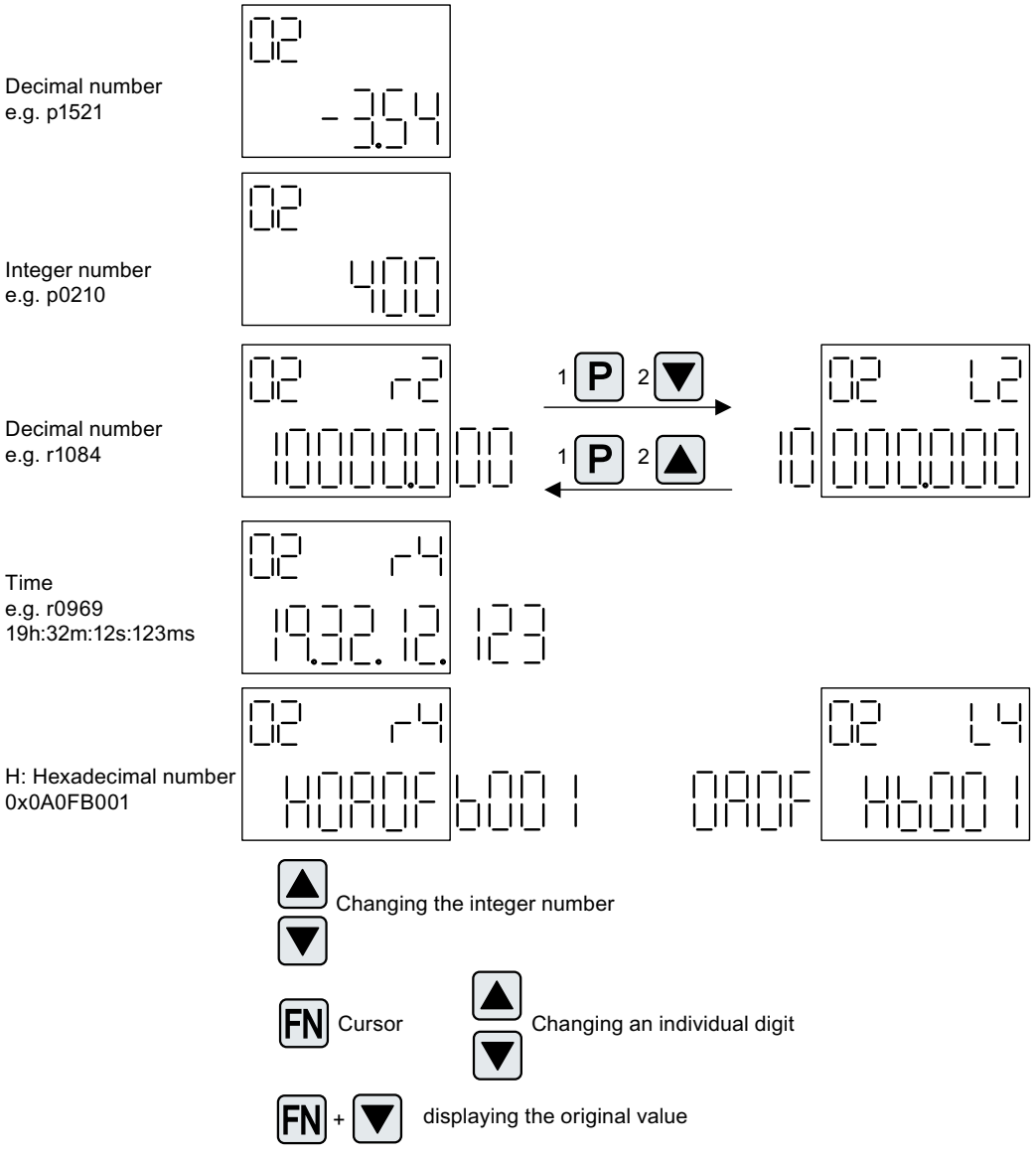


Figure 8-10 Value display

Example: Changing a parameter

Requirement: The appropriate access level is set
(for this particular example, p0003 = 3).

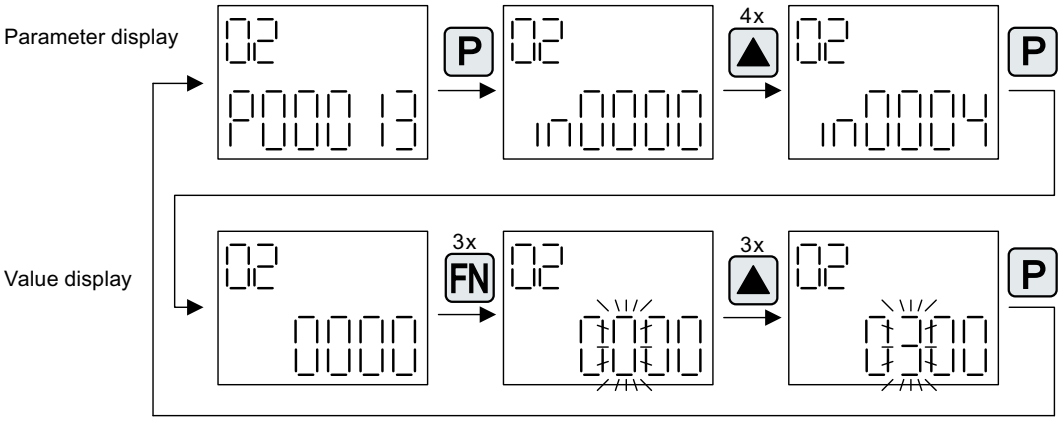


Figure 8-11 Example: Changing p0013[4] from 0 to 300

Example: Changing binector and connector input parameters

For the binector input p0840[0] (OFF1) of drive object 2 binector output r0019.0 of the Control Unit (drive object 1) is interconnected.

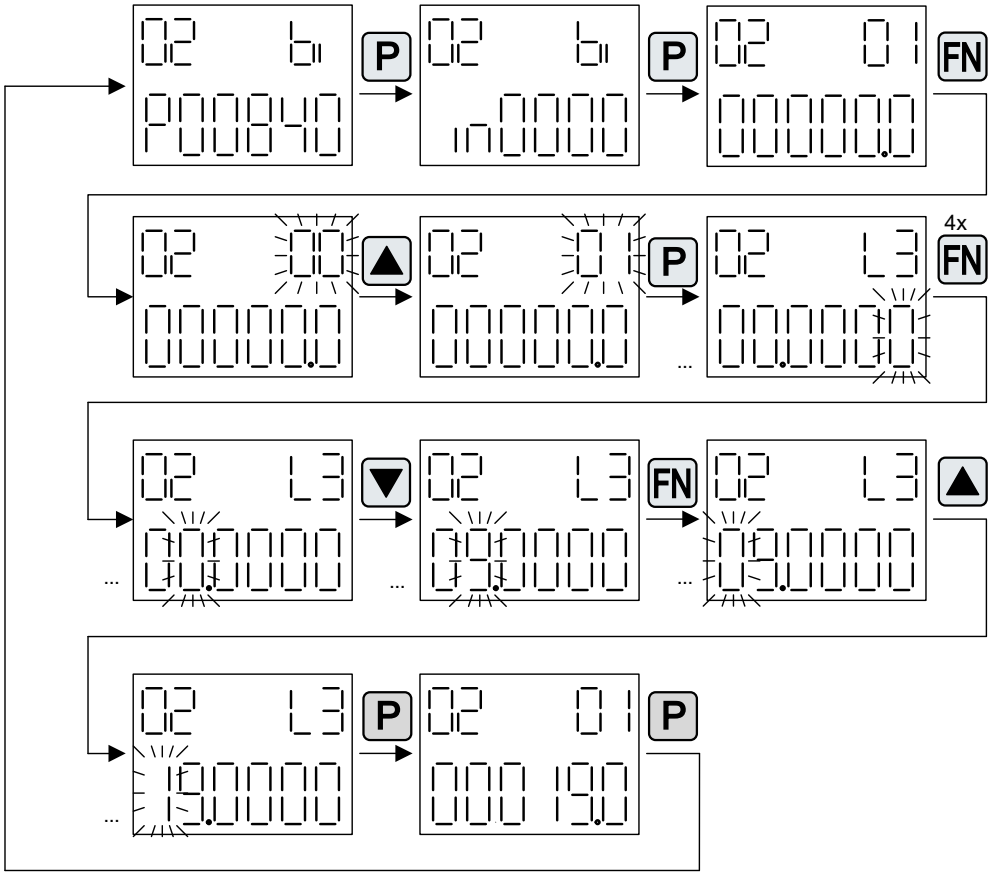


Figure 8-12 Example: Changing indexed binector parameters

8.1.2.3 Displaying faults and alarms

Displaying faults

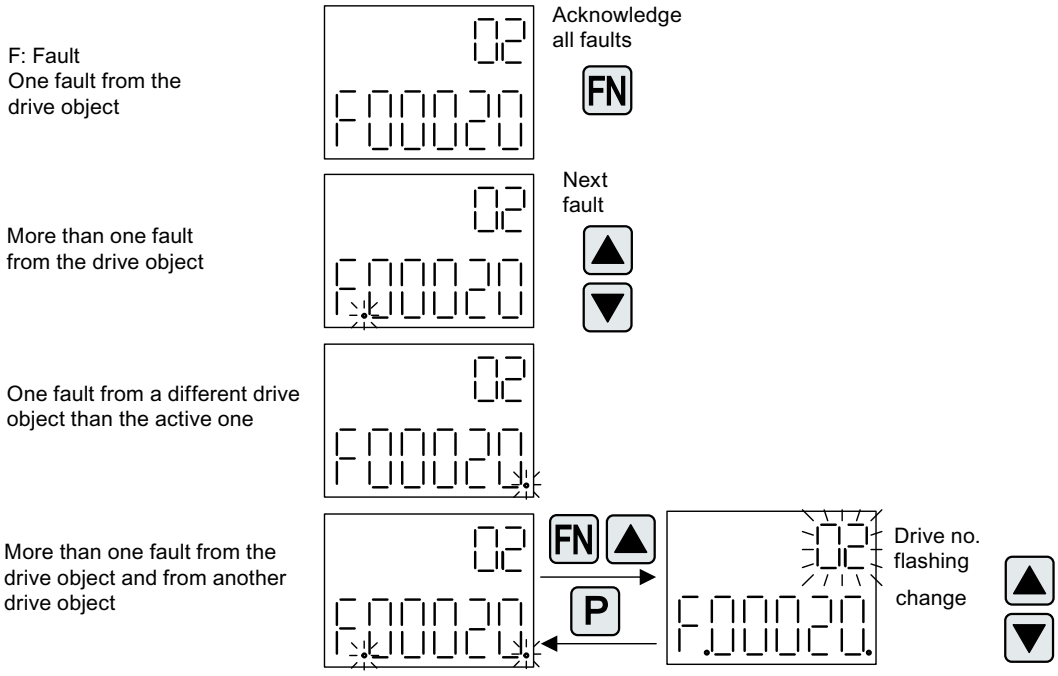


Figure 8-13 Faults

Displaying alarms

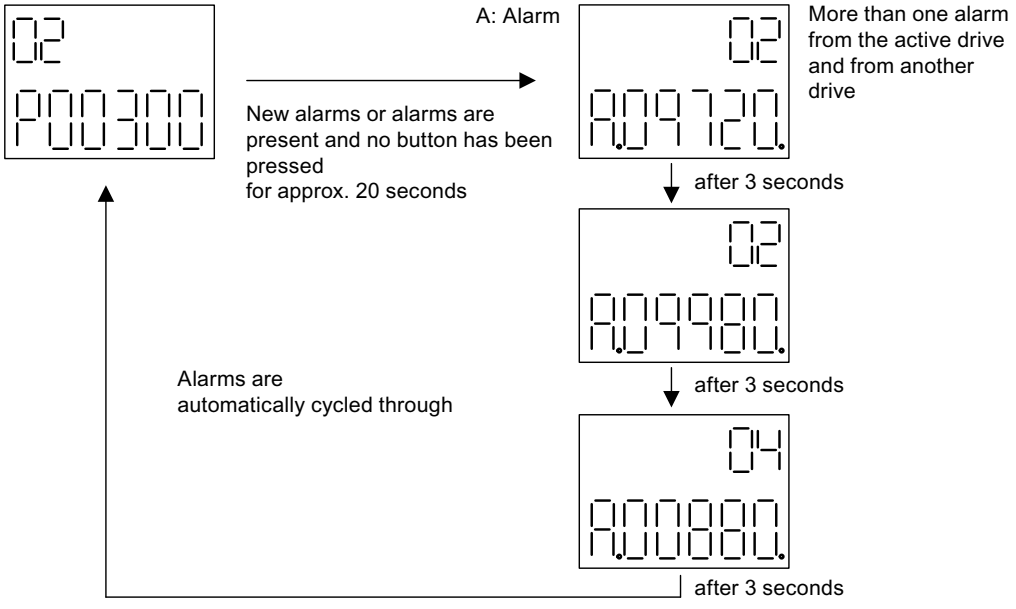


Figure 8-14 Alarms

8.1.2.4 Controlling the drive using the BOP20

When commissioning the SINAMICS DCP, it can be controlled via the BOP20. A control word is available on the Control Unit drive object (r0019) for this purpose, which can be interconnected with the appropriate binector inputs, e.g. of the SINAMICS DCP.

Table 8-7 BOP20 control word

Bit (r0019)	Name	Example, interconnection parameters
0	ON/OFF (OFF1)	p0840
1	No coast down / coast down (OFF2)	p0844
2	No fast stop / fast stop (OFF3)	p0848
7	Acknowledge fault (0 -> 1)	p2102

Note

For simple commissioning, only bit 0 should be interconnected. When interconnecting bits 0 ... 2, the system is switched off according to the following priority: OFF2, OFF3, OFF1.

8.2 Inputs/outputs

8.2.1 Overview of the inputs/outputs

Table 8-8 Overview of inputs and outputs

Component	Digital	Analog
CUD	• 4 inputs • 4 bidirectional inputs/outputs • 4 outputs	• 7 inputs • 2 outputs
Technical data for inputs and outputs: • For the CUD and power unit, see Chapter "Electrical connection (Page 39)".		

8.2.2 Digital inputs/outputs

Function diagrams in the SINAMICS DCP List Manual

2050 Digital inputs DI 0 ... DI 3
2055 Digital outputs DO 0 ... DO 3
2060 Digital inputs/outputs, bidirectional DI/DO 4 and DI/DO 5
2065 Digital inputs/outputs, bidirectional DI/DO 6 and DI/DO 7

8.2.3 Analog inputs

Properties

Table 8-9 Properties of the analog inputs

Inputs	Properties
AI 0, AI 1	• Differential inputs • Voltage inputs -10 to +10 V or • Current inputs -20 to +20 mA or 4 to 20 mA • Hardware input filter: T = 1 ms • Integrating measuring procedure. Averaging time = 1 ms. The value averaged over this time is made available as BICO, and is updated in a 1 ms cycle.
AI 2	• Differential input • Voltage input -10 to +10 V • Hardware input filter: T = 1 ms • Integrating measuring procedure. Averaging time = 1 ms. The value averaged over this time is made available as BICO, and is updated in a 1 ms cycle.
AI 3, AI 4, AI 5, AI 6	• Differential inputs • Voltage inputs -10 to +10 V • Hardware input filter: T = 100 µs • Integrating measuring procedure. Sampling time = 250 µs. The average value over four sampling values is made available as BICO, and updated in a 1 ms cycle.

Function diagrams

2075	Analog input AI 0
2080	Analog inputs AI 1 and AI 2
2085	Analog inputs AI 3 and AI 4
2090	Analog inputs AI 5 and AI 6

8.2.4 Analog outputs

See function diagram 2095 in the SINAMICS DCP List Manual.

8.3 Communication, IT security

Note

IT security (industrial security)

In order to ensure the safe operation of your systems, you must take suitable measures, e.g. industrial security or network segmentation. You can find more information on Industrial Security on the Internet at:
Industrial Security (http://www.siemens.com/industrialsecurity)

8.3.1 SINAMICS network settings

SINAMICS converters support the communication protocols listed in the following table. The address parameters, the relevant communication layer, as well as the communication role and the communication direction are decisive for each protocol. You require this information to match the security measures for the protection of the automation system to the used protocols (e.g. firewall). The security measures are restricted to Ethernet or PROFINET networks.

The following table shows the various layers and protocols that are used.

PROFINET protocols

PROFINET protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
DCP Discovery and Configuration Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	Accessible nodes, PROFINET Discovery and configuration	DCP is used by PROFINET to determine PROFINET devices and to make basic settings. DCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
LLDP Link Layer Discovery Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88CC (PROFINET)	PROFINET Link Layer Discovery protocol	LLDP is used by PROFINET to determine and manage neighborhood relationships between PROFINET devices. LLDP uses the special multicast MAC address: 01-80-C2-00-00-0E
MRP Media Redundancy Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88E3 (PROFINET)	PROFINET medium redundancy	MRP enables the control of redundant routes through a ring topology. MRP uses the special multicast MAC address: xx-xx-xx-01-15-4E, xx-xx-xx = Organizationally Unique Identifier

PROFINET protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
PTCP Precision Transparent Clock Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET send clock and time synchronisation, based on IEEE 1588	PTC allows the delay time between RJ45 ports to be measured – and as a consequence, send cycle synchronization and time synchronization to be implemented. PTCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
PROFINET IO data	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET Cyclic IO data transfer	The PROFINET IO telegrams are used to cyclically transfer IO data between the PROFINET IO controller and IO devices via Ethernet.
PROFINET Context Manager	34964	(4) UDP	PROFINET connection less RPC	The PROFINET context manager provides an endpoint mapper in order to establish an application relationship (PROFINET AR).

Connection-oriented communication protocols

Connection-oriented communication protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
DHCP Dynamic Host Configuration Protocol	68	(4) UDP	Dynamic Host Configuration Protocol	Is used to query an IP address. Is closed when delivered, and is opened when selecting the DHCP mode.
ISO on TCP (according to RFC 1006)	102	(4) TCP	ISO-on-TCP protocol	ISO on TCP (according to RFC 1006) is used for the message-oriented data exchange to a remote CPU, WinAC, or devices of other suppliers. Communication with ES, HMI, etc. Is open in the delivery state and is always required.
SNMP Simple Network Management Protocol	161	(4) UDP	Simple network management protocol	SNMP enables the reading out and setting of network management data (SNMP managed Objects) by the SNMP manager. Is open in the delivery state and is always required.

Connection-oriented communication protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
Internal protocol	5188	(4) TCP	Server/ incoming	Communication with commissioning tools for downloading project data.
Reserved	49152...65535	(4) TCP (4) UDP	-	Dynamic port area that is used for the active connection endpoint if the application does not specify the local port.

EtherNet/IP protocols

EtherNet/IP protocols	Port number	(2) Link layer (4) Transport layer	Function	Description
Explicit messaging	44818	(4) TCP (4) UDP	-	Is used for parameter access, etc. Is closed when delivered, and is opened when selecting EtherNet/IP.
Implicit messaging	2222	(4) UDP	-	Is used for exchanging I/O data. Is closed when delivered, and is opened when selecting EtherNet/IP.

Modbus TCP protocols (server)

Modbus TCP protocols (server)	Port number	(2) Link layer (4) Transport layer	Function	Description
Request & Response	502	(4) TCP	-	Is used for exchanging data packages. Is closed when delivered, and is opened when selecting Modbus TCP.

8.3.2 Time synchronization between the control and converter

8.3.2.1 Overview

In the factory setting, SINAMICS drives use an operating hours counter. Based on the operating hours, the SINAMICS drive saves alarms and warnings that occur. Using this method, it is not possible to have a comparable timestamp between various converters.

In order to obtain a comparable timestamp between several converters, you must change over the operating hours counting to time in the UTC format and synchronize with the time master (control system).

This means that the events of all bus nodes, which are synchronized with the control system time, can be referenced with one another.

Benefits: Improved diagnostic options by having a comparable time stamp of the bus nodes involved.

Converters provide the following options to synchronize the time:

Synchronization type	Accuracy
Basic synchronization	approx. 100ms
Synchronization using ping compensation for non-isochronous communication	approx. 10 ms

Principle of operation of time synchronization

Basic synchronization

The control system transfers the time to the converter at time intervals that you specify in the control system. Transfer is realized acyclically in the UTC format. The converter accepts this time as soon as transfer has been completed without correcting the transfer duration. The converter logs alarms and warnings based on this time.

Time synchronization with ping compensation

At intervals that you specify in the control system, the control system cyclically sends a "ping" (a positive signal edge) to the converter. Simultaneously, in acyclic operation, the device sends the time in the UTC format in what is known as "snap".

As soon as the ping has been received in the drive, a timer starts which measures the time until the snap has been completely transferred. The drive accepts the time that the snap transfers. It then corrects it by the time that has expired between receiving the ping and the complete transfer of the snap.

If the snap has not been transferred within 5 s after receiving the ping, then this synchronization cycle is not used.

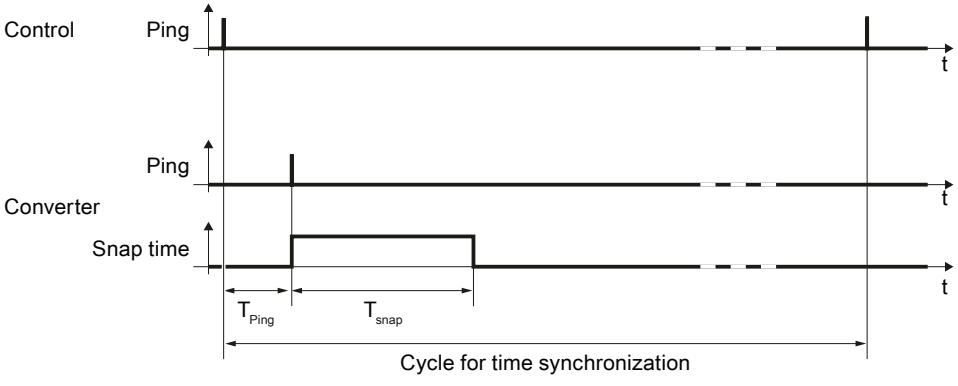


Figure 8-15 Ping snap

You can influence the accuracy of the ping compensation using the PZD sampling time (p2048).

8.3.2.2 Setting SINAMICS time synchronization

Setting time synchronization

1. Using p3100, changeover the time format from operating hours into the UTC format (see "Changing the time format").
2. Set the synchronization technique:
   - Basic synchronization (p3103 = 2)
   - Time synchronization with ping compensation (p3103 = 0)
3. Using p3104, set the ping source:
   - If you implement a customized solution for the time synchronization, then interconnect the source of the ping (p3104) with the cyclic fieldbus interface via BICO.
   - If you use the following blocks, interconnect the source of the ping (p3104) with the receive PZD 1, bit 1 of the CUD (r2090.1).
     - LAcycCom_RTCSinamics of library LAcycCom (see application example 1 further below)
     - SYNC_SINAMICS_CU_TIME (see application example 2 further below)
     As parameter, the blocks expect the basis address of the cyclic telegram to the CU.

Result:

After time synchronization, the current time is obtained from the time transferred by the time master plus the necessary delay time associated with the transfer (ping-snap time).

The actual UTC time is displayed in the drive system using r3102.

At certain intervals, synchronization (according to the same technique) is repeated (depending on the setting in the time master).

If a previously defined tolerance window is exceeded, then alarm A01099 is output. Define the tolerance window for time synchronization using p3109. If alarm A01099 occurs, then generally the synchronization interval is too long.

In this case, reduce the synchronization interval in your control system.

Changing the time format

The time format is entered via parameter p3100. This parameter cannot be changed online To change the value, proceed as follows:

1. Connect STARTER ONLINE with the converter.
2. Carry out an upload ("Load drive unit to PG").
3. Exit the online mode in STARTER.
4. Offline, make the setting p3100 = 1.
5. Reactivate the ONLINE mode.
6. Carry out a parameter download ("Load drive unit to target device").
7. Save the settings in a non-volatile fashion on the memory card of the drive.

You have now changed over the converter time format to the UTC format.

Application examples

Application examples for SINAMICS time synchronization are provided in the SIEMENS "Industry Online Support" (SIOS):

1. SIMATIC S7-1200/S7-1500 and SIMOTION: Acyclic communication
   Time synchronization via LAcycCom_RTCSinamics / LAcycCom_RTCSinamicsAcyclic
   Time synchronization via LAcycCom_RTCSinamics (https://support.industry.siemens.com/cs/de/en/view/109479553)
2. SINAMICS S: Time synchronization between S7-300/400/1200/1500 and S120
   time synchronization via SYNC_SINAMICS_CU_TIME
   Time synchronization via SYNC_SINAMICS_CU_TIME (https://support.industry.siemens.com/cs/de/en/view/88231134)

8.3.2.3 Messages and parameters

Faults and alarms (see SINAMICS DCP List Manual)

- A01099 UTC synchronization tolerance violated

Overview of important parameters (see the SINAMICS DCP List Manual)

- p2048 IF1 PROFIdrive PZD sampling time
- p3100 RTC time stamp mode
- p3101[0...1] Set UTC time
- r3102[0...1] Display UTC time
- p3103 UTC synchronization technique
- p3104 BI: UTC PING synchronization
- r3107[0...3] UTC synchronization time out of tolerance
- r3108[0...1] UTC synchronization deviation
- p3109 UTC synchronization tolerance
- p3116 BI: Suppress automatic acknowledgment

8.4 Communication according to PROFIdrive

8.4.1 General Information

Note

This chapter applies to several components of the SINAMICS drive family. These include the SINAMICS DCP even though it is not a drive. Therefore, in this chapter, the terms "drive," "drive unit," or "drive system" always refer to the SINAMICS DCP.

PROFIdrive is the PROFIBUS and PROFINET profile for drive technology with a wide range of applications in production and process automation systems.

PROFIdrive is independent of the bus system used (PROFIBUS, PROFINET).

Note

PROFINET for drive technology is standardized and described in the following document:

- **PROFIdrive – Profile Drive Technology**
  PROFIBUS User Organization e. V.
  Haid-und-Neu-Strasse 7, D-76131 Karlsruhe, Germany
  http://www.profibus.com
- IEC 61800-7

PROFIdrive device classes

Table 8-10 PROFIdrive device classes

PROFIdrive	PROFIBUS DP	PROFINET IO
Peripheral device (P device)	DP device (I devices)	IO Device
Controller (higher-level controller or host of the automation system)	Class 1 DP master	IO Controller
Supervisor (engineering station)	Class 2 DP master	IO Supervisor

Note

Standard naming conventions

For reasons of consistency, the terms "device", "controller", and "supervisor" are used below. The term "master" is only used in the PROFIBUS chapter and is still use there.

Properties of the Controller, Supervisor and drive units

Table 8-11 Properties of the Controller, Supervisor and drive units

Properties	Controller	Supervisor	Drive unit
As bus node	Active		Passive
Send messages	Permitted without external request		Only possible on request by the controller
Receive messages	Possible without any restrictions		Only receive and acknowledge permitted

- Drive unit (PROFIBUS: Device, PROFINET IO: IO Device)
  Example: Control Unit CUD
- Controller (PROFIBUS: Master Class 1, PROFINET IO: IO Controller)
  A controller is typically a higher-level controller in which the automation program runs.
  Example: SIMATIC S7 and SIMOTION
- Supervisor (PROFIBUS: Master Class 2, PROFINET IO: IO Supervisor)
  Devices for configuring, commissioning, operating control and monitoring while the bus is in operation
  Devices that only exchange data with drive units and controllers acyclically.
  Examples: Programming devices, human machine interfaces

Communication services

Three communication services are defined in the PROFIdrive profile.

- Cyclic data exchange via a cyclic data channel:
  Motion control systems require cyclically updated data in operation for open-loop and closed-loop control tasks. This data must be sent to the drive units in the form of setpoints or transmitted from the drive units in the form of actual values, via the communications system. This also applies to the SINAMICS DCP.
  Transmission of this data is usually time-critical.
- Acyclic data exchange via an acyclic data channel:
  An acyclic parameter channel for exchanging parameters between the controller/supervisor and drive units is additionally available. Access to this data is not time-critical.
- Message channel:
  The messages are output on an event-driven basis, and indicate the incoming and outgoing status of error states.

Interface IF1 and IF2

The Control Unit CUD can communicate via two separate interfaces (IF1 and IF2).

You can assign both interfaces to the following physical interfaces (p8839):

- PROFIBUS (onboard X126)
- PROFINET (X1400 on Communication Board CBE20)

Table 8-12 Properties of IF1 and IF2

	IF1	**IF2**
PROFIdrive	Yes	No
Standard telegrams	No	No
Isochronous mode	No	No
Drive object types	All	All
Can be used for	PROFINET IO, PROFIBUS DP	PROFINET IO, PROFIBUS DP
Cyclic operation possible	Yes	Yes
PROFIsafe possible	No	No

Note

SINAMICS DCP does not support isochronous operation. The closed-loop control is independent of the bus clock cycle.

For additional information on the IF1 and IF2 interfaces, see Chapter "Parallel operation of communication interfaces (Page 201)".

Connecting the PC to the STARTER commissioning tool

You can go online with STARTER in a number of ways, which are illustrated below:

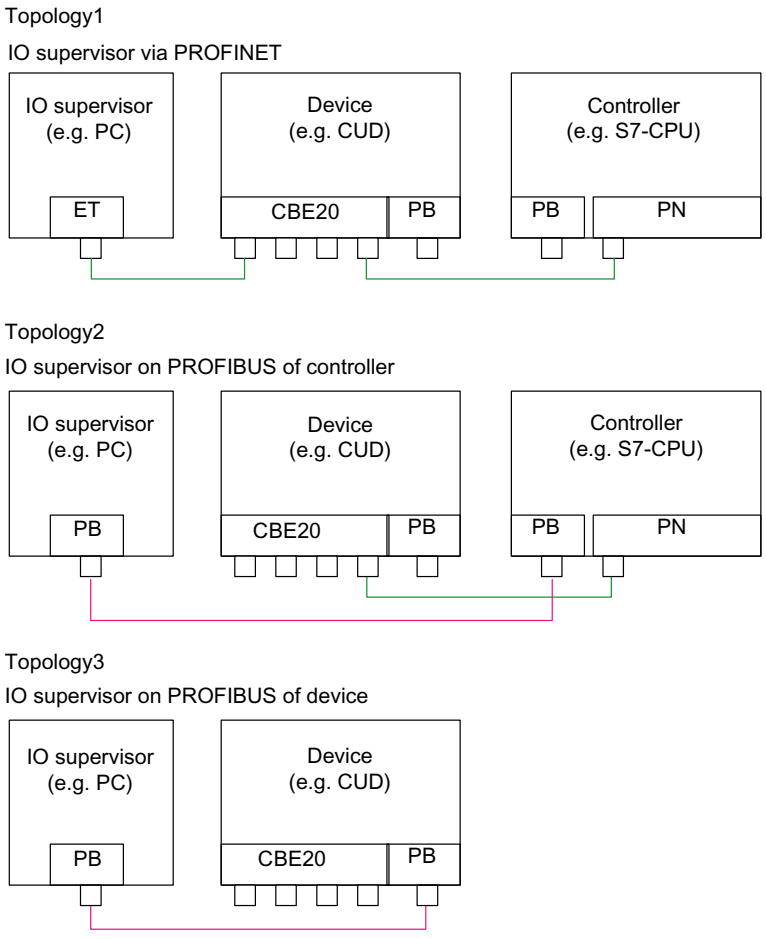


Figure 8-16 Connecting the supervisor

Note

SINAMICS does not support routing from PROFIBUS to PROFINET and vice versa.

Note

If a CBE20 Communication Board Ethernet fails (e.g. due to a power failure), then communication with the subsequent nodes is interrupted at this point.

8.4.2 Application classes

There are various application classes for PROFIdrive corresponding to the scope and type of the application processes.
These application classes refer to drive technology and are therefore not suitable for SINAMICS DCP.

8.4.3 Cyclic communication

Cyclic communication is used to exchange time-critical process data.

8.4.3.1 Telegrams and process data

The process data (PZD) that is to be transferred is defined by appropriately configuring the drive unit (Control Unit).

For each drive object (CU_DCP, DCP_CTRL, TM15DI_DO, TM31, TM150) of the SINAMICS DCP, dedicated process data can be defined for sending or receiving.

From the perspective of the drive unit, the received process data represents the receive words and the process data to be sent the send words.

The receive and send words comprise the following elements:

- Receive words: Control words or setpoints
- Send words: Status words or actual values

PROFIdrive telegrams

- Standard telegrams
  There are no standard telegrams defined for SINAMICS DCP.
- Proprietary telegrams
  There are no proprietary telegrams defined for SINAMICS DCP.
- Free telegrams (p0922 = 999)
  The send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive process data.

Table 8-13 Interconnection parameters for PROFIdrive telegrams

	DCP_CTRL	CU_DCP
Receive process data		
DWORD connector output	r2060[0 ... 62]	-
WORD connector output	r2050[0 ... 63]	r2050[0 ... 19]
Binector output	r2090.0 ... 15 r2091.0 ... 15 r2092.0 ... 15 r2093.0 ... 15	
Free binector-connector converter	p2080[0 ... 15] p2081[0 ... 15] p2082[0 ... 15] p2083[0 ... 15] p2084[0 ... 15] r2089[0 ... 4]	
Send process data		
DWORD connector input	p2061[0 ... 62]	-

	DCP_CTRL	CU_DCP
WORD connector input	p2051[0 ... 63]	p2051[0 ... 24]
Free connector-binector converter	p2099[0 ... 1] / r2094.0 ... 15, r2095.0 ... 15	

Notes on the telegram structure

- Parameter p0978 contains the drive objects that use cyclic PZD exchange. All drive objects after the first entry with "0" do not participate in the cyclic exchange.
- If the value 255 is written to p0978, this drive object is visible to the PROFIdrive controller and empty (without actual process data exchange). This permits cyclic communication of a PROFIdrive controller in the following cases:
  - With unchanged configuration to drive units that have a different number of drive objects.
  - With deactivated drive objects, without having to change the project
- The following must apply to ensure conformity with the PROFIdrive profile:
  - Use PZD receive word 1 as control word for the sequence control.
  - Use PZD send word 1 as status word of the sequence control.
  - The WORD format should be used for PZD1.
- A PZD corresponds to a data word (16 bit).
- Only one of the interconnection parameters (p2051 or p2061) can have the value ≠ 0 for a PZD word, as the assignment of word and double word to the PZDs overlap.

Scaling process data in telegrams

- Physical word and double word variables are transferred in the telegram as reference variables in the value range -200.00 % ... +199.99 %.
  The following definitions apply:
  - Word interconnection (via p2051[...] or r2050[...])

Value in PZD (fieldbus)			Reference variable
WORD	**UINT**	**INT**	
0000 hex	0	0	0.000%
0001 hex	1	+1	+0.006%
...	...	...	...
4000 hex	16.384	+16.384	+100.000%
...	...	...	...
7FFF hex	32.767	+32.767	+199.994%
8000 hex	32.768	-32.768	-200.000%
...	...	...	...
C000 hex	49.152	-16.384	-100.000%
...	...	...	...
FFFF hex	65,535	-1	-0.006 %

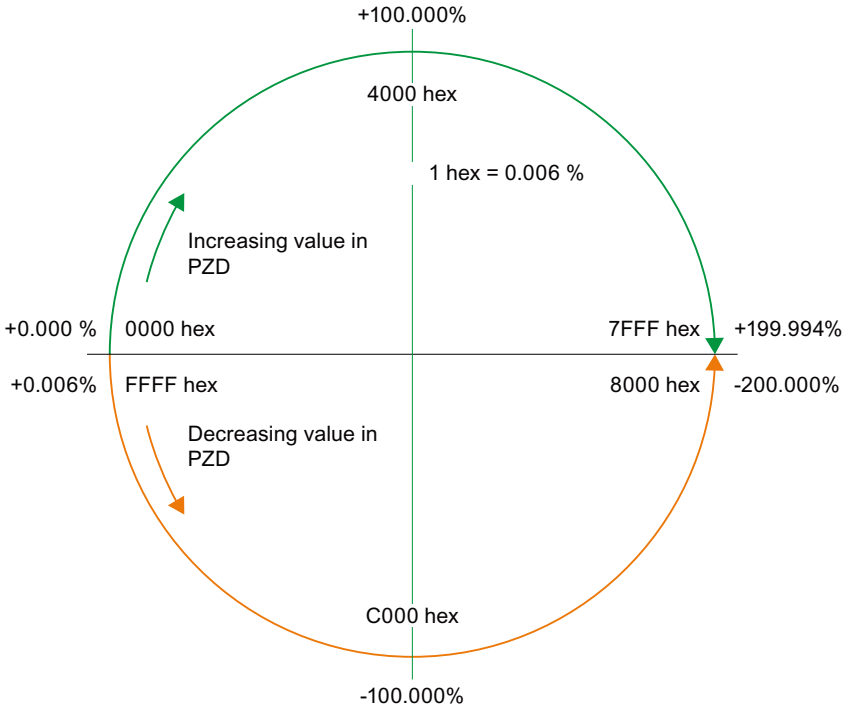


Figure 8-17 The value range and assignment of the value in PZD and reference variable (16 bit / WORD / UINT / integer)

– Double word interconnection (via p2061[...] or r2060[...])

Value in PZD (fieldbus)			Reference variable
DWORD	UDINT	DINT	
0000 0000 hex	0	0	0.000000000 %
0000 0001 hex	1	+1	+0.000000093 %
...	...	...	...
4000 0000 hex	1.073.741.824	+1.073.741.824	+100.000000000 %
...	...	...	...
7FFF FFFF hex	2.147.483.647	+2.147.483.647	+199.999999907 %
8000 0000 hex	2.147.483.648	-2.147.483.648	-200.000000000 %
...	...	...	...
C000 0000 hex	3.221.225.427	-1.073.741.824	-100.000000000 %
...	...	...	...
FFFF FFFF hex	4.294.967.295	-1	-0.000000093 %

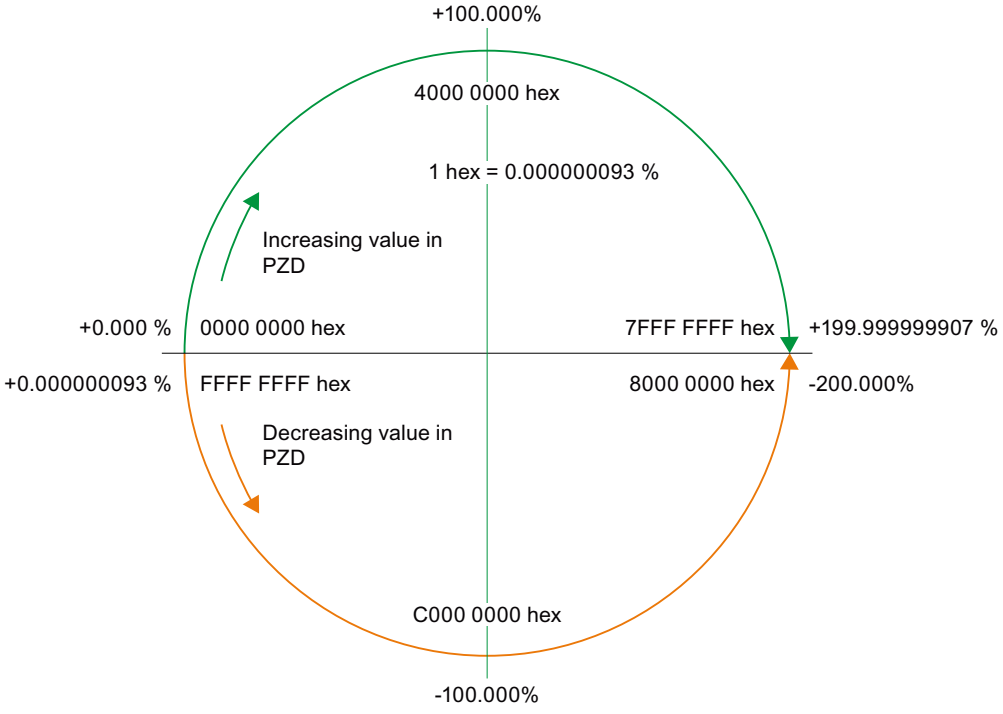


Figure 8-18 The value range and assignment of the value in PZD and reference variable (32 bit / DWORD / UDINT / DINT)

Remark:
For SINAMICS DCP, the double word interconnection hardly has any practical significance as the data to be transferred do not have the accuracy that would justify the high resolution (32 bit).

- In SINAMICS DCP, the conversion described is automatically carried out by the BICO interconnection.

  - Example 1:
    BICO connection p2051[1] = r55501 (see FP2470 and FP6850) means that via PZD word 2 the voltage at side 1 is cyclically sent to the higher-level control system.
    If r55501 outputs 100.00 %, in the higher-level control, value 4000 hex (+16384 dec) is received.
    If r55501 outputs 50.00 %, value 2000 hex (+8192 dec) is received.
  - Example 2:
    BICO connection p55050 = r2050[1] (see FP2460 and FP6805) means that at PZD word 2, the setpoint for the current control, is cyclically received from the higher-level control system.
    If the higher-level control sends a value 4000 hex (+16384 dec), then this is interpreted as setpoint +100.00 %.
    In operation, this value can be seen in r55070.

- Reference quantities:
  Reference parameters p2001 (reference voltage), p2002 (reference current) and r2004 (reference power), known from SINAMICS S120, are not available for SINAMICS DCP.
  Instead, the following reference values should be used:
  - Voltages in the power unit, e.g. r55501, r55502:
    Voltages are referred to the reference voltage (r50071). For a display or setting value of 100.00 %, the voltage therefore corresponds to the reference voltage of SINAMICS DCP. The rated voltage according to the technical data (Chapter "Device data (Page 434)") is used as reference voltage.
  - Currents in the power unit, e.g. r55521, r55522, r55523:
    Currents are referred to the reference current (r50072). For a display or setting value of 100.00 %, the current therefore corresponds to the reference current of the SINAMICS DCP. The rated current according to the technical data (Chapter "Device data (Page 434)") is used as reference current.
  - Powers in the power unit, e.g. r55540:
    Powers are referred to the rated power (r55602 or r50071 x r50072). For a display or setting value of 100.00 %, the power therefore corresponds to the reference power of SINAMICS DCP (Chapter "Device data (Page 434)").
  - Temperatures in the drive (drive object DC_CTRL):
    0 °C are transferred as 0.00 %.
    100 °C is transferred as 100.00 %.
  - Temperatures for TM31, TM150:
    Temperatures are referred to reference temperature (p2006).
    For a display or setting value of 100.00 %, the temperature therefore corresponds to reference temperature of the TM31 or the TM150.

Structure of the telegrams

Depending on the drive object, the following maximum number of process data words can be transferred:

Table 8-14 Number of process data items

Drive objects	Maximum number of PZD	
	Send	Receive
DCP_CTRL	64	64
TM15DI_DO	5	5
TM31	5	5
TM150	5	5
CU_DCP	25	20

Function diagrams (see SINAMICS DCP List Manual)

- 2410 PROFIdrive - PROFIBUS (PB) / PROFINET (PN), addresses and diagnostics

8.4.3.2 Description of the control word

An example for converting control word 1 (STW 1) on the fieldbus is provided in the following.

Table 8-15 Control word 1 (STW1)

Bit	Value	Meaning	Explanation	Operating condition	BICO
0	0	OFF1 requested	Power unit is switched off (pulse inhibit), voltage disconnected, main contactors are opened, switching-on inhibit is withdrawn.	1	BI: p0840
	1	ON	Operating enable (bit 3) possible.		
	0 → 1	Switch-on command	Precharging starts.		
	Note: After the shutdown as a result of OFF2, OFF3 or a fault, the switching-on inhibit becomes active. This is withdrawn using a 0 signal (OFF1).				
1	0	OFF2 requested	Power unit is switched off (pulse inhibit), voltage disconnected, main contactors are opened, switching-on inhibit applied.	1	BI: p0844 BI: p0845
	1	Operating condition no OFF2	Enable (ON, operation) possible.		
	Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845.				

Bit	Value	Meaning	Explanation	Operating condition	BICO
2	0	OFF3 requested	Power unit is switched off (pulse inhibit), voltage disconnected, main contactors are opened, switching-on inhibit applied.	1	BI: p0848 BI: p0849
	1	Operating condition no OFF3	Enable (ON, operation) possible.		
	Note: Control signal OFF3 is generated by ANDing BI: p0848 and BI: p0849.				
3	0	Operation locked	Power unit is switched off (pulse inhibit).	1	BI: p0852
	1	Operation enabled	Power unit enabled, DCP follows the active setpoints.		
4		Reserved			
5		Reserved			
6		Reserved			
7	0 → 1	1. Acknowledge fault			BI: p2103[0]
8		Reserved			
9		Reserved			
10	0	PLC has no master control	Control words and setpoints from the PROFIdrive interface are not evaluated.	1	BI: p0854
	1	Master control by PLC	Control words and setpoints from the PROFIdrive interface are not evaluated.		
	Note: The PROFIdrive controller should only set this bit to "1" after the PROFIdrive device has requested "Master control by PLC" (ZSW1.9 = 1 signal).				
11		Reserved			
12		Reserved			
13		Reserved			
14		Reserved			
15		Reserved			

8.4.3.3 Description of the status word

The following list describes an example for implementing status word 1 (ZSW 1) on the fieldbus.

Table 8-16 Status word 1 (ZSW1)

Bit	Meaning	Explanation		Parameter
0	Ready for switching on	1	Device ready for switching on Power supply switched on, electronics initialized, main contactors are open, pulses inhibited (operation of the power unit).	BO: r0899.0
		0	Device not ready for switching on	
1	Ready for operation	1	Device ready for operation Precharging of sides 1/2 completed, main contactors closed, wait for operating enable (STW1.3).	BO: r0899.1
		0	Device not ready for switching on	

Bit	Meaning	Explanation		Parameter
2	Operation enabled	1	Operation enabled Pulses (operation of the power unit) enabled Operating state o0.	BO: r0899.2
		0	Pulses/operation inhibited	
3	Reserved	-	-	-
4	No OFF2 active	1	OFF2 not active.	BO: r0899.4
		0	OFF2 command active, device was shut down	
5	No OFF3 active	1	OFF3 not active.	BO: r0899.5
		0	OFF3 command active, device was shutdown	
6	Switching on inhibited active	1	Switching-on inhibited active. Before switching on with ON (STW1.0), the operating conditions (see STW1) must be fulfilled and a 0 signal must be available at ON/OFF1 (STW1.0).	BO: r0899.6
		0	Switching-on inhibited not active. The device can be switched on using ON (STW1.0).	
7	Device ready	1	The device is ready (operating states o0...o7).	BO: r0899.7
		0	The device is not ready.	
8	Controller enable	1	Controller enabled (operating state o0)	BO: r0899.8
		0	Controller inhibited	
9	Control requested	1	The automation system is requested to assume control. A 1 signal is always active here.	BO: r0899.9
10	Reserved	-	-	-
11	Pulses enabled	1	Pulses (operation of the power unit) enabled (operating state o0).	BO: r0899.11
		0	Pulses (operation of the power unit) inhibited.	
12	Reserved	-	-	-
13	Reserved	-	-	-
14	Reserved	-	-	-
15	Reserved	-	-	-

8.4.4 Parallel operation of communication interfaces

Cyclic process data (setpoints / actual values) are processed using interfaces IF1 and IF2. The following interfaces are used:

- Onboard interfaces of the CUD for PROFIBUS DP
- An additional interface (COMM-BOARD) for PROFINET or SINAMICS Link, EtherNet/IP and MODBUS (CBE20) for insertion in the CUD as option

Parameter p8839 is used to set the parallel use of the onboard interfaces of the CUD and of the COMM-BOARD in the SINAMICS system. The functionality is assigned to interfaces IF1 and IF2 using indices.

For example, the following applications are possible:

- PROFIBUS DP for control and PROFINET to acquire actual values / measured values of the drive
- PROFIBUS DP for control and PROFINET for engineering only
- Mixed mode with two masters (the first for logic and coordination, and the second for technology)
- SINAMICS Link via IF1 (CBE20); PROFIBUS on IF2
- Operation of redundant communication interfaces

Assignment of communication interfaces to cyclic interfaces

The two cyclic interfaces for the setpoints and actual values differ by the parameter ranges used (BICO technology, etc.) and the functions that can be used. The interfaces are designated as cyclic interface 1 (IF1) and cyclic interface 2 (IF2).

With the factory setting p8839 = 99, the communication interfaces are permanently assigned one of the cyclic interfaces (IF1, IF2), depending on the communication system, e.g. PROFIBUS DP, PROFINET.

The assignment to the cyclic interfaces can essentially be freely defined by user parameterization for the parallel operation of the communication interfaces.

Properties of the cyclic interfaces IF1 and IF2

The following table shows the different features of the two cyclic interfaces:

Table 8-17 Properties of the cyclic interfaces IF1 and IF2

Feature	IF1	IF2
Setpoint (BICO signal source)	r2050, r2060	r8850, r8860
Actual value (BICO signal sink)	p2051, p2061	p8851, p8861
PROFIdrive conformance	Yes	No
PROFIdrive telegram selection (p0922)	No	No
Isochronous mode possible (p8815[0])	No	No
PROFIsafe possible (p8815[1])	No	No
Direct data exchange (PROFIBUS only)	Yes	Yes
List of drive objects (p0978)	Yes	Yes
Max. PZD (16-bit) setpoint / actual value DCP_CTRL	64 / 64	64 / 64
Max. PZD (16-bit) setpoint / actual value TM31	5 / 5	5 / 5
Max. PZD (16-bit) setpoint / actual value TM15DI_DO	5 / 5	5 / 5
Max. PZD (16-bit) setpoint / actual value TM150	5 / 5	5 / 5
Max. PZD (16-bit) setpoint / actual value CU_DCP (Device)	20 / 25	20 / 25

Table 8-18 Implicit assignment of hardware to cyclic interfaces for p8839[0] = p8839[1] = 99

Plugged hardware interface	IF1	IF2
No option, only use Control Unit onboard interface (PROFIBUS)	Control Unit onboard	--
CUD with CBE20 (optional PROFINET interface)	COMM BOARD	Control Unit onboard PROFIBUS

Parameter p8839[0,1] is used to set the parallel operation of the hardware interfaces and the assignment to the cyclic interfaces IF1 and IF2 for the Control Unit drive object.

The object sequence for process data exchange via IF2 depends on the object sequence from IF1; see "List of drive objects" (p0978).

The factory setting of p8839[0.1] = 99 enables the implicit assignment (see previous table).

An alarm is generated in case of invalid or inconsistent parameterization of the assignment.

Parameters for IF2

The following parameters are available in order to optimize the IF2 for a PROFIBUS or PROFINET interface:

- Receive and send process data:
  r8850, p8851, r8853, r8860, p8861, r8863[1)]
- Diagnostic parameters:
  r8874, r8875, r8876[1)]
- Binector-connector converters:
  p8880, p8881, p8882, p8883, p8884, r8889[1)]
- Connector-binector converters:
  r8894, r8895, p8898, p8899[1)]

[1)] Meaning of 88xx is identical to 20xx (for IF1)

Note

Using the HW Config configuration tool, a PROFIBUS/PROFINET device with two interfaces cannot be shown. In parallel operation, this is the reason that SINAMICS DCP appears twice in the project or in two projects, although physically it is just one device.

Parameters

p8839	PZD Interface hardware assignment
Description:	Assigning the hardware for cyclic communication via PZD interface 1 and interface 2.
Values:	0: Inactive
	1: Control Unit onboard
	2: COMM BOARD
	99: Automatic

For p8839, the following rules apply:

- The setting of p8839 applies for all drive objects of a Control Unit (device parameter).
- For the setting p8839[0] = 99 and p8839[1] = 99 (automatic assignment, factory setting), the hardware used is automatically assigned to interfaces IF1 and IF2. Both indices must be selected so that the automatic assignment is activated. If both indices are not selected, then an alarm is output and the setting p8839[x] = 99 is treated just like 'inactive'.
- An alarm is issued if the same hardware (Control Unit onboard or COMM-BOARD) is selected in p8839[0] and p8839[1]. Then the setting of p8839[0] is valid, and the setting of p8839[1] is treated as 'inactive'.
- If p8839[x] is set to 2, and the COMM-BOARD is missing / defective, then the corresponding interface is not automatically supplied from the Control Unit onboard interface. Message A08550 is output instead.

Overview of important parameters (see the SINAMICS DCP List Manual)

- p0922 IF1 PROFIdrive PZD telegram selection
- p0978[0...24] List of drive objects
- p8815[0...1] IF1/IF2 PZD functionality selection
- p8839[0...1] PZD Interface hardware assignment

8.4.5 Acyclic communication

8.4.5.1 General information about acyclic communication

With acyclic communication, as opposed to cyclic communication, data transfer takes place only when an explicit request is made (e.g. in order to read and write parameters).

The "Read data record" and "Write data record" services are available for acyclic communication.

The following options are available for reading and writing parameters:

- S7 protocol
  This protocol uses the STARTER commissioning tool in online operation via PROFIBUS/ PROFINET, for example.
- PROFIdrive parameter channel with the following data sets:
  - PROFIBUS: Data block 47 (0x002F)
    The DPV1 services are available for master class 1 and class 2.
  - PROFINET: Data block 47 and 0xB02F al global access, data set 0xB02E as local access

Note

A detailed description of acyclic communication is provided in the following reference:

- References: PROFIdrive profile
  You can obtain the current version from "PROFIBUS and PROFINET International (PI) (https://www.profibus.com/download/profidrive-profile-drive-technology/)".

Addressing:

- PROFIBUS DP
  The addressing is carried out via the logical address or the diagnostics address.
- PROFINET IO
  The addressing is only undertaken using a diagnostics address which is assigned to a module as of slot 1. Parameters cannot be accessed via slot 0.

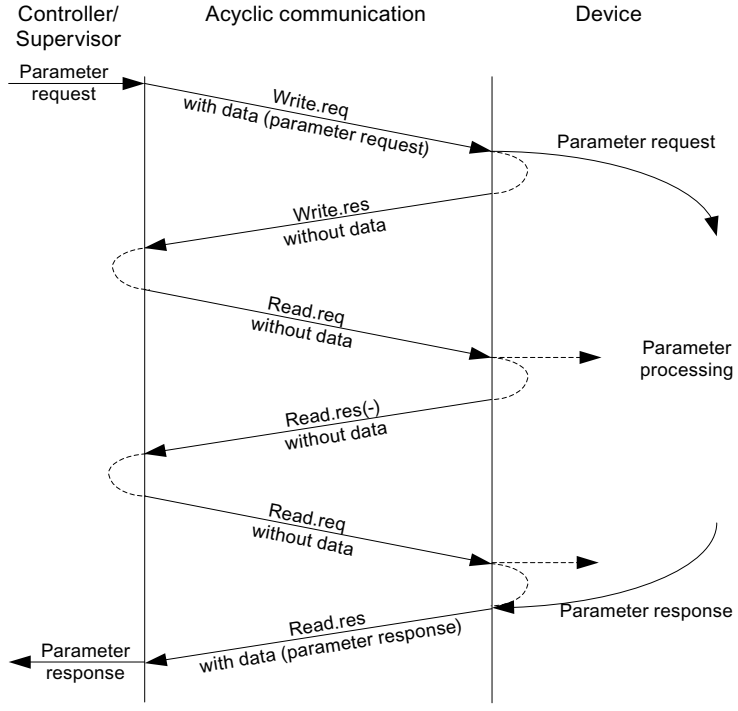


Figure 8-19 Reading and writing data

Properties of the parameter channel

- One 16-bit address exists for each parameter number and subindex.
- Concurrent access by several additional PROFIBUS masters (master class 2) or PROFINET IO Supervisor (e.g. commissioning tool).
- Transfer of different parameters in one access (multiple parameter request).
- Transfer of complete arrays or part of an array possible.
- Only one parameter request is processed at a time for each controller/device connection (no pipelining).
- A parameter request/parameter response must fit into a data set (e.g. PROFIBUS: max. 240 bytes).
- The task or response header are user data.

8.4.5.2 Structure of orders and responses

Structure of parameter request and parameter response

Table 8-19 Parameter request

	Parameter request			**Offset**
Values for write access only	Request header	Request reference	Request ID	0
		Drive object No.	Number of parameters	2
	1st parameter address	Attribute	Number of elements	4
		Parameter number		6
		Subindex		8
	...			
	nth parameter address	Attribute	Number of elements	
		Parameter number		
		Subindex		
	1st parameter value(s)	Format	Number of values	
		Values		
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values		
		...		

Table 8-20 Parameter response

	Parameter response			**Offset**
Values for read access only Error values for negative response only	Response header	Request reference mirrored	Response ID	0
		Drive object No. mirrored	Number of parameters	2
	1st parameter value(s)	Format	Number of values	4
		Values or error values		6
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values or error values		
		...		

Description of fields in the parameter request and response

Table 8-21 Fields

Field	**Data type**	**Values**	**Remark**
Request reference	Unsigned8	01 hex ... FF hex	
	Unique identification of the request/response pair for the master. The master changes the request reference with each new request. The device mirrors the request reference in its response.		
Request ID	Unsigned8	01 hex 02 hex	Read request Write request
	Specifies the type of request. In the case of a write request, the changes are made in a volatile memory (RAM). A save operation is needed in order to transfer the modified data to the non-volatile memory (p0971, p0977).		
Response ID	Unsigned8	01 hex 02 hex 81 hex 82 hex	Read request (+) Write request (+) Read request (-) Write request (-)
	Mirrors the request identifier and specifies whether request execution was positive or negative. Negative means: Cannot execute part or all of request. The error values are transferred instead of the values for each subresponse.		
Drive object number	Unsigned8	01 hex ... FE hex	Number
	Specification of the drive object number for a drive unit with more than one drive object. Different drive objects with separate parameter number ranges can be accessed over the same DPV1 connection.		
Number of parameters	Unsigned8	01 hex ... 27 hex	No. 1 ... 39 Limited by DPV1 telegram length
	Defines the number of adjoining areas for the parameter address and/or parameter value for multi-parameter requests. The number of parameters = 1 for single requests.		

Field	Data type	Values	Remark
Attribute	Unsigned8	10 hex 20 hex 30 hex	Value Description Text (not implemented)
	Type of parameter element accessed.		
Number of elements	Unsigned8	00 hex 01 hex ... 75 hex	Special function No. 1 ... 117 Limited by DPV1 telegram length
	Number of array elements accessed.		
Parameter number	Unsigned16	0001 hex ... FFFF hex	No. 1 ... 65535
	Addresses the parameter to be accessed.		
Subindex	Unsigned16	0000 hex ... FFFF hex	No. 0 ... 65535
	Addresses the first array element of the parameter to be accessed.		
Format	Unsigned8	02 hex 03 hex 04 hex 05 hex 06 hex 07 hex 08 hex other values	Data type integer8 Data type integer16 Data type integer32 Data type unsigned8 Data type unsigned16 Data type unsigned32 Data type floating point See the actual PROFIdrive profile
		40 hex 41 hex 42 hex 43 hex 44 hex	Zero (without values as a positive subresponse to a write request) Byte Word Double word Error
	The format and number specify the adjoining space containing values in the telegram. For write access, it is preferable to specify data types according to the PROFIdrive profile. Bytes, words and double words are also possible as a substitute.		
Number of values	Unsigned8	00 hex ... EA hex	No. 0 ... 234 Limited by DPV1 telegram length
	Specifies the number of subsequent values.		
Error values	Unsigned16	0000 hex ... 00FF hex	Significance of the error values → refer to the following table "Error values in the DPV1 parameter responses"
	The error values in the event of a negative response. If the values make up an odd number of bytes, a zero byte is attached. This ensures the integrity of the word structure of the telegram.		
Values	Unsigned16	0000 hex ... 00FF hex	
	The values of the parameter for read or write access. If the number of bytes is odd, a zero byte is appended. This ensures the integrity of the word structure of the telegram.		

Error values in parameter responses

Table 8-22 Error values in parameter responses

Error value	Meaning	Remark	Additional info
00 hex	Illegal parameter number.	Access to a parameter that does not exist.	–
01 hex	Parameter value cannot be changed.	Modification access to a parameter value that cannot be changed.	Subindex
02 hex	Lower or upper value limit exceeded.	Modification access with value outside value limits.	Subindex
03 hex	Invalid subindex.	Access to a subindex that does not exist.	Subindex
04 hex	No array.	Access with subindex to an unindexed parameter.	–
05 hex	Wrong data type.	Modification access with a value that does not match the data type of the parameter.	–
06 hex	Setting not allowed (only reset).	Modification access with a value not equal to 0 in a case where this is not allowed.	Subindex
07 hex	Description element cannot be changed.	Modification access to a description element that cannot be changed.	Subindex
09 hex	No description data available.	Access to a description that does not exist (the parameter value exists).	–
10 hex	Read request is not executed.	The read request is refused because know-how protection is active.	
0B hex	No operating priority.	Modification access with no operating priority.	–
0F hex	No text array exists.	Access to a text array that does not exist (the parameter value exists).	–
11 hex	Request cannot be executed due to operating status.	Access is temporarily not possible for unspecified reasons.	–
14 hex	Illegal value.	Modification access with a value that is within the limits but is illegal for other permanent reasons (parameter with defined individual values).	Subindex
15 hex	Response too long.	The length of the present 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.	Write request: Illegal or unsupported parameter data format.	–
18 hex	Number of values inconsistent.	Write request: A mismatch exists between the number of values in the parameter data and the number of elements in the parameter address.	–
19 hex	Drive object does not exist.	You have attempted to access a drive object that does not exist.	–
20 hex	Parameter text cannot be changed.	–	–
21 hex	Service is not supported.	Illegal or unknown request ID	–
65 hex	Parameter presently deactivated.	You have tried to access a parameter that, although available, does not currently perform a function (e.g. n control set and access to a V/f control parameter).	–

Error value	Meaning	Remark	Additional info
6B hex	Write access for enabled controller.	Write access is realized while the device is in the "Controller enable" state. In this context, for a description of the parameters, observe parameter attribute "Changeable" (C1, C2, U, T) in the SINAMICS DCP List Manual.	–
6C hex	Parameter %s [%s]: Unknown unit.	–	–
6D hex	Parameter %s [%s]: Write access only in the commissioning state, encoder (p0010 = 4).	–	–
6E hex	Parameter %s [%s]: Write access only in the commissioning state, motor (p0010 = 3).	–	–
6F hex	Parameter %s [%s]: Write access only in the commissioning state, power unit (p0010 = 2).	–	–
70 hex	Parameter %s [%s]: Write access only in the quick commissioning mode (p0010 = 1).	–	–
71 hex	Parameter %s [%s]: Write access only in the ready mode (p0010 = 0).	–	–
72 hex	Parameter %s [%s]: Write access only in the commissioning state, parameter reset (p0010 = 30).	–	–
73 hex	Parameter %s [%s]: Write access only in the commissioning state, Safety (p0010 = 95).	–	–
74 hex	Parameter %s [%s]: Write access only in the commissioning state, tech. application/units (p0010 = 5).	–	–
75 hex	Parameter %s [%s]: Write access only in the commissioning state (p0010 not equal to 0).	–	–
76 hex	Parameter %s [%s]: Write access only in the commissioning state, download (p0010 = 29).	–	–
77 hex	Parameter %s [%s] must not be written during download.	–	–
78 hex	Parameter %s [%s]: Write access only in the commissioning state, drive configuration (device: p0009 = 3).	–	–
79 hex	Parameter %s [%s]: Write access only in the commissioning state, define drive type (device: p0009 = 2).	–	–
7A hex	Parameter %s [%s]: Write access only in the commissioning state, data record base configuration (device: p0009 = 4).	–	–

Error value	Meaning	Remark	Additional info
7B hex	Parameter %s [%s]: Write access only in the commissioning state, device configuration (device: p0009 = 1).	–	–
7C hex	Parameter %s [%s]: Write access only in the commissioning state, device download (device: p0009 = 29).	–	–
7D hex	Parameter %s [%s]: Write access only in the commissioning state, device parameter reset (device: p0009 = 30).	–	–
7E hex	Parameter %s [%s]: Write access only in the commissioning state, device ready (device: p0009 = 0).	–	–
7F hex	Parameter %s [%s]: Write access only in the commissioning state, device (device: p0009 not equal to 0).	–	–
81 hex	Parameter %s [%s] must not be written during download.	–	–
82 hex	Transfer of master control is blocked by BI: p0806.	–	–
83 hex	Parameter %s [%s]: Requested BICO interconnection not possible.	The BICO output does not supply a float value. However, the BICO input requires a float value.	–
84 hex	Parameter %s [%s]: Parameter change inhibited (refer to p0300, p0400, p0922)	–	–
85 hex	Parameter %s [%s]: Access method not defined.	–	–
87 hex	Write request is not executed.	The write request is rejected because know-how protection is active.	–
C8 hex	Below currently valid limit.	Modification request for a value that, although within "absolute" limits, is below the currently valid lower limit.	–
C9 hex	Above currently valid limit.	Modification request for a value that, although within "absolute" limits, is below the currently valid lower limit (e.g. governed by the current converter rating).	–
CC hex	Write access not permitted.	Write access is not permitted because an access code is not available.	–

8.4.5.3 Determining the drive object numbers

Further information about the drive system (e.g. drive object numbers) can be determined as follows using parameters p0101, r0102, and p0107/r0107:

1. The value of parameter r0102 ("Number of drive objects") for drive object/axis 1 is read via a read request.
   Drive object 1 is the Control Unit (CU) which is a minimum requirement for each drive system.
2. Depending on the result of the initial read request, further read requests for drive object 1 are used to read the indices for parameter p0101 ("Drive object numbers"), as specified by parameter r0102.
   Example:
   If the number of drive objects is "5", the values of indices 0 to 4 of parameter p0101 are read.
   Of course, the relevant indexes can also be read at once.

   Note

   The first two points provide you with the following information:
   - The number of drive objects that exist in the drive system
   - The numbers of the existing drive objects
3. Following this, parameter r0107/p0107 ("Drive object type") is read for each drive object (indicated by the drive object number).
   Depending on the drive object, parameter 107 can be either an adjustable parameter or a display parameter.
   The value in parameter r0107/p0107 indicates the drive object type. The coding for the drive object type is specified in the parameter list.
4. As of here, the list of parameters applies to the particular drive object.

8.4.5.4 Example 1: read parameters

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data sets in conformance with PROFIdrive DPV1.

Task description

Following the occurrence of at least one fault (r2139.3 = "1") on drive object 2, the active fault codes must be read from the fault buffer r0945[0] ... r0945[7].

The request is to be handled using a request and response data block.

Basic procedure

1. Create a request to read the parameters.
2. Invoke the request.
3. Evaluate the response.

Create the request

Parameter request			Offset
Request header	Request reference = 25 hex	Request ID = 01 hex	0 + 1
	Drive object No. = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter address	Attribute = 10 hex	Number of elements = 08 hex	4 + 5
	Parameter no. = 945 dec		6
	Subindex = 0 dec		8

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request ID:
  01 hex → This identifier is required for a read request.
- Drive object No.:
  02 hex → Drive 2, fault buffer with drive- and device-specific faults
- Number of parameters:
  01 hex → One parameter is read.
- Attribute:
  10 hex → The parameter values are read.
- Number of elements:
  08 hex → The actual fault incident with eight faults is to be read.
- Parameter number:
  945 dec → p0945 (fault code) is read.
- Subindex:
  0 dec → Reading starts at index 0.

Initiate parameter request

If r2139.3 = "1" → Initiate parameter request.

Evaluate parameter response

Parameter response			Offset
Response header	Request reference mirrored = 25 hex	Response ID = 01 hex	0 + 1
	Drive object No. mirrored = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter value	Format = 06 hex	Number of values = 08 hex	4 + 5
	1st value = 1355 dec		6
	2nd value = 0 dec		8
	...		...
	8th value = 0 dec		20

Information about the parameter response:

- Request reference mirrored:
  This response belongs to the request with request reference 25.
- Response ID:
  01 hex → Read request positive, values stored as of 1st value
- Drive object No. mirrored, number of parameters:
  The values correspond to the values from the request.
- Format:
  06 hex → Parameter values are in the unsigned16 format.
- Number of values:
  08 hex → Eight parameter values are available.
- 1st value ... 8th Value
  A fault is only entered in value 1 of the fault buffer for drive 2.

8.4.5.5 Example 2: write parameters (multi-parameter request)

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data sets in conformance with PROFIdrive DPV1.

Task description

ON command and enable are to be set up via the input terminals of the CUD. A parameter request is to be used to write the corresponding parameters as follows:

- BI: p0840 = r53010.0 ON/OFF1
- BI: p0852 = r53010.6 Enable operation
- CI: p55050 = r52401 Fixed value 1 as current setpoint filter
- p50401 = 80 % Set fixed value 1 to 80 %

The request is to be handled using a request and response data block.

