SIEMENS

Operating Instructions

# SINAMICS

## SINAMICS DCM

Control Module

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# SINAMICS

# DCM
# SINAMICS DCM Control Module

Operating Instructions

Firmware Version V1.5


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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 personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

## Proper use of Siemens products

Note the following:

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

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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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# Preface

## Product name

The SINAMICS DCM Control Module documentation also uses the following product names:

- SINAMICS DCM
- SINAMICS DC MASTER

These designations are often (frequently in circuit diagrams and topology arrangements) used in these instructions as an alternative designation for the combination of SINAMICS DCM Control Module and external converter power unit.

## Device firmware version

As these Operating Instructions went to print, SINAMICS DCM Control Modules were being supplied from the factory with firmware version specified on the inside front page.

However, these Operating Instructions can, in principle, also apply to other firmware versions.

- **Older firmware versions:**
  It is possible that not all of the functions described here are actually available.
- **Newer firmware versions:**
  It is possible that SINAMICS DCM Control Modules 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 version is displayed using r50060[6].

Example:
01010203 displayed on the BOP20 means 01.01.02.03 → Version 1.1, Service Pack 2, Hotfix 3

When required, you can obtain the current firmware from your local Siemens sales office.

Download of the current firmware version for registered users
(https://support.industry.siemens.com/cs/ww/en/view/44029688)

**Note**

**Hardware/firmware compatibility**

The hardware version of the Control Unit (CUD) must be taken into account when updating the device firmware, see the following table.

The hardware version can be read from the label on the right-hand side of the CUD.

| CUD (print on label) | Executable firmware versions |
|---|---|
| C98043-A7100-**L1**-...<br>C98043-A7100-**L2**-...<br>C98043-A7100-**L100**-...<br>C98043-A7100-**L200**-... | 1.1, 1.2, 1.3 |
| C98043-A7100-**L3**-...<br>C98043-A7100-**L4**-...<br>C98043-A7100-**L103**-...<br>C98043-A7100-**L204**-... | All versions |
| A5E... | All versions |

## SINAMICS DCM documentation available

**SINAMICS DCM DC Converters Operating Instructions**

Contains all information on
ordering, installation, connecting, commissioning, maintaining, description of functions, and service

**SINAMICS DCM Control Modules Operating Instructions**

Contains all information on
ordering, installation, connecting, commissioning, maintaining, description of functions, and service

**SINAMICS DCM List Manual** (for DC converters and control modules)

Contains
parameter list, function diagrams, list of faults and alarms

**SINAMICS free function blocks, function description**

Includes a general description, list of parameters, the function block diagrams as well as the list of faults and alarms.

## Manuals and application notes on the Internet

The manuals and application documents are also available in the Internet:

Manuals (https://support.industry.siemens.com/cs/ww/en/ps/13298/man)

The list of general conditions available there include current supplements to the manuals. The notes included in the general condition lists have a higher priority than the statements made in the manuals.

## FAQ in the Internet

FAQ (http://support.automation.siemens.com/WW/view/en/38157755/133000)

## Service

You can find information on our services and regional contact persons in the Internet (https://support.industry.siemens.com/sc/ww/en/sc)

## Technical Support

Our technical support can provide you with technical assistance for products, systems, and solutions:

Service (https://support.industry.siemens.com/sc/ww/en/sc)

## Central hotlines for SINAMICS DCM technical support

| | | |
|---|---|---|
| European and African time zone | Service Request (https://support.industry.siemens.com/My/ww/en/requests#createRequest) | |
| America time zone | **24-hour hotline: +1 800 333 7421** | |
| | Tel.: +1 423 262 2960<br>Fax: +1 423 262 2200<br>email (mailto:support.america.automation@siemens.com) | 8:00 to 17:00<br>Eastern Standard Time |
| Asia/Australia time zone | Tel.: +86 1064 757575<br>Fax: +86 1064 747474<br>email (mailto:support.asia.automation@siemens.com) | 7:30 to 17:30<br>Beijing local time |

## Spare parts

You can find information on spare parts

- In catalog D23.1
- Via the electronic spare parts catalog Spares On Web, after entering the serial number and article number of your SINAMICS DCM in the Internet (registration required).

  Spares on Web (https://www.sow.siemens.com/)

## Websites of third parties

This publication contains hyperlinks to websites of third parties. Siemens does not take any responsibility for the contents of these websites or adopt any of these websites or their contents as their own, because Siemens does not control the information on these websites and is also not responsible for the contents and information provided there. Use of these websites is at the risk of the person doing so.

## Use of OpenSSL

This product contains software that has been developed by the OpenSSL project for use in the OpenSSL toolkit.

This product contains cryptographic software created by Eric Young.

This product contains software developed by Eric Young.

## Compliance with the General Data Protection Regulation

Siemens respects the principles of data protection, in particular the data minimization rules (privacy by design).

For this product, this means:
The product does not process neither store any person-related data, only technical function data (e.g. time stamps). If the user links these data with other data (e.g. shift plans) or if he stores person-related data on the same data medium (e.g. hard disk), thus personalizing these data, he has to ensure compliance with the applicable data protection stipulations.

## Further Internet links

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)

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# Safety instructions

# 1

## 1.1 General safety instructions

**⚠WARNING**

**Electric shock and danger to life due to other energy sources**

Touching live components can result in death or 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 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.

- Connect cable shields and unused conductors of power cables (e.g. brake conductors) at least on one side to the grounded housing potential.

**⚠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**

**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**

**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**

**Failure of pacemakers or implant malfunctions due to electromagnetic fields**

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment, such as transformers, converters, or motors. People with pacemakers or implants in the immediate vicinity of this equipment are at particular risk.

- If you have a heart pacemaker or implant, maintain a minimum distance of 2 m from electrical power equipment.

**⚠WARNING**

**Unexpected movement of machines caused by radio devices or mobile phones**

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

- If you come closer than around 2 m to such components, switch off any radio devices or mobile phones.
- Use the "SIEMENS Industry Online Support App" only on equipment that has already been switched off.

**⚠WARNING**

**Motor fire in the event of insulation overload**

There is higher stress on the motor insulation through a ground fault in an IT system. If the insulation fails, it is possible that death or severe injury can occur as a result of smoke and fire.

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

**⚠WARNING**

**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 inverters 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.

**⚠CAUTION**

**Hot component surfaces**

Certain components (e.g. the heat sink and reactor) can become very hot during operation. These components can remain hot for a long time after operation. Contact can result in serious injury, such as skin burns.

- Do not touch hot components, even after you have switched off the device.

**⚠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 live operation once you have guaranteed that the functions relevant to safety are running correctly.

**Note**

The OFF switch on the AOP30 operator panel does not have an EMERGENCY OFF function.

The OFF switch on the AOP30 operator panel does not have an STO function regarding functional safety.

## 1.2 ESD-sensitive components

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

**NOTICE**

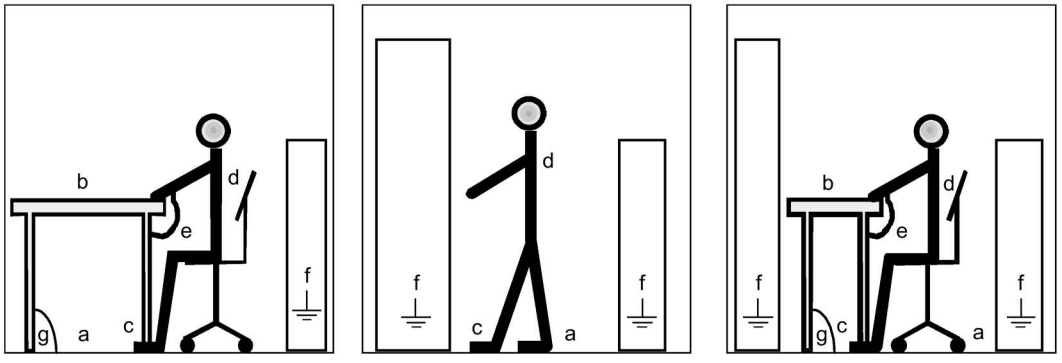
**Damage caused by electric fields or electrostatic discharge**

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).

The necessary ESD protection measures are elucidated once again in the following illustration:

Seated Standing Seated/standing




| | | | |
|---|---|---|---|
| a | Conductive floor | d | ESD overall |
| b | ESD Table | e | ESD wrist strap |
| c | ESD footwear | f | Cubicle ground connection |

## 1.3 Industrial security

**Note**

**Industrial Security**

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

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art Industrial Security concept. Siemens products and solutions only represent one component of such a concept.

The customer is solely responsible for preventing unauthorized access to its plants, systems, machines and networks. Systems, machines and components should only be connected to the company's network or the internet if and to the extent necessary and with appropriate security measures (e.g. use of firewalls and network segmentation) in place.

Additionally, Siemens' guidance on appropriate security measures should be taken into account. For more information about Industrial Security, please visit:

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

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

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at:

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

**⚠WARNING**

**Unsafe operating states resulting from software manipulation**

Software manipulation (e.g. viruses, trojans, malware or worms) can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.
- Make sure that you include all installed products into the holistic industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by applying suitable protection measures, e.g. virus scanners.

**Note**

**Industrial security Configuration Manual**

You can find a Configuration Manual on the topic of industrial security at this address (https://support.industry.siemens.com/cs/ww/en/view/108862708).

## 1.4 Residual risks of power drive systems

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

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

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

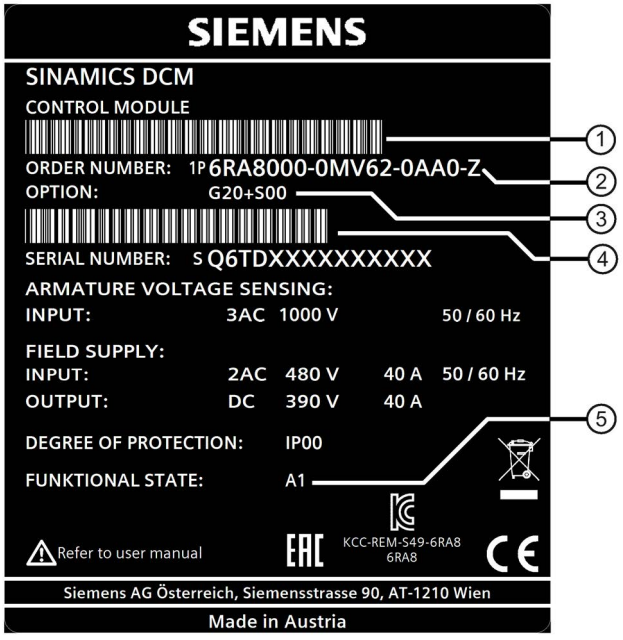
# Ordering information

# 2

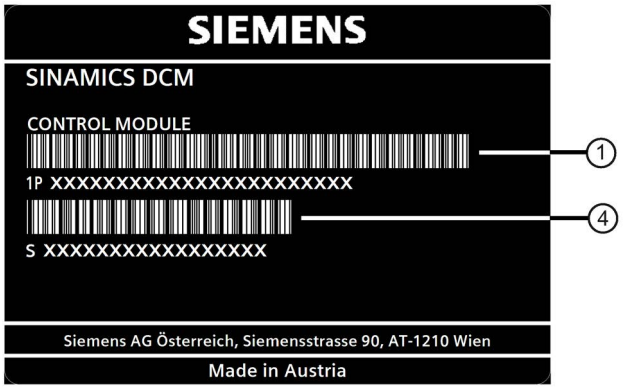
## 2.1 Device article numbers

| | |
|---|---|
| Without option: | 6RA8000 - 0MV62 - 0AA0 |
| With options: | 6RA8000 - 0MV62 - 0AA0 - Z |

## 2.2 Rating plates, packaging label




Rating plate on front cover




Rating plate in the device

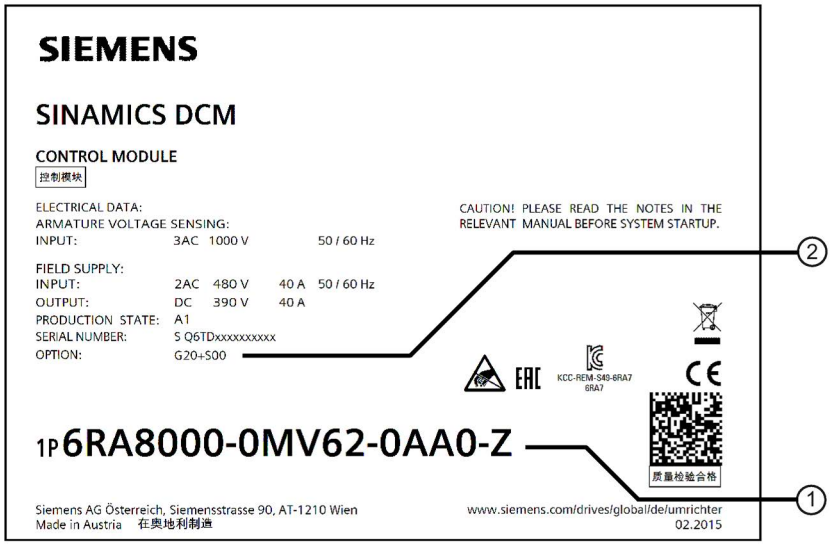
① Bar code for article number (MLFB)

② For options: "Z" after the article number

③ Order codes for options (according to ordering information for options) (order-specific)

④ Serial number bar code (order-specific)

⑤ Product version




① For options: "Z" after the article number
② Order codes for options (according to ordering information for options)

Figure 2-1 Packaging label

## 2.3 Ordering information for options and accessories

### Ordering information for options with order codes

6RA8000 - 0MV62 - 0AA0 - Z

□□□ + □□□ + □□□

□□□□□□□□□□

Article number of SINAMICS DCM Control Module with Z designation and order codes (multiple order codes together) and/or plain text, if necessary

Table 2- 1 Control Unit CUD options

| Option | Order codes |
|---|---|
| Advanced CUD in left slot | G00 |
| Standard CUD in right slot (possible with option G00) | G10 |
| Advanced CUD in right slot (possible with option G00) | G11 |
| CBE20 PROFINET, left (possible with option G00) | G20 |
| CBE20 PROFINET, right (possible with option G11) | G21 |
| CompactFlash card, left | S01 |
| Memory card, right (possible with options G10 and G11) | S02 |
| Note: Standard equipment = Standard CUD, left | |

Table 2- 2 Additional options

| Option | Order codes |
|---|---|
| Terminal Module Cabinet (TMC)<br>Can be snapped onto a 35 mm mounting rail.<br>Enables the simple connection of the CUD standard signals (X177) via spring-loaded terminals in an easily accessible area of the control cabinet.<br>The CUD is equipped with an adapter board. Terminal Module Cabinet and connecting cable (3 m) are supplied separately.<br>Notes:<br>• In the device version with option G63, the X177 terminal connections are no longer available directly on the CUD.<br>• When ordering, please specify which CUD (at the left or right slot) is to be equipped with the option.<br>• If two CUDs are to be equipped with option G63, the option must be ordered for each CUD. | G63 |
| Coated modules<br>Coated modules increase the degree of ruggedness with respect to climatic effects:<br>Relative / absolute humidity 5% to 95% / 1 to 29 g/m³ for ambient temperature or cooling medium temperature ≤30 °C<br>≤ 60% with the occurrence of $SO_2$ and $H_2S$ and/or for ambient temperature or cooling medium temperature 30 °C to 40 °C<br>Oil mist, salt mist, formation of ice, condensation, dropping, spray, splashing and jet-water not permissible. | M08 |
| Field power unit 2Q | L11 |
| Without field power unit | L10 |
| Nickel-plated copper bars (in the field power unit) | M10 |
| Control for switching over the power unit topology for devices connected in parallel and series<br>This option is described in the application document "12-pulse applications". | S50 |

## Ordering information for accessories

Table 2- 3 Articles numbers for accessories

| Article | Article number |
|---|---|
| Standard CUD retrofit kit<br>Combination of the spare parts, Standard CUD and connector board | 6RY1803-0AA00-0AA1 +<br>6RY1803-0GA00 |
| Standard CUD coated retrofit kit<br>Combination of the spare parts, Standard CUD coated and connector board coated | 6RY1803-0AA20-0AA1 +<br>6RY1803-0GA20 |
| Advanced CUD retrofit kit<br>Combination of the spare parts, Advanced CUD and connector board | 6RY1803-0AA05-0AA1 +<br>6RY1803-0GA00 |
| Advanced CUD coated retrofit kit<br>Combination of the spare parts, Advanced CUD coated and connector board coated | 6RY1803-0AA25-0AA1 +<br>6RY1803-0GA20 |
| Fuse monitoring module | 6RY1803-0CM02 |
| Fuse monitoring distributor<br>incl. 3 m ribbon cable to connect to the SINAMICS DCM Control Module;<br>can be snapped onto mounting rails according to DIN EN 50022-35x7.5 | 6RY1803-0CM26 |

| Article | Article number |
|---|---|
| CBE20 PROFINET | 6SL3055-0AA00-2EB0 |
| Memory card (equivalent to spare part for options S01 and S02) | 6RX1800-0AS01 |
| Terminal Module TM15 | 6SL3055-0AA00-3FA0 |
| Terminal Module TM31 | 6SL3055-0AA00-3AA0 |
| Terminal Module TM150 | 6SL3055-0AA00-3LA0 |
| Sensor Module Cabinet-Mounted SMC10 | 6SL3055-0AA00-5AA3 |
| Sensor Module Cabinet-Mounted SMC30 | 6SL3055-0AA00-5CA2 |
| SICROWBAR overvoltage protection | 1) |
| Fuses, reactors, filters | 2) |
| STARTER commissioning tool | 6SL3072-0AA00-0AG0 |
| Drive Control Chart (DCC) for SINAMICS | 6AU1810-1HA20-1XA0 |
| Drive Control Chart (DCC) for SINAMICS and SIMOTION | 6AU1810-1JA20-1XA0 |
| 1) Please contact your local Siemens office.<br>2) See Chapters "Line reactors (Page 112)" and "Fuses (Page 116)" or contact your local Siemens office | |

Table 2- 4 Article numbers for the Advanced Operator Panel AOP30

| Article | Article number |
|---|---|
| Advanced Operator Panel AOP30 | 6SL3055-0AA00-4CA5 |
| RS485 connecting cable for connecting the AOP30 to one CUD; 3 m | 6RY1807-0AP00 |
| RS485 connecting cable for connecting the AOP30 to two CUDs; 3 m | 6RY1807-0AP10 |
| Additional cable lengths can be ordered as option.<br>When ordering the RS485 cable with option, the suffix "-Z" must be attached to the article number followed by the order code for the required option.<br>Ordering example for a 35 m long cable:<br>Article number: 6RY1807-0AP00-Z, order code: K35 | |
| Cable length | Order code |
| 5 m | K05 |
| 10 m | K10 |
| 15 m | K15 |
| 20 m | K20 |
| 25 m | K25 |
| 30 m | K30 |
| 35 m | K35 |
| 40 m | K40 |
| 45 m | K45 |
| 50 m | K50 |

## Ordering information for cable sets

The SINAMICS DCM Control Module is supplied with front and rear plates mounted one on top of the other. The correct ribbon cables for this mounting type are already in place.

The cable sets listed below for connecting components (printed circuit boards or their parts) in the case of other mounting types (see Chapter "Connecting (Page 55)") are available on request.