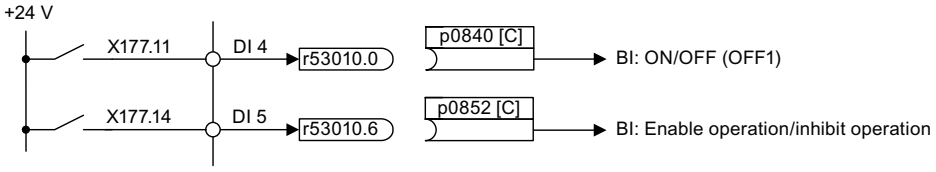


Figure 8-20 Task description for multi-parameter request (example)

To establish BICO interconnections, the target parameters (p0840, p0852, p55050) are transferred a reference to the source parameters (r53010.0, r53010.6, r52401):

Source parameter number	Drive object number	Index number	Parameter value (DINT) for BICO interconnection
r53010	2 (in the example, DCP_CTRL)	0	CF12 0800 hex
r53010	2 (in the example, DCP_CTRL)	6	CF12 0806 hex
r52401	2 (in the example, DCP_CTRL)	0	CCB1 0800 hex
DINT			
Bits 31 ... 16	Bits 15 ... 10	Bits 9 ... 0	

Using drive object No. 63, a drive object can only be interconnected with itself. More detailed information is provided in Chapter "BICO technology: Interconnecting signals (Page 167)".

Basic procedure

1. Create a request to write the parameters.
2. Invoke the request.
3. Evaluate the response.

1. Creating a request

Table 8-23 Parameter request

Parameter request			Offset
Request header	Request reference = 40 hex	Request ID = 02 hex	0 + 1
	Drive object No. = 02 hex	Number of parameters = 04 hex	2 + 3
1st parameter address	Attribute = 10 hex	Number of elements = 01 hex	4 + 5
	Parameter number = 840 dec		6
	Subindex = 0 dec		8
2nd parameter address	Attribute = 10 hex	Number of elements = 01 hex	10 + 11
	Parameter number = 852 dec		12
	Subindex = 0 dec		14
3rd parameter address	Attribute = 10 hex	Number of elements = 01 hex	16 + 17
	Parameter number = 55050 dec		18
	Subindex = 0 dec		20

Parameter request			**Offset**
4th parameter address	Attribute = 10 hex	Number of elements = 01 hex	22 + 23
	Parameter number = 50401 dec		24
	Subindex = 1 dec		26
1st parameter value(s)	Format = 07 hex	Number of values = 01 hex	28 + 29
	Value = CF12 hex		30
	Value = 0800 hex		32
2nd parameter value(s)	Format = 07 hex	Number of values = 01 hex	34 + 35
	Value = CF12 hex		36
	Value = 0806 hex		38
3rd parameter value(s)	Format = 07 hex	Number of values = 01 hex	40 + 41
	Value = CCB1 hex		42
	Value = 0800 hex		44
4th parameter value(s)	Format = 08 hex	Number of values = 01 hex	46 + 47
	Value = 42A0 hex		48
	Value = 0000 hex		50

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request ID:
  02 hex → This identifier is required for a write request.
- Drive object No.:
  02 hex → The parameters are written to drive 2.
- Number of parameters
  04 hex → The multi-parameter request comprises four individual parameter requests.

1st parameter address ... 4th parameter address

- Attribute:
  10 hex → The parameter values are to be written.
- Number of elements
  01 hex → One array element is written.
- Parameter number
  Specifies the number of the parameter to be written to (p0840, p0852, p55050, p50401).
- Subindex:
  0 dec → ID of the first array element.

1st parameter value ... 4th parameter value

- Format:
  07 hex → Data type, unsigned32
  08 hex → Data type, floating point
- Number of values:
  01 hex → A value is written to each parameter in the specified format.
- Value:
  BICO input parameter: Enter signal source
  Adjustable parameter: Enter value

2. Initiating the parameter request

3. Evaluating the parameter response

Parameter response			Offset
Response header	Request reference mirrored = 40 hex	Response ID = 02 hex	0
	Drive object No. mirrored = 02 hex	Number of parameters = 04 hex	2

Information about the parameter response

- Request reference mirrored:
  This response belongs to the request with request reference 40.
- Response ID:
  02 hex → Write request positive
- Drive object No. mirrored:
  02 hex → The value matches the value from the request.
- Number of parameters:
  04 hex → The value matches the value from the request.

8.4.6 Diagnostic channels

SINAMICS drives provide the standard diagnostics for PROFIBUS and PROFINET. This allows the PROFIdrive classes of the SINAMICS drive to be integrated into the system diagnostics of a higher-level control system and automatically displayed on an HMI.

The information transferred is saved for the drive objects in the following parameters:

- r0947[0...63] fault number
- r2122[0...63] alarm code
- r3120[0...63] component fault
- r3121[0...63] component alarm

The messages entered in these parameters are combined to create PROFIdrive message classes for diagnostics. Determining the source of a message is realized by transferring the component number as channel number.

The diagnostics are activated through appropriate parameterization in the configuring tools used (e.g. using HW Config or via HWCN in the TIA Portal).

The functional scope of the diagnostics channels depends on the bus system.

		PROFIdrive message classes		
		Faults	Alarms	Component assignment
PN	GSDML	X	X	X
	TIA	X	X	X
DP	GSD	X	-	-
	TIA	X	-	-

- SINAMICS transfers the messages in the sequence in which they occurred.
- If an alarm appears, SINAMICS sends an "incoming" message. The alarm remains until SINAMICS sends the corresponding "outgoing" message.
- The time stamps are generated from the higher-level controller when the messages are received
- The existing mechanisms of TIA and S7 Classic can be used.
- Alarms or faults are acknowledged using the already known acknowledgment routes.
- Transfer is possible via interface IF1 and/or IF2.

Note

Constraint

If a shared device is activated, only the A-controller can receive diagnostics.

Note

Additional information

PROFIdrive message classes of the individual SINAMICS faults and alarms are provided in the SINAMICS List Manuals.

8.4.6.1 PROFINET-based diagnostics

For PROFINET, to transfer PROFIdrive message classes, channel diagnostics (Channel Diagnosis) are used (see PROFINET IO specification (http://www.profibus.com)).

A message always comprises the following components in this specific sequence:

- Block Header (6 Byte)
  - Blocktype
  - Blocklength
  - BlockversionHigh
  - BlockversionLow
- API (4 Byte)

- Slot Number (2 Byte)
- Sub Slot Number (2 Byte)
- Channel Number (2 Byte)
- Channel Properties (0x8000) (2 Byte)
- User Structure Identifier (2 Byte)
- Channel Diagnosis Data (6 Byte)
  - Channel Number (2 Byte)
  - Channel Properties (2 Byte)
  - Channel Error Type (2 Byte)

Additional information

- Message components (Page 219)
- System response - reading out diagnostics data (Page 221)

Message components

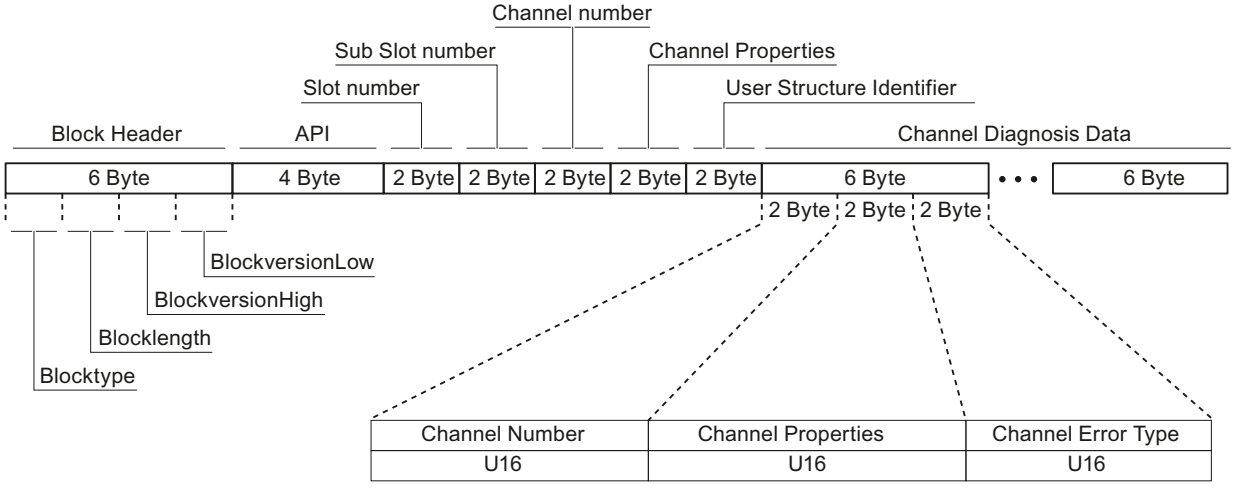


Figure 8-21 Components of a message

Explanation of these message components

Individual components of the Channel Diagnosis Data block can be included n times in a message. A precise explanation of these message components is subsequently provided:

Designation		Data type/ length	For SINAMICS	
			Value	Meaning
Channel Number		U16	1 ... 399	Component number
			0x8000	No component assignment[1)]
Channel Properties		U16		
	.Type	Bits 7 ... 0	0	No data length
	.Accumulative	Bit 8	0	1 channel; no group formation
	.Maintenance	Bits 10, 9	0	Fault → diagnostics
			1	Alarm, Class 0 or A → maintenance *required* Alarm, Class B or C → maintenance *demanded*
			2	
	.Specifier	Bits 12, 11	0	Not used
			1	Message received
			2	Message issued, no additional message available in the channel
			3	Message issued, additional messages are available in the channel
	.Direction	Bits 15 ... 13	3	Input/Output
Channel Error Type		U16	0x9000	Hardware / software error
			0x9001	Network fault
			0x9002	Supply voltage fault
			0x9003	DC link overvoltage
			0x9004	Power electronics faulted
			0x9005	Overtemperature of the electronic components
			0x9006	Ground fault / inter-phase short circuit
			0x9007	Motor overload
			0x9008	Communication error to the higher-level control system
			0x9009	Safety monitoring channel has identified an error
			0x900A	Position/speed actual value incorrect or not available
			0x900B	Internal (DRIVE-CLiQ) communication error
			0x900C	Infeed faulted
			0x900E	Line filter faulted
			0x900F	External measured value / signal state outside the permissible range
			0x9010	Application / technological function faulted
			0x9011	Error in the parameterization / configuration / commissioning procedure
			0x9012	General drive fault
			0x9013	Auxiliary unit faulted

[1)] For messages, which cannot be assigned to any particular component

System response - reading out diagnostics data

The converter can request diagnostics data via "Read data set" (detailed information is provided in the PROFINET-IO specification).

Example:

For example, a read record with index 0x800C can be used to read out diagnostics data from specific sub slots. The following rules apply as example:

- 1 message block
  if, at this drive object (one or several) faults of the same message class are identified
- n messages
  if, at this drive object, n faults of different message classes are identified

Note

If a fault is active on the CU_DCP drive object, then this fault is propagated to all of the drive objects associated with the CU_DCP. This fault can therefore be read out at each drive object.

8.4.6.2 PROFIBUS-based diagnostics

For communication via PROFIBUS, in the case of fault the following diagnostics data is output:

- Standard diagnostics (Page 222)
- Identifier-related diagnostics (Page 222)
- Status messages/module status (Page 223)
- Channel-related diagnostics (Page 224)
- Data sets DS0/DS1 and diagnostics alarm (Page 224)

Message structure

The following applies if a message contains all of the specified diagnostics data:

- Standard diagnostics
  Is always located at the beginning of the message.
- Data sets DS0/DS1 and diagnostics alarm
  Is always located at the end of the message. This message part is always slot-specific. The actual state of the slot responsible for the message is always transferred in the message.

The other diagnostics data (types) can be in any sequence. This is the reason that the following diagnostics data include a header:

- Identifier-related diagnostics
- Status messages/module status
- Channel-related diagnostics

The diagnostic data type can be uniquely identified based on the header.

Note

The master must operate in the DPV1 mode.

Standard diagnostics

For communication via PROFIBUS, standard diagnostics is structured as follows.

	Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Octet	**Name**								
1	Station status 1	Master_ Lock = 0	Prm_Fault	0	Not_ Supported	**Ext_Diag**	Cfg_Fault	Station_ Not_ Ready	Station_ Non_ Exist = 0
2	Station status 2	0	0	Sync_ Mode	Freeze_ Mode	WD_On	1	**Stat_Diag** = 0	Prm_Req
3	Station status 3	**Ext_ Diag_ Overflow**	0	0	0	0	0	0	0
4		Master_Add							
5		Ident_Number (HighByte) of the device							
6		Ident_Number (LowByte) of the device							

In this context, the following values are decisive for diagnostics:

- Ext_Diag
  - Group signal for diagnostics in the device
  - = 1, if at least 1 alarm is active
- Ext_Diag_Overflow
  Display, diagnostics overflow in the device (for more than 240 bytes)

Identifier-related diagnostics

The identifier-related diagnostics provides a bit (KB_n) for each slot 1 allocated when configuring the device. If a diagnostics message is active at a slot, then it's KB_n = true.

	Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Octet	**Name**								
1	Header-Byte Station status 1	0	1	Block length (2 ... 32) incl. this byte					
2	Bit structure	KB_7	KB_6	KB_5	KB_4	KB_3	KB_2	KB_1	KB_0
3	Bit structure	...	...	...	...	KB_11	KB_10	KB_9	KB_8

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
...		...							
x	Bit structure	...	...	KB_n+1	KB_n	...	...	...	...

Status messages/module status

Status messages and module status briefly represent an overview of the state of the devices:

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
1	Header byte	0	0	Block length (2 ... 32) incl. this byte					
2	Module status	0x82							
3	Slot	0							
4	Specifier	0							
5		Slot_4		Slot_3		Slot_2		Slot_1	
6		...		Slot_7		Slot_6		Slot_5	
...		...							
x		00		Slot_n		...		...	

Note

Status value

Diagnostics for SINAMICS are only available in cyclic PROFIBUS operation, so that the state 00 = "Valid useful data" is always output for all slots.

Channel-related diagnostics

Channel-related diagnostics encompasses the following data:

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
x	Header-Byte	1[1)]	0[1)]	0 ... 63 (module number) including this byte					
x + 1		1[2)]	1[2)]	0 (no component assignment)					
x + 2		0[3)]	0[3)]	Message classes: 2 undervoltage 3 overvoltage 9 error 16 Hardware/software error 17 Line supply/filter faulted 18 DC-link overvoltage 19 Power electronics faulted 20 Electronic component overtemp. 21 Ground/phase fault detected 22 Motor overload 23 Commun. with controller faulted 24 Safety monit. Detected an error 25 Act. Position/speed value error 26 Internal communication faulted 27 Infeed faulted 28 Braking controller faulted 29 External signal state error 30 Application/function faulted 31 Parameterization/commiss. error				

1) ≙ Channel-related diagnostics

2) ≙ Input/output

3) ≙ "Channel type "non specific"

System response

Only one signal is generated if channel-related diagnostics identifies several faults belonging to the same message class at the same drive object.

Data sets DS0/DS1 and diagnostics alarm

The PROFIdrive message classes are transferred using diagnostic alarm DS0/DS1. All faults are assigned channel 0 (Cha 0). The drive objects are assigned using the slot number.

The structure is as follows:

Bit		7	6	5	4	3	2	1	0
Octet	**Name**								
1	Header-Byte	0	0	= 15 (block length)					
2		0	= 1 (diagnostics alarm)						
3		0 ... 244 (slot number ≙ drive object)							
4		0 ... 31 (sequence number)					Add_Ack	Alarm_Specifier[1)]	
5	DS0 (byte 0)	0	0	0	0	1[2)]	0	1[3)]	1[4)]

Bit		7	6	5	4	3	2	1	0
Octet	Name								
6	DS0 (byte 1)	0	0	0	1[5)]	0[6)]	0[6)]	1[6)]	1[6)]
7	DS0 (byte 2)	0	0	0	0	0	0	0	0
8	DS0 (byte 3)	0	0	0	0	0	0	0	0
9	Info (byte 1)	Mixed	= 0x45 (ChannelTypeID = SINAMICS)						
10	Info (byte 2)	= 24 (number of diagnostic bits/channel)							
11	Info (byte 3)	= 1 (1 channel signals)							
12	Channel Error Vector	0	0	0	0	0	0	0	Channel 0 1
13	Channel -related diag-nostics (channel 0)	Err 7	Err 6	Err 5	Err 4	Err 3	Err 2	Err 1	Err 0
14		Err 15	Err 14	Err 13	Err 12	Err 11	Err 10	Err 9	Err 8
15		0	0	0	0	Err 19	Err 18	Err 17	Err 16

1) Alarm_Specifier
1 ≙ error has occurred and the slot is not OK
2 ≙ error is resolved and the slot is OK
3 ≙ error is resolved and the slot is not okay

2) Channel fault present
= 1; as long as the drive object has an error condition

3) Internal fault
= 1; as long as the drive object has an error condition

4) Module fault
= 1; as long as the drive object has an error condition

5) Channel information present
= 1; ≙ DS1 exists

6) Type class of module
= 0011; ≙ Distributed

8.5 Communication via PROFIBUS DP

8.5.1 General information about PROFIBUS

8.5.1.1 General information about PROFIBUS for SINAMICS

PROFIBUS is an open international fieldbus standard for a wide range of production and process automation applications.

The following standards ensure open, multi-vendor systems:

- International standard IEC 50170
- International standard IEC 61158

PROFIBUS is optimized for high-speed, time-critical data communication at field level.

Note

PROFIBUS for drive technology is standardized and described in the following document:

PROFIdrive Profile Drive Technology

PROFIBUS User Organization e. V.
Haid-und-Neu-Strasse 7, D-76131 Karlsruhe, Germany
http://www.profibus.com

NOTICE
Destruction of the CUD or other CAN bus nodes when connecting a CAN cable
No CAN cables must be connected to interface X126. If CAN cables are connected, the CUD and other CAN bus nodes may be destroyed.

Master and device

- Master and device properties

Properties	**Master**	Device
As bus node	Active	Passive
Send messages	Permitted without external request	Only possible on request by master
Receive messages	Possible without any restrictions	Only receive and acknowledge permitted

- Master
  Masters are categorized into the following classes:
  - Master class 1 (DPMC1):
    Central automation stations that exchange data with the devices in cyclic and acyclic mode. Communication between the masters is also possible.
    Examples: SIMATIC S7, SIMOTION
  - Master class 2 (DPMC2):
    Devices for configuration, commissioning, operator control and monitoring during bus operation. Devices that only exchange data with the devices in acyclic mode.
    Examples: Programming devices, human machine interfaces
- Devices
  With respect to PROFIBUS, the SINAMICS drive unit is a device.

Bus access method

PROFIBUS uses the token passing method, i.e. the active stations (masters) are arranged in a logical ring in which the authorization to send is received within a defined time frame.

Within this time frame, the master with authorization to send can communicate with other masters or handle communication with the assigned devices in a master/device procedure.

PROFIBUS telegram for cyclic data transmission and acyclic services

Each drive unit that supports cyclic process data exchange uses a telegram to send and receive all the process data. A separate telegram is sent in order to perform all the acyclic services (read/write parameters) under a single PROFIBUS address. The acyclic data is transferred with a lower priority after cyclic data transmission.

The overall length of the telegram increases with the number of drive objects that are involved in exchanging process data.

Note

SINAMICS DCP does not support isochronous operation. The closed-loop control is independent of the PROFIBUS clock cycle.

Sequence of drive objects in the telegram

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...24] where it can also be changed.

You can use the STARTER commissioning tool to display the sequence of drive objects for a commissioned drive system in online mode in the project navigator under "Drive unit" **>** "Communication" > "Telegram configuration".

When you create the configuration on the controller side (e.g. HWConfig), the process-data-capable drive objects for the application are added to the telegram in this sequence.

The following drive objects can exchange process data:

- Control Unit (CU_DCP)
- DC control (DCP_CTRL)

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

After the first entry with "0" in p0978, it is not permissible that drive objects are configured in HW Config.

The telegram structure depends on the drive objects taken into account during configuration. Configurations are permitted that do not take into account all of the drive objects that are present in the drive system.

Example:

The following configurations, for example, are possible:

- Configuration with CU_DCP, DCP_CTRL
- Configuration with DCP_CTRL
- and others

8.5.1.2 Example of a telegram structure for cyclic data transfer

Task

The drive system comprises the following drive objects:

SINAMICS DCP with the objects

- Control Unit (CU_DCP)
- DC control (DCP_CTRL)

8.5.2 PROFIBUS connection



⚠ WARNING

Electric shock when connecting with voltage present

When connecting the PROFIBUS cable with voltage present, there is a danger of coming into contact with live components behind the connection point.

Touching live components can result in death or serious injury.

- Only connect the PROFIBUS cable to connector X126 when the unit is in a de-energized state.

Position of PROFIBUS connection and diagnostics LEDs

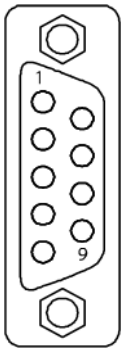
The PROFIBUS connection and diagnostics LEDs are located on the Control Unit (CUD).

The PROFIBUS connection is via a 9-pin Sub-D socket (X126). The connections are electrically isolated.

See also Chapter "Description of the LEDs on the CUD (Page 362)".

PROFIBUS connection

Table 8-24 X126 - PROFIBUS connector assignment

Connector	Pin	Signal name	Technical specifications
	1	-	Not assigned
	2	-	Not assigned
	3	RxD/TxD-P	RS485 receive/transmit data P (B)
	4	CNTR-P	Control signal (TTL)
	5	DGND	PROFIBUS data ground
	6	VP	Positive supply voltage (5 V +/-10%)
	7	-	Not assigned
	8	RxD/TxD-N	RS485 receive/transmit data N (A)
	9	-	Not assigned
Advanced CUD			

Bus connector

PROFIBUS cables must be connected using special PROFIBUS plug connectors. These include additional bus terminating resistors in order to correctly terminate the ends of the PROFIBUS bus line.

Matching PROFIBUS bus connector, Order No. 6GK1500-0FC10:

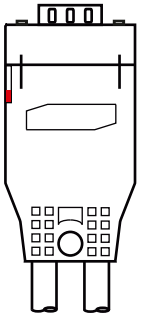


Figure 8-22 PROFIBUS bus connector

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 transferred correctly.

Rule: The terminating resistors must only be switched on at both ends of the bus line; the resistors must be switched off at all other connectors.

The cable shield must be connected at both ends and over a large surface area.

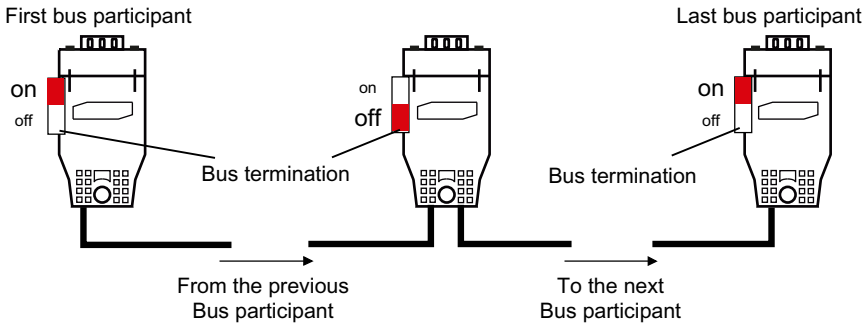


Figure 8-23 Position of the bus terminating resistors

8.5.3 Commissioning PROFIBUS

8.5.3.1 Setting the PROFIBUS interface

Interfaces and diagnostic LED

See Chapter "PROFIBUS connection (Page 228)".

Note

A teleservice adapter can be connected to the PROFIBUS interface (X126) for remote diagnostics purposes.

Setting the PROFIBUS address

The PROFIBUS address is set using p0918.

The factory setting is 126.

Each PROFIBUS address in a PROFIBUS line can only be assigned once. When several Control Units are connected to a PROFIBUS line, you set the addresses differently than the factory setting.

The PROFIBUS address can be changed

- Using the BOP20
- Using STARTER

You must switch to DO 1 (CU_DCP) to change the bus address using the BOP. Access level p0003 = 3 is required to change p0918.

When using the STARTER commissioning tool, make sure that the bus address p0918 in the offline project matches the online value. If this is not the case, the value is overwritten at the next upload or download.

The PROFIBUS address must be saved in a non-volatile way using the "Copy RAM to ROM" function.

The change made to the bus address takes effect after POWER ON.

8.5.3.2 PROFIBUS interface in operation

Generic Station Description

A generic station description file clearly and completely defines the properties of a PROFIBUS device.

The GSD files can be found:

- On the Internet. For the link, see "Product documentation (Page 13)"
- On the memory card in the \\SIEMENS\SINAMICS\DATA\CFG directory.

The integration of a GSD file in HW Config is described in the SIMATIC documentation. PROFIBUS component suppliers can provide their own bus configuration tool. The description of the respective bus configuration tool is described in the relevant documentation.

Device identification

Identification for individual devices facilitates diagnostics and provides an overview of the nodes on the PROFIBUS.

The information for each device is stored in the following CU-specific parameter:
r0964[0...6] device identification

Bus terminating resistor and shielding

Reliable data transmission via PROFIBUS depends, amongst other things, on the setting of the bus terminating resistors and the shielding of the PROFIBUS cables.

- Bus terminating resistor
  The bus terminating resistors in the PROFIBUS plugs must be set as follows:
  - First and last nodes in the line: Switch on terminating resistor
  - Other nodes in the line: Switch off terminating resistor
- Shielding of the PROFIBUS cables
  The cable shield must be connected in the plug through a large surface area at both ends. See also Chapter "PROFIBUS connection (Page 228)".

8.5.3.3 Commissioning PROFIBUS

Preconditions and assumptions for commissioning

PROFIBUS device

- The PROFIBUS address to be set for the application is known.

PROFIBUS master

- The communication properties of the SINAMICS DCP device must be available in the master (GSD file or Drive ES device OM).

Commissioning steps (example with SIMATIC S7)

1. Set the PROFIBUS address on the device.
2. Set the telegram type on the device.
3. Perform the following in the HW Config:
   - Connect the drive unit to PROFIBUS and assign the address.
   - Set the telegram type.
     SINAMICS DCP only supports the "Free telegram configuration with BICO".
     The master can send more process data than the device uses. A telegram with a larger PZD number than is assigned for the drive object STARTER can be configured on the master.
     The PZDs not supplied by the drive object are filled with zeros.
     The setting "without PZD" can also be defined for a node or object.
4. Assign the I/O addresses according to the user program.

8.5.3.4 Diagnostics options

The standard device diagnostics can be read online in the HW Config.

8.5.3.5 SIMATIC HMI addressing

You can use a SIMATIC HMI as a PROFIBUS master (master class 2) to access SINAMICS directly. With respect to SIMATIC HMI, SINAMICS behaves like a SIMATIC S7. For accessing drive parameters, the following simple rule applies:

- Parameter number = data block number
- Parameter subindex = bit 0 ... 9 of data block offset
- Drive object number = bit 10 ... 15 of data block offset

Pro Tool and WinCC flexible

The SIMATIC HMI can be configured flexibly with "Pro Tool" or "WinCC flexible".

The following specific settings for drives must be observed when configuration is carried out with Pro Tool or WinCC flexible.

Controllers: Protocol always "SIMATIC S7 - 300/400"

Table 8-25 Additional parameters

Field	Value
Network parameter profile	DP
Network parameter baud rate	Any

Field	Value
Communication partner address	PROFIBUS address of the drive unit
Communication partner slot/rack	don't care, 0

Table 8-26 Variables: "General" tab

Field	Value
Name	Any
Controller	Any
Type	Depending on the addressed parameter value, e.g.: INT: for integer 16 DINT: for integer 32 WORD: for unsigned 16 REAL: for float
Range	DB
DB (data block number)	Parameter number 1 ... 65535
DBB, DBW, DBD (data block offset)	Drive object no. and subindex bit 15 ... 10: Drive object no. 0 ... 63 bit 9 ... 0: Subindex 0 ... 1023 or expressed differently DBW = 1024 * drive object no. + subindex
Length	Not activated
Acquisition cycle	Any
Number of elements	1
Decimal places	Any

Note

- You can operate a SIMATIC HMI together with a drive unit independently of an existing controller.
  A basic "point-to-point" connection can only be established between two nodes (devices).
- The "variable" HMI functions can be used for drive units. Other functions cannot be used (e.g. "messages" or "recipes").
- Individual parameter values can be accessed. Entire arrays, descriptions, or texts cannot be accessed.

8.5.3.6 Monitoring telegram failure

When monitoring telegram failure, SINAMICS differentiates between two cases:

- Telegram failure with a bus fault
  After a telegram failure, and the additional monitoring time has elapsed (p2047), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for shutdown, for example.
  Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 initiates fault response OFF3 (shutdown) at the DO DCP_CTRL. If no OFF response is to be initiated, then the fault response can be reparameterized accordingly.
  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.

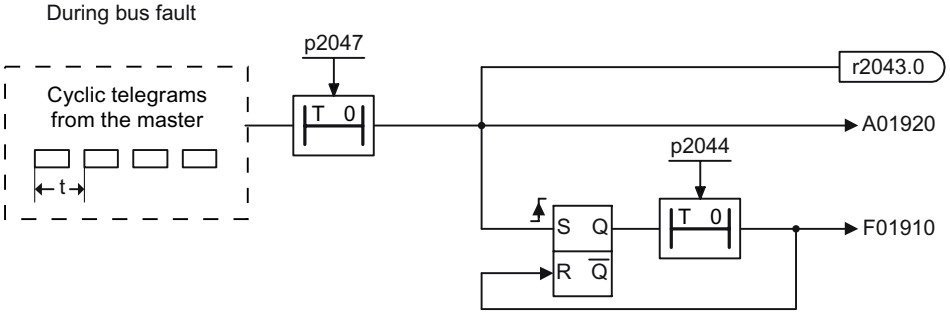


Figure 8-24 Monitoring telegram failure with a bus fault

- Telegram failure with a CPU stop
  After telegram failure, bit r2043.0 is set to "1". Binector output r2043.0 can be used for shutdown, for example.
  Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 initiates fault response OFF3 (shutdown) at the DO DCP_CTRL. If no OFF response is to be initiated, then the fault response can be reparameterized accordingly.
  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.

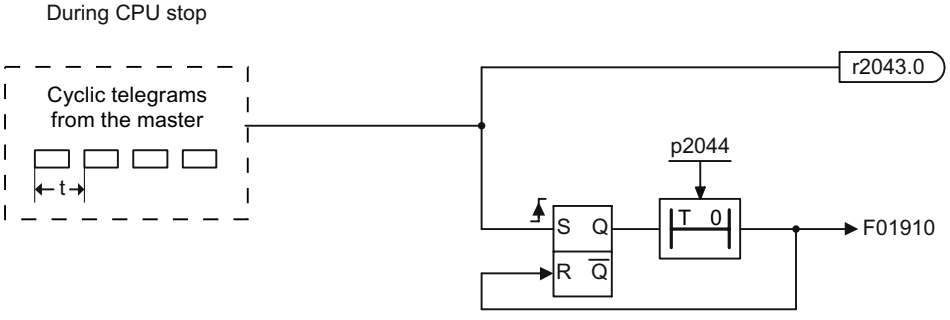


Figure 8-25 Monitoring telegram failure for a CPU stop

Example: Quick stop at telegram failure

Settings:

- CU_DCP p2047 = 20 ms
- DCP_CTRL p2044 = 0 s

Sequence:

1. Following a telegram failure and once the additional monitoring time (p2047) has elapsed, binector output r2043.0 of drive object CU_DCP goes to "1".
   Alarm A01920 and fault F01910 are output at the same time for DC_CTRL drive objects.

- When F01910 is output, an OFF3 is triggered.

Note

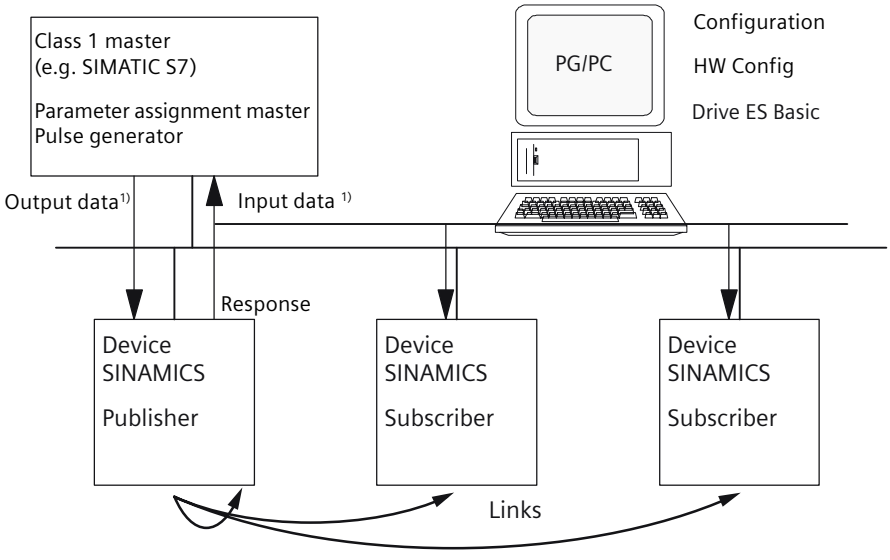
The additional monitoring time (p2047) is only useful for cyclic communication.

8.5.4 Direct data exchange

For PROFIBUS DP, the master interrogates all of the devices one after the other in a DP cycle. In this case, the master transfers its output data (setpoints) to the particular device and receives as response the input data (actual values). Fast, distributed data transfer between drives (devices) is possible using the "direct data exchange" function without direct involvement of the master.

The following terms are used for the function described in this chapter:

- Device-to-device communication
- Data exchange broadcast (DXB.req)
- Direct data exchange (is used in the following)



1) From the perspective of the Class 1 master

Figure 8-26 Direct data exchange communication with the publisher-subscriber model

Publisher

With the "direct data exchange" function, at least one device must act as the publisher.

The publisher is addressed by the master when the output data is transferred with a modified layer-2 function code (DXB.req). The publisher then sends its input data for the master with a broadcast telegram to all bus nodes.

Subscriber

The subscribers evaluate the broadcast telegrams sent from the publishers, and use the data which has been received as setpoints. These setpoints of the publisher are used in addition to the setpoints received from the master, corresponding to the configured telegram structure (p0922).

Links and taps

The links configured in the subscriber (connections to publisher) contain the following information:

- From which publisher is the input data received?
- What is the content of the input data?
- Where are the additional setpoints received?

Several taps are possible within a link. Several input data or input data areas, which are not associated with one another, can be used as setpoint via a tap.

Links are possible on the drive unit itself. This internal link corresponds, as far as the timing is concerned, to a link via PROFIBUS.

Requirements

The following requirements should be observed for the "direct data exchange" function:

- STARTER as of Version 4.2
- Configuration:
  - Drive ES Basic, Drive ES SIMATIC or Drive ES PCS7 as of Version 5.3 SP3
  - Alternatively using a GSD file
- The maximum number of process data per drive can be identified from the value in r2050 - minus the resources that have already been used
- A maximum of 16 links to publishers

Applications

For example, the following application can be implemented using the "direct data exchange" function:

- Specifying binector connections from another device

8.5.4.1 Setpoint assignment in the subscriber

Information about setpoints

- Number of setpoint
  When bus communication is being established, the master signals the device the number of setpoints (process data) to be transferred using the configuring telegram (ChkCfg).
- Contents of the setpoints
  The structure and contents of the data are determined using the local process data configuration for the "SINAMICS device".
- Operation as "standard" device
  The drive unit (device) only receives its setpoints as output data from the master.
- Operation as subscriber
  When a device is operated as a subscriber, some of the setpoints are defined by one or more publishers rather than by the master.
  The device is informed of the assignment via the parameterization and configuration telegram when bus communication is being established.

8.5.4.2 Activating/parameterizing direct data exchange

The "direct data exchange" function must be activated in the publishers as well as in the subscribers, whereby only the subscriber is to be configured. The publisher is automatically activated during bus startup.

Activation in the publisher

The master is informed abut which devices are to be addressed as publishers with a modified layer 2 function code (DXB req) via the configuration of the subscriber links.

The publisher then sends its input data not only to the master but also as a broadcast telegram to all bus nodes.

These settings are made automatically using the bus configuration tool (e.g. HW Config).

Activation in the subscriber

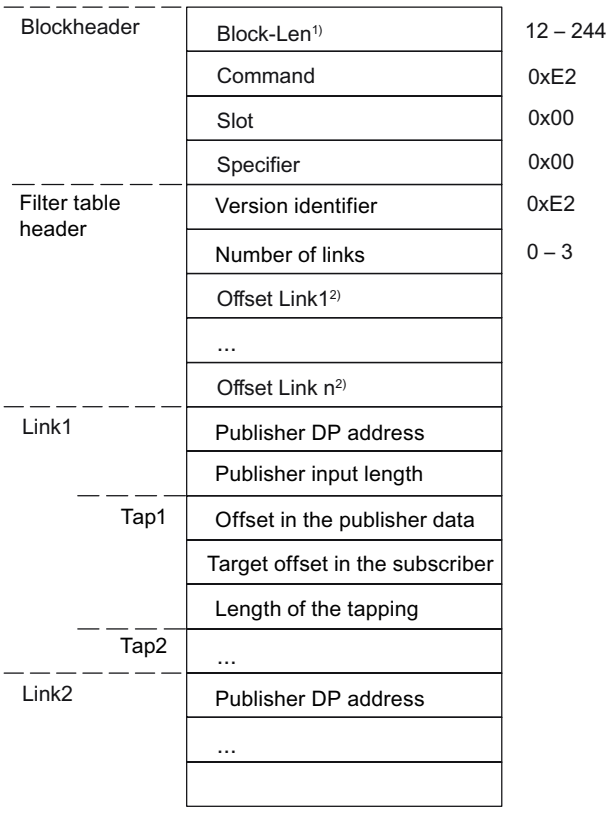
The device, which is to be used as subscriber, requires a filter table. The device must know which setpoints are received from the master and which are received from a publisher.

The filter table is created automatically via the bus configuration tool (e.g. HW Config).

The following diagram shows the information contained in the filter table.

Parameterizing telegram

The filter table is transferred as a dedicated block from the master to the device with the parameterizing telegram when a bus communication is established.



1) Specified in bytes
2) Calculated as of version identifier

Figure 8-27 Filter block in the parameterizing telegram (SetPrm)

Configuration telegram

Using the configuration telegram, a device knows how many setpoints are to be received from the master and how many actual values are to be sent to the master.

For direct data exchange, a special space ID is required for each tap. The PROFIBUS configuration tool (e.g. HW Config) generates this ID. The ID is then transferred with the ChkCfg to the drive devices that operate as subscribers.

8.5.4.3 Commissioning the PROFIBUS direct data exchange

The commissioning of direct data exchange between two SINAMICS drives using the additional Drive ES Basic package is described below.

Settings in HW Config

The project below is used to describe the settings in HW Config.

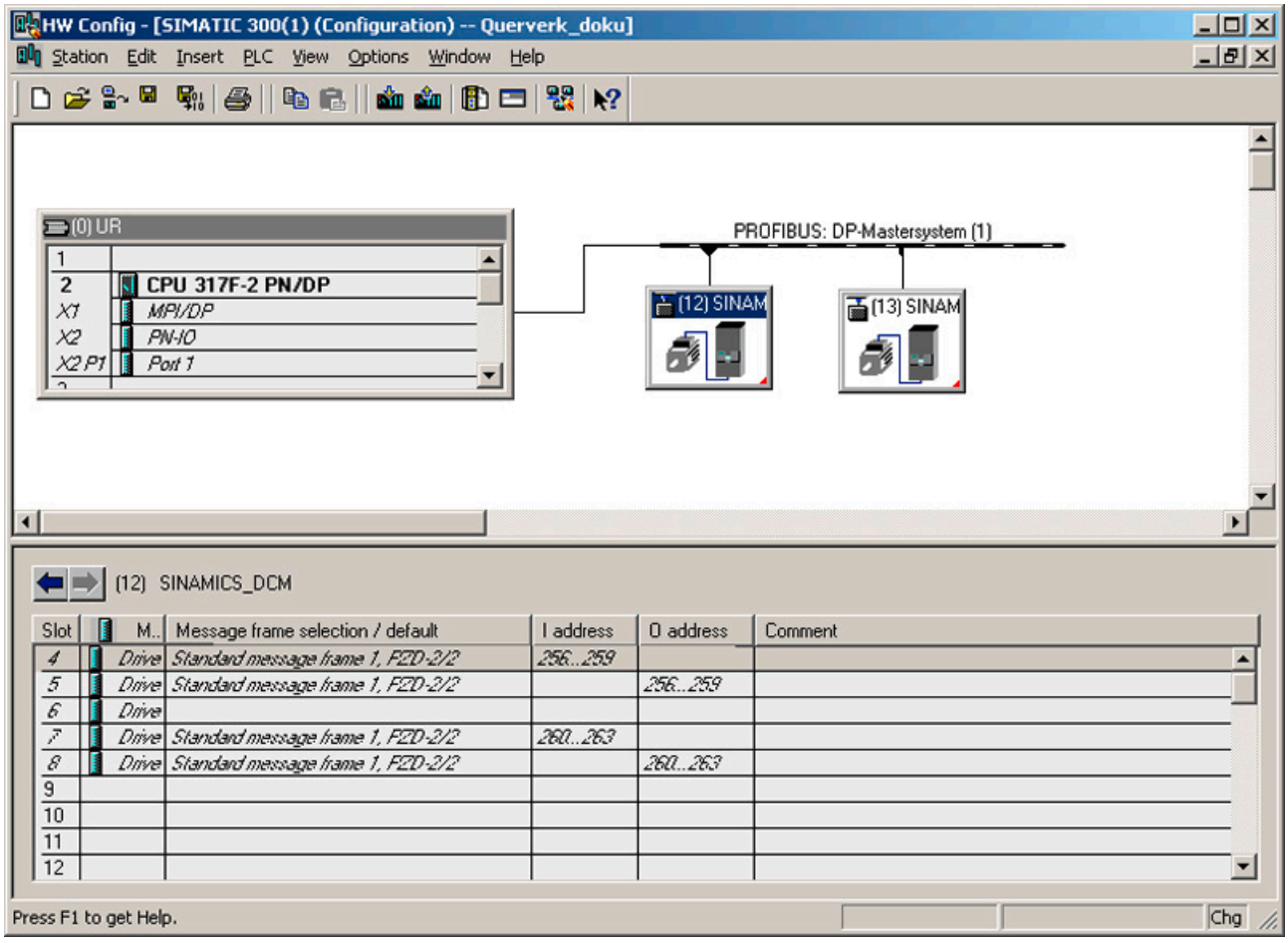


Figure 8-28 Example of a PROFIBUS network in HW Config

Procedure

1. Select a device (e.g. SINAMICS DCP) and use its properties to configure the telegram for the connected drive object.
2. Configure the telegram for the drive object.

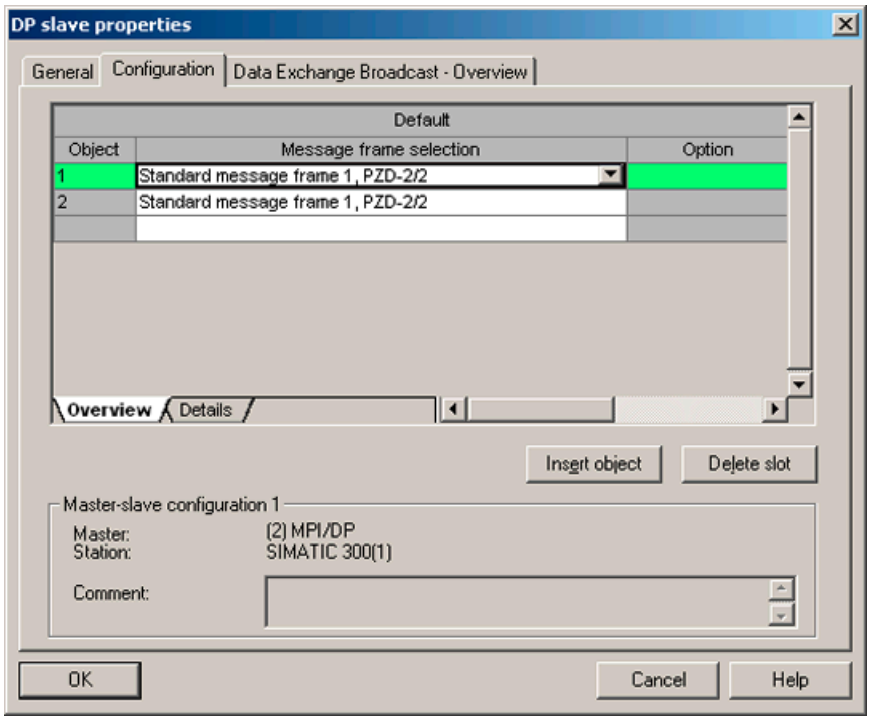


Figure 8-29 Telegram selection for drive object

3. Then go to the detail view.
   Slots 4/5 contain the actual value / setpoint for the drive object.
   Slots 7/8 are the telegram portions for the actual value / setpoint of the CU.

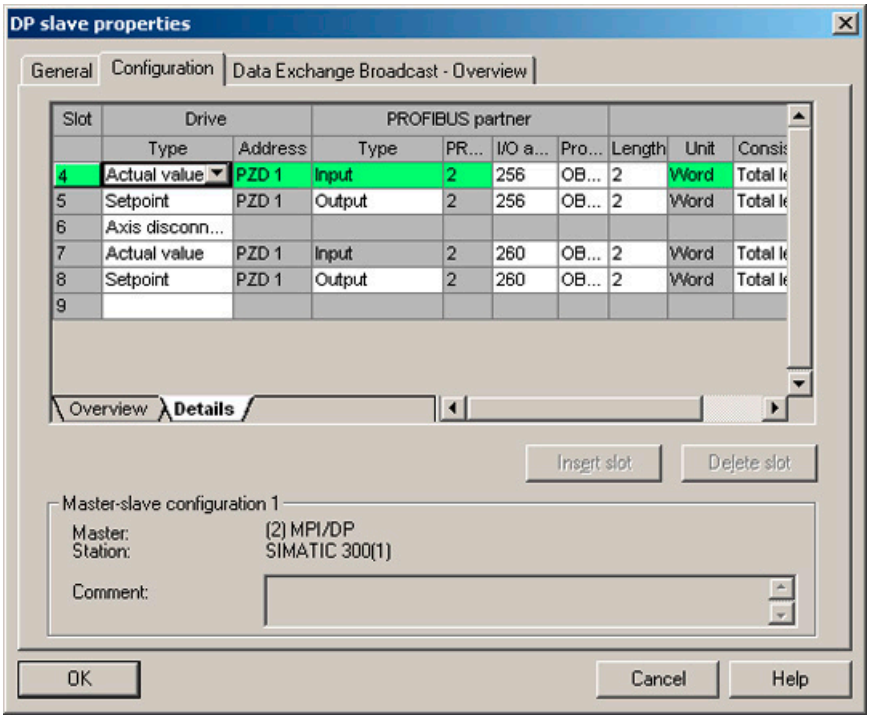


Figure 8-30 Detail view of device configuration

4. The "Insert slot" button can be used to create a new setpoint slot for the SINAMICS DCP drive object.

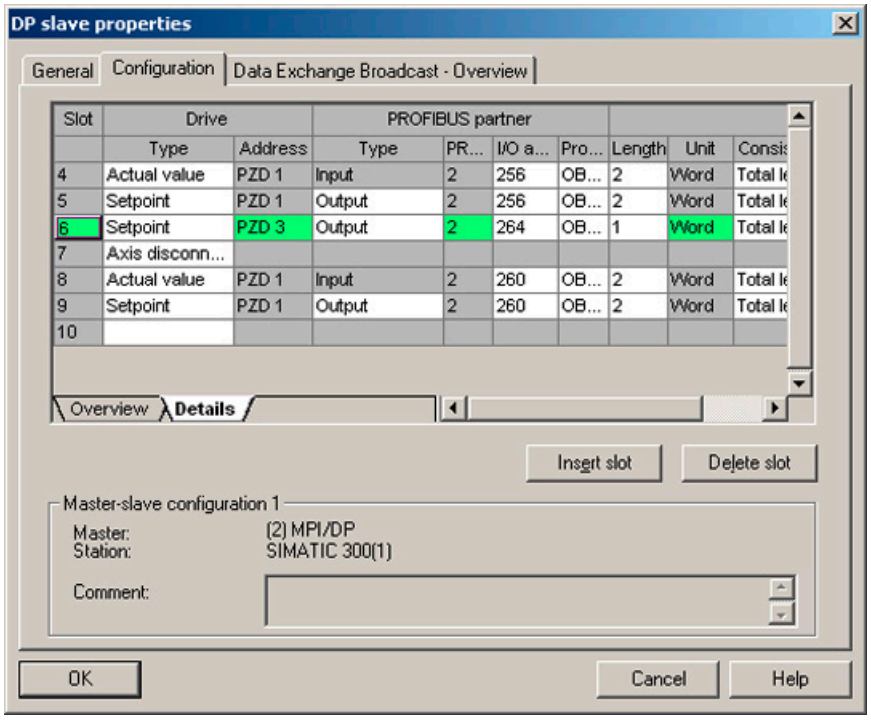


Figure 8-31 Insert new slot

5. Assign the setpoint slot the type "direct data exchange".
6. Select the publisher DP address in the "PROFIBUS address" column. All PROFIBUS DP devices are listed here from which actual value data can be requested. It also provides the possibility of sharing data via direct data exchange within the same drive group.

7. The "I/O address" column displays the start address for every DO. Select the start address of the DO data to be read. In example 268: If the complete data of the publisher is not read, then set this using the "Length" column. You may also offset the start address for the request so that data can be read out in the middle of the DO telegram.

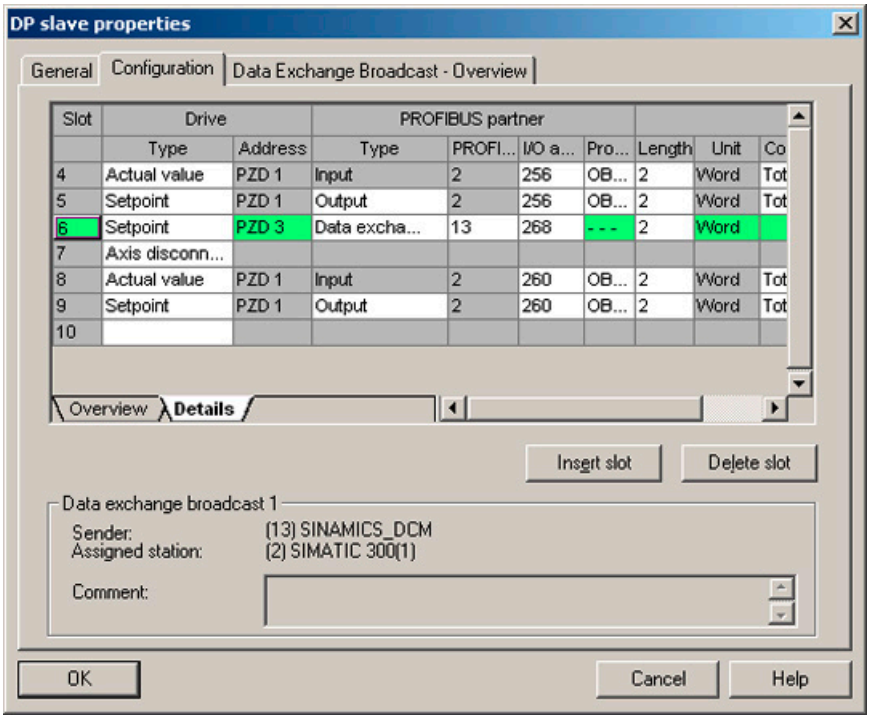


Figure 8-32 Configuring the direct data exchange nodes

8. The "Direct data exchange - Overview" tab shows you the configured direct data exchange relationships which correspond to the current status of the configuration in HW Config.

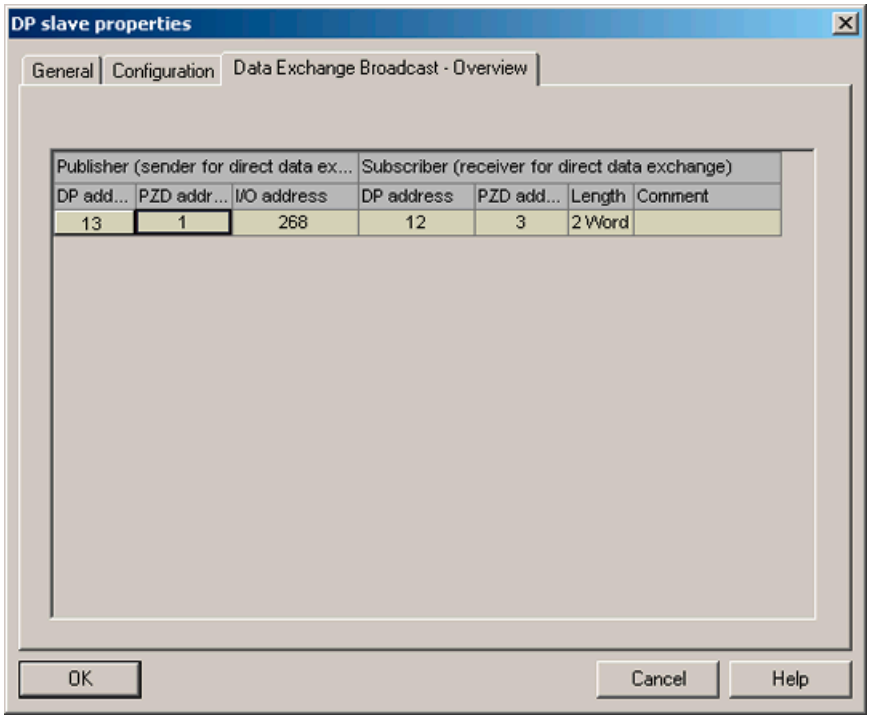


Figure 8-33 Direct data exchange - overview

9. When the direct data exchange link has been created, the standard telegram for the drive object is replaced with the "User-defined" telegram in the configuration overview.

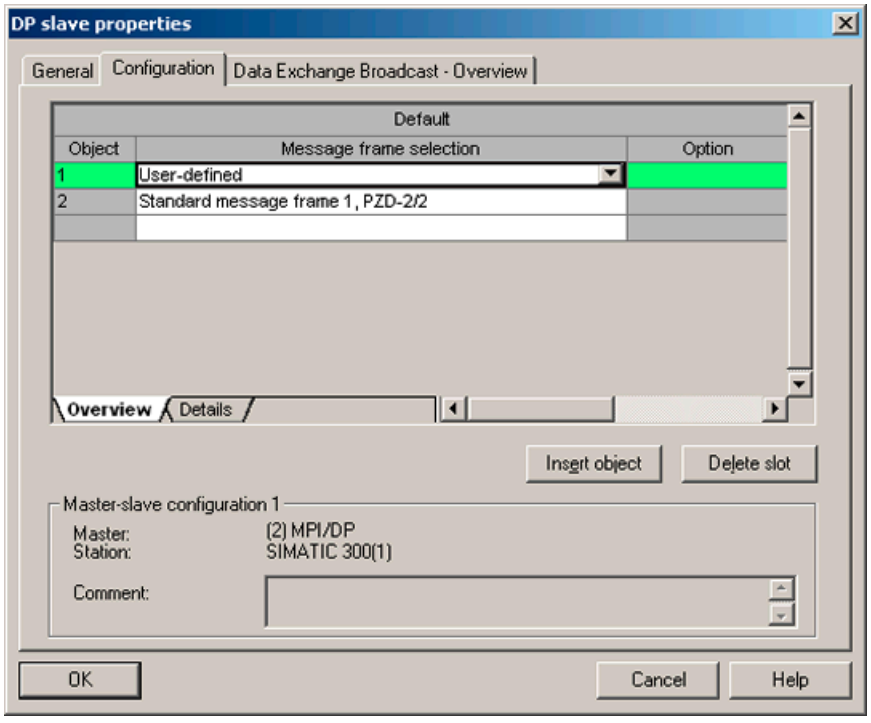


Figure 8-34 Telegram assignment for direct data exchange

10. The details after the creation of the direct data exchange link for the drive object of the SINAMICS DCP are as follows:

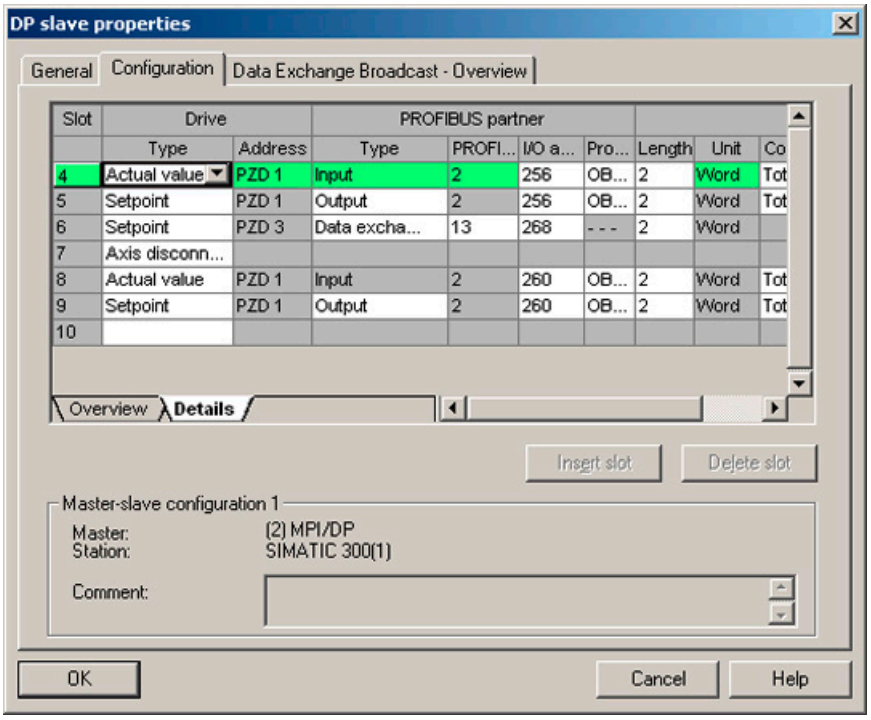


Figure 8-35 Details after the creation of the direct data exchange link

11. You must adjust the standard telegrams accordingly for every DO (drive object) of the selected CU that shall actively participate in direct data exchange.

Commissioning in STARTER

Direct data exchange is configured in HW Config and is simply an extension of an existing telegram. Telegrams can be extended in STARTER (e.g. p0922 = 999).

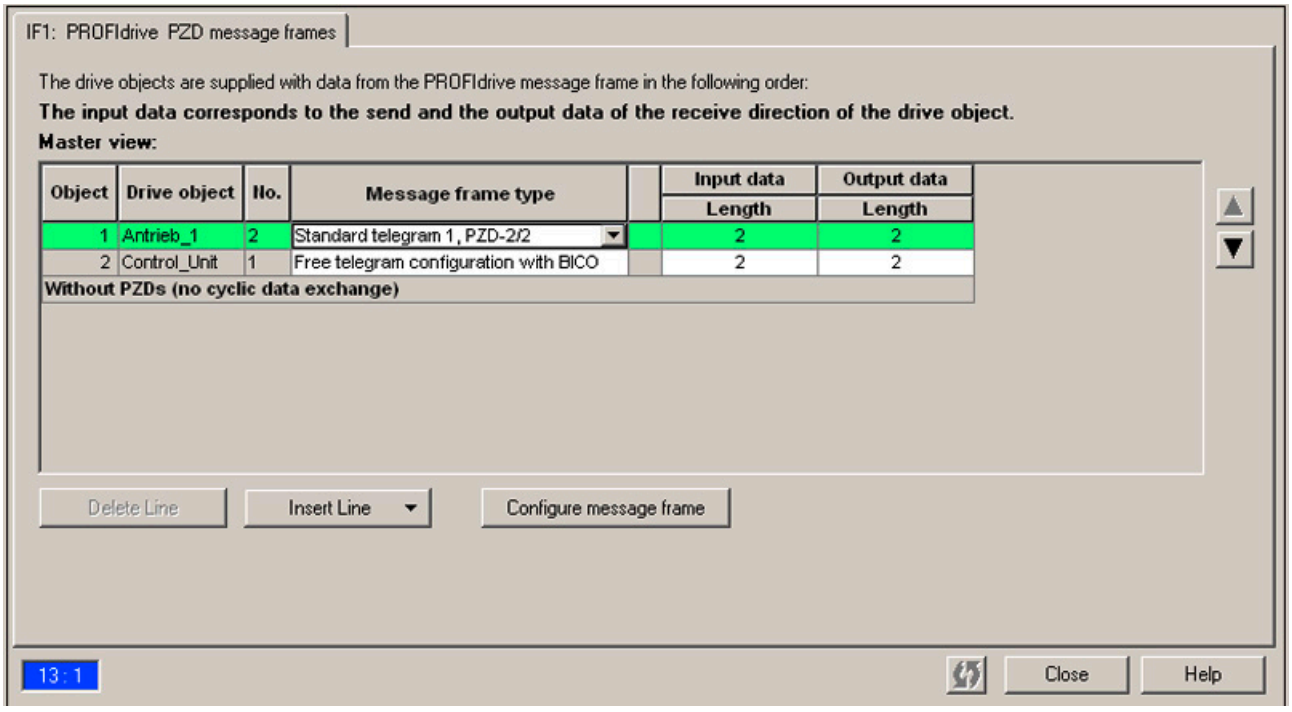


Figure 8-36 Configuring the direct data exchange links in STARTER

In order to terminate the configuration of direct data exchange for the DOs, the telegram data of the DOs in STARTER must be matched to those in the HW Config and must be extended. The configuration is made centrally via the configuration of the respective CU.

Procedure

1. In the overview for the PROFIBUS telegram, you can access the telegram portions of the drive objects, here DCP_CTRL. Select the telegram type "Free telegram configuration" for the configuration.
2. Enter the telegram lengths for the input data and output data according to the settings in HW Config. For direct data exchange links, the input data consists of the telegram component of the master and the direct data exchange data.

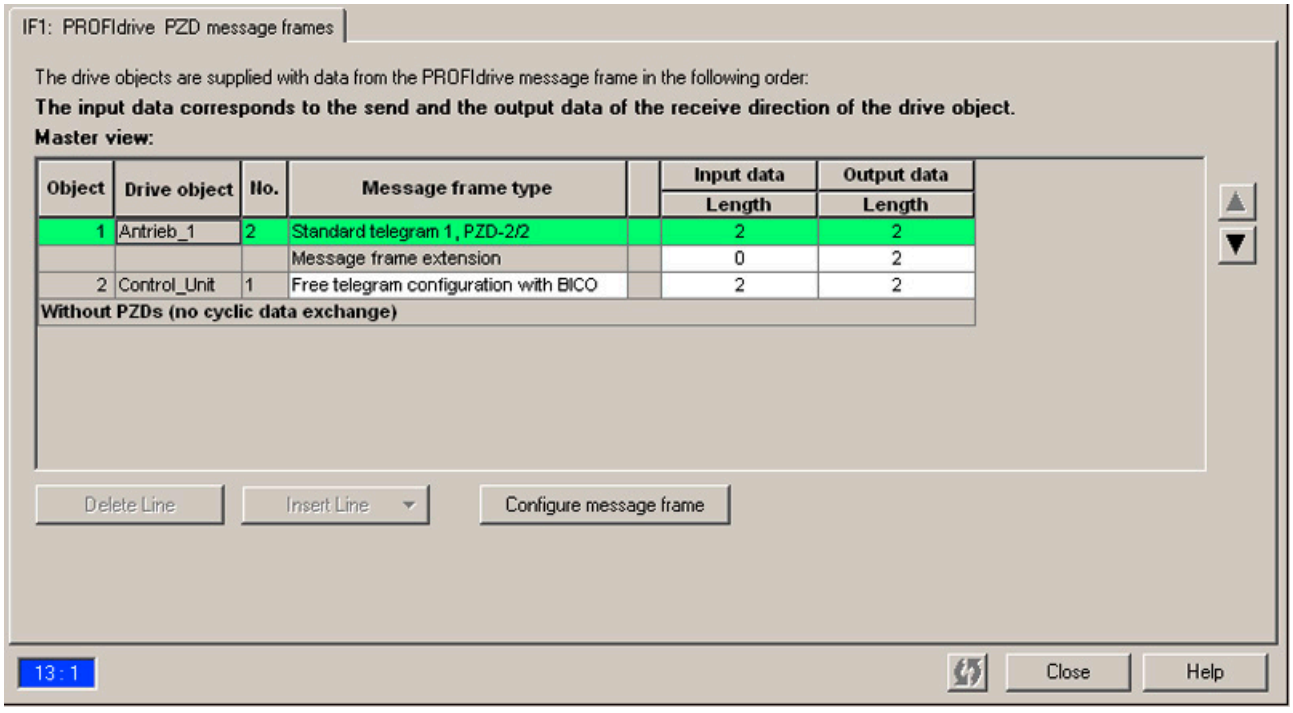


Figure 8-37 Display of the telegram extension

By selecting the item "Communication → PROFIBUS" for the drive object "DCP_CTRL" in the project navigator, you get the structure of the PROFIBUS telegram in the receive and send direction.
The telegram extension from PZD3 is the portion for direct data exchange.

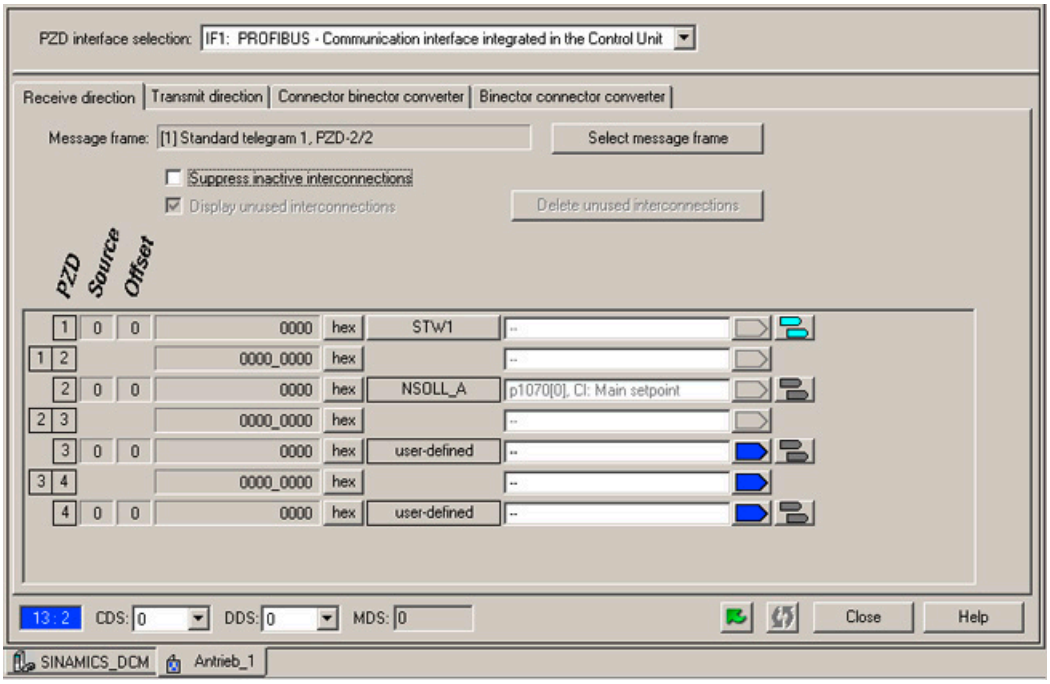


Figure 8-38 Configuring the PROFIBUS direct data exchange in STARTER

To connect the drive objects to the process data which is received via direct data exchange, you also need to connect the appropriate connectors to the corresponding signal sinks. A list for the connector shows all signals that are available for interconnection.