Table 2- 5 Ordering information for cable sets

| Product description | Contents | For connecting | Article no. |
|---|---|---|---|
| Set of loose parts | Rear enclosure part including accessories for mounting the firing pulse transformer module and/or fuse monitoring module with a parallel connection | | 6RY1805-0CM00 |
| Set of loose parts | Screws, stud bolts, and snap-on parts for the external mounting of module parts | | 6RY1807-0CM00 |
| Prefabricated ribbon cable bridge set: for connecting the two plates when mounted at a distance from each other | 2 x 26-pin ribbon cable, shielded (L = 3 m) | from X21A, X22A on PCB "Power interface for the Control Module" to X21A, X22A on PCB "Firing pulse transformer module" | 6RY1807-0CM01 |
| | 1 x 10-pin ribbon cable, shielded (L = 3 m) | X23B on PCB "Power interface for the Control Module" to X23B on PCB "Fuse monitoring" | |
| | 1 x 20-pin ribbon cable, shielded (L = 3 m) | XF1 on PCB "Power interface for the Control Module" to XF1 on PCB "Field supply power unit" | |
| | 1 x RJ45 patch cable shielded (L = 3 m) | X45 on PCB "Power interface for the Control Module" to X45 on PCB "Voltage measurement" | |
| Prefabricated ribbon cable bridge set: for connecting the two plates when mounted at a distance from each other | 2 x 26-pin ribbon cable, shielded (L = 10 m) | from X21A, X22A on PCB "Power interface for the Control Module" to X21A, X22A on PCB "Firing pulse transformer module" | 6RY1807-0CM02 |
| | 1 x 10-pin ribbon cable, shielded (L = 10 m) | X23B on PCB "Power interface for the Control Module" to X23B on PCB "Fuse monitoring" | |
| | 1 x 20-pin ribbon cable, shielded (L = 10 m) | XF1 on PCB "Power interface for the Control Module" to XF1 on PCB "Field supply power unit" | |
| | 1 x RJ45 patch cable shielded (L = 10 m) | X45 on PCB "Power interface for the Control Module" to X45 on PCB "Voltage measurement" | |
| Prefabricated bridge set for current transformer | 2x 2-pin twisted cables (L = 2 m) | XB on PCB "Power interface for the Control Module" to the current transformers | 6RY1707-0CM03 |

| Product description | Contents | For connecting | Article no. |
|---|---|---|---|
| Prefabricated bridge set for current transformer | 2x 2-pin twisted cables (L = 10 m) | XB on PCB "Power interface for the Control Module" to the current transformers | 6RY1707-0CM04 |
| Prefabricated bridge set for recording heat sink temperature | 1x 2-pin twisted cables (L = 10 m) | XT5 or XT6 on PCB "Power interface for the Control Module" to temperature sensor on heat sink | 6RY1807-0CM05 |
| Prefabricated bridge set for firing pulse cables | Bridge set for 12 x 2-pin twisted cables (L = 3 m) | XIMP11, XIMP12, XIMP13, XIMP14, XIMP15, XIMP16, XIMP21, XIMP22, XIMP23, XIMP24, XIMP25, XIMP26 to thyristors | 6RY1707-0CM06 |
| Prefabricated bridge set for fuse monitoring | 6 x 2-pin twisted cables (L = 10 m) | XS1_5, XS2_5, XS3_5, XS4_5, XS5_5, XS6_5, XS7_5, XS8_5, XS9_5, XS10_5, XS11_5, XS12_5<br>or XS1_4, XS2_4, XS3_4, XS4_4, XS5_4, XS6_4, XS7_4, XS8_4, XS9_4, XS10_4, XS11_4, XS12_4<br>or XS1_3, XS2_3, XS3_3, XS4__3, XS5_3, XS6_3, XS7_3, XS8_3, XS9_3, XS10_3, XS11_3, XS12_3<br>or XS1_2, XS2_2, XS3_2, XS4_2, XS5_2, XS6_2, XS7_2, XS8_2, XS9_2, XS10_2, XS11_2, XS12_2<br>or XS1_1, XS2_1, XS3_1, XS4_1, XS5_1, XS6_1, XS7_1, XS8_1, XS9_1, XS10_1, XS11_1, XS12_1<br>depending on the voltage (50 V, 125 V, 250 V, 575 V, or 1,000 V) to fuses | 6RY1807-0CM07 |
| Prefabricated bridge set for voltage measurement | 1x 3-pin twisted cables U-V-W (L = 3 m) | XU6, XV6, XW6<br>or XU5, XV5, XW5<br>or XU4, XV4, XW4<br>or XU3, XV3, XW3<br>or XU2, XV2, XW2<br>or XU1, XV1, XW1<br>depending on the voltage (5.6 V, 50 V, 125 V, 250 V, 575 V, or 1,000 V) to the supply | 6RY1807-0CM08 |
| | 1x 2-pin twisted cables C-D (L = 3 m) | XC6, XD6 or XC5, XD5 or XC4, XD4 or XC3, XD3 or XC2, XD2 or XC1, XD1 depending on the voltage (5.6 V, 50 V, 125 V, 250 V, 575 V, or 1,000 V) to the supply | |
| Prefabricated bridge set for controlling firing pulse transformers | 12 x 2-pin twisted cables (L = 1 m) | from XIMP1, XIMP4 or XIMP2, XIMP5 or XIMP3, XIMP6 on PCB "Firing pulse transformer module" (side sections) to firing pulse transformer modules (single boards) with terminals X11, X12, X13, X14, X15, X16, X21, X22, X23, X24, X25, X26 | 6RY1707-0CM13 |

| Product description | Contents | For connecting | Article no. |
|---|---|---|---|
| Prefabricated bridge set for controlling firing pulse transformers | 2x 12-pin twisted cables (L = 10 m) | from XIMP1, XIMP4 and/or XIMP2, XIMP5 and/or XIMP3, XIMP6 on PCB "Firing pulse transformer module" to external firing pulse transformers | 6RY1707-0CM10 |
| Prefabricated bridge set for mounting plates next to each other | 2 x 26-pin ribbon cable, shielded (L = 0.68 m) | from X21A, X22A on PCB "Power interface for the Control Module" to X21A, X22A on PCB "Firing pulse transformer module" | 6RY1807-0CM11 |
| | 1 x 10-pin ribbon cable, shielded (L = 0.5 m) | X23B on PCB "Power interface for the Control Module" to X23B on PCB "Fuse monitoring" | |
| | 1 x 20-pin ribbon cable, shielded (L = 0.76 m) | XF1 on PCB "Power interface for the Control Module" to XF1 on PCB "Field supply power unit" | |
| | 1 x RJ45 patch cable shielded (L = 1 m) | X45 on PCB "Power interface for the Control Module" to X45 on PCB "Voltage measurement" | |

# Description

# 3

## Application

The SINAMICS DCM Control Module is mainly used for modifying and modernizing DC drives in existing systems.

Many DC systems still use analog technology. When such systems are modified or upgraded, the motor, mechanical parts, and power unit are retained, with just the closed-loop control section being replaced by a SINAMICS DCM Control Module. This is a highly cost-effective solution for those interested in a modern DC drive with the entire range of functions associated with the fully digital units in the SINAMICS DCM range.

A simple process of parameter assignment is all that is required in terms of adapting the product to the existing components' configuration.

The SINAMICS DCM Control Module contains a power unit for field supply with a rated current of up to 40 A.

## Structure

A striking feature of the SINAMICS DCM Control Module is its compact, space-saving structure. Its compact design makes it easier to service, as the individual components are readily accessible.

To make the most of the installation options existing systems have to offer, the SINAMICS DCM Control Module can be divided into smaller parts (from the top down).

The printed circuit board for generating and distributing firing pulses can also be divided up and, like the fuse monitoring and voltage measurement equipment, attached to the power unit directly, either partly or completely outside the device, with a cable providing the connection to the basic unit.

All connecting terminals can be accessed from the front.

The SINAMICS DCM Control Module has a Basic Operator Panel BOP20 in the front plate.

The BOP20 offers the following options:

- Commissioning the drive
- Display for all relevant measured values
- Display of faults and alarms and acknowledgment of faults
- Switching the drive on and off

The electronics (CUD) are available in the following versions:

- Standard CUD
- Advanced CUD (option)
  This CUD can be expanded to include a PROFINET module (CBE20) and features 2 DRIVE-CLiQ connections for connecting additional components from the SINAMICS drive system, as well as a connector for expansion purposes (to include a second CUD).
- Additional (second) CUD (Standard CUD or Advanced CUD) (option)
  This additional CUD can be fitted to the right of the first CUD and is used for system-specific extension of the SINAMICS DC MASTER functions.

## Additional components

- **Advanced Operator Panel AOP30**
  The optional Advanced Operator Panel AOP30 is installed outside of the unit – in the control cabinet door, for example – rather than inside it.
  The AOP30 ensures the following additional comfort:
  - Commissioning is supported by a wizard.
  - Measured values are represented by a graphical operation screen.
  - Displays a user-friendly parameter list, including text.
  - There are several editors for user-friendly setting and changing of parameters.
  - As well as help texts on individual faults and alarms, the fault and alarm messages which occur are listed.
  - Control of the drive (ON/OFF, setpoint specification, jog, direction of rotation reversal) is enabled "on-site".
  - Three LEDs display the drive status.
- **Additional module CBE20**
  The additional module CBE20 is inserted in the optional module slot of an Advanced CUD. It enables the SINAMICS DC MASTER to access the **PROFINET** network as a slave as well as to establish **SINAMICS Link** connections.
- **DRIVE-CLiQ components**
  The DRIVE-CLiQ interface enables components from the SINAMICS drive system to be connected.
  The following components are supported:
  - TM15 (digital inputs/outputs)
  - TM31 (digital inputs/outputs, analog inputs/outputs)
  - TM150 (temperature sensor inputs)
  - SMC10 (resolver evaluation for speed actual value sensing)
  - SMC30 (incremental encoder evaluation for actual speed value acquisition)

An SMC10 or SMC30 and up to three TMx modules can be connected to each CUD.

## Extended functions

- **Free function blocks (FBLOCKS)**
  In a wide variety of applications, a logic operation connecting several states (e.g. access control, system status) to a control signal (e.g. ON command) is required to control the drive system. However, in addition to logic operations, drive systems require mathematical operations and memory elements.
  These functions are available in the form of the "free function blocks" function module.

  A series of elementary function blocks are available that can be freely used:

  – Logic function blocks (AND, OR, XOR, inverter)

  – Calculation function blocks (adder, multiplier, divider, absolute-value generator)

  – Time function blocks (pulse generator, pulse contracting block, ON delay, OFF delay, pulse stretching)

  – Memory function blocks (RS flip-flop, D flip-flop)

  – Switch function blocks (binary selector switch, numerical selector switch)

  – Control function blocks (limiter, smoothing element, integrator, differentiator)

  – Complex function blocks (double-sided limit monitor with hysteresis)

- **Drive Control Chart (DCC)**
  DCC is available for applications requiring a more complex method of controlling the drive system which cannot be accomplished using the free function blocks. DCC makes it possible to generate a graphical depiction of a function diagram consisting of interconnected elementary function blocks and load it to the SINAMICS DC MASTER. The function diagram may contain up to 750 function blocks. It is possible to configure the time slices in which the individual parts of the function diagram are processed.
  Note:
  A DCC function diagram can be loaded not only to the CUD in the left-hand slot, but also to an optional second CUD in the right-hand slot.
  The automatic speed control processes are computed on the CUD in the left-hand slot, This means that only a restricted amount of computing capacity is available for a DCC function block diagram. In other words, either only a few function blocks can be computed, or computing can only be carried out in a long time slice.
  The CUD in the right-hand slot is primarily available (in addition to the operating system) for one DCC function diagram only.

- **Technology controller**
  Simple closed-loop control functions can be implemented with the technology controller, e.g.:

  – Liquid level control

  – Temperature control

  – Dancer roll position control

  – Pressure control

  – Flow control

  – Simple control without higher-level control

  – Tension control

# Technical data

# 4

**Note**

You can find the technical data for the connectors and terminals in the section titled "Connecting (Page 55)".

## 4.1 Environmental conditions

### Environmental classes according to EN 60721-3

Table 4- 1 Environmental classes

| Use | Environmental condition | Environmental class | Comment |
|---|---|---|---|
| Operation | Mechanical stability | see remark | • Vibratory load (test and measuring procedure according to EN 60068-2-6, Fc): Constant deflection = 0.075 mm at 10 ... 58 Hz Constant acceleration = 10 m/s² at 58 ... 200 Hz<br>• Shock load (test and measuring procedure according to EN 60068-2-27, Ea): Acceleration = 150 m/s² at 11 ms |
| | Climatic influences | 3K3 | No condensation, splash water, or icing allowed. For air temperature, see "Ambient temperature" below |
| | Biological influences | 3B1 | - |
| | Hazardous chemical substances | 3C1 | - |
| | Mechanically hazardous materials | 3S2 | - |
| Trans-portation | Mechanical stability | 2M2 | Tipping is not permitted. |
| | Climatic influences | 2K2 | Air temperature of -40 °C to +70 °C is permitted [1] |
| | Biological influences | 2B1 | - |
| | Hazardous chemical substances | 2C1 | - |
| | Mechanically hazardous materials | 2S1 | - |
| Storage | Mechanical stability | 1M2 | Tipping is not permitted. |
| | Climatic influences | 1K3 | Air temperature of -40 °C to +70 °C is permitted [1] |
| | Biological influences | 1B1 | - |
| | Hazardous chemical substances | 1C1 | - |
| | Mechanically hazardous materials | 1S1 | - |

[1] Only applies when product is in its original packing

### Ambient temperature

| Application | Tu [°C] | Comment |
|---|---|---|
| Transport, storage | -40 ... +70 | Only applies when product is in its original packing |
| Operation | 0 ... +55 | In order to ensure sufficient cooling for the electronics components, the supply air temperature needs to be reduced by 3.5 K/500 m for altitudes more than 1000 m above sea level. |

## 4.2 Unit data

Table 4- 2 Technical data for SINAMICS DC MASTER Control Module

| | | |
|---|---|---|
| Armature<br>Measurable rated supply voltage | V | 5.6 / 50 / 125 / 250 / 575 / 1000 |
| Electronics power supply,<br>rated supply voltage | V | 18 to 30 DC; In = 5 A |
| Rated field supply voltage [1] | V | 2-ph. 400 V AC (+15% / -20%)<br>2-ph. 480 V AC (+10% / -20%) |
| Rated frequency | Hz | The units automatically adjust to the frequency of the applied line voltage in a range from 45 to 65 Hz [3]. |
| Rated field DC voltage [1] | V | 325 / 390 |
| Rated field DC current | A | 40 |
| Closed-loop control constancy | | Δn = 0.006% of rated motor speed during operation with incremental encoder and digital setpoint<br>Δn = 0.1% of rated motor speed during operation with analog tachometer or analog setpoint [2] |
| Degree of protection | | IP00 acc. to DIN EN 60529 |
| Protection class | | Class I (with protective conductor system) and class III (PELV) to EN 61800-5-1 |
| Dimensions | | See Dimension drawings Chapter "Transport, unpacking, installation (Page 39)" |
| Weight | kg | 12 |

1) The field supply voltage may be below the rated field voltage (setting for p50078.1, input voltages of up to 85 V are permitted). The output voltage decreases accordingly.
This output voltage can no longer be achieved at voltages below 95% of the rated supply voltage.

2) Conditions:
The closed-loop control (PI control) constancy is referred to the rated motor speed and applies when the SINAMICS DC MASTER is in the warm operating state. This is subject to the following preconditions:
- Temperature changes of ± 10 °C
- Changes to the line voltage of +10%/-5% of the rated input voltage
- Temperature coefficient of the tachometer generator with temperature compensation: 0.15‰ every 10 °C (for analog tachometer generator only)
- Constant setpoint (14-bit resolution)

3) The option of operating with an extended frequency range can be provided on request.

# Transport, unpacking, installation 5

## 5.1 Transportation, unpacking

The SINAMICS DC MASTER is packaged at the manufacturer's site in accordance with the order specification. A product packaging label is located on the carton.

Avoid heavy vibration and severe shocks during transportation, e.g. when when lowering into position.

Follow the instructions on the packaging concerning transportation, storage and proper handling.

The SINAMICS DC MASTER can be installed once it has been unpacked, and you have checked that the delivery is complete and the unit is intact.

The packaging materials consist of the carton and corrugated cardboard. And can be disposed of in accordance with local regulations for cardboard packaging.

If you discover any damage that has occurred in transit, please inform your shipping agent immediately.

## 5.2 Installation

**⚠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.
- When assessing the risk, take into account remaining risks.

## 5.2.1 Dimension drawings

### Device

All dimensions in mm
Tolerance for external dimensions is +2 mm

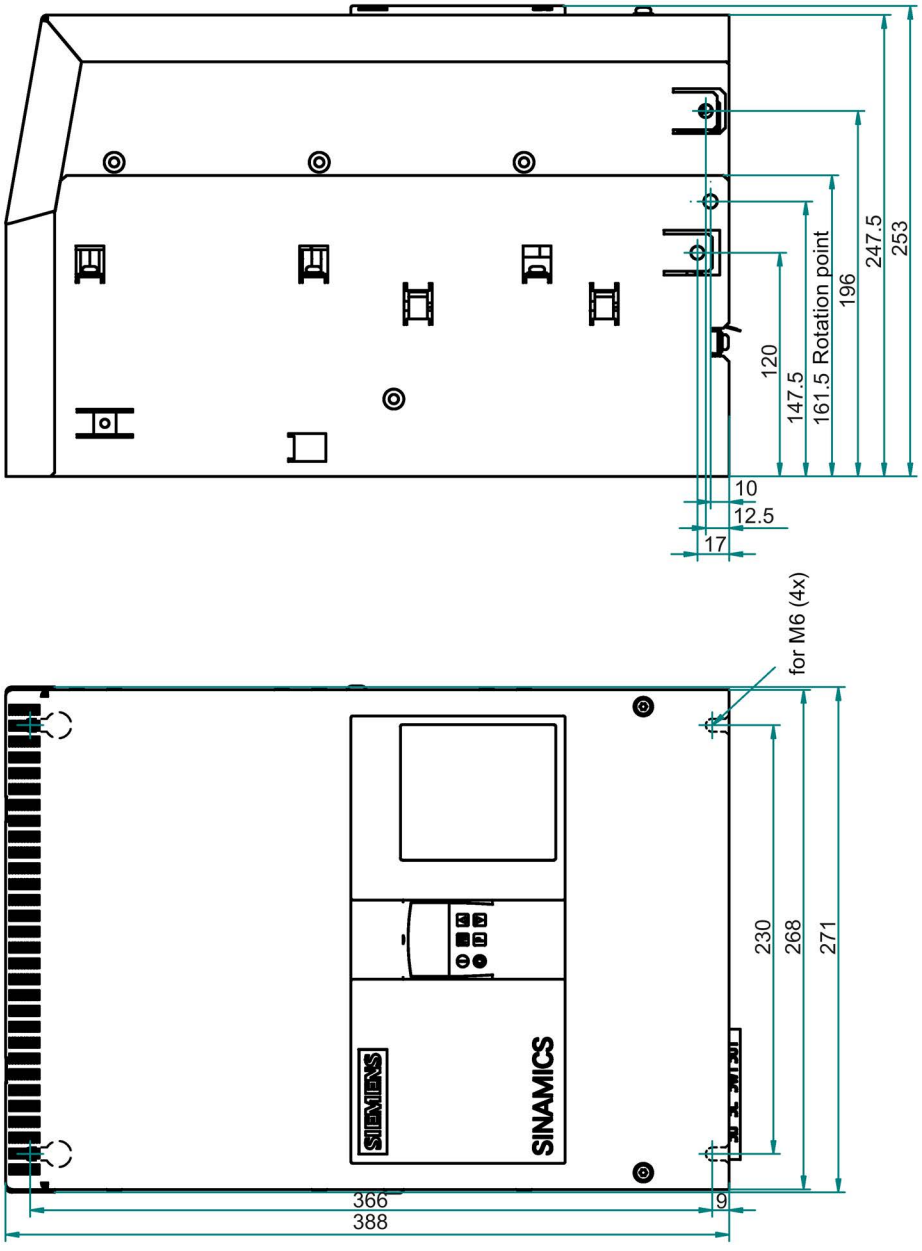



Figure 5-1 Device components after assembly (on delivery)