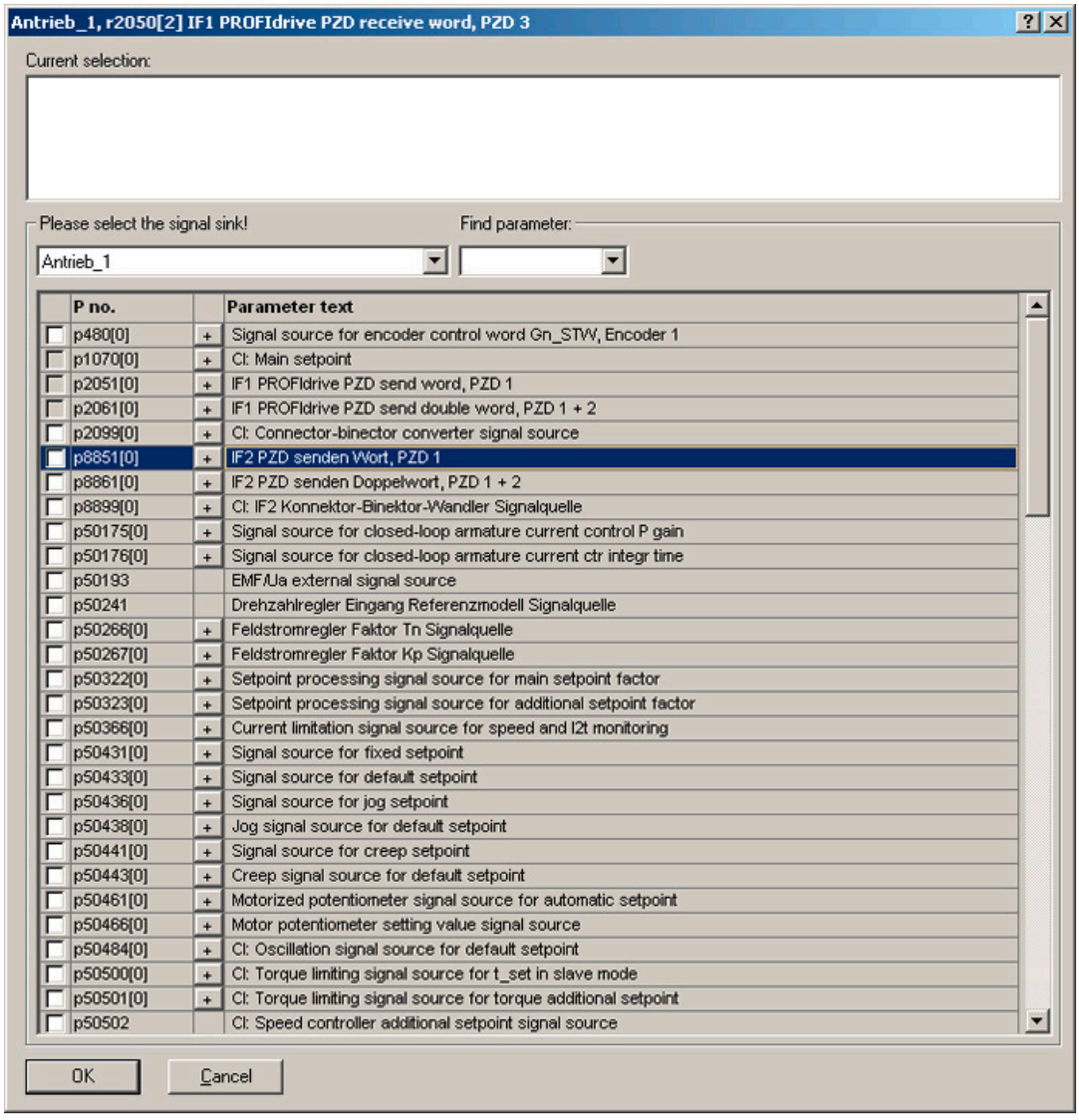


Figure 8-39 Linking the PZDs for direct data exchange with external signals

8.5.4.4 Diagnosing the PROFIBUS device-to-device communication in STARTER

Since the PROFIBUS direct data exchange is implemented on the basis of a broadcast telegram, only the subscriber can detect connection or data faults, e.g. via the publisher data length (see "Configuration telegram").

The publisher can only detect and report an interruption of the cyclic connection to the DP master (A01920, F01910). The broadcast telegram to the subscriber will not provide any feedback. A fault of a subscriber must be fed back via direct data exchange. In case of a "master drive" 1:n, however, the limited quantity framework (see "Links and requests") should be observed. It is not possible to have n subscribers report their status via direct data exchange directly to the "master drive" (publisher).

Diagnostics can be performed using the diagnostic parameters r2075 ("Receive PROFIBUS diagnostics telegram offset PZD") and r2076 ("Send PROFIBUS diagnostics telegram offset PZD"). The parameter r2074 ("PROFIBUS diagnostics, receive bus address PZD") displays the DP address of the setpoint source of the respective PZD.

r2074 and r2075 enable the source of a direct data exchange relationship to be verified in the subscriber.

Note

The subscribers do not monitor the existence of an isochronous publisher sign of life.

Faults and alarms with PROFIBUS direct data exchange

Alarm A01945 signals that the connection to at least one publisher of the drive device is missing or has failed. Any interruption to the publisher is also reported by fault F01946 at the affected drive object. A failure of the publisher only impacts the respective drive objects.

More detailed information on the messages can be found in the SINAMICS DCP List Manual.

8.5.5 Messages via diagnostics channels

Messages can be displayed not only via the well-known commissioning tools (STARTER, SCOUT). After the activation of a diagnostics function, the messages are also transferred to the higher-level controller via the standardized diagnostics channels. The messages are evaluated there or forwarded for convenient display at the various user interfaces (SIMATIC HMI, TIA Portal, etc.). The messages are shown on the respective user interfaces similarly as in STARTER.

In this way, problems or faults can be located immediately regardless of the tool currently being used, and then corrected immediately. No further tools must therefore be called for the correction.

Note

Also note the general information on the diagnostics channels in Section "Diagnostic channels (Page 217)".

Activating the diagnostics function

The diagnostics function is activated or deactivated via the parameterization of the relevant configuration tool (HW Config, TIA Portal, etc.).

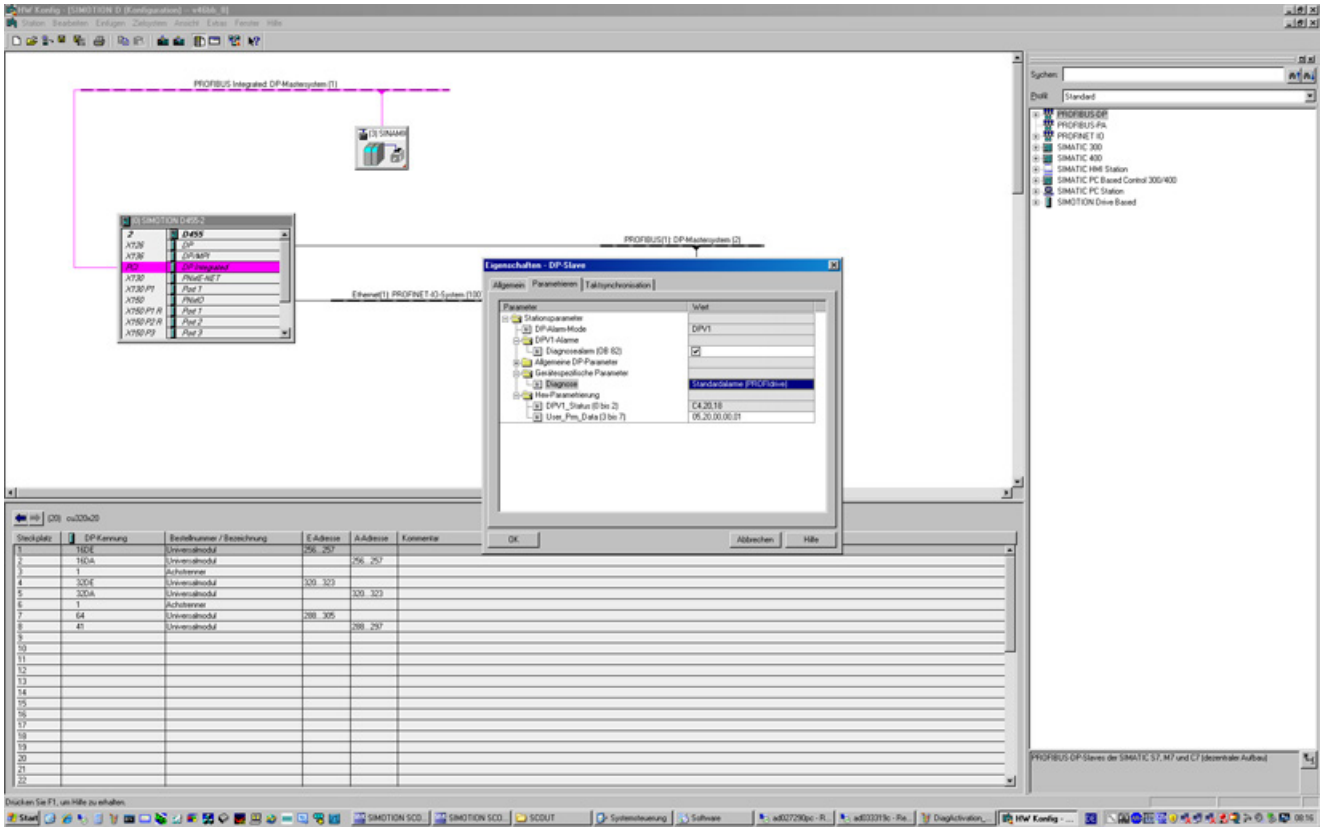


Figure 8-40 Activation of PROFIBUS

The following parameter assignments are possible:

Setting	Code for parameter assignment
Inactive	0
PROFIdrive error classes	1

When establishing the communication between SINAMICS and a master/controller, the activated diagnostics mode of this master/controller is first transferred to the drive. With activated diagnostics, SINAMICS first transfers all pending messages to the master/controller.

Messages

The following PROFIBUS error texts can be displayed:

Power electronics faulted

An impermissible operating state of the power electronics was detected (overcurrent, overtemperature, etc.). Check compliance with the permissible load cycles. Check the ambient temperatures (fan).

Overtemp. electronic component

The temperature in the component has exceeded the highest permissible limit. Check the ambient temperature / control cabinet ventilation.

Communication to the controller faulted

The communication to the higher-level controller (internal coupling, PROFIBUS, PROFINET, etc.) is faulted or interrupted. Check the state of the higher-level controller. Check the communication connection/wiring. Check the bus configuration/cycles.

Internal communication faulted

The internal communication between the SINAMICS components is faulted or interrupted. Check the DRIVE-CLiQ wiring. Ensure an EMC-compliant installation. Observe the maximum permissible quantity structures / cycles.

External signal state error

A measured value / signal state read-in via the input area (digital/analog/temperature) has assumed an impermissible value/state. Identify and check the relevant signal. Check the set thresholds.

Error in the parameterization / commissioning

An error was identified in the parameterization or in a commissioning procedure, or the parameterization does not match the actual device configuration. Determine the exact cause of the error with the commissioning tool, adapt the parameterization or device configuration.

8.6 Communication via PROFINET IO

8.6.1 General information about PROFINET IO

General information

PROFINET IO is an open Industrial Ethernet standard for a wide range of production and process automation applications. PROFINET IO is based on Industrial Ethernet and uses TCP/IP and IT standards.

Deterministic signal processing in realtime is important in industrial networks. PROFINET IO satisfies these requirements.

International standard IEC 61158 ensures open, multi-vendor systems.

PROFINET IO is optimized for high-speed, time-critical data communication at field level.

PROFINET IO

Within the context of Totally Integrated Automation (TIA), PROFINET IO is the systematic development of the following:

- PROFIBUS DP, the established fieldbus
- Industrial Ethernet, the communications bus for the cell level.

Experience gained from both systems was integrated into PROFINET IO. An Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET IO is a manufacturer-independent communication and engineering model.

PROFINET IO defines every aspect of the data exchange between IO controllers (devices with what is known as "master functionality") and the IO devices (those with what is known as "device functionality") as well as carrying out parameterization and diagnostics. A PROFINET IO system is configured in virtually the same way as a PROFIBUS system.

A PROFINET IO system is made up of the following devices:

- An IO controller controls automation tasks.
- An IO device is controlled and monitored by an IO controller. An IO device consists of several modules and submodules.
- An IO supervisor is an engineering tool, typically based on a PC, with which the individual IO devices (drive units) are parameterized and diagnosed.

IO devices: Drive units with PROFINET interface

- SINAMICS DCP with inserted CBE20

Cyclic communication using PROFINET IO with IRT or using RT is possible on all drive units equipped with a PROFINET interface. This means that error-free communication using other standard protocols is guaranteed within the same network.

Note

PROFINET for drive technology is standardized and described in the following document:

PROFIBUS profile PROFIdrive - Profile Drive Technology

PROFIBUS User Organization e. V.

Haid-und-Neu-Strasse 7

D-76131 Karlsruhe

You can obtain the current version from "PROFIBUS and PROFINET International (PI) (https://www.profibus.com/download/profidrive-profile-drive-technology/)".

Order Number 3.172, spec. Chap. 6

- IEC 61800-7

Note

PROFINET for drive technology is standardized and described in the following document:

- **PROFIBUS profile PROFIdrive – Profile Drive Technology**
  Version V4.1, May 2006
  PROFIBUS User Organization e. V.
  Haid-und-Neu-Strasse 7, D-76131 Karlsruhe, Germany
  http://www.profibus.com (http://www.profibus.com), Order Number 3.172, spec. Chapter 6
- IEC 61800-7

Note

For a CUD with inserted CBE20, the cyclic PZD channel is deactivated for PROFIBUS DP. By setting parameter p8839 = 1, the PZD channel can be reactivated, see Chapter "Parallel operation of communication interfaces (Page 201)".

8.6.1.1 Realtime (RT) and isochronous realtime (IRT) communication

Real-time communication

When communication takes place via TCP/IP, the resultant transmission times may be too long and not defined to meet the production automation requirements. When communicating time-critical IO user data, PROFINET IO therefore uses its own real-time channel, rather than TCP/IP.

Real time means that a system processes external events over a defined period.

Determinism

Determinism means that a system will react in a predictable (deterministic) manner.
With PROFINET IO with IRT, it is possible to precisely determine (predict) transmission times.

PROFINET IO with RT (Real Time)

Real-time data is treated with a higher priority than TCP(UDP)/IP data. Transmission of time-critical data takes place at guaranteed time intervals. RT communication is the basis for data exchange with PROFINET IO.

PROFINET IO with IRT (Isochronous Real Time)

Isochronous real time: Real-time property of PROFINET IO where IRT telegrams are transferred deterministically via planned communication paths in a defined sequence to achieve the best possible synchronism and performance between the IO controller and IO device (drive unit). IRT is also known as time-scheduled communication whereby knowledge about the network structure (topology) is utilized. IRT requires special network components that support scheduled data transmission.

Minimum cycle times of 500 µs and a jitter accuracy of less than 1 µs can be achieved with this transmission method.

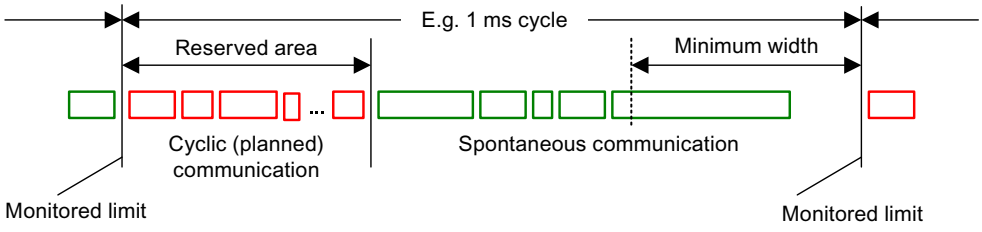


Figure 8-41 Bandwidth distribution/reservation, PROFINET IO

8.6.1.2 Addresses

MAC address

Every Ethernet and PROFINET interface is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address is divided up as follows:

- Three bytes for the manufacturer's ID
- Three bytes for the device identifier (consecutive number)

The MAC address is on a label (CBE20), e.g. 08-00-06-6B-80-C0

IP address

The TCP/IP protocol is a prerequisite for establishing a connection and for parameter assignment. To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device requires a unique IP address in the network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a decimal point. The IP address comprises:

- The address of the node (also called host or network node)
- The address of the (sub) network

IP address assignment

The IP addresses of IO devices can be assigned by the IO controller and always have the same subnet screen as the IO controller. In this case, the IP address is not stored permanently. The IP address entry is lost after POWER ON/OFF. The IP address can be assigned retentively via the STARTER function "Accessible nodes".

This function can also be performed with HW Config of STEP 7. Here, the function is called "Edit Ethernet node".

Note

If the network is part of an existing Ethernet company network, obtain the information (IP address) from your network administrator.

Device name (NameOfStation)

When it is shipped, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

Note

The device name must be stored retentively either with STARTER or with HW Config of STEP 7.

Note

You can enter the address data for the ports of the optional CBE20 module in STARTER in the expert list using parameters p8940, p8941, p8942 and p8943.

Replacing the Control Unit (CUD) (IO device)

If the IP address and device name are stored in non-volatile memory, this data is also forwarded with the memory card of the Control Unit.

If a complete Control Unit needs to be replaced due to a device or module defect, the new Control Unit automatically parameterizes and configures using the data on the memory card. Following this, cyclic exchange of user data is restarted. The memory card allows a module to be replaced without an IO supervisor when a fault occurs in a PROFINET device.

8.6.1.3 Dynamic IP address assignment

In those cases in which the PROFINET interface is not used for the IO communication, it is possible to generate an IP address centrally using a DHCP (DHCP = Dynamic Host Configuration Protocol) server. The following requirements must be satisfied to do this:

- At least one DHCP server must be active.
- The PG/PC and the SINAMICS devices must be connected to the same physical Ethernet subnet.

Note

DHCP is not supported together with PROFINET. No cyclical connection is established for an activated DHCP. It is therefore recommended that DHCP not be used within PROFINET networks!

The DHCP address assignment can be set from the SIMATIC Manager or using SINAMICS parameters.

Setting the DHCP address assignment with SIMATIC Manager (STEP 7)

1. Call the "Target system > Edit Ethernet node" menu path in the SIMATIC Manager.
2. Click the "Search" button in the "Ethernet nodes" area.
3. Select the desired SINAMICS device.
   You can now specify in the "Edit Ethernet nodes" configuration dialog that a dynamic IP address will be generated via a DHCP server. The IP address can be identified in two ways:
   – MAC address
   – Device name (name of station)

   The "MAC address" option has the disadvantage that the MAC address is no longer correct after a device has been replaced.
4. Click the "Obtain the IP address from a DHCP server" option in the dialog to activate.

5. Activate either the "MAC address" or the "Device name" option in the "Identified via" area.
6. Click "Assign IP configuration".
   The IP address is then taken from the DHCP server. The SINAMICS device uses the associated setting after a POWER ON to obtain a new IP address from the DHCP server.

Setting the DHCP address assignment with SINAMICS parameters

As an alternative to the address assignment by the SIMATIC Manager, the DHCP address assignment can also be initiated using SINAMICS parameters. In this case, the Control Unit always fetches the IP address from a DHCP server after each POWER ON. You can make the settings using the expert list in STARTER:

1. Activate the DHCP address assignment using one of the following settings (where the values 2 and 3 mean "MAC address" and "Device name", respectively):
   - For CBE20 (X1400): p8944 = 2 or 3

   The DHCP server now assigns temporarily an IP address.
2. You can now activate the interface configuration (value of 1) or activate and save retentively (value of 2). Make one of the following settings:
   - For CBE20 (X1400): p8945 = 2
     Direct activation is not possible for the CBE20. The configuration can only be saved. The setting then becomes automatically active for the next POWER ON.

8.6.1.4 DCP flashing

This function is used to check the correct assignment to a module and its interfaces.

Activating DCP flashing

1. In HW Config or the STEP 7 Manager, select the menu item "Target system > Ethernet > Edit Ethernet node".
   The "Edit Ethernet Node" dialog box opens.
2. Click the "Browse" button.
   The "Browse Network" dialog box opens and displays the connected nodes.
3. Select the CUD with inserted CBE20 as node.
   The "DCP flashing" function is then activated via the "Flash" button.

The "DCP flashing" function is switched to the RDY LED (READY LED 2 Hz, green/orange or red/orange) on the CUD.

The LED will continue to flash as long as the dialog is open. When the dialog box is closed, the LED automatically goes dark. The function is available as of STEP 7 V5.3 SP1 via Ethernet.

Note

The LEDs are only visible when the front cover of the SINAMICS DCP is opened.

8.6.1.5 Data transfer

Properties

The PROFINET interface on a drive unit supports the simultaneous operation of:

- IRT - isochronous real-time Ethernet
- RT - real-time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive telegram for cyclic data transmission, acyclic services

Telegrams to send and receive process data are available for each drive object of a drive unit with cyclic process data exchange.
In addition to cyclic data transfer, acyclic services can also be used for parameterizing and configuring the drive unit. These acyclic services can be utilized by the IO supervisor or IO controller.

Sequence of drive objects in the telegram

On the drive side, the sequence of drive objects in the telegram is displayed via a list in p0978[0...24] where it can also be changed.

You can use the STARTER commissioning tool to display the sequence of drive objects for a commissioned drive system in online mode in the project navigator under "Drive unit" > "Communication" > "Telegram configuration".

When you create the configuration on the controller side (e.g. HWConfig), the process-data-capable drive objects for the application are added to the telegram in this sequence.

The following drive objects can exchange process data:

- Control Unit (CU_DCP)
- DC control (DCP_CTRL)

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

After the first entry with "0" in p0978, it is not permissible that drive objects are configured in HW Config.

The telegram structure depends on the drive objects taken into account during configuration. Configurations are permitted that do not take into account all of the drive objects that are present in the drive system.

Example:

The following configurations, for example, are possible:

- Configuration with CU_DCP, DCP_CTRL
- Configuration with DCP_CTRL
- and others

8.6.1.6 Communication channels for PROFINET

CUD with CBE20 Communication Board Ethernet

A Communication Board can be optionally inserted in the CUD:

- The CBE20 Communication Board is a PROFINET switch with four PROFINET ports.

Notes

Note

Ring topology

When connecting the ports, it must be ensured that for standard applications a ring topology is not created. Additional information on ring topologies can be found in Chapter "Media redundancy (Page 272)".

Note

Support for the medium-dependent interface auto-MDI(X)

- The CBE20 Communication Board also supports auto-MDI(X). It is therefore possible to use both crossover and straight through cables to connect the devices.

8.6.1.7 References

- The integration of a SINAMICS Control Unit in a PROFINET IO system is described in detail in "SIMOTION SCOUT Communication" System Manual.
- For an example of how to link a Control Unit to a SIMATIC S7 via PROFINET IO, please refer to the FAQ "PROFINET IO communication between an S7-CPU and SINAMICS S120" on the Internet (http://support.automation.siemens.com/WW/view/de/27196655).
- For a description of the CBE20 Communication Board Ethernet and how you can use this in the drive, see Chapter "Option Board: Communication Board EtherNet CBE20 (Page 68)".

8.6.1.8 Overview of important parameters

(see SINAMICS DCP List Manual)

- p8940[0...239] CBE2x Name of Station
- p8941[0...3] CBE2x IP address

- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 Activating CBE2x interface configuration
- r8950[0...239] CBE2x Name of Station actual
- r8951[0...3] CBE2x IP Address of Station actual
- r8952[0...3] CBE2x Default Gateway of Station actual
- r8953[0...3] CBE2x Subnet Mask of Station actual
- r8954 CBE2x DHCP Mode actual
- r8955[0...5] CBE2x MAC address
- r8959 CBE2x DAP ID

8.6.2 Establishing online operation: STARTER via PROFINET IO

Description

The following options are available for online operation via PROFINET IO:

- Online operation via IP

Requirements

- STARTER with Version ≥ 4.1.5 (SINAMICS DCP is only supported as of STARTER Version 4.1.5)
- CBE20

STARTER via PROFINET IO (example)

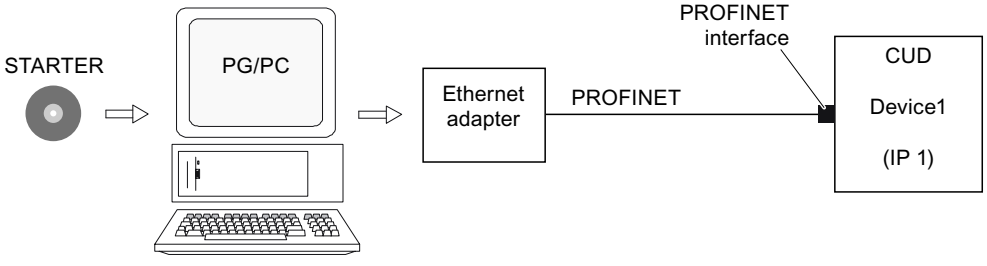


Figure 8-42 STARTER via PROFINET (example)

Procedure for establishing online operation with PROFINET

1. Assign the PG/PC a fixed, free IP address. In our example, we have selected 169.254.11.1. Set the subnet mask to 255.255.0.0.
2. Make the settings in STARTER
3. Select online operation in STARTER.

Setting the IP address in Microsoft Windows 7

Note

The following procedure is based on the Microsoft Windows 7 operating system. With other operating systems (such as Microsoft Windows XP or Microsoft Windows 10), operation may differ slightly.

1. In the PG/PC call the control panel using the "Start > Control Panel" menu item.
2. In the control panel of your PG/PC, under "Network and Internet", select the "Network and Sharing Center" function.
3. For your network card that is displayed, click the connection link.
4. Click in the status dialog of the connection on "Properties" and acknowledge the subsequent confirmation prompt with "Yes".
5. In the properties dialog of the connection, select the "Internet protocol 4 (TCP/IPv4)" element and then click "Properties".
6. In the properties dialog, activate the "Use the following IP address" option.
7. Set the IP address of the PG/PC access interface of the Control Unit to 169.254.11.1 and the subnet mask to 255.255.0.0.

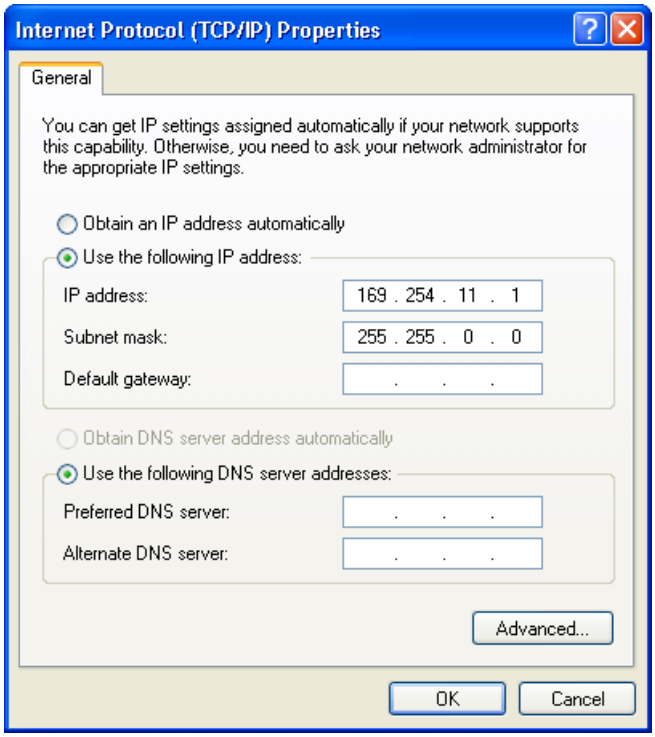


Figure 8-43 Properties of the Internet protocol (TCP/IP)

8. Click "OK" and close the Microsoft Windows-specific window of the network connections.

Setting the interface in STARTER

In STARTER, you set communication via PROFINET as follows:

1. Call the menu "Tools > Set PG/PC interface ...".
2. Select the "Access point of the application", and therefore the interface parameter assignment (in the example we use the access point "S7ONLINE (STEP 7)" and the interface parameterization "TCP/IP(Auto)->Belkin F5D 5055").

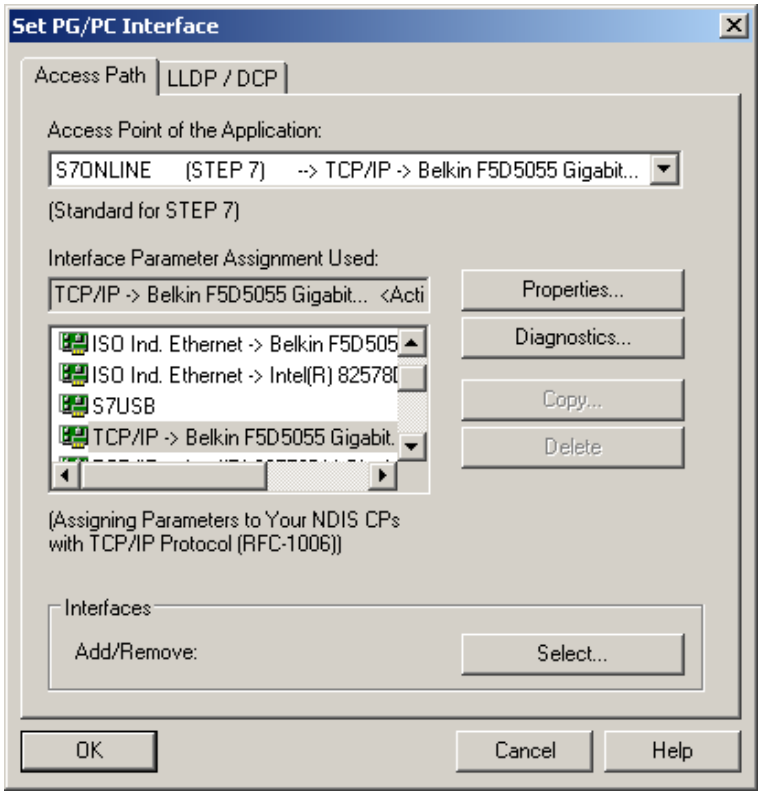


Figure 8-44 Setting the PG/PC interface

If the desired interface does not yet exist in the selection list, you can create it.

3. Click the "Select" button.

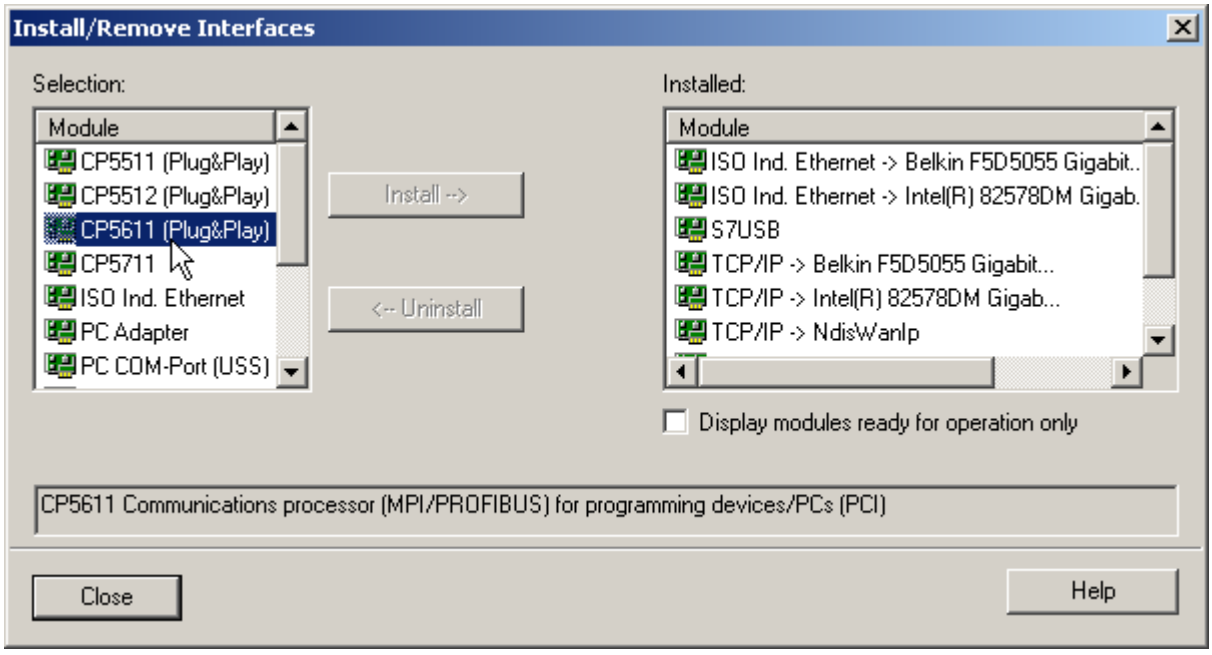


Figure 8-45 Installing the PG/PC interface

4. In the selection list on the left-hand side, select the module that you want to use as the interface.
5. Click the "Install" button.
   The selected module is then listed in the "Installed" list.
6. Click the "Close" button.

You can then check the IP address of the integrated Ethernet interface as follows:

1. Select the drive unit and call the shortcut menu "Target device > Online access ...".
2. Click the "Module addresses" tab.
   The IP address that you set must be located under "Connect to target station".

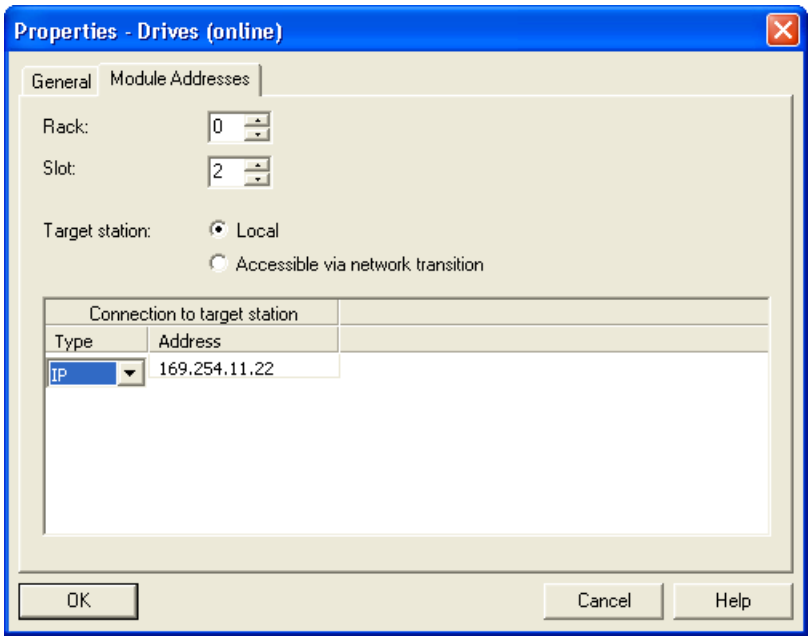


Figure 8-46 Setting online access

Assigning the IP address and name for the PROFINET interface of the drive unit

With STARTER, you can assign an IP address and a name to the PROFINET interface (e.g. CBE20) of the drive unit. The following steps are required:

1. Connect the programming device via a Crosslink-Ethernet cable with the CBE20, inserted in the CUD.
2. Switch on the Control Unit.
3. Open STARTER.

4. Call the menu "Project > Accessible nodes" or click the "Accessible nodes" icon.
   – The search is performed for available nodes connected to PROFINET.
   – The Control Unit is identified and displayed under "Accessible nodes" as the bus node with the IP address 0.0.0.0, without any type information.

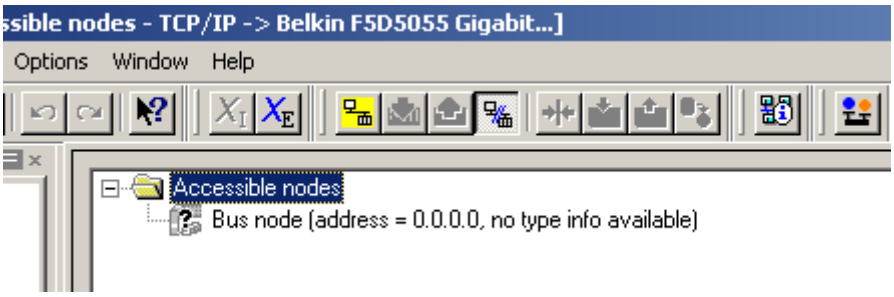


Figure 8-47 Bus nodes found

5. Right-click the bus node entry to open the shortcut menu "Edit Ethernet node ...".
   – In the selection window that opens "Edit Ethernet node" you will also see the MAC address.
6. Under "Set IP configuration", enter the IP address that you selected (e.g. 169.254.11.33) and the subnet mask (e.g. 255.255.0.0).
7. Click the "Set IP configuration" button.
   – The data transfer is confirmed.
8. Click the "Update" button.
   – The bus node is identified as a drive unit.
   – The address and the type are specified.

   In the "Edit Ethernet node" selection window you can also assign a device name to the drive unit that has been detected.
9. In the "Device name" field, enter the name that you have selected.

Note

ST (Structured Text) conventions must be satisfied for the name assignment of IO devices in PROFINET (SINAMICS components). The names must be unique within PROFINET. Rules for assigning names:

- Other than "-" and ".", no special characters (such as accented characters, spaces, brackets) are permitted in the name of an IO device.
- The device name must not begin or end with the "-" character.
- The device name must not begin with a number.
- Maximum total length of 240 characters (lowercase characters, numbers, hyphen, or period)
- A name component within the device name, e.g. a string between two periods, must not exceed 63 characters.
- The device name must not take the form n.n.n.n (n = 0...999).
- The device name must not begin with the character sequence "port-xyz" or "port-xyz-abcde" (a, b, c, d, e, x, y, z = 0...9).

In the "Device name" field, enter the name that you have selected.

10. Click the "Assign name" button.
    – The data transfer is confirmed.
11. Click the "Update" button.
    – The bus node is detected as drive unit and is consecutively numbered.
    – The address, device name and the type are specified.
12. Close the "Edit Ethernet node" window.
13. Activate the option button in front of the detected drive unit and click the "Accept" button.
    The SINAMICS drive with CBE20 is transferred as a drive object into the project tree. You can now continue to configure the drive object.
14. Click the "Connect to target system" button and then call the menu "Target system > Load > To target device", to load the project to the Control Unit memory card.
    The IP address and device name are stored in a non-volatile fashion on the memory card of the Control Unit.

8.6.3 RT classes for PROFINET IO

PROFINET IO is a scalable realtime communication system based on Ethernet technology. The scalable approach is expressed with three realtime classes.

RT

RT communication is based on standard Ethernet. The data is transferred via prioritized Ethernet telegrams. Because standard Ethernet does not support any synchronization mechanisms, isochronous operation is not possible with PROFINET IO with RT!

The real update cycle in which cyclic data is exchanged depends on the bus load, the devices used and the quantity framework of the I/O data. The update cycle is a multiple of the send cycle.

IRT

Two options are available with this RT class:

- IRT "high flexibility"
  is not supported by SINAMICS DCP.
- IRT "high performance"

Software preconditions for configuring IRT:

- STEP 7 5.4 SP4 (HW Config)

Note

For further information about configuring the PROFINET interface for the I/O controller and I/O device, please refer to the following document: SIMOTION SCOUT Communication System Manual.

IRT "high flexibility"

Note

IRT "high flexibility" is not supported by SINAMICS DCP.

The telegrams are sent cyclically in a deterministic cycle (Isochronous Real Time). The telegrams are exchanged in a bandwidth reserved by the hardware. One IRT time interval and one standard Ethernet time interval are created for each cycle.

IRT "high performance"

In addition to the bandwidth reservation, the telegram traffic can be further optimized by configuring the topology. This enhances the performance during data exchange and the deterministic behavior. The IRT time interval can thus be further optimized or minimized with respect to IRT "high flexibility".

In addition to the isochronous data transfer provided by IRT, even the application itself (position control cycle, IPO cycle) can be isochronous in the devices. This is an essential requirement for closed-loop axis control and synchronization via the bus. Isochronous data transfer with cycle times well below one millisecond and with a deviation in the cycle start (jitter) of less than a microsecond provide sufficient performance reserves for demanding motion control applications.

The RT classes IRT "high flexibility" and IRT "high performance" can be selected as options in the synchronization settings configuration area of HW Config. In the description below, both these classes are simply referred to as "IRT".

In contrast to standard Ethernet and PROFINET IO with RT, the telegrams for PROFINET IO with IRT are transferred according to a time schedule.

Modules

The following SINAMICS modules support the IRT "high performance":

- S120 CU320 together with the CBE20
- S120 CU320-2 DP together with the CBE20
- S120 CU320-2 PN
- S120 CU310 PN
- S120 CU310-2 PN
- S110 CU305 PN
- CUD in conjunction with the CBE20

Note

SINAMICS DCP does not support isochronous operation. Also for cyclic communication via PROFINET IRT the closed-loop control is independent of the PROFINET clock cycle.

Comparison between RT and IRT

Table 8-27 Comparison between RT and IRT

RT class	RT	IRT "high flexibility"	IRT "high performance"
Transfer mode	Switching based on the MAC address; prioritization of the RT telegrams possible using Ethernet-Prio (VLAN tag).	Switching using the MAC address; bandwidth reservation by reserving an IRT "high flexibility" interval in which only IRT "high flexibility" frames are transferred but, for example, no TCP/IP frames.	Path-based switching according to a topology-based plan; no transmission of TCP/IP frames and IRT "high flexibility" frames in the IRT "high performance" interval.
Isochronous application in the IO controller	No	No	Yes
Determinism	Variance of the transmission duration by started TCP/IP telegrams	Guaranteed transmission of the IRT "high flexibility" telegrams in the current cycle by the reserved bandwidth.	Exactly planned transfer; times for transmission and receiving are guaranteed for any topologies.
Reload the network configuration after a change	Not relevant	Only when the size of the IRT "high flexibility" interval needs to be modified (reservation of position is possible).	Always when the topology or the communications relationships change
Maximum switching depth (number of switches in one line)	10 at 1 ms	61	64
For possible send cycles, see subitem "Send cycles and update cycles for RT classes" in table "Adjustable send cycles and update cycles"			

Set the RT class

The RT class is set by means of the IO controller interface properties. If RT class IRT "high performance" is set, it is not possible to operate any IRT "high flexibility" devices on the IO controller and vice versa. IO devices with RT can always be operated, regardless of the IRT class setting.

You can set the RT class in the HW Config for the associated PROFINET device.

1. In HW Config, double-click item PROFINET interface in the module.
   The "Properties" dialog box opens.
2. Select the RT class under RT class on the "Synchronization" tab.
3. Once you have selected "IRT", you can also choose between option "high flexibility" and "high performance".

   Note

   The "high flexibility" option must not be selected for SINAMICS DCP, otherwise an error message is output.

4. Confirm with "OK".

Synchronization domain

The sum of all devices to be synchronized form a synchronization domain. The whole domain must be set to a single, specific RT class (real-time class) for synchronization. Different synchronization domains can communicate with one another via RT.

For IRT, all IO devices and IO controllers must be synchronized with a common synchronization master.

RT allows an IO controller to communicate with a drive unit outside a synchronization domain or "through" another synchronization domain. As of version 5.4 SP1, STEP 7 supports multiple synchronization domains on a single Ethernet subnet.

Example:

- Synchronization domain IRT: SIMOTION2 with SINAMICS
- SINAMICS, which is assigned to the IO system of SIMOTION1, is arranged in the topology in such a way that its RT communication must be established through the IRT synchronization domain.

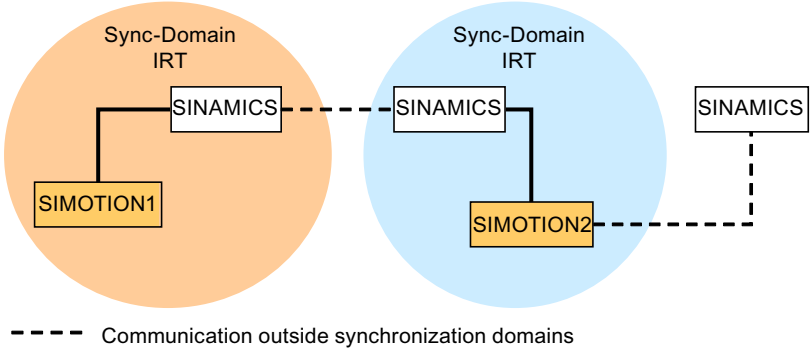


Figure 8-48 RT communication across the limits of synchronization domains

Update cycles and send cycles for RT classes

Definition of the update time / send cycle:

If we take a single IO device in the PROFINET IO system as an example, this device has been supplied with new data (outputs) by the IO controller and has transferred new data (inputs) to the IO controller within the update time. The send cycle is the shortest possible update cycle.

All cyclic data is transferred within the send cycle. The actual send cycle that can be set depends on various factors:

- Bus load
- Type of devices used
- Computing capacity available in the IO controller
- Supported send clocks in the participating PROFINET devices of a synchronization domain. A typical send cycle is, e.g. 1 ms.

The table below specifies the reduction ratios which can be set between the send cycle and the update times for IRT "high performance", IRT "high flexibility", and RT.

Table 8-28 Settable send cycles and update cycles

Send cycle		**Reduction ratio between update and send cycles**	
		RT **IRT "high flexibility"** [4]	**IRT "high performance"**
Range "even"[1]	250, 500, 1000 µs	1, 2, 4, 8, 16, 32, 64, 128, 256, 512	1, 2, 4, 8, 16[2]
	2000 µs	1, 2, 4, 8, 16, 32, 64, 128, 256	1, 2, 4, 8, 16[2]
	4000 µs	1, 2, 4, 8, 16, 32, 64, 128	1, 2, 4, 8, 16[2]
Range "odd" [3]	375, 625, 750, 875, 1125, 1250 µs ... 3875 µs (increment 125 µs)	Not supported [5]	1

Explanations for the previous table:

1) It is only possible to set send cycles from the "even" range when IO devices with real-time class "RT" are assigned to a synchronization domain. Likewise, only the reduction ratios from the "even" range can be set for a send cycle setting from the "even" range.

2) It is generally only possible to set a reduction ratio of 1:1 between the update time and send cycle for IO devices (ET200S IM151-3 PN HS, SINAMICS S) which are operated in isochronous mode. In this case, the update time mode must always be set to "fixed factor" (under "IO device" properties, "IO cycle" tab, "Mode" drop-down menu). This means that STEP 7 will not automatically adjust the update cycle and thus the update cycle will always correspond to the send cycle.

3) The send cycles from the "odd" range can be set only if a synchronization domain does not include any IO devices with real-time class "RT". Likewise, only the reduction ratios from the "odd" range can be set for a send cycle setting from the "odd" range.

4) Isochronous operation is not compatible with IRT "high flexibility".

5) Odd send cycles can be used only if the IO systems assigned to the synchronization domain do not include any RT or IRT "high flexibility" devices.

Furthermore, the send cycles which can actually be set are determined by the intersection of the send cycles supported by all the devices in the synchronization domain.

The reduction ratio between the update cycle of an IO device and the send cycle is set in the "Properties" of the PROFINET interface for the relevant device.

Note

There is no intersection between the send cycles for the "even" and "odd" ranges!

Send cycles for SINAMICS drive units

A SINAMICS drive unit with PROFINET interface which supports IRT permits send cycle settings of between 0.25 ms and 4.0 ms in a 250 µs time frame.

Topology rules

Topology rules for RT

- A topology can be, but need not be configured for RT. If a topology has been configured, the devices must be wired in accordance with the topology.
- Otherwise, the wiring between devices is entirely optional.

Topology rules for IRT

- Mixed operation is not supported by STEP 7 V5.4 SP4, i.e. IRT "high performance" cannot be combined with IRT "high flexibility" in the same synchronization domain.
- A synchronization domain with IRT "high performance" can contain a maximum of one IRT "high performance" island. "Island" means that the devices must be interconnected to match the configured topology. A synchronization master must be positioned in the relevant island.
- IRT "high flexibility" is subject to the same topology rules as IRT "high performance", the only exception being that a topology does not need to be configured. However, if a topology has been configured, the devices must be wired to match the topology.

Device selection in HW Config

Hardware catalog:

The drive unit from the appropriate device family entry in the hardware catalog must be configured.

8.6.4 PROFINET GSDML

As with PROFIBUS, when DriveES is present, the device can be inserted using a DriveES/STARTER interface or using a GSDML file.

The GSDML file is available as a zip archive on the memory card with the current firmware:

`\\Siemens\SINAMICS\DATA\CFG\PNGSD.zip`

See Chapter "Ordering information for options and accessories (Page 30)" for ordering data of the memory card.

Alternatively, the GSDML file can be requested from the Customer Support.

Table 8-29 Submodules depending on the particular drive object

Module	Subslot 1 MAP	Subslot 2 PROFIsafe	Subslot 3 PZD telegram	Subslot 4 PZD extension	Max. number of PZD
DCP_CTRL	MAP	-	free PZD-16/16, 32/32	PZD-2/2, -2/4, -2/6	64/64
DI_DO	MAP	Reserved	Telegrams: no free PZD-4/4	Reserved	5/5
CU_DCP	MAP	Reserved	free PZD-4/4	Reserved	20/25

The telegrams in subslots 2, 3 and 4 can be freely configured, i.e. they can also remain empty.

8.6.5 Communication with CBE20

The CBE20 is a Communication Board that can be flexibly used and which can be operated with different communication profiles. Only one firmware of a communication profile can be loaded at any one time. The available firmware files are saved with the communication profiles in UFW files.

The required file is selected using parameter p8835. A POWER ON must be carried out after selecting the desired UFW file. During the subsequent system boot, the corresponding UFW file is loaded. The new selection then becomes active.

Table 8-30 UFW files and selection in the pointer file

UFW file and folder on the memory card	Functionality (p8835)	Pointer file content
/SIEMENS/SINAMICS/CODE/CB/CBE20_1.UFW	PROFINET device	1
/SIEMENS/SINAMICS/CODE/CB/CBE20_3.UFW	SINAMICS Link	3
/SIEMENS/SINAMICS/CODE/CB/CBE20_4.UFW	EtherNet/IP	4
/SIEMENS/SINAMICS/CODE/CB/CBE20_5.UFW	Modbus TCP	5
/OEM/SINAMICS/CODE/CB/CBE20.UFW	Customized	99

Note

All communication profiles are saved on the memory card. Some communication profiles (UFW files) can also be saved to the flash memory in the device itself. In this case, the memory card does not have to be inserted.
p8835=1 (PROFINET): The memory card does not have to be inserted.
p8835 = 3 (SINAMICS Link): The memory card must remain inserted.
p8835 = 4 (EtherNet/IP): The memory card does not have to be inserted.
p8835 = 5 (Modbus TCP): Memory card must remain inserted.

Identification of the firmware version

Using parameter r8858, the loaded firmware version of the PROFINET interface can be uniquely identified.

Overview of important parameters (see the SINAMICS DCP List Manual)

- p8835 CBE20 firmware selection
- r8858[0...39] COMM BOARD read diagnostics channel
- r8859[0...7] COMM BOARD identification data

8.6.6 Media redundancy

To increase the availability of PROFINET, you can create a ring topology. If the ring is interrupted at one point, the data paths between the devices are automatically reconfigured. Following reconfiguration, the devices can once again be accessed in the resulting new topology.

To create a ring topology with media redundancy, route the two ends of a line-type PROFINET topology to a switch which serves as redundancy manager (e.g. a suitable SCALANCE switch). Closing the linear bus topology is realized using 2 ports (ring ports) of the SCALANCE redundancy manager, which monitors the data telegrams in the PROFINET ring. All other connected PROFINET nodes are redundancy clients.

The Media Redundancy Protocol (MRP) is the standard procedure for media redundancy. Using this procedure, a maximum of 50 devices can participate in each ring. In the case of an interrupted cable, data transfer is only briefly interrupted as the system switches over to the redundant data path: This is the reason that the switchover is not bumpless (200 ms).

If a brief interruption is not permitted, then you have the following options

- Correspondingly set the failure monitoring time in the hardware configuration to more than 200 ms.
  or
- Set the data transfer to IRT High Performance.

The uninterruptible MRRT is automatically set. A SIMOTION controller (or another suitable controller) is required in this case.

From a CBE20, only the first two ports are capable of establishing a ring topology.

Note

In order to use the ring topology, the GSDML file version V2.3 must be installed.

This file can be found, for example, on the memory card as "\SIEMENS\SINAMICS\DATA\CFG\PNGSD.ZIP".

Configuring media redundancy

The ring topology is configured by appropriately configuring the participating devices individually in STEP 7.

8.6.7 Messages via diagnostics channels

Messages can be displayed not only using the established commissioning tools (STARTER, SCOUT). After the activation of a diagnostics function, the messages are also transferred to the higher-level controller via the standardized diagnostics channels. The messages are evaluated there or forwarded for convenient display at the various user interfaces (SIMATIC HMI, TIA Portal, etc.). The messages are shown on the respective user interfaces similarly as in STARTER.

In this way, problems or faults can be located immediately regardless of the tool currently being used, and then corrected immediately. No further tools must therefore be called for the correction.

Activating the diagnostics function

The diagnostics function is activated or deactivated via the parameterization of the relevant configuration tool (HW Config, TIA Portal, etc.).

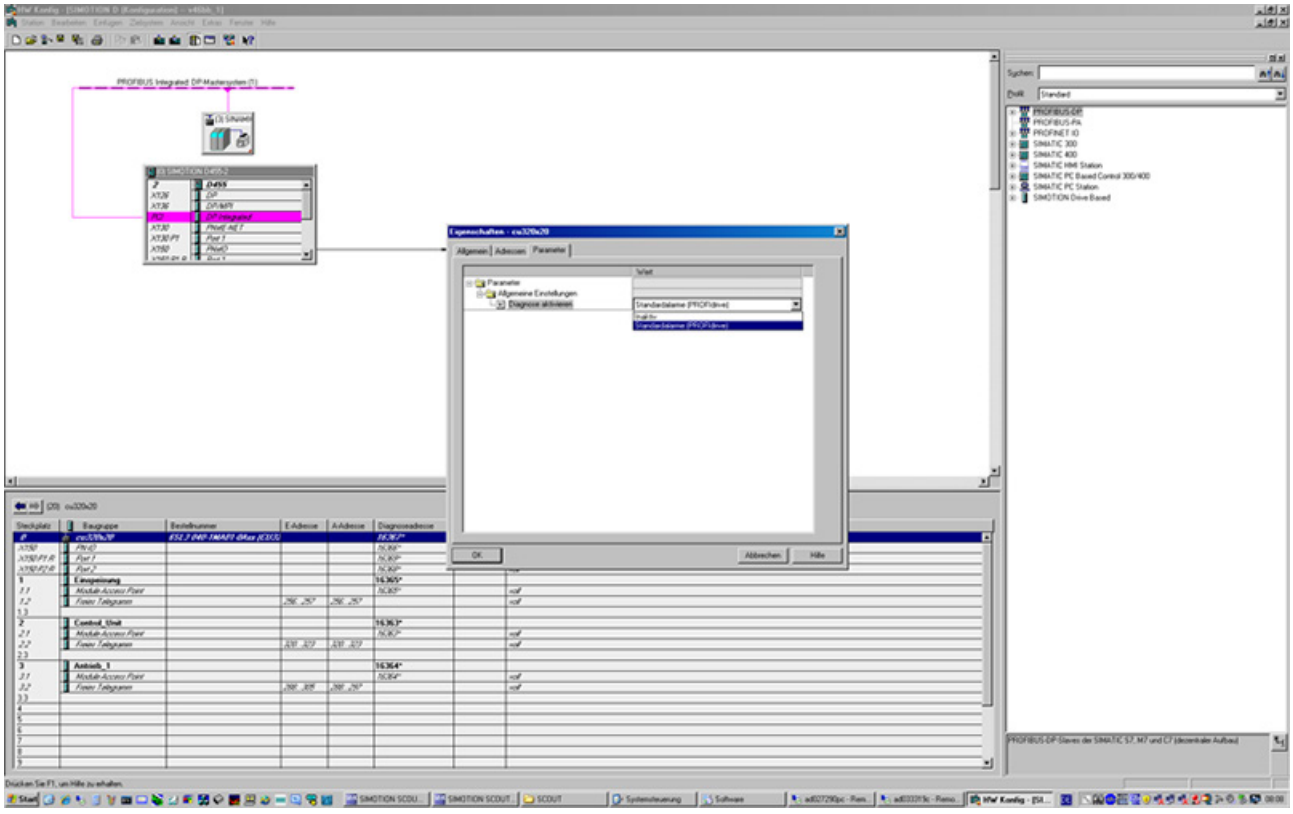


Figure 8-49 Activation of PROFINET

The following parameter assignments are possible:

Setting	Code for parameter assignment
Inactive	0
PROFIdrive error classes	1

When establishing the communication between SINAMICS and a master/controller, the activated diagnostics mode of this master/controller is first transferred to the drive. With activated diagnostics, SINAMICS first transfers all pending messages to the master/controller.

Messages

The following PROFIdrive error texts are displayed during forwarding via the PROFINET diagnostics channel:

Hardware fault/software error

A hardware or software malfunction was detected. Carry out a POWER ON for the relevant component. If it occurs again, contact the hotline.

Line fault

A line supply fault has occurred (phase failure, voltage level...). Check the line supply and fuses. Check the supply voltage. Check the wiring.

Supply voltage fault

An electronics supply voltage fault (48 V, 24 V, 5 V...) was detected. Check the wiring. Check the voltage level.

Power electronics fault

An impermissible operating state of the power electronics was detected (overcurrent, overtemperature, etc.). Check compliance with the permissible load cycles. Check the ambient temperatures (fan).

Electronic component overtemperature

The temperature in the component has exceeded the highest permissible limit. Check the ambient temperature / control cabinet ventilation.

Communication error to the higher-level controller

The communication to the higher-level controller (internal coupling, PROFIBUS, PROFINET, etc.) is faulted or interrupted. Check the state of the higher-level controller. Check the communication connection/wiring. Check the bus configuration/cycles.

Internal (DRIVE-CLiQ) communication error

The internal communication between the SINAMICS components is faulted or interrupted. Check the DRIVE-CLiQ wiring. Ensure an EMC-compliant installation. Observe the maximum permissible quantity structures / cycles.

External measured value / signal state outside the permissible range

A measured value / signal state read-in via the input area (digital/analog/temperature) has assumed an impermissible value/state. Identify and check the relevant signal. Check the set thresholds.

Error in the parameterizing/configuring/commissioning sequence

An error was identified in the parameterization or in a commissioning procedure, or the parameterization does not match the actual device configuration. Determine the exact cause of the error with the commissioning tool, adapt the parameterization or device configuration.

General drive fault

Group fault, determine the exact cause of the fault with the commissioning tool.

8.6.8 Support of I&M data sets 1...4

Identification & Maintenance (I&M)

I&M data sets contain information for a standardized and simplified identification and maintenance of PROFIBUS/PROFINET devices. I&M data sets 1...4 contain plant-specific information, such as the installation location and date. PROFINET supports I&M data sets 0...4.

I&M data sets 1...3 can be set with the SIMATIC Manager (STEP 7) and also with HW Config (STEP 7).

I&M parameters

Table 8-31 Parameter designation, assignment and meaning

I&M parameter designation	Format	Size/ octets	Initialization	SINAMICS parameters	Meaning
I&M 0: IM_SUPPORTED	-	-	-	r8820[62,63]	The parameter indicates which I&M data sets are supported. The value 0x1E indicates that I&M data sets 1...4 are available.
I&M 1: TAG_FUNCTION	Visible string	32	Space 0x20... 0x20	p8806[0...31]	Text that identifies the function or task of the device.
I&M 1: TAG_LOCATION	Visible string	22	Space 0x20... 0x20	p8806[32...53]	Text that identifies the device location.
I&M 2: INSTALLATION_DATE	Visible string	16	Space 0x20... 0x7E	p8807[0...15]	Text with the date of the installation or the initial commissioning of the device. The following date formats are supported: • YYYY-MM-DD • YYYY-MM-DD hh:mm – YYYY: Year – MM: Month 01...12 – DD: Day 01...31 – hh: Hours 00...23 – mm: Minutes 00...59 The separators between the individual specifications, i.e. hyphen '-', blank ' ' and colon ':', must be entered.

I&M parameter designation	Format	Size/ octets	Initialization	SINAMICS parameters	Meaning
I&M 3: DESCRIPTOR	Visible string	54	Space 0x20... 0x20	p8808[0...53]	Text with any comments or notes.
I&M 4: SIGNATURE	Octet string	54	Space 0x00... 0x00	r8809[0...53]	The parameter is automatically populated by the system, in which case it contains a functional check signature for the change tracking with Safety Integrated. The check signature has the following format: • The first four octets (0...3) contain the content of parameter r9781 index 0: "SI change monitoring checksum (Control Unit)". • The second four octets (4...7) contain the content of parameter r9782 index 0: "SI change monitoring time stamp (Control Unit)". • The remainder (octets 8...53) contains zeroes.

The I&M data sets 1...3 are stored permanently in the parameters p8806...p8808. Essential properties of these 3 parameters:

- They can be displayed in the STARTER expert list.
- The SINAMICS "Reset parameter" (p0976 = 1, p0970 = 1) function does not have any effect on the content of parameters.
- I&M data sets are not changed when the alternative parameter sets are stored or loaded. The transfer of parameter sets between a memory card and non-volatile device memory does not have any effect on the I&M data sets.

Overview of important parameters (see the SINAMICS DCP List Manual)

- p8806[0...53] Identification and Maintenance 1
- p8807[0...15] Identification and Maintenance 2
- p8808[0...53] Identification and Maintenance 3
- r8809[0...53] Identification and Maintenance 4

8.7 Communication via Modbus TCP

8.7.1 Overview

The Modbus protocol is a communication protocol based on a controller/device architecture.

Modbus offers three transmission modes:

- **Modbus ASCII -** via a serial interface
  data in the ASCII code. The data throughput is lower compared to RTU.
- **Modbus RTU -** via a serial interface
  data in the binary format. The data throughput is greater than in ASCII code.
- **Modbus TCP -** via Ethernet
  data as TCP/IP packages. TCP port 502 is reserved for Modbus TCP.

Only transfer type "Modbus TCP" is available for SINAMICS DCP.

Modbus functionality

Process data and parameters are accessed via the Modbus tab.

- Process data: 40100 - 40119
  A maximum of 10 process data (PZD) can be exchanged.
- Drive data: 40300 - 40499
- All parameters via DS47: 40601 - 40722

Modbus TCP always provides a basic Ethernet functionality:

- Commissioning access for STARTER with S7 protocol
- DCP (Discovery and Configuration Protocol) to set the IP address etc.
- SNMP for identification

General information about communication

Communication with MODBUS TCP is established via the Ethernet/PROFINET interface X1400 on the CBE20 module.
Further, the memory card (with the device firmware) must be permanently inserted.

The required parts are included when ordering the SINAMICS DCP with options G33 (Profinet CBE20) and L03 (memory card). For ordering data, see Chapter "Ordering information for options and accessories (Page 30)".

For further details on the CBE20 module, see Chapter "Option Board: Communication Board EtherNet CBE20 (Page 68)".

Note

Using the memory card

Information on how to correctly use the memory card is provided in Chapter "Memory card functions (Page 161)".

It is especially important to note that it is not permissible to insert the card when the device is operational.

Drive object that can be addressed via Modbus

With Modbus TCP, you always address the first drive object from the list of drive objects (p0978[0]). To access the DCP control, this parameter must therefore make reference to the drive object, type "[17] DC_CTRL".

- However, Modbus TCP is only activated if, under p0978[0], there is a drive object that is supported by Modbus TCP.
- If p0978[0] does not contain a valid drive object, then establishing communication is acknowledged with alarm A08555(2).

Diagnostics LEDs in Modbus TCP

For Modbus TCP, diagnostic states are shown using the following LEDs:

X1400 (CBE20): "**OPT**" LED

The following states can be displayed using these LEDs:

Color	State	Meaning
Green	Continuous light	Connections and setpoints are OK.
Green	Flashing light	Connection is OK, but no setpoints (dependent on timeout).
Red	2 Hz flashing light	No connection or setpoint timeout.

8.7.2 Configuring Modbus TCP via interface X1400

Activating Modbus TCP via X1400 (CBE20)

1. Switch off the SINAMICS DCP supply voltage. Wait until all LEDs on the SINAMICS DCP are dark.
2. Insert the memory card with firmware version 1.2 or higher into the appropriate slot of the CUD.
   Note that the device configuration can be overwritten if the memory card already has a parameterization file.

   Note

   Using the memory card

   Information on how to correctly use the memory card is provided in Chapter "Memory card functions (Page 161)".

   It is especially important to note that it is not permissible to insert the card when the device is operational.
3. Switch on the SINAMICS DCP and wait for it to run up.
4. Using STARTER or the BOP, switch to drive object CU_DCP.
5. Activate the device configuration by setting p0009 = 1.
6. For drive object CU_DCP, using p8835 = 5, set the firmware version "Modbus TCP".

7. Set the IP address for the CBE20 using p8941.
   The currently valid address is in r8951.
8. Set the subnet mask for the CBE20 using p8943.
   The currently valid subnet mask is in r8953.
9. Set the default gateway for the CBE20 using p8942.
   You can find the currently valid default gateway in r8952.
10. Set the DHCP mode for the CBE20 using p8944.
11. Select the setting "Activate and save configuration" as interface configuration using p8945 = 2.
12. In the STARTER commissioning tool, check the list of drive object p0978.
    If required, change the sequence of the drive objects using the telegram configuration ("Drive device" > "Communication" > "Telegram configuration").
13. Complete the device configuration with p0009 = 0.
14. Save the data using command "Copy RAM to ROM".
15. Switch off the supply voltage for the SINAMICS DCP.
    Before you switch on again, wait until all LEDs on the SINAMICS DCP are dark.
16. Switch on the supply voltage for the SINAMICS DCP.
    Your settings become active after the system has run up.

Modbus settings with interface X1400

Using the following parameters, set the communication for Modbus TCP with a X1400 interface:

Parameter	Explanation
r2050[0...19]	Connector output to interconnect the PZD received from the fieldbus controller via IF1.
p2051[0...24]	Selects the PZD (actual values) to be sent to the fieldbus controller in the word format via IF1.
r2053[0...24]	Displays the PZD (actual values) sent to the fieldbus controller in the word format via IF1.
p8840	Setting the monitoring time to monitor the received process data via the COMM BOARD. If, within this time, the Control Unit does not receive any process data from the COMM BOARD, then the drive shuts down with fault F08501.
p8839[0...1]	Assigning the CBE20 Communication Board Ethernet (X1400) for cyclic communication via PZD interface 1 (IF1) and interface 2 (IF2).
r8850[0...19]	Connector output to interconnect the PZD (setpoints) received in the word format via IF2.
p8851[0...24]	Selects the PZD (actual values) to be sent in the word format via IF2.
r8853[0...24]	Displays the PZD (actual values) sent in the word format via IF2.

8.7.3 Mapping tables

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 device.

The valid holding register address range extends from 40001 up to 40722. When trying to access other holding registers, the "Exception code" error is output

The process data are transferred into the register range from 40100 up to 40119.

Note

"R"; "W"; "R/W" in the “Access" column stands for read (with FC03); write (with FC06); read/write.

Table 8-32 Assigning the Modbus register to the parameters - process data

Register	Description	Access	Unit	Scaling	ON/OFF text or Value range	Data / parameter
Control data						
40100	PZD 1	R/W	-	1	-	Process data 1 (r2050[0])
40101	PZD 2	R/W	-	1	-	Process data 2 (r2050[1])
40102	PZD 3	R/W	-	1	-	Process data 3 (r2050[2])
40103	PZD 4	R/W	-	1	-	Process data 4 (r2050[3])
40104	PZD 5	R/W	-	1	-	Process data 5 (r2050[4])
40105	PZD 6	R/W	-	1	-	Process data 6 (r2050[5])
40106	PZD 7	R/W	-	1	-	Process data 7 (r2050[6])
40107	PZD 8	R/W	-	1	-	Process data 8 (r2050[7])
40108	PZD 9	R/W	-	1	-	Process data 9 (r2050[8])
40109	PZD 10	R/W	-	1	-	Process data 10 (r2050[9])
Status data						
40110	PZD 1	R	-	1	-	Process data 1 (p2051[0])
40111	PZD 2	R	-	1	-	Process data 2 (p2051[1])
40112	PZD 3	R	-	1	-	Process data 3 (p2051[2])

Register	Description	Access	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40113	PZD 4	R	-	1	-	Process data 4 (p2051[3])
40114	PZD 5	R	-	1	-	Process data 5 (p2051[4])
40115	PZD 6	R	-	1	-	Process data 6 (p2051[5])
40116	PZD 7	R	-	1	-	Process data 7 (p2051[6])
40117	PZD 8	R	-	1	-	Process data 8 (p2051[7])
40118	PZD 9	R	-	1	-	Process data 9 (p2051[8])
40119	PZD 10	R	-	1	-	Process data 10 (p2051[9])

Table 8-33 Assigning the Modbus register to the parameters - parameter data

Register	Description	Access	Unit	Scaling	ON/OFF text or Value range	Data / parameter
Drive identification						
40300	Actual power unit code number	R	-	1	0 ... 65535	r0200
40301	Control Unit firmware	R	-	1	0 ... 65535	r50060
Drive diagnostics						
40345	Reactor current actual value	R	A	100	0 ... 655.35	r0027
Fault diagnostics						
40400	Failure number, index 0	R	-	1	0 ... 65535	r0947 [0]
40401	Failure number, index 1	R	-	1	0 ... 65535	r0947 [1]
40402	Failure number, index 2	R	-	1	0 ... 65535	r0947 [2]
40403	Fault number, index 3	R	-	1	0 ... 65535	r0947 [3]
40404	Fault number, index 4	R	-	1	0 ... 65535	r0947 [4]
40405	Fault number, index 5	R	-	1	0 ... 65535	r0947 [5]
40406	Fault number, index 6	R	-	1	0 ... 65535	r0947 [6]
40407	Fault number, index 7	R	-	1	0 ... 65535	r0947 [7]
40408	Alarm number	R	-	1	0 ... 65535	r2110 [0]
40409	Actual alarm code	R	-	1	0 ... 65535	r2132
40499	PRM ERROR code	R	-	1	0 ... 255	-

Table 8-34 Assignment of the Modbus register for general parameter access using DS47

Register	Description	Access	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40601	DS47 Control	R/W	-	-	-	-
40602	DS47 header	R/W	-	-	-	-

Register	Description	Access	Unit	Scaling	ON/OFF text or Value range	Data / parameter
40603	DS47 data 1	R/W	-	-	-	-
...	...					
40722	DS47 data 120	R/W	-	-	-	-

Note

Limited value range

Modbus TCP registers have a maximum 16 bit width. The values of display parameters (r parameters) cannot always be represented with 16 bits. In these particular cases, the maximum value that can be represented is displayed.

- Unsigned: 65535
- Signed min: -32768
- Signed max: 32767

8.7.4 Write and read access using function codes

Function codes used

For data exchange between the controller and device, predefined function codes are used for communication via Modbus.

The Control Unit uses the following Modbus function codes:

- FC 03: Holding register to read data from the converter
- FC 06: Write single register to write to individual register
- FC 16: Write to multiple registers to write to several registers

Structure of a Modbus TCP message

Application Data Unit (ADU)					
Modbus Application Header				Protocol Data Unit (PDU)	
Transaction ID	Protocol ID	Length	Unit ID	FCode	Data
2 Bytes	2 Bytes	2 Bytes	1 Byte	1 Byte	0 ... 252 Bytes

Figure 8-50 Individual components, including the Modbus Application Header (MBAP) and function code

Note

In the following examples, the bytes of the Application Data Unit (ADU) are counted starting with "0".

Structure of a read request via Modbus function code 03 (FC 03)

Any valid register address is permitted as the start address.

Via FC 03, the control can address more than one register with one request. The number of addressed registers is contained in bytes 10 and 11 of the read request.

Table 8-35 Structure of a read request for device number 17, example

Value	Byte	Description
MBAP header		
03 h	7	
00 h	8	Register start address "High" (register 40110)
6D h	9	Register start address "Low"
00 h	10	Number of registers "High" (2 registers: 40110; 40111)
02 h	11	number of registers "Low"

The response returns the corresponding data set:

Table 8-36 Device response to the read request, example

Value	Byte	Description
MBAP header		
03 h	7	Function code
04 h	8	Number of bytes (4 bytes are returned)
11 h	9	Data, first register "High"
22 h	10	Data, first register "Low"
33 h	11	Data, second register "High"
44 h	12	Data, second register "Low"

Table 8-37 Invalid read request

Read request	Converter 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)

Structure of a write request via Modbus function code 06 (FC 06)

Start address is the holding register address.

Via FC 06, with one request, only precisely one register can be addressed. The value, which is written to the addressed register, is contained in bytes 10 and 11 of the write request.

Table 8-38 Structure of a write request for device number 17, example

Value	Byte	Description
MBAP header		
06 h	7	Function code
00 h	8	Register start address "High" (write register 40100)
63 h	9	Register start address "Low"
55 h	10	Register data "High"
66 h	11	Register data "Low"

The response returns register address (bytes 8 and 9) and the value (bytes 10 and 11), which the higher-level control had written to the register.

Table 8-39 Device response to the write request, example

Value	Byte	Description
MBAP header		
06 h	7	Function code
00 h	8	Register start address "High"
63 h	9	Register start address "Low"
55 h	10	Register data "High"
66 h	11	Register data "Low"

Table 8-40 Invalid write request

Write request	Converter response
Incorrect address (a holding register address does not exist)	Exception Code 02 - invalid data address
Write to a "read-only" register	Exception Code 04 - device failure
Write to a reserved register	

For Exception Code 4, via the holding register 40499, you can read out the internal drive error code, which has occurred for the last parameter access via the holding register.

8.7.5 Communication via data set 47

8.7.5.1 Overview

Using FC 16, with one request, up to 122 registers can be written to directly one after the other, while for Write Single Register (FC 06) you must individually write the header data for each register.

Header

In addition to the transfer type, the start address and the number of the following registers in the header.

User data

You control the access in the user data via register 40601.

In register 40602, you define the access as well as the length of the request data.

Register 40603 contains the request reference - it is defined by the user - and the access type - reading or writing.

From register 40603 and higher, the request aligns communication via data set 47 according to PROFIdrive.

Register 40604 contains the number of the drive object and the number of parameters that are read out or written to.

Register 40605 contains the attribute that you use to control whether you read out the parameter value or the parameter attribute. In the number of elements you specify how many indices are read.

8.7.5.2 Communication details

General parameter access is realized using the Modbus register 40601 ... 40722.

Communication via DS47 is controlled using 40601. 40602 contains the function code (always = 47 = 2F hex) and the number of the following user data. User data are contained in registers 40603 ... 40722.

Communication overview

Value in the register				Explanation
40601	**40602**		**40603 ... 40722**	
0	47	...	...	Write values for acyclic access
1	47	Request length [bytes]	Request data	Activate acyclic access
2	47	Response length [bytes]	Response data	Response for a successful request
2	47	0	Error code	Response for an erronous request

Error codes

1 hex: Invalid Length (invalid length)
2 hex: Invalid State (in the actual converter state, this action is not permitted)
3 hex: Invalid function code (FC ≠ 2F hex)
4 hex: Response not ready (the response has still not been issued)
5 hex: Internal Error (general system error)

Incorrect access operations to parameters via data set 47 are logged in registers 40603 ... 40722. The error codes are described in the PROFIdrive profile.

8.7.5.3 Examples: Read parameter

Table 8-41 Write parameter request: Reading parameter value of r0002 from device number 17 (DCP_CTRL)

Value	Byte	Description
MBAP header		
10 h	7	Function code (write multiple)
0258 h	8,9	Register start address
0007 h	10,11	Number of registers to be read (40601 … 40607)
0E h	12	Number of data bytes (7 registers, each 2 bytes = 14 bytes)
0001 h	13,14	40601: DS47 control = 1 (acyclic access - activate request)
2F0A h	15,16	40602: Function 2F h (47), request length 10 bytes (0A h)
8001 h	17,18	40603: Request reference = 80 h, request identifier = 1 h (read)
0101 h	19,20	40604: DO-Id = 1, number of parameters = 1
1001 h	21,22	40605: Attribute, number of elements = 1
0002 h	23,24	40606: Parameter number = 2
0000 h	25,26	40607: Subindex = 0

Table 8-42 Start parameter request: Reading parameter value of r0002 from device number 17 (DCP_CTRL)

Value	Byte	Description
MBAP header		
03 h	7	Function code (read)
0258 h	8,9	Register start address
0007 h	10,11	Number of registers to be read (40601 … 40607)
0010 h	12,13	Number of registers

Table 8-43 Response for successful read operation

Value	Byte	Description
MBAP header		
03 h	7	Function code (read)
20 h	8	Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0002 h	9,10	40601: DS47 Control = 2 (the request was executed)
2F08 h	11,12	40602: Function code 2F h (47), response lengths 8 bytes
8001 h	13,14	40603: Request reference mirrored = 80 h, response identifier = 1 (request parameter)
0101 h	15,16	40604: DO-ID = 1, number of parameters = 1
0301 h	17,18	40605: Format, number of elements = 1
001F h	19,20	40606: Parameter value = 1F h (31)

Table 8-44 Response for unsuccessful read operation - read request still not completed

Value	Byte	Description
MBAP header		
03 h	7	Function code (read)
20 h	8	Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0001 h	9,10	40601: Check value 1 = request is processed
2F00 h	11,12	40602: Function code 2F h (47), response length 0 (error)
0004 h	13,14	40603: Error code: 0004 Response Not Ready (response has still not been issued)

8.7.5.4 Examples: Write parameter

Table 8-45 Write parameter request: Writing the parameter value of p55450 from device number 17 (DCP_CTRL)

Value	Byte	Description
MBAP header		
10 h	7	Function code (write multiple)
0258 h	8,9	Register start address
000A h	10,11	Number of registers to be written to (40601 … 40610)
14 h	12	Number of data bytes (10 registers, each 2 bytes = 20 bytes)
0001 h	13,14	40601: 1 (activate request)
2F10 h	15,16	40602: Function 2F h (47), request length 16 bytes (10 h)
8002 h	17,18	40603: Request reference = 80 h, request identifier = 2 h (write)
0101 h	19,20	40604: DO-Id = 1, number of parameters = 1
1001 h	21,22	40605: Attribute, number of elements = 1
D89A h	23,24	40606: Parameter number = 55450
0000 h	25,26	40607: Subindex = 0
0801 h	27,28	40608: Format + number of values
4142 h	29,30	40609: Parameter value 12,15
6666 h	31,32	40610: Parameter value

Table 8-46 Start parameter request: Writing the parameter value of p55450 from device number 17 (DCP_CTRL)

Value	Byte	Description
MBAP header		
03 h	7	Function code (read)
0258 h	8,9	Register start address
0007 h	10,11	Number of registers to be written to (40601 … 40610)
0010 h	12,13	Number of registers

Table 8-47 Response for successful write operation

Value	Byte	Description
MBAP header		
03 h 20 h	7 8	Function code (read) Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0002 h 2F04 h 8002 h 0101 h	9,10 11,12 13,14 15,16	40601: DS47 Control = 2 (request was executed) 40602: Function code 2F h (47), response length 4 bytes 40603: Request reference mirrored = 80 h, response identifier = 2 (change parameter) 40604: DO-ID = 1, number of parameters = 1

Table 8-48 Response for unsuccessful write operation - write request still not completed

Value	Byte	Description
MBAP header		
03 h 20 h	7 8	Function code (read) Number of following data bytes (20 h: 32 bytes ≙ 16 registers)
0001 h 2F00 h 0004 h	9,10 11,12 13,14	40601: DS47 Control = 1 (request is processed) 40602: Function code 2F h (47), response length 0 (error) 40603: Error code: 0004 Response Not Ready (response has still not been issued)

8.7.6 Communication procedure

Logical error

If the device detects a logical error within a request, it responds to the controller with an "exception response". In the response, the device sets the highest bit in the function code to 1. If the device receives, for example, an unsupported function code from the controller, the device responds with an "exception response" with code 01 (illegal function code).

Table 8-49 Overview of exception codes

Exception code	Modbus name	Remark
01	Illegal function code	An unknown (unsupported) function code was sent to the device.
02	Illegal Data Address	An invalid address was requested.
03	Illegal data value	An invalid data value was detected.
04	Server failure	The device has terminated during processing.

Process data monitoring time (setpoint timeout)

The "Setpoint timeout" only applies for access to process data (40100 ... 40109, 40110 ... 40119). The "Setpoint timeout" is not generated for parameter data (40300 ... 40499).

COMM BOARD:

In parameter p8840 you define the time for cyclic process data exchange.

Setting range 0 - 2000 s.

The time depends on the amount of data to be transferred and the control.

"Setpoint timeout" (F08501) is issued by the Modbus if p8840 is set to a value > 0 ms and no process data is requested within this time period.

8.7.7 Messages and parameters

Faults and alarms (see DCP List Manual)

- A01925 Modbus TCP connection interrupted
- F08501 PN/COMM BOARD: Setpoint timeout
- A08526 PN/COMM BOARD: No cyclic connection
- A08555 Modbus TCP commissioning fault

Overview of important parameters (see the SINAMICS DCP List Manual)

- p0978[0...n] List of drive objects
- r2050[0...19] CO: IF1 PROFIdrive PZD receive word
- p2051[0...24] CI: IF1 PROFIdrive PZD send word
- r2053[0...24] IF1 PROFIdrive diagnostics PZD send word
- p8835 CBE20 firmware selection
- p8839[0...1] PZD interface hardware assignment
- p8840 COMM BOARD monitoring time
- r8850[0...19] CO: IF2 PZD receive word
- p8851[0...24] CI: IF2 PZD send word
- r8853[0...24] IF2 diagnostics PZD send
- p8920[0...239] PN Name of Station
- p8921[0...3] PN IP address
- p8922[0...3] PN default gateway
- p8923[0...3] PN Subnet Mask
- p8924 PN DHCP mode
- p8925 PN interfaces configuration
- p8940[0...239] CBE2x Name of Station
- p8941[0...3] CBE2x IP address
- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 CBE2x interfaces configuration

8.8 Communication via EtherNet/IP (EIP)

EtherNet/IP (EIP) is a realtime Ethernet, and is mainly used in automation technology.

The EtherNet Industrial Protocol (EtherNet/IP) is an open standard for industrial networks. It is used to transmit cyclic I/O data and acyclic parameter data. EtherNet/IP was developed by Rockwell Automation and the Open Device-Net Vendor Association (ODVA (https://www.odva.org/Technology-Standards/EtherNet-IP/Overview)), and standardized in the series of international IEC 61158 standards. EtherNet/IP uses the basis technology of Ethernet TCP/IP, which has been well proven in practice. Ethernet twisted-pair cables or fiber-optic cables are used as data transmission medium.

Note

This chapter applies to several components of the SINAMICS drive family. These include the SINAMICS DCP even though it is not a drive. Therefore, in this chapter, the terms "drive," "drive unit," or "drive system" always refer to the SINAMICS DCP.

8.8.1 Components to connect SINAMICS DCP with EtherNet/IP

A Communication Board Ethernet CBE20 is required for connection to EtherNet/IP.

When ordering SINAMICS DCP with option G33 (Profinet CBE20), the CBE20 module is included.
For ordering data, see Chapter "Ordering information for options and accessories (Page 30)".

For further details on the CBE20 module, see Chapter "Option Board: Communication Board EtherNet CBE20 (Page 68)".

8.8.2 Configuration of SINAMICS DCP for EtherNet/IP

Precondition

- CBE20 Communication Board Ethernet

SINAMICS DCP for EtherNet/IP is configured using STARTER, or parameters are directly entered at the BOP.

Carry out the following steps to communicate with a higher-level control system via EtherNet/IP:

1. Using STARTER or the BOP, switch to drive object CU_DCP.
2. Activate the device configuration by setting p0009 = 1.
3. With p8835 = 4, set the firmware version "EtherNet/IP".
4. Set the IP address for the CBE20 using p8941.
   The currently valid address is in r8951.
5. Set the subnet mask using p8943.
   The currently valid subnet mask is in r8953.

6. Set the default gateway using p8942.
   You can find the currently valid default gateway in r8952.
7. Set the station names using p8940.
   You can find the currently valid station names in r8950.
   This setting is not absolutely necessary for operation with EtherNet/IP; however, it can be necessary in conjunction with DHCP.
8. Accept and activate the settings by setting p8945 = 2.
9. Complete the device configuration with p0009 = 0.
10. Save the data using command "Copy RAM to ROM".
11. Switch off the supply voltage for the SINAMICS DCP.
    Before you switch on again, wait until all LEDs on the SINAMICS DCP are dark.
12. Switch on the supply voltage for the SINAMICS DCP.
    Your settings become active after the system has run up.

In addition to directly entering the IP address, it is also possible to retrieve this via DHCP.

1. Set the required DHCP mode using p8944 (CBE2x DHCP mode):

Parameter assignment	Meaning
p8944 = 2	The DHCP server assigns the IP address based on the MAC address.
p8944 = 3	The DHCP server assigns the IP address based on the station name.

2. Save the settings with p8945 = 2.
   The next time the drive runs up, it retrieves the IP address from the DHCP server.
   After the system has run up, you can address the drive as Ethernet participant.

Note

Immediate switchover without restart

The switchover to DHCP is performed immediately and without a restart if the change is carried out with the EtherNet/IP command "Set Attribute Single" (TCP/IP Interface Object / Class code F5 hex, attribute 3), e.g. using an EtherNet/IP control or a commissioning tool.

Note

When DHCP is activated (p8944 not equal to 0), PROFINET communication via the CBE20 is not possible.

As a consequence, DHCP must be deactivated before switching over the interface to PROFINET.

8.8.3 Communication with the SINAMICS DCP

The EtherNet/IP communication with SINAMICS DCP is possible using the following connection types:

- Implicit (I/O) messaging
  for cyclic I/O or process data (setpoints, actual values, control and status words)
- Explicit messaging
  for acyclic message requirements

For communication via EtherNet/IP, SINAMICS DCP supports the following CIP objects:

Class code (hex)	Class code	Object name
001 hex	1	Identity Object
004 hex	4	Assembly Object
006 hex	6	Connection Manager Object
0F5 hex	245	TCP/IP Interface Object [1]
0F6 hex	246	Link Object [1]
32C hex	812	Siemens Drive Object (reading and writing certain device parameters)
401 hex ... 43E hex	1025 - 1086	Parameter Object (general reading and writing of device parameters)

[1] These objects are part of the EtherNet/IP system management

The communication types and objects that are supported are described in more detail in the following.

8.8.3.1 Implicit messaging – cyclic communication as I/O device

Assembly Object (Class Code 4 hex) is used for cyclic communication.

As standard, the SINAMICS DCP as I/O device exchanges cyclic process data (PZDs) with a PLC or another control system.

Cyclic information, such as control words, status words, actual values and setpoints, are called process data.

The following I/O assembly settings must be made (from the PLC perspective):

Assembly	Content	Description
101	Receive data	Total length of the receive data in bytes (= 2x number of receive PZD)
102	Send data	Total length of the send data in bytes (= 2x number of send PZD)
103	Configuration data	Length 0 bytes

In addition, the cycle time of the data transfer - the RPI (Requested Packet Interval) - must be additionally defined in the PLC. 4 ms is supported as the minimum value.

PZD are transferred as words (16 bit integer).

The data length for the assemblies of the receive and send data correspond to the total number of PZD for all drive objects:

- Example 1:

Drive object (DO)	Number of PZD in the send direction	Number of PZD in the receive direction
DCP_CTRL	10	10
CU	2	2
Total data length	12 words = 24 bytes	12 words = 24 bytes

- Example 2:

Drive object (DO)	Number of PZD in the send direction	Number of PZD in the receive direction
DCP_CTRL	10	5
CU	0	0
TM31	1	1
Total data length	11 words = 22 bytes	6 words = 12 bytes

The highest PZD of a drive object, whose data is sent or received in an assembly, must be connected with the data source or data sink via BiCO technology.

In example 1, PZD 10 of drive object DCP_CTRL and PZD 2 of the drive object CU_DCP must have an active BiCO interconnection in the receive and send directions.

The highest interconnected PZD is displayed separately in r2067 (IF1) or r8867 (IF2) of a drive object for the receive direction (index 0) and send direction (index 1).

In example 1, the total length of the send data can be calculated based on this parameter:

- DO DCP_CTRL: r2067[1] = 10
- DO CU_DCP: r2067[1] = 2

In total, 12 PZD or 24 bytes are obtained in the send direction.

The sequence in which the drive object data are arranged, depends on the communication settings of the SINAMICS DCP.
The position of the data in the assembly can be set in the STARTER window "Telegram configuration":

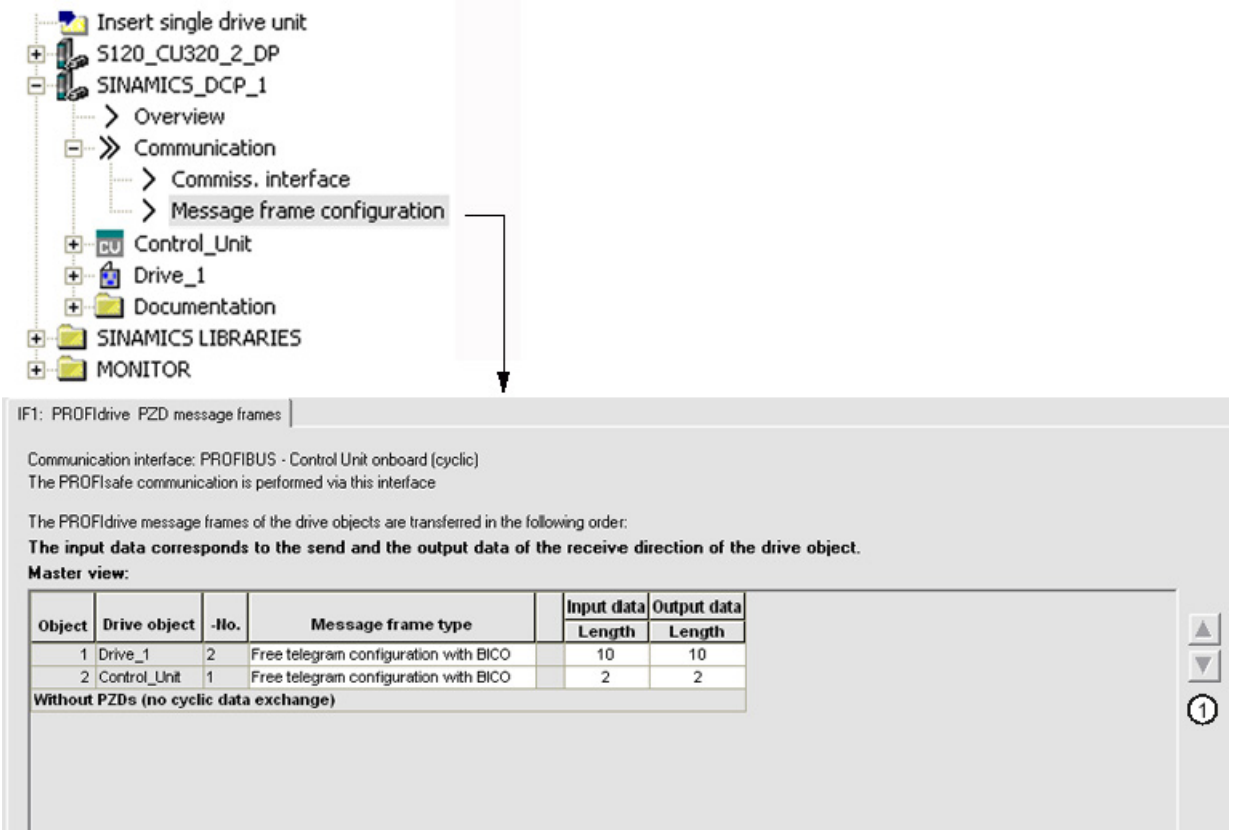


Figure 8-51 Changing the sequence of the drive objects

The sequence can only be changed offline using the arrows on the right ①. For the change to take effect, it must be subsequently downloaded from the PG/PC to the SINAMICS DCP.

Note

If the secondary conditions described for the communication are not complied with, then alarm A50011 "EtherNetIP/COMM BOARD; configuration error" is output.

Description of the Assembly Object

Table 8-50 Assembly Object – supported services

Environment	Service
Class	Get Attribute single
Instance	Get Attribute single
	Set Attribute single

Table 8-51 Assembly Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-52 Assembly Object – Instance Attributes

Attribute ID	Service	Type	Name	Value	Description
3	get	UINT8[]	Assembly	...	1 byte array

8.8.3.2 Explicit messaging - acyclic or event-driven communication

Using this communication type, when requested by the SINAMICS DCP, data can be read or transferred there.

Identity Object, Class code 1 hex

The Identity Object allows basic information to be queried about the device, for example, the serial number and the product name.

Table 8-53 Identity Object – supported services

Environment	Service
Class	Get Attribute all
	Get Attribute single
Instance	Get Attribute all
	Get Attribute single
	Reset

Table 8-54 Identity Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-55 Identity Object – Instance Attributes

Attribute ID	Service	Type	Name	Value	Description
1	get	UINT16	Vendor ID	1251	Siemens
2	get	UINT16	Device Type	0C hex	Siemens Drive
3	get	UINT16	Product Code	5480	CU_DCP r0964[1]

Attribute ID	Service	Type	Name	Value	Description
4	get	Struct of	Revision	-	-
5	get	WORD	Status	...	See the following table
6	get	UINT32	Serial number	...	Bit 0 ... 19: Consecutive number Bits 20 ...23: Production day Bits 24 ... 27: Month of manufacture (0 = Jan, B = Dec) Bits 28 ... 31: Year of manufacture (0 = 2002)
7	get	SHORT_STRING	Product Name	SINAMICS DCP	Max. length 32 bytes

Table 8-56 Identity Object – explanation of Instance Attribute ID 5 of the previous table

Byte	Bit	Name	Description
1	0	Owned	0: Converter is not assigned to a controller 1: Converter is assigned to a controller
	1	-	Reserved
	2	Configured	0: Ethernet/IP basic settings 1: modified Ethernet/IP settings
	3	-	Reserved
	4 ... 7	Extended Device Status	0: Self-test or status not known 1: Firmware update active 2: At least one I/O connection with error 3: No I/O connections 4: Incorrect configuration in the ROM 5: Fatal fault 6: At least one I/O connection is active 7: All I/O connections in the quiescent state 8 ... 15: Reserved
2	8 ... 11	-	not used
	12 ... 15	-	Reserved

Siemens Drive Object, Class code 32C hex

Using the Siemens Drive Object, a defined subset of the parameters of all drive objects (DO) of the SINAMICS DCP can be read out (get) and changed (set).
Drive objects of the SINAMICS DCP are accessed via the instance ID and the position of the drive object in the sequence of the telegram configuration, i.e. instance ID corresponds to the entry under "Object" of the drive object in the STARTER window "Telegram configuration".

Parameter Object (Class codes 401 hex ... 43E hex) should always be used for reading and writing drive objects; in contrast to the Siemens Drive Object, it allows all parameters of the drive object to be accessed.

Table 8-57 Siemens Drive Object - supported services

Environment	Service
Class	Get Attribute single
Instance	Get Attribute single
	Set Attribute single

Table 8-58 Siemens Drive Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

The following table describes the available attributes and/or the parameters of the drive objects. It should be noted that some attributes are not supported by all drive devices.

Table 8-59 Siemens Drive Object – Instance Attributes

Attribute ID	Service	Type	Name	Description	Comment
2	get, set	UINT16	Commissioning state	p0010 Commissioning parameter filter	Only for drive objects DCP_CTRL, TM15 DI/DO, TM31, TM150
3 ... 18	get	UINT8	STW1	r2090[0] (r2050[0] bit-by-bit) STW1 bit-by-bit access Attribute ID 3 = STW1.0 ... Attribute ID 18 = STW1.15	
20 ... 35	get	UINT8	ZSW1	r2089[0] ZSW1 bit-by-bit access Attribute ID 20 = ZSW1.0 Attribute ID 35 = ZSW1.15	
54	get	REAL32	Actual Current	r0027 Reactor absolute actual current smoothed	Only for drive object DCP_CTRL
60	get	UINT8	CDS Eff (Local Mode)	r0050 Command data set CDS effective	Only for drive object DCP_CTRL
61	get	UINT16	Status Word 2	r2089[1] binector-connector converter Send status word, status word 2	
62	get	UINT16	Control Word 1	r0898 Control word sequence control	Only for drive object DCP_CTRL
70	get	UINT16	Fault Code 1	r0947[0] Fault number 1	
71	get	UINT16	Fault Code 2	r0947[1] Fault number 2	
72	get	UINT16	Fault Code 3	r0947[2] Fault number 3	
73	get	UINT16	Fault Code 4	r0947[3] Fault number 4	
74	get	UINT16	Fault Code 5	r0947[4] Fault number 5	
75	get	UINT16	Fault Code 6	r0947[5] Fault number 6	
76	get	UINT16	Fault Code 7	r0947[6] Fault number 7	

Attribute ID	Service	Type	Name	Description	Comment
77	get	UINT16	Fault Code 8	r0947[7] Fault number 8	
79	get	UINT16	Alarm Code 1	r2110[0] Alarm number 1	
80	get	UINT16	Alarm Code 2	r2110[1] Alarm number 2	
81	get	UINT16	Alarm Code 3	r2110[2] Alarm number 3	
82	get	UINT16	Alarm Code 4	r2110[3] Alarm number 4	

Parameter Object, Class codes 401 hex ... 43E hex

Using Parameter Object, it is possible to write to any parameter of the addressed drive object (get) or to read any parameter of the addressed drive object (set).

Table 8-60 Parameter Object – supported services

Environment	Service
Class	Get Attribute single
Instance	Get Attribute single
	Set Attribute single

Table 8-61 Parameter Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Parameters of the drive objects are accessed via Class code, Instance ID and Instance Attribute:

Class code: The Class code corresponds to 400 hex + <Drive object No.>

The drive object No. can be taken from column "(Drive object) No." in the STARTER "Telegram configuration" window.

For example,
Class code 401 hex: Drive object 1
Class code 402 hex: Drive object 2
... ...
Class code 43E hex: Drive object 62

Instance ID: The parameter No. is transferred in the Instance ID.

For example, access to r50001 ⇒ Instance ID = 50001

(Instance) attribute: Parameter indices are transferred as Instance Attributes.

For example, access to r52051[2] ⇒ Instance Attribute = 2

Generally, the following applies:

- Drive object No. 1 = CU_DCP ⇒ Class code 401 hex
- Drive object No. 2 = DCP_CTRL ⇒ Class code 402 hex

Example:Read parameter r52051[2] (temperature power unit 3) from DO 2 (in this case, DCP_CTRL)

Service "Get Attribute single" with the following values:

EtherNet/IP task	Value	Comment
Class code	402 hex	Drive object 2 (default: DCP_CTRL)
Instance ID	52051	Parameter r52051: temperature sensor power unit display
Instance Attribute	2	Index 2: temperature power unit 3

Example:Write to p0009 (device commissioning parameter filter) in DO 1 (in this case, CU_DCP)

Service "Set Attribute single" with the following values:

EtherNet/IP task	Value	Comment
Class code	401 hex	Drive object 1 (default: CU_DCP)
Instance ID	9	Parameter p0009: device commissioning parameter filter
Instance Attribute	0	No index
Data	1	Parameter value: [1] device configuration

The data type of the parameter, and therefore the representation in the user data of the Parameter Object, is specified by the drive and can be found in the SINAMICS DCP List Manual (Chapter "List of parameters").

Note

For write access, the number of user data bytes must correspond to the parameter data width.

Otherwise, the write request is rejected.

Examples:

- Precisely 2 bytes must be transferred for a parameter, data type Integer16 (e.g. P0010).
- Precisely 4 bytes must be transferred for a parameter, data type FloatingPoint32.

Other supported objects

Connection Management Object, Class code 6 hex

Table 8-62 Connection Management Object – supported services

Environment	Service
Class	Get Attribute all
	Get Attribute single

Environment	Service
Instance	Forward open
	Forward close
	Get Attribute all
	Get Attribute single

Table 8-63 Connection Management Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-64 Connection Management Object – Instance Attributes

Attribute ID	Service	Type	Name	Value	Description
1	get	UINT16	Open Requests	...	Counters
2	get	UINT16	Open Format Rejects	...	Counters
3	get	UINT16	Open Resource Rejects	...	Counters
4	get	UINT16	Open Other Rejects	...	Counters
5	get	UINT16	Close Requests	...	Counters
6	get	UINT16	Close Format Requests	...	Counters
7	get	UINT16	Close Other Requests	...	Counters
8	get	UINT16	Connection Timeouts	...	Counters Number of bus errors

TCP/IP Interface Object, Class code F5 hex

Table 8-65 TCP/IP Interface Object – supported services

Environment	Service
Class	Get Attribute all
	Get Attribute single
Instance	Get Attribute all
	Get Attribute single
	Set Attribute single

Table 8-66 TCP/IP Interface Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-67 TCP/IP Interface Object – Instance Attributes

Attribute ID	Service	Type	Name	Value/explanation
1	get	UNIT32	Status	Fixed value: 1 hex 1: Configuration acknowledged, by DHCP or saved values
2	get	UNIT32	Configuration Capability	Fixed value: 94 hex 4 hex: DHCP supported, 10 hex: Configuration can be adjusted, 80 hex: ACD-capable
3	get, set	UNIT32	Configuration Control	1 hex: Saved values 3 hex: DHCP
4	get	UNIT16	Physical Link	Path Size (in WORDs); fixed value: 2 hex
	get, set			Interface Configuration
5	get, set	STRING	Host Name	r61000 Name of Station
	get, set			Select ACD
6	get, set	UNIT16	Last Conflict Detected	Host Name Length
		STRING		-
10	get	UNIT8	Close Other Requests	local OM flash: 0: Disabled, 1: Enabled
11	get	UNIT8	Connection Timeouts	local OM flash ACD Activity
		UNIT8		local OM flash Remote MAC
		UNIT8		local OM flash ARP PDU

Link Object, Class code F6 hex

Table 8-68 Link Object – supported services

Environment	Service
Class	Get Attribute all
	Get Attribute single
Instance	Get Attribute all
	Get Attribute single
	Set Attribute single

Table 8-69 Link Object – Class Attributes

Attribute ID	Service	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Max Instance
3	get	UINT16	Num of Instances

Table 8-70 Link Object – Instance Attributes

Attribute ID	Service	Type	Name	Value/explanation
1	get	UINT32	Interface Speed	0: link down, 10: 10 Mbps, 100: 100 Mbps
2	get	-	Interface Flags	Bit 1: Link-Status Bit 2: Duplex Mode (0: half duplex, 1 duplex) bit 3 ... 5: Automatic state identification Bit 6: Reset required Bit 7: Local hardware fault (0 = ok)
3	get	ARRAY	Physical Address	r8935 Ethernet MAC address
4	get, get_and_clear	Struct of	Interface Counters	Optional, required if the "Media Counters Attribute" is implemented.
		UINT32	In Octets	Received octets
		UINT32	In Ucast Packets	Received Unicast packets
		UINT32	In NUcast Packets	Received non-Unicast packets
		UINT32	In Discards	Incoming packets, not processed
		UINT32	In Errors	Incoming packets with errors
		UINT32	In Unknown Protos	Incoming packets with unknown protocol
		UINT32	Out Octets	Sent octets
		UINT32	Out Ucast Packets	Sent Unicast packets
		UINT32	Out NUcast packets	Sent non-Unicast packets
		UINT32	Out Discards	Outgoing packets, not processed
		UINT32	Out Errors	Outgoing packets, with errors

Attribute ID	Service	Type	Name	Value/explanation
5	get, get_and_clear	Struct of	Media Counters	Media-specific counters
		UINT32	Alignment Errors	Structure received, which does not match the number of octets
		UINT32	FCS Errors	Structure received, which does not pass the FCS check
		UINT32	Single Collisions	Structure successfully transmitted, precisely one collision
		UINT32	Multiple Collisions	Structure successfully transmitted, several collisions
		UINT32	SQE Test Errors	Number of SQE errors
		UINT32	Deferred Transmissions	First transmission attempt delayed
		UINT32	Late Collisions	Number of collisions that occurred delayed by 512 bit timers to the request
		UINT32	Excessive Collisions	Transmission unsuccessful as a result of intensive collisions
		UINT32	MAC Transmit Errors	Transmission unsuccessful as a result of an internal MAC sublayer transmission error.
		UINT32	Carrier Sense Errors	Number of errors when attempting to send a request frame, where the transmission condition was lost or was not assigned
		UINT32	Frame Too Long	Structure too large
		UINT32	MAC Receive Errors	Transmission unsuccessful as a result of an internal MAC sublayer receive error.
6	get, set	Struct of	Interface Control	-
		UINT16	Control Bits	-
		UINT16	Forced Interface Speed	-
10	get	String	Interface_Label	Interface-Label
11	get	-	Interface Capability	Bit 0: Manual setting Bit 1: Auto negotiate Bit 2: Auto MDIX Bit 3: Manual speed/duplex Bits 4 – 31: reserved Rest: Speed/Duplex options

8.8.4 Configuration of a Rockwell controller with SINAMICS DCP

Note

The user must have basic knowledge of Allen-Bradley / Rockwell PLCs.

The associated Allen-Bradley / Rockwell documentation should be used for detailed information about communication with EtherNet/IP and general programming of Rockwell PLCs.

A "Generic Ethernet/IP" module must be created in order to communicate with a SINAMICS DCP.

The following configurations must be made for the basic communication:

- Selection of the module, figures "Selection of the module (1), (2) and (3)"
  The dialog box for the selection of the module for the appropriate EtherNet interface is selected in the I/O configuration through > right-click > New Module.

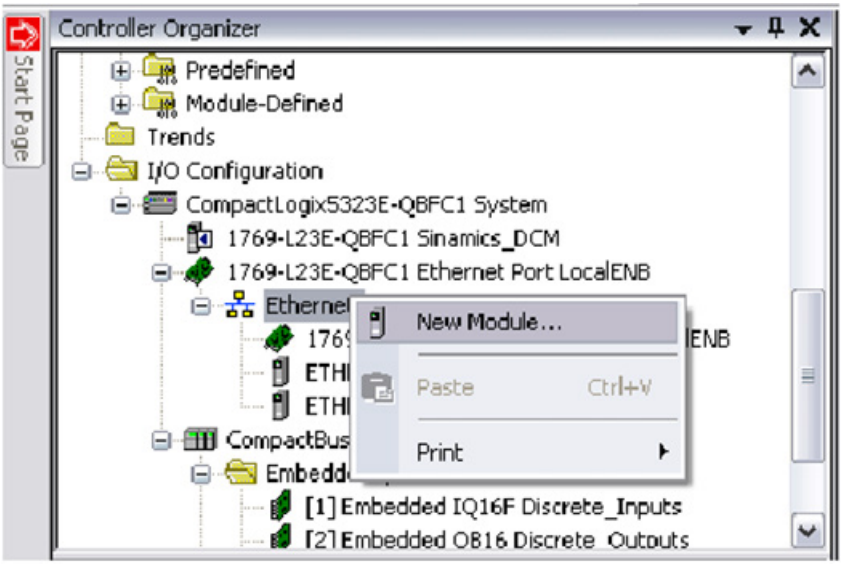


Figure 8-52 Selection of the module (1)

The "Generic EtherNet Module" is selected at Communication:

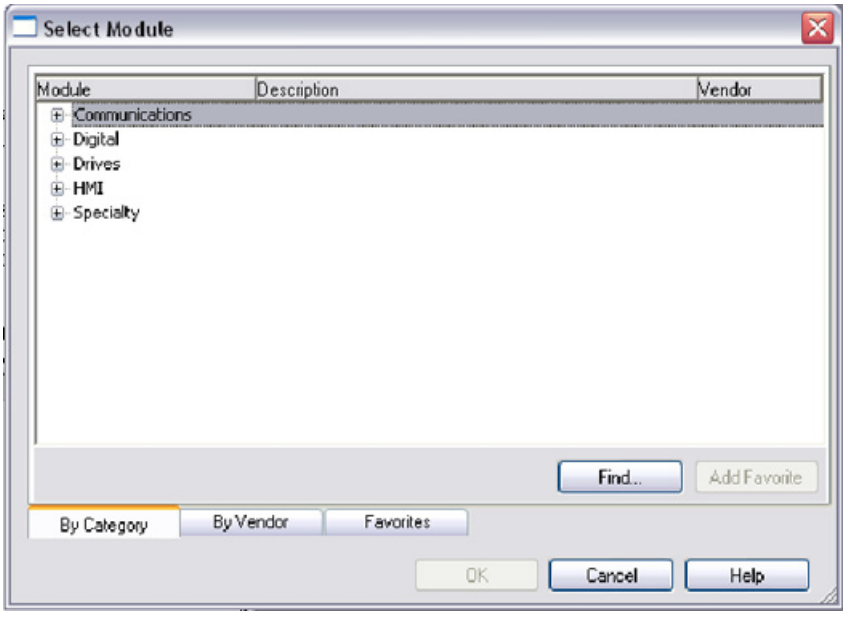


Figure 8-53 Selection of the module (2)

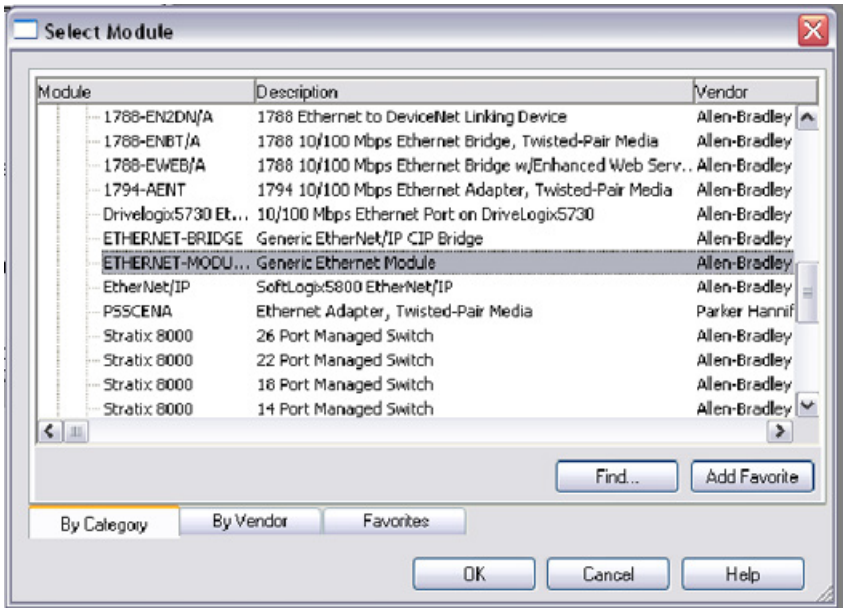


Figure 8-54 Selection of the module (3)

- After the module has been inserted by clicking OK, a new EtherNet/IP device appears in the structure tree.
  By double-clicking or right-clicking and then selecting "Properties", the following window opens.

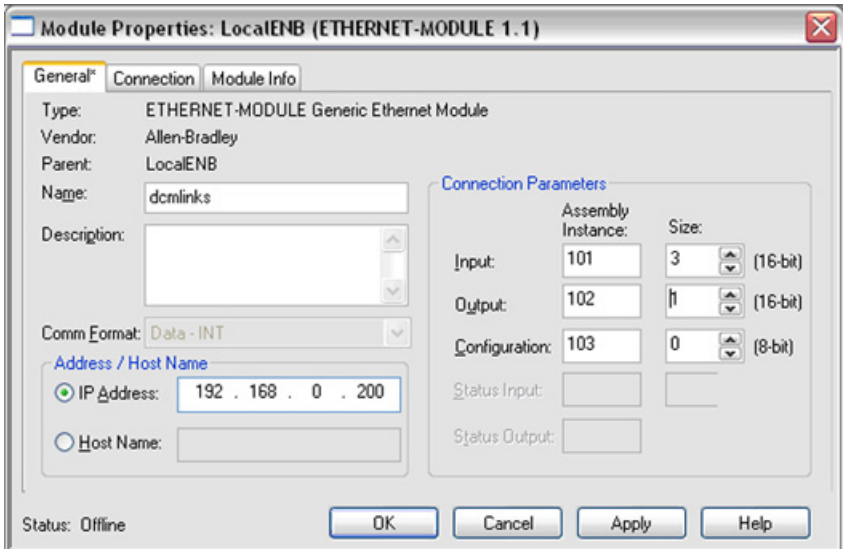


Figure 8-55 Properties

Make the following settings:

- Select a name to identify the drive.
- Enter the IP address of the drive
- Set the "Connection Parameters" as described in Chapter "Implicit messaging – cyclic communication as I/O device (Page 293)".

After the configuration has been activated, the drive data can be accessed via the input and output data fields (following diagram).

To improve the program documentation, it is recommended that aliases are defined for each input and output signal.

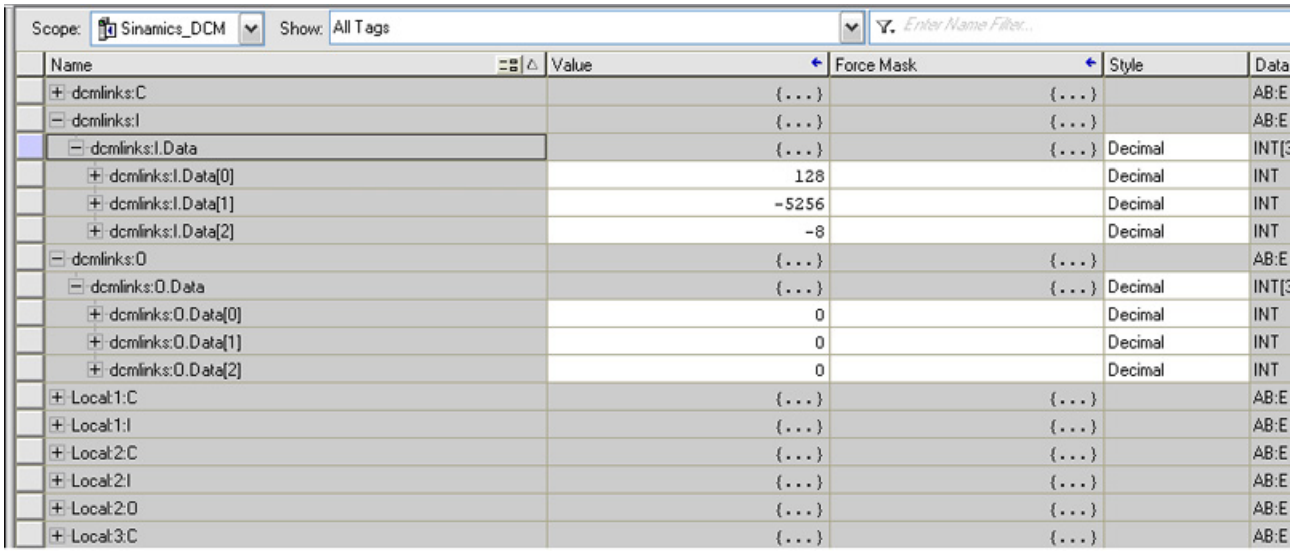


Figure 8-56 Input data and output data

Now configure the drive in order to use EtherNet/IP.

8.8.4.1 Reading and writing parameters using the Parameter Object (Class code 4xx hex)

As described in Chapter "Explicit messaging - acyclic or event-driven communication (Page 296)", in Section "Parameter Object, Class codes 401 hex ... 43E hex", individual drive parameters can be read and written to.

In order to use this function, a "MSG" message block must be inserted in the program (figure below). A control tag of the "MESSAG" type must be declared and assigned to the message block for saving the configuration and status information.

The class information is assigned to the block in the next step. The configuration dialog must be opened by clicking (1).

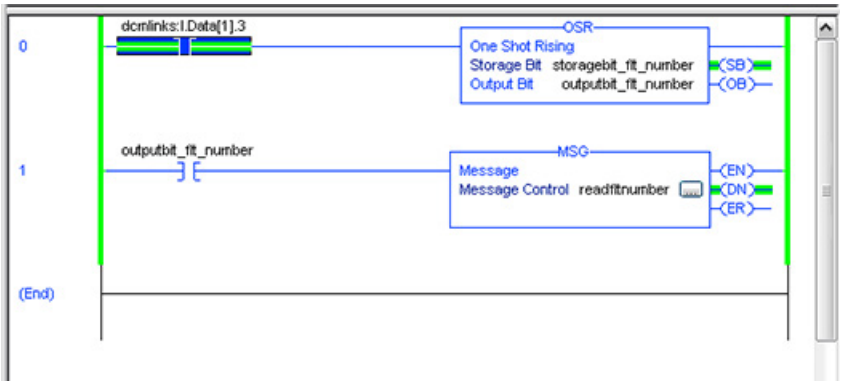


Figure 8-57 Inserting MSG

The configuration dialog shown in the following figure opens:

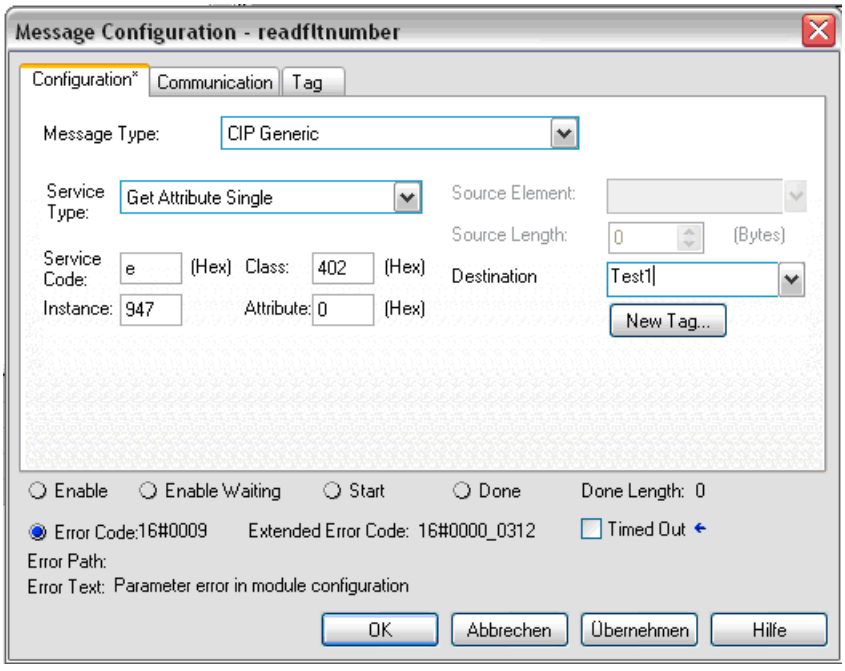


Figure 8-58 Configuration dialog

Configuration:

- Set "Message Type" to "CIP Generic"
- Set "Service Type" to
  - "Get Attribute Single" for reading
  - "Set Attribute Single" for writing
- Class: 4xx-xx represents the drive object No. (standard 02 hex for closed-loop control DCP_CTRL).
- Instance: Parameter number
- Attribute: Parameter index
- Destination: Sufficiently large variable to store the queried value
- "Source Element" and "Source Length" must be defined for writing with service type "Set Attribute Single". The number of bytes must match the data type of the parameter to be written.

If the above settings have been activated, the source or destination EtherNet/IP device to which the message is to be sent must be specified.

This is done under the "Communication" tab:

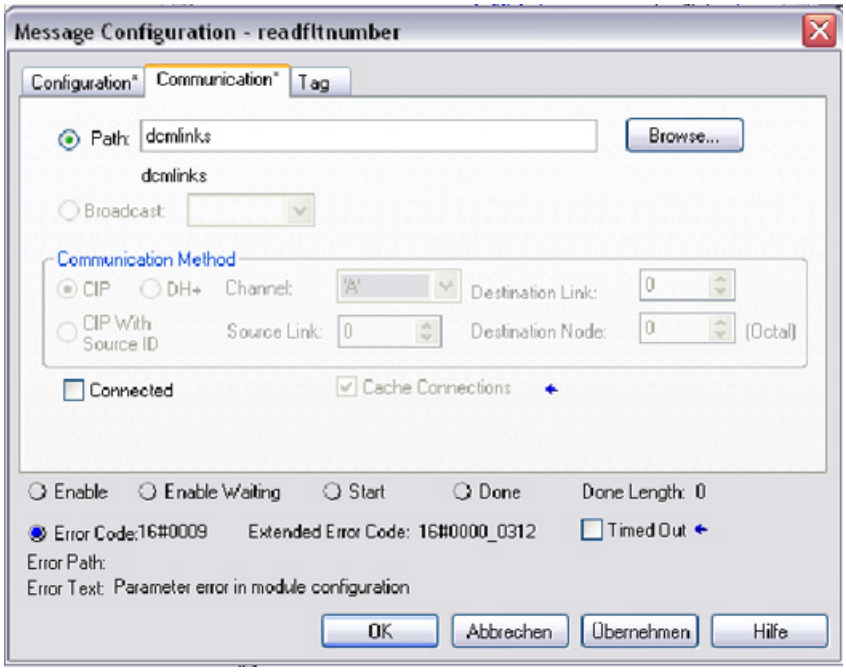


Figure 8-59 Communication

"Path": Defines the EtherNet/IP module, in this example "dcmlinks".

The previous example reads the active error number from parameter r0947 index 0 on drive object No. (Default: 2 for closed-loop control DCP_CTRL).

8.8.5 Messages and parameters

Faults and alarms (see SINAMICS DCP List Manual)

- F08501 (N,A) PN/COMM BOARD: Setpoint timeout
- F01910 (N,A) Fieldbus: Setpoint timeout
- A08526 (F) PN/COMM BOARD: No cyclic connection
- A01980 (F) PN: Cyclic connection interrupted
- A50011 (F) EtherNetIP/COMM BOARD: Configuration error

Overview of important parameters (see the SINAMICS DCP List Manual)

- p0922 IF1 PROFIdrive PZD telegram selection
- p0978[0...n] List of drive objects
- p0999[0...99] List of modified parameters 10
- p2030 Fieldbus interface protocol selection
- p8835 CBE20 firmware selection
- p8940[0...239] CBE2x Name of Station

- p8941[0...3] CBE2x IP address
- p8942[0...3] CBE2x Default Gateway
- p8943[0...3] CBE2x Subnet Mask
- p8944 CBE2x DHCP mode
- p8945 CBE2x interfaces configuration
- r8950[0...239] CBE2x Name of Station actual
- r8951[0...3] CBE2x IP address actual
- r8952[0...3] CBE2x Default Gateway actual
- r8953[0...3] CBE2x Subnet Mask actual
- r8954 CBE2x DHCP Mode actual
- r8955[0...5] CBE2x MAC address
- r8956[0...1] CBE2x cyclic connection state
- r8957[0...5] CBE2x cyclic connection diagnostics

8.9 Communication via SINAMICS Link

8.9.1 Basic principles of SINAMICS Link

A drive unit (with a node number) most frequently comprises a Control Unit with a number of connected drive objects (DOs). SINAMICS Link allows data to be directly exchanged between up to 64 CU320-2 PN or CU320-2 DP Control Units or CUD. Possible applications are, for example:

- Torque distribution for n drives
- Setpoint cascading for n drives
- Load distribution of drives coupled through a material web
- Master/device function for infeed units
- Couplings between SINAMICS DCP and SINAMICS S120

Requirements

The following preconditions must be fulfilled to operate SINAMICS Link:

- One CBE20 must be inserted for each Control Unit.
  The installation is described in the following chapter: "Option Board: Communication Board EtherNet CBE20 (Page 68)".
- The memory card (with the device firmware) must be inserted.

Note

Using the memory card

Information on how to correctly use the memory card is provided in Chapter "Memory card functions (Page 161)".

It is especially important to note that it is not permissible to insert the card when the device is operational.

Send and receive data

The SINAMICS Link telegram contains 32 indices (0...31) for the process data (PZD1...32). Each PZD is precisely 1 word long (= 16 bits). Indices that are not required are automatically filled with zeros. There is always a fixed assignment between the index and PZD: The index i corresponds to PZD i+1.

Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PZD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

SINAMICS Link telegram content, Part 1

Index	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PZD	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

SINAMICS Link telegram content, Part 2

Each transfer cycle, every SINAMICS Link node can send 1 telegram with 32 PZD. Each node receives all of the telegrams that are sent. For each transfer cycle clock, a node can select and process up to 32 PZD from all telegrams that have been received. Single words and double words can be sent and received. You must write double words in two consecutive PZDs.

Limitations:

- In a telegram, a PZD may only be sent and received once. If a PZD occurs more than once in a telegram, then Alarm A50002 or A50003 is output.
- It is not possible to read in your own send data. An appropriate alarm is initiated. The following alarms are possible:
  - A50006: It is parameterized that own data sent can be received. This is not permitted.
  - A50007: The send telegram word is larger than possible in the project.
  - A50008: The receive telegram word is larger than possible in the project.

- The maximum number of PZDs that can be received and sent also depends on the drive object. The number of PZDs that can be evaluated corresponds to communication according to PROFIdrive; however, for SINAMICS Link, it is limited to a maximum of 32 PZDs.
- If, as a result of a project download, parameters of the CBE20 are change, then alarm A08531 is output. In this case, a POWER ON is required to activate the values.

Transmission time

A transmission time of up to 1.5 ms is possible when using SINAMICS Link.

Bus cycle and number of nodes

A maximum of 64 participants can communicate with one another via SINAMICS Link. To do so, set the maximum number of nodes with p8811 (project selection):

Number of participants / project no.	Number of PZD	Bus cycle (ms)
64	16	1 or 2
16	16	0.5
12	24	0.5
8	32	0.5

In the non-synchronized mode, the bus cycle of the SINAMICS Link can be set with p8812[1] to 500 µs, 1000 µs or 2000 µs.

After changing parameter p8811, p8812, p8835 or p8836, carry out a POWER ON to transfer the settings.

8.9.2 Topology

Only a line topology with the following structure is permitted for SINAMICS Link. You must manually set the parameters in the expert lists of the Control Units and drive objects. To do this, use the STARTER commissioning tool.

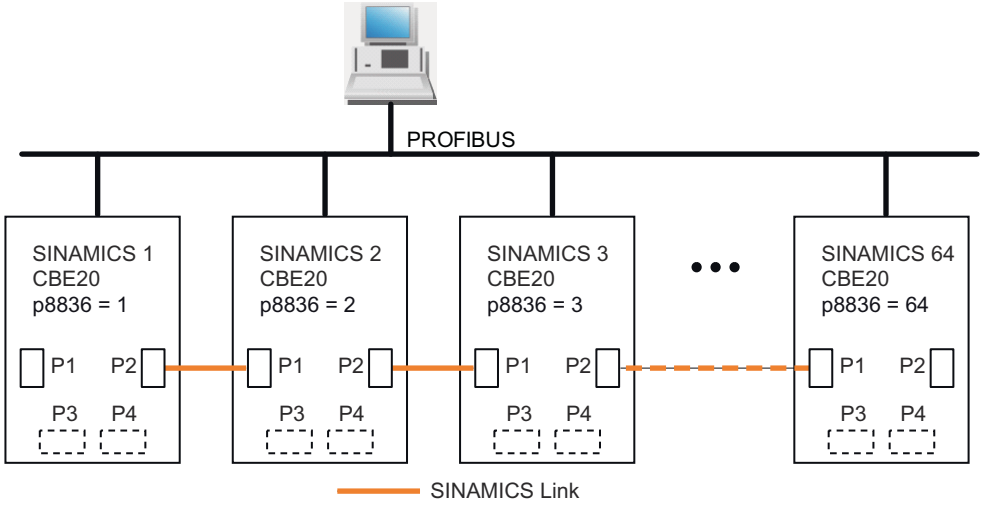


Figure 8-60 Maximum topology

Features

- The CBE20 can be assigned to IF1 or IF2 when SINAMICS Link is used.
  You must also make the following parameter settings in order to assign, e.g. IF1 to SINAMICS Link:
  - For IF1: p8839[0] = 2 (COMM BOARD)
  - For IF2: p8839[1] = 1 (Control Unit onboard)

  The data in the additional description are applicable for the case (IF1 ≙ SINAMICS Link).
- The number of the respective node must be entered manually in parameter p8836. Each node must be assigned a different number. Enter the numbers in ascending order starting with 1.
- If p8836 is set to 0, the nodes and the complete following line is shut down for SINAMICS Link.
- Gaps in the numbering are not permitted, as then SINAMICS Link would not function.
- The node with the number 1 is automatically the sync master of the communication link.
- The ports of the CBE20 must be interconnected strictly in accordance with the previous diagram. You must always connect port 2 (P2) of node n with port 1 (P1) of node n + 1.

Corresponding parameters for IF1 or IF2

Use different parameters for configuring, depending on which interface SINAMICS Link is assigned:

Table 8-71 Corresponding parameters

Parameters	IF1	IF2
Setting of the processing mode for PROFIdrive STW1.10 "Control by PLC".	p2037	p8837
Connector output to interconnect the PZD (setpoints) received from the fieldbus controller in the word format.	r2050	r8850
Selects the PZD (actual values) to be sent to the fieldbus controller in the word format.	p2051	p8851
Displays the PZD (actual values) sent to the fieldbus controller in the word format.	r2053	r8853
Connector output to interconnect the PZD (setpoints) received from the fieldbus controller in the double word format.	r2060	r8860
Selects the PZD (actual values) to be sent to the fieldbus controller in the double word format.	p2061	p8861
Displays the PZD (actual values) sent to the fieldbus controller in the double word format.	r2063	r8863

8.9.3 Configuring and commissioning

Note

When using SINAMICS Link, the memory card must remain inserted in the CUD.
p8835 cannot be set to 3 if it is not inserted.

Commissioning

When commissioning, proceed as follows:

1. Set the Control Unit parameter p0009 = 1 (device configuration).
2. Set the Control Unit parameter p8835 = 3 (SINAMICS Link).
3. Using p8839, define which interface should be used (for example for IF1: p8839[0] = 2).
4. If SINAMICS Link is assigned to IF1, set parameter p2037 of the drive objects to 2 (do not freeze setpoints).
   If SINAMICS Link was assigned IF2, then p8837 must be used for the setting.
5. Assign the nodes in parameter p8836 to the SINAMICS Link node number.
   The first Control Unit is always assigned the number 1. Node number 0 means that for this Control Unit SINAMICS Link has been shut down. Observe the specifications under "Topology".

6. Check and/or correct the following parameters:
   – p8811 must be identical for all nodes
   – p8812[1] must be identical for all nodes
   – p8812[0] may be different for local nodes
7. Set the Control Unit parameter p0009 = 0 (ready).
8. Execute a "Copy RAM to ROM".
9. Carry out a POWER ON (switch off the Control Unit and switch on again).

Sending data

Note

The parameters listed in the following description refer to the assignment of SINAMICS Link to IF1. If you assigned SINAMICS Link to IF2, then you find the corresponding parameters in the "Table 8-71 Corresponding parameters (Page 314)".

In this example, the first "Control Unit 1" node has two drive objects: "Drive 1" and "Drive 2". Proceed as follows to send data:

1. If SINAMICS Link is assigned to IF1, then for each drive object, in its associated parameter p2051[0...31], you define which data (PZDs) should be sent.
   If SINAMICS Link was assigned IF2, then p8851 must be used for the setting. The data is simultaneously reserved in the send slot of the p8871[0...31].
2. Enter the double words in p2061[x].
   Double word data is simultaneously written to p8861[0...31].
3. For each drive object, allocate the send parameters in p8871[0...31] to a send slot of its own node.

Table 8-72 Compile send data of drive 1 (DO2)

p2051[x] index	p2061[x] index	Content	From parameter	Telegram word p8871
0	-	ZSW1	r0899	1
-	1	Actual speed value part 1	r0061[0]	2
-		Actual speed value part 2		3
-	3	Actual torque value part 1	r0080	4
-		Actual torque value part 2		5
5	-	Actual fault code	r2131	6
6	-	0	0	0
...	-	...	-	...
15	-	0	0	0
...	-	...	-	...
31	-	0	0	0

Table 8-73 Compile send data of drive 2 (DO3)

p2051[x] index	p2061[x] index	Content	From parameter	Slots in the send buffer p8871[x]	
				x	Telegram word
-	-	-	-	0...5[1]	0
0	-	ZSW1	r0899	6	7
-	1	Actual speed value part 1	r0061[0]	7	8
-		Actual speed value part 2		8	9
-	3	Actual torque value part 1	r0080	9	10
-		Actual torque value part 2		10	11
5	-	Actual fault code	r2131	11	12
6	-	0	0	12	0
...		...		...	...
15	-	0	0	15	0
...	-	...	-	...	...
31	-	0	0	31	0

[1] 0...5 here remain free, as they are already assigned by DO2.

Table 8-74 Compile send data of Control Unit 1 (DO1)

p2051[x] index	p2061[x] index	Content	From parameter	Slots in the send buffer p8871[x]	
				x	Telegram word
-	-	-	-	0...11[2]	0
0	-	Control word, faults/alarms	r2138	12	13
-	1	Missing enables part 1	r0046	13	14
-		Missing enables part 2		14	15
15	-	0	0	15	0
...	-	...	-	...	...
31	-	0	0	31	0

[2] 0...11 here remain free, as they are already assigned by DO2 and DO3.

Send slots PZD 16 to 31 are not required for this telegram and are therefore filled with a zero.

1. For double words (e.g. 1 + 2), assign two consecutive send slots, e.g. p2061[1] => p8871[1] = PZD 2 and p8871[2] = PZD 3.
2. Enter the following PZD into the next parameter slots of p2051[x] or p2061[2x].
3. You must fill the unused slots of p8871[0...31] with zeros.
4. The sequence of the PZDs in the send telegram of this node are defined in parameter p8871[0...31] by the entries in the required slots.

Receiving data

The sent telegrams of all nodes are simultaneously available at the SINAMICS Link. Each telegram has a length of 32 PZD. Each telegram has a marker of the sender. You select those PZD that you want to receive for the relevant node from all telegrams. You can process a maximum of 32 PZD.

Note

If you have not deactivated the evaluation of bit 10 with p2037 = 2, the first word of the receive data (PZD 1) must be a control word, where bit 10 = 1 is set.

In this example, Control Unit 2 receives selected data from the telegram of Control Unit 1. Proceed as follows to receive data:

1. In parameter p8872[0...31] enter the address of the node for which you want to read one or more PZDs (e.g. p8872[3] = 1 → from node 1, read in PZD 4, p8872[15] = 0 → do not read in PZD 16).
2. After setting the parameters, using parameter r2050[0...31] or r2060[0...31] you can read out the values.

Table 8-75 Receive data for Control Unit 2

From the sender		Receiver					
Transfer from	Tel. word[1] p8871[x]	Address p8872[x]	Receive buffer p8870[x]	Data transferred in		Parameter	Content
				r2050[x]	r2060[x]		
p2051[0]	0	1	PZD 1	0	-	r0899	ZSW1
p2061[1]	1	1	PZD 2	-	1	r0061[0]	Actual speed value part 1
	2	1	PZD 3	-		r0061[0]	Actual speed value part 2
p2061[3]	3	1	PZD 4	-	3	r0080	Actual torque value part 1
	4	1	PZD 5	-			Actual torque value part 2
p2051[5]	5	1	PZD 6	5	-	r2131	Actual fault code
p2051[4]	6	1	PZD 7	6	-	r0899	ZSW1
p2061[5]	7	1	PZD 8	-	7	r0061[0]	Actual speed value part 1
	8	1	PZD 9	-			Actual speed value part 2
p2061[6]	9	1	PZD 10	-	9	r0080	Actual torque value part 1
	10	1	PZD 11	-			Actual torque value part 2
p2051[7]	11	1	PZD 12	11	-	r2131	Actual fault code
p2051[8]	12	1	PZD 13	12	-	r2138	Control word, faults/alarms
p2061[9]	13	1	PZD 14	-	13	r0046	Missing enables part 1
	14	1	PZD 15	-			Missing enables part 2
-	15	0	PZD 16	15	-	0	Empty
...	...	...	...	...	...	...	...
-	31	0	PZD 32	31	0	0	-

[1] Tel.word = telegram word

Note

For double words, two PZD must be read in succession. To do this, read in a 32 bit setpoint, which is on PZD 2 + PZD 3 of the telegram of node 2. Map this setpoint to PZD 2 + PZD 3 of participant 1: p8872[1] = 2, p8870[1] = 2, p8872[2] = 2, p8870[2] = 3

Activating SINAMICS Link

To activate SINAMICS Link connections, perform a POWER ON for all nodes.

Without POWER ON, the following can be changed:

- The assignments of p2051[x]/2061[2x] and the links of the read parameters r2050[x]/2060[2x]
- Parameters p8870, p8871, and p8872 In this case, the SINAMICS Link connections can also be connected via p8842 = 1.

8.9.4 Example

Task

Configure SINAMICS Link for two nodes and transfer the following values:

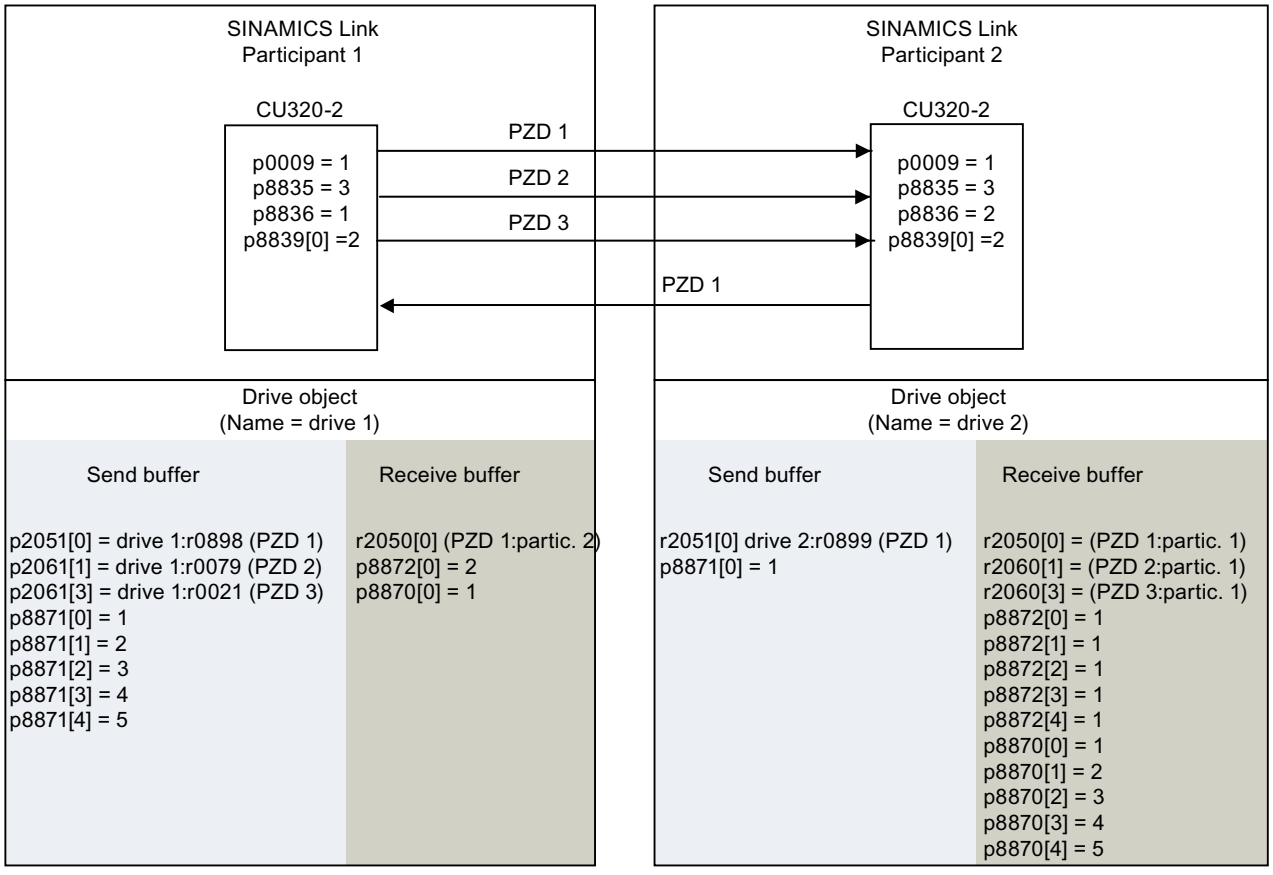
- Send data from node 1 to node 2
  - r0898 CO/BO: Control word, sequence control, drive 1 (1 PZD), in the example PZD 1
  - r0079 CO: Total torque setpoint (2 PZD), in the example PZD 2
  - r0021 CO: Smoothed actual speed (2 PZD), in the example PZD 3
- Send data from node 2 to node 1
  - r0899 CO/BO: Status word, sequence control, drive 2 (1 PZD), in the example PZD 1
- IF1 is used for SINAMICS Link.