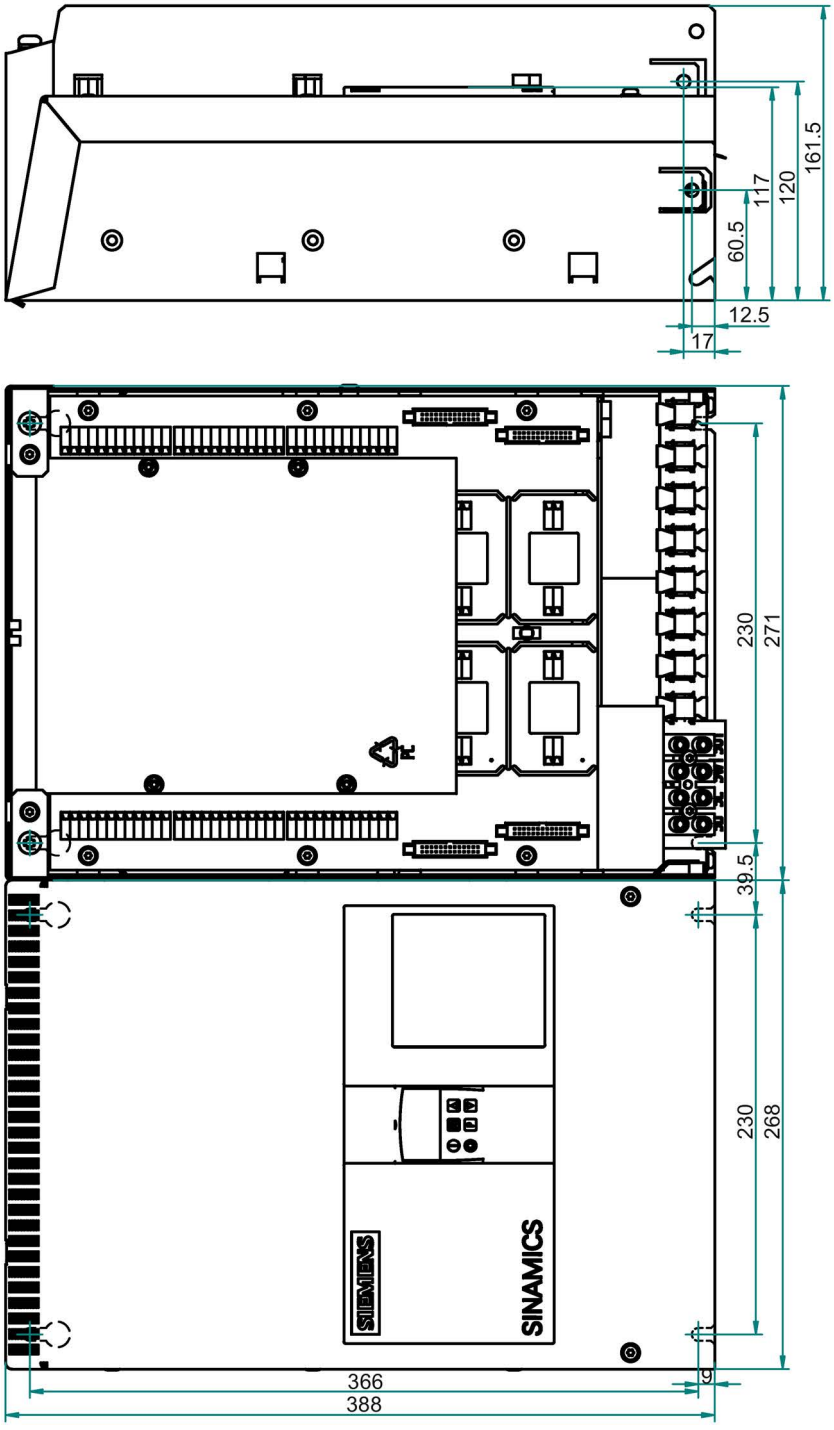



Figure 5-2 Device components arranged alongside each other

## Firing pulse transformer module

Dimensions of the complete module W × H = 260 × 298 mm

**Control PCB:**

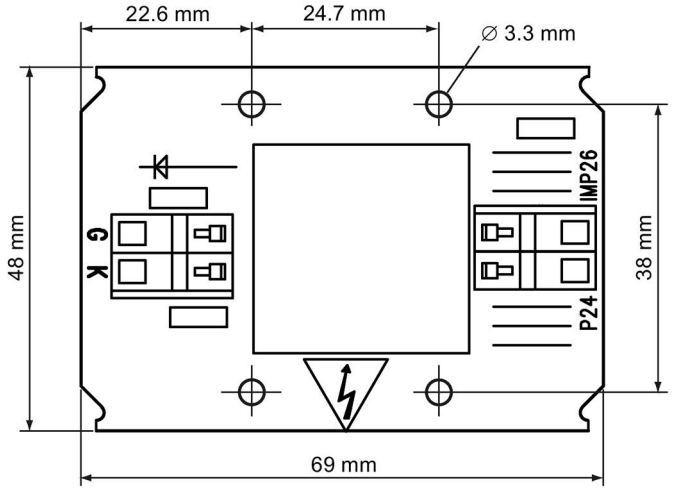
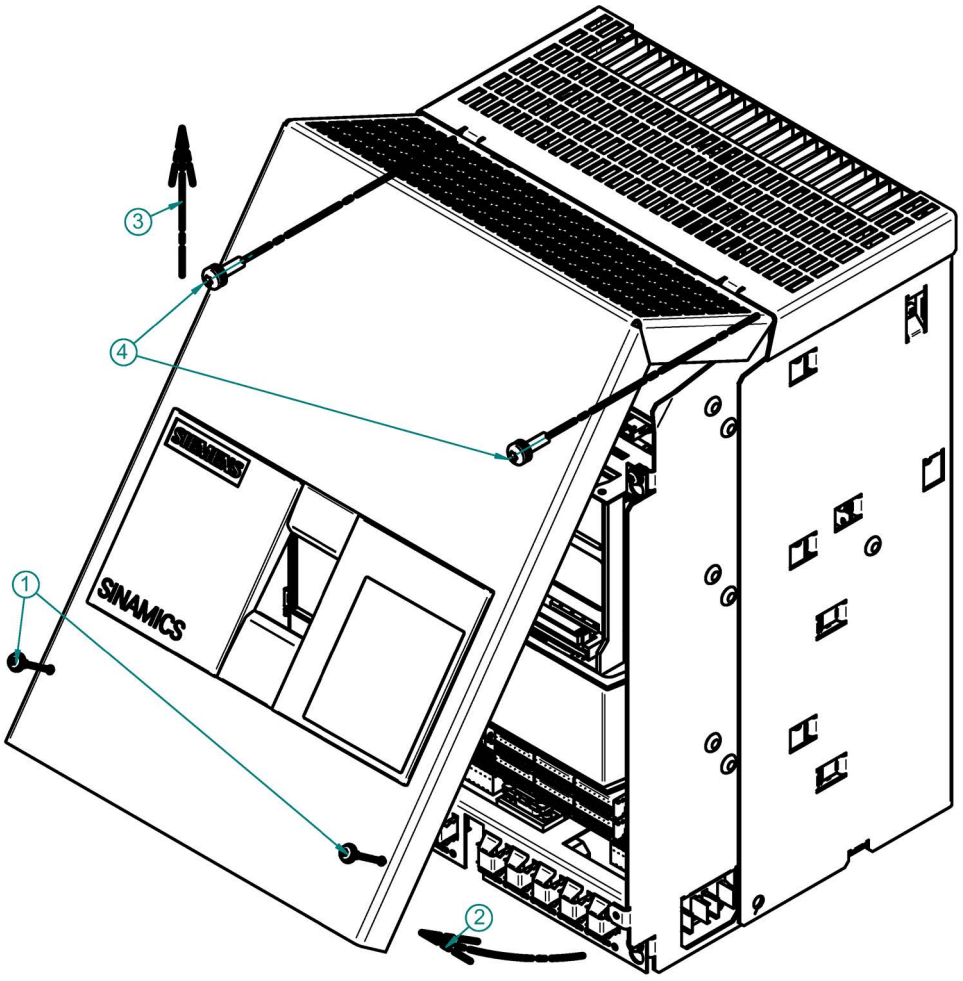


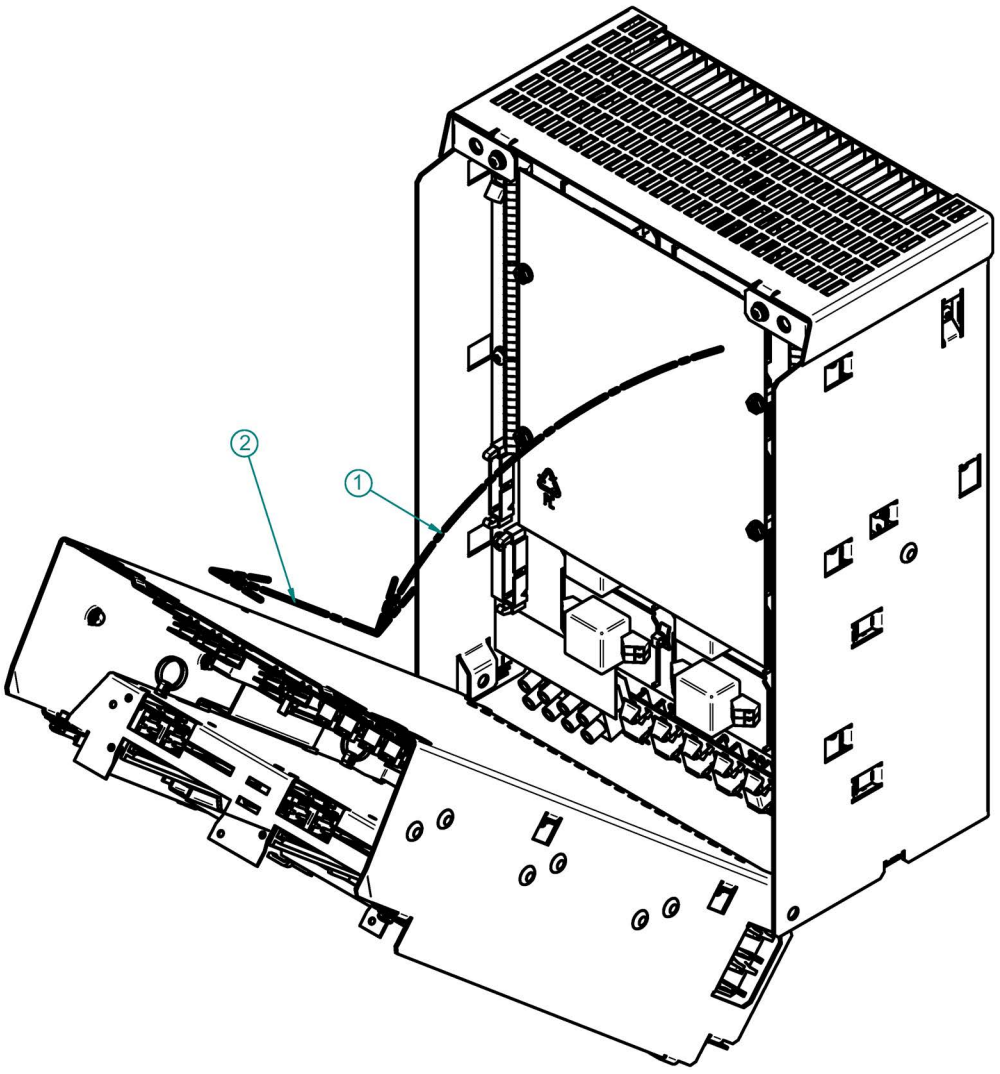

Figure 5-3 Dimension drawing, control PCB

## 5.2.2 Dividing the unit




1. Loosen the screws ①.
2. Pull the front cover towards you ② and then upwards to remove it ③.
3. Unplug the cable connections between the two plates.
4. Loosen the screws ④.

Figure 5-4 Dividing the unit (1)

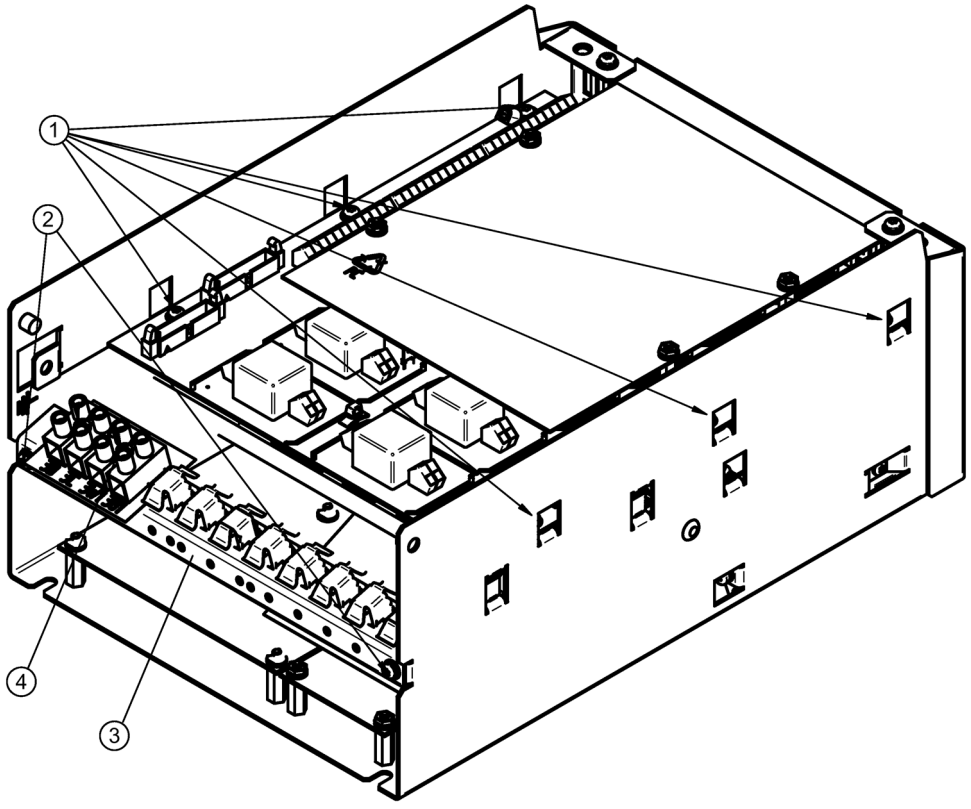



5. Pull the plate towards you ① and remove it ②.

Figure 5-5 Dividing the unit (2)

## 5.2.3 Removal/Installation and division of modules

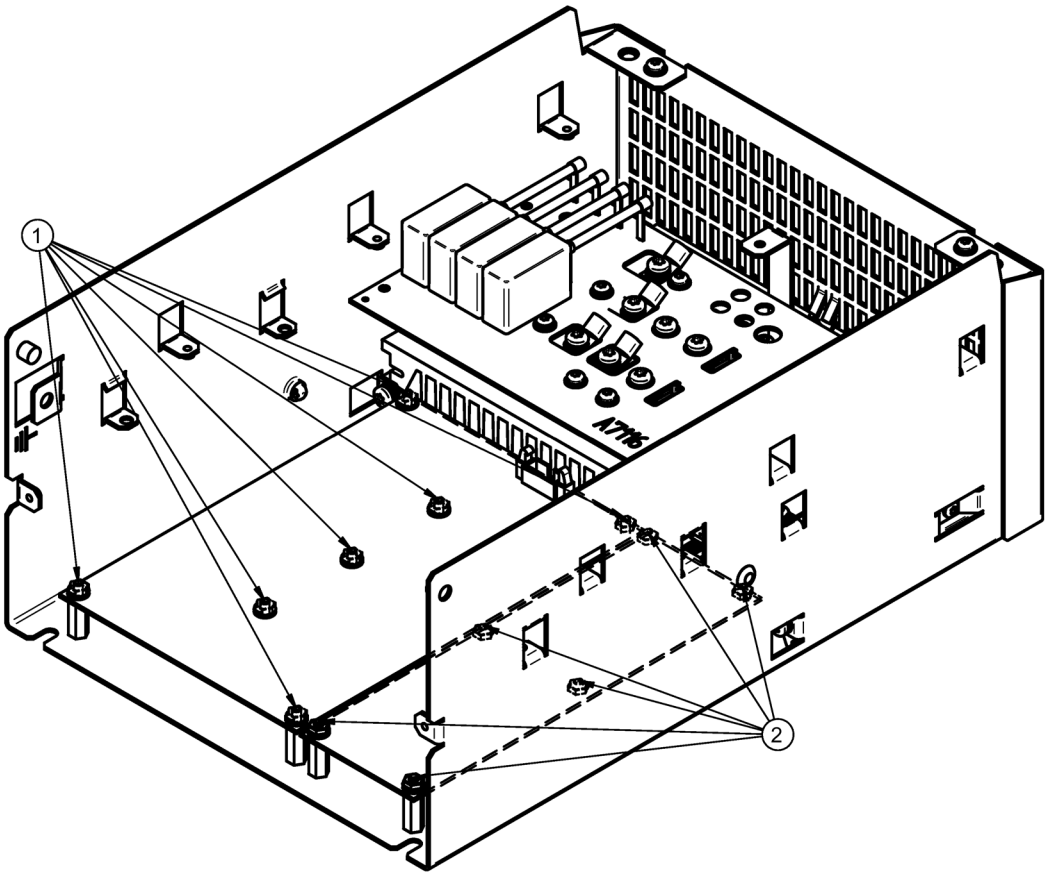
### 5.2.3.1 Removing modules




To remove the firing pulse transformer module, pull the cables out from the module and loosen the screws ①.

To remove other modules, remove the shield ③ by pulling it towards you. You will need to unscrew the field terminal ④ and then loosen the screws ② before doing this.

Figure 5-6 Removing modules (1)



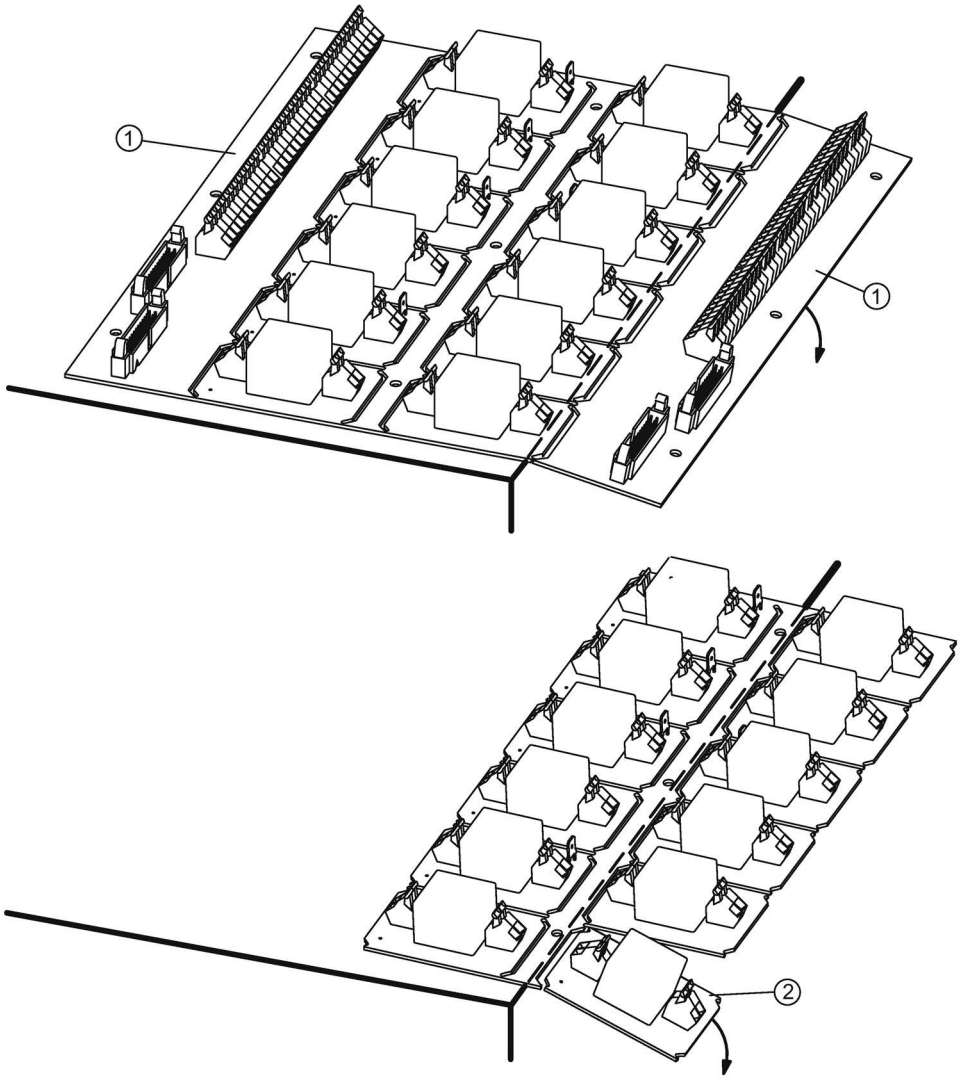

To remove the fuse monitoring equipment, pull the cables out from the module and loosen the screws ①.

To remove the voltage measurement equipment, pull the cables out from the module and loosen the screws ②.

Figure 5-7 Removing modules (2)

### 5.2.3.2 Firing pulse transformer module

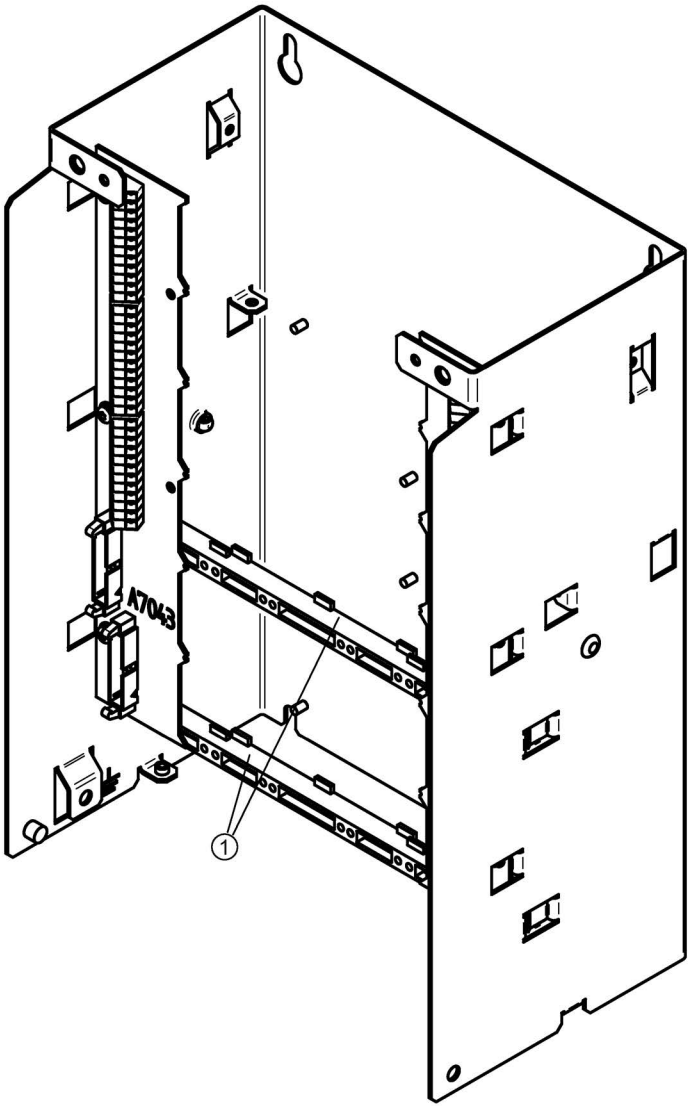
## Dividing the module




1. Use the edge of a table to separate the two terminal parts ①.
2. Use the edge of a table to separate the small control boards ②.

Figure 5-8 Dividing the firing pulse transformer module

## Installing terminal strips

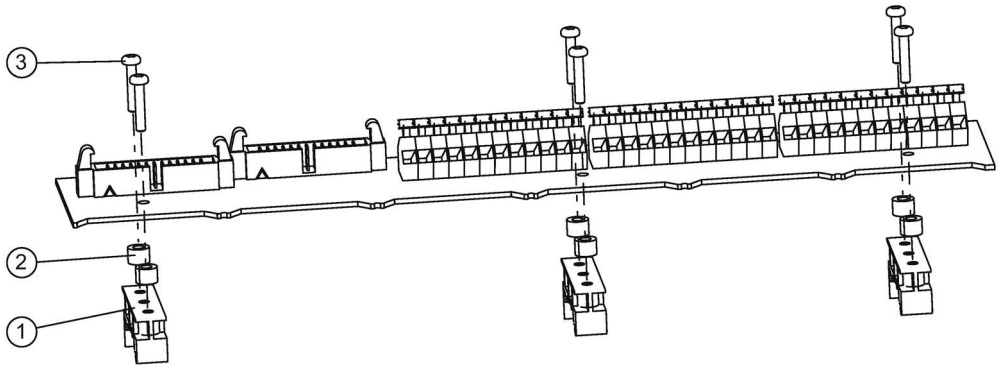



Leave the two crossbraces ① for supporting the side sections of the modules in the device.