Procedure

1. For all nodes, set p0009 = 1 to change the device configuration.
2. For all CBE20 nodes, set the "SINAMICS Link" mode using p8835 = 3.
3. Limit the maximum number of nodes for all nodes with p8811 = 8. By setting p8811, parameter p8812[1] is preassigned, and parameter p8836, if necessary, is corrected.
4. Assign the node numbers for the devices involved:
   - Node 1 (≙ device 1): p8836 = 1
   - Node 2 (≙ device 2): p8836 = 2

5. Make the following interface setting for all nodes:
   - For IF1: p8839[0] = 2 (COMM BOARD)
   - For IF2: p8839[1] = 1 (Control Unit onboard)
6. For both nodes p0009 = 0, carry out a "Copy RAM to ROM" followed by a POWER ON in order to activate the modified firmware versions and the new settings in the CBE20.
7. Define the send data for node 1:
   - Define the PZD that node 1 should send:
     p2051[0] = drive1:r0898 (PZD 1)
     p2061[1] = drive1:r0079 (PZD 2 + PZD 3)
     p2061[3] = drive1:r0021 (PZD 4 + PZD 5)
   - Place these PZD in the send buffer (p8871) of node 1:
     p8871[0] = 1 (r0898)
     p8871[1] = 2 (r0079 1st part)
     p8871[2] = 3 (r0079 2nd part)
     p8871[3] = 4 (r0021 1st part)
     p8871[4] = 5 (r0021 2nd part)
8. Define the receive data for node 2:
   - Specify that the data placed in the receive buffer p8872 of node 2 in locations 0 to 4 will be received by node 1:
     p8872[0] = 1
     p8872[1] = 1
     p8872[2] = 1
     p8872[3] = 1
     p8872[4] = 1
   - Specify that PZD1, PZD2, and PZD3 of node 1 will be placed in the receive buffer p8870 of node 2 in locations 0 to 4:
     p8870[0] = 1 (PZD1)
     p8870[1] = 2 (PZD2 1st part)
     p8870[2] = 3 (PZD2 2nd part)
     p8870[3] = 4 (PZD3 1st part)
     p8870[4] = 5 (PZD3 2nd part)
   - r2050[0], r2060[1] and r2060[3] subsequently contain (after step 13) the values of PZD 1, PZD 2 and PZD 3 of node 1.
9. Define the send data for node 2:
   - Specify the PZD that node 2 should send:
     :p2051[0] = drive1:r0899 (PZD length is 1 word)
   - Place this PZD in the send buffer (p8871) of node 2:
     p8871[0] = 1

10. Define the receive data for node 1:
    - Specify the data that should be placed in the receive buffer p8872 of node 1 in location 0, received from node 2:
      p8872[0] = 2
    - Define that PZD1 of node 2 is saved in the receive buffer p8870 of node 1 in location 0:
      p8870 [0] = 1
    - r2050[0] subsequently contains (after step 13) the value of PZD 1 of node 2.
11. At the two nodes carry-out a "Copy RAM to ROM" to backup the parameterization and the data.
12. Set p8842 =1 to activate parameters p8870, p8871 and p8872.



r0021: Speed actual value smoothed
r0079: Total torque setpoint
r0898: Control word sequence control drive 1
r0899: Status word sequence control drive 2

Figure 8-61 SINAMICS Link: Configuration example

8.9.5 Communication failure when booting or in cyclic operation

If at least one sender does not correctly boot after commissioning or fails in cyclic operation, then alarm A50005 is output to the other nodes: “Sender was not found on SINAMICS Link”. The message contains the number of the faulted node. After you have resolved the fault at the node involved and the system has identified the node, the system automatically withdraws the alarm.

If several nodes are involved, the message occurs a multiple number of times consecutively with different node numbers. After you have resolved all of the faults, the system automatically withdraws the alarm.

When a node fails in cyclic operation, in addition to alarm A50005, fault F08501 is output: "COMM BOARD: Monitoring time, process data expired"

At node 1, fault F08501 is not triggered. This node should be used for specifying setpoint values to other nodes.

8.9.6 Examples: Transmission times for SINAMICS Link

Example 1: Transmission times at a communication cycle of 1 ms

p2048 or p8848 = 1 ms

Bus cycle [ms]	Transmission time [ms]			
	Sync both	Sync send	Sync receive	Async both
0.5 *)	1.0	1.5	1.3	1.6
1.0	1.5	2.1	2.1	2.2
2.0	3.0	3.6	3.1	2.8

Example 2: Transmission times at a communication cycle of 4 ms

p2048 or p8848 = 4 ms

Bus cycle [ms]	Transmission time [ms]			
	Sync both	Sync send	Sync receive	Async both
0.5 *)	1.0	3.0	2.8	4.6
1.0	1.5	3.6	3.6	5.2
2.0	3.0	5.1	4.6	5.8

*) Only possible for SINAMICS S120/S150.

8.9.7 Function diagrams and parameters

Function diagrams (see SINAMICS DCP List Manual)

- 2197 SINAMICS Link overview (r0108.31 = 1, p8835 = 3)
- 2198 SINAMICS Link configuration (r0108.31 = 1, p8835 = 3)

- 2199 SINAMICS Link receive data (r0108.31 = 1, p8835 = 3)
- 2200 SINAMICS Link send data (r0108.31 = 1, p8835 = 3)

Overview of important parameters (see the SINAMICS DCP List Manual)

- p0115[0] Sampling time for additional functions
- p2037 IF1 PROFIdrive STW1.10 = 0 mode
- r2050[0...31] CO: IF1 PROFIdrive PZD receive word
- p2051[0...31] CI: IF1 PROFIdrive PZD send word
- r2060[0...30] CO: IF1 PROFIdrive PZD receive double word
- p2061[0...30] CI: IF1 PROFIdrive PZD send double word
- p8811 SINAMICS Link project selection
- p8812[0...1] SINAMICS Link cycle settings
- p8835 CBE20 firmware selection
- p8836 SINAMICS Link node address
- p8839[0...1] PZD interface hardware assignment
- p8870[0...31] SINAMICS Link PZD receive word
- p8871[0...31] SINAMICS Link PZD send word
- p8872[0...31] SINAMICS Link PZD receive address

8.10 Switch on, switch off, enable

Functions OFF1, OFF2 and OFF3 cause the current to be immediately reduced to zero, and the two main contactors opened.

8.10.1 Switch on / switch off (ON/OFF1) - control word bit 0

The "Switch on / switch off (ON / OFF1)" command is the command for switching the SINAMICS DCP on and off under normal operating conditions.

After running up, a fault, OFF2 or OFF3, the SINAMICS DCP is in the switching-on inhibit state (operating state o8), which must be acknowledged with a 0 signal at ON/OFF1 before being switched on again.

The signal source is selected via p0840.

See function diagram 2580.

Procedure when switching on:

1. Specify the "Switch on" command.
2. The system exits operating state o7.
3. The precharging is performed in succession at both sides.
4. The controllers are enabled if signal "Operating enable" is active.

Procedure when switching off:

1. Enter command "Switch off" (OFF1).
2. The controllers are disabled.
3. The main contactors drop out.
4. Operating state o7.1 or higher is reached.
5. The DC link capacitors are not discharged and can still have a hazardous voltage for another 5 minutes.

8.10.2 OFF2 (disconnection) - control word bit 1

The OFF 2 signal is LOW active (state, log. "0" = OFF 2).

The signal source is selected via p0844 or p0845.

See function diagram 2580.

Procedure for specifying disconnection:

1. The controllers are disabled.
2. The main contactors drop out.
3. Operating state o10.0 or higher is reached.
4. The DCP changes to the "Switching-on inhibit" state.
5. The DC link capacitors are not discharged and can still have a hazardous voltage for another 5 minutes.

8.10.3 OFF 3 (disconnection) - control word bit 2

Note

The sequence for "OFF 3" is the same as for OFF 2

The OFF 3 signal is LOW active (log. "0" state = disconnection).

The signal source is selected via p0848 or p0849.

See function diagram 2580.

Procedure for specifying OFF 3:

1. The controllers are disabled.
2. The main contactors drop out.
3. Operating state o9.0 or higher is reached.

4. The DCP changes to the "Switching-on inhibit" state.
5. The DC link capacitors are not discharged and can still have a hazardous voltage for another 5 minutes.

Note

The "OFF 3" command only needs to be active as a short pulse (> 10 ms). It is then saved internally. It is only possible to reset the memory by applying the "Switch off" command.

8.10.4 Operation enable (enable) - control word bit 3

The enable signal is HIGH active (log. "1" state = enable).

The signal source is selected via p0852.

See function diagram 2580.

Procedure for specifying the operation enable (if an ON command is active and precharging has been completed):

1. The controllers are enabled.

Procedure for removing the operation enable:

1. The controllers are disabled.
2. Operating state o1.0 or higher is reached (the line contactors remain switched on).

8.11 Closed-loop control

8.11.1 General information

The SINAMICS DCP basically uses two control modes:

- Current control
- Voltage control

Current control

In a typical current control application, the SINAMICS DCP is connected on side 1 and on side 2 to a voltage source (for example, DC link of a frequency converter, energy storage device). The current control establishes the required current flow between both sides of the device. This means that energy is transferred from one voltage level to the other voltage level.

In current-controlled operation, SINAMICS DCP receives the setpoint via parameter p55050 (current setpoint signal source), see function diagram 6805 in List Manual SINAMICS DCP.

This setpoint can be interpreted differently by the device, see Chapter "Setpoint specification for current current control (Page 326)".

Internally, SINAMICS DCP comprises several DC-DC converters connected in parallel (power units), and exclusively controls the current in the energy storage reactors of these power units.
As a consequence, the specified setpoint is always converted over to the current in the energy storage reactors, and only this current is measured in the device.
The sum of the currents in the energy storage reactors of the individual power units is called "Reactor current".

The magnitude of the voltage level on both sides of the SINAMICS DCP can be any arbitrary value within the limits specified in the technical data of the DCP.
However, it is crucial that the maximum voltage is not exceeded; further, the current and power limitation (Chapter "Current limitation and power limitation (Page 334)") and the derating (Chapter "Derating (Page 358)") must be carefully taken into consideration.
In addition, there is a restriction that when current flows from a lower to a higher voltage level ("stepping up/boosting"), a voltage ratio of 8 cannot be exceeded.
For example, a voltage of 100 V can be stepped up to a maximum voltage of 800 V.
For a higher step-up factor, the modulation depth (see parameter r55250, r55251) is automatically limited.
As a consequence, the current is also limited and the actual current value can no longer follow the setpoint.
However, neither a fault nor alarm is initiated.

Note

Different current controller structure in various firmware versions

As a result of the ongoing development and improvements made to the product, the current controller structure has changed between the firmware versions.

In firmware version V1.1 a PI main current controller with additional PI differential current controllers is used for the individual power units.

In firmware version V1.2, the main current controller was expanded to include actual value filtering in the integral component. As a consequence, from this firmware version, other values should be set for the proportional gain (p55220) and the integral time (p55221).
In firmware version V1.2, the factory settings these two parameters was appropriately adapted.

To further improve the control response, from firmware version V1.2 HF1, each power unit is controlled by its own dedicated PI current controller.
In addition, a setpoint delay was integrated for the integral component.
As a consequence, depending on the particular application, it may be necessary to reduce the proportional gain of the current controller (p55220) to achieve a stable current control response.

As a consequence, when using older firmware versions the associated List Manuals, function diagrams and parameter descriptions should be used.

Voltage control

In voltage-controlled operation, SINAMICS DCP receives the voltage setpoint via parameter p54100, see function diagram 6818 in List Manual SINAMICS DCP.

The voltage on the side of the SINAMICS DCP - selected with p54102 and p54104 - is controlled to this voltage setpoint. The voltage control is implemented as cascade control; i.e. the voltage control specifies a current setpoint for the subordinate current control. The statements made in the previous chapter apply to the current control.

The following diagram provides an overview of the controller structure.

- To ensure transparency, a conscious decision has been made to not include all details.
- For the individual function blocks, the corresponding detail function diagrams are specified in the List Manual in square brackets.
- The most important adjustable parameters are specified above the individual function blocks.

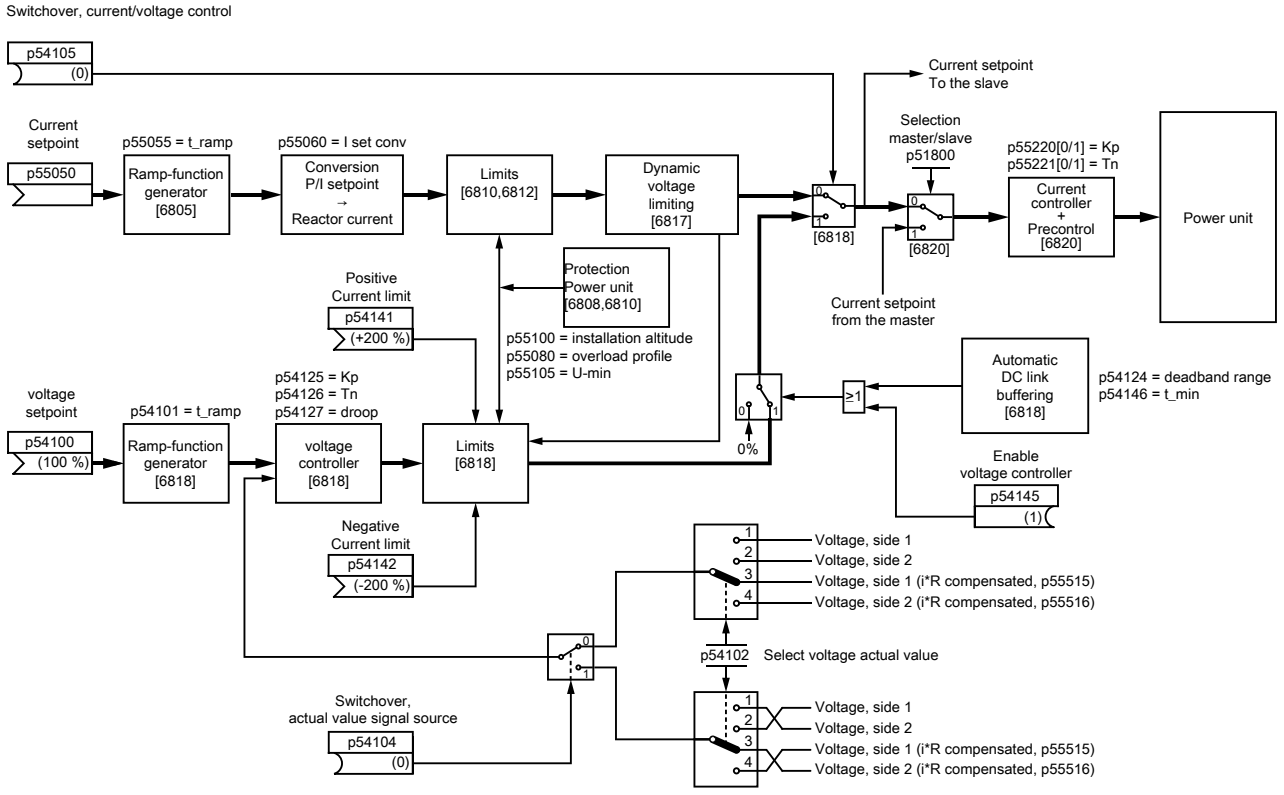


Figure 8-62 Controller structure

8.11.2 Setpoint specification for current current control

See function diagrams 6805 and 6806 in the SINAMICS DCP List Manual.

In current-controlled operation, the SINAMICS DCP receives the current or power setpoint via connector input p55050 (current setpoint signal source).

Depending on the setting in p55060 (current setpoint meaning), the device interprets this setpoint as follows:

- Current setpoint for the energy storage reactor (p55060 = 10)
- Current setpoint for the current on side 1 (p55060 = 11)

- Current setpoint for the current on side 2 (p55060 = 12)
- Power setpoint (p55060 = 20)

The setpoint should be entered as signed value referred to the reference current (r50072) or the rated power (r50071 × r50072 or r55602):

- Positive setpoint means current flow from side 1 to side 2.
- Negative setpoint means current flow from side 2 to side 1.

The setpoint is controlled along an adjustable ramp to limit the gradient (p55055, factory setting: 0 ... 100 % in 50 ms).

Setpoints whose values are below a parameterizable threshold (p55056) are ignored and evaluated as zero.

8.11.3 Current correction controller

See function diagram 6806 in the SINAMICS DCP List Manual.

The current correction controller is used to improve the accuracy of the current control, by feeding in an externally measured current actual value.

A BICO input (p55156) is provided, which allows an externally derived input current actual value or output current actual value to be used in the calculation internally. The external current transformer should have a precision greater than +/-0.5 %.

If the external current actual value is used, it is continuously compared with the internal current actual value. The maximum deviation that can be tolerated can be specified using p55161. This parameter is scaled to reference current (r50071). If the deviation is greater than the tolerance, then fault message F60511 is output. Even when the current correction control is active, the DCP is still protected against overload as a result of the internal current actual value sensing.

The external current actual value can be fed in via analog inputs of the CUD or via fieldbus.

Note

As a result of the sampling and the dead times of the actual value channels, as well as the structure of the current correction controller, this is not suitable for responding to dynamic switching operations.

8.11.4 Dynamic overload capability

See function diagrams 6808 and 6810 in the SINAMICS DCP List Manual.

SINAMICS DCP permits operation with overload profiles.

With the appropriate ambient conditions, SINAMICS DCP devices can handle 120 % of the rated current for an unlimited time.

In addition, the 120 kW and 250 kW devices can be operated with up to 160 % of the rated current for a limited time. The maximum duration of this overload depends on the

overload current characteristic with respect to time, the previous load characteristic and the air intake temperature. The thermal state of the power unit is continually determined based on a temperature model.

Each overload phase must be followed by a recovery phase with a current below the rated current. The overload current characteristic is monitored using a load counter (r55091); it is incremented for operation above the rated current and decremented for operation below the rated current.

As soon as this counter has exceeded a value of 100 %, fault F60530 (dynamic overload time overflow (timeout)) is output and the device is shut down. Independent of this, the device monitors the power semiconductor temperature. If its maximum permissible temperature is exceeded, then the device limits the maximum reactor current to the rated current and Alarm A60039 (dynamic overload temperature too high) is output.

Operation in the overload range is only again possible if the power semiconductor temperature has decreased and is again in the permitted range and the reactor current is less than the rated current. Alarm A60039 is then also reset.

Note

The rated current depends on the specific device, and is specified in Chapter "Device data (Page 434)".

In the following diagrams, the reactor current and/or the current is always shown on the side with the lower voltage.

For the overload capability of SINAMICS DCP, load cycles other than for SINAMICS AC drives are used as basis. Contrary to SINAMICS AC drives, SINAMICS DCP shuts down when the permissible overload time is exceeded.

Using parameter p55080, 3 overload profiles and "no overload" (factory setting) can be selected:

- Load profile "Increased current" (p55080 = 1) (Page 328)
- Load profile "low overload" (p55080 = 2) (Page 329)
- Load profile "high overload" (p55080 = 3) (Page 331)

Note

The 30 kW device only supports the "Increased current" load profile. This is the reason that only settings p55081 = 0, 1 are permissible.

When selecting a load profile that is not permitted, when switching on (p0840 = 1) fault F60058 is output.
The fault is immediately output if the device is operational when the selection is made.

8.11.4.1 Load profile "Increased current" (p55080 = 1)

This load profile is available for all device versions (30 kW, 120 kW, 250 kW).

For the "Increased current" load profile, a continuously higher current up to 120 % of the rated current is permitted.

The required current increase is set in p55081 (dynamic overload current increase).
In so doing, it is not permissible that the rated device power is exceeded.
However, the temperature-dependent derating (see Chapter "Derating (Page 358)") starts at a lower ambient temperature than for operation without increased current.

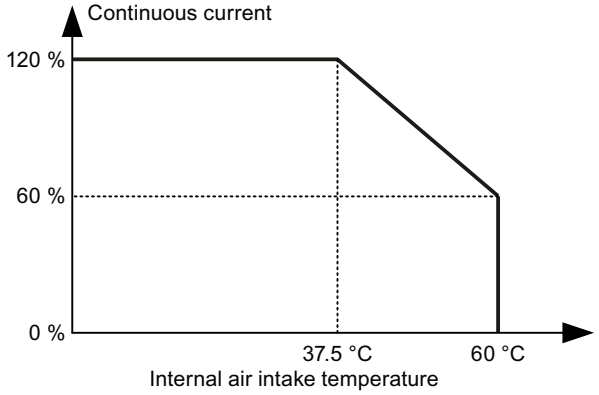


Figure 8-63 Current derating example - internal air intake temperature, p55080 = 1, p55081 = 20 %

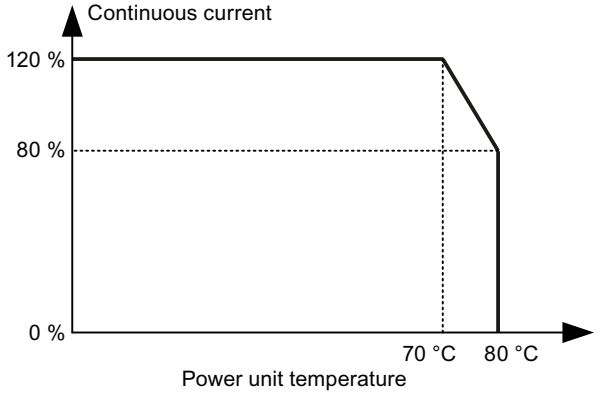


Figure 8-64 Current derating example - power unit temperature, p55080 = 1, p55081 = 20 %

As a consequence, this load profile is especially useful for lower ambient temperatures and for voltages below the rated voltage.

8.11.4.2 Load profile "low overload" (p55080 = 2)

The "Low overload" load profile is only available for 120 kW and 250 kW devices.

With this load profile, the device can be operated with a load of 150 % of the rated current for approximately 6.7 s.
For sufficiently high voltages, the device power correspondingly increases.

For longer overload times, the device shuts down and outputs fault F60530.

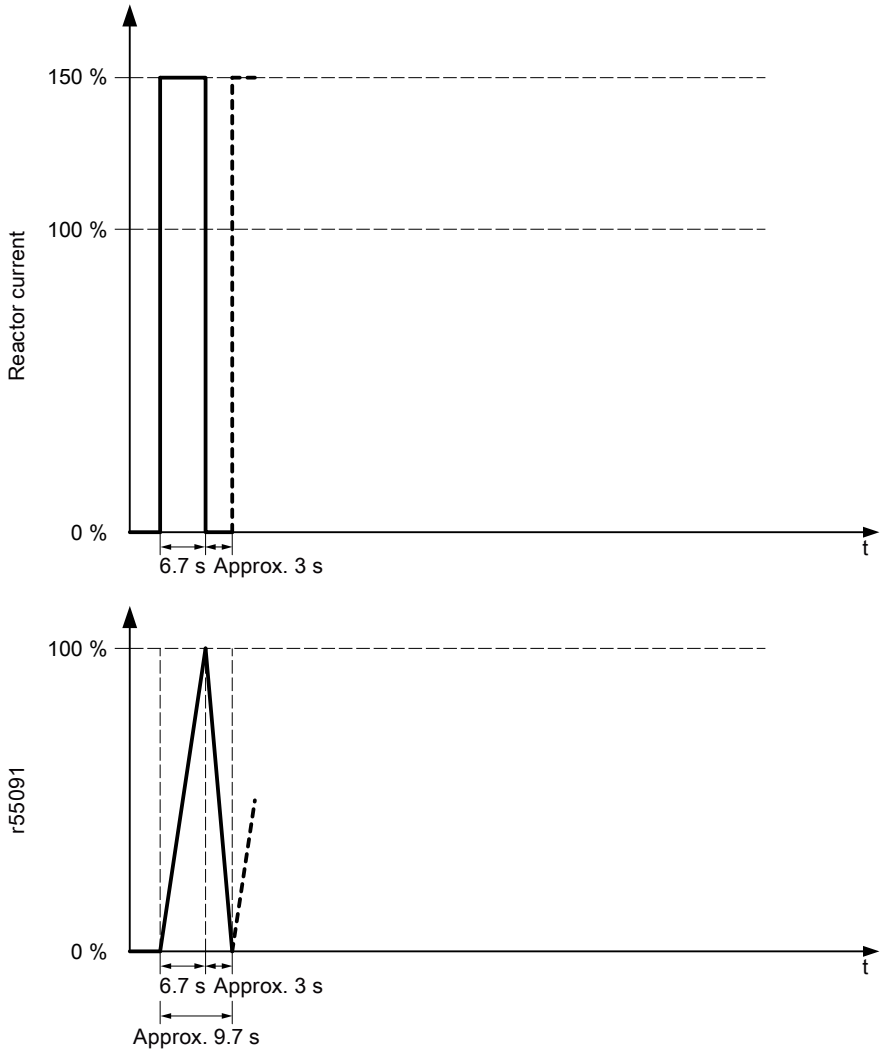


Figure 8-65 "Low overload" load cycle - example: Load with 150 %

A load with 110 % of the rated current is possible for 60 seconds:

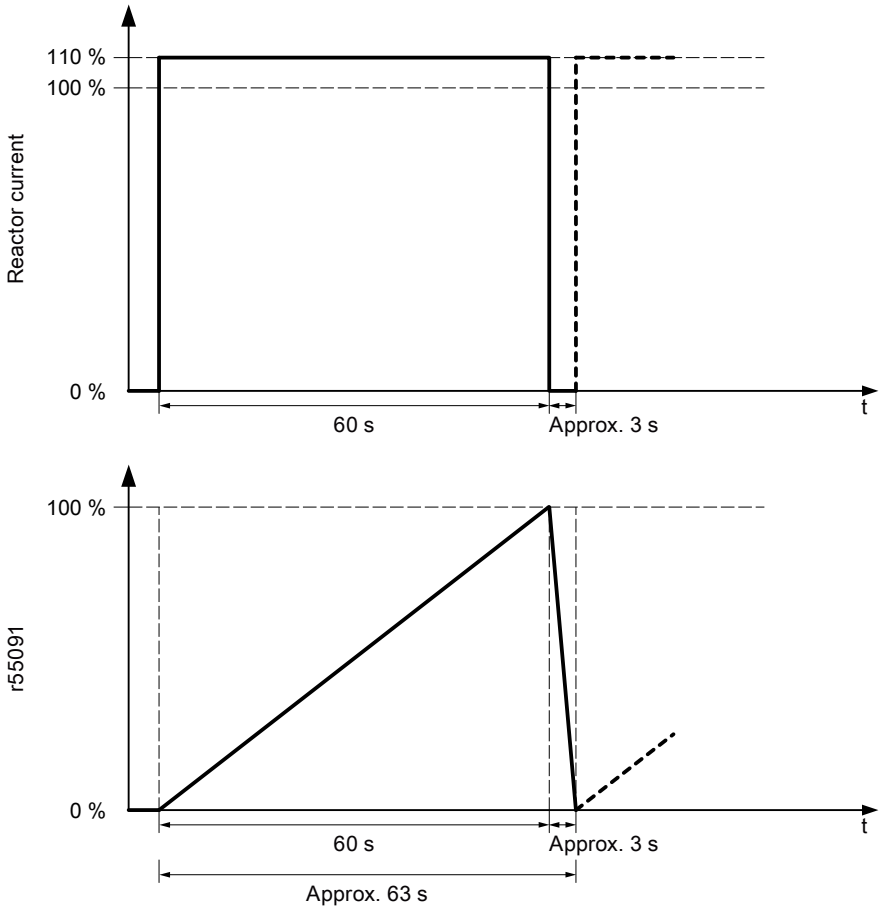


Figure 8-66 "Low overload" load cycle - example: Load with 110 %

If load counter r55091 is at 100 %, for example, for a current of 0 A, then a recovery time of approximately 3 seconds is required until the counter again reaches a value of 0 %. The shorter recovery time is an advantage when compared to load cycle "High overload".
For higher currents, however below the rated current, then this time is correspondingly extended.

8.11.4.3 Load profile "high overload" (p55080 = 3)

The "high overload " load profile is only available for 120 kW and 250 kW devices.

With this load cycle, a brief overload up to 160 % of the rated current is possible.
For sufficiently high voltages, the device power correspondingly increases.

With this load profile, the device can be operated with a load of 150 % of the rated current for 60 s; for a load of 160 %, only approximately 50 s is possible.
For longer overload times, the device shuts down and outputs fault F60530.

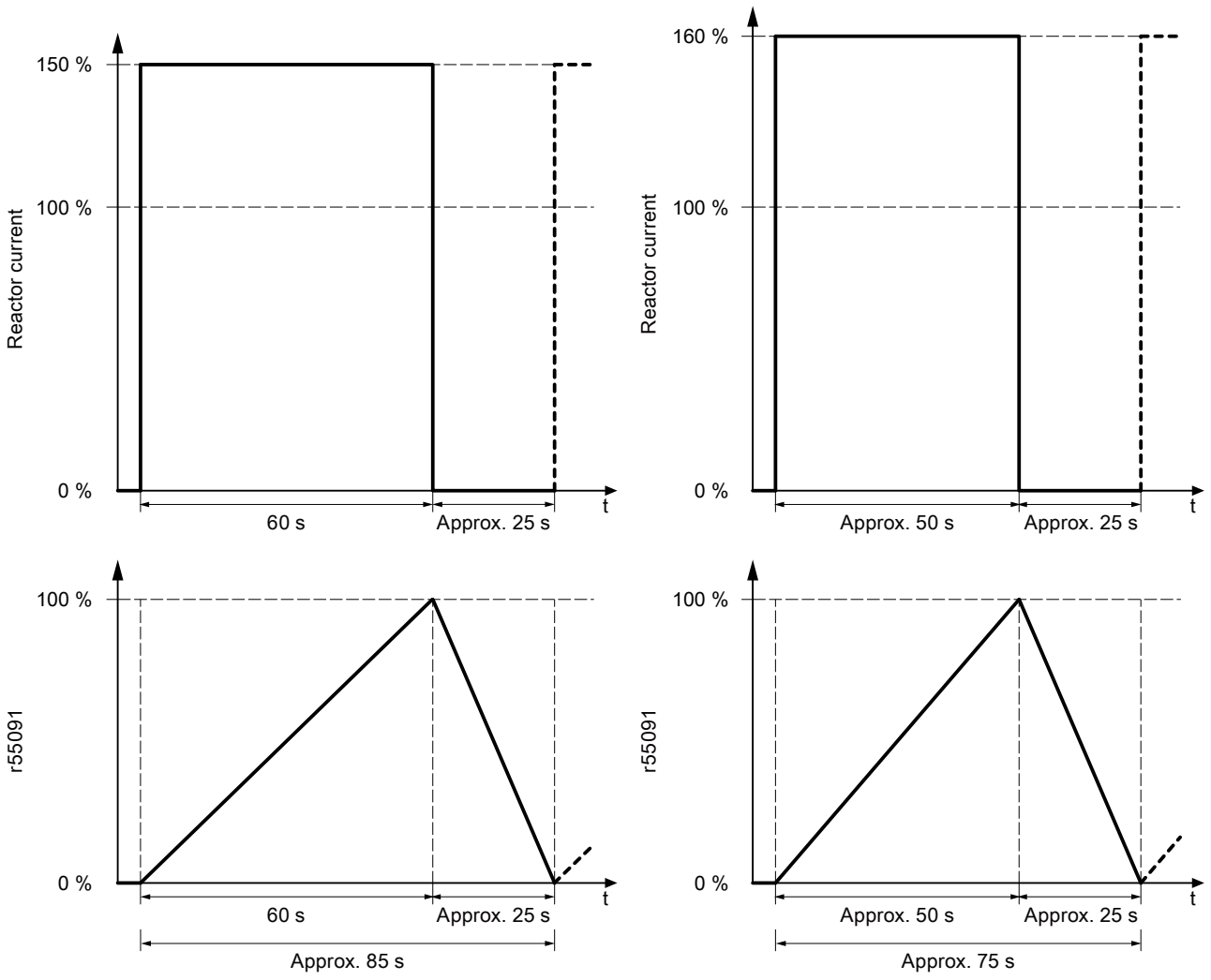


Figure 8-67 "High overload" load cycle - examples: Load with 150 % or 160 %

For a lower overload, significantly longer operation up to shutdown with fault F60530 is possible. 540 s for an overload of 110 %, for example:

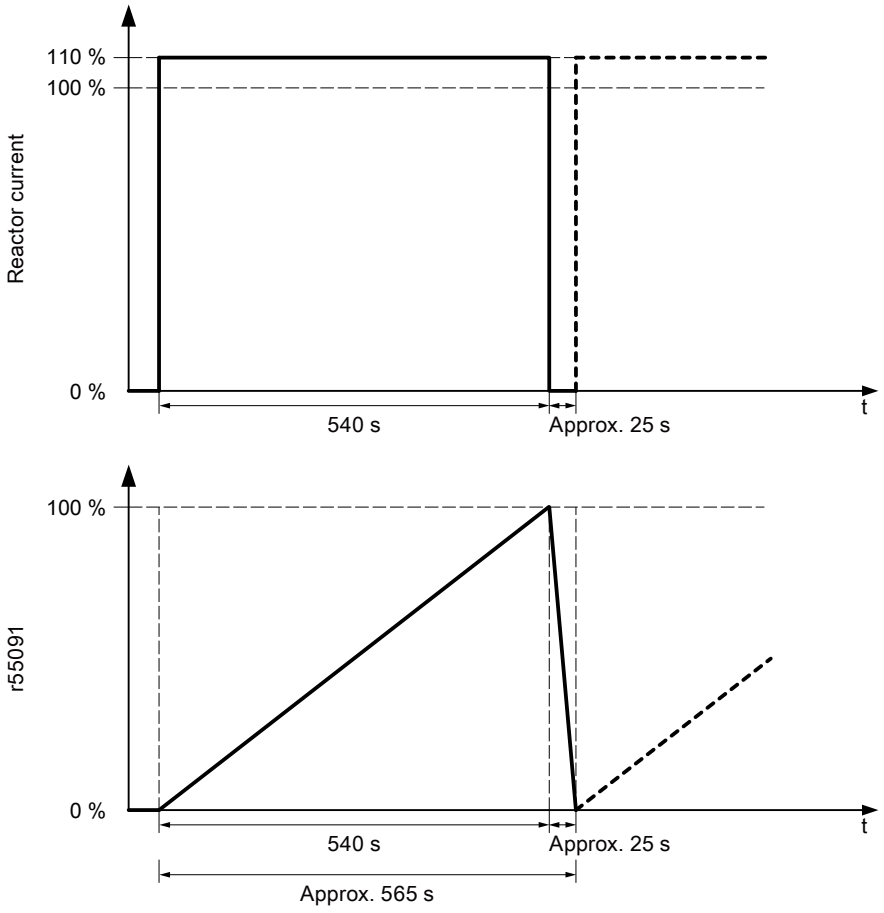


Figure 8-68 "High overload" load cycle - examples: Load with 110 %

If load counter r55091 is at 100 %, for example, for a current of 0 A, then a recovery time of approximately 25 seconds is required until the counter again reaches a value of 0 %. This is a significantly longer period of time than for the "Low overload" duty cycle.
For higher currents, however below the rated current, this time is correspondingly extended.

A recovery time after 150 % overload with various currents below the rated current is shown in the following diagram as example:

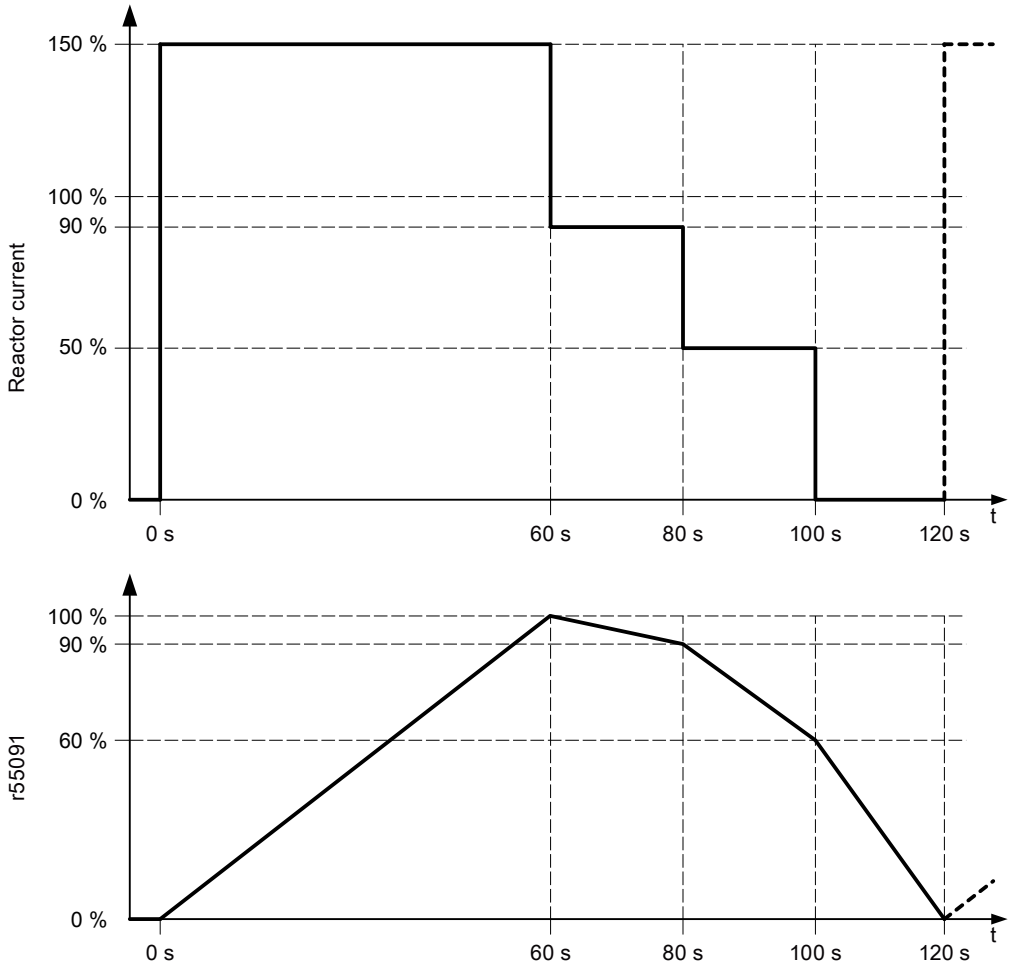


Figure 8-69 "High overload" load cycle - example of a recovery process after 150 % overload

8.11.5 Current limitation and power limitation

See function diagram 6810 in the SINAMICS DCP List Manual.

Limiting functions are implemented to protect the power unit.

In addition to the electrical limits described here, ambient factors such as temperature and installation altitude can result in the current and/or power being reduced (derating), see Chapter "Derating (Page 358)".

The device can be operated with currents higher than the rated current when using the "Dynamic overload capability" function. As a consequence, depending on the setting, also the power can be increased (see Chapter "Dynamic overload capability (Page 327)").

Note

The maximum device power is reduced when the device is operated in the overvoltage range.

The overvoltage range of the individual device types is specified in Chapter "Device data (Page 434)".

8.11.5.1 Current limitation functions

The maximum reactor current is limited, depending on the factors subsequently listed.

The limiting functions are shown separately to improve transparency.

However, the limit function with the lowest current limit is always active.
For SINAMICS DCP, the reactor current always corresponds to the current on the side with the lower voltage.

Limiting the reactor current to the rated and/or maximum current

For operation without overload profiles, the reactor current is limited to the rated device current.
For operation with overload profiles, the reactor current is limited to the maximum current of the overload profile.
For more detailed information, see Chapter "Dynamic overload capability (Page 327)".

Limiting the power to the rated power in the standard voltage range

This limit is active if the voltage at side 1 or side 2 is greater than the rated voltage (see Chapter "Device data (Page 434)") of the device.

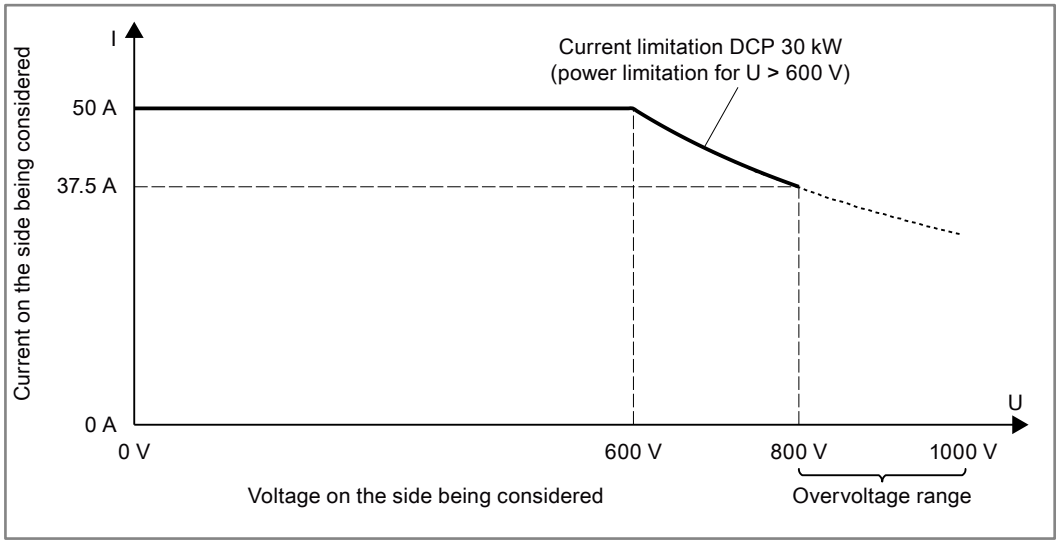


Figure 8-70 Limiting the reactor current by the rated power, 30 kW device

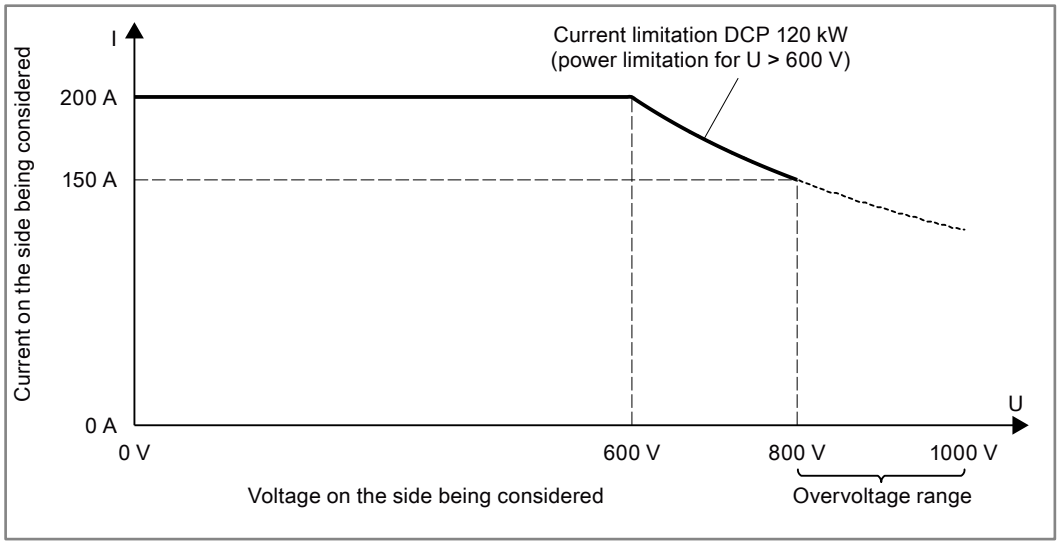


Figure 8-71 Limiting the reactor current by the rated power, 120 kW device

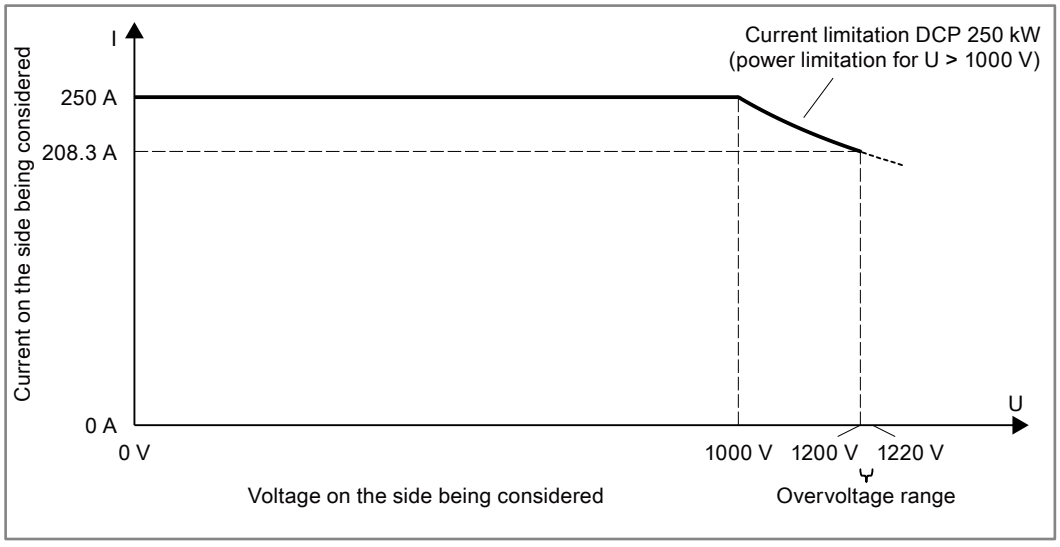


Figure 8-72 Limiting the reactor current by the rated power, 250 kW device

Limiting the reactor current in the overvoltage range

This limit is only active if the voltage on side 1 or side 2 lies in the overvoltage range.
The side of the DCP with the higher voltage is always considered when determining the current limit.
Voltages in the overvoltage range that are briefly permitted may only be available for a maximum of 30 s after switching on or switching off (ON/OFF1).
Otherwise, the device outputs fault F60500 and possibly shuts down.
In this range, the devices can only be operated with reduced current (30 kW device) or with no current flow (120 kW and 250 kW devices).
The overvoltage ranges of the individual device types are specified in Chapter "Device data (Page 434)".

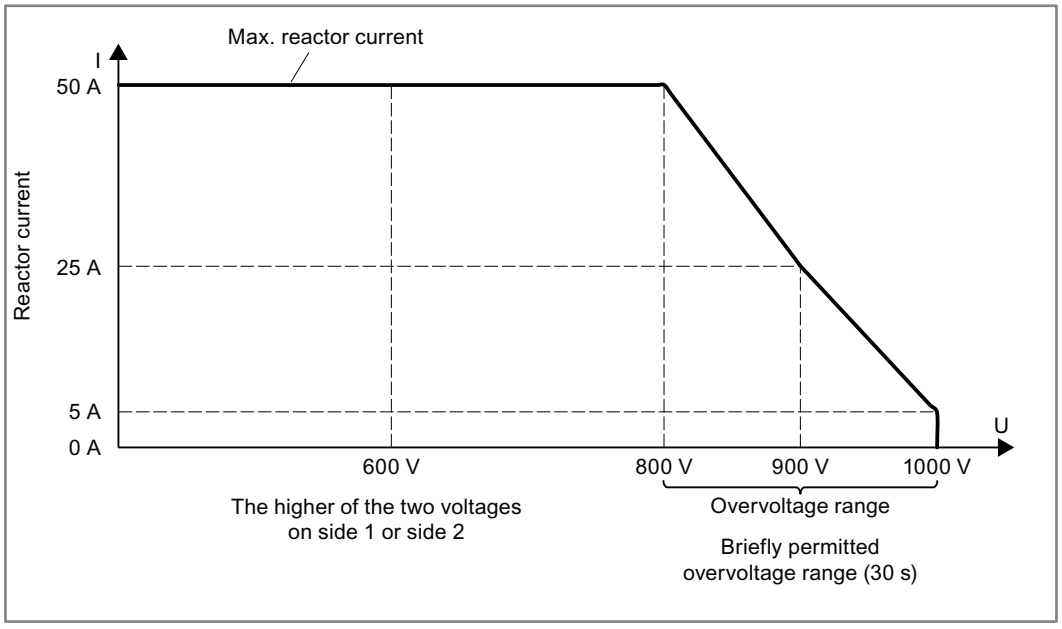


Figure 8-73 Limiting the reactor current in the overvoltage range of a 30 kW device

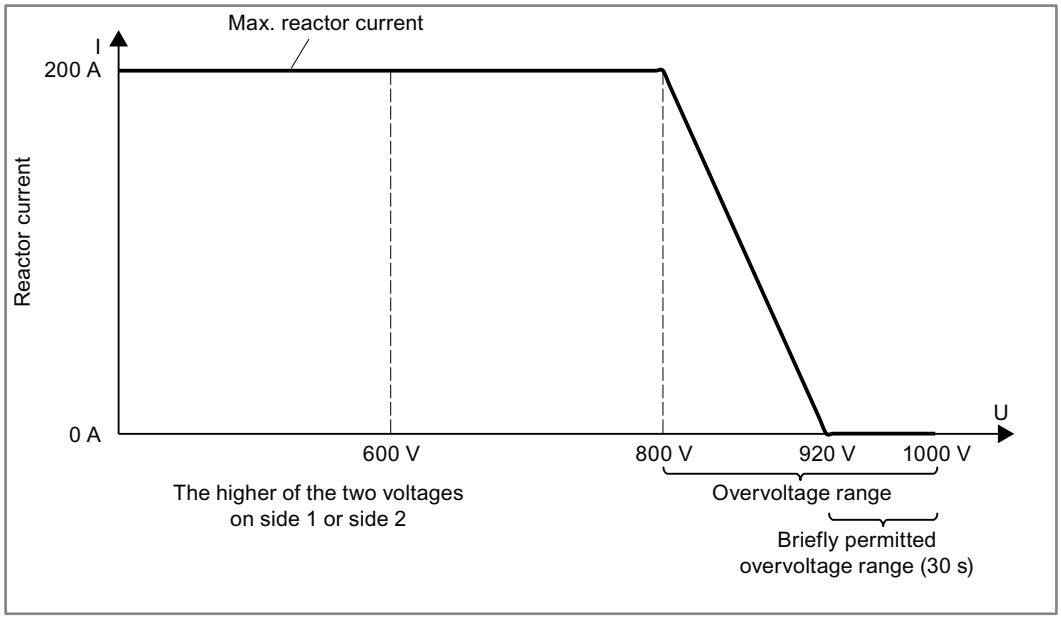


Figure 8-74 Limiting the reactor current in the overvoltage range of a 120 kW device

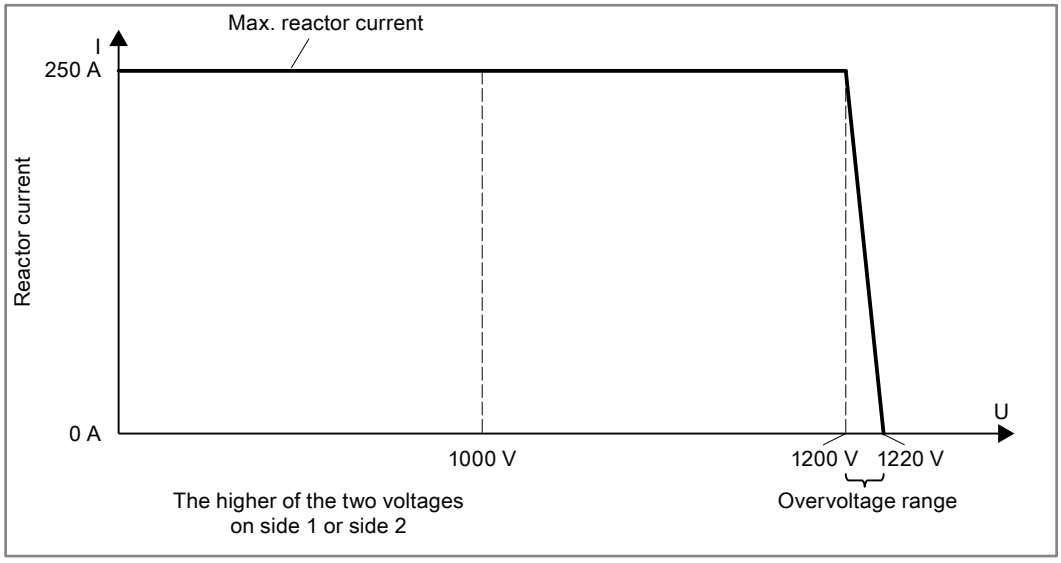


Figure 8-75 Limiting the reactor current in the overvoltage range of a 250 kW device

Example for the 120 kW device [1]:

- Assumed values:
  U_{S1} = 600 V (rated voltage)
  U_{S2} = 850 V (operation in the overvoltage range)
- Side 2 is the side with the higher voltage; as a consequence, the following is obtained from the diagram above:
  $I_{max, reactor}$ = 116.7 A
- Side 1 is the side with the lower voltage. As a consequence, the current on this side corresponds to the reactor current; however, due to the voltage on side 2, is limited to $I_{max, reactor}$.

- Therefore, in this operating state the device only provides a maximum power of: $P_{max} = U_{S1} \times I_{max,\ reactor} = 600\ V \times 116.7\ A = 70\ kW$
- This is the reason that side 2 can only be operated with a maximum current given by: $I_{max,\ S2} = P_{max} / U_{S2} = 70\ kW / 850\ V = 82.35\ A$

[1] Conversion losses were not taken into account in this example.

8.11.5.2 Example: Influence of the current and power limitation for a constant rated voltage on side 1

The following diagrams show as example the influence of the current and power limitation on the reactor current and the current on the side 2 if side 1 is kept constant at the rated voltage of 600 V.

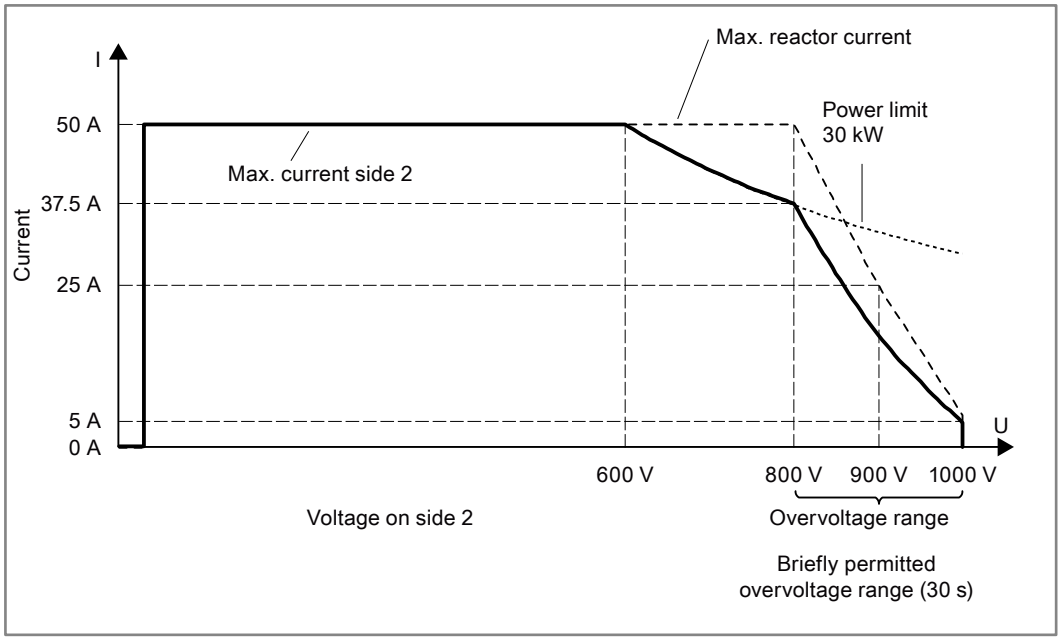


Figure 8-76 Example of the influence of the current and power limitation for a 30 kW device (side 1 is constant at the rated voltage of 600 V, the voltage on side 2 is variable)

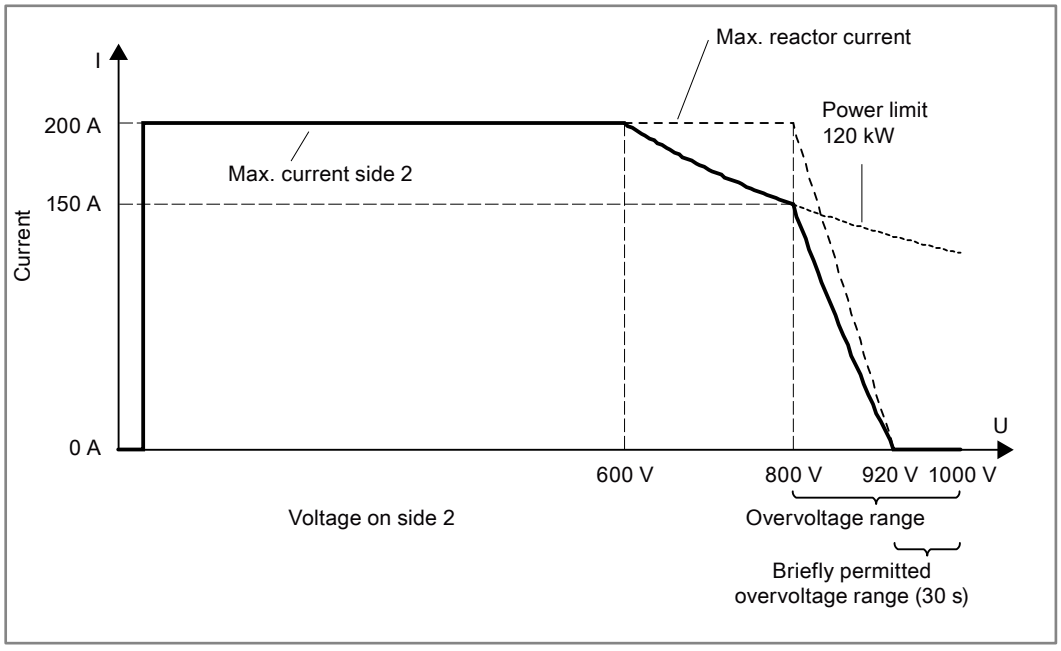


Figure 8-77 Example of the influence of the current and power limitation for a 120 kW device (side 1 is constant at the rated voltage of 600 V, the voltage on side 2 is variable)

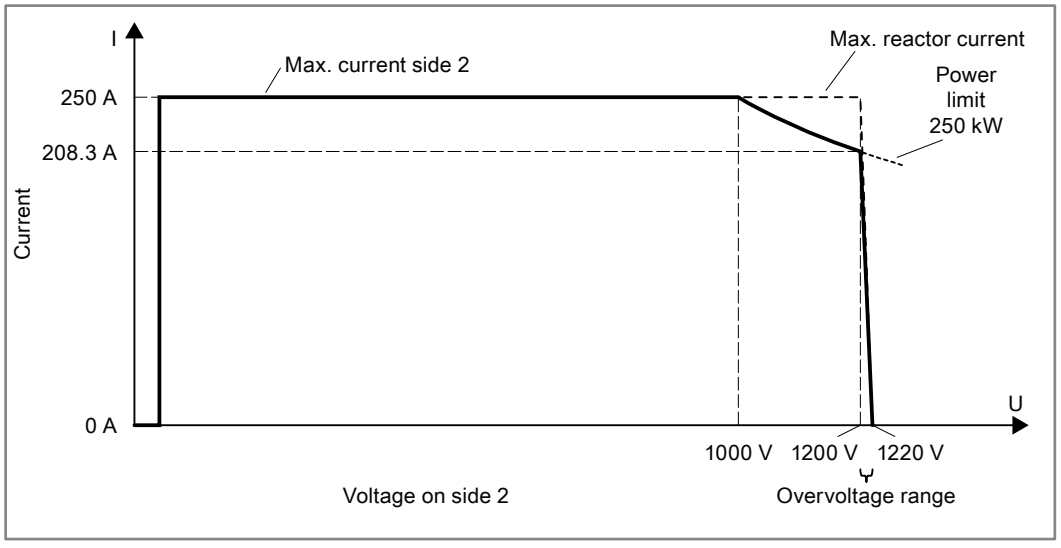


Figure 8-78 Example of the influence of the current and power limitation for a 250 kW device (side 1 is constant at the rated voltage of 1000 V, the voltage on side 2 is variable)

8.11.5.3 Additional dependency of the current and power limiting on ambient factors

The current and power limits additionally depend on the installation altitude, the internal air intake temperature and the temperatures of the power units, see Chapter "Derating (Page 358)".

The influence of the derating for a 120 kW device installed at an altitude of 5000 m is shown as example in the following diagram.

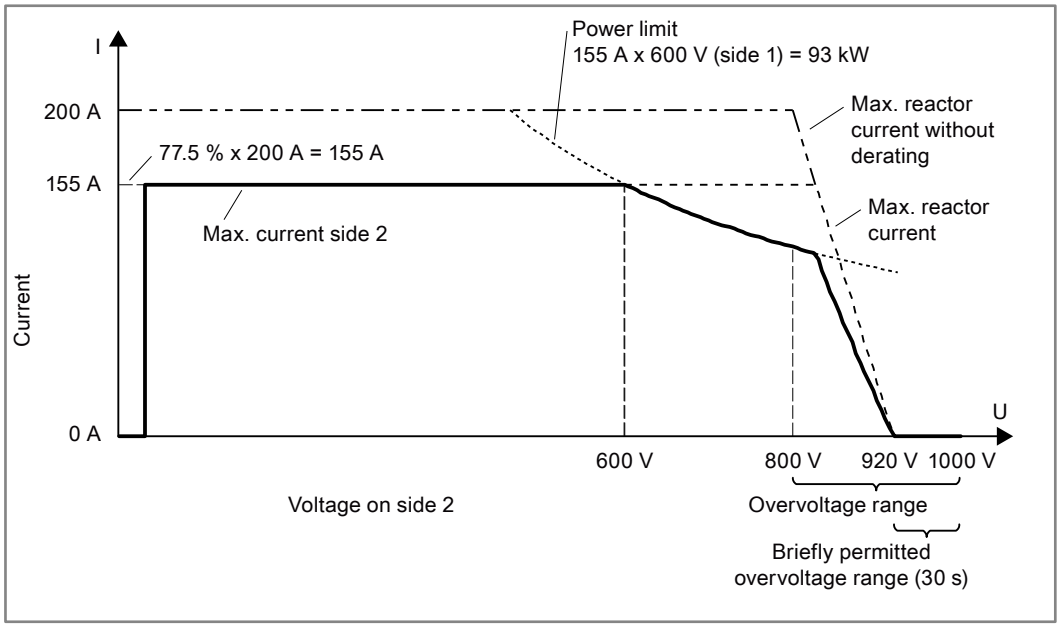


Figure 8-79 Derating of a 120 kW device for an installation altitude of 5000 m (side 1 is constant at the rated voltage of 600 V, the voltage on side 2 is variable)

For a 30 kW device, it should be additionally noted that the voltage limits decrease depending on the installation altitude, see Chapter "Derating (Page 358)".

8.11.6 Voltage limitation

See function diagram 6812 in the SINAMICS DCP List Manual.

Using the voltage limiting, SINAMICS DCP - and the connected electrical sources and sinks - can be protected against overvoltage and undervoltage conditions.
Voltage limiting only acts on the reactor current, and is only active in closed-loop current controlled operation.

The following protection functions can be implemented using the voltage limiting function, for example:

- Protecting an energy storage device against being overcharged
- Protecting an energy storage device against deep discharge
- DC link overvoltage
- DC link undervoltage

Each limit is parameterized using a voltage value pair.

- Voltage value for the start of the limitation (current reduction) and
- Voltage value for full limiting, i.e. the current limitation reaches the value 0 A.

For the voltage limiting, the internal resistance of the connected voltage sources is taken into account - assuming that has been parameterized.
See parameters p55515, p55516, r55505, r55506, r55507, r55508.

8.11.7 Dynamic voltage limitation

See function diagram 6817 in the SINAMICS DCP List Manual.

The dynamic voltage limiting can be freely used to limit the maximum voltage on side 1 and side 2.

It acts on the reactor current in the closed-loop current and voltage control and also in the precharging "pulsing up" mode.

8.11.8 Voltage control

See function diagrams 6818 and 6819 in the SINAMICS DCP List Manual.

The voltage controller controls either the voltage on side 1 or on side 2 to a definable setpoint.

Properties of the voltage controller

- PI controller with droop (p54125, p54126, p54127), which outputs a reactor current setpoint. The principle of operation of the droop function is described in Chapter "Connecting several SINAMICS DCPs in parallel (Page 397)".
- Actual value selection (p54102, p54104):
  Using the actual value selection, the side of the DCP where the voltage should be controlled is defined.
  For selection, in addition to the voltage actual values at the DCP connections on both sides, in p54102 there are also the "internal" voltages, i.e. the calculated voltage after the internal resistance of a connected (capacitive) load.
  To do this, the load internal resistance must be known and set in p55515 (side 1) or p55516 (side 2).
  The internal resistance must be specified referred to the reference resistance:
  Reference resistance = reference voltage (r50071) / reference current (r50072).
  The following reference resistance for the device versions is obtained:
  - 30 kW-DCP: 600 V / 50 A = 12 Ω
  - 120 kW-DCP: 600 V / 200 A = 3 Ω
  - 250 kW DCP: 1000 V / 250 A = 4 Ω

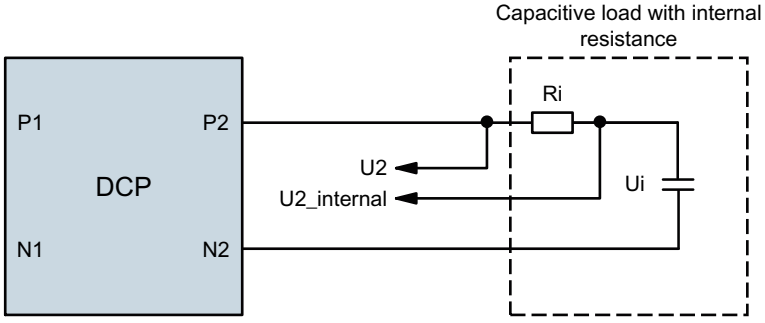


Figure 8-80 Internal voltage of a voltage source

  In addition, the assignment of the DCP sides to the voltage control can be interchanged using p54104.
  Switchover is possible in operation; however, it should only be done under specific conditions:
  - Approximately the same voltage is available at side 1 and side 2 or
  - the voltage setpoint is correspondingly set to the new voltage actual value at the instant of switchover.

  This means that undesirable equalization responses of the voltage controller can be avoided.
- Rate/delay time in the actual value channel (p54121, p54122):
  This element is used to improve the control dynamic response by increasing the phase response or reducing the amplitude response in certain frequency ranges.
  In the factory setting, the voltage controller is optimized for compensating disturbances. This is simplified using the D component (p54121, p54122) in the actual value channel. The control response can be optimized; to do this, the D component must either be reduced or deactivated.

- Input of a current limit during closed-loop voltage control:
  For the closed-loop voltage control, a limit can be entered for the positive (p54141) and the negative (p54142) reactor current. As a consequence, these limits always refer to the side with the lower voltage.
  To limit the current on one side independent of the voltage relationships, the input values for p54141 and p54142 must be appropriately converted.

Required current limit	Voltages Site 1/ side 2	Input values for BICO parameters
Positive current limit on side 1 I_lim_pos_S1	U1 ≤ U2	p54141 = I_lim_pos_S1
	U1 > U2	p54141 = (U1 / U2) x I_lim_pos_S1
Negative current limit on side 1 I_lim_neg_S1	U1 ≤ U2	p54142 = I_lim_neg_S1
	U1 > U2	p54142 = (U1 / U2) x I_lim_neg_S1
Positive current limit on side 2 I_lim_pos_S2	U1 ≤ U2	p54141 = (U1 / U2) x I_lim_pos_S2
	U1 > U2	p54141 = I_lim_pos_S2
Negative current limit on side 2 I_lim_neg_S2	U1 ≤ U2	p54142 = (U1 / U2) x I_lim_neg_S2
	U1 > U2	p54142 = I_lim_neg_S2

  In addition, the current limitations to protect the power unit (r55115, see FP 6810) and the dynamic voltage limits (r55195, r55190, see FP 6817) are active.

- BICO interconnectable switchover between closed-loop current and voltage control (p54105):
  The voltage controller is linked with the "Automatic DC link buffering" function.
  p54124 must be set = 100 % to be able to use the voltage controller without this function. This means that the automatic DC link buffering is deactivated and the voltage controller can be enabled and inhibited using p54145.
  The voltage controller output after limiting (r54134) is used as current setpoint for the power unit if the voltage controller is enabled with p54145 = 1 and activated with p54105 = 1.

Automatic DC link buffering

See function diagrams 6730 and 6819 in the SINAMICS DCP List Manual.

This function is used to supply the DC link of a frequency converter, which is usually fed from the three-phase line supply via an infeed unit, from an energy storage device if the power fails and, in this way, to maintain uninterrupted operation of a connected motor.

To do this, a dead range (p54124) is defined symmetrically around the voltage setpoint (r54103); this means that the DCP voltage controller remains inhibited as long as the voltage actual value lies in the range between the following limits:

- r54103 + (0.5 × p54124)
- r54103 - (0.5 × p54124)

In this case, the infeed unit controls the DC link voltage. If the voltage actual value leaves the dead range, then the DCP voltage controller is enabled.

It controls the voltage back to the setpoint and remains enabled until the set minimum time (p54146) has expired. The voltage controller can also be enabled using BICO input p54145.

- For the factory setting p54124 = 0 %, the automatic DC link buffering is always active; as a consequence, the voltage controller is always enabled independent of the value of parameter p54145.
- For p54124 = 100 %, the automatic DC link buffering is deactivated. The voltage controller can either be enabled or inhibited via BICO (p54145).
- For values of p54124 between 0 % and 100 %, the automatic DC link buffering is enabled and when required intervenes.
  In addition, the voltage controller can also be enabled via BICO (p54145). However, the voltage controller can only be inhibited if the voltage is within the tolerance range.

Note

To use this function, p54105 = 1 must be set.

8.11.9 Voltage correction controller

See function diagram 6807 in the SINAMICS DCP List Manual.

The voltage correction controller is used to improve the precision of the voltage control and/or to compensate the voltage drop across the power cables.
To do this, external voltage measured values can be read-in, and the setpoint for the internal voltage controller appropriately corrected.
The correction controller is always superimposed on the internal voltage controller and corrects its setpoint depending on the deviation between the voltage setpoint and external voltage actual value. This is the reason that the internal voltage control loop is essentially uninfluenced by the external actual value.

The voltage correction controller can be activated on one or both sides of the DCP. This is configured using parameter p54155.
It is then enabled depending on the actual voltage controlled side (r54106.0, r54106.1) and the setting of p54155.
For each DCP side, an external voltage actual value can be read-in via BICO inputs (p54151, p54152); the switchover is then realized dependent on the actual voltage-controlled side of the DCP (r54106.0, r54106.1).
External voltage actual values can be fed in via analog inputs of the CUD or via digital field buses.

The deviation between external and internal voltage actual value is monitored, assuming that the voltage correction controller is active.
If the maximum tolerated deviation (p54162) is exceeded, then fault message F60512 is output.

The fact that the internal voltage controller and the internal voltage sensing functions of the DCP are still active, means that even when the voltage correction controller is activated, the device can protect itself against overvoltages and overload conditions.

Note

As a result of the sampling and the dead times of the actual value channels, as well as the structure of the voltage correction controller, this is not suitable for responding to dynamic switching operations.

The following secondary conditions must be satisfied in order that the voltage correction controller functions correctly:

- The voltage setpoint must be interconnected with p54150.
- The external voltage actual values must be interconnected with p54151 (side 1) or p54152 (side 2).
- The corrected voltage setpoint (r54170) must be interconnected with the input of the voltage controller p54100.

8.11.10 Current control

See function diagram 6820 in the SINAMICS DCP List Manual.

The current control comprises several components:

- Precontrol
  to relieve the controller for setpoint changes.
  The rate time (Tv) of the D component of the precontrol and the precontrol factor can be parameterized.
- Current controller
  Each power unit has its own current controller that is configured as adaptive PI controller.
  The controller parameters proportional gain (Kp) and integral time (Tn) can be set separately for the two current directions.
  A delay of 2.1 ms is effective in the setpoint of the I component to reduce the settling operations of the I component for setpoint changes.

Note

To a large extent, the energy storage reactor defines the closed-loop current control response. As a consequence, changes to controller parameters Kp (p55220), Tn (p55221), precontrol factor (p55230) and Tv (p55222) are generally not required.

8.11.11 Pulse width modulation (PWM)

See function diagram 6830 in the SINAMICS DCP List Manual.

The PWM unit generates the control signals for the power semiconductors in the power unit. Further, it controls the switchover of the direction of the current.

In the closed-loop current control, switching over the direction of the current can be delayed (p55065).

In the current control, a delay (p55065) can be set for switching over the current direction. During this delay time, the current setpoint is set to zero.

The individual power sections are clocked with the switching frequency; however, the switch-on instants are phase shifted with respect to one another:

- 30 kW device: 2 power units, 2x interleaved with 180° phase offset
- 120 kW device: 3 power units, 3x interleaved with 120° phase offset
- 250 kW device: 3 power units, 3x interleaved with 120° phase offset

Depending on the modulation depth (r55250, r55251[0], r55251[1]), the power units are operated as follows:

200 % ... 100 %	Step up	pos. Current (side 1 → side 2)
100 % ... 0 %	Step down	pos. Current (side 1 → side 2)
0 % ... -100 %	Step down	neg. Current (side 2 → side 1)
-100 % ... -200 %	Step up	neg. Current (side 2 → side 1)

The parameters for limiting the modulation depth (P55305 and p55306) allow the possible operating range of the SINAMICS°DCP to be limited (FP6825).

Examples:

- Modulation depth limited to 0 % ... +200 %: only positive current possible
- Modulation depth limited to -200 % ... +0 %: only negative current possible
- Modulation depth limited to -100 % ... +100 %: only stepping down possible

Transition range between stepping up and stepping down

In the transition range between stepping up and stepping down, approximately the same voltages are present at both sides of the SINAMICS DCP. Modulation depths would be required, which would result in very short switch-on durations of the power transistors. Short switch-on durations such as these would not be permitted in order to protect the power transistors.

The response of the PWM units in this range can be set using parameter p55321 (Optimized modulator step-down/step-up transition):

- p55321 = 0 (deactivated):
  In the transition range, the two sides of the DCP are directly connected through the power transistors without any clocking. This state is maintained until the current controller intervenes, which means that the system exits the transition range.
  If the system still operates close to the transition range, then operation alternates between being directly connected and being clocked.
  This results in a slight low-frequency oscillation of the current, comparable with the response of a 3-level control system.
- p55321 = 1 (activated):
  As a result of the optimized pulse pattern, the power transistors are also clocked in the transition range, so that all of the required modulation depths can be realized.
  As a consequence, the current controller has a steadier control response in the transition range.
- p55321 = 2 (activated with frequency derating):
  Corresponds to the response for p55321 = 1; however, in the transition range, the switching frequency is additionally reduced, therefore reducing the switching losses.
  In the transition range, the current ripple on both sides of the DCP is very low as the voltages at both sides of the DCP are very low; as a consequence, reducing the switching frequency does not noticeably influence the control response.

8.11.12 Flying restart

This function is required for SINAMICS DCP applications in energy generating systems with high no-load voltage.

Using this function, energy generating units with a no-load voltage of up to 1000 V can be operated with 30 kW and 120 kW SINAMICS DCP devices, even if this voltage exceeds the continuous operating range of the devices.

When operated without load, a no-load voltage is available at the output terminals of an energy generating unit. This high output voltage can be reduced by applying a load.
As a consequence, when the SINAMICS DCP is switched on, the "flying restart" function attempts to reduce the output voltage of the energy generating unit by impressing a load current so that it lies in the continuous operating range of the SINAMICS DCP:

- 30 kW device: U ≤ 800 V
- 120 kW device: U ≤ 920 V

See also Chapter "Technical specifications (Page 433)".

Clocked operation of the device is not possible for voltages that lie outside the continuous operating range of the SINAMICS DCP. As a consequence, the load current is generated by connecting side 1 and side 2 of the SINAMICS DCP with one another via the power semiconductors (that are permanently turned on), the reactor (see function diagram 6830 in the SINAMICS DCP List Manual) and the series resistors.

For p55110 = 1 or 2, the function "flying restart" is automatically executed after each ON command (r0898.0 = 1). This is the reason that the function is already active during

precharging (operating state < o7), and the load current is limited by the precharging resistors on that side of the DCP that is connected to the energy generating unit.

Note

Dimensioning the precharging resistors

The precharging resistors to the energy generating unit must be dimensioned so that on one hand, the voltage of the energy generating unit can be reduced down into the continuous operating range of the SINAMICS DCP as a result of an adequately high load current – and on the other hand, the voltage difference across the main contactor is sufficiently low so that this is not damaged when it is switched.

The function "flying restart" is exited once the SINAMICS DCP has reached the operating state (o0), and the voltage of the energy generating unit has reached the continuous operating range of the device.
The load current that is obtained during the "flying restart" is then maintained for 5 s. Further, this load current is indicated in r55112 and can be used as start value by other functions.

Monitoring functions

While the "flying restart" function is active, the following monitoring functions are performed:

- If the voltage of the energy generating unit does not reach the continuous operating range of the SINAMICS DCP within a maximum of 30 s, then fault F60500 is initiated and the device shuts down.
  The device can only be switched on again after a wait time of maximum of 5 minutes has elapsed (depending on the time the device was operated in the overvoltage range).
  During this time, the SINAMICS DCP remains in operating state o8.2 (switching-on inhibit).
- It is not permissible that the voltage – on that side of the SINAMICS DCP where the flying restart function is not active – exceeds the specified voltage limit for this side (p55182 or p55187).
  Otherwise, the SINAMICS DCP is shut down with fault F60500, fault value = 3.

Note

The "flying restart" operating mode (p55110 > 0) can only be used in conjunction with resistance precharging (p55350 = 3, 4).

8.11.13 Switching frequency

The switching frequency (r55325) refers to a single power unit.

SINAMICS DCP devices comprise several power units connected in parallel that are operated with offset clocking (interleaved operation) ensuring a higher resulting switching frequency. For more detailed information, see Chapter "Pulse width modulation (PWM) (Page 346)".

Fixed or variable switching frequency

Either a fixed or variable switching frequency can be selected. The variable switching frequency should be selected for those applications where it is required that at each operating point the DCP achieves the highest possible efficiency.

- p55322 = 0: fixed switching frequency (factory setting)
  - 30 kW device: 20 kHz
  - 120 kW device: 15 kHz
  - 250 kW device: 20 kHz
- p55322 = 1: variable switching frequency
  - At each operating point (= ratio, input/output voltage), the switching frequency is reduced as far as possible.
  - **Advantage**: **Improved efficiency**
    The efficiency is increased as lower switching frequencies reduce switching losses in the power semiconductors.
  - **Disadvantage:** The current control can be somewhat less steady.
  - Remark: Reducing the switching frequency can increase the current ripple inside the device. As this ripple may neither result in overloading the power semiconductors nor saturating the internal reactor, the possibility of reducing the frequency is restricted, depending on the particular operating point.
    For a voltage ratio of 1:2 or 2:1, in principle, the internal current ripple is the highest; in this case, the frequency cannot be reduced. For a voltage ratio of 1:1, in principle, the internal current ripple is the lowest; in this case, the frequency can be reduced the most. However, the switching frequency is not reduced to less than 5 kHz.
- r55325: displays the actual switching frequency

Note

In addition, the switching frequency can also be reduced for an overtemperature condition, see Chapter "Derating (Page 358)".

The power units are always operated with the lowest switching frequency of all adaptation and derating functions, however, as a minimum with 5 kHz.

8.11.14 Actual value acquisition

See function diagram 6850 in the SINAMICS DCP List Manual.

The actual value acquisition provides all the actual values required for the closed-loop control.

The most important values are available as BICO in standardized representation and also as display parameters in physical units.

Basic information about current actual values:
The current actual value acquisition in the SINAMICS DCP acquires the reactor current. The reactor is an energy store that takes the current from one voltage level to another. The

reactor current is always the current that flows on the side with the lower voltage. A lower current flows on the side with the higher voltage.

8.11.15 Actual value adjustment on site

The current and voltage actual value sensing are calibrated in the manufacturer's plant.

- The accuracy of the ex-factory current sensing is better than +/-1 % of the rated device current.
- The accuracy of the ex-factory voltage detection is better than +/-1 % of the rated device current.

The voltage and current actual values can be adjusted "on site", if necessary.
In this way, the voltage and current values that the DCP displays (r55503, r55504, r55520, etc.) can be adjusted so that they correspond to externally measured values.

The current and voltage actual values can be subsequently adjusted using the following parameters:

- p55545[0..1] / p55546[0..1]
- p55525 / p55526

Note

Factory calibration

The factory calibration always remains active, and is only adapted by the parameterized adjustment.

Note

Accuracy of the actual value sensing

The accuracy of the factory actual value sensing is only valid if all adjustment parameters are set to 0.00 %.

8.12 Precharging DC links

In the switched-off state, the DC link capacitors on side 1 and side 2 of the SINAMICS DCP are in a no-voltage condition.

When the device is switched on, it must be charged up to the connected voltage sources (e.g. DC link, energy storage device).

This is referred to as precharging.

NOTICE
Current peaks Directly connecting the DCP to a voltage source without precharging, results in high equalization currents, and can destroy the device.

Precharging is controlled by the DCP. It is assumed that the appropriate switchgear and precharging resistances are present in the system (not part of the scope of delivery), and connected according to the following diagram "Connecting the resistance precharging at both sides".

The parameters to be set can be seen in function diagram 6835 and are described in the parameter list in the List Manual.

NOTICE
Malfunctions or damage if parameters are incorrectly set Incorrectly set parameters (delay times, target value for precharging when pulsing up, voltage tolerance) can result in malfunctions or damage to the system. • Set the delay times (p55355[0,1], p55356[0,1]), the target value when precharging using pulsing up (p55352) and the voltage tolerance (p55357) so that they match your particular system.

There are two types of precharging:

- Resistance precharging
- Precharging using "pulsing up"

This results in the following precharging methods:

1. Resistance precharging at both sides
2. Resistance precharging at one side, pulsing up at the other side

Note

To ensure a successful connection, the transferred target value of the precharging operation (p55352) must maintain an accuracy of ±2.5 % of the rated device voltage.

Note

If "Precharging using pulsing up" is used in one of the two precharging circuits, then the precharging relay, the precharging resistors, the precharging contactors and precharging fuses can be omitted on this side.

If one of the two sides of the DCP is permanently connected to the DC link of a line infeed unit (e.g. SINAMICS Active Line Module), then it can be precharged together with the DC link of this unit, and does not require its own precharging.
In this case, the precharging circuit can be eliminated.
For this side of the DCP, resistance precharging must then be parameterized. In so doing, the maximum permissible DC link capacitance of these devices must be taken into careful consideration.
In this case, wait times p55355 and p55356 on this side can be set to the lowest value.

⚠ WARNING

Fire and device damage as a result of ground fault/short-circuit

Inadequate installation of the cables to the precharging circuit of the SINAMICS DCP can result in a ground fault/short-circuit and place persons at risk as a result of the associated fire and smoke.

- Comply with local installation regulations, which allow this fault to be ruled out.
- Protect the cables from mechanical damage.
- In addition, apply one of the following measures:
  - Using cables with double insulation.
  - Observe adequate clearances, e.g. through the use of spacers.
  - Route the cables in separate cable ducts or pipes.

8.12.1 Resistance precharging at both sides

Resistance precharging at both sides is selected via:

- p55350 = 3 (first side 1, then side 2)
- p55350 = 4 (first side 2, then side 1)

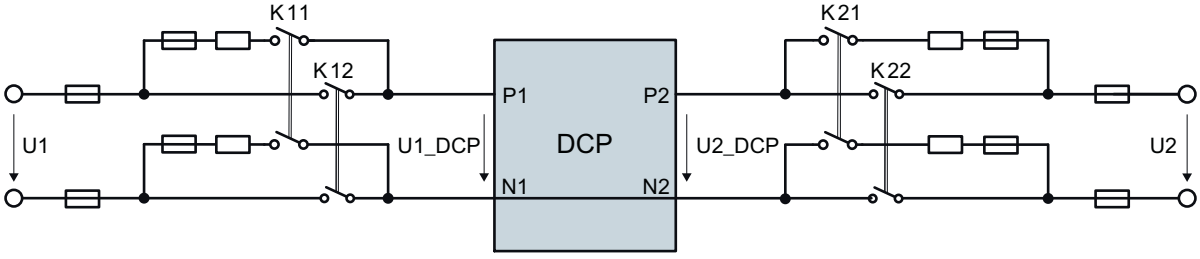


Figure 8-81 Resistance precharging circuit at both sides

Example: Resistance precharging on side 1, followed by side 2 (p55350 = 3)

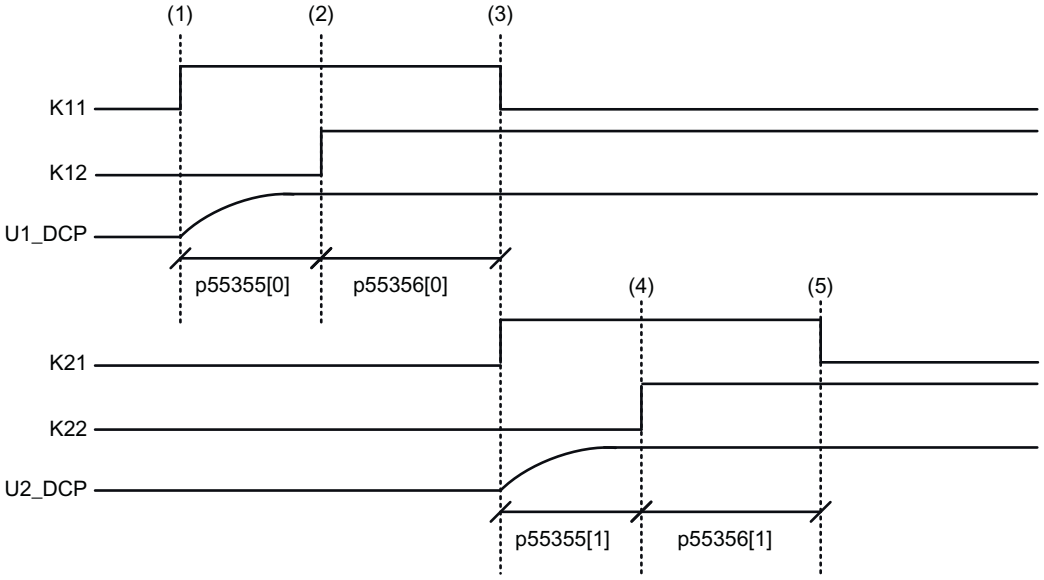


Figure 8-82 Example: Sequence of resistance precharging on side 1, followed by side 2 (p55350 = 3)

Sequence of resistance precharging on side 1, followed by side 2 (p55350 = 3)

1. Time (1):
   A request is issued to close the precharging contactor of side 1 (K11) and the system waits for the delay time p55355[0] for the voltage precharging at side 1 to expire.
2. Time (2):
   The capacitance at side 1 of the SINAMICS DCP (U1_DCP) must have been charged up to voltage U1 at this time.
   After the delay time p55355[0] has expired, the following conditions are checked:
   - voltage U1_DCP must be greater than the minimum voltage of the device (p55105) and
   - voltage U1_DCP must be greater than or equal to the minimum voltage for side 1 (p55353[0]) and
   - it must not fluctuate more than the tolerance for side 1 (p55357[0]).

   If these conditions are satisfied, then a request is issued to close the main contactor of side 1 (K12), and the system waits for delay time p55356[0] to expire to close the contactor.
   If this is not the case, then fault message F60501 is output with fault value 1.
3. Time (3):
   The precharging contactor of side 1 (K11) is opened, and a request is issued to close the precharging contactor of side 2 (K21). The system then waits for the delay time p55355[1] to expire for the precharging of the voltage at side 2.

4. Time (4):
   The capacitance at side 2 of the SINAMICS DCP (U2_DCP) must have been charged up to voltage U2 at this time.
   After the delay time p55355[1] has expired, the following conditions are checked:
   – voltage U2_DCP must be greater than the minimum voltage of the device (p55105) and
   – voltage U2_DCP must be greater than or equal to the minimum voltage for side 2 (p55353[1]) and
   – it must not fluctuate more than tolerance for side 2 (p55357[1]).

   If these conditions are satisfied, then a request is issued to close the main contactor of side 2 (K22), and the system waits for delay time p55356[1] to expire to close the contactor.
   If this is not the case, fault message F60501 is output with fault value 2.
5. Time (5):
   The precharging contactor of side 2 (K21) is opened. The closed-loop control and the pulses are enabled.

8.12.2 Resistance precharging at one side, pulsing up at the other side

One-sided resistance precharging is realized via

- p55350 = 1 (side 1: resistance precharging, side 2: pulsing up)
- p55350 = 2 (side 2: resistance precharging, side 1: pulsing up)

Example: Resistance precharging on side 1, pulsing up on side 2 (p55350 = 1)

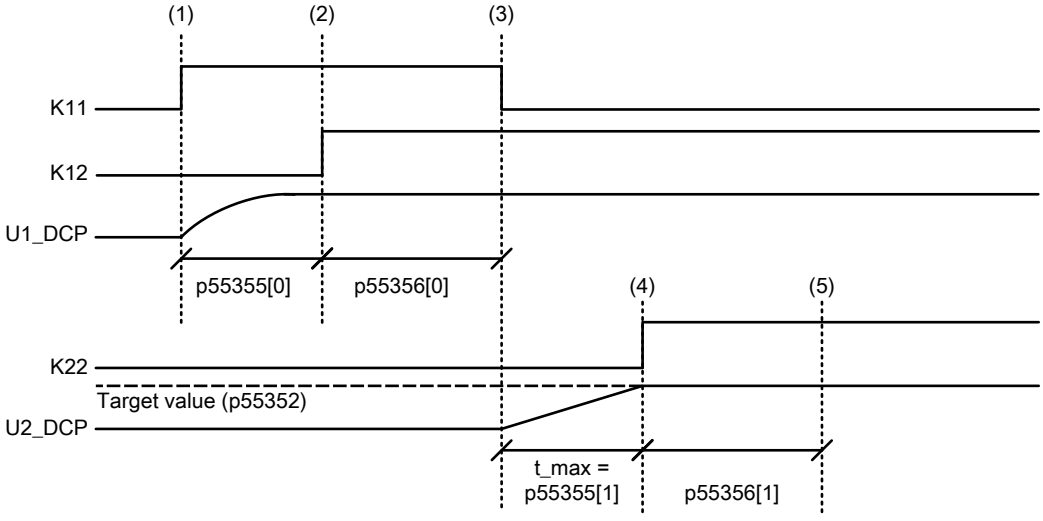


Figure 8-83 Example: Sequence of resistance precharging on side 1, pulsing up on side 2 (p55350 = 1)

Sequence of resistance precharging on side 1, pulsing up on side 2 (p55350 = 1)

1. Time (1):
   A request is issued to close the precharging contactor of side 1 (K11) and the system waits for the delay time p55355[0] for the voltage precharging at side 1 to expire.
2. Time (2):
   The capacitance at side 1 of the SINAMICS DCP (U1_DCP) must have been charged up to voltage U1 at this time.
   After the delay time p55355[0] has expired, the following conditions are checked:
   - voltage U1_DCP must be greater than the minimum voltage of the device (p55105) and
   - voltage U1_DCP must be greater than or equal to the minimum voltage for side 1 (p55353[0]) and
   - it must not fluctuate more than the tolerance for side 1 (p55357[0]).

   If these conditions are satisfied, then a request is issued to close the main contactor of side 1 (K12), and the system waits for delay time p55356[0] to expire to close the contactor.
   If this is not the case, then fault message F60501 is output with fault value 1.
3. Time (3):
   The precharging contactor of side 1 (K11) is opened, the DCP starts to pulse up at side 2 (U2_DCP).
   The current set in p55360 is impressed in the internal capacitance on side 2 until the following conditions are satisfied:
   - voltage U2_DCP must be greater than the minimum voltage of the device (p55105) and
   - voltage U2_DCP must be greater than or equal to the minimum voltage for side 2 (p55353[1]) and
   - as a maximum it may fluctuate within the tolerance for side 2 (p55357[1]) around the target value p55352.

   A request is issued to close the main contactor of side 2 (K22) (time (4)).
   This operation may not be longer than the delay time p55355[1], otherwise fault message F60501 is output with fault value 2.
4. Time (4):
   A request is issued to close the main contactor of side 2 (K22), and the system waits for delay time p55356[1] to expire to close the contactor.
5. Time (5):
   The closed-loop control and the pulses are enabled.
   The pulsing up rate is obtained from the set precharging current (p55360). With the factory setting of 5 %, pulsing up takes approximately 10 ms.

Note

When precharging using pulsing up, the voltage can only be increased (pulsing up) and not decreased. As a consequence, the actual voltage for this precharging type must be less or equal to the target value (p55352).
If this is not the case, then precharging is canceled and fault F60501 is output. For precharging to an already available voltage, the target value for precharging should be set equal to the actual voltage value.

8.13 Device fan

The SINAMICS DCP converter is equipped with device fans.

Fan control

The fans are switched in as required by the fan control system integrated in the device; see function diagram 6845.

In the default setting, the fans are activated along with the pulse enable. For example, to avoid drawing-in cold air and condensation at low temperatures, the minimum heat sink temperature when switching on the fan - with overload operation deactivated (p55080 = 0) - can be increased up to max. 40 °C (p55458).
When the pulse enable is withdrawn, the fan remains active until the run-on time (p55450) has expired.

- 30 kW device:
  The fans are operated at a fixed speed.
- 120 kW and 250 KW devices:
  The fan speed is changed as a function of the power unit temperature (heat sink temperature).
  The fans operate with 20 % of their rated speed up to a heat sink temperature of 30 °C. From this temperature, the fan speed increases linearly up to 100 % of the rated speed for a heat sink temperature of 70 °C.
  The speeds of all three fans are individually monitored.
  If the speed of at least one fan does not as a minimum reach half of the setpoint, then fault F60067 with fault value 10 is output.
  For diagnostic purposes, the speeds of the individual fans are indicated in r55480[0...2].
  For test purposes, the device fans can be switched on using p55455.
  This is also possible in the STARTER screen form "Fan control".

Operating hours counter

Each device fan has an operating hours counter.

The counter state is indicated in r55470.

Monitoring the fan service life

The planned service life is set at p55471, the factory setting is 30000 h.

500 h before the planned service life expires, alarm A60510 is output.

It is recommended that the fans are replaced at the next interruption in operation.

By setting the service life to zero (p55471 = 0 h), fan service life monitoring is deactivated.

By setting p55472 to 1, the operating hours counter is reset to 0. This should be performed after every fan replacement.

See also the SINAMICS DCP List Manual, function diagram 6845.

Instructions on how to replace fans are provided in Chapter "Replacing the fans (Page 412)".

8.14 Derating

As a result of the physical relationships, depending on the installation altitude and the ambient temperature, the current, the power and the overvoltage range must be limited.

This reduction is called "derating."

The derating affects the current and power limitation (see function diagram 6810).

8.14.1 Derating of the available continuous current

The device limits the available continuous current depending on the parameterized installation altitude as well as the air intake and power unit temperatures.

The limits according to installation altitude and temperature are superimposed; this means that if the current has already been reduced due to the installation altitude, it is reduced even further as a result of an increased internal air intake temperature, for example.

Reducing the available continuous current as a function of the installation altitude

For an installation altitude (p55100) above 2000 m, the available continuous current is reduced by 7.5 % / 1000 m.

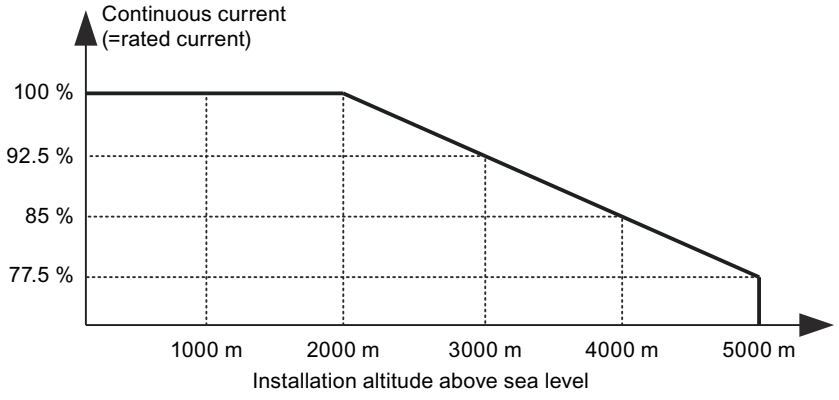


Figure 8-84 Current derating as a function of the installation altitude

8.14.2 Temperature derating

The available continuous current is limited as a function of the air intake and power unit temperatures.
The lower value from the two characteristics is active.

Reducing the available continuous current as a function of the internal air intake temperature

For an internal air intake temperature (p52050[5]) of between 45 °C and 60 °C, the available continuous current linearly decreases from 100 % of the rated current down to 60 %.

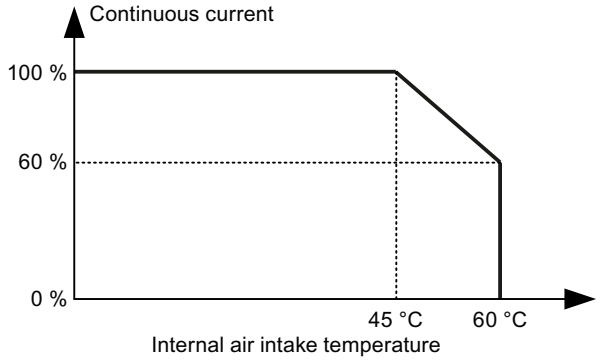


Figure 8-85 Current derating as a function of the internal air intake temperature

The temperature thresholds for the internal air intake temperature can be reduced down to 20 °C using p55101[0]:

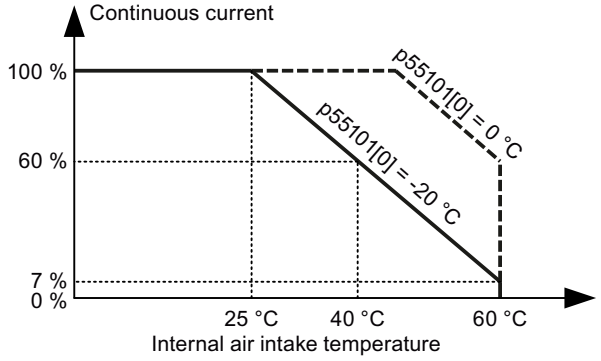


Figure 8-86 Example for temperature threshold reduction - internal air intake temperature

For an internal air intake temperature above 45 °C, alarm A60502 is output; below 43 °C it is again reset. Also this threshold can be reduced using p55101[0].

Reducing the available continuous current as a function of the power unit temperature

For this temperature derating, the highest heat sink temperature (r52050[0], r52050[1]; r52050[6] for the 120 kW and 250 kW devices) of all device power units is used.
For a temperature between 75 °C and 80 °C, the available continuous current is linearly decreased from 100 % of the rated current down to 80 %.

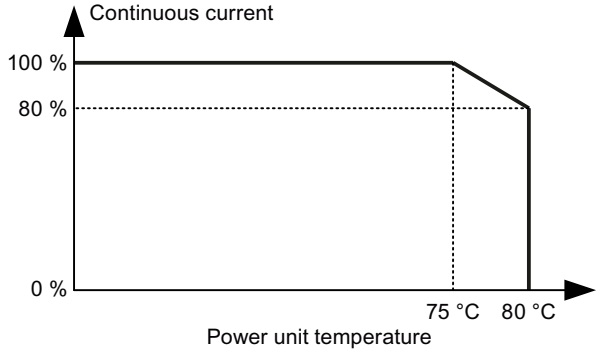


Figure 8-87 Current derating as a function of the power unit temperature

The temperature thresholds for the power unit temperature can be reduced down to 20 °C using p55101[1]:

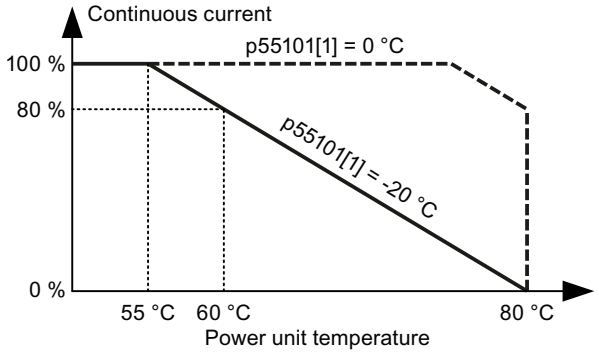


Figure 8-88 Example for temperature threshold reduction - power unit temperature

The response when the permissible power unit temperature is exceeded can be set using p55102:

- p55102 = 1: Switching frequency and current reduction
- p55102 = 2: Current reduction
- p55102 = 3: Switching frequency reduction
- p55102 = 4: Immediate shutdown with fault

For p55102 = 1, 2, 3, the following applies:
At the start of the derating (75 °C), alarm A60080 is output.
If the temperature threshold was reduced via p55101[1] then A60080 is output for an appropriately lower temperature.
As soon as the full derating at 80 °C has been reached, fault F60067 is output and the device is shut down.
p55101[1] does not influence this threshold.

For p55102 = 4, the following applies:
Fault F60067 is already initiated at the start of the derating (75 °C), and the device is shut down.
Alarm A60080 is already output at 70 °C.
Both thresholds can be reduced using p55101[1].

8.14.3 Derating of the maximum voltage limits (only 30 kW devices)

For 30 kW devices, the following additional constraint applies:

The voltage limits are reduced by 12 % per 1000 m at installation altitudes above 2000 m. This derating is applied to parameter r55600[2 ... 5]; however, it does not influence the value of this parameter itself.

Therefore, the derating influences the current and power limits, see Chapter "Current limitation and power limitation (Page 334)", fault F60500 is output at the corresponding lower voltages.

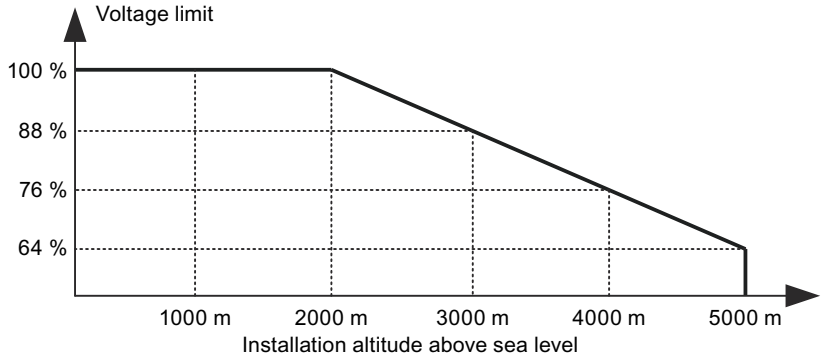


Figure 8-89 Derating of the maximum voltage limits for 30 kW devices

8.15 Runtime (operating hours counter)

Total system runtime

The total system runtime is displayed in r2114 (Control Unit).

- Index 0 = system runtime in ms.
  After reaching 86400000 ms (24 h), the value is reset.
- Index 1 = system runtime in days.
  The counter value is saved when the power is switched off. After the drive unit is powered up, the counter continues to run with the most recently saved value.

Note

Faults and alarms are stamped with this system runtime.

Relative system runtime

The relative system runtime since the last POWER ON is displayed in p0969 (Control Unit) in ms. The counter runs over after approx. 49 days.

8.16 Diagnostics

8.16.1 Diagnostic memory

To provide support for troubleshooting and correcting problems, the SINAMICS DCP records various data in a diagnostics file. SIEMENS specialists can use the contents of this file to obtain more in-depth information about the cause of inexplicable faults or other problems such as blown fuses or defective semiconductor switches.

When contacting SIEMENS with queries related to problems of this type, it is, therefore, advisable that you both read out this file and e-mail a copy of it to the SIEMENS experts.

Proceed as follows to read out the diagnostics file:

1. Insert the memory card in the card slot.
2. Set p50832 = 1:
   this copies the diagnostics file to the memory card. This process takes approximately 2 minutes. Copying is complete when p50832 again assumes a value 0.
3. The diagnostics file is called **DiagStor.spd**, and is approx. 600 kB in size. It can be found in the **\USER\SINAMICS\DATA\LOG** directory on the memory card.

For more details on the diagnostic memory, please refer to function diagram 8056.

Note

Using the memory card

Using the memory card, see Chapter "Memory card functions (Page 161)".

8.16.2 Description of the LEDs on the CUD

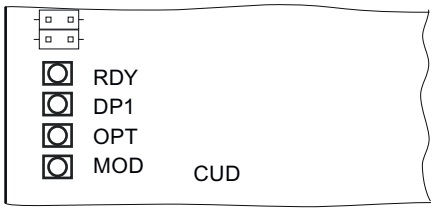


Figure 8-90 Layout of the LEDs

The individual states during ramp-up are indicated by means of the LEDs on the CUD.

- The duration of the individual states varies.
- If an error occurs, the ramp-up procedure is aborted and the cause of the error is indicated via the LEDs.
  Remedy: Insert the appropriate memory card with the correct firmware and parameterization.
- Once the device has successfully ramped up, all the LEDs are switched off briefly.
- After the ramp-up, the LEDs are controlled via the loaded firmware.
  The description of the LEDs after ramp-up applies.

Note

The LEDs are only visible when the front cover of the SINAMICS DCP is opened.

CUD - response of LEDs while updating the firmware

Table 8-76 Firmware update

LED				Meaning
RDY	DP1	OPT	MOD	
Red	Off	Off	Off	Firmware is being updated.
Red	Red	Off	Off	Firmware on the memory card is incomplete or defective.
2 Hz				The firmware update was unsuccessful. The CRC of the programmed firmware is incorrect.
Red 0.5 Hz	Red 0.5 Hz	Off	Off	The firmware was successfully updated. The electronics power supply must be switched off and back on again.
Red	Red	Off	Off	The firmware on the memory card does not belong to SINAMICS DCP.
2 Hz	2 Hz			The firmware release and hardware version of the CUD are not compatible. For information on the hardware/firmware compatibility, see Chapter "Upgrading the device firmware (Page 410)".
Orange 0.5 Hz	x	x	Off	DRIVE-CLiQ component is being updated.
Orange 2 Hz	x	x	Off	DRIVE-CLiQ component has been updated.

CUD - Response of LEDs during ramp-up (following POWER ON)

Table 8-77 Ramp-up

LED				State	Remark
RDY	DP1	OPT	MOD		
Red	Red	Off	Off	BIOS loaded	-
Red 2 Hz	Red	Off	Off	BIOS error	-
Red 2 Hz	Red 2 Hz	Off	Off	File error	Memory card not present or flash file system faulty
Red	Orange flashing	Off	Off	Firmware loading	DP1 flashing without specific flashing frequency
Red	Off	Off	Off	Firmware loaded	-
Off	Red	Off	Off	No CRC error	Firmware checked
Red 0.5 Hz	Red 0.5 Hz	Off	Off	CRC error	Firmware checked, CRC error
Orange	Off	Off	Off	Drive initialization	-

Response of the LEDs after ramp-up

Table 8-78 CUD - Description of the LEDs after ramp-up

LED	Color	State	Description, cause	Remedy
RDY (READY)	-	Off	Electronics power supply is missing or outside permissible tolerance range.	Check power supply
	Green	Continuous light	The component is ready for operation. No errors are present.	-
		0.5 Hz flashing light	Commissioning/reset	-
		2 Hz flashing light	Writing to memory card or internal flash memory **Notice!** The electronics power supply for the SINAMICS DCP must not be switched off during this write process. Switching off the electronics power supply can lead to the loss of the parameter assignments. See also Chapter "Memory card functions (Page 161)".	-
	Red	2 Hz flashing light	General errors	Check parameterization/ configuration
	Orange	0.5 Hz flashing light	Updating the firmware of the DRIVE-CLiQ components.	–
		2 Hz flashing light	DRIVE-CLiQ component firmware update complete. Wait for POWER ON for the respective components.	Carry out POWER ON for the respective components
	Green/ orange or red/ orange	1 Hz flashing light	Component detection via LED is activated (p0124[0]). **Note:** Both options depend on the LED state when component detection is activated via p0124[0] = 1.	-
DP1 PROFIdrive cyclic operation	-	Off	Cyclic communication has not (yet) taken place. **Note:** The PROFIdrive is ready to communicate when the CUD is ready for operation (see LED RDY).	-
	Green	Continuous light	Cyclic communication is taking place.	-
		0.5 Hz flashing light	Bus fault (dataEx, no operate) Full cyclic communication is not yet taking place. Possible cause: The controller is not transferring any setpoints.	-
	Red	Continuous light		
		0.5 Hz flashing light	Bus fault (no dataEx)(config fault)	-
		2 Hz flashing light	Bus fault (no more dataEx)	-
			Bus fault (search baud rate)	
			No link established	-

LED	Color	State	Description, cause	Remedy
OPT (OPTION)	-	Off	Electronics power supply is missing or outside permissible tolerance range, component not ready for operation, Option Board not installed, no associated drive object has been created.	Check power supply and/or component
	Green	Continuous light	Option Board is ready for operation.	-
		0.5 Hz flashing light	Depends on the Option Board used	-
	Red	2 Hz flashing light	At least one fault is present in this component. Option Board not ready (e.g. after switching on).	Correct the fault and acknowledge
RDY and DP1	Red	2 Hz flashing light	Bus fault – communication has been interrupted.	Correct the fault
RDY and OPT	Orange	0.5 Hz flashing light	Firmware update in progress for connected Option Board CBE20.	-
MOD	-	Off	Reserved	-

8.16.3 Faults and alarms

8.16.3.1 General information

Description

The faults and states detected by the individual components of the drive unit are indicated by messages.

The messages are categorized into faults and alarms.

Note

The individual faults and alarms are described in Chapter "Faults and alarms" in the SINAMICS DCP List Manual. Here you can also find a section titled "Function diagrams" → "Faults and alarms", which contains function diagrams for the fault buffer, alarm buffer, fault trigger, and fault configuration.

Properties of faults and alarms

- Faults
  - Are identified by Fxxxxx
  - Can lead to a fault reaction
  - Must be acknowledged once the cause has been remedied
  - Status via Control Unit and LED RDY
  - Status via PROFIdrive status signal ZSW1.3 (fault active).
  - Entry in the fault buffer
- Alarms
  - Are identified by Axxxxx
  - Have no further effect on the drive unit
  - Are automatically reset once the cause has been corrected. No acknowledgment is required.
  - Status via PROFIdrive status signal ZSW1.7 (alarm active).
  - Entry in the alarm buffer
- General properties of faults and alarms
  - Can be configured (e.g. change fault to alarm, fault reaction)
  - Triggering on selected messages possible
  - Initiation of messages possible via an external signal
  - Contains the component number for identifying the SINAMICS component involved
  - Contains diagnostic information on the message involved

Acknowledging faults

The list of faults and alarms specifies how each fault is acknowledged after the cause has been remedied.

1. Acknowledgment of faults with "POWER ON"
   - Switch the drive unit on/off (POWER ON).
2. Acknowledgment of faults with "IMMEDIATE"
   - Via a PROFIdrive control signal:
     STW1.7 (reset fault memory): 0/1 edge
     Set STW1.0 (ON/OFF1) = "0" and "1"
   - Via external input signal
     Binector input and interconnection with digital input
     p2103 = "Requested signal source"
     p2104 = "Requested signal source"
     p2105 = "Requested signal source"
     Across all of the drive objects (DO) of a Control Unit
     p2102 = "Requested signal source"
3. Acknowledgment of faults with "PULSE INHIBIT"
   - The fault can only be acknowledged with a pulse inhibit (r0899.11 = 0).
   - The same options are available for acknowledging as described under acknowledgment with IMMEDIATE.

Note

The SINAMICS DCP cannot resume operation until all active faults have been acknowledged.

8.16.3.2 Buffer for faults and alarms

Note

A fault buffer and an alarm buffer are provided for each drive object. The specific messages are entered in these buffers for this object.

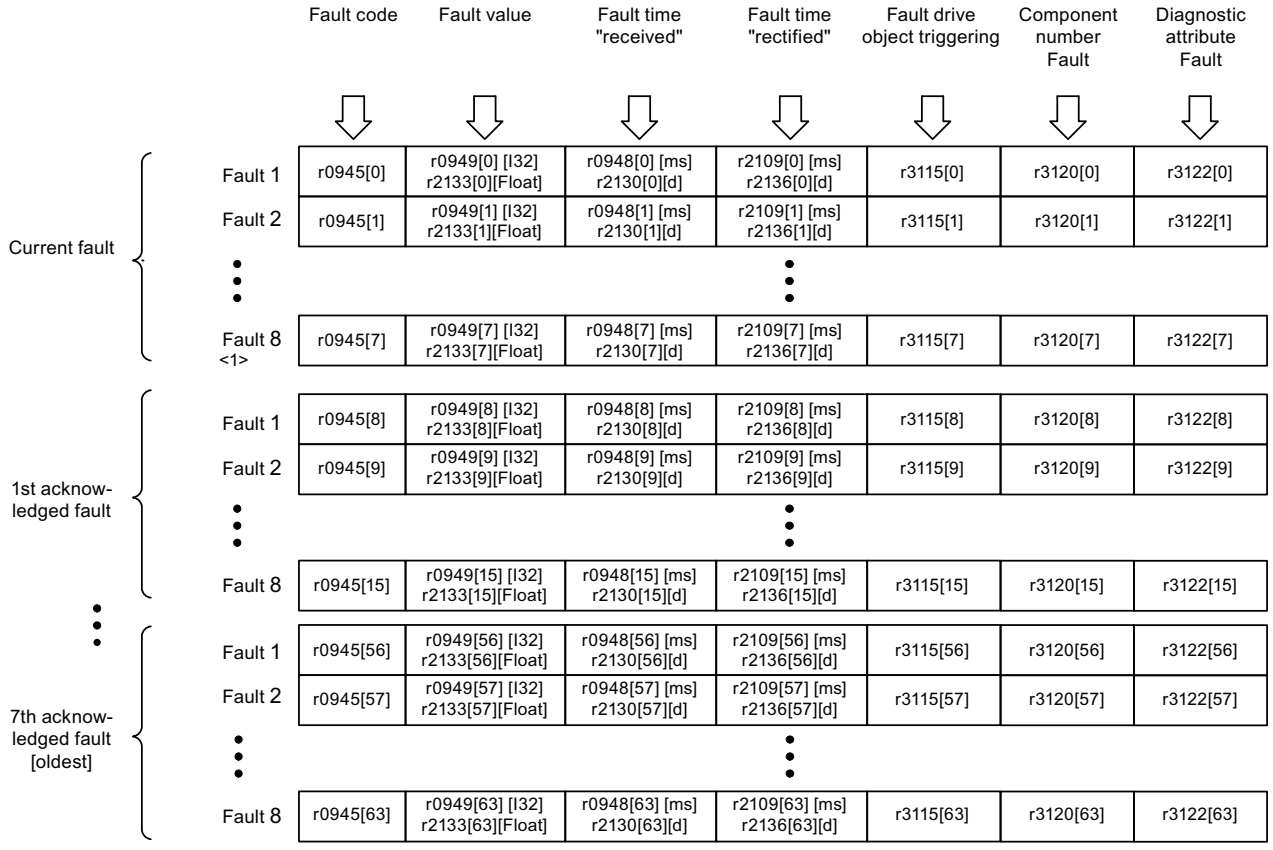
The contents of the fault buffer are saved to the non-volatile memory when the Control Unit is powered down, i.e. the fault buffer history is still available when the device is powered up again.

Note

The entry in the fault/alarm buffer is made after a delay. For this reason, the fault/alarm buffer should not be read until a change in the buffer is also recognized (r0944, r2121) after "Fault active"/"Alarm active" is output.

Fault buffer

Faults which occur are entered in the fault buffer as follows:



<1> This fault is overwritten when "newer" faults occur

Figure 8-91 Structure of the fault buffer

Properties of the fault buffer

- A new fault incident encompasses one or more faults and is entered in "Current fault incident".
- The entries appear in the buffer according to the time at which they occurred.
- If a new fault incident occurs, the fault buffer is reorganized. The history is recorded in "Acknowledged fault incident" 1 to 7.
- If the cause of at least one fault in "Current fault incident" is remedied and acknowledged, the fault buffer is reorganized. Faults that have not been remedied remain in "Current fault incident".
- If "Current fault incident" contains eight faults and a new fault occurs, the fault in the parameters in index 7 is overwritten by the new fault.
- r0944 is incremented each time the fault buffer changes.
- A fault value (r0949) can be output for a fault. The fault value is used to diagnose the fault more accurately; please refer to the fault description for details of the meaning.

Clearing the fault buffer

- The fault buffer is reset as follows: p0952 = 0

Alarm buffer, alarm history

The alarm buffer comprises the alarm code, the alarm value, and the alarm time (received, resolved). The alarm history occupies the last indices ([8...63]) of the parameter.

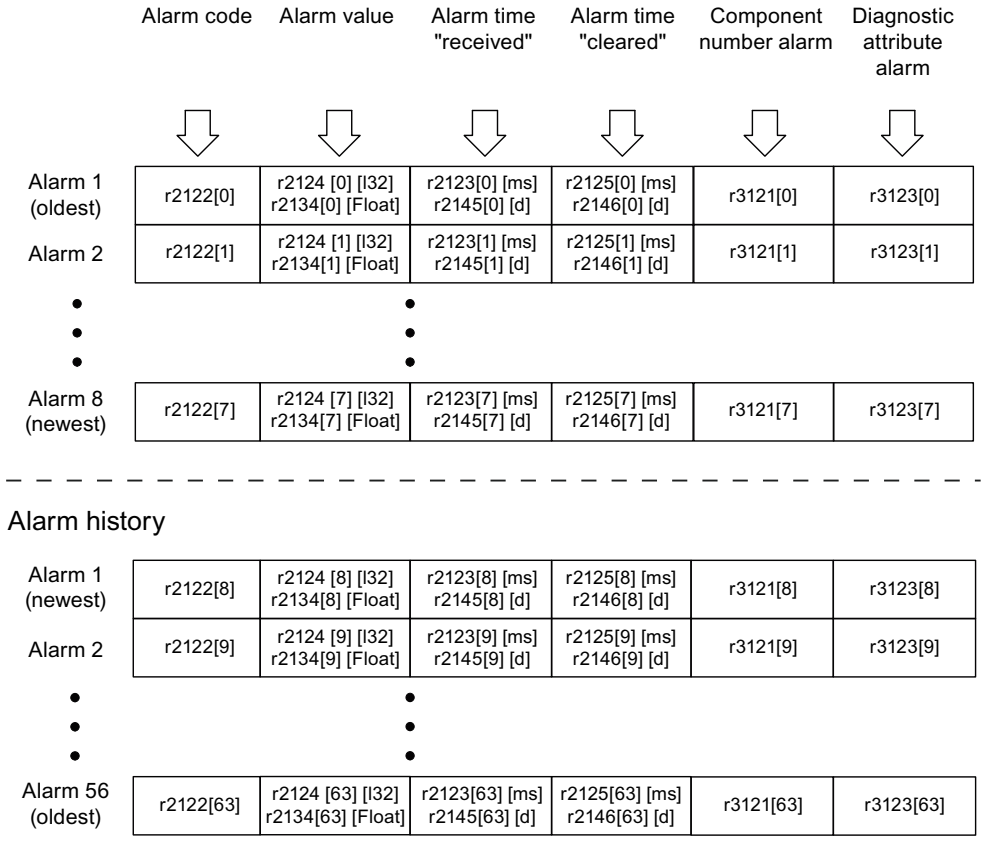


Figure 8-92 Structure of alarm buffer

Alarms that occur are entered in the alarm buffer as follows:

A maximum of 64 alarms are displayed in the alarm buffer:

- Index 0 ... 6: The first 7 alarms are displayed.
- Index 7: The most recent alarm is displayed.

A maximum of 56 alarms are displayed in the alarm history:

- Index 8: The most recent alarm is displayed.
- Index 9 ... 63: The first 55 alarms are displayed.

Properties of the alarm buffer/alarm history:

- The alarms in the alarm buffer are arranged from 7 to 0 according to the time that they occurred. In the alarm history, this is from 8 to 63.
- If eight alarms have been entered in the alarm buffer, and a new alarm is received, the alarms that have been resolved are transferred to the alarm history.
- r2121 is incremented each time the alarm buffer changes.
- An alarm value (r2124) can be output for an alarm. The alarm value is used to diagnose the alarm more accurately; please refer to the alarm description for details of the meaning.

Clearing the alarm buffer, index [0...7]:

- The alarm buffer index [0...7] is reset as follows: p2111 = 0.

8.16.3.3 Configuring messages

The properties of the faults and alarms in the SINAMICS DCP are permanently defined.

The following configuration settings can be made for some of the messages within a permanently defined framework for the SINAMICS DCP:

Change message type (example)

Select message	Set message type	
p2118[5] = 1057	p2119[5]	= 1: Fault (F)
		= 2: Alarm (A)
		= 3: No message (N)

Change fault reaction (example)

Select message	Set fault reaction	
p2100[3] = 1910	p2101[3]	= 0: None
		= 1: OFF1
		= 2: OFF2
		= 3: OFF3

Change acknowledgment (example)

Select message	Set acknowledgment	
p2126[4] = 1800	p2127[4]	= 1: POWER ON
		= 2: IMMEDIATE
		= 3: PULSE INHIBIT

Note

Only those messages which are listed in the indexed parameters can be changed as desired. All other messages retain their factory settings or are reset to the factory settings.

Examples:

- In the case of messages listed via p2128[0...19], the message type can be changed. The factory setting is set for all other messages.
- The fault response of fault F12345 has been changed via p2100[n]. The factory settings are to be restored.
  – p2100[n] = 0

Triggering on messages (example)

Select message	Trigger signal
p2128[0] = 1001	BO: r2129.0
or	
p2128[1] = 1002	BO: r2129.1

Note

The value from CO: r2129 can be used as a group trigger.

CO: r2129 = 0 No selected message has been output.

CO: r2129 > 0 Group trigger.
At least one selected message has been output.
The individual binector outputs BO: r2129 should be investigated.

Triggering messages externally

If the appropriate binector input is interconnected with an input signal, fault 1, 2, or 3 or alarm 1, 2, or 3 can be triggered via an external input signal.

After an external fault 1 to 3 has been triggered on the Control Unit drive object, then this fault is also present on all associated drive objects. If one of these external faults is triggered on a different drive object, it is only present on that particular drive object.

BI: p2106	→ External fault 1	→ F07860(A)
BI: p2107	→ External fault 2	→ F07861(A)
BI: p2108	→ External fault 3	→ F07862(A)
BI: p2112	→ External alarm 1	→ A07850(F)
BI: p2116	→ External alarm 2	→ A07851(F)
BI: p2117	→ External alarm 3	→ A07852(F)

Note

An external fault or alarm is triggered by a 1/0 signal.

An external fault and alarm do not usually mean that an internal message has been generated. The cause of an external fault and alarm should therefore be corrected outside the SINAMICS DCP.

8.16.3.4 Parameters and function diagrams for faults and alarms

Function diagrams (see SINAMICS DCP List Manual)

- 8060 Faults and alarms – fault buffer
- 8065 Faults and alarms – alarm buffer
- 8070 Faults and alarms – fault/alarm trigger word r2129
- 8075 Faults and alarms – fault/alarm configuration

Overview of important parameters (see the SINAMICS DCP List Manual)

- r0944 Counter for fault buffer changes
  ...
- p0952 Fault incident counter
- p2100[0...19] Fault code for fault reaction selection
  ...
- r2139 Status word for faults
- r3120[0...63] Component number fault
- r3121[0...63] Component number alarm
- r3122[0...63] Diagnostics attribute fault
- r3123[0...63] Diagnostics attribute alarm

8.16.3.5 Forwarding faults and alarms

Forwarding faults and alarms of the CU_DCP

When faults or alarms are triggered on the drive object of the CU_DCP, it is always assumed that central functions of the drive unit are involved. For this reason, these faults and alarms are not only signaled on the drive object of the CU_DCP, but are also forwarded to all other drive objects. The fault response affects the drive object of the CU_DCP and all other drive objects. This behavior also applies to the faults set in a DCC chart on the CU_DCP using the DCB STM.

A fault that is set on the drive object of the CU_DCP must be acknowledged on all drive objects to which this fault was transferred. In this way, the fault is then automatically

acknowledged on the drive object of the CU_DCP. Alternatively, all faults of all drive objects can also be acknowledged on the CU_DCP.

If a set alarm is reset on the drive object of the CU_DCP, this alarm also disappears automatically on the other drive objects to which this alarm was forwarded.

Forwarding faults and alarms as a result of BICO interconnections

If two or more drive objects are connected via BICO interconnections, then faults and alarms of drive objects, type CU_DCP, TM15 DI/DO, TM31, TM150 are forwarded to type DCP_CTRL drive objects. Faults are not forwarded within these two groups of drive object types.

This behavior also applies to the faults set in a DCC chart on the previously named drive object types using DCB STM.

8.17 CPU time load with SINAMICS DCP

The CPU time load of the SINAMICS DCP is indicated in r9976[1] of the drive object CU_DCP. The following rules always apply:

1. The cyclic DC closed-loop control of the SINAMICS DCP generates a base load of approx. 50 % (r9976[1]).
2. The use of peripherals (STARTER, TM15, TM31, TM150, CBE20,...), certain settings in the closed loop control and/or use of the free function blocks along with the DCC technology option increases this base load. The additional CPU time load as a result of the main components is summarized in the following table.
3. It is not permissible that the CPU time load (r9976[1]) exceeds 100 %.

⚠ WARNING

Exceeding the CPU time load

It is no longer ensured that the SINAMICS DCP functions correctly for a CPU time load of >100 % in p9976[1].

- Ensure that the CPU time load remains below 100 %.

Note

When the time load of the CUD is too high (r9976[1] >100%), fault F60099 (in extreme cases F01205) is output (time slice overflow). In such a case, the drive needs to be switched off and then back on again (POWER OFF / POWER ON).

The CPU time load must be taken into consideration when configuring and commissioning the SINAMICS DCP.

Table 8-79 Additional CPU time load as a result of optional components

Component	Additional CPU time load
1 TM31	+4%
2 TM31	+5%
3 TM31	+6%

Component	Additional CPU time load
1 TM15	+1%
2 TM15	+1.5 %
3 TM15	+2%
1 TM150	+1%
2 TM150	+1.5 %
3 TM150	+2%
1 CBE20	+1%
Parallel interface	+4%
Memory card inserted	+1%
Free function blocks	Depending on the number of free function blocks being used and their runtime groups, see Chapter "Free function blocks (Page 375)".
DCC	Depending on the number of DCC blocks being used and their runtime groups, see Chapter "Drive Control Chart (DCC) (Page 376)".

Note

The additional CPU time loads specified above for TM15, TM31 and TM150 apply for a sampling time of 4 ms (TM15, TM31: p4099 = 4000) or 26 ms (TM150). Setting faster sampling rates for the TM modules increases the CPU time load of the SINAMICS DCP to values considerably higher than those stated previously.

Note

The stated computing rules are to be understood as support during configuring and commissioning. The theoretical CPU time load computed from these rules can deviate from the CPU time load actually measured on the r9976[1] by several percentage points.

8.17.1 Maximum configuration

At the CUD of a SINAMICS DCP, the following maximum configuration can be operated:

Table 8-80 Maximum configuration for the SINAMICS DCP

Number	Component	Note
3	TM15, TM31, TM150	Connecting any combination of TM15, TM31 and TM150 modules on DRIVE-CLiQ. Connecting other TM modules (TM17, TM41, ...) as well as more than 3 TM modules is not permissible. Sampling in a 4 ms clock cycle (p4099 = 4000). Faster sampling increases the CPU time load, and means that operation with the maximum configuration is not possible.
1	CBE20	The connection of other OMI modules (TB30, CBE10) is not permissible.

Number	Component	Note
1	STARTER	Online
1	Parallel interface	Active

8.18 Free function blocks

A logic operation, which connects several states (e.g. access control, plant status) to a control signal (e.g. ON command), is required for controlling the drive system in a wide variety of applications.

Along with logic operations, a number of arithmetical operations and storing elements are becoming increasingly important in drive systems. This functionality is available as a "Free function blocks" function module (FBLOCKS) on the drive object type of the SINAMICS DCP.

You can find the documentation on the Internet: Function Manual "Free Function Blocks" (https://support.industry.siemens.com/cs/de/en/view/59745768)

General remarks

- Exact information on the scope of the blocks, about parameter assignment and about commissioning the free function blocks is available in the "Free function blocks" Function Manual. This chapter describes the special features of the free function blocks with SINAMICS DCP.
- This additional functionality increases the CPU time load. That means the maximum possible configuration with a Control Unit may be restricted.
- The free function blocks are restricted in their scope to 52 blocks per drive object (DO). Furthermore, the unassigned function blocks as compared to DCC cause a significantly higher CPU time load.
  If an application with free function blocks cannot be implemented, then the DCC technology option is available, see Chapter "Drive Control Chart (DCC) (Page 376)".
- In SINAMICS DCP, free function blocks and the DCC technology option can be simultaneously used.
- With SINAMICS DCP, parameters that specify scaled variables have the unit "Percent". With free function blocks, parameters that specify scaled variables have no dimension. When setting parameter values, the unit of the parameter must **always** be taken into account. The unit is specified in the List Manual and is directly displayed in STARTER.
  Remark:
  The relationship between percent variables and dimensionless variables is 100% corresponds to 1.00.
  The conversion is performed according to the formula: Y=X/100%.
  X..percentage variable
  Y..dimensionless variable
  Example: The fixed value r52401 is used as the input value of the limit monitor (p20266 = 52401). p50401 and r52401 both have the unit "%". If the value "50 %" is specified at p50401, the value "50 %" appears at r52401. The value "50%" (= 0.5) is therefore effective as the input signal X of the limit monitor. If a mean interval value of 50% is to be set, then p20267 = 0.5 must be set because parameter p20267 is dimensionless and the relationship 50% = 0.5 applies.

CPU time load as a result of free function blocks with the SINAMICS DCP

Processing free function blocks requires considerable computation time. If little CPU time remains, you have to check whether all the activated function modules are required and whether all the function blocks used need to be computed within the same sampling time.

The CPU time load can be reduced by either deactivating function modules or assigning used function blocks to a runtime group with a longer sampling time.

Table 8-81 CPU time load as a result of free function blocks with the SINAMICS DCP

Time slice	Number of free function blocks	CPU time load
16 ms	52	+30%
8 ms	23	+30%
5 ms	12	+30%
4 ms	6	+30%
2 ms	3	+30%

Notes regarding the CPU time

- The actual CPU time load of the CUD can be read out in r9976. Please refer to Chapter "CPU time load with SINAMICS DCP (Page 373)" for more information about the CPU time load for SINAMICS DCP.
- To make your own calculations, the illustrated CPU time loads can be taken to be "linear". This means that:
  - half as many blocks in the same time slice generate half as much CPU time load, etc.
  - the same number of blocks in time slices half as fast generate half as much CPU time load, etc.
- Each individual free function block can be assigned to a runtime group via parameter (e.g. p20032). Ten runtime groups are available. Every runtime group can be assigned a time slice using p20000.
  - The time slices that can be selected with p20000 = 1 to 1096 are calculated asynchronously to the closed-loop control functions.

8.19 Drive Control Chart (DCC)

For complex applications that cannot be implemented with the free function blocks, the DCC technology option is available. With DCC, a function diagram can be graphically created, which comprises elementary function blocks that are connected with each other, and which can then be loaded into the SINAMICS DCP.

The following steps are required to implement an executable DCC control with the SINAMICS DCP:

1. Installation of STARTER and a DCC license on the PC
2. Loading the DCC technology option on to the memory (ROM) in the drive unit.

3. Configure a DCC diagram on the PC (DCC editor)
4. Compile the DCC chart on the PC and load it to the drive

Notes

- Detailed information on the function blocks is contained in the "SINAMICS SIMOTION Function Manual DCC Block Description" as well as in the "SINAMICS SIMOTION Programming Manual DCC Editor". This chapter describes the special features of the DCC technology option with SINAMICS DCP.
- Simultaneous use of the free function blocks and the DCC technology option are feasible.
- This additional functionality through DCC increases the CPU time load. That means the maximum possible configuration with a Control Unit may be restricted.
- Before you load a STARTER project with DCC chart into the drive, you must load the DCC technology option into the memory of the drive unit (see the following Chapter). If you attempt to load a DCC chart into the drive, although the DCC technology option is not available in the drive, then the drive signals a fault.
  To eliminate this fault, you have the following options:

1. Now install the DCC technology option as described in the following Chapter. Then, carry out a POWER OFF / ON. Now load the STARTER project together with the DCC chart into the drive.
2. Delete the DCC chart from the STARTER project and load the project into the drive without DCC chart.
3. Restore the factory settings
4. Carry out a POWER OFF / ON.

8.19.1 Loading the DCC technology option into the drive unit memory

Loading the DCC technology option into the drive unit is usually performed with STARTER and with the SINAMICS DCP takes about 7 min. During this process, the entire DCB library with a scope of approx. 2 MB data is transferred to the drive.

To accelerate this process, the SINAMICS DCP supports an alternative option for transferring the DCB library to the drive. With this method, the process is shortened to less than 5 min:

- **Step 1**
  In STARTER, open a project that includes a SINAMICS DCP drive with at least one DCC chart. In the shortcut menu (right mouse button), select "Load into file system" (only possible in the offline mode).

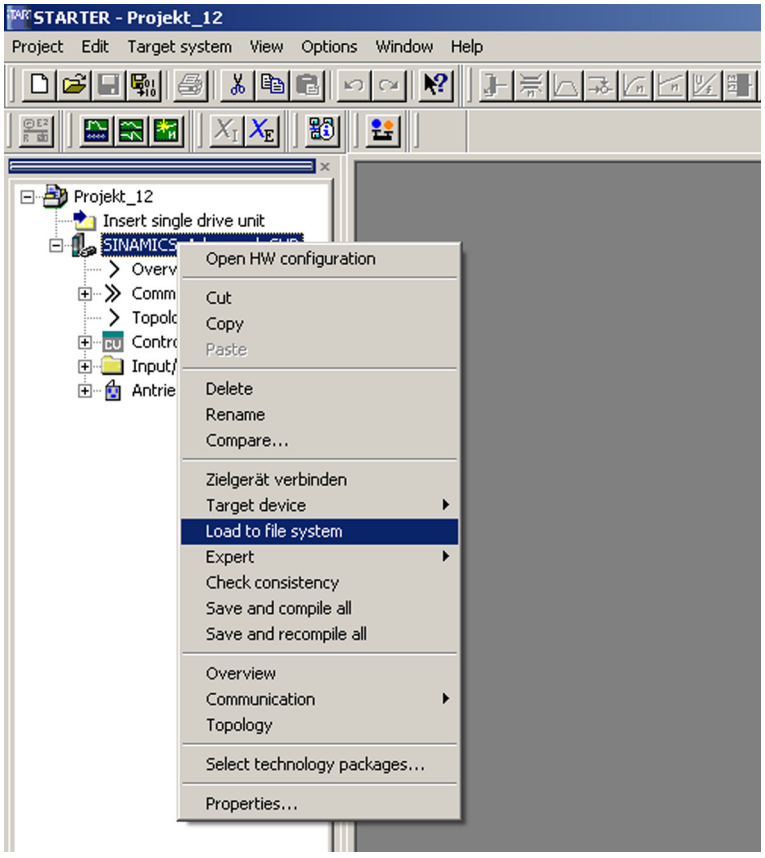


Figure 8-93 Loading into the file system

- **Step 2**
  A dialog, "Load into file system", opens. Choose "Select target" and select an empty folder on a local hard drive.
- **Step 3**
  After a folder has been selected, STARTER copies the DCB library into this local folder. 2 folders named "OEM" and "USER" are created.
- **Step 4**
  Copy the OEM folder to an empty memory card.

Note

The memory card supplied from Siemens as option S03 includes, when supplied, a dump of the internal device firmware. These files are only required to update firmware.

These files can be deleted for all other applications of the memory card. Copy the files into a local folder of your PG/PC and delete the files on the memory card, before you use the card for the functions described in this chapter.

- **Step 5**
  Insert the CompactFlash Card into the switched-off drive and switch on (POWER ON). The DCB library is copied into the non-volatile memory (ROM) in the drive during power-up. The process is complete as soon as the power-up has ended (operating state 7.0 reached).
- **Step 6**
  Switch off the device.
  The memory card can now be removed if the selected parameterization permits operation without memory card.
  After the SINAMICS DCP has been switched on and has run up the DCC option is ready.
- Repeat **steps 5 and 6** on additional SINAMICS DCP devices.