Figure 5-9 Firing pulse transformer module

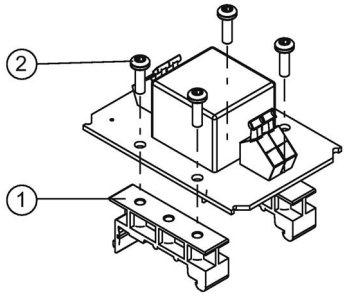
## External mounting of module parts

The parts required are not included in the scope of delivery, but are available as a "set of loose parts" under article no. 6RY1807-0CM00.




The three snap-on parts ① for the DIN rail, which satisfies DIN EN 50022-35x7.5, are mounted on the terminal strip with spacer rollers ② and M3x16 screws ③.

Figure 5-10 External mounting of the terminal strip

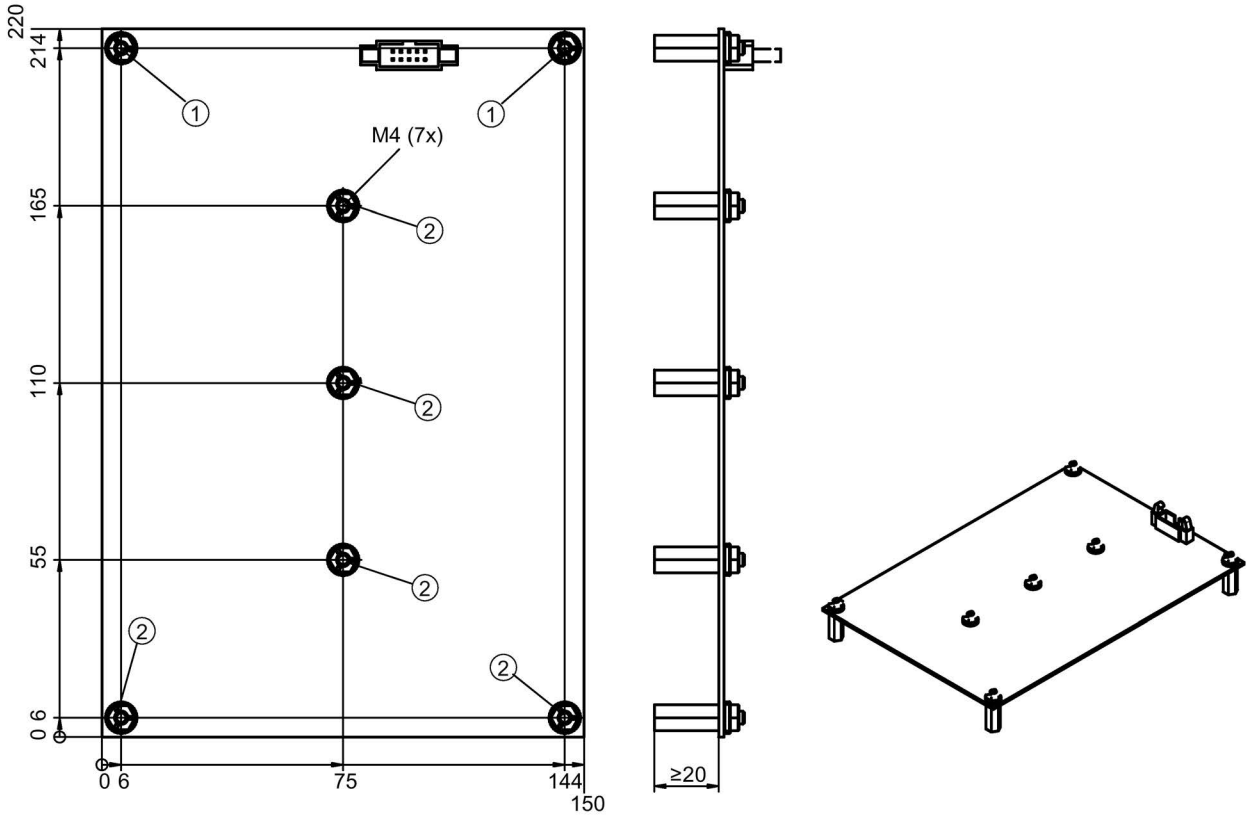



The two snap-on parts ① for the DIN rail, which satisfies DIN EN 50022-35x7.5, are mounted on the small control boards with M3x8 screws ②.

Figure 5-11 External mounting of the small firing pulse transformer boards

### 5.2.3.3 Fuse monitoring and voltage measurement

## External mounting of fuse monitoring equipment



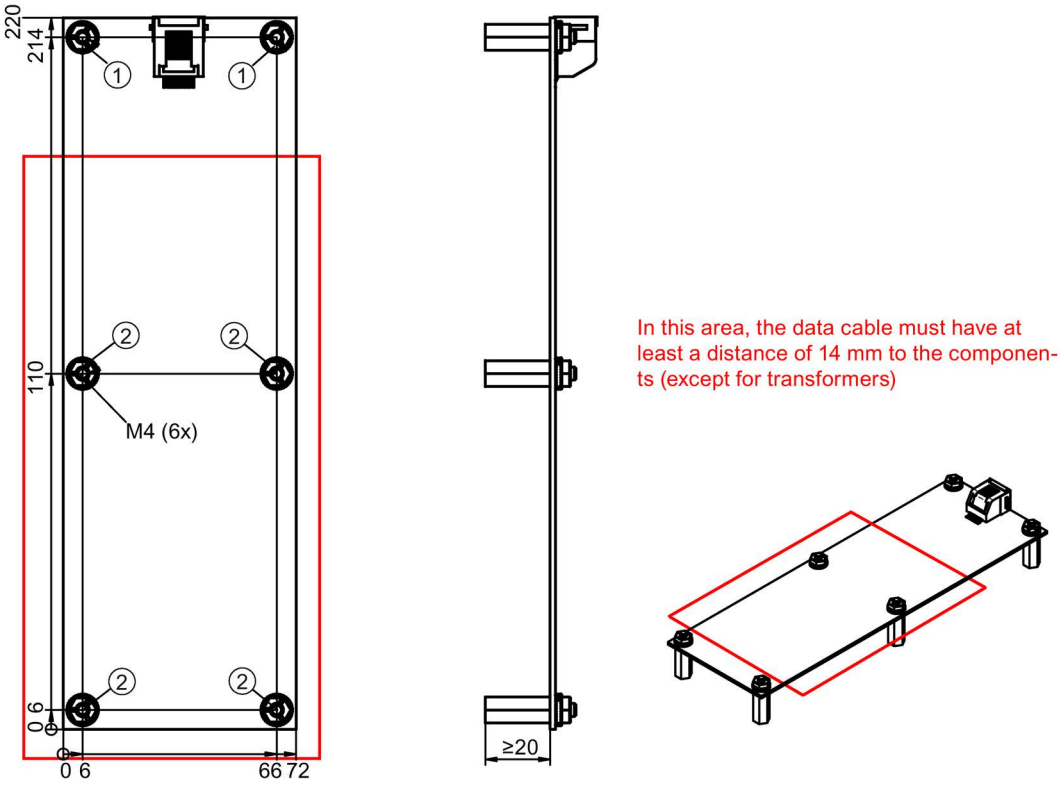

Mount the module on the spacing bolts.

① Ferrous fixing elements (x2)

② Insulating fixing elements (x5)

Figure 5-12 External mounting of the fuse monitoring equipment

## External mounting of voltage measurement equipment




Mount the module on the spacing bolts.

① Ferrous fixing elements (x2)

② Insulating fixing elements (x4)

Figure 5-13 External mounting of the voltage measurement equipment

## 5.2.4 Installing options and accessories

### 5.2.4.1 AOP30 operator panel

Installation cut-out required in the cabinet door: 197.5 × 141.5 mm

### 5.2.4.2 Fuse monitoring distributor

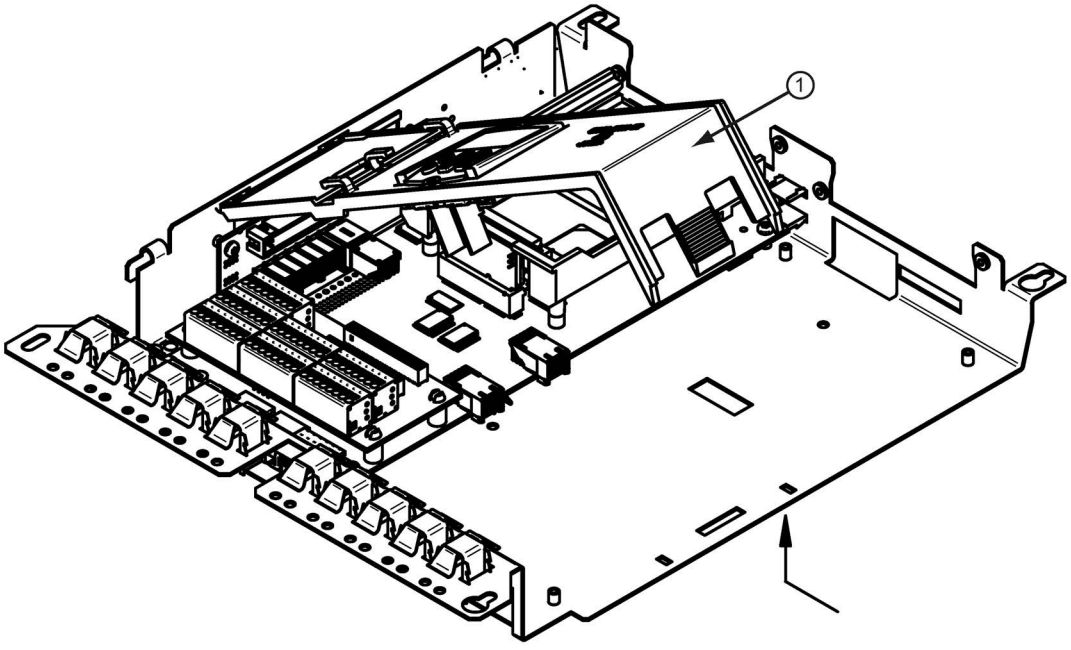
The module can be snapped onto a mounting rail according to DIN EN 50022-35x7.5.

### 5.2.4.3 Installing a second CUD

| NOTICE |
| --- |
| **Electrostatic-sensitive devices (ESD)** |
| Note the information provided on "Electrostatic sensitive devices (ESD)" in Chapter 1. |

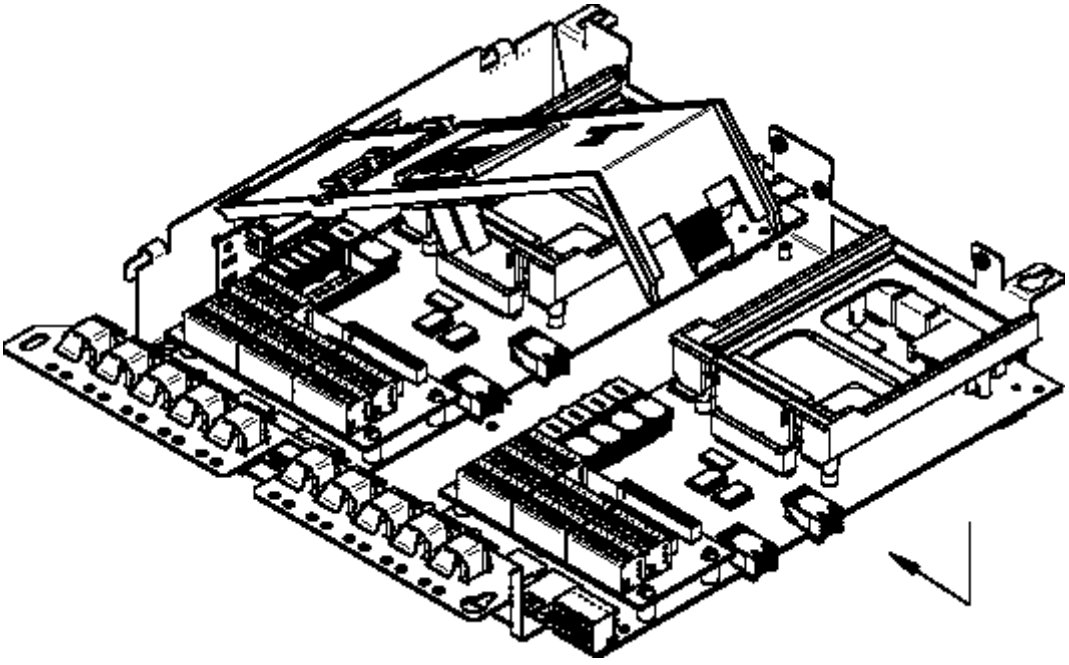
**Note**

Use the supplied mounting aid. See Chapter "Replacing the CUD (Page 656)".



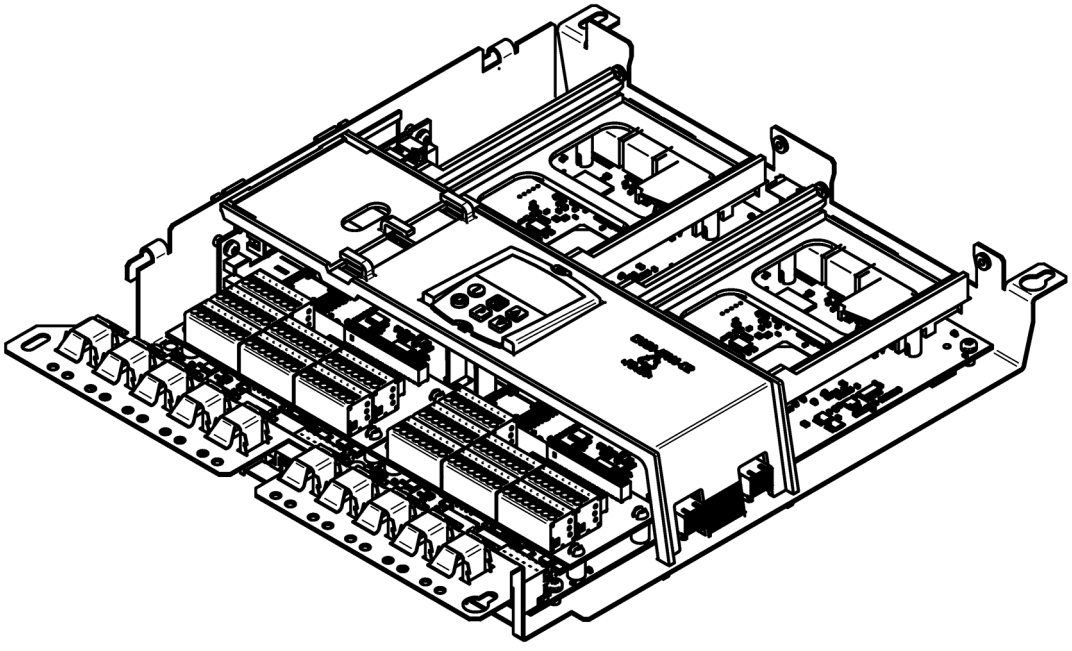

1. Unlock and tilt up the BOP support ①.

Figure 5-14 Installing a second CUD (1)



2. Mount the CUD and push it into the connectors for the left-hand CUD.
3. Secure the CUD using four screws (screw and washer assembly, M3×6), tightening torque 1 Nm

Figure 5-15 Installing a second CUD (2)



4. Lock the BOP support again.
   CAUTION: Do not clamp the BOP cable

Figure 5-16 Installing a second CUD (3)

# Connecting

# 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.
- When assessing the risk, take into account remaining risks.

**⚠WARNING**

**Electric shock due to the residual charge of the capacitors**

Because of the capacitors of the external power unit, 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 the absence of voltage by measuring all poles, also to ground.

The devices may be connected to a line supply with residual current operated circuit breaker if a universal current sensitive device is being used, which in the case of a ground fault, can also detect a DC component in the fault current. We recommend a residual current operated circuit breaker with an operating current ≥ 300 mA, which means that it is not suitable to protect personnel. If you have additional questions, please contact Technical Support.

The power and control terminals may be live even when the motor is not running.

When handling the device while it is open, remember that live parts are exposed. The device must only be operated with the front covers provided by the factory fitted. When required, additional covers should be provided in the control cabinet (for example, in the area around the busbars).

To operate the SINAMICS DC MASTER, both front cover fixing screws must be tight.

**⚠WARNING**

**Electric shock when connecting a PROFIBUS cable under voltage**

When connecting the PROFIBUS cable while voltage is present, there is a danger of coming into contact with live components behind the terminal.

Touching live components can result in death or serious injury.

- Only connect the PROFIBUS cable to connector X126 when the device is in a no-voltage condition.

**NOTICE**

**Surge arresters**

Surge arresters must be in compliance with IEC 60364-5-53:2002.

# 6.1 Instructions for EMC-compliant drive installation

**Note**

These installation instructions do not claim to contain all details and versions of devices, or to take into account all conceivable operational cases and applications.

Should you require further information or encounter specific problems which have not been dealt with in enough detail for your field of application, please contact your local Siemens office.

## 6.1.1 Basic information about 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 interference unacceptable for other devices in the environment". Therefore, the various devices used should not cause interference to one another.

Within the context of the EMC Directive, the SINAMICS DC MASTER devices described in this document are not "devices" 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 "devices" is used in many cases.

## Interference emissions and interference immunity

EMC is dependent upon two properties demonstrated by the devices involved in the system: interference emissions and interference immunity. Electrical devices may be sources of interference (senders) and/or potentially susceptible equipment (receivers).

Electromagnetic compatibility is ensured when the existing sources of interference do not impair the function of potentially susceptible equipment.

A device 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 EN 61800-3

Product standard EN 61800-3 describes the EMC requirements placed on "Variable-speed drive systems" (power drive systems). A variable-speed drive system (or Power Drive System PDS) consists of the drive converter and the electric motor including cables. The driven machine is not part of the drive system. EN 61800-3 defines different limit values depending on the location of the drive system, referred to as the first and second environments.

Residential buildings or locations at which the drive 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 which are powered from the medium-voltage network via their own transformers.

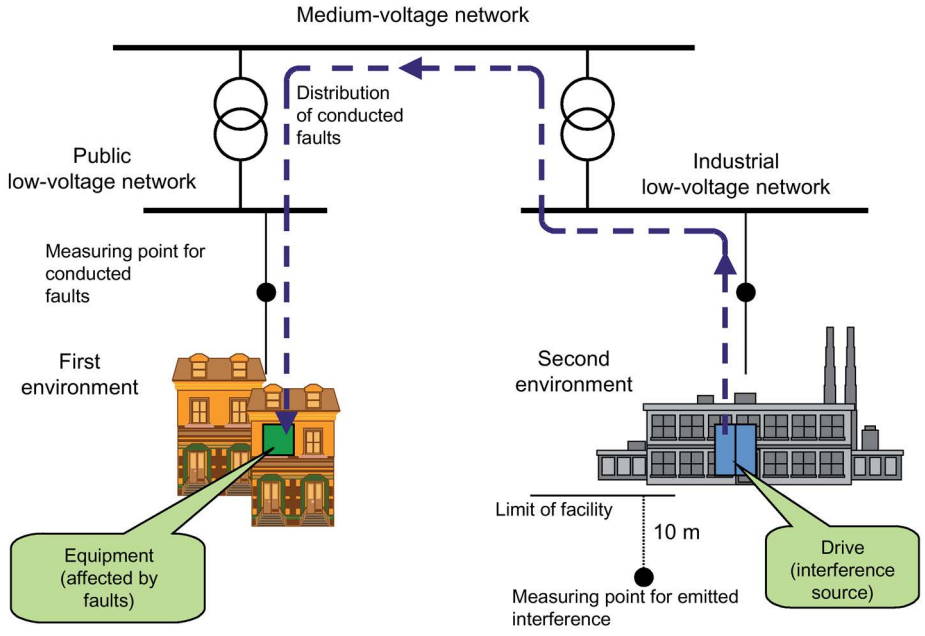



Figure 6-1 Definition of the first and second environments

Four different categories are defined in EN 61800-3 Ed.2 depending on the installation site and the power of the drive:

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

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

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

Category C4: Drive 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:

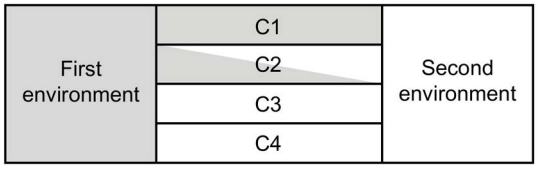



Figure 6-2 Definition of categories C1 to C4

SINAMICS DC MASTER devices are nearly always used in the second environment (Categories C3 and C4).

RFI suppression filters and line reactors are required whenever they are to be used in Category C2.

SINAMICS DC MASTER devices conform to the interference immunity requirements defined in EN 61800-3 for the second environment, and thus also with the lower interference immunity requirements in the first environment.

## SINAMICS DC MASTER: Industrial applications

Industrial applications demand that devices demonstrate an extremely high level of interference immunity, but by contrast place very low requirements on them in terms of interference emission levels.

SINAMICS DC MASTER converters are components of an electrical drive, such as contactors and switches. Qualified personnel must install them into a drive system which, as an absolute minimum, consists of the converter, motor cables and motor. Line reactors and fuses are also required in most cases. Therefore, whether or not a limit value is adhered to is determined by the components being installed correctly. Limiting interference emission levels in line with limit value "A1" according to EN 55011 requires not only the converter unit itself, but also the RFI suppression filter allocated to it and the line reactor, at the very least. Without a radio interference suppression filter, the interference emission level of SINAMICS DC MASTER converter units exceeds limit value "A1" of EN 55011.

If the drive forms part of a system, it does not initially need to fulfill any interference emission requirements, but the EMC Directive does require the system as a whole to be electromagnetically compatible with its environment.

If all the control components in the plant or system (such as PLCs) demonstrate a level of interference immunity that is suitable for industrial applications, then it is not necessary for every drive to adhere to limit value "A1".

### Non-grounded networks

Non-grounded networks (IT systems) are used in some branches of industry in order to increase the availability of the plant. In the event of a ground fault, no fault current flows and the plant can continue with production. If RFI suppression filters are brought into the equation, however, a fault current does flow in the event of a ground fault, which may cause the drives to shut down or the RFI suppression filter to potentially be destroyed. For this reason, the product standard does not define any limit values for these networks. From an economical perspective, any necessary EMC conformance measures should be taken on the grounded primary side of the supply transformer.

### EMC planning

If two devices are not electromagnetically compatible, you can reduce the interference emission level of the source of interference or increase the interference immunity of the potentially susceptible equipment. Sources of interference are generally power electronics devices with high power consumption; reducing their interference emission levels requires complex filters. Potentially susceptible equipment usually refers to controlgear and sensors, including their evaluation circuit. There is less work involved in increasing the interference immunity of inefficient devices, meaning that – economically speaking – increasing interference immunity is generally a more favorable option for industrial applications than reducing the interference emission level.

In industrial applications, EMC between devices should be based on a carefully-balanced combination of the interference emission and interference immunity levels.

The most cost-effective measure that can be put in place to achieve EMC conformance is to physically separate sources of interference and potentially susceptible equipment – provided that you have taken this option into account during the planning stage of your machine/plant. In the first instance, it is necessary to determine whether each device used is a potential source of interference or potentially susceptible equipment. Within this context, converter units and contactors, for example, can be counted as sources of interference. While examples of potentially susceptible equipment include PLCs, encoders and sensors.

The components in the control cabinet (sources of interference and potentially susceptible equipment) must be physically separated, by means of partition plates if necessary, or by installing them in metal enclosures.

## 6.1.2 EMC-compliant drive installation (installation instructions)

### General information

Not only are drives operated in a wide variety of environments, but the electrical components used (controllers, switch mode power supplies, and so on) can also differ widely with respect to interference immunity and interference emission levels, meaning that all installation guidelines of any kind can offer is a practical compromise. For this reason, EMC rules do not need to be implemented to the letter in all cases, provided that measures are tested on a case-by-case basis.

In order to ensure electromagnetic compatibility (EMC) in your control cabinets 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 design stages.

Rules 1 to 10 apply on a general level. Rules 11 to 15 must be followed in order to fulfill interference emission standards.

## Rules for EMC-compliant installation

1. Connect all metallic parts of the control cabinet to one another over a flat area with good conductivity (not paint against paint!). Use contact or scratch 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. Whenever possible, guide signal cables [1)] into the cabinet at one level only.
4. Unshielded cables in the same circuit (outgoing/incoming conductors) must be twisted where possible, or the area between them minimized, to prevent unnecessary frame antennae.
5. Connect spare wires to the cabinet ground [2)] at both ends. This achieves an additional shielding effect.
6. Avoid unnecessary cable lengths in order to keep coupling capacities and inductances low.
7. Crosstalk is generally reduced if the cables are laid close to the control cabinet ground. Do not, therefore, 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: You should aim for a minimum of 20 cm.
   If it is not possible to physically separate the encoder and motor cables, the encoder cable must be decoupled either using a metal partition or by laying it in a metal conduit. The partition or metal conduit must be grounded at several points.
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 mm² 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, and connected at several points outside the control cabinet.
   Foil shields should be avoided as they are 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.

Connecting a shield at one end prevents low-frequency, capacitive interference from being coupled in (e.g. 50 Hz hum). In this case, the shield should be connected in the control cabinet; a sheath wire may also be used for this purpose.

The cable to the temperature sensor on the motor (X177:53 to 55) must be shielded. The shield must be connected to ground at both ends.

11 Ensure that the RFI suppression filter is always located close to the suspected source of interference. The filter must be attached to the cabinet enclosure, mounting plate, etc., over a flat area. Incoming and outgoing cables must be physically separated.

12 RFI suppression filters must be used in order to conform to limit value class A1. Additional loads must be connected upstream of the filter (on the line side). The controller used and the manner in which the rest of the control cabinet is wired will determine whether an additional line filter needs to be installed.

13 A line reactor must be included in the field circuit for controlled field power supplies.

14 A line reactor must be included in the armature circuit of the converter.

15 The motor cables do not have to be shielded. There must be a clearance of at least 20 cm between the line supply feeder cable and the motor cables (field, armature). Use a partition if necessary.

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
Serial interfaces: e.g. PROFIBUS-DP

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.

## Cabinet configuration and shielding

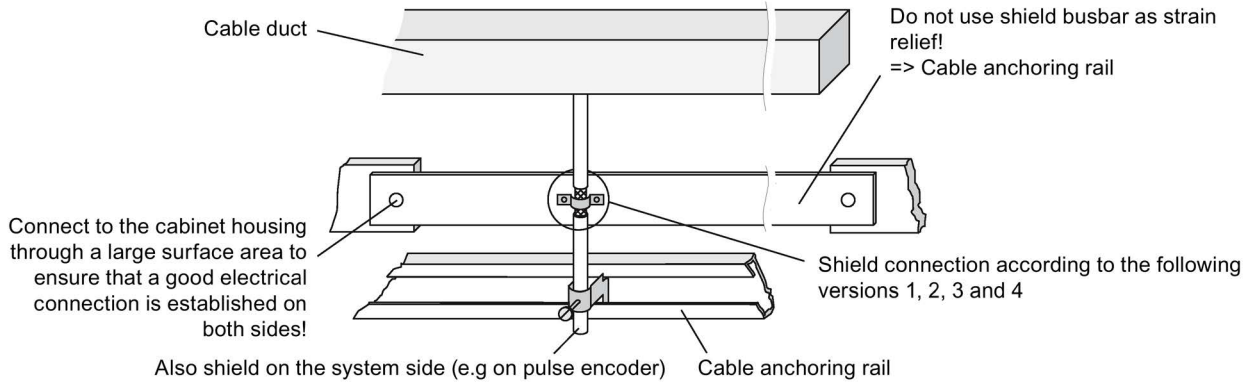



Figure 6-3 Shielding at control cabinet inlet

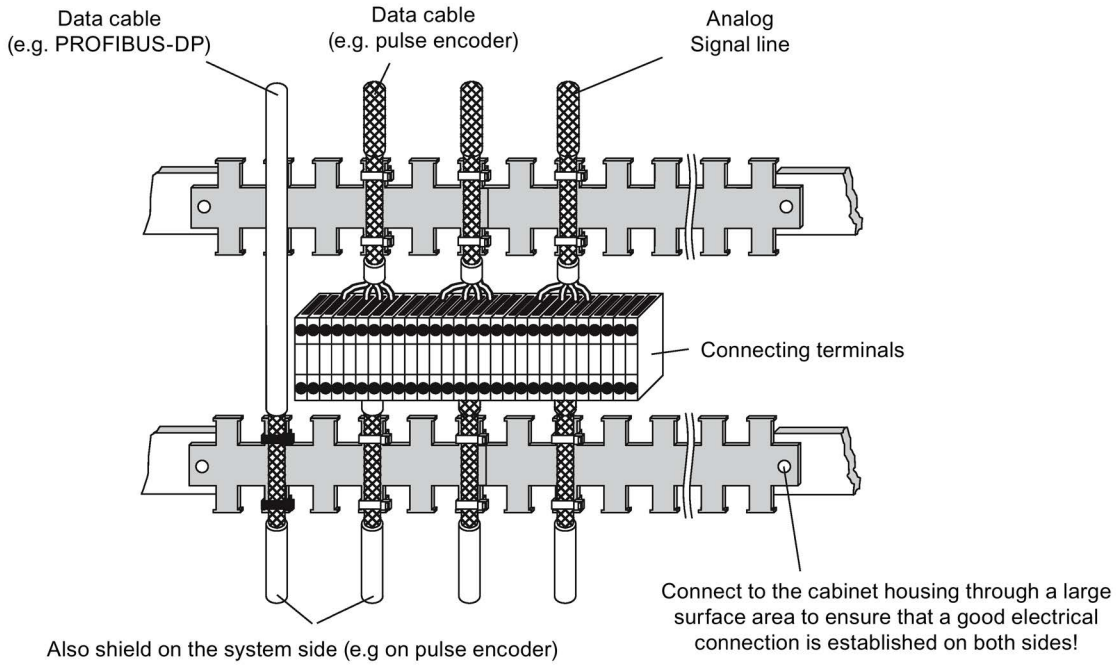



Figure 6-4 Shielding in control cabinet

## Connecting shields on the SINAMICS DC MASTER

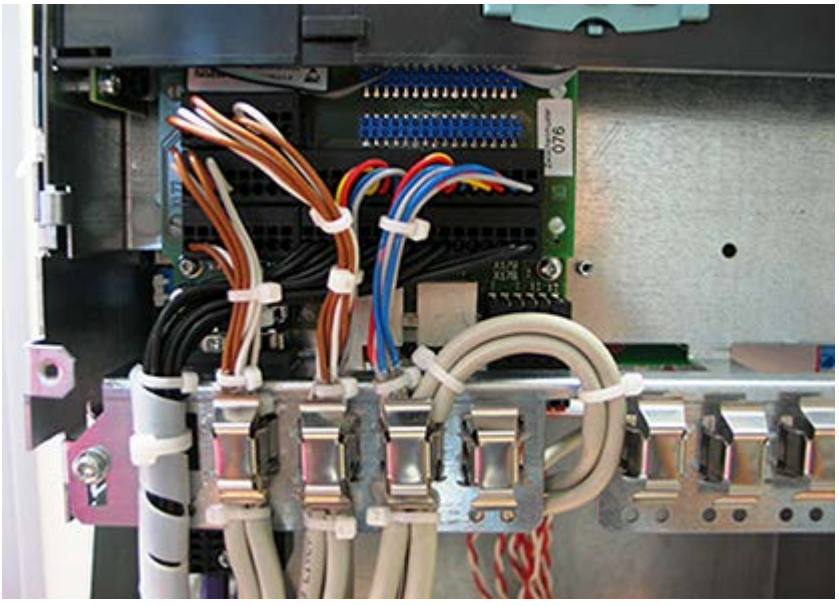


Figure 6-5 Connecting shields

**Note**

The strain relief of shielded cables and the shield support must be mechanically decoupled from one another.

## Radio interference suppression filters for the field circuit

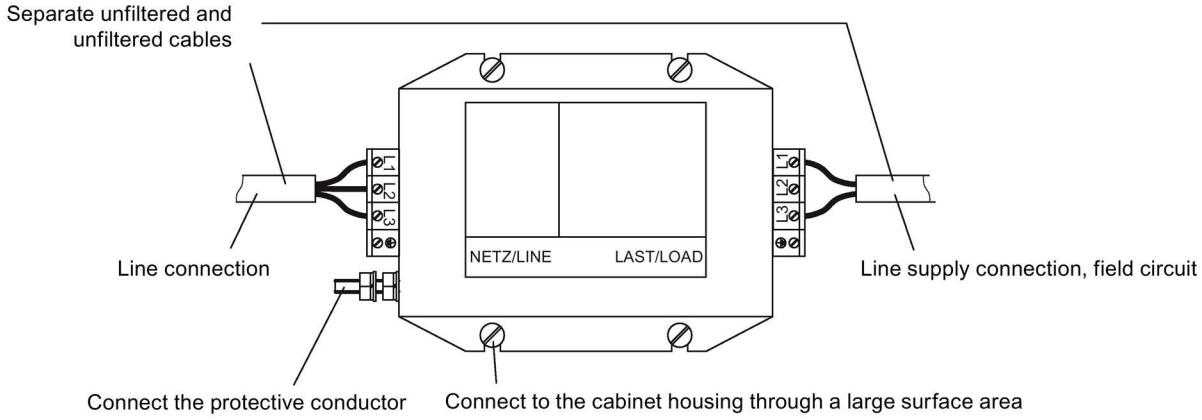
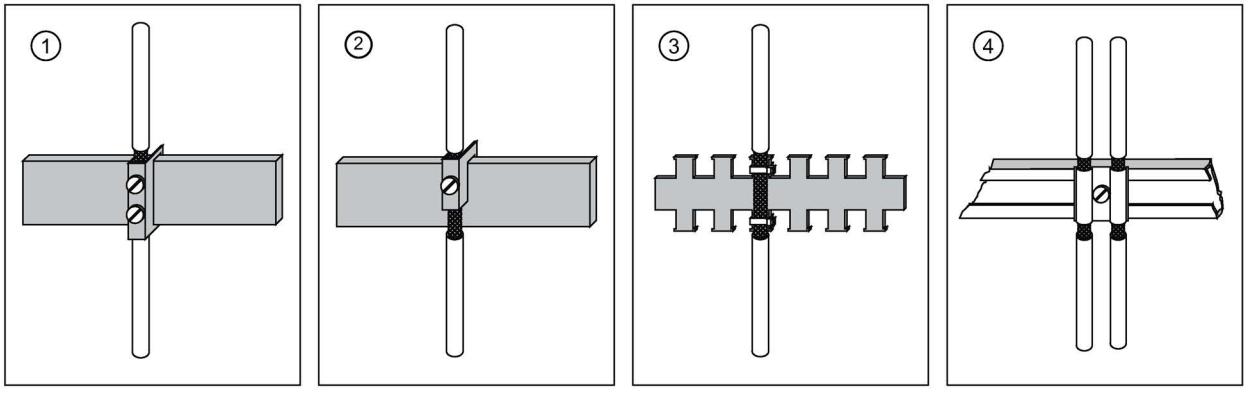



Figure 6-6 Radio interference suppression filters

## Shield connection




① Connecting terminal on copper bar, max. cable diameter 15 mm
Notice! Risk of pinching cable if screws tightened too much

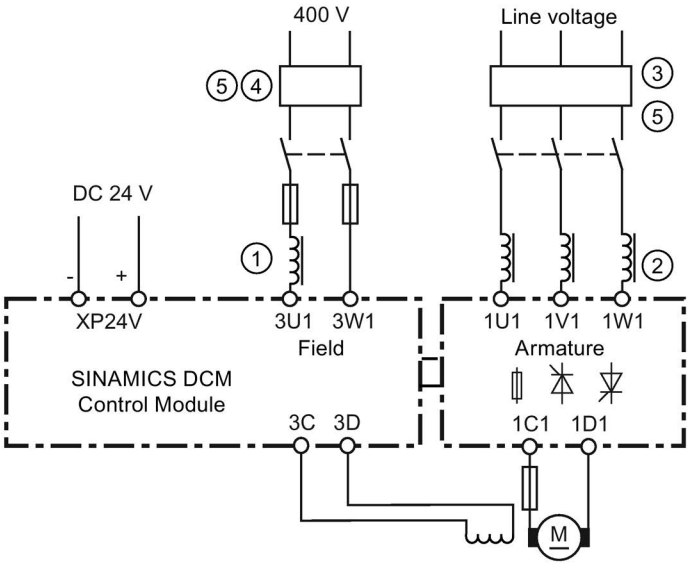
② Bus-mounting terminal on copper bar, max. cable diameter 10 mm
Notice! Risk of pinching cable if screws tightened too much

③ Ferrous tube or cable tie on bare ferrous comb-type/toothed bar

④ Clamp with ferrous backing plate on cable support rail

Figure 6-7 Shield connection

## 6.1.3 Arranging components for converter units




① The line reactor in the field circuit is dimensioned for the rated current of the motor field.

② The line reactor in the armature circuit is dimensioned for the rated motor current in the armature. The line current equals 0.82 times the DC current.

③ The RFI suppression filter for the armature circuit is dimensioned for the rated motor current in the armature. The line current equals 0.82 times the DC current.

④ The RFI suppression filter for the field circuit is dimensioned for the motor field's rated current.

⑤ If the supply voltages for the armature circuit and field circuit are the same, the supply voltages for the field can also be taken after the radio interference suppression filter for the armature circuit. In this case, the radio interference suppression filter must be dimensioned for the sum of the rated armature current times 0.82 and the rated field current. The armature circuit and the field circuit must always be separately protected.

Figure 6-8 Arrangement of reactors and RFI suppression filters

**NOTICE**

**Use of radio interference suppression filters**

When RFI suppression filters are being used, line reactors must always be used at the unit input to decouple the TSE circuit.

An incorrect arrangement can destroy a thyristor (short-circuit) and rupture a fuse.

- The components must be wired in the following order:
  Line supply – radio interference suppression filter – commutating reactor – power unit.

## 6.1.4 RFI suppression filter

Table 6- 1 Recommended RFI suppression filter from EPCOS

| Rated AC current Radio interference suppression filter A | TN / TT line supply V | Weight kg | IT line system V | Terminal cross-section mm² Hole for the screw M* | Article number EPCOS | Article number SIEMENS |
|---|---|---|---|---|---|---|
| **Line filters for armature circuit** | | | | | | |
| 25 | 760/440 | 4 | 580/335 | Terminal 10 mm² | B84143A0025R021 | - |
| 50 | 760/440 | 4 | 580/335 | Terminal 10 mm² | B84143A0050R021 | - |
| 80 | 760/440 | 9.5 | 630/365 | Terminal 25 mm² | B84143A0080R021 | 6RX1800 - 0LF03 |
| 120 | 760/440 | 10 | 630/365 | Terminal 50 mm² | B84143A0120R021 | 6RX1800 - 0LF13 |
| 180 | - | 13 | 690/400 | M10 | B84143B0180S024 | 6RX1800 - 0KF00 |
| 180 | 520/300 | 5 | 360/208 | M10 | B84143B0180S080 | 6RX1800 - 0GF00 |
| 180 | 760/440 | 5 | 560/320 | M10 | B84143B0180S081 | 6RX1800 - 0LF04 |
| 250 | 520/300 | 5 | 360/208 | M10 | B84143B0250S080 | 6RX1800 - 0GF01 |
| 250 | 760/440 | 5 | 560/320 | M10 | B84143B0250S081 | 6RX1800 - 0LF14 |
| 400 | - | 21 | 690/400 | M10 | B84143B0400S024 | 6RX1800 - 0KF02 |
| 400 | 520/300 | 7.5 | 360/208 | M10 | B84143B0400S080 | 6RX1800 - 0GF03 |
| 400 | 760/440 | 7.5 | 560/320 | M10 | B84143B0400S081 | 6RX1800 - 0LF07 |
| 600 | - | 22 | 690/400 | M10 | B84143B0600S024 | 6RX1800 - 0KF03 |
| 600 | 520/300 | 7.8 | 360/208 | M10 | B84143B0600S080 | 6RX1800 - 0GF04 |
| 600 | 760/440 | 7.8 | 560/320 | M10 | B84143B0600S081 | 6RX1800 - 0LF08 |
| 1000 | - | 28 | 690/400 | M12 | B84143B1000S024 | 6RX1800 - 0KF04 |
| 1000 | 520/300 | 18.5 | 360/208 | M12 | B84143B1000S080 | 6RX1800 - 0GF05 |
| 1000 | 760/440 | 18.5 | 560/320 | M12 | B84143B1000S081 | 6RX1800 - 0LF10 |
| 1600 | - | 34 | 690/400 | 2 x M12 | B84143B1600S024 | 6RX1800 - 0KF05 |
| 1600 | 520/300 | 24.5 | 360/208 | 2 x M12 | B84143B1600S080 | 6RX1800 - 0GF06 |
| 1600 | 760/440 | 24.5 | 560/320 | 2 x M12 | B84143B1600S081 | 6RX1800 - 0LF11 |
| 2500 | 530/310 | 105 | 460/265 | 4 x M12 | B84143B2500S020 | 6RX1800 - 0GF07 |
| 2500 | 760/440 | 105 | 560/320 | 4 x M12 | B84143B2500S021 | 6RX1800 - 0LF12 |
| 2500 | - | 105 | 690/400 | 4 x M12 | B84143B2500S024 | 6RX1800 - 0KF06 |
| **Line filters for auxiliary power supply** | | | | | | |
| 25 A | 520/300 A | 1.1 | 440/255 A | Terminal 4 mm² | B84143A0025R105 | 6RX1800 - 1GF00 |
| 50 A | 520/300 A | 1.75 | 440/255 A | Terminal 10 mm² | B84143A0050R105 | - |
| 66 A | 520/300 A | 2.70 | 440/255 A | Terminal 16 mm² | B84143A0066R105 | 6RX1800 - 1GF02 |
| 90 A | 520/300 A | 4.20 | 440/255 A | Terminal 35 mm² | B84143A0090R105 | - |
| 120 A | 520/300 A | 4.90 | 440/255 A | Terminal 35 mm² | B84143A0120R105 | 6RX1800 - 1GF04 |

Operating temperature 0 °C to 40 °C.

Rated frequency 50/60 Hz (± 6%).