Note

If DCC is installed in the drive, the power-up time increases by approx. 10 s.

Note

This procedure does **not** transfer the STARTER parameter assignments into the unit. In order to transfer the parameter assignments from STARTER into the drive, the "Load into the target system" function must be run in STARTER.

8.19.2 CPU time load through DCC

Calculating the DCC blocks requires CPU time. If the CPU time becomes meager, you have to check whether all the activated blocks are required and whether all the function blocks used need to be computed within the same sampling time.

The CPU time load can be reduced by either deactivating blocks or assigning used blocks to a runtime group with a longer sampling time.

A list of all of the DCC blocks available for SINAMICS DCP and the required computation times are listed in the Appendix.

Table 8-82 CPU time load of DCC blocks

Time slice	Number of blocks [1)]	CPU time load
1 ms	50	+30%
2 ms	100	+30%
4 ms	200	+30%
6 ms	300	+30%
8 ms	400	+30%
16 ms	800	+30%

1) This information applies to the CUD without additional options. These options increase the basic load of the CUD and reduce the available CPU time for the DCC blocks.

In this information, an average complexity of the blocks being used is assumed. If only highly complex or very simple blocks are computed, the stated limit shifts accordingly.

Notes

- The actual CPU time load of the CUD can be read out in r9976. More information on the CPU time load for SINAMICS DCP is provided in Chapter "CPU time load with SINAMICS DCP (Page 373)".
- To make your own calculations, the previously illustrated CPU time loads can be taken to be "linear". This means that:
  - half as many blocks in the same time slice generate half as much CPU time load, etc.
  - the same number of blocks in time slices half as fast generate half as much CPU time load, etc.

Examples

1. In the 1 ms time slice, 50 blocks generate about 30 % additional CPU time load. For that reason, 50 blocks in the 2 ms time slice generate about 30 % × 0.5 = 15 % additional CPU time load.
2. In the 7 ms time slice, (300 + 400) / 2 = 350 blocks generate about 30 % additional CPU time load. That means 250 blocks generate 250 / 350 × 30 % = 21.5 % additional CPU time load.

8.19.3 Memory load through DCC

Along with the CPU time load, the memory load of the processor must also be considered when designing a closed-loop control with the DCC technology option. A higher number of configured DCC blocks and @parameters also more highly loads the internal memory (ROM) of the CUD.

For using DCC, on the SINAMICS DCP, when compared to the maximum possible configurations documented in the "Maximum configuration" chapter, depending on the size of the diagram, optional components must be eliminated. The number of blocks and the @parameters are decisive.

For one CUD without additional options, the following rules apply.

Table 8-83 Maximum number of DCC blocks and @parameters

Drive object	Number of DCC blocks and @parameters
CU_DCP	800
DCP_CTRL	600

Note

The specified maximum numbers for blocks and @parameters always apply for the entire drive unit and should be regarded as guide values. The CUD is completely utilized with 800 DCC blocks and @parameters on the DO CU_DCP or 600 DCC blocks and @parameters on the DO DCP_CTRL. Conserving @parameters has little effect on the quantity structure of the blocks; the specified maximum numbers for the blocks should therefore not be exceeded.

On the DO DCP_CTRL, due to the large number of drive parameters, fewer DCC blocks can be computed than on the DO CU_DCP.

In addition, the memory is loaded by optional components as follows:

Table 8-84 Additional memory load through optional components

Component	Additional memory load (expressed in DCC blocks)
TM31	- 150 blocks
TM15	- 150 blocks
TM150	- 150 blocks
CBE20	- 25 blocks

The final limits are determined by the total memory available on the CUD. If the previously mentioned recommended maximum limits are exceeded, this can result in errors during upload or download (e.g. fault F1105: CU memory insufficient) and the drive can no longer be switched on; POWER OFF/ON must be performed on the drive unit.

Note

In most cases, the CPU time load of the CUD becomes the limiting factor when designing the DCC application and not the memory load.

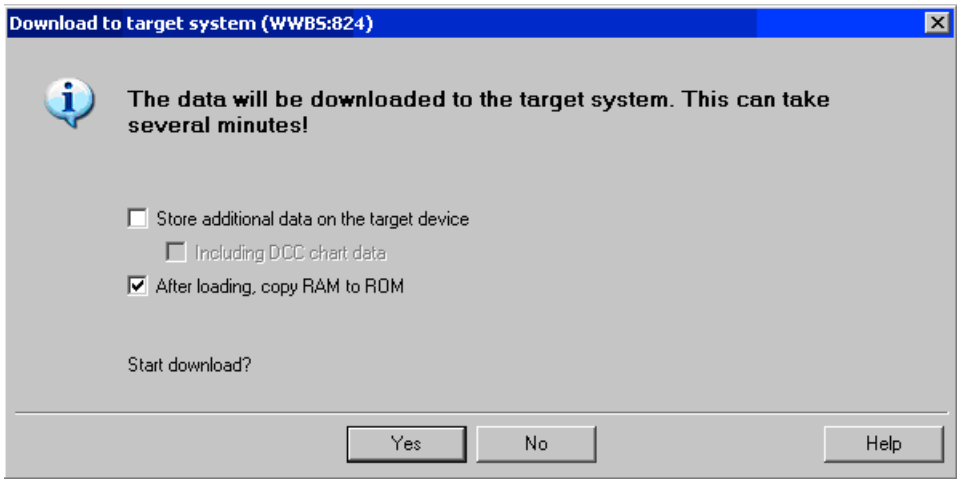
8.19.4 Backing up the DCC diagrams

A DCC project comprises two parts.

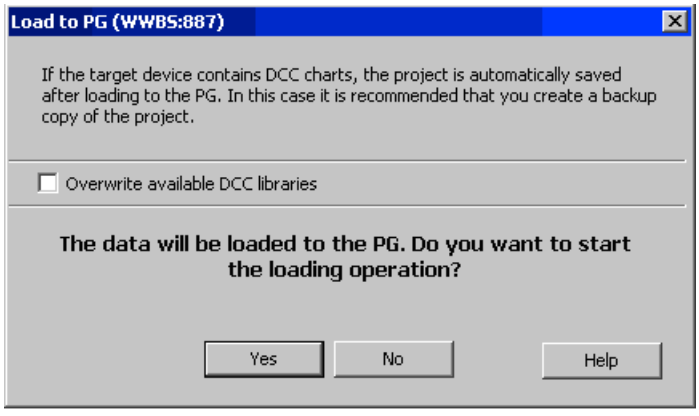
1. Information about the type, time slices and interconnection of the DCB blocks
2. Information about the layout and graphics in the DCC charts

When downloading the DCC chart to the drive (download to the target system), only the information about the type, time slices and interconnection of the DCB blocks (Point 1) are downloaded to the drive.

The DCC charts can also be saved in the target device by selecting the option “Store additional data on the target device”. This is recommended if the DCC charts will also be opened by another PG.
A further prompt appears after selecting the "Download to Target System" window. The DCC charts are also saved when both checkboxes are activated.



The following prompt appears when selecting "Load to PG" later:



If the checkbox is activated, the DCC charts in the project are overwritten by those in the target device.

The information about layout and graphics in the DCC charts (Point 2) is still available in the STARTER project.

8.20 Write and know-how protection

In order to protect your own projects against changes, unauthorized viewing or copying, the "Write protection" and "Know-how protection" (KHP) functions are available.

Protection	Validity	Objective	Effect
Write protection	Online	Protection of the parameterization against inadvertent changes by the user.	p-parameters can be read, but cannot be written.
Know-how protection	Online	Protection of intellectual property, especially the know-how of the machine manufacturers, against unauthorized use or reproduction of their products.	p-parameters can neither be read nor written.

8.20.1 Write protection

Write protection prevents settings from being inadvertently changed. No password is required for write protection.

Setting up and activating write protection

1. Connect the Control Unit to the programming device.
2. Call STARTER.
3. Download your project.
4. Establish a connection to the target device.

5. Select the required drive unit in the project navigator of your STARTER project.
6. Call the shortcut menu "Write protection drive unit > Activate".

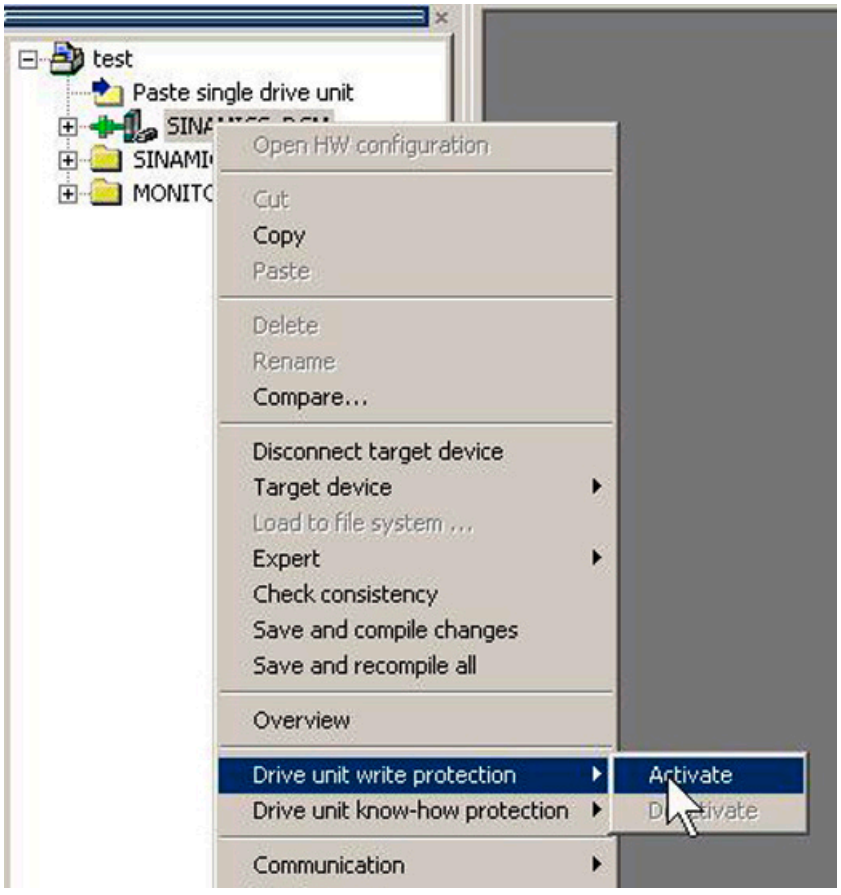


Figure 8-94 Activating write protection

Write protection is now activated. In the expert list you can recognize that write protection is active by the fact that the entry fields of all adjustable parameters are shown with gray shading.
In order to permanently transfer your setting, after changing write protection, you must perform a "Copy RAM to ROM" to save the data.

Note

Know-how protection with active write protection

If write protection is active, the know-how protection setting cannot be changed.

Note

Access via fieldbus

Per default, in spite of write protection, parameters can be changed via fieldbusses with acyclic access. If write protection should also be active for access operations via fieldbusses, then in the expert list, you must set p7762 to 1.

Deactivating write protection

1. Connect the Control Unit to the programming device.
2. Call STARTER.
3. Download your project.
4. Establish a connection to the target device.
5. Select the required drive unit in the project navigator of your STARTER project.
6. Call the shortcut menu "Write protection drive unit > Deactivate".
   The hatching in the expert list disappears after deactivation. The parameters can be set again.

Parameters without write protection

Certain parameters are excluded from the write protection in order not to restrict the functionality and operability of the drives. The list of these parameters can be found in the SINAMICS DCP List Manual in Chapter "Parameters for write protection and know-how protection", Section "Parameters with WRITE_NO_LOCK".

The "Restore factory settings" function can also be used when write protection is activated.

8.20.2 Know-how protection

The "know-how protection" (KHP) function prevents, for example, confidential company knowledge for configuration and parameter assignment from being read by unauthorized persons.

The know-how protection requires a password. The password must comprise at least 1 and a maximum of 30 characters.

Note

Password security

You are responsible for the security of your password. Whenever possible, use a password with sufficient length (min. eight characters); use upper- and lower-case letters and special characters.

The know-how protection is a pure online function. Therefore, establish a direct connection to the Control Unit before setting the password.

Features when know-how protection is active

Active know-how protection provides the following:

- With just a few exceptions, the values of all adjustable parameters p ... are invisible. In STARTER, instead of the parameter values, the text "Know-how protection" is displayed. You can hide know-how protected parameters in the expert list of STARTER using the "Without know-how protection" display filter.
- The values of display parameters r... remain visible.

- STARTER does not display any screen forms.
- Adjustable parameters cannot be changed using commissioning tools.

When know-how protection is active, support can only be provided (from Technical Support) after prior agreement from the machine manufacturer (OEM).

Functions locked using know-how protection

Active know-how protection inhibits the following functions:

- Download of drive unit settings using STARTER
- Deletion of the alarm history and fault history
- Creating acceptance documentation

Functions that can be executed for know-how protection

The following functions can be executed when know-how protection is active:

- Restoring factory settings
- Acknowledging faults
- Displaying faults, alarms, fault history, and alarm history
- Reading-out the diagnostics buffer
- Controlling the drive unit via the control panel in STARTER
- Displaying created acceptance documentation

Optional functions that can be executed:

The functions listed below can be executed despite activated know-how protection provided diagnostic functions were permitted when it was activated:

- Trace function
- Function generator
- Measuring function

Functions with restricted executability:

The following listed functions can only be partly executed when know-how protection is active:

- Displaying the topology (actual topology only)
- Uploading adjustable parameters that can be changed or read when know-how protection is active (see Chapter "OEM exception list (Page 388)")

Parameters that can be changed when know-how protection is active

In spite of active know-how protection, certain parameters can be changed and read. The list of these parameters can be found in the SINAMICS DCP List Manual in Section "Parameters for write protection and know-how protection", Subsection "Parameters with KHP_WRITE_NO_LOCK".

In addition, you can define an exception list of adjustable parameters, which end users may change.

Parameters that can be read when know-how protection is active

In spite of know-how protection being active, additional parameters can be read, but are locked against changes. The list of these parameters can be found in the SINAMICS DCP List Manual in Section "Parameters for write protection and know-how protection", Subsection "Parameters with KHP_ACTIVE_READ".

Note

Password check for know-how protection

Please note that if the language settings are changed in Microsoft Windows, after activating know-how protection, errors can occur when subsequently checking the password. If you use language-specific special characters, you must ensure that the same language setting is active on the computer for subsequent entry of the password.

Note

Data security of the memory card

After setting up and activating the know-how protection, for encrypted data backup on the memory card, previously backed up, non-encrypted data of the SINAMICS firmware will be deleted. This is the standard deletion procedure, in which only the entries on the memory card are deleted. The data itself is still available and can be reconstructed.

To ensure know-how protection, we recommend the use of a new empty memory card. If you cannot obtain a new memory card in the short term, you should delete all safety-related data on the current memory card.

To completely delete your previous data on the memory card, you must reliably delete this data using a suitable PC tool before activating know-how protection. The data is located on the memory card in the "\\USER\SINAMICS\DATA" directory.

Note

Diagnostics under know-how protection

If service or diagnostics is to be performed when know-how protection is active, then Siemens can only provide support in collaboration with the OEM partner.

8.20.2.1 Copy protection

Features of the activated copy protection

Copy protection prevents project settings from being copied and transferred to other Control Units.

Additional features include:

- Copy protection can only be activated in conjunction with the know-how protection (see Chapter "Activating know-how protection (Page 389)").
- When copy protection is activated, the memory card and Control Unit are connected with one another and only function together.
- The copy protection prevents the use of each memory card with copied data of one Control Unit in another Control Unit.
- With the exception of the DCC library, the copy-protected data on the memory card cannot be read or copied. If a copied memory card is used, a copy protection error is displayed and a pulse inhibit set.

8.20.2.2 Configuring know-how protection

Requirements

Before activating know-how protection, the following conditions must be met:

- The drive unit has been fully commissioned.
  (Configuration, download into the drive unit, complete commissioning. You have then carried out an upload in order to upload the parameters calculated by the drive into the STARTER project.)
- The OEM exception list has been created (see below).
- To guarantee know-how protection, you must ensure that the project does not remain at the end user as a file.

Creating the OEM exception list

Before activating the know-how protection, enter the parameters in this exception list that are to remain readable and writable despite the know-how protection. The exception list can only be created via the expert list. The exception list has no influence on the input screen forms in STARTER.

Factory setting for the exception list:

- p7763 = 1 (exception list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Procedure

1. Use parameter p7763 to define the required number of parameters for the exception list.
   You can enter a maximum of 500 parameters in the exception list.
2. Execute the "Load to PG" function.
   Parameter p7764 is adapted in the expert list according to the setting in p7763. Indices are inserted or deleted depending on the setting.
3. In parameter p7764[0...n], assign the individual indices of p7763 to the required parameter numbers.
4. Transfer the changes to the Control Unit so that they can become effective.

Note

Parameters of the exception list are not checked

The Control Unit does not check which parameters you include or delete in the exception list.

Absolute know-how protection

By removing parameter p7766 from the exception list of p7764[0] = 0, you prevent any access at all to the data of the Control Unit and your project settings. It is then impossible to read or change the protected data. The know-how protection and the copy protection can no longer be canceled or deactivated.

Activating know-how protection

1. Connect the Control Unit to the programming device.
2. Call STARTER.
3. Open your project.
4. Establish a connection to the target device.
5. Select the required drive unit in the project navigator of your STARTER project.
6. In the shortcut menu, select "Drive unit know-how protection > Activate".
   The "Activate Know-how Protection for Drive Object" dialog box opens.

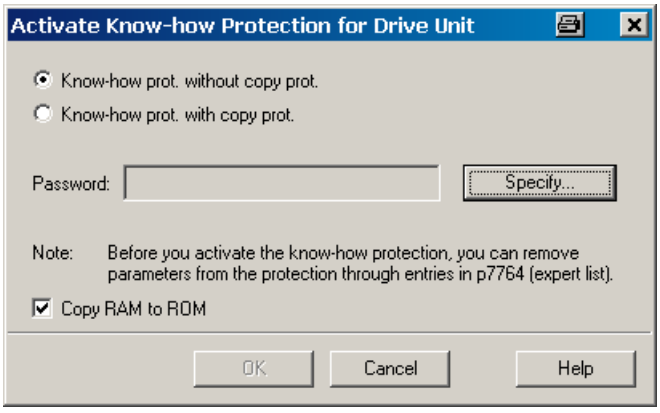


Figure 8-95 Activating

   The "Know-how protection without copy protection" option is active by default.

7. If you want to activate the copy protection in addition to know-how protection, click the "Know-how protection with copy protection" option.

8. Click "Specify".
   The "Know-how Protection for Drive Object - Specify Password" dialog box opens.

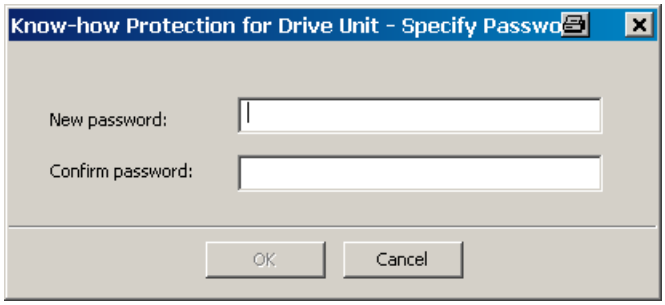


Figure 8-96 Setting the password

9. In the "New password" field, enter the password (1 to 30 characters). Pay attention to upper- and lower-case.
10. Enter it again in the "Confirm password" field and click "OK" to confirm the entry.
    The dialog box is closed and the password is shown in encrypted form in the "Activate Know-how Protection for Drive Object" dialog box.
    The "Copy RAM to ROM" option is active by default and ensures that the know-how protection is permanently stored in the Control Unit. If you only want to activate the know-how protection temporarily, you can deactivate this option.
11. Then click "OK".
    Know-how protection is now activated. The text "Know-how protected" is in all protected parameters of the expert list instead of the content.

Deactivating know-how protection

1. Connect the Control Unit to the programming device.
2. Call STARTER.
3. Open your project.
4. Establish a connection to the target device.
5. Select the required drive unit in the project navigator of your STARTER project.
6. In the shortcut menu, select "Drive unit know-how protection > Deactivate"
   The "Deactivate Know-how Protection for Drive Unit" dialog box opens.

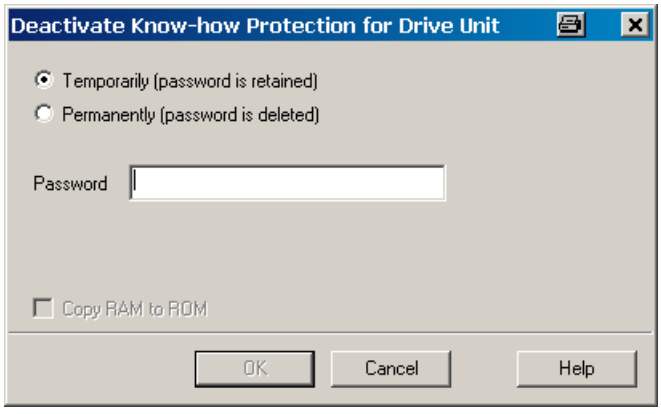


Figure 8-97 Deactivating

7. Select whether you want to deactivate the know-how protection "Temporarily" or "Permanently" by clicking the corresponding checkbox.
   - "Temporarily" deactivating: Know-how protection is active again after switching off and switching on.
   - "Permanently" deactivating: Know-how protection remains deactivated even after switching off and switching on again.

   If you select "Permanently", you can also carry out a data backup on the Control Unit with "Copy RAM to ROM". The checkbox with the same name is active in this case and is automatically activated. If you deactivate this checkbox, then you must subsequently backup the data manually with "Copy RAM to ROM" if know-how protection should remain deactivated after switching off and switching on again.
8. Enter your password, and click "OK".
   Know-how protection is now deactivated. The values of all parameters are displayed again in the expert list.

Changing the password

A password can only be changed when know-how protection is activated.

To change the password for the know-how protection, proceed as follows:

1. Connect the Control Unit to the programming device.
2. Call STARTER.
3. Open your project.
4. Select the required drive unit in the project navigator of your STARTER project.
5. Call the shortcut menu "Drive unit know-how protection > Change password".
   The "Change Password" dialog box opens.

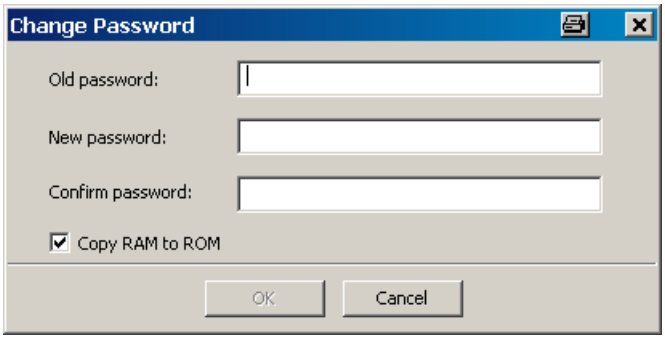


Figure 8-98 Changing the password

6. Enter your old password in the uppermost text box.
7. Enter your new password in the following text box and repeat it in the lowest text box.
   The "Copy RAM to ROM" option is active by default and ensures that the new password for the know-how protection is permanently stored in the Control Unit. If you only want to change the password temporarily, you can deactivate this option.
8. Click "OK" to close the dialog box.
   Once the password has been changed successfully, you will receive a confirmation.

8.20.2.3 Loading know-how protected data to the file system

Data with know-how protection can be directly loaded or saved to the file system from the drive unit. The activated know-how protection ensures that the data cannot be forwarded to unauthorized third parties.

The following applications are conceivable at the end user:

- Adaptations of encrypted SINAMICS data are required.
- The memory card is defective.
- The Control Unit of the drive is defective.

In these cases, the OEM can create a new encrypted subproject (for a drive object) via STARTER. The serial number of a new memory card or a new Control Unit is saved in this encrypted data record in advance.

Application example: Control Unit is defective

Scenario:

The Control Unit of an end user is defective. The machine manufacturer (OEM) has the end user's STARTER project files of the machine.

Sequence:

1. The end user sends the OEM the serial numbers of the new Control Unit (r7758) and the new memory card (r7843), and specifies the machine in which the Control Unit is installed.
2. The OEM loads the STARTER project data of the end user.
3. The OEM performs the STARTER function "Load to file system" (see Chapter “Save data to the file system (Page 392)”).
   – The OEM specifies whether the data is to be stored zipped or unzipped.
   – The OEM makes the required know-how protection settings.
   – The OEM enters the serial numbers of the memory card and the new Control Unit.
4. The OEM sends the stored data to the end user (e.g. by e-mail).
5. The end user copies the "User" directory to the new memory card and inserts it into the new Control Unit.
6. The end user switches on the drive.
   When powering up, the Control Unit checks the new serial numbers and deletes the values p7759 and p7769 if they match.
   After it has powered-up without any errors, the Control Unit is ready for operation. The know-how protection is active.
   If the serial numbers do not match, then fault F13100 is output.
   If required, the end user must re-enter the changed parameters from the OEM exception lists.

Calling the "Load to File System" dialog box

1. Call STARTER.
2. Open the required project.

3. Select the required drive unit in the project navigator of your STARTER project.
4. Call the "Load to file system" function.
   The "Load to File System" dialog box opens.

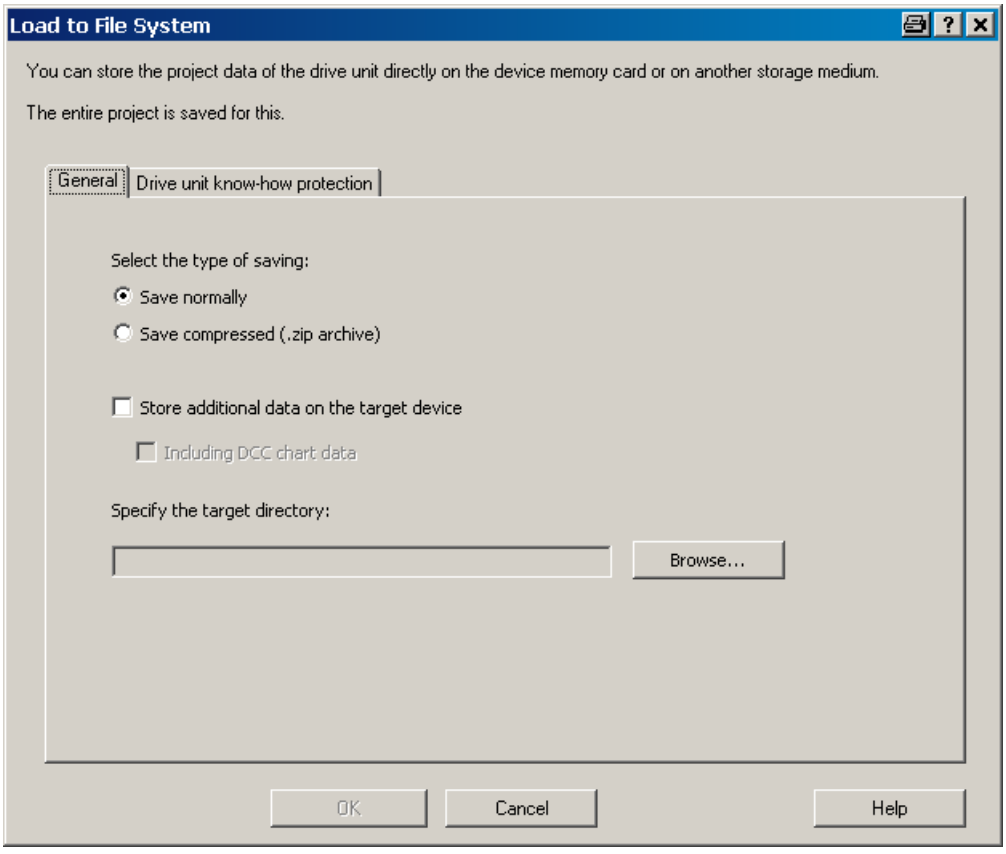


Figure 8-99 Load to file system (default setting)

Specifying the general memory data

The "General" tab is displayed automatically when the dialog is called. The "Save normally" option is activated by default.

1. If you want to save the data in compressed form, click the "Save compressed (.zip archive)" option button.
   The "Store additional data on the target device" option is deactivated in the default setting.
2. If you want to store additional data, such as program sources, on the target device, activate this option.
   Optionally you can also activate "Including DCC chart data". Graphical chart data can then also be stored.
3. Then enter the path for the storage directory in the appropriate input field, or click "Browse" and select the directory in your file system.

Configuring know-how protection

Make the settings for the know-how protection on the "Drive unit know-how protection" tab.

1. Click the "Drive unit know-how protection" tab.

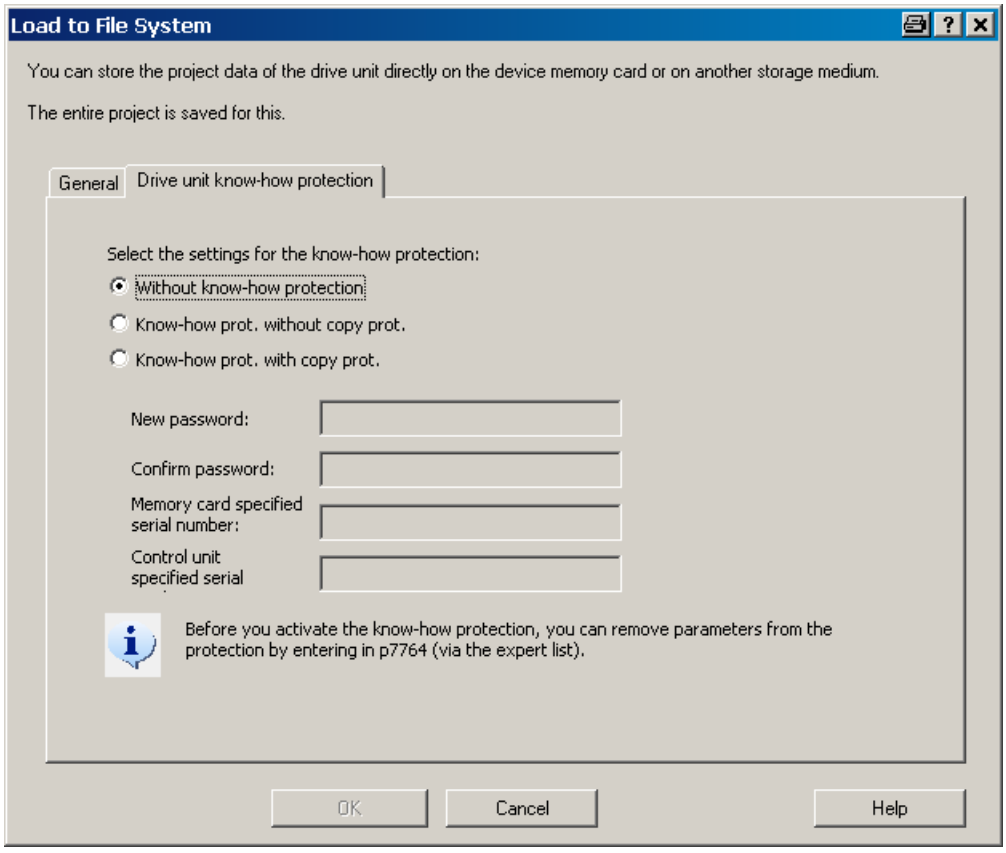


Figure 8-100 Load to file system know-how protection

By default, the "Without know-how protection" option is active. If you really want to store the data without protection (not recommended), you can exit the dialog box with "OK" or "Cancel" at this point.

2. If you want to save with protection, click on "Know-how protection without copy protection" or "Know-how protection with copy protection" option.

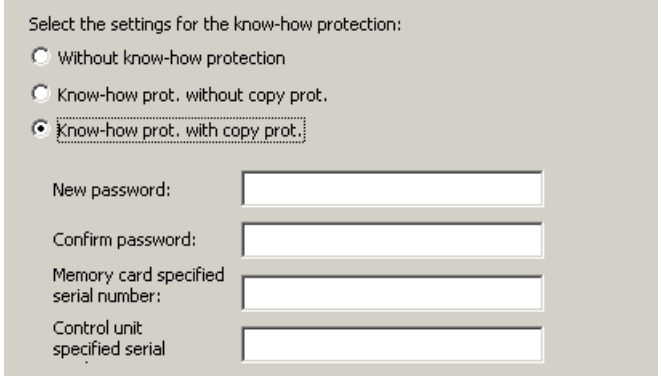


Figure 8-101 Activating load to file system know-how protection

The input fields are then active. Without copy protection, only the input fields for password input are active. With copy protection, the two input fields for the serial number are also active. Generally, the entries in the input fields are shown in encrypted form.

3. Enter the required password in the "New password" field and enter it again in the "Confirm password" field.
4. Enter the serial number of the new memory card for which the data is intended.
   If you have selected the "Know-how protection with copy protection" option, the input of the Control Unit serial number is also obligatory.
5. In this case, also enter the serial number of the Control Unit in the appropriate input field.
6. Click "OK" to confirm the settings you made.

Result

The data of the subproject is stored in the required encryption in your file system. With the aid of this encrypted data, an end user can install a new memory card or Control Unit for the drive unit.

8.20.3 Overview of important parameters

Overview of important parameters (see the SINAMICS DCP List Manual)

- r7758[0...19] KHP Control Unit serial number
- p7759[0...19] KHP Control Unit reference serial number
- r7760 Write protection / know-how protection status
- p7761 Write protection
- p7762 Write protection multi-master fieldbus system access behavior
- p7763 KHP OEM exception list number of indices for p7764
- p7764[0...n] KHP OEM exception list
- p7765 KHP memory card copy protection
- p7766[0...29] KHP password input
- p7767[0...29] KHP password new
- p7768[0...29] KHP password confirmation
- p7769[0...20] KHP memory card reference serial number
- r7843[0...20] Memory card serial number

8.21 Battery charging characteristic

See function diagram 6720 in the SINAMICS DCP List Manual.

General information

A simple battery charging characteristic curve is available if the SINAMICS DCP is used as a battery charging device.

Principle of operation

Dependent on the battery voltage, the battery charging characteristic outputs a setpoint charge current.
This means that towards the end of the charging process when the battery voltage is increasing, the charge current can be reduced.
The charging characteristic can be specified with 4 interpolation points each for the battery voltage in volts (p54210) and the charge current in amps (p54211).

The voltage range according to the breakpoints in p54210, in which the voltage value (p54203) is currently located, is output in r54225, bits 0...4.
Only the bit of the currently highest voltage range is set in each case.

After being enabled, the system follows the characteristic (p54204) until the maximum voltage (p54210[3]) is reached. At this point in time, the charge current is reduced to zero until, starting from the maximum voltage (p54210[3]), the battery voltage is reduced again by the hysteresis (p54214).
A charge current can then be again output according to the settings defined by the characteristic.

At its output (r54221) the battery charge characteristic outputs a current setpoint, which must be interconnected with the current setpoint of the current controller (p55050).
The DCP should be operated in the closed-loop current controlled mode when applying the battery charge characteristic.

Example

It is assumed that the battery is connected to side 2 of the DCP. The meaning of the setpoint should then be set to "Current from side 2" (p55060 = 12) and the internal voltage actual value at side 2 (r55506) should be interconnected with the voltage input of the battery charge characteristic (p54203).
In addition, the approximate internal resistance of the battery (p55516) and an appropriate smoothing time constant (p55518[1]) must be parameterized.

Notes

Here, the internal battery voltage must be used instead of the voltage actual value or the terminal voltage of the DCP. This is the voltage with which the battery is actually charged, without the current-dependent voltage drop across its internal resistance. As the charge current increases, the battery terminal voltage increases as a result of the voltage drop across the internal resistance. If the characteristic is supplied with the terminal voltage of the battery (e.g. R55501 / r55502), then it would immediately reduce the charge current in the reduction range of the characteristic (U > p54210[0]) as a result of the increasing terminal voltage. This can result in a tendency to oscillate:

As a consequence, it is better to supply the characteristic with the internal voltage of the battery (r55505 / r55506), which then takes into account the voltage drop across the battery internal resistance. Calculating the internal voltage and the appropriate parameterization is described in more detail in Chapter "Voltage control (Page 342)".

8.22 Connecting several SINAMICS DCPs in parallel

See function diagram 9350 in the SINAMICS DCP List Manual.

Several SINAMICS DCP can be connected in parallel to increase the current, respectively the power rating; they can be connected in parallel on side 1, side 2 - or on both sides simultaneously.

8.22.1 Controlling the main contactors and precharging circuits

In principle, when connecting the devices in parallel there are two options for controlling the precharging circuits and main contactors on each side:

- **Common contactors/precharging circuits**
  The DCPs connected in parallel are connected to the voltage source on the relevant side using a common main contactor.
  Only a common precharging circuit is used on each side.
  The main contactor as well as the precharging circuits must be dimensioned to handle the loads made up of the devices connected in parallel.
  The main contactor and the precharging circuit are controlled using one of the DCP devices involved. However, each device must be protected with its own dedicated overcurrent protection equipment.

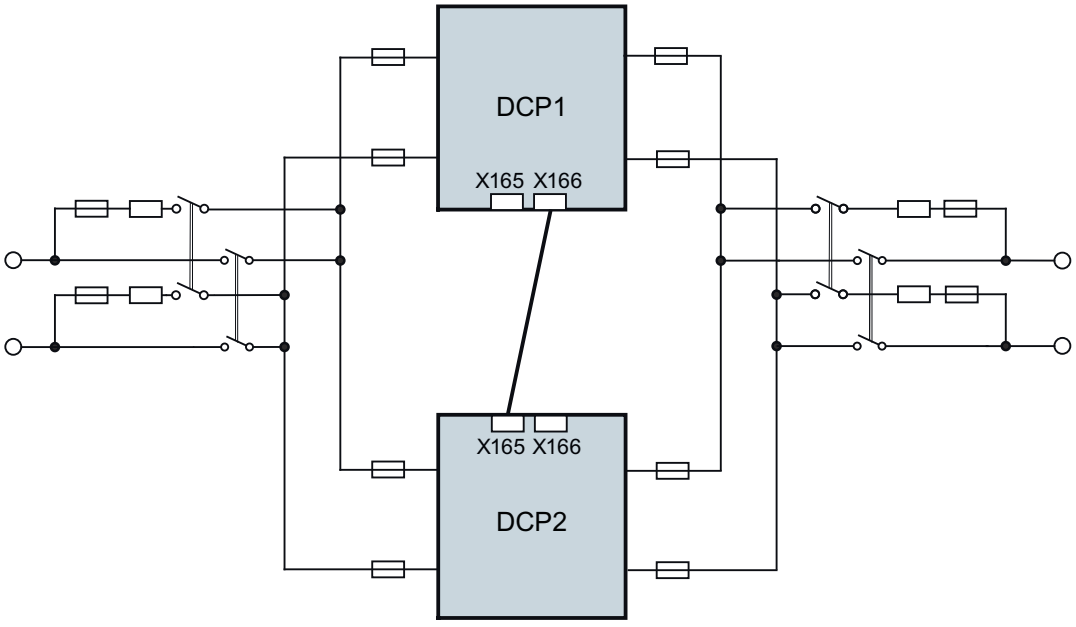


Figure 8-102 Hardware structure with common contactors and precharging circuits (example)

- **Separate contactors/precharging circuits**
  Each of the DCPs connected in parallel is connected with the voltage source on the relevant side through its own dedicated main contactor. Each DCP has its own precharging input circuit. The DCP devices control their own main contactors and precharging circuits.

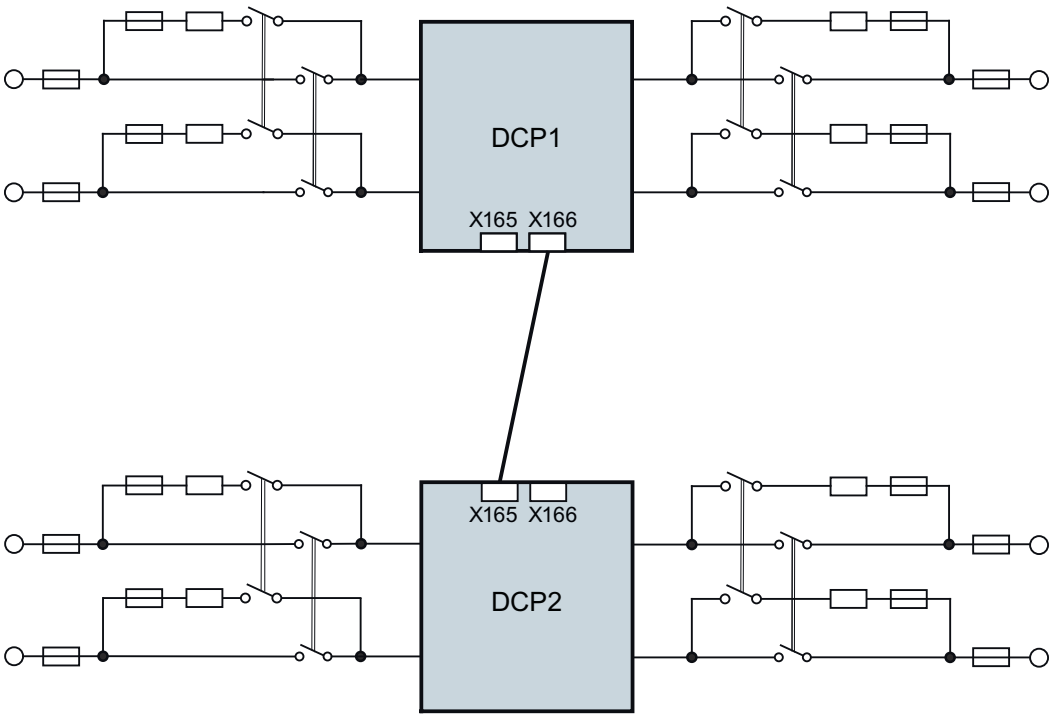


Figure 8-103 Hardware structure with separate contactors and precharging circuits (example)

⚠ WARNING

Electric shock or fire due to inadequate protection against overcurrent

Overcurrent protective devices that trip too late or not all can result in electric shock or fire.

- Protect each individual DCP device connected in a parallel group against overcurrent on both sides.

Note

Same setting of the precharging parameters

For devices connected in parallel on the power side, the precharging parameters or setpoints for the connected side(s) must be set or specified the same for all devices.

8.22.2 Options to couple several SINAMICS DCPs

There are two ways of operating DCP devices connected in parallel:

- **Independent operation of DCPs connected in parallel**
  Each SINAMICS DCP is supplied with its own setpoint from a higher-level control system. The devices operate independently of one another and there is no direct communication between devices.
  For example, this operating mode can be practical in the following cases:
  - The DCP devices are individually controlled from a higher-level control system, e.g. if the devices are to be precharged with a time offset.
  - Closed-loop voltage control with droop to address high dynamic requirements, if the devices are to be separately switched-on and switched-off.
- **Parallel operation using a parallel interface**
  All DCP devices are connected with one another via a parallel interface.
  One device is the master, and issues the individual setpoints to the devices.
  For example, this operating mode can be practical in the following cases:
  - Controlling the group of DCP devices as one device.
  - When using higher-level technological functions.
  - Closed-loop voltage control with transfer of the current setpoints to the devices to address moderate requirements relating to the dynamic response.

  In this case, only the master is controlled from the higher-level control – or the voltage controller or the higher-level technological function is only executed on the master. The master then issues the current setpoint to the devices.

8.22.3 Parallel interface

Properties of the parallel interface:

- The parallel interface allows a maximum of 15 SINAMICS DCP devices to communicate with one another.
- They are connected via interfaces X165 and X166, which are located at the lower edge of the Control Unit (CUD). The two interfaces are connected in parallel electrically, and can be used to loop through the connection from one DCP to the next. See also "Block diagram with connection suggestion (Page 49)".
- The devices are connected using (8-pole) shielded patch cables, type UTP CAT5 in acc. with ANSI/EIA/TIA 568, such as those that are used in PC network technology.
  A 5 m standard cable can be obtained directly from Siemens (Article No.: 6RY1707-0AA08).
  To connect n devices, (n-1) cables are required.
  For the devices at the beginning and end of the data bus of the parallel interface, the bus termination must be switched-in (p51805 = 1).

Note

Both connectors of the patch cable must have the same pin assignment; a crossover cable is not suitable.

- **Parallel interface operating modes**
  The parallel interface offers various device operating modes.
  These can be selected using p51800.
  - **p51800 = 11: Device (STW, I_SET, PULSEFREQ)**
    In this operating mode, the device reads-in the switch-on commands ON/OFF1 (r0898.0) and operating enable (r0898.3) as well as the setpoint current (r55172) and the switching frequency (r55325) of the master.
    This means that when switching-on, the device follows the master and also accepts its setpoint.
  - **p51800 = 21: Device (STW, PULSEFREQ)**
    The device reads-in the switch-on commands ON/OFF1 (r0898.0), operating enable (r0898.3) and the switching frequency (r55325) of the master.
    The device itself calculates the current setpoint.
    In operation, the device follows the switching frequency of the master, e.g. for a variable switching frequency (see Chapter "Switching frequency (Page 349)") or overtemperature (see Chapter "Derating (Page 358)").
    This means that closed-loop voltage control with droop can be implemented, where the device is switched-on together with the master; however, it uses its own voltage controller.
  - **p51800 = 22: Device (STW)**
    The device only reads-in the switch-on commands ON/OFF1 (r0898.0) and operating enable (r0898.3) from the master. The device must calculate the current setpoint and the switching frequency based on the signals and operating conditions that are available.
    This means that the master switches on the DCP devices in synchronism; however, they can independently respond to operating condition changes.

- **Configuration and commissioning**
  - Set a unique station address in the range 1... 15 (p51806) for each participant/node (master and devices).
  - The bus termination (p51805) must be activated at the devices at the beginning and end of the data bus of the parallel interface.
  - Interconnect the switch-on commands of the master (r53310.2, r53310.3) to the devices (p0840 = r53310.2, p0852 = r53310.3).
    The current setpoint and the switching frequency of the master are automatically connected depending on the setting of p51800.
  - Activate the parallel interface; define the master and device as well as the operating mode (p51800).
  - Adapt the remaining parameters to the system configuration (p51807, etc.).

Note

Before activating the parallel interface (i.e. before setting p51800 > 0), a unique station address must be set at all SINAMICS DCPs (p51806).
If this is not done, then the parallel interface will not reliably start.
Remedy if this does occur: Switch the electronics power supply (POWER ON) of the device group off and on.

In the device, the switch-on commands of the master (r53310.2, r53310.3) must be connected with the enable signals of the device (p0840, p0852).
Otherwise, the device will not be able to be switched on via the parallel interface.
Further, the device must have valid operating conditions, e.g. no OFF2 (p0844 = 1, p0845 = 1) and no OFF3 (p0848 = 1, p0849 = 1).

- **Monitoring functions**
  The master of a group of parallel devices monitors the behavior of the devices as follows:
  - **Monitoring the devices for a fault condition**
    If a device connected to the parallel interface transitions into the fault state o11 (r50000 = 11.0), fault F60044, fault value 1 is initiated at the master.
  - **Monitoring the devices for shutdown**
    If a device connected to the parallel interface was in operation o0 (r50000 = 0.0, 0.1, 0.2), and without being requested by the master, transitions into another operating state > o0, i.e. is shut down, then fault F60044, fault value 2 is initiated at the master.
  - **Monitoring the operating feedback signal of the devices**
    When switching on a group of devices connected in parallel, within the monitoring time (p51807[1]) devices must signal back operating state o0 (r50000 = 0.0, 0.1, 0.2). Otherwise, fault F60044, fault value 3 is initiated at the master.
  - **Monitoring communication interruption with the devices**
    If a device was already visible at the parallel interface, and then no data was received from it for longer than monitoring time p51807[0], then the status of the device is set to a value of 998 in r51816 and fault F60044, fault value 4 is initiated.

  In addition to these monitoring functions, communication via the parallel interface is monitored in general.
  A communication failure/error is indicated using r53310.0 and r53310.1, and in the factory setting (p51808 = r53310.0) fault F60014 is initiated.
  The default response to faults F60014 and F60044 is a shutdown via OFF2.
- **Diagnostics**
  The actual operating state of all devices, which are connected via the parallel interface, is indicated at each device in parameter r51816.
  The assignment of the indices of r51816 is realized via the station addresses of the devices. r51816[station address - 1].
  The values in r51816 correspond to parameter r52800 of the individual stations.
  Depending on the state of the communication to the individual stations, the following values can be indicated in r51816:
  - r51816 [station address - 1] = 999:
    Since running-up, no data has been received from this station address.
  - r51816 [station address - 1] = 998:
    Since running-up, data has been received from this station address; however communication is currently interrupted.

8.22.4 Connection to fieldbuses

From the perspective of the fieldbus, each individual DCP connected in parallel is a fieldbus participant/node. From the fieldbus perspective, it is not possible to treat several SINAMICS DCP devices connected in parallel just like an individual DCP.

Current setpoint

Depending on the parallel interface configuration, the devices take the current setpoint from the master or from other sources, e.g. a fieldbus or analog inputs:

- Current setpoint from the master (p51800 of the devices = 11)
  Only the master has to be supplied with a current setpoint.
  For n devices, the setpoint of the master then refers to the sum of the reference currents (r50072) of all devices connected in parallel; i.e. the (n+1) x the current of an individual device is set.
- Current setpoint from a fieldbus or analog inputs (p51800 of the devices = 21, 22)
  The master and each individual device must be supplied with its own current setpoint.
  The current setpoint then refers to the reference current (r50072) of the individual devices.

Actual values

The master and each device supply their own actual values via the fieldbus.

The actual values of the individual devices must be added to determine the total current and the total power of the devices connected in parallel.

8.22.5 Closed-loop voltage control with SINAMICS DCP devices connected in parallel

There are two basic implementation possibilities:

1. Variant 1: One DCP is defined as master; this executes the closed-loop voltage control
2. Variant 2: Each DCP executes its own voltage control with droop

Variant 1: One DCP is defined as master

The master executes the closed-loop voltage control. It outputs the current setpoint at the voltage controller output to the remaining SINAMICS DCP (= devices) via the parallel interface. These are exclusively operated in the closed-loop current controlled mode using this setpoint.

Advantage

The voltage controller in the master precisely controls the voltage to follow the setpoint.

Disadvantage

The dynamic response of the closed-loop voltage control is lower than for closed-loop voltage control by a DCP alone. This is due to the signal transfer via the parallel interface that involves a dead time of approximately 2 ms in the control loop. This dead time is independent of the number of devices connected in parallel, which means that this variant only functions if a large capacitance is available on the voltage-controlled side.

Example

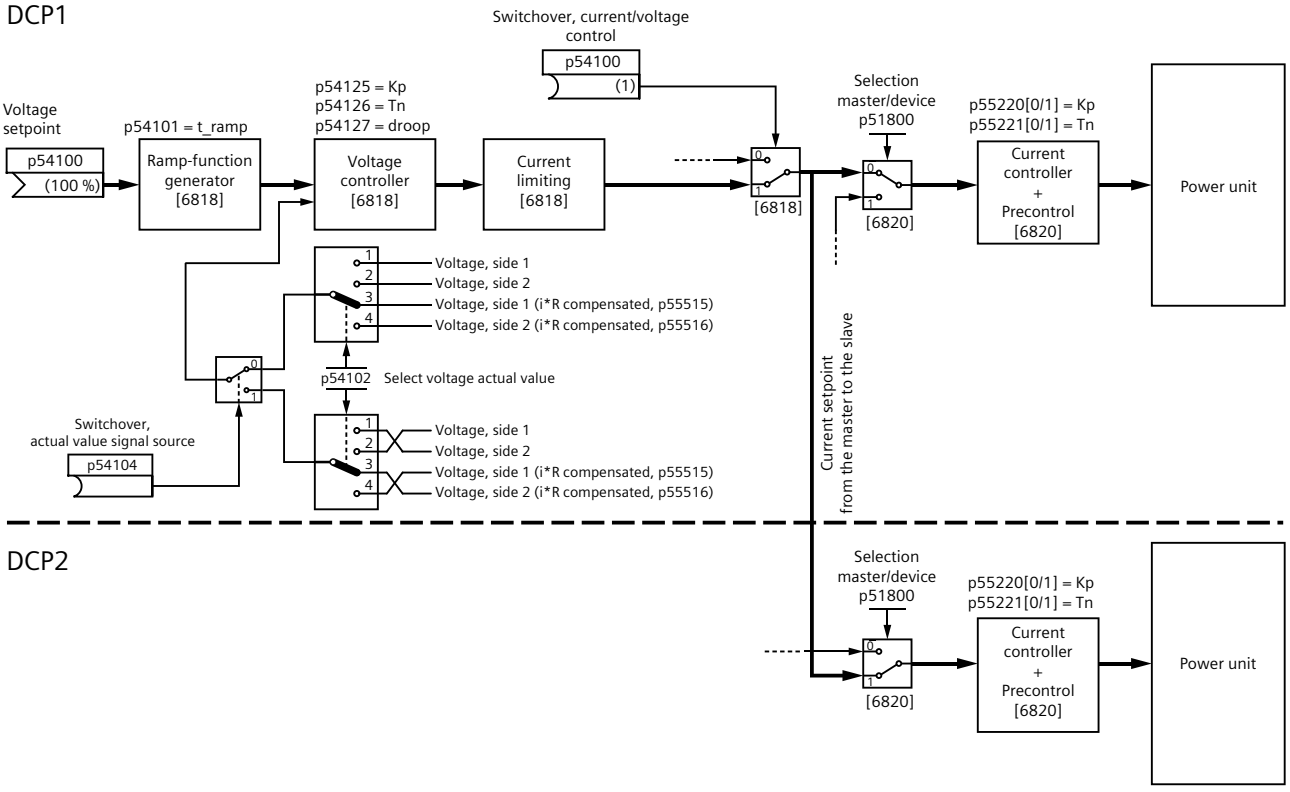


Figure 8-104 Controller structure of the voltage control for variant 1

For this variant, the DCP devices must be connected via parallel interface X165/X166. The two interface ports are connected in parallel internally. This means that the connecting cable can be connected to any of the two connectors.
DCP1 muss to be configured as master (p51800 = 10).
DCP2 must be configured as device with its setpoint current from the master (p51800 = 11).

Variant 2: Each DCP executes its own voltage control with droop

By selecting an appropriate droop (p54127 ≈ 2...5 %), all voltage controllers respond "softly" to load current changes. This function avoids that the integral components of the individual voltage controllers work against each other.

Advantage

The dynamic response of the voltage control in a parallel CONNECTION is comparable with that of an individual DCP.

Disadvantage

As the load current increases, the voltage actual value increasingly deviates from the specified setpoint; this means that depending on the selected droop factor, under load, the voltage decreases by several percent.
As a consequence, additional measures may be required to actually reach the specified voltage setpoint.

Example

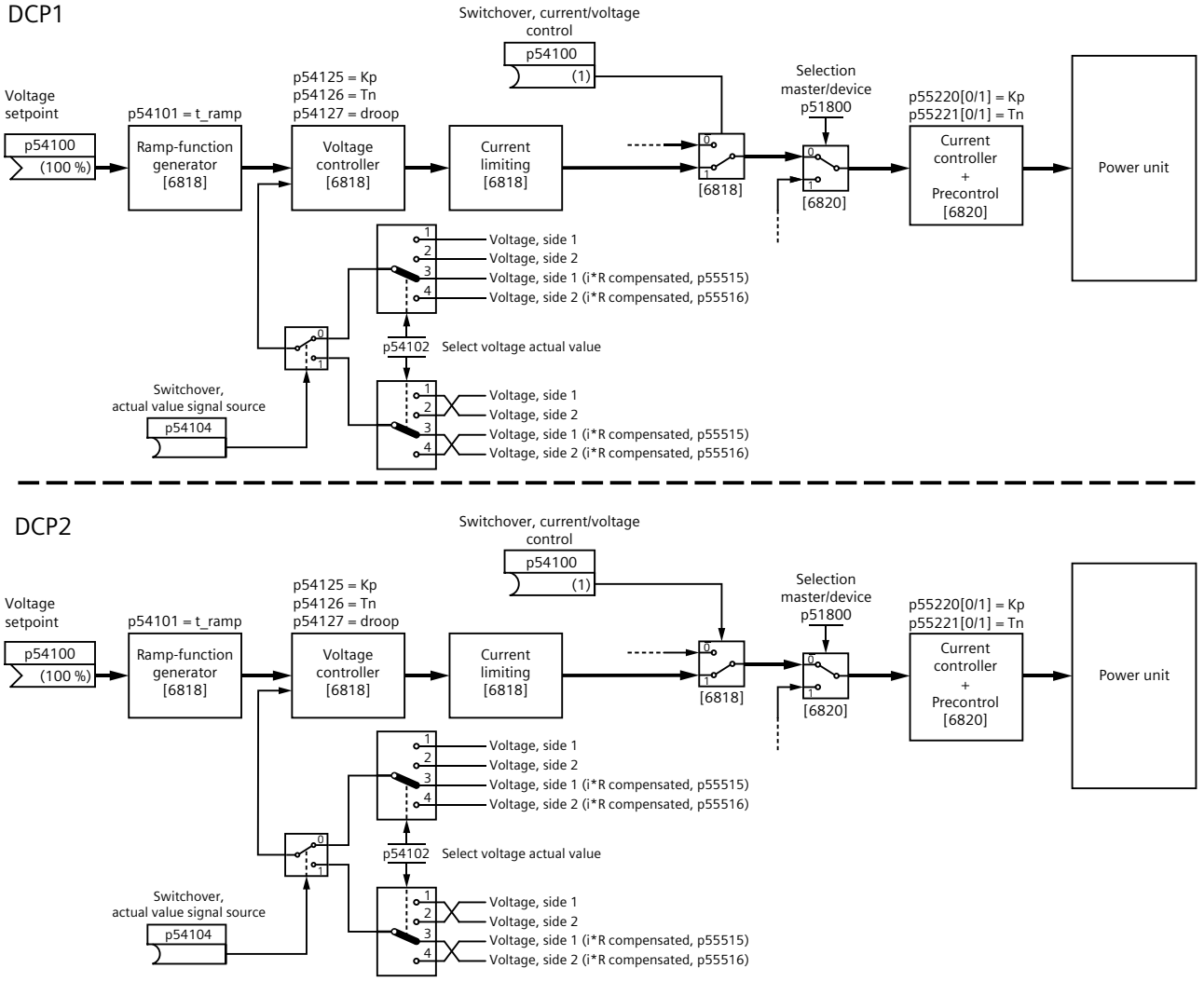


Figure 8-105 Controller structure of the voltage control for variant 2

For this variant, the voltage controller in each DCP must calculate its own current setpoint. Either the parallel interface must be deactivated (p51800 = 0), or the actual setpoint from the master must be ignored (master DCP: p51800 = 10, device DCPs: p51800 = 21, 22).

As a result of the droop function, as the integral component of the voltage controller increases, the voltage controller linearly reduces the internal voltage setpoint to create a "softer" characteristic. The internal voltage setpoint is correspondingly increased for a negative integral component. Parameter p54127 (voltage controller droop) defines the magnitude of this intervention. It specifies by which factor the internal voltage setpoint must be reduced if the integral component of the voltage controller corresponds to the rated current (p55510 = 100 %).

The following diagram shows the principle mode of operation of the droop function.

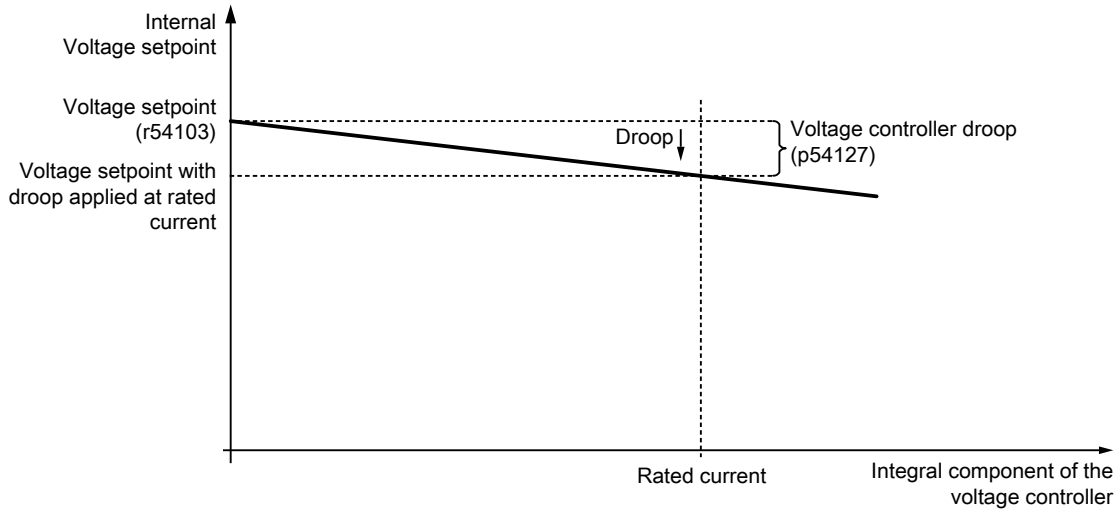


Figure 8-106 Principle of operation of the voltage controller with droop function

Example of a droop function

If parameter p54127 is set to 5 % for a 120 kW device (rated current = 200 A, rated voltage = 600 V), then the voltage decreases by 30 V (= 5 % of 600 V) when a load of 200 A is applied.

For example, if two DCP devices are now connected in parallel, and operated in closed-loop voltage control with droop, then a common operating point is obtained from the combination of the droop characteristics of both devices:

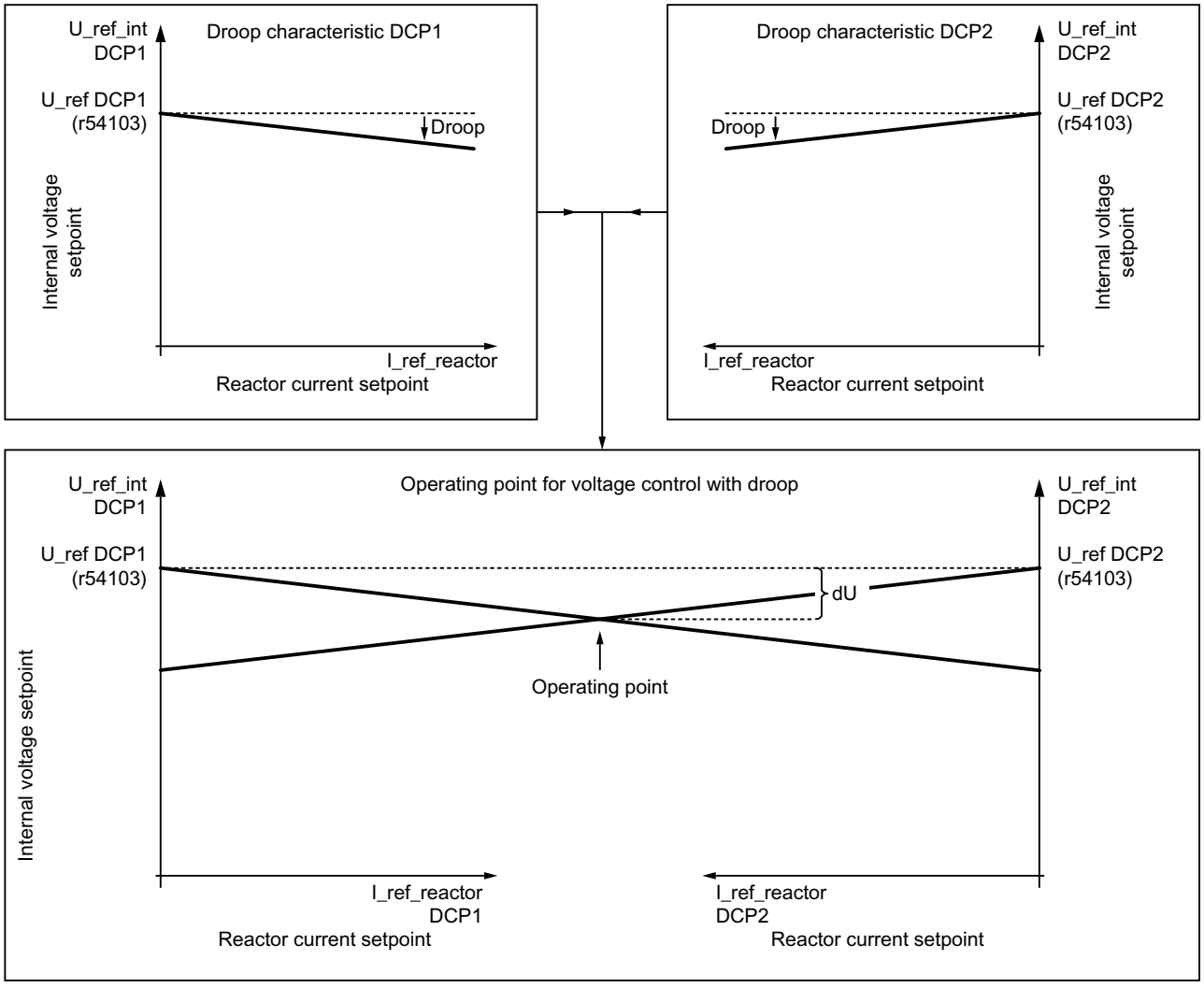


Figure 8-107 Common operating point by superimposing the droop characteristics

As a result of the droop function, when loaded, the voltage actual value at the common operating point lies just below the actual setpoint voltage (dU in the previous diagram).

To achieve a uniform current distribution between the devices, parameter p54127 must be set to the same value in all DCP devices.

Droop values of approximately 2...5 % are required to ensure stable operation. Excessively low values mean that stable operation is not possible as the voltage controllers of the two devices mutually influence one another in a seesaw action. A value that has been set too high results in an unnecessarily high voltage dip under load.

Maintenance

9

⚠ WARNING

Not observing fundamental safety instructions and residual risks

The non-observance of the fundamental safety instructions and residual risks stated in Chapter 1 can result in accidents with severe injuries or death.

- Adhere to the fundamental safety instructions.
- Take into account residual risks when assessing risk.



⚠ DANGER

Electric shock due to residual capacitor charge

Because of the capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off.

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

- Only open the device after 5 minutes have elapsed.

The SINAMICS DCP must be provided with extensive protection measures against contamination in order to prevent voltage flashovers and damage. Dust and foreign bodies, which are brought in by the cooling-air flow in particular, must be thoroughly removed at certain intervals; this depends on the rate of accumulation of dirt, but should be carried out at least every 12 months. The device must be blown out with dry compressed air at a maximum of 1 bar, or cleaned using a vacuum cleaner.

The screw connections (also the protective conductor connections) must be retightened each time that maintenance work is carried out on a SINAMICS DCP.

9.1 Upgrading firmware releases

This chapter describes how you can upgrade a SINAMICS DCP – including STARTER project – from one firmware version to a higher firmware version (e.g. V1.3 to V1.4).

Basics

The following steps are necessary:

Upgrading the device firmware

1. Backup the configuration
2. Update the SINAMICS DCP firmware (incl. the peripherals)

3. Update the STARTER project
4. Load to the target system - copy RAM to ROM

Note

A memory card is required for the firmware update (see Chapter "Ordering information for options and accessories (Page 30)").

When updating the firmware, always proceed as follows:

1. Update the SINAMICS DCP firmware
2. Update the STARTER project
3. Load the converted STARTER project to the SINAMICS DCP (download)

Do not proceed as follows:

1. Update the SINAMICS DCP firmware
2. Create a NEW STARTER project
3. Load into the PG

In this case, under certain circumstances, STARTER cannot assign the project to the correct device version. If the STARTER project is not available, generate a new project with the old device version (load into the PG before the firmware update) and then proceed as normal.

9.1.1 Upgrading the device firmware

9.1.1.1 Backup the configuration

The SINAMICS DCP parameter assignment is not lost while updating the firmware. In spite of this, before starting the firmware update, back up the SINAMICS DCP configuration:

- Back up the parameter assignment on a memory card (see Chapter "Memory card functions (Page 161)")

and/or

- Backup the parameter assignment in a STARTER project (see Chapter "Commissioning using the STARTER commissioning tool (Page 128)")

9.1.1.2 Update the SINAMICS DCP firmware

Note

Only memory cards which have been prepared for these systems by Siemens will be accepted.

If the memory card is formatted, formatting must be performed with the FAT16 setting.

Downloading the latest firmware release see Firmware updates and constraints (Page 15).

Procedure

1. Unzip the *.zip file to an empty memory card.
2. Insert the card in the SINAMICS DCP, which has been switched-off, and switch the device on again. The firmware is updated. The update has been completed if the RDY-LED and the DP1-LED flash at 0.5 Hz (the update takes about 12 minutes).
3. Carry out a POWER OFF. Remove the memory card from the SINAMICS DCP.

   NOTICE

   Removing the memory card before POWER ON

   If the memory card is not removed from the SINAMICS DCP before the POWER ON, the parameterization in the SINAMICS DCP is copied to the memory card during ramp-up, or a parameterization already on the card copied to the SINAMICS DCP.