Further information on the RFI suppression filters can be found on the Internet page of Epcos (Epcos (http://en.tdk.eu)).

Radio interference suppression filters generate leakage currents. In accordance with EN 61800-5-1, a PE connection with a cross-section of 10 $mm^2$ is required. For the filters to have maximum effect, it is absolutely essential that they and the device are installed on a single metal plate.

In the case of converters with a 3-phase connection, the minimum rated current of the filter is the same as the device's input current or output DC current, as specified on the device rating plate (see Armature Input and Armature Output respectively), times 0.82.

In the case of a two-phase connection (field supply), only two phases are connected to the three-phase radio interference suppression filter. In this case, the minimum rated current of the filter is the same as the input current (see Field input) or field DC current specified on the device rating plate.

## 6.1.5 Information on line-side harmonics produced by converter units in a fully-controlled two-pulse bridge circuit configuration (B6C and (B6)A(B6)C)

The majority of converter units for medium-power applications have a fully-controlled three-phase bridge circuit. Below is an example of the harmonics that can be found in a typical system configuration for two firing angles (α = 20° and α = 60°).

The values have been taken from a previous publication, "Oberschwingungen im netzseitigen Strom sechspulsiger netzgeführter Stromrichter (Harmonics in the Line-Side Current of Six-Pulse, Line-Commutated Converters)" by H. Arremann and G. Möltgen, Siemens Research and Development Division, Volume 7 (1978) No. 2, © Springer-Verlag 1978.

In addition, the formulas are specified which, depending on the actual operating data in use [line voltage (no-load voltage $U_{v0}$), line frequency $f_N$, and DC current $I_d$], can be used to calculate the short-circuit power $S_K$ and armature inductance $L_a$ for the motor for which the specified harmonics spectrum applies. If the actual line short-circuit power and/or actual armature inductance deviate from the values calculated in this way, then they will need to be calculated on a case-by-case basis.

The harmonics spectrum listed below is produced if the values for the short-circuit power $S_K$ at the connection point of the device and the armature inductance $L_a$ of the motor, calculated using the formulas below, match the actual system values. If the values do not match, the harmonics will have to be calculated separately.

a) α = 20°
Fundamental factor g = 0.962

| v | $I_v / I_1$ | v | $I_v / I_1$ |
|---|---|---|---|
| 5 | 0.235 | 29 | 0.018 |
| 7 | 0.100 | 31 | 0.016 |
| 11 | 0.083 | 35 | 0.011 |
| 13 | 0.056 | 37 | 0.010 |
| 17 | 0.046 | 41 | 0.006 |
| 19 | 0.035 | 43 | 0.006 |
| 23 | 0.028 | 47 | 0.003 |
| 25 | 0.024 | 49 | 0.003 |

b) α = 60°
Fundamental factor g = 0.953

| v | $I_v / I_1$ | v | $I_v / I_1$ |
|---|---|---|---|
| 5 | 0.283 | 29 | 0.026 |
| 7 | 0.050 | 31 | 0.019 |
| 11 | 0.089 | 35 | 0.020 |
| 13 | 0.038 | 37 | 0.016 |
| 17 | 0.050 | 41 | 0.016 |
| 19 | 0.029 | 43 | 0.013 |
| 23 | 0.034 | 47 | 0.013 |
| 25 | 0.023 | 49 | 0.011 |

The fundamental component of current $I_1$ as a reference variable is calculated using the following formula

$I_1 = g \times 0.817 \times I_d$

where $I_d$ is the DC current of the operating point under investigation and
where g is the fundamental factor (see previous table)

The harmonic currents calculated according to the previous table **only** apply for:

**I.) Short-circuit power $S_K$ at the location where the converter is connected**

$S_K = U^2_{v0} / X_N$ (VA)

with

$X_N = X_K - X_D = 0.03526 \times U_{v0} / I_d - 2\pi f_N \times L_D$ (Ω)

and

$U_{v0}$ No-load voltage on the power unit terminal V
$I_d$ Direct current of the operating point examined in A
$f_N$ Line frequency in Hz
$L_D$ Inductance of the commutating reactors used in H
$X_D$ Impedance of the commutating reactor
$X_N$ Impedance of the line
$X_K$ Impedance at the unit terminals

**II.) Armature inductance $L_a$**

$L_a = 0.0488 \times U_{v0} / (f_N \times I_d)$ (H)

If the actual values for the short-circuit power $S_K$ and/or armature inductance $L_a$ deviate from the values calculated using the previous formulas, a separate calculation procedure will need to be carried out.

**Example:**

Let us assume a drive with the following data:

$U_{v0} = 400$ V
$I_d = 150$ A
$f_N = 50$ Hz
$L_D = 0.169$ mH (4EU2421-7AA10 with $I_{Ln} = 125$ A)

With
$X_N = 0.03536 \times 400 / 150 - 2\pi \times 50 \times 0.169 \times 10^{-3} = 0.0412\ \Omega$

the network short-circuit power at the converter unit terminal is as follows:

$S_K = 400^2 / 0.0412 = 3.88$ MVA

and the armature inductance of the motor is as follows:

$L_a = 0.0488 \times 400 / (50 \times 150) = 2.60$ mH

The harmonic currents $I_v$ (with $I_1 = g \times 0.817 \times I_d$ for firing angles $\alpha = 20°$ and $\alpha = 60°$) that can be taken from the tables, **only** apply for the values $S_K$ and $L_a$ that have been calculated in this way. If the actual values deviate from these, a separate calculation will have to be made.

For the purpose of dimensioning filters and compensation equipment with reactors, it is only possible to draw on the information provided by the harmonics values calculated in this way if the values calculated for $S_K$ and $L_a$ match the actual drive values. In all other cases, a separate calculation procedure needs to be carried out (this particularly applies when using machines with compensation, as they demonstrate a very low armature inductance level).

## 6.1.6 Data on the line-side harmonics from converter units in a fully-controlled AC bridge circuit B2C

Converter units for lower power ratings can be connected and parameterized as fully-controlled AC bridge circuit.

Below is an example for the current harmonics of a typical system configuration of a field excitation controller (this is a system with a large DC circuit inductance). The case with the highest harmonic load of the line supply has been selected here.

For every motor used, a separate investigation must be performed to determine the actual harmonic load. In any case, the result will be less than in the example shown.

For comparison purposes, the table also includes the harmonic load of a B6C three-phase bridge at the same operating point as the field excitation controller.

| Harmonic order | B2C [2] | B6C [2] | Harmonic order | B2C [2] | B6C [2] |
|---|---|---|---|---|---|
| v | Iv / I | Iv / I | v | Iv / I | Iv / I |
| 1 [1] | 90.1% | 95.6% | 27 | 3.3% | |
| 3 | 30.0% | | 29 | 3.1% | 3.3% |
| 5 | 18.0% | 19.1% | 31 | 2.9% | 3.1% |
| 7 | 12.9% | 13.7% | 33 | 2.7% | |
| 9 | 10.0% | | 35 | 2.6% | 2.7% |
| 11 | 8.2% | 8.7% | 37 | 2.4% | 2.6% |
| 13 | 6.9% | 7.4% | 39 | 2.3% | |
| 15 | 6.0% | | 41 | 2.2% | 2.3% |
| 17 | 5.3% | 5.6% | 43 | 2.1% | 2.2% |
| 19 | 4.7% | 5.0% | 45 | 2.0% | |
| 21 | 4.3% | | 47 | 1.9% | 2.0% |
| 23 | 3.9% | 4.2% | 49 | 1.8% | 2.0% |
| 25 | 3.6% | 3.8% | | | |

[1] Fundamental content
[2] converter circuit

## 6.2 Cable routing in the unit

### Cable routing example

**Note**

Cables, which are not mechanically fixed in the device, must be externally fixed.

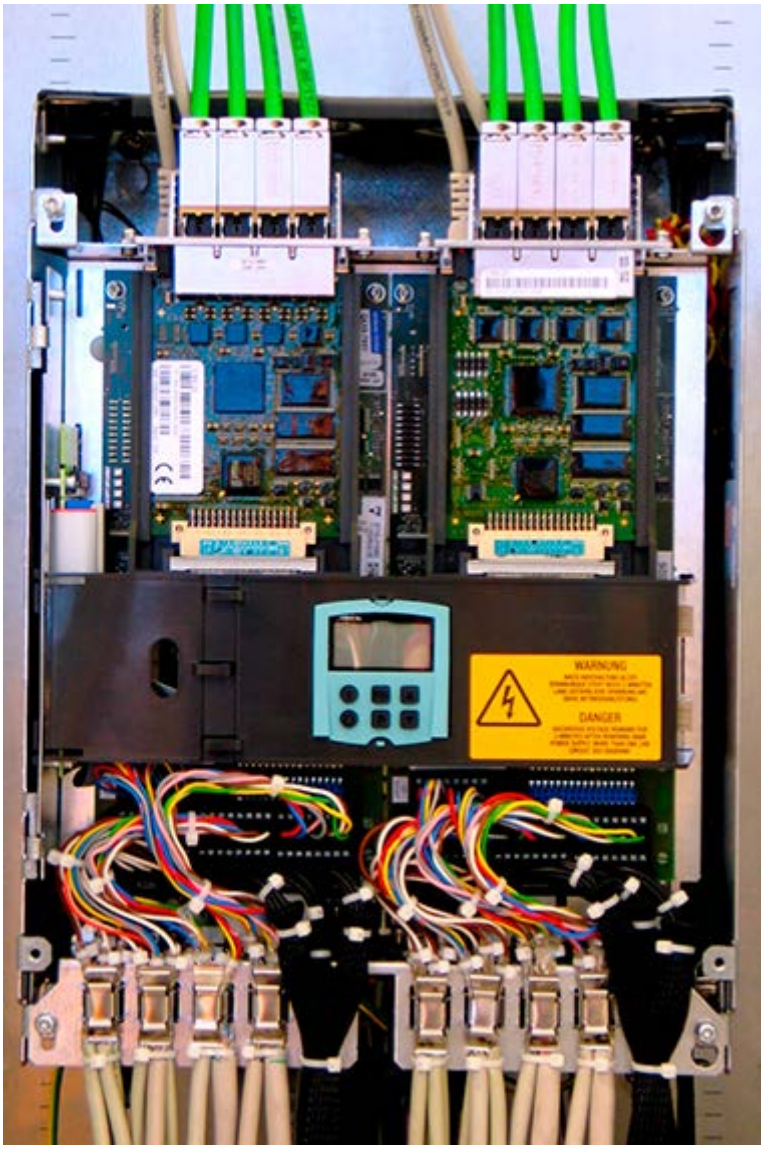
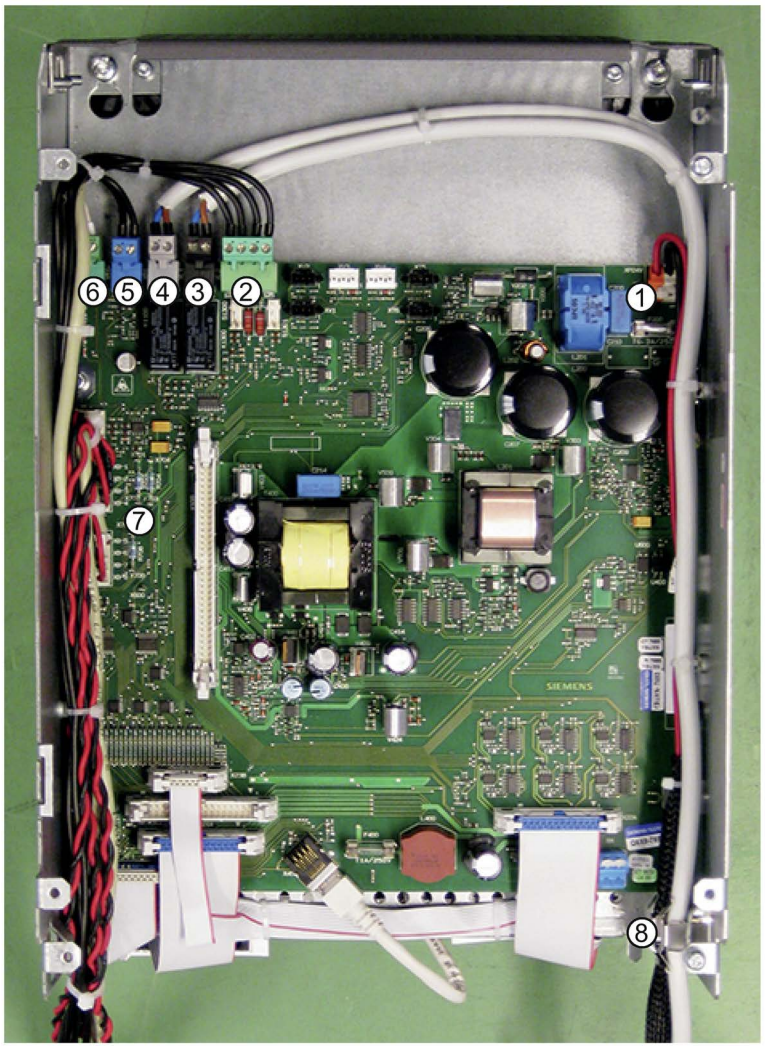



Figure 6-9 Example for cable routing when fully expanded

**Note**

The PROFINET cables must be routed into the device from the top (PROFINET is only available with Communication Board(s) CBE20).




① XP24V, electronics power supply connection
② XL1, fan monitoring input, external fault input
③ XL2, floating relay output for the fan. Mechanically attach the cable using one of the shield clamps ⑧ at the side of the enclosure.
④ XR1, floating relay output for the line contactor. Mechanically attach the cable using one of the shield clamps ⑧ at the side of the enclosure.
⑤ XS1, E-STOP connection
⑥ XT1, analog tachometer connection
⑦ XB, current transformer connection

Route all cables into the device from the bottom. Cable clamps are provided at the side panels to mechanically fix the cables.

Figure 6-10 Cable routing, power interface

**PROFIBUS cable connection** (cannot be seen in the previous diagrams):

1. Route the PROFIBUS cables into the device from the bottom
2. Screw the PROFIBUS bus connector to connector X126 at the CUD using the two screws
3. A shield support is not required in the device

**⚠WARNING**

**Electric shock during connection while voltage is present**

When connecting the PROFIBUS cable while voltage is present, there is a danger of coming into contact with live components behind the terminal.

Touching live components can result in death or serious injury.

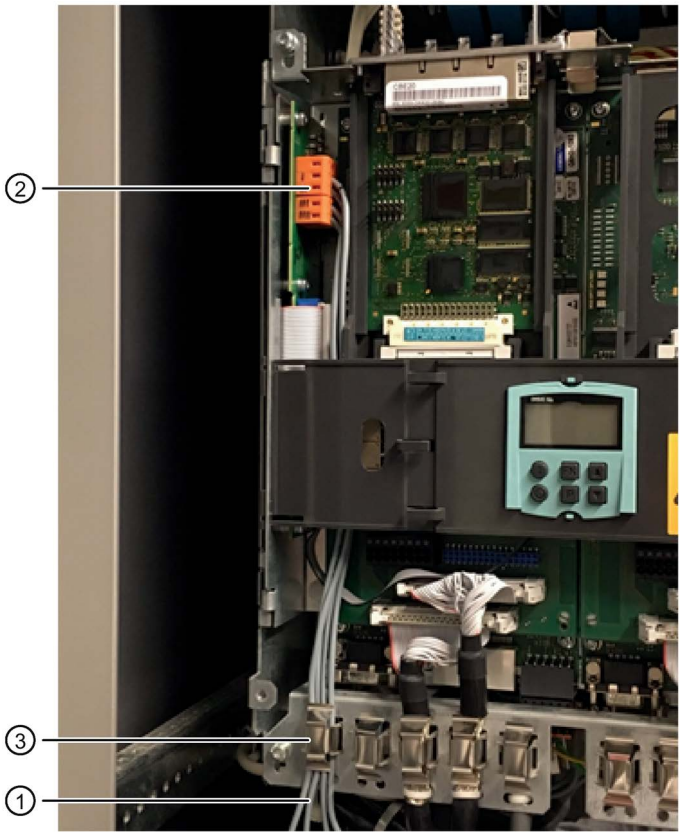
- Only connect the PROFIBUS cable to connector X126 when the unit is in a de-energized state.

**Note**

**Routing the PROFIBUS connection**

If the PROFIBUS bus connector is connected and removed in a system during operation, the system manufacturer must ensure that the PROFIBUS connection is routed outwards.

## Routing the functional safety cable




① Route the cable into the device from the bottom.
② Connect the cable to terminals X200, X201.
③ Strain relief of the cables through positioning on shield clamps on the lower edge of the housing.

Figure 6-11 Routing the functional safety cable

**Note**

It is not required to use shielded cables and shield connection in the device.