   For a detailed description of this function, see Chapter "Memory card functions (Page 161)", Section "Copying parameter data sets from non-volatile memory to the memory card".

4. Carry out a POWER ON. The new firmware is now active.
   If a memory card is already in the SINAMICS DCP, the mechanism described in Chapter "Memory card functions (Page 161)", Section "Copying parameter data sets from non-volatile memory to the memory card" takes effect.
5. When running-up for the first time, connected TM modules carry out a firmware update. A POWER OFF / POWER ON of these components is required after the firmware update. The memory card no longer needs to be inserted for this step.

Note

Electronics power supply must not be interrupted during the update, otherwise the update will need to be restarted.

Note

To safely remove the memory card, see Chapter "Memory card functions (Page 161)".

9.1.1.3 Update the STARTER project

Install the SSP that matches the new SW version (e.g. SSP SINAMICS DCP V1.4).

SSPs for different versions of the same SINAMICS DCP can be simultaneously installed in STARTER.

Open the existing STARTER project (that refers to an old device version). Right-click the device in the project navigator and select "Target device" → "Device version...". Select the new device version and confirm with "Change version". The project is converted to the new device version.

Note

STARTER does not support a "downgrade" of the firmware version (e.g. V1.4 to V1.3).

9.1.1.4 Load to the target system - copy RAM to ROM

Load the project into the SINAMICS DCP (load to the target system) and permanently save the parameter assignment (carry out a "Copy RAM to ROM").

9.2 Replacing the fans

The recommendation to replace the fans is indicated by the alarm in Chapter "Device fan (Page 357)".

The individual fans cannot be replaced. The entire fan unit must always be replaced.

The fan unit for the 30 kW device has 4 fans; the fan unit for the 120 kW and 250 kW devices has 3 fans.

9.2.1 Replacing the fan of a 30 kW device

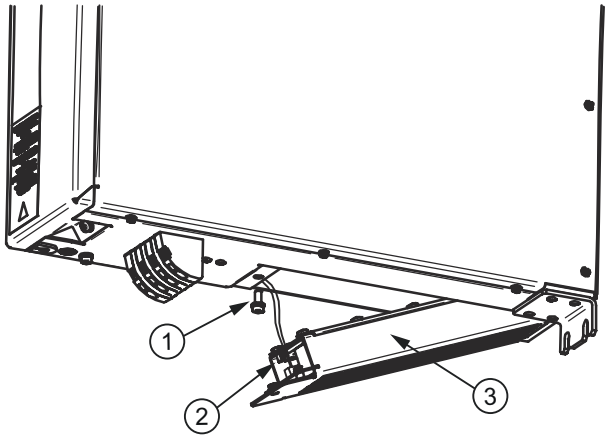


Figure 9-1 Replacing the fan of a 30 kW device

1. Release the screw ①.
2. Withdraw the connector ②.

3. Remove the fan unit ③.
4. Insert the new fan unit ③.
5. Reinsert the connector ②.
6. Retighten the screw ①.

Set the operating hours counter to 0, see Chapter "Device fan (Page 357)".

9.2.2 Replacing the fans for the 120 kW and 250 kW devices

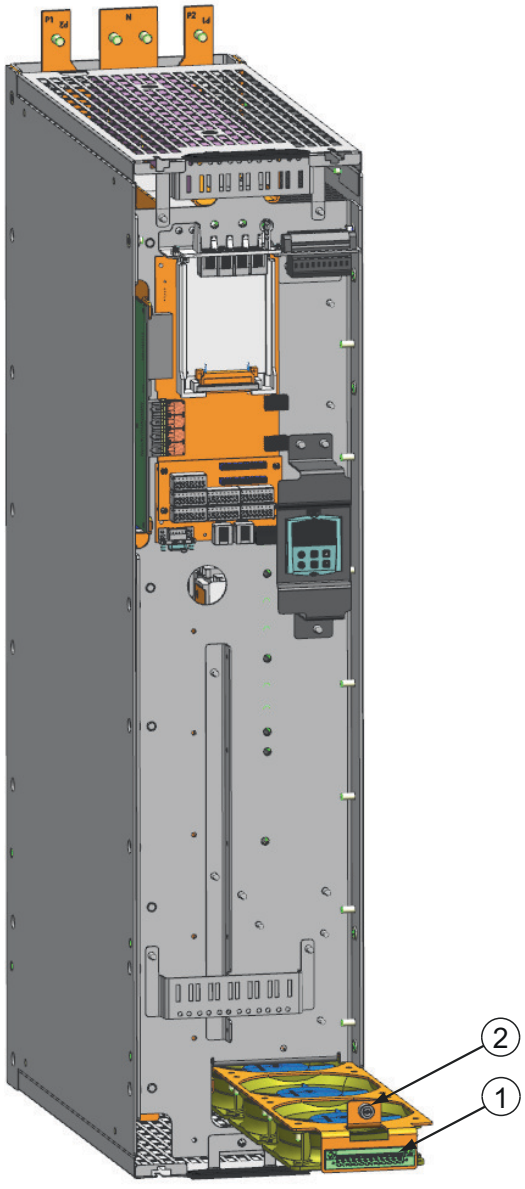


Figure 9-2 Replacing the fans for the 120 kW and 250 kW devices

1. Release the 2 screws at the lower side of the device and remove the front panel.
2. Remove the connector ①.
3. Release the screw ②.
4. Replace the fan unit.
5. Retighten the screw ②.
6. Reinsert the connector ①.
7. Reattach the front panel and retighten the 2 screws at the lower side of the device.

Set the operating hours counter to 0, see Chapter "Device fan (Page 357)".

9.3 Replacing the Control Unit CUD

9.3.1 Replacing the CUD for a 30 kW device

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdrivers TX10 (CUD) and TX20/TX30.

Removing the CUD

Opening the device

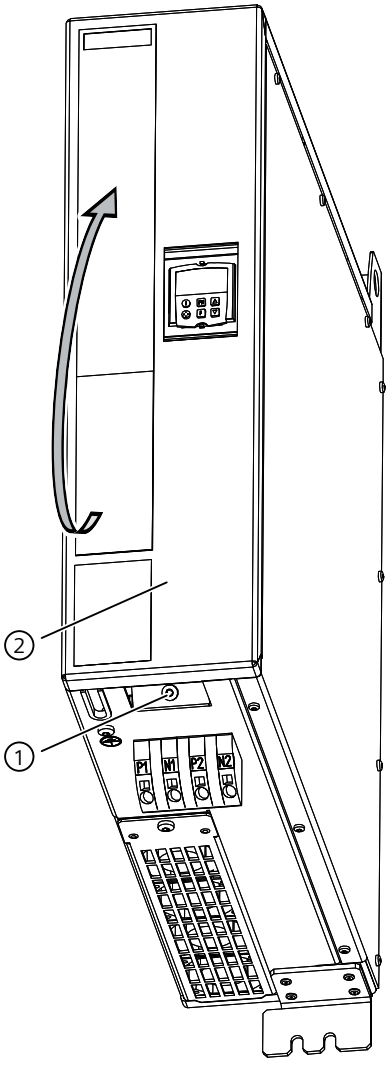


Figure 9-3 Opening the device

1. Remove the lower screw ①.
2. Flip up the front cover ② and remove it.

Removing the Control Unit CUD

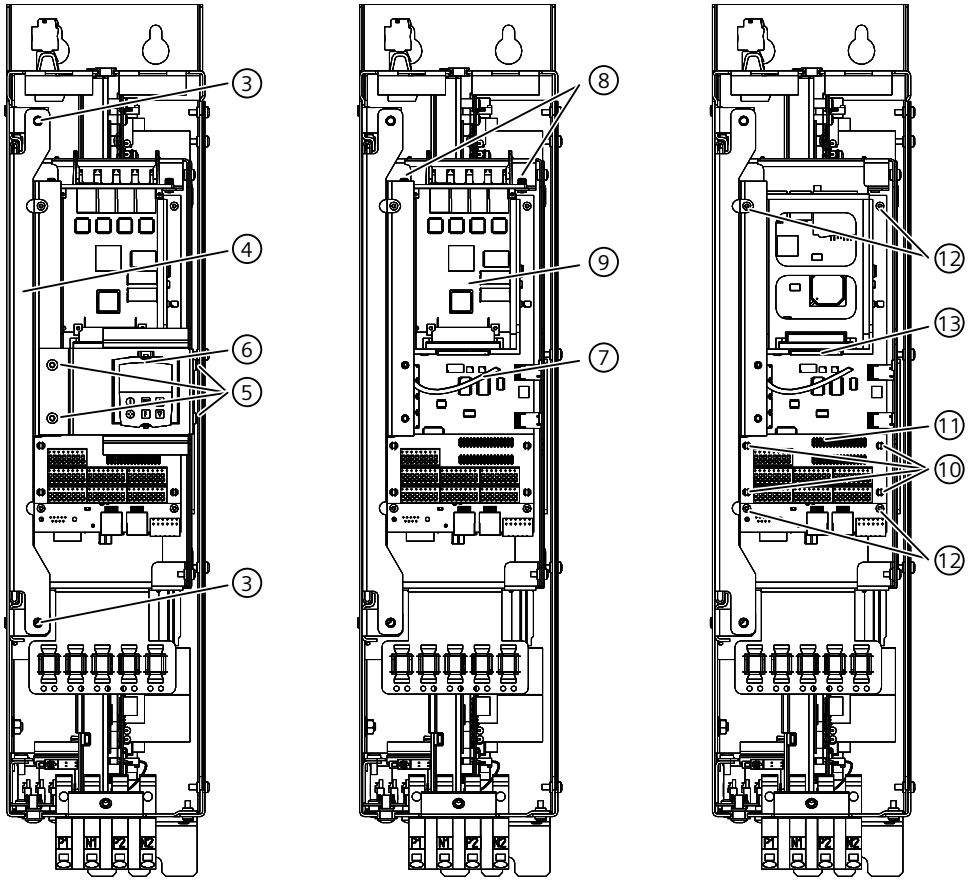


Figure 9-4 Removing the Control Unit CUD

1. Release two screws ③ and pull out control unit ④ somewhat until screws ⑤ on the right-hand side of the support for the BOP20 can be seen.
2. Release screws ⑤ and remove the support for the BOP20 ⑥.
3. Release the ribbon cable from the rear side of the BOP20.
   When doing this, note down the orientation of the connector, as it is not coded in a way that prevents it from being incorrectly inserted.
4. Fold over the ribbon cable ⑦ and secure it.
5. If a CBE20 module is installed, then remove the PROFINET cable.
6. Release screws ⑧, and withdraw the CBE20 module ⑨ towards the top.
7. Using a pair of pliers, carefully press the tips of plastic pins ⑩ together and withdraw Connector Board ⑪ from the Control Unit.
8. Release the 4 fastening screws ⑫ of CUD ⑬.
9. Carefully withdraw the CUD to the right.

Installing the CUD

1. Position the new CUD ⑬ at an angle of between 10° and 15° at the connector, and align it so that it is parallel to the side panel.
2. Fix the CUD by applying pressure to the connector strip.
3. Tighten the 4 fastening screws ⑫ of CUD (1 Nm).
4. Place Connector Board ⑪ on plastic pins ⑩ and firmly press it until it snaps into place.
5. If a CBE20 module is to be inserted, push CBE20 ⑨ into the guide from the top.
6. Insert the screws ⑧ (1 Nm) and reinsert the PROFINET cable.
7. Insert ribbon cable ⑦ into the rear side of the BOP20 ⑥ with the correct orientation.
8. Mount the support for BOP20 ⑥ and fix using screws ⑤ (2.5 Nm).
9. Push Control Unit ④ into the device and fix it using the two screws ③ (5 Nm).
10. Then mount the front cover ② and fix it with the lower screw ① (5 Nm).

9.3.2 Replacing the CUD for the 120 kW and 250 kW devices

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdriver TX10 (CUD), TX20/TX30 and 10 mm ring wrench.

Removing the CUD

Opening the device

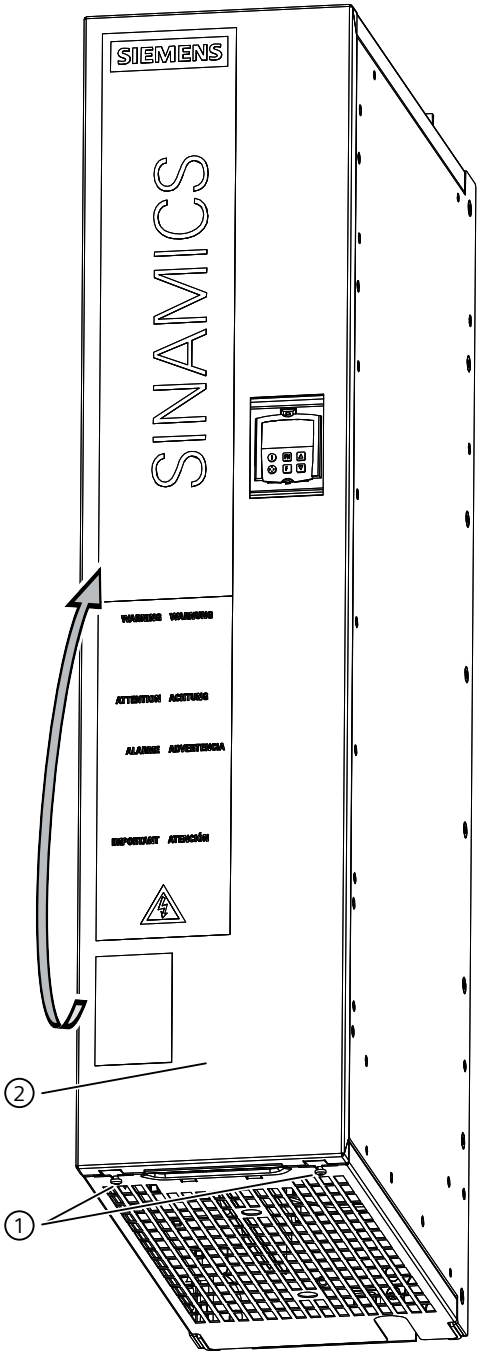


Figure 9-5 Opening the device

1. Remove lower screws ①.
2. Flip up the front cover ② and remove it.

Removing the Control Unit CUD

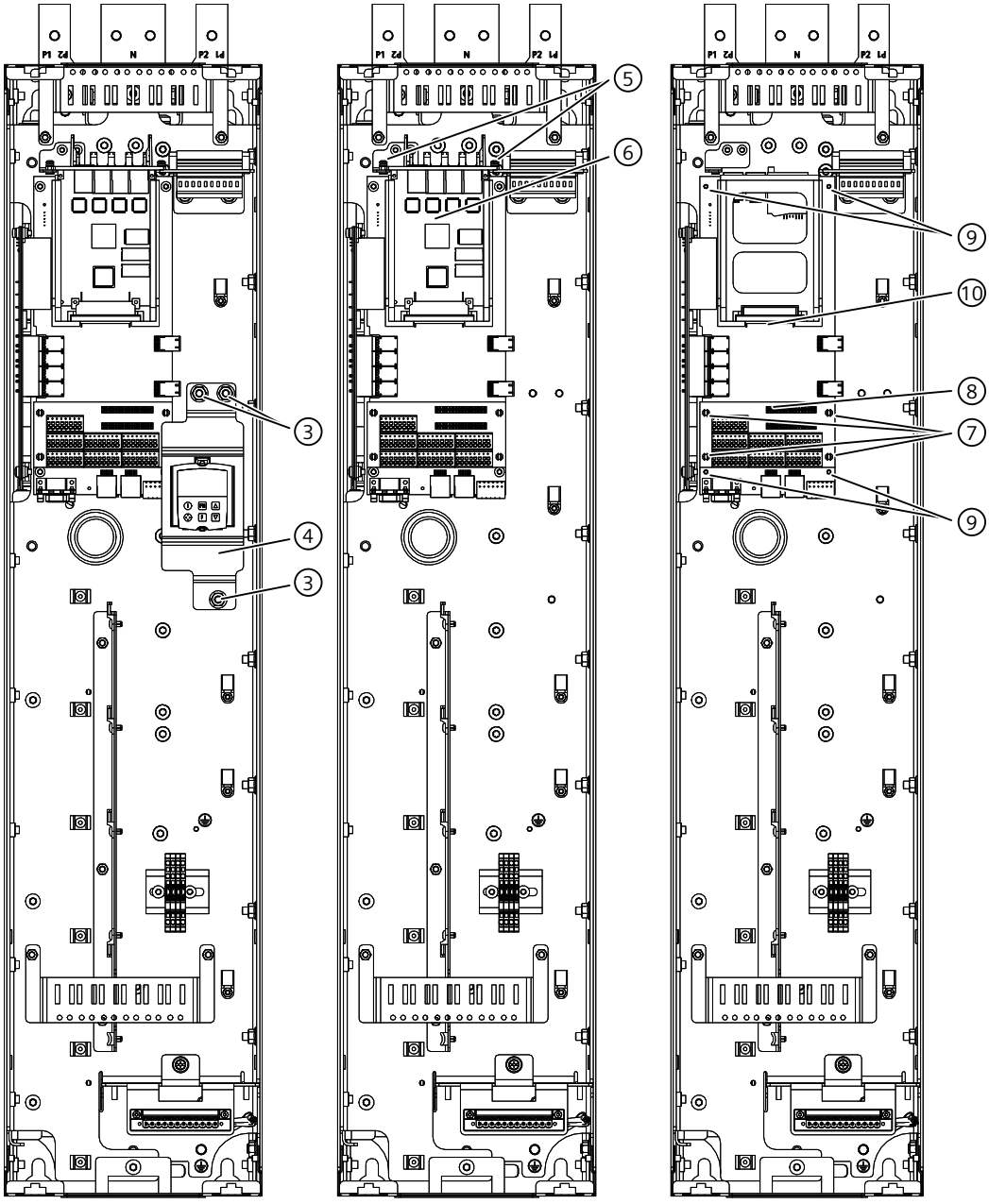


Figure 9-6 Removing the Control Unit CUD

1. Release screws ③ and remove the support for BOP20 ④.
2. Release the ribbon cable from the rear side of the BOP20.
   When doing this, note down the orientation of the connector, as it is not coded in a way that prevents it from being incorrectly inserted.
3. If a CBE20 module is installed, then remove the PROFINET cable.
4. Release screws ⑤, and withdraw the CBE20 module ⑥ towards the top.

5. Using a pair of pliers, carefully press the tips of plastic pins ⑦ together and withdraw Connector Board ⑧ from the Control Unit.
6. Release the 4 fastening screws ⑨ of CUD ⑩.
7. Carefully withdraw the CUD to the right.

Installing the CUD

1. Position the new CUD ⑩ at an angle of between 10° and 15° at the connector, and align it so that it is parallel to the side panel.
2. Fix the CUD by applying pressure to the connector strip.
3. Tighten the 4 fastening screws ⑨ of CUD (1 Nm).
4. Place Connector Board ⑧ on plastic pins ⑦ and firmly press it until it snaps into place.
5. If a CBE20 module is to be inserted, push CBE20 ⑥ into the guide from the top.
6. Insert the screws ⑤ (1 Nm) and reinsert the PROFINET cable.
7. Insert ribbon cable into the rear side of the BOP20 ④ with the correct orientation.
8. Mount the support for BOP20 ④ and fix it using screws ③ (6 Nm).
9. Then mount the front cover ② and fix it with the lower screws ① (1.8 Nm).

9.4 Replacing the BOP

9.4.1 Replacing the BOP for a 30 kW device

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdrivers TX20/TX30 (front cover).

Replacing the BOP20

Opening the device

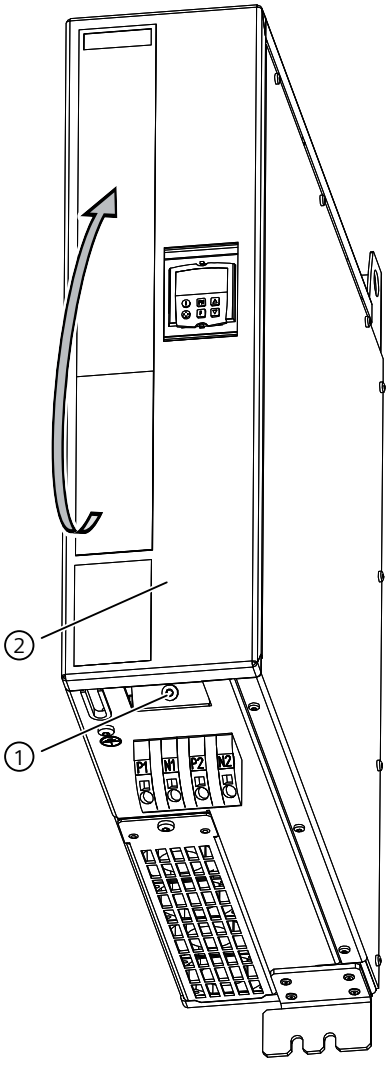


Figure 9-7 Opening the device

1. Remove the lower screw ①.
2. Flip up the front cover ② and remove it.

Replacing the BOP20

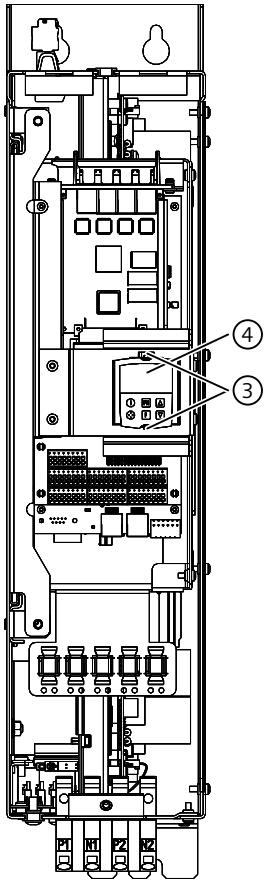


Figure 9-8 Replacing the BOP20

1. Press the two catches ③ together and withdraw BOP20 ④ out of the support towards the front.
2. Release the ribbon cable from the rear side of the BOP20.
   When doing this, note down the orientation of the connector, as it is not coded in a way that prevents it from being incorrectly inserted.
3. Insert ribbon cable into the rear side of the BOP20 ④ with the correct orientation.
4. Place the BOP20 ④ into the support, and press it until the catches snap into place.
5. Then mount the front cover ② and fix it with the lower screw ① (5 Nm).

9.4.2 Replacing the BOP for the 120 kW and 250 kW devices

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdrivers TX20/TX30 (front cover).

Replacing the BOP20

Opening the device

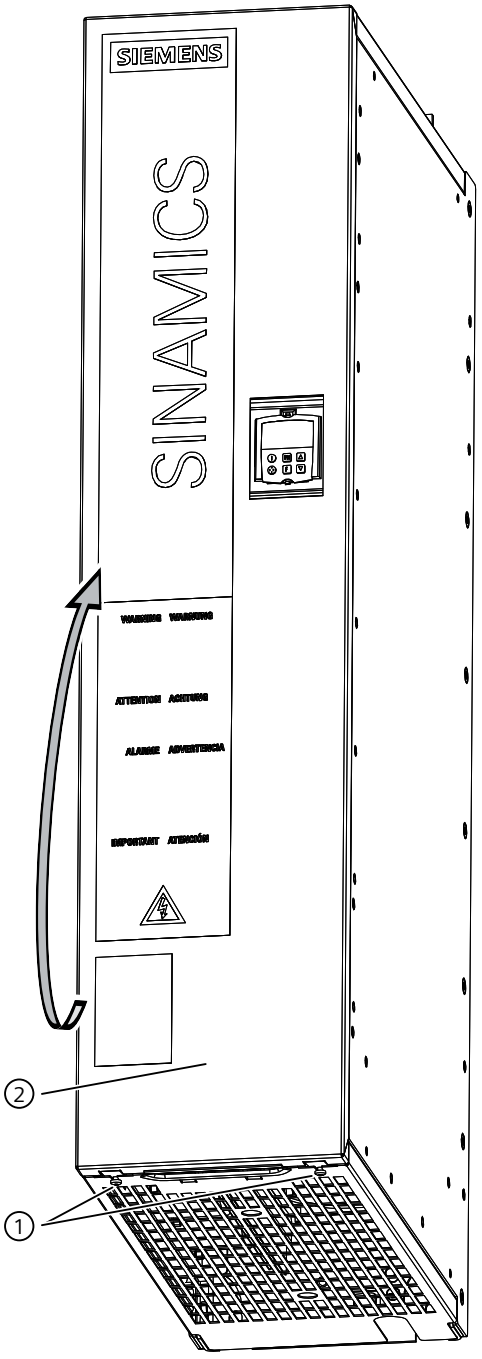


Figure 9-9 Opening the device

1. Remove lower screws ①.
2. Flip up the front cover ② and remove it.

Replacing the BOP20

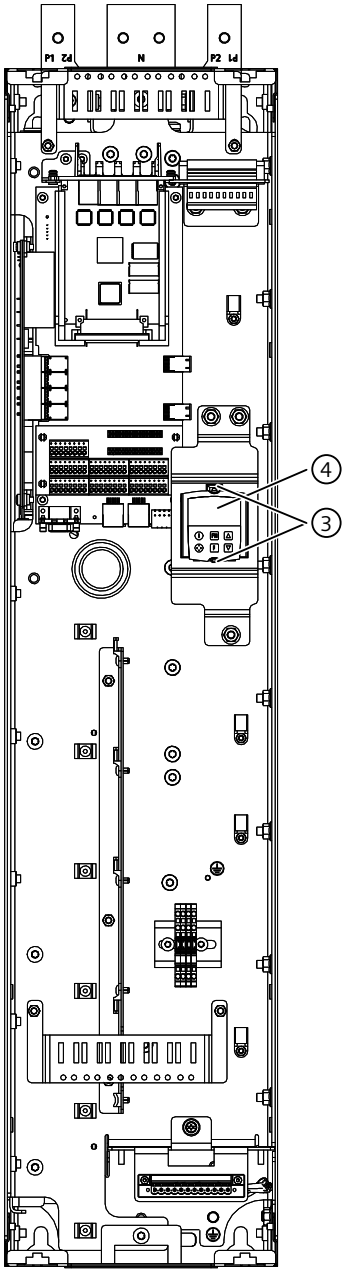


Figure 9-10 Replacing the BOP20

1. Press the two catches ③ together and withdraw BOP20 ④ out of the support towards the front.
2. Release the ribbon cable from the rear side of the BOP20.
   When doing this, note down the orientation of the connector, as it is not coded in a way that prevents it from being incorrectly inserted.

3. Insert ribbon cable into the rear side of the BOP20 ④ with the correct orientation.
4. Place the BOP20 ④ into the support, and press it until the catches snap into place.
5. Then mount the front cover ② and fix it with the lower screw ① (1.8 Nm).

9.5 Replacing the Connector Board

9.5.1 Replacing the Connector Board for a 30 kW device

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdrivers TX20/TX30 (front cover).

Replacing the Connector Board

Opening the device

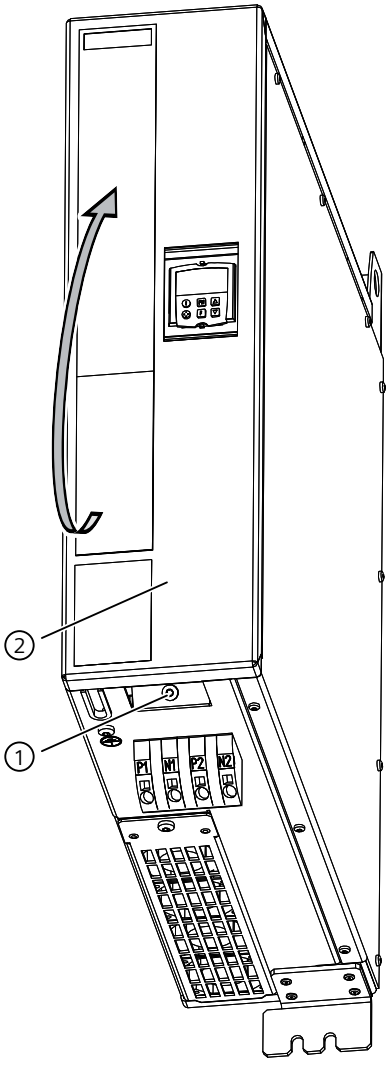


Figure 9-11 Opening the device

1. Remove the lower screw ①.
2. Flip up the front cover ② and remove it.

Replacing the Connector Board

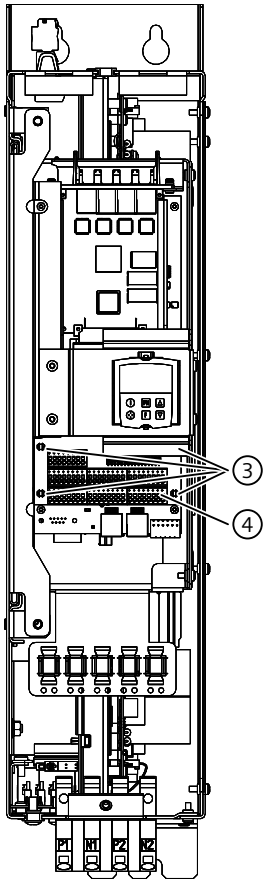


Figure 9-12 Replacing the Connector Board

The Connector Board is inserted in the Control Unit and fixed using plastic pins.

1. Using a pair of pliers, carefully press the tips of plastic pins ③ together and withdraw Connector Board ④ from the Control Unit.
2. Withdraw all connectors from the Connector Board and insert these on the new Connector Board.
3. Place the new Connector Board on the plastic pins and press it firmly until it snaps into place.
4. Then mount the front cover ② and fix it with the lower screw ① (5 Nm).

9.5.2 Replacing the Connector board for 120 kW and 250 kW devices

Note

Observe the notes relating to electrostatic sensitive devices, see Chapter "Equipment damage due to electric fields or electrostatic discharge (Page 21)".

Required tools

Torx screwdrivers TX20/TX30 (front cover).

Replacing the Connector Board

Opening the device

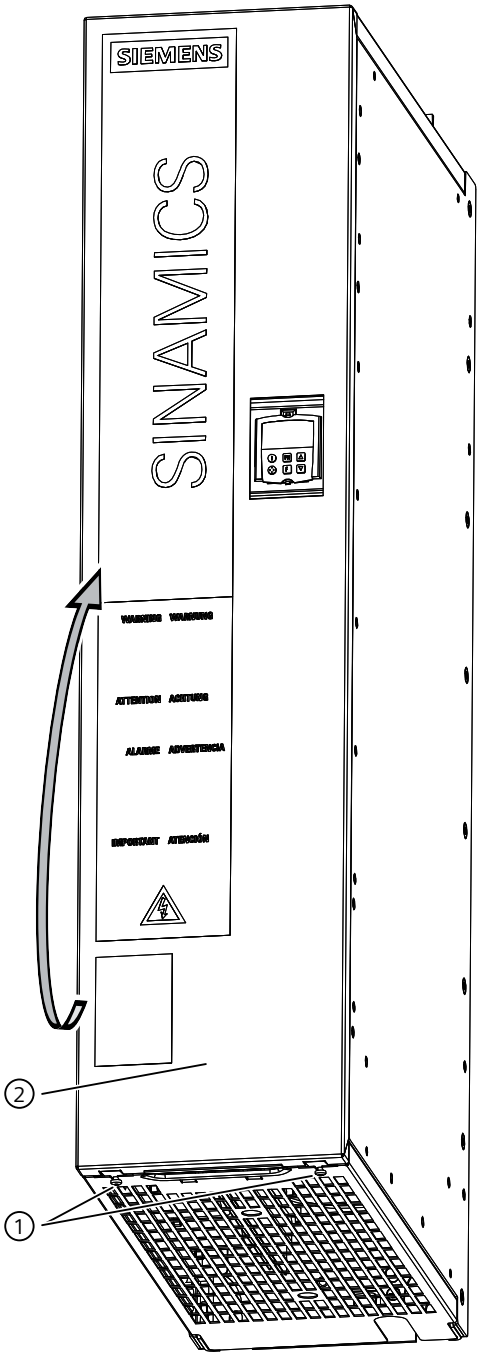


Figure 9-13 Opening the device

1. Remove lower screws ①.
2. Flip up the front cover ② and remove it.

Replacing the Connector Board

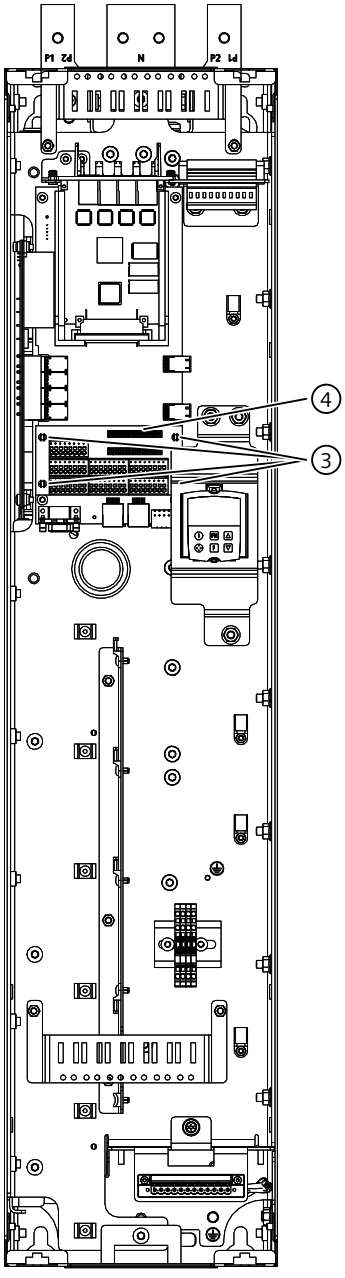


Figure 9-14 Replacing the Connector Board

The Connector Board is inserted in the Control Unit and fixed using plastic pins.

1. Using a pair of pliers, carefully press the tips of plastic pins ③ together and withdraw Connector Board ④ from the Control Unit.
2. Withdraw all connectors from the Connector Board and insert these on the new Connector Board.
3. Place the new Connector Board on the plastic pins and press it firmly until it snaps into place.
4. Then mount the front cover ② and fix it with the lower screw ① (1.8 Nm).

9.6 Spare parts

The following spare parts are available for the SINAMICS DCP:

Table 9-1 Spare parts for SINAMICS DCP

Spare part	Article No.
Fan cartridge DCP 30 kW	6RY1801-5AA00
Fan cartridge DCP 120 kW / 250 kW	6RY1801-5AA01
SINAMICS DCP memory card	6RX1800-0AS50
BOP20	6SL3055-0AA00-4BA0
CUD Advanced (uncoated) for DCP 30 kW without option M08	6RY1803-0AA06-0AA1
CUD Advanced (coated) for • DCP 30 kW with option M08 • DCP 120 kW • DCP 250 kW	6RY1803-0AA26-0AA1
Connector Board (uncoated) for DCP 30 kW without option M08	6RY1803-0GA00
Connector Board (coated) for • DCP 30 kW with option M08 • DCP 120 kW • DCP 250 kW	6RY1803-0GA20

Spares On Web

Information about spare parts is provided through the electronic spare parts catalog Spares On Web when you enter the serial number and Article No. of your SINAMICS DCP in the Internet (registration required).
Spares On Web (http://www.siemens.com/sow)

Disposal

10

10.1 Environmental compatibility

Environmental aspects during development

The use of highly-integrated components has enabled the number of parts to be kept to a minimum, with energy being used as efficiently as possible during production as a result.

Particular emphasis has been placed on ensuring that the metal and plastic parts have a low volume and low weight, and that the number of different types is kept to a minimum.

Pollutant-free materials have been used for all significant parts. Insulation materials containing silicone are not used. Materials containing halogens are only present to a slight extent (cable insulation) in the SINAMICS DCP.

All materials meet ROHS criteria.

Environmental compatibility was a key criterion in selecting supplier parts.

Environmental aspects during production

The packaging material can be recycled. and consists mainly of cardboard.

With the exception of the enclosure, no surface coatings have been used.

The production processes do not produce any emissions.

Environmental aspects for disposal



For environmentally friendly recycling and disposal of your old device, please contact a company certified for the disposal of old electrical and/or electronic devices and dispose of the device in accordance with the regulations in your country.

The device features screw-in and snap-in connections that can be easily released in order to separate it into different mechanical components for recycling purposes.

The assembled PCBs may be used in accordance with the regional regulations. The proportion of components containing hazardous substances is low.

11 Technical specifications

11.1 Ambient conditions

Environmental classes according to IEC 60721-3

Table 11-1 Environmental classes

Usage	Environmental condition	Environmental class	Remark
Operation	Mechanical stability	See Remark	• Vibration test acc. to IEC 61800-5-1 (Table 27) – Test: Fc test according to IEC 60068-2-6 – Motion: Sinusoidal – 10 to 57 Hz: Amplitude = 0.075 mm – 57 to 150 Hz: Acceleration = 1 g – Duration of vibration: 10 cycles per axis
	Climatic influences	3K3	• acc. to IEC 60721-3-3:2002 • Maximum ambient temperature: 0°C to +40°C (up to + 55 °C with "Derating (Page 358)") • No condensation, splash water or icing permitted.
	Biological influences	3B1	-
	Chemical influences	3C1	-
Transportation	Mechanical stability	2M1	• Vibration test: – 2 to 9 Hz: Amplitude = 3.5 mm – 9 to 200 Hz: Acceleration = 10 m/s^2
	Climatic influences	2K3	• acc. to IEC 60721-3-2:1997 • Ambient temperature: – -25 °C to +70 °C (briefly to -40° C for max. 24 h)
	Biological influences	2B1	-
	Chemical influences	2C1	-
Storage	Mechanical stability	1M2	
	Climatic influences	1K4	• acc. to IEC 60721-3-1:1997 • Ambient temperature: – -25 °C to +55 °C (temperature fluctuations ≤ 20 K / h) Before commissioning, make sure that any condensation has dried out.
	Biological influences	1B1	-
	Chemical influences	1C1	-

Installation altitude above sea level

≤ 2000 m	rated DC current
> 2000 m	With derating, see Chapter "Derating (Page 358)".

Additional properties

For a standard application, **side 1** (terminals P1/N1) of the device is connected to a DC link.

- It is **not** necessary to ground the DC link.
  This applies to the 30 kW device from functional state 02.
- Side 1 of the device must be connected (precharging circuit, fuse) as described in Chapter "Electrical connection (Page 39)".

For a standard application, **side 2** (terminals P2/N2) of the device is connected to an energy storage device.

- Side 2 of the device must be connected (precharging circuit, fuse) as described in Chapter "Electrical connection (Page 39)".

Parallel configuration

Several devices can be connected in parallel simultaneously at side 1, side 2 or at both sides.

For more details, see Chapter "Connecting several SINAMICS DCPs in parallel (Page 397)".

11.2 Device data

Table 11-2 Technical specifications of the 30 kW device

Variable	Unit	Value	Remark
Rated power	kW	30	
Rated DC current	A	50	
Rated DC voltage	V	600	
Operating voltage range	V	0 ... 1000	Applicable for side 1 and side 2
Continuous operating range	V	0 ... 800	Applicable for side 1 and side 2
Overvoltage range (briefly)	V	800 ... 1000	Applies for side 1 and side 2: after switching on and off, voltages are only permissible in this range for 30 s. Operation is possible with a reduced current (5 A at 1000 V).
AC system voltage	V	600	According to IEC 61800-5-1 Overvoltage Category III
Periodic peak voltage	V	940	between the DC line connections (P1, N1, P2, N2) and enclosure / ground (according to IEC 60664-1:2007)
Maximum power loss	W	800	
Protection class		I	
Input capacitance	µF	40	per side

Variable	Unit	Value	Remark
Inductance of the energy storage reactor	µH	700	per power unit a total of 2 power units
Monitoring functions			Hardware monitoring and shutdown: - Voltage > 1050 V - Current > 60 A Maximum short-circuit current: 60 A
DC electronics power supply	V	24	Permissible voltage range: 18 ... 30 V Current consumption: 5 A at 24 V
Degree of protection		IP20	The following applies to applications in Australia: **Fire enclosure** The enclosure of the device does not meet the requirements of a fire enclosure. Therefore, the device must be installed in a suitable enclosure to meet the application and site requirements.
Use			Exclusively for cabinet installation Pollution degree 2
Cooling method		Forced ventilation	Forced air cooling with integrated fans
Fan air flow	m^3/h	300	
Fan noise level	dB(A)	73	
Power connections - P1, N1, P2, N2 - PE		1.5 ... 16 mm^2	Plug-in terminals M6 screw, 6 Nm
Dimensions (W x H x D)	mm	150 x 655 x 545	
Weight (approx.)	kg	38	
MTBF	Years	20	Expected operating time between two consecutive failures

Table 11-3 Technical specifications of the 120 kW device

Variable	Unit	Value	Remark
Rated power	kW	120	
Rated DC current	A	200	
Rated DC voltage	V	600	
Operating voltage range	V	0 ... 1000	Applicable for side 1 and side 2
Continuous operating range	V	0 ... 920	Applicable for side 1 and side 2
Overvoltage range (reduced current)	V	800 ... 920	Applies for side 1 and side 2: operation is possible in this range with reduced current. Starting at 800 V, the maximum current reduces down to 0 A at 920 V
Overvoltage range (briefly)	V	920 ... 1000	Applies for side 1 and side 2: after switching on and off, voltages are only permissible in this range for 30 s.
AC system voltage	V	600	According to IEC 61800-5-1 Overvoltage Category III

Variable	Unit	Value	Remark
Periodic peak voltage	V	1000	between the DC line connections (P1, N1, P2, N2) and enclosure / ground (according to IEC 60664-1:2007)
Maximum power loss	W	2800	
Protection class		I	
Input capacitance	µF	1200	per side
Inductance of the energy storage reactor	µH	500	per power unit a total of 3 power units
Monitoring functions			Hardware monitoring and shutdown: - Voltage > 1050 V - Current > 3 x 180 A = 540 A Maximum short-circuit current: 540 A
DC electronics power supply	V	24	Permissible voltage range: 18 ... 30 V Current consumption: 20 A at 24 V
Degree of protection		IP00	The degree of protection is applicable when delivered. The power connections protrude out of the enclosure. An IP20 degree of protection is easy to achieve if the power connections are covered on the cabinet side. The following applies to applications in Australia: **Fire enclosure** The enclosure of the device does not meet the requirements of a fire enclosure. Therefore, the device must be installed in a suitable enclosure to meet the application and site requirements.
Use			Exclusively for cabinet installation Pollution degree 2
Cooling method		Forced ventilation	Forced air cooling with integrated fans The fan speed is changed as a function of the temperatures of the power units.
Rated fan speed	rpm	12000	
Fan air flow	m^3/h	1200	
Fan noise level	dB(A)	65 ... 80	The fan noise changes as a function of the fan speed, which is controlled dependent on the temperatures of the power units.
Power connections P1, N1, P2, N2 PE		 max. 95 mm^2	 M8 bolts, 13 Nm M8 bolts, 13 Nm
Dimensions (W x H x D)	mm	205 x 900 x 500	
Weight (approx.)	kg	118	
MTBF	Years	20	Expected operating time between two consecutive failures

Table 11-4 Technical specifications for the 250 kW device

Variable	Unit	Value	Remark
Rated power	kW	250	
Rated DC current	A	250	

Variable	Unit	Value	Remark
Rated DC voltage	V	1000	
Operating voltage range	V	0 ... 1220	Applicable for side 1 and side 2
Continuous operating range	V	0 ... 1200	Applicable for side 1 and side 2
Overvoltage range (reduced current)	V	1200 ... 1220	Applies to side 1 and side 2: Operation is possible in this range with a reduced current. Starting at 1200 V, the maximum current reduces down to 0 A at 1220 V
AC system voltage	V	600	According to IEC 61800-5-1 Overvoltage Category III
Periodic peak voltage	V	1220	between the DC line connections (P1, N1, P2, N2) and enclosure / ground (according to IEC 60664-1:2007)
Maximum power loss	W	5800	
Protection class		I	
Input capacitance	µF	800	per side
Inductance of the energy storage reactor	µH	500	per power unit branch a total of 3 power unit branches
Monitoring functions			Hardware monitoring and shutdown: - Voltage > 1242.5 V - Current > 3 x 180 A = 540 A Maximum short-circuit current: 540 A
DC electronics power supply	V	24	Permissible voltage range: 18 ... 30 V Current consumption: 20 A at 24 V
Degree of protection		IP00	Degree of protection is applicable when delivered. The power connections protrude out of the enclosure. An IP20 degree of protection is easy to achieve if the power connections are covered on the cabinet side. The following applies to applications in Australia: **Fire enclosure** The enclosure of the device does not meet the requirements of a fire enclosure. Therefore, the device must be installed in a suitable enclosure to meet the application and site requirements.
Use			Exclusively for cabinet installation Pollution degree 2
Cooling method		Forced ventilation	Forced air cooling with integrated fans The fan speed is changed as a function of the temperatures of the power units.
Rated fan speed	rpm	12000	
Fan air flow	m^3/h	1200	
Fan noise level	dB(A)	65 ... 80	The fan noise changes as a function of the fan speed, which is controlled dependent on the temperatures of the power units.
Power connections P1, N1, P2, N2 PE		 max. 120 mm^2	 M8 bolts, 13 Nm M8 bolts, 13 Nm

Variable	Unit	Value	Remark
Dimensions (W x H x D)	mm	205 x 900 x 500	
Weight (approx.)	kg	118	
MTBF	Years	20	Expected operating time between two consecutive failures

Appendix

A

A.1 Standards and certifications

Relevant standards

IEC 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
IEC 61800-3	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
IEC 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Certification

The following certifications are valid if attached to the product:

CE

The product has a CE mark and an EC Declaration of Conformity as part of the Low-Voltage Directive (2014/35/EU), the EMC Directive (2014/30/EU) and the RoHS Directive (2011/65/EU).

UK CA

The product has a UKCA marking on the rating plate and satisfies the requirements for the UK market (England, Wales and Scotland).

c UL us

The product has USR and CNR certification based on UL Standard UL 61800-5-1 and CSA Norm C22.2 No. 274-13.



The product has EAC and RCM certification.



The product has the KC marking on the rating plate, therefore complying with the EMC requirements for South Korea.

A.2 List of abbreviations

Note

The following list of abbreviations includes all abbreviations and their meanings used in the entire SINAMICS user documentation.

Abbreviation	Meaning, German	Meaning, English
A		
A...	Warnung	Alarm
AC	Wechselstrom	Alternating Current
ADC	Analog-Digital-Konverter	Analog Digital Converter
AI	Analogeingang	Analog Input
AIM	Active Interface Module	Active Interface Module
ALM	Active Line Module	Active Line Module
AO	Analogausgang	Analog Output
AOP	Advanced Operator Panel	Advanced Operator Panel
APC	Advanced Positioning Control	Advanced Positioning Control
ASC	Ankerkurzschluss	Armature Short-Circuit
ASCII	Amerikanische Code-Norm für den Informationsaustausch	American Standard Code for Information Interchange
ASM	Asynchronmotor	Induction motor
B		
BB	Betriebsbedingung	Operating condition
BERO	Firmenname für einen Näherungsschalter	Tradename for a type of proximity switch

Abbreviation	Meaning, German	Meaning, English
BI	Binektoreingang	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	German Institute for Occupational Safety
BICO	Binektor-Konnektor-Technologie	Binector Connector Technology
BLM	Basic Line Module	Basic Line Module
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Kapazität	Capacitance
C...	Safety-Meldung	Safety message
CAN	Serielles Bussystem	Controller Area Network
CBC	Kommunikationsbaugruppe CAN	Communication Board CAN
CD	Compact Disk	Compact Disk
CDS	Befehlsdatensatz	Command Data Set
CF	CompactFlash	CompactFlash
CI	Konnektoreingang	Connector Input
CNC	Computerunterstützte numerische Steuerung	Computer Numerical Control
CO	Konnektorausgang	Connector Output
CO/BO	Konnektor-/Binektorausgang	Connector Output/Binector Output
COB-ID	CAN Object-Identification	CAN Object-Identification
COM	Mittelkontakt eines Wechselkontaktes	Common contact of a change-over relay
CP	Kommunikationsprozessor	Communications Processor
CPU	Zentrale Recheneinheit	Central Processing Unit
CRC	Checksummenprüfung	Cyclic Redundancy Check
CSM	Control Supply Module	Control Supply Module
CU	Control Unit	Control Unit
CUD	Control Unit DC	Control Unit DC
D		
DAC	Digital-Analog-Konverter	Digital Analog Converter
DC	Gleichstrom	Direct Current
DCB	Drive Control Block	Drive Control Block
DCC	Drive Control Chart	Drive Control Chart
DCN	Gleichstrom negativ	Direct Current Negative
DCP	Gleichstrom positiv	Direct Current Positive
DDS	Antriebsdatensatz	Drive Data Set
DI	Digitaleingang	Digital Input
DI/DO	Digitaleingang/-ausgang bidirektional	Bidirectional Digital Input/Output
DMC	DRIVE-CLiQ Module Cabinet (Hub)	DRIVE-CLiQ Module Cabinet (Hub)
DO	Digitalausgang	Digital Output
DO	Antriebsobjekt	Drive Object
DP	Dezentrale Peripherie	Decentralized Peripherals (Distributed I/Os)
DPRAM	Speicher mit beidseitigem Zugriff	Dual-Port Random Access Memory
DRAM	Dynamischer Speicher	Dynamic Random Access Memory

Abbreviation	Meaning, German	Meaning, English
DRIVE-CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
E		
EASC	Externer Ankerkurzschluss	External Armature Short-Circuit
EDS	Geberdatensatz	Encoder Data Set
EGB	Elektrostatisch gefährdete Baugruppen	Electrostatic Sensitive Devices (ESD)
EMC	Elektromagnetische Verträglichkeit	Electromagnetic Compatibility
EMF	Elektromagnetisches Feld	Electromagnetic Field (EMF)
EMK	Elektromotorische Kraft	Electromotive Force (EMF)
EMV	Elektromagnetische Verträglichkeit	Electromagnetic Compatibility (EMC)
EN	Europäische Norm	European Standard
EnDat	Geber-Schnittstelle	Encoder-Data-Interface
EP	Impulsfreigabe	Enable Pulses
EPOS	Einfachpositionierer	Basic positioner
ES	Engineering System	Engineering System
ESB	Ersatzschaltbild	Equivalent circuit diagram
ESR	Erweitertes Stillsetzen und Rückziehen	Extended Stop and Retract
F		
F...	Störung	Fault
FAQ	Häufig gestellte Fragen	Frequently Asked Questions
FBL	Freie Funktionsblöcke	Free Blocks
FCC	Function Control Chart	Function Control Chart
FCC	Flussstromregelung	Flux Current Control
F-DI	Fehlersicherer Digitaleingang	Failsafe Digital Input
F-DO	Fehlersicherer Digitalausgang	Failsafe Digital Output
FEM	Fremderregter Synchronmotor	Separately excited synchronous motor
FEPROM	Schreib- und Lesespeicher nichtflüchtig	Flash-EPROM
FG	Funktionsgenerator	Function Generator
FI	Fehlerstrom-Schutzschalter	Earth Leakage Circuit-Breaker (ELCB)
FP	Funktionsplan	Function diagram
FPGA	Field Programmable Gate Array	Field Programmable Gate Array
FS	Erzeugnisstand	Functional State
FW	Firmware	Firmware
G		
GB	Gigabyte	Gigabyte
GC	Global-Control-Telegramm (Broadcast-Telegramm)	Global Control Telegram (Broadcast Telegram)
GSD	Gerätestammdatei: beschreibt die Merkmale eines PROFIBUS-Devices	Device master file: describes the features of a PROFIBUS device
GSV	Gate Supply Voltage	Gate Supply Voltage
GUID	Globally Unique Identifier	Globally Unique Identifier
H		
HF	Hochfrequenz	High Frequency

Abbreviation	Meaning, German	Meaning, English
HFD	Hochfrequenzdrossel	High frequency reactor
HLG	Hochlaufgeber	Ramp-function generator
HMI	Mensch-Maschine-Schnittstelle	Human Machine Interface
HTL	Logik mit hoher Störschwelle	High-Threshold Logic
HW	Hardware	Hardware
I		
i. V.	In Vorbereitung: this feature is currently not available	In preparation: this feature is currently not available
I/O	Eingang/Ausgang	Input/Output
IASC	Interner Ankerkurzschluss	Internal Armature Short-Circuit
IBN	Inbetriebnahme	Commissioning
ID	Identifizierung	Identifier
IEC	Internationale Norm in der Elektrotechnik	International Electrotechnical Commission
IF	Interface	Interface
IGBT	Bipolartransistor mit isolierter Steuerelektrode	Insulated Gate Bipolar Transistor
IL	Impulslöschung	Pulse suppression
IPO	Interpolatortakt	Interpolator clock
IT	Drehstromversorgungsnetz ungeerdet	Insulated three-phase supply network
IVP	Interner Spannungsschutz	Internal Voltage Protection
J		
JOG	Tippen	Jogging
K		
KDV	Kreuzweiser Datenvergleich	Data cross-checking
KIP	Kinetische Pufferung	Kinetic buffering
Kp	Proportionalverstärkung	Proportional gain
KTY	Spezieller Temperatursensor	Special temperature sensor
L		
L	Induktivität	Inductance
LED	Leuchtdiode	Light Emitting Diode
LIN	Linearmotor	Linear motor
LR	Lageregler	Position controller
LSB	Niederstwertiges Bit	Least Significant Bit
LSS	Netzschalter	Line Side Switch
LU	Längeneinheit	Length Unit
LWL	Lichtwellenleiter	Fiber-optic cable
M		
M	Masse	Reference potential, zero potential
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDS	Motordatensatz	Motor Data Set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine-readable product designation
MMC	Mensch-Maschine-Kommunikation	Man-Machine Communication
MOSFET	Field effect transistor with insulated gate	Metal Oxide Semiconductor - field effect transistor

Abbreviation	Meaning, German	Meaning, English
MSB	Höchstwertiges Bit	Most Significant Bit
MSCY_C1	Zyklische Kommunikation zwischen Master (Klasse 1) und Device	Master Device Cycle Class 1
MSC	Motorstromrichter	Motor power converter
MT	Messtaster	Measuring probe
N		
N. C.	Nicht angeschlossen	Not Connected
N...	Keine Meldung oder Interne Meldung	No Report
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie	Standardization association for instrumentation and control in the chemical industry
NC	Öffner	Normally Closed (contact)
NC	Numerische Steuerung	Numerical Control
NEMA	Normengremium in USA (United States of America)	National Electrical Manufacturers Association
NM	Nullmarke	Zero Mark
NN	Normal Null	Normal zero
NO	Schließer	Normally Open (contact)
NSR	Netzstromrichter	Line power converter
O		
OA	Open Architecture	Open Architecture
OEM	Original Equipment Manufacturer	Original Equipment Manufacturer
OLP	Busstecker für Lichtleiter	Optical Link Plug
OMI	Option Module Interface	Option Module Interface
P		
p...	Einstellparameter	Adjustable parameter
PB	PROFIBUS	PROFIBUS
PcCtrl	Steuerungshoheit	Master Control
PD	PROFIdrive	PROFIdrive
PDS	Leistungsteildatensatz	Power Unit Data Set
PE	Schutzerde	Protective Earth
PELV	Schutzkleinspannung	Protective Extra Low Voltage
PEM	Permanenterregter Synchronmotor	Permanent-magnet synchronous motor
PG	Programmiergerät	Programming terminal
PI	Proportional Integral	Proportional Integral
PID	Proportional Integral Differential	Proportional Integral Differential
PLC	Speicherprogrammierbare Steuerung (SPS)	Programmable Logic Controller (PLC)
PLL	Phase Locked Loop	Phase Locked Loop
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organization
PPI	Punkt zu Punkt Schnittstelle	Point to Point Interface
PRBS	Weißes Rauschen	Pseudo Random Binary Signal
PROFIBUS	Serieller Datenbus	Process Field Bus
PS	Stromversorgung	Power Supply
PSA	Power Stack Adapter	Power Stack Adapter

Abbreviation	Meaning, German	Meaning, English
PTC	Positiver Temperaturkoeffizient	Positive Temperature Coefficient
PTP	Punkt zu Punkt	Point-To-Point
PWM	Pulsweitenmodulation	Pulse Width Modulation
PZD	PROFIBUS Prozessdaten	PROFIBUS process data
Q		
2Q	2-Quadrant	2-Quadrant
4Q	4-Quadrant	4-Quadrant
R		
r...	Beobachtungsparameter (nur lesbar)	Display parameter (read only)
RAM	Speicher zum Lesen und Schreiben	Random Access Memory
RCCB	Fehlerstrom-Schutzschalter	Residual Current Circuit Breaker
RCD	Fehlerstrom-Schutzschalter	Residual Current Device
RJ45	Norm. Describes an 8-pin plug connector with twisted pair Ethernet.	Standard. Describes an 8-pin plug connector with twisted pair Ethernet.
RKA	Rückkühlanlage	Recooling system
RO	Nur lesbar	Read Only
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Serielle Schnittstelle	Serial Interface
RS485	Norm. Beschreibt die Physik einer digitalen seriellen Schnittstelle.	Standard. Describes the physical characteristics of a digital serial interface.
RTC	Echtzeituhr	Real Time Clock
RZA	Raumzeigerapproximation	Space vector approximation (SVA)
S		
S1	Dauerbetrieb	Continuous operation
S3	Aussetzbetrieb	Periodic duty
SBC	Sichere Bremsenansteuerung	Safe Brake Control
SBH	Sicherer Betriebshalt	Safe Operating Stop
SBR	Sichere Beschleunigungsüberwachung	Safe Acceleration Monitor
SCA	Sichere Nocke	Safe Cam
SE	Sicherer Software-Endschalter	Safe software limit switch
SG	Sicher reduzierte Geschwindigkeit	Safely reduced speed
SGA	Sicherheitsgerichteter Ausgang	Safety-related output
SGE	Sicherheitsgerichteter Eingang	Safety-related input
SH	Sicherer Halt	Safety standstill
SI	Safety Integrated	Safety Integrated
SIC	Siliciumcarbid	Silicon carbide
SIL	Sicherheitsintegritätsgrad	Safety Integrity Level
SIOS	SIEMENS Industry Online Support	SIEMENS Industry Online Support
SLM	Smart Line Module	Smart Line Module
SLP	Sicher begrenzte Position	Safely-Limited Position
SLS	Sicher begrenzte Geschwindigkeit	Safely-Limited Speed
SLVC	Geberlose Vektorregelung	Sensorless Vector Control

Abbreviation	Meaning, German	Meaning, English
SM	Sensor Module	Sensor Module
SMC	Sensor Module Cabinet	Sensor Module Cabinet
SME	Sensor Module External	Sensor Module External
SN	Sicherer Software-Nocken	Safe software cam
SOS	Sicherer Betriebshalt	Safe Operating Stop
SPC	Sollwertkanal	Setpoint Channel
SPS	Speicherprogrammierbare Steuerung	Programmable Logic Controller (PLC)
SS1	Sicherer Stop 1	Safe Stop 1
SS2	Sicherer Stop 2	Safe Stop 2
SSI	Synchron Serielle Schnittstelle	Synchronous Serial Interface
SSM	Sichere Rückmeldung der Geschwindigkeitsüberwachung (n < nx)	Safe Speed Monitor
SSR	Sichere Bremsrampe	Safe Stop Ramp
STO	Sicher abgeschaltetes Moment	Safe Torque Off
STW	PROFIBUS Steuerwort	PROFIBUS control word
T		
TB	Terminal Board	Terminal Board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
Tn	Nachstellzeit	Integral time
TPDO	Transmit Process Data Object	Transmit Process Data Object
TT	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
TTL	Transistor-Transistor-Logik	Transistor-Transistor Logic
Tv	Vorhaltezeit	Derivative-action time
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
USV	Unterbrechungsfreie Stromversorgung	Uninterruptible Power Supply (UPS)
V		
VC	Vektorregelung	Vector Control
Vdc	Zwischenkreisspannung	DC-link voltage
VdcN	Teilzwischenkreisspannung negativ	Partial DC-link voltage negative
VdcP	Teilzwischenkreisspannung positiv	Partial DC-link voltage positive
VDE	Verband Deutscher Elektrotechniker	Association of German Electrical Engineers
VDI	Verein Deutscher Ingenieure	Association of German Engineers
Vpp	Volt Spitze zu Spitze	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
W		
WEA	Wiedereinschaltautomatik	Automatic restart
WZM	Werkzeugmaschine	Machine tool
X		

Abbreviation	Meaning, German	Meaning, English
XML	Erweiterbare Auszeichnungssprache (Standardsprache für Web-Publishing und Dokumentenmanagement)	Extensible Markup Language
Z		
ZK	Zwischenkreis	DC Link
ZSW	PROFIBUS Zustandswort	PROFIBUS status word

A.3 Runtimes of the DCC blocks for SINAMICS DCP

The typical runtimes of the DCC blocks (in µs) are listed in the following table.

Table A-1 DCC blocks on the SINAMICS DCP

Designation	Function	Typ. runtime	Group
ADD	Adder (REAL type)	8	Arithmetic
ADD_D	Adder (double integer type)	7	
ADD_I	Adder (integer type)	7	
ADD_M	Modulo adder for addition in correct axis cycle	8	
AVA	Absolute value generator with sign evaluation	6	
AVA_D	Absolute value generator (double integer)	6	
DIV	Divider (REAL type)	9	
DIV_D	Divider (double integer type)	7	
DIV_I	Divider (integer type)	7	
MAS	Maximum evaluator	7	
MIS	Minimum evaluator	8	
MUL	Multiplier	7	
MUL_D	Multiplier (double integer type)	7	
MUL_I	Multiplier (integer type)	7	
PLI20	Polyline, 20 break points	9	
SII	Converter	6	
SUB	Subtractor	6	
SUB_D	Subtractor (double integer type)	6	
SUB_I	Subtractor (integer type)	5	

Designation	Function	Typ. runtime	Group
DEL	Dead zone element	6	Closed Loop Control
DEZ	Dead zone element	6	
DIF	Derivative-action element	7	
DT1	Smoothing element	8	
INT	Integrator	8	
LIM	Limiter (REAL type)	6	
LIM_D	Limiter (DOUBLE type)	6	
MVS	Sliding-type mean value generator	8	
PC	P controller	9	
PIC	PI controller	10	
PT1	Delay element	7	
RGE	Ramp-function generator	12	
RGJ	Ramp-function generator with jerk limiting	78	

Designation	Function	Typ. runtime	Group
BY_W	Status byte to status word converter	14	Conversion
B_DW	Converter 32 binary variables to status double word	10	
B_W	Converter 16 binary variables to status word	6	
DW_B	Converter status double word to 32 binary variables	6	
DW_R	Accepting bit string as real value	5	
DW_W	Status double word to status word converter	6	
D_I	DOUBLE INTEGER to INTEGER converter	6	
D_R	DOUBLE INTEGER to REAL converter	7	
D_UI	DOUBLE INTEGER to UNSIGNED INTEGER converter	6	
D_US	DOUBLE INTEGER to UNSIGNED SHORT INTEGER converter	6	
I_D	INTEGER to DOUBLE INTEGER converter	6	
I_R	INTEGER to REAL converter	6	
I_UD	INTEGER to UNSIGNED DOUBLE INTEGER converter	6	
I_US	INTEGER to UNSIGNED SHORT INTEGER converter	6	
N2_R	Converting 16-bit fixed-point format (N2) to REAL	7	
N4_R	Converting 32-bit fixed-point format (N4) to REAL	6	
R_D	REAL to DOUBLE INTEGER converter	6	
R_DW	Bit string transfer as WORD	6	
R_I	REAL to INTEGER converter	6	
R_N2	Converting REAL to 16-bit fixed-point format (N2)	6	
R_N4	Converting REAL to 32-bit fixed-point format (N4)	6	
R_UD	REAL to UNSIGNED DOUBLE INTEGER converter	6	
R_UI	REAL to UNSIGNED INTEGER converter	6	
R_US	REAL to UNSIGNED SHORT INTEGER converter	5	
UD_I	INTEGER DOUBLE INTEGER to INTEGER converter	5	
UD_R	UNSIGNED DOUBLE INTEGER to REAL converter	6	
UI_D	UNSIGNED INTEGER to DOUBLE INTEGER converter	6	
UI_R	UNSIGNED INTEGER to REAL converter	6	
US_D	UNSIGNED-SHORT-INTEGER to DOUBLE INTEGER converter	6	
US_I	UNSIGNED-SHORT-INTEGER to INTEGER converter	5	

Designation	Function	Typ. run-time	Group
US_R	UNSIGNED-SHORT-INTEGER to REAL converter	5	
W_B	Converter, status word to 16 binary variables	5	
W_BY	Status word to status byte converter	5	
W_DW	Status word to status double word converter	6	

Designation	Function	Typ. run-time	Group
AND	BOOL type	7	Logic
BF	Flash function BOOL	12	
BSW	Binary change-over switch (BOOL type)	5	
CNM	Controllable numeric memory (REAL type)	6	
CNM_D	Controllable numeric memory (double integer type)	6	
CNM_I	Controllable numeric memory (integer type)	6	
CTR	Counter (BOOL type)	7	
DFR	Reset-dominant D-type flip-flop (BOOL type)	6	
DLB	Delay element (REAL type)	7	
DX8	Demultiplexer, 8 outputs, (REAL type)	6	
DX8_D	Demultiplexer, 8 outputs, (DOUBLE INTEGER type)	14	
DX8_I	Demultiplexer, 8 outputs, (INTEGER type)	13	
ETE	Edge evaluator (BOOL type)	6	
LVM	Double-sided limit monitor with hysteresis (BOOL type)	7	
MFP	Pulse generator (BOOL type)	6	
MUX8	Multiplexer, cascadable (BREAL type)	6	
MUX8_D	Multiplexer, cascadable (DOUBLE INTEGER type)	12	
MUX8_I	Multiplexer, cascadable (INTEGER type)	13	
NAND	Block (BOOL type)	7	
NCM	Numeric comparator (REAL type)	6	
NCM_D	Numeric comparator (DOUBLE INTEGER type)	5	
NCM_I	Numeric comparator (INTEGER type)	6	
NOP1	Dummy block (REAL type)	5	
NOP1_B	Dummy block (BOOL type)	5	
NOP1_D	Dummy block (DOUBLE INTEGER type)	4	
NOP1_I	Dummy block (INTEGER type)	6	
NOP8	Dummy blocks (REAL type)	8	
NOP8_B	Dummy blocks (BOOL type)	8	
NOP8_D	Dummy blocks (DOUBLE INTEGER type)	8	
NOP8_I	Dummy blocks (INTEGER type)	8	
NOR	Block (BOOL type)	7	
NOT	Converter (BOOL type)	5	
NSW	Numeric change-over switch (REAL type)	6	
NSW_D	Numeric change-over switch (DOUBLE INTEGER type)	5	
NSW_I	Numeric change-over switch (INTEGER type)	6	
OR	(BOOL type)	7	
PCL	Pulse shortening device (BOOL type)	6	
PDE	Closing delay device (BOOL type)	5	

Designation	Function	Typ. runtime	Group
PDF	Breaking delay device (BOOL type)	6	
PST	Pulse stretching device (BOOL type)	6	
RSR	RS flip-flop, R-dominant (BOOL type)	6	
RSS	RS flip-flop, S-dominant (BOOL type)	6	
SH_DW	Shift block (DWORD type)	6	
TRK	Tracking/memory element (REAL type)	6	
TRK_D	Tracking/memory element (WORD type)	6	
XOR	Block (BOOL type)	6	
RDP	Reading drive parameters (REAL type)	14	System
RDP_D	Reading drive parameters (DOUBLE type)	14	
RDP_I	Reading drive parameters (INTEGER type)	15	
RDP_UD	Reading drive parameters (UNSIGNED DOUBLE INTEGER type)	15	
RDP_UI	Reading drive parameters (UNSIGNED INTEGER type)	16	
RDP_US	Reading drive parameters (UNSIGNED SHORT INTEGER type)	15	
SAH	Sample and hold (REAL type)	23	
SAH_B	Sample and hold (BOOL type)	23	
SAH_BY	Sample and hold (BYTE type)	24	
SAH_D	Sample and hold (DOUBLE type)	24	
SAH_I	Sample and hold (INTEGER type)	24	
SAV	Value buffering (REAL type)	5	
SAV_BY	Value buffering (BYTE type)	6	
SAV_D	Value buffering (DOUBLE type)	6	
SAV_I	Value buffering (INTEGER type)	6	
STM	Fault/alarm trigger	41	
WRP	Writing drive parameters (REAL type)	17	
WRP_D	Writing drive parameters (DOUBLE type)	13	
WRP_I	Writing drive parameters (INTEGER type)	17	
WRP_UD	Writing drive parameters (UNSIGNED DOUBLE INTEGER type)	18	
WRP_UI	Writing drive parameters (UNSIGNED INTEGER type)	16	
WRP_US	Writing drive parameters (UNSIGNED SHORT INTEGER type)	17	
DCA	Diameter calculator	16	Technology
INCO	Axial winder moment of inertia	51	
TTCU	Winding characteristic	25	
OCA	Software cam group	8	
WBG	Wobble generator	50	

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