## 6.3 Block diagram with connection suggestion

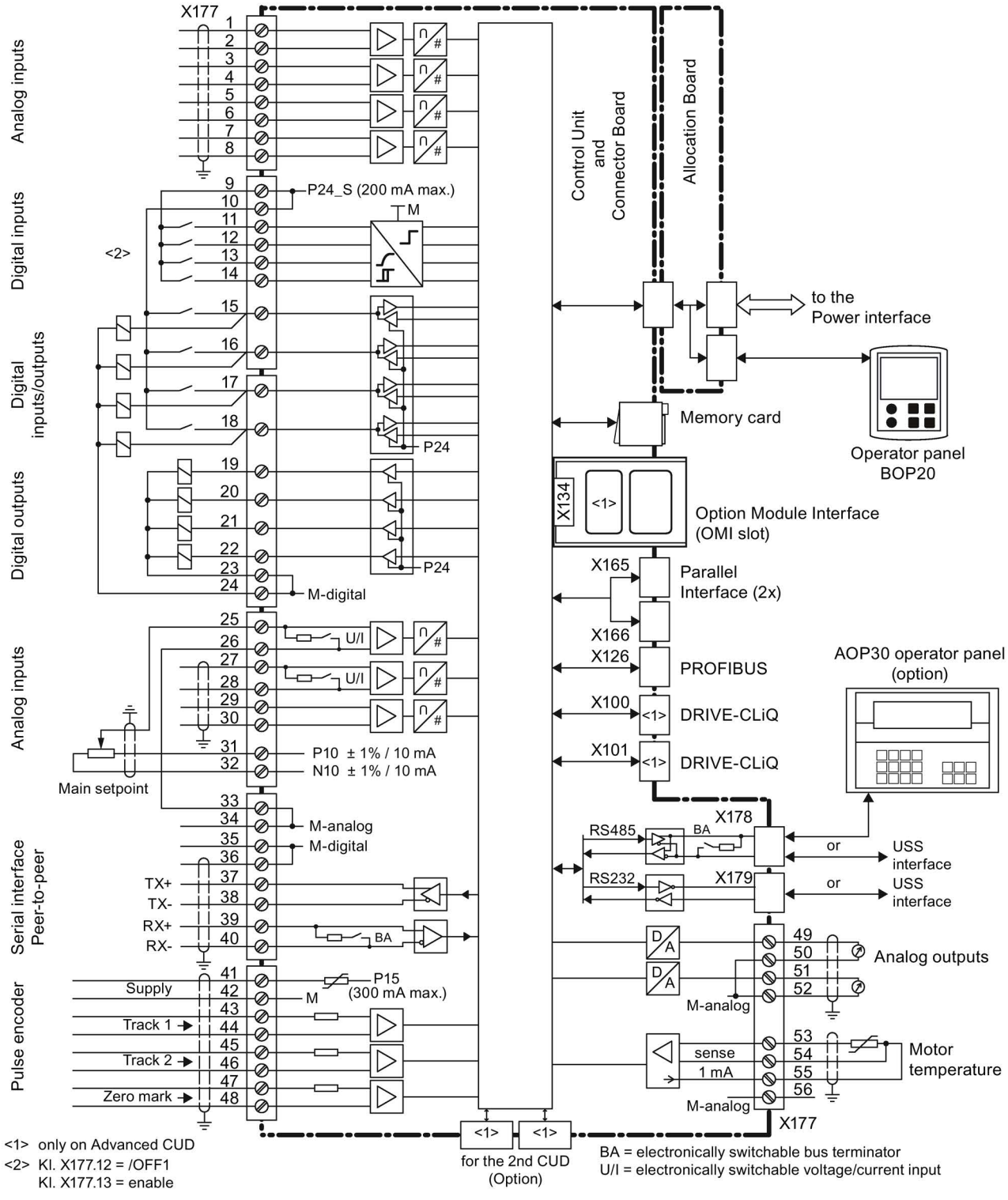



Figure 6-12 Open-loop/closed-loop control section block diagram

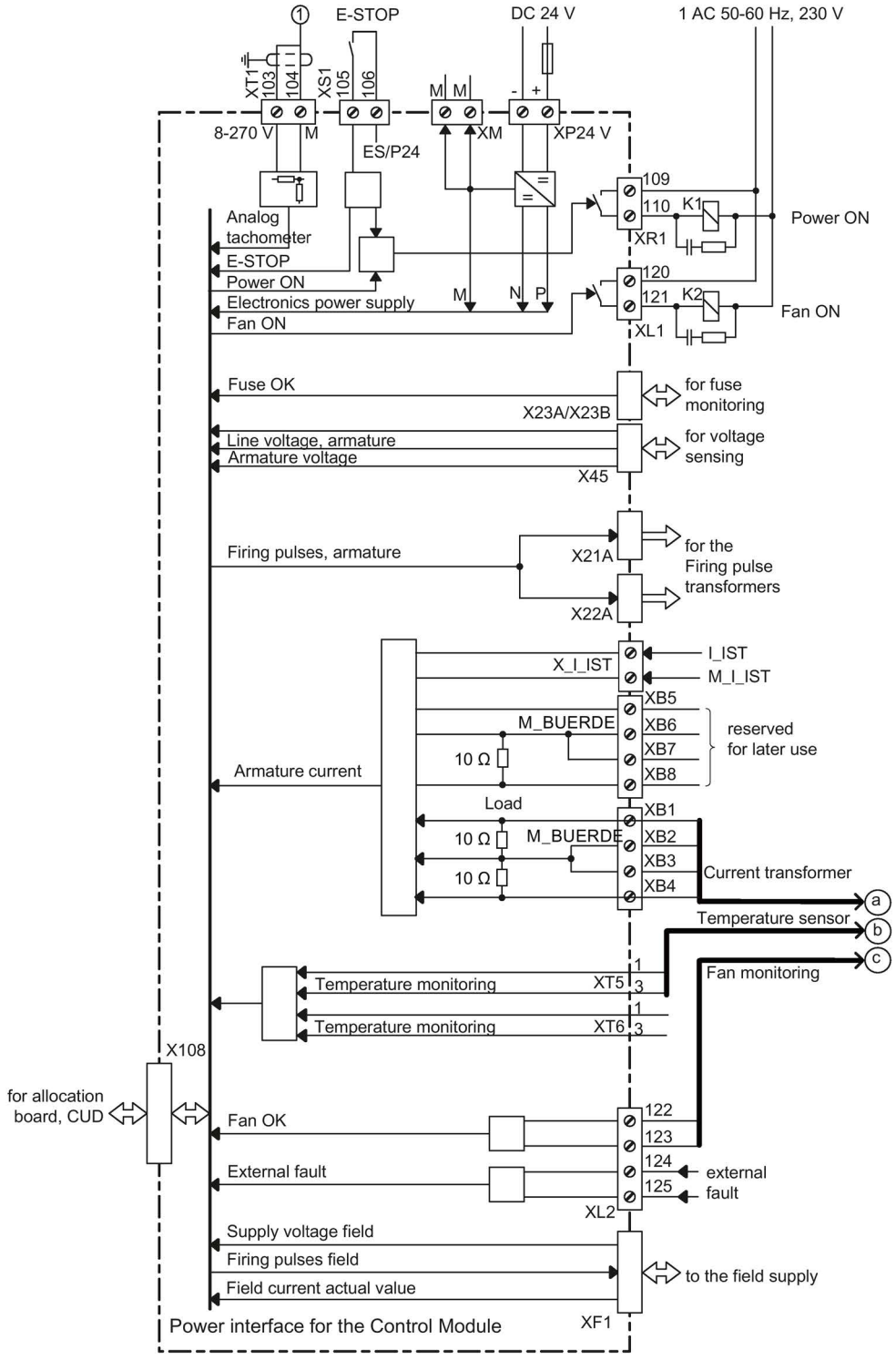



Figure 6-13 Block diagram for power interface

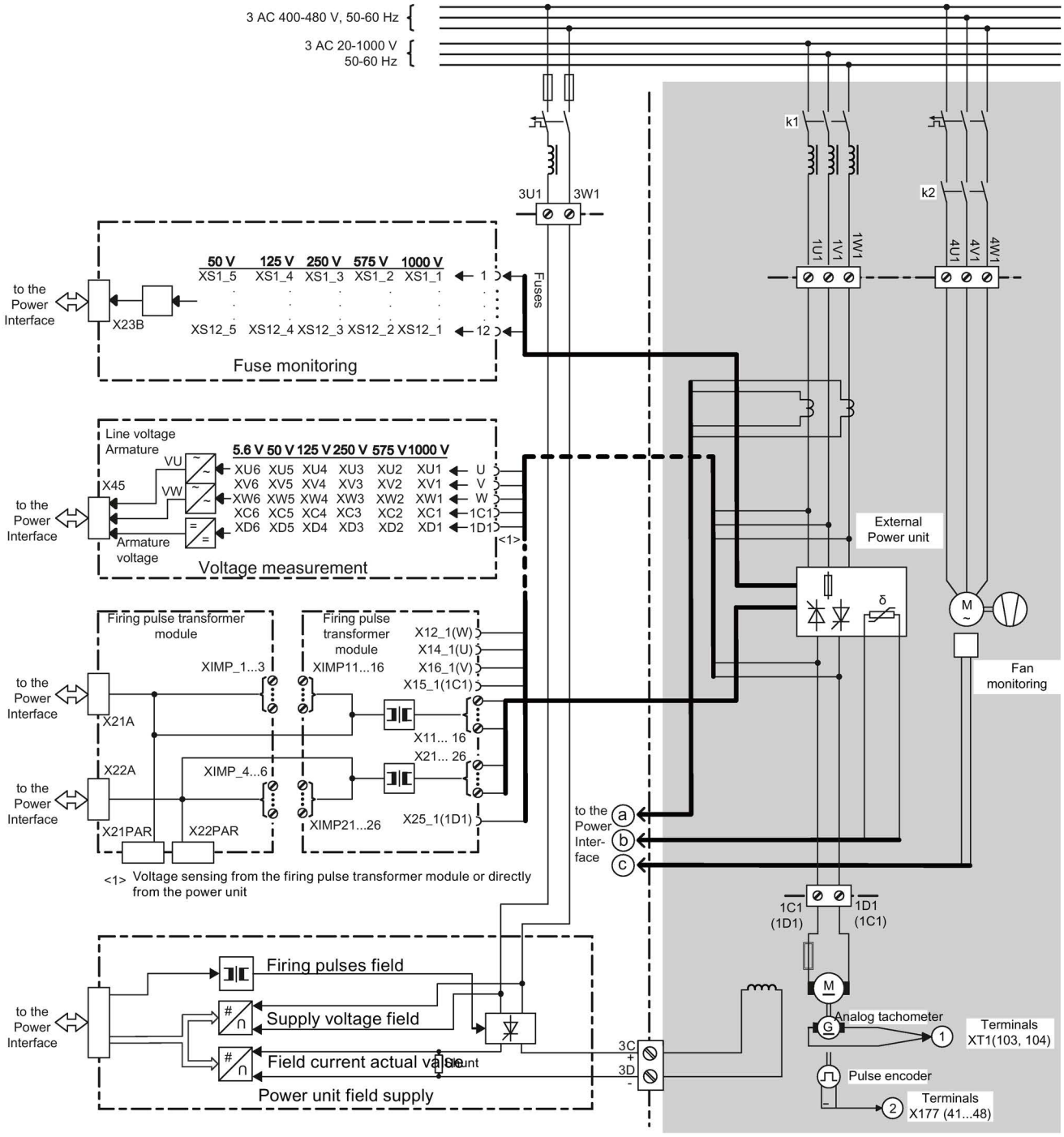



Figure 6-14 Block diagram for fuse monitoring/voltage measurement equipment, firing pulse transformers, power unit

## 6.4 Connecting the external power unit

The following 5 figures show all the required connections to the power unit.

- Figure: "Connection of a 4-quadrant power unit (1)":
  - 4-quadrant drive (parameters assigned for a 4-quadrant drive as delivered – p51825 = 4)
  - Line voltage and armature voltage measured via Faston terminals on the firing pulse transformer module (as delivered)
- Figure: "Connection of a 4-quadrant power unit (2)":
  - 4-quadrant drive (parameters assigned for a 4-quadrant drive as delivered – p51825 = 4)
  - Line voltage and armature voltage measured via cables directly from the power unit
- Figure: "Connection of a 2-quadrant power unit (1)":
  - 2-quadrant drive (parameter assignment: parameter p51825 = 2)
  - Line voltage and armature voltage measured via Faston terminals on the firing pulse transformer module (as delivered). The armature current can only be measured if a connection is made to 1D1 on the power unit.
- Figure: "Connection of a 2-quadrant power unit (2)":
  - 2-quadrant drive (parameter assignment: parameter p51825 = 2)
  - Line voltage and armature voltage measured via cables directly from the power unit
- Figure: "Connections to the power interface":
  - Connection of fan contactor, fan monitoring equipment, temperature sensors on the heat sink, external monitoring equipment

**⚠WARNING**

**Electric shock due to incorrectly replaced lines**

In its delivered state, the Control Module (both plates mounted on top of each other) is equipped with connection cables for voltage sensing devices. If the device is mounted in another form, (according to the descriptions in Chapter "Division options (Page 83)"), the existing connection cables must be replaced 1:1 by longer cables accordingly.

The cables installed ex works are of type Spec 44 with a voltage rating of 2500 V. The replacement cables must be selected according to the criteria for routing unprotected active cables according to EN 61439-1.

Please refer to the Chapter "Division options (Page 83)" for options on how to position the two plates and how the unit can be divided.

**⚠WARNING**

**Electric shock due to non-fused electrical connections**

The following electrical connections between the power unit (line voltage) and the electronics are affected:

- Secondary sides of the firing pulse transformers
- Voltage sensing devices
- Fuse monitoring equipment

All these cables must be routed according to the criteria for routing unprotected active cables.

- Route the cables between the plates so that a ground fault or short-circuit can be ruled out.
- Comply with local installation regulations, which allow this fault to be ruled out.
- Protect the cables from mechanical damage.
- Apply one of the following measures:
  - Use cables with double insulation.
  - Observe adequate clearances, e.g. through the use of spacers.
  - Route the cables in separate cable ducts or pipes.

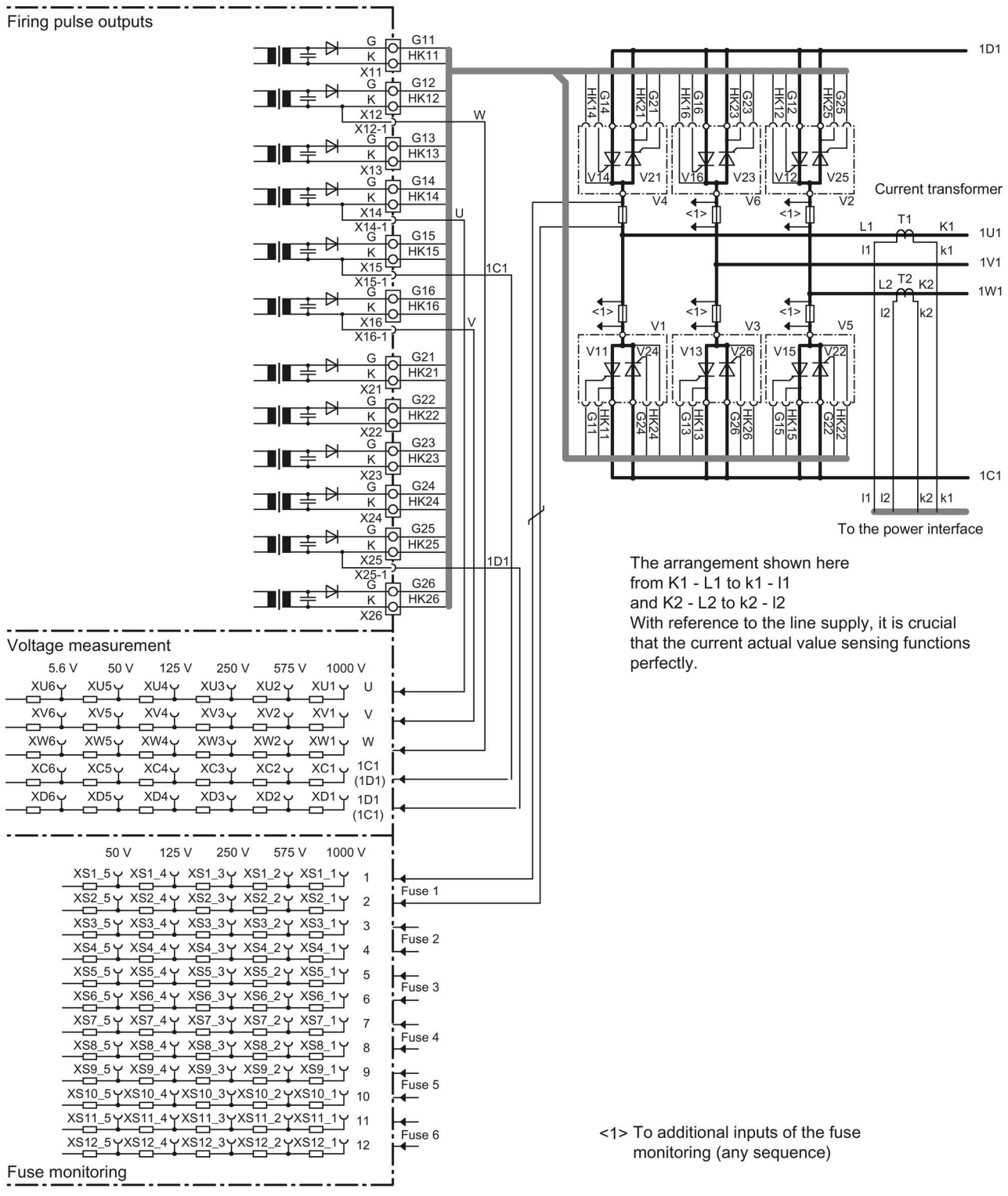



Figure 6-15 Connection of a 4-quadrant power unit (1)

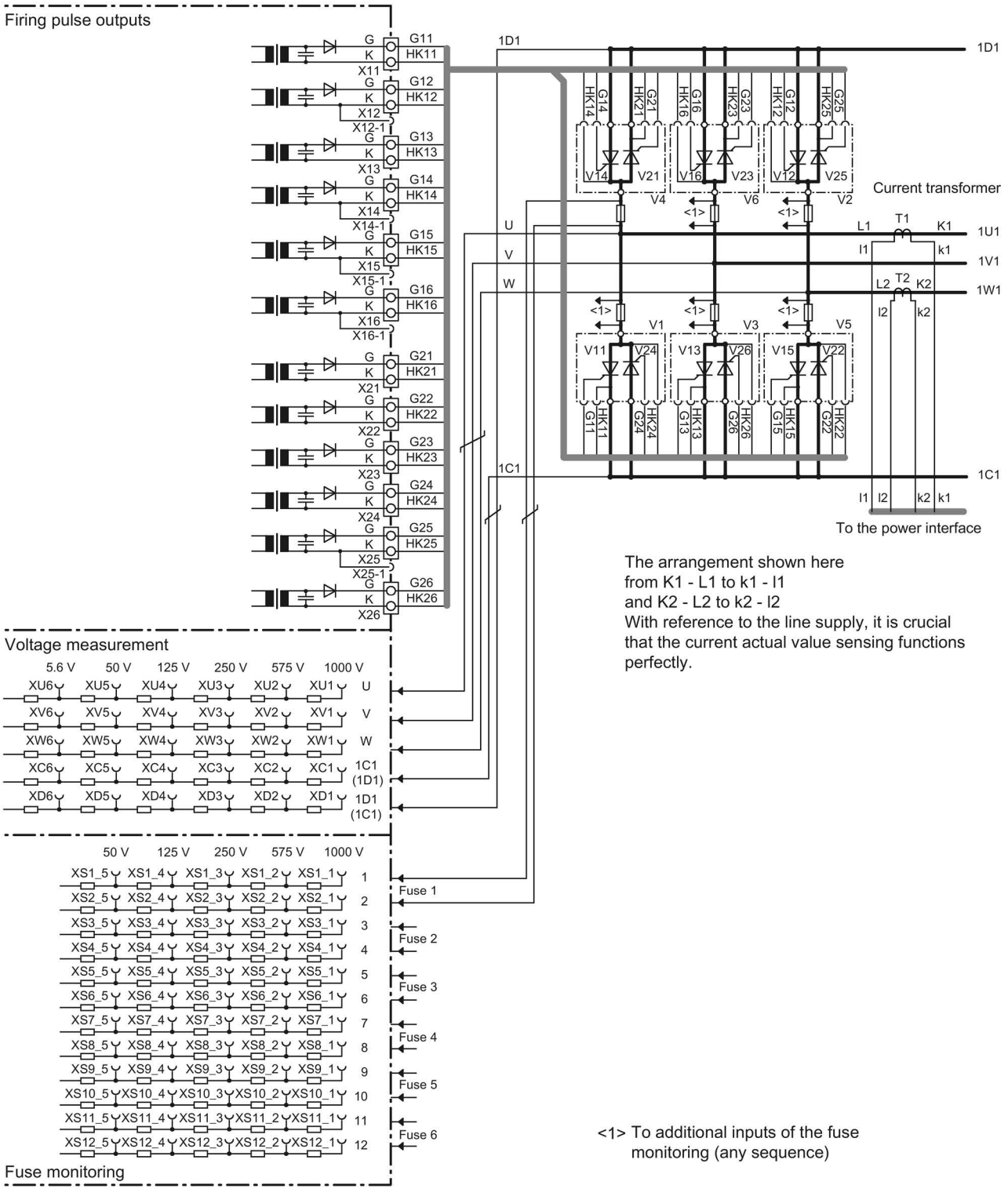



Figure 6-16 Connection of a 4-quadrant power unit (2)

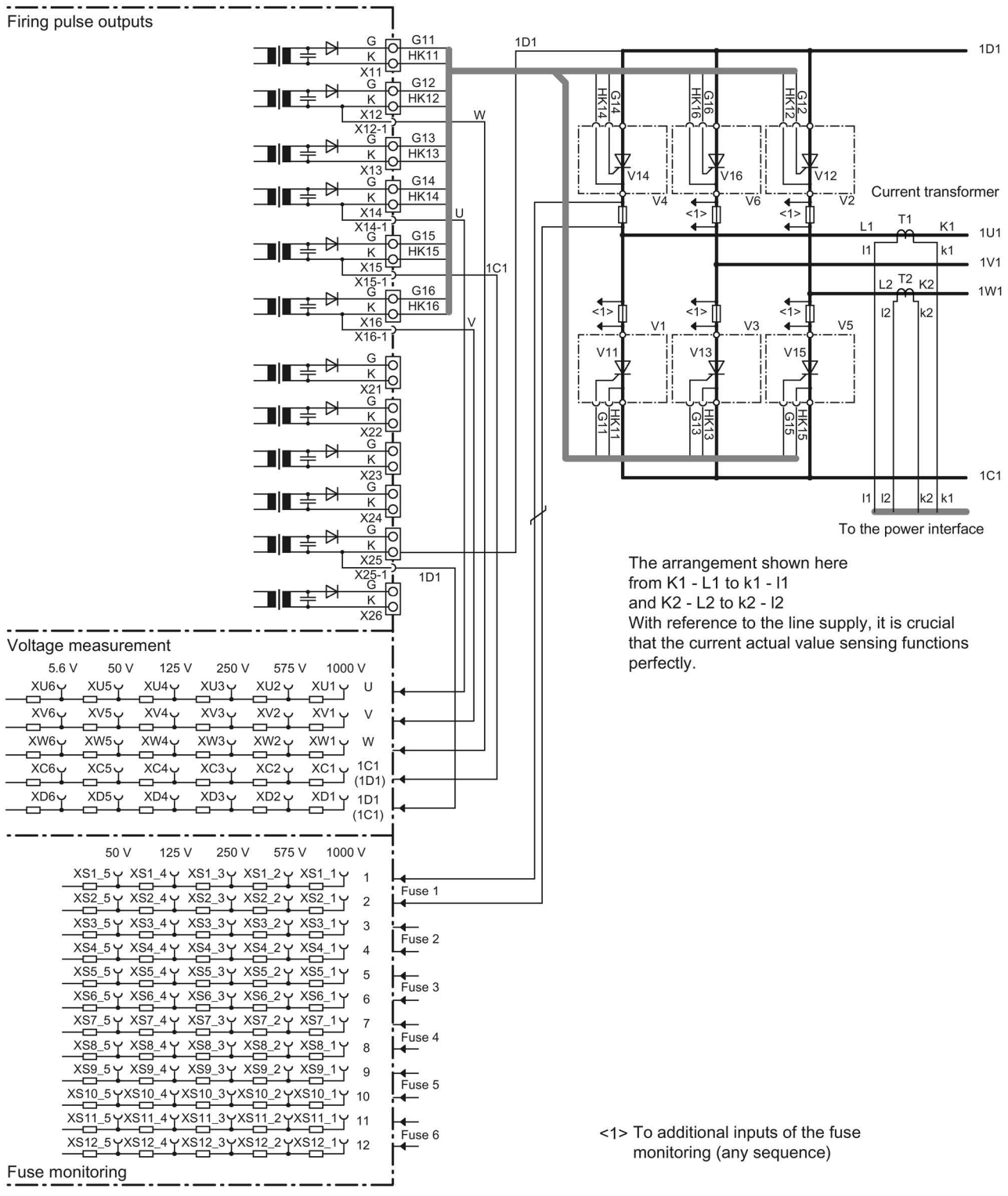



Figure 6-17 Connection of a 2-quadrant power unit (1)

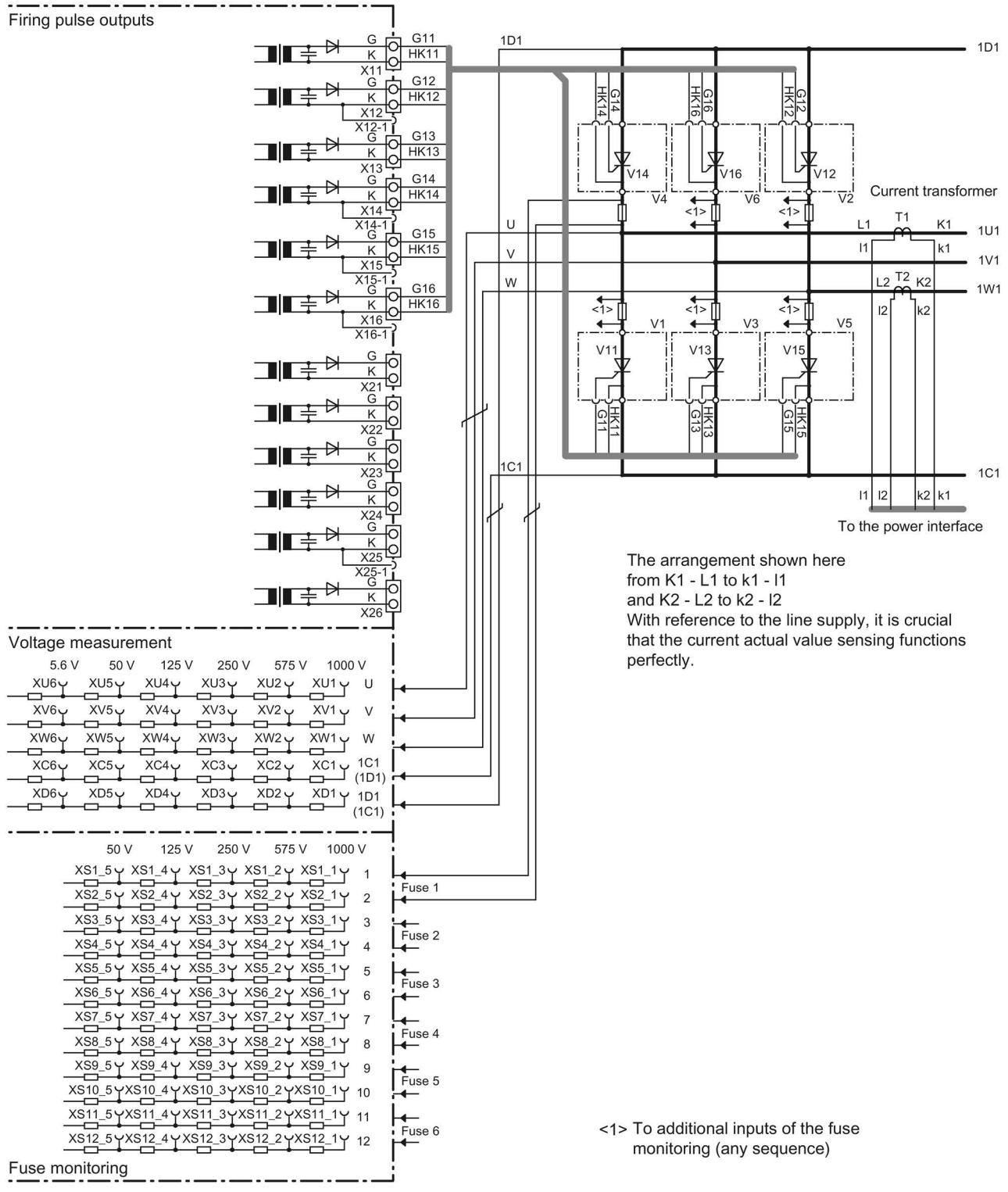



Figure 6-18 Connection of a 2-quadrant power unit (2)

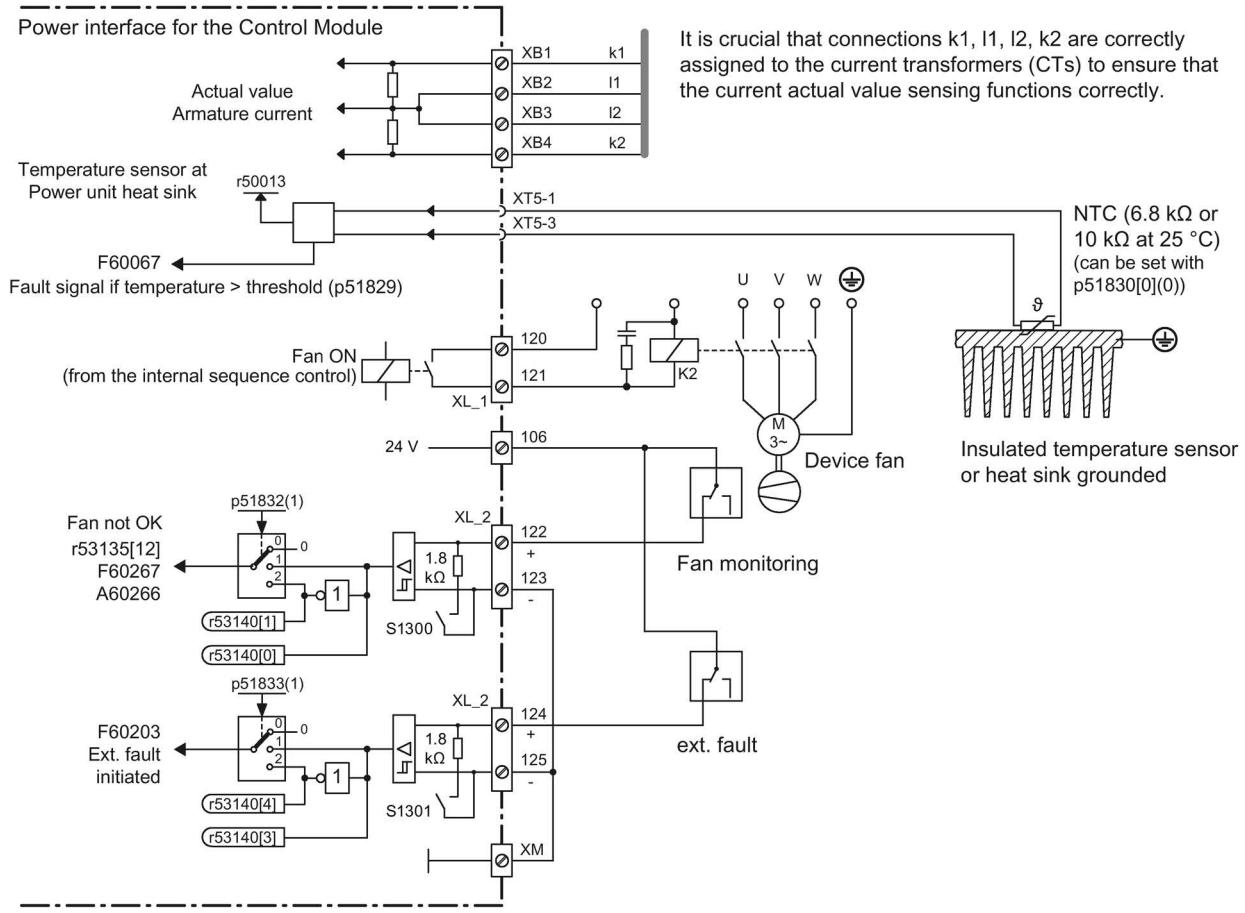



Figure 6-19 Connections to the power interface

**⚠WARNING**

**Electric shock in the event of voltage flashovers at the temperature sensor**

Voltage flashovers in the signal electronics can occur in motors without safe electrical separation of the temperature sensors.

- Use temperature sensors that comply with the specifications relating to protective separation.

## 6.5 Division options

The SINAMICS DCM Control Module consists of two plates.

Modules in the front plate:

- Power interface for the Control Module
- Control Unit (CUD)
- BOP20 Operator Panel
- Second CUD (optional)
- Communication Board(s) CBE20 (optional)

Modules in the rear plate:

- Fuse monitoring
- Voltage measurement
- Firing pulse transformer module

The two plates can be mounted at a distance from each other in the system, if required.

The firing pulse transformer module can be physically divided. This means parts of it can be mounted outside the device itself in the area around the power unit.

Some examples are shown below:

**Note**

The SINAMICS DCM Control Module is supplied with front and rear plates mounted one on top of the other. The correct cables (connectors X21A, X22A, XS20, XS21, and X102) for this mounting type are already in place.

Refer to Chapter "Ordering information for options and accessories (Page 26)" for cable ordering information if plates are being mounted in accordance with the examples below.

**Note**

**Firing pulse cables (X11...X16, X21...X26)**

The firing pulse cables should not be shielded.

If shielding is required, the shield is not connected to ground, but is connected to the auxiliary cathode of the particular thyristor. This shield must be adequately insulated with respect to its environment as it is at the full line supply voltage including the hole storage effect peaks.

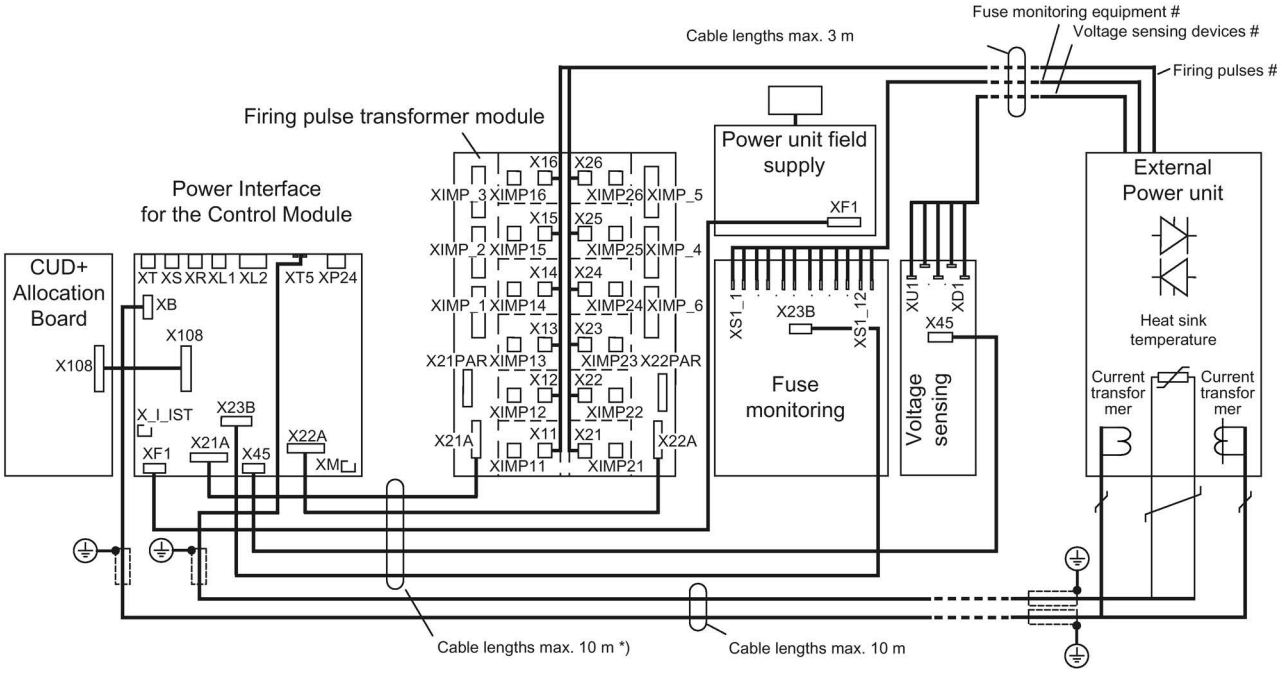
**Note**

**Restriction regarding dismantling in conjunction with functional safety**

In conjunction with the use of functional safety, the extent to which the Control Module can be dismantled is restricted:

- It is permissible to mount both plates of the Control Module separately.
- The fuse monitoring and the voltage sensing may be removed and mounted outside the device.
- It is **not** permissible that the firing pulse transformer module is removed.

## Example 1: Rear plate and front plate mounted one on top of the other or at a distance from each other, firing pulse transformer module not divided




# Short-circuit proof cable installation

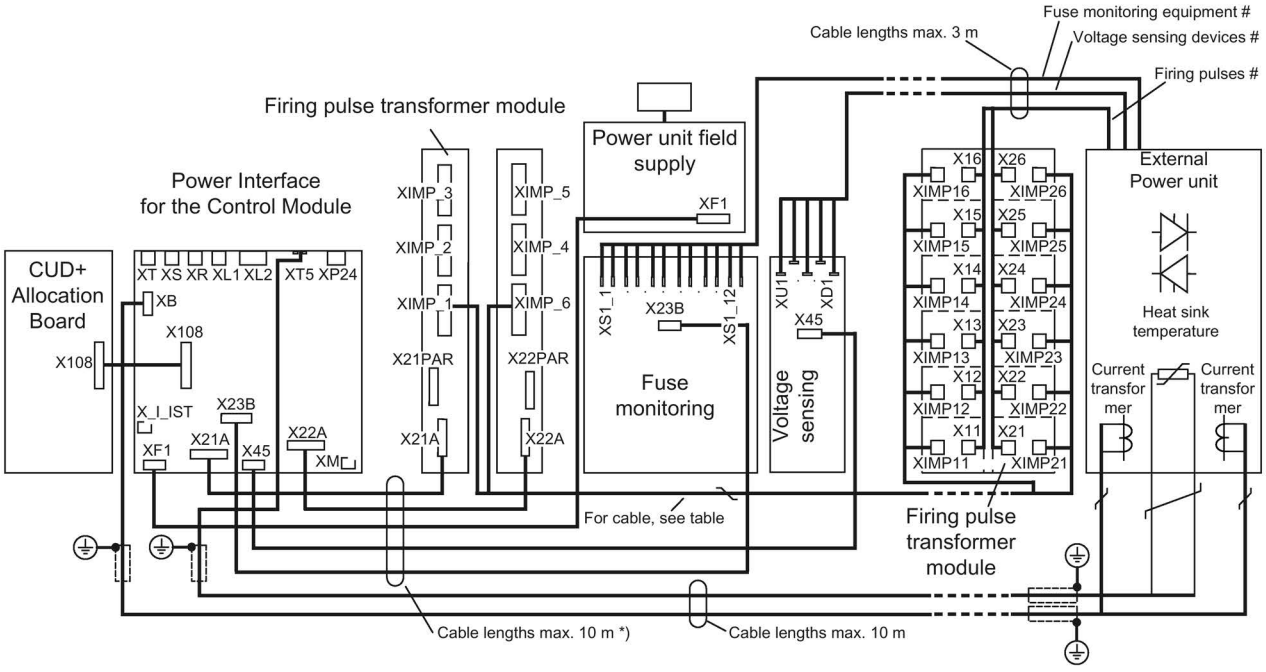
Figure 6-20 Division options – Example 1

Table 6- 2 Cable

| Connection (Connectors/Terminals) | Cable | Length max. | Notes |
|---|---|---|---|
| X21A (torque direction 1) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X22A (torque direction 2) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X23B (fuse monitoring equipment) | Ribbon cable, 10-pin | 10 m | Shield if >1 m. |
| X45 (voltage measurement equipment) | CAT5 cable, 8-pin | 15 m | Do not roll up the cable<br>Connect the cable shield at both ends of the cable<br>Provide the cable with insertion loss elements ("snap-on ferrites")<br>Type: Würth Elektronik<br>Article no.: 742 711 32 or comparable |
| XF1 (field) | Ribbon cable, 20-pin | 10 m | Shield if >1 m. |
| Current transformer (XB1) | Single wires (stranded wires), twisted-pair | 10 m | Shield if >2 m. |
| Heat sink temperature (XT5, XT6) | Single wires (stranded wires), twisted | 10 m | Shield if >2 m. |
| Firing pulses (X11 ... X16, X21 ... X26) | Single wires (short-circuit proof routing), twisted-pair | 3 m | Do not shield! |
| Fuse monitoring equipment (XS1_1 ... XS1_12 etc.) | Single wires (short-circuit proof routing), installed in pairs (for each fuse being monitored) | 10 m | - |
| Voltage sensing devices (XU1, XV1, XW1, XC1, XD1 etc.) | Single wires (short-circuit proof routing),<br>U-V-W twisted, C-D twisted | 3 m | See also Chapter "Connecting the external power unit (Page 76)" |

## Example 2: Rear plate and front plate mounted one on top of the other or at a distance from each other, firing pulse transformer module divided, firing pulse transformers mounted on the power unit

For mechanical modifications, see Chapter "Installation (Page 39)".




\# Short-circuit proof cable installation

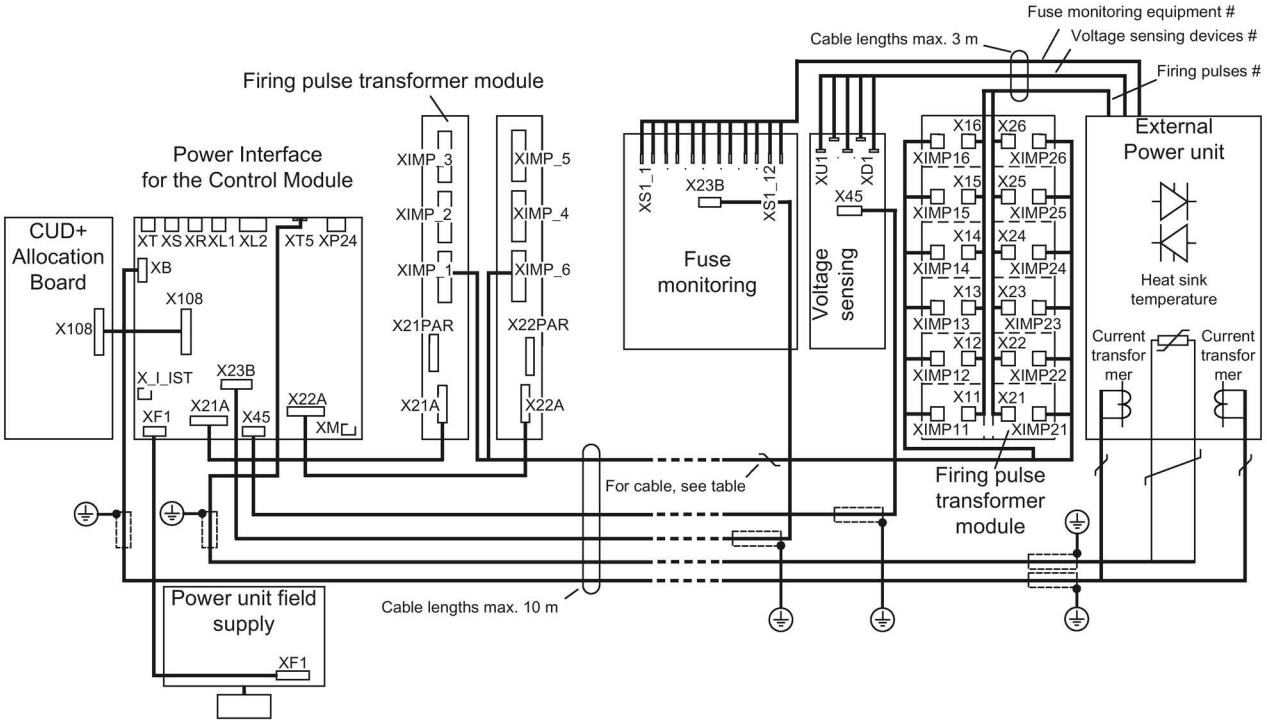
Figure 6-21 Division options – Example 2

Table 6- 3 Cable

| Connection (Connectors/Terminals) | Cable | Length max. | Notes |
|---|---|---|---|
| X21A (torque direction 1) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X22A (torque direction 2) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X23B (fuse monitoring equipment) | Ribbon cable, 10-pin | 10 m | Shield if >1 m. |
| X45 (voltage measurement equipment) | CAT5 cable, 8-pin | 15 m | Do not roll up the cable<br>Connect the cable shield at both ends of the cable<br>Provide the cable with insertion loss elements ("snap-on ferrites")<br>Type: Würth Elektronik<br>Article no.: 742 711 32 or comparable |
| XF1 (field) | Ribbon cable, 20-pin | 10 m | Shield if >1 m. |
| Current transformer (XB1) | Single wires (stranded wires), twisted-pair | 10 m | Shield if >2 m. |
| Heat sink temperature (XT5, XT6) | Single wires (stranded wires), twisted | 10 m | Shield if >2 m. |
| Firing pulse transformer control (XIMP_1 - XIMP11...16) (XIMP_6 - XIMP21...26) | 2 x LiyCY 8 x 2 x 0.5 (or 1) $mm^2$ | 10 m | Connect both ends of the shield. |
| | Or | | |
| | Single wires (stranded wires), twisted-pair | 3 m | Shield if >1 m. |
| Firing pulses (X11 ... X16, X21 ... X26) | Single wires (short-circuit proof routing), twisted-pair | 3 m | Do not shield! |
| Fuse monitoring equipment (XS1_1 ... XS1_12 etc.) | Single wires (short-circuit proof routing), installed in pairs (for each fuse being monitored) | 10 m | - |
| Voltage sensing devices (XU1, XV1, XW1, XC1, XD1 etc.) | Single wires (short-circuit proof routing),<br>U-V-W twisted, C-D twisted | 3 m | See also Chapter "Connecting the external power unit (Page 76)" |

**Example 3: Rear plate and front plate mounted one on top of the other or at a distance from each other, firing pulse transformer module divided, firing pulse transformers, voltage measurement equipment and fuse monitoring equipment mounted on the power unit, field supply remains in the plate.**

For mechanical modifications, see Chapter "Installation (Page 39)".




\# Short-circuit proof cable installation

Figure 6-22 Division options – Example 3

Table 6- 4 Cable

| Connection (Connectors/Terminals) | Cable | Length max. | Notes |
|---|---|---|---|
| X21A (torque direction 1) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X22A (torque direction 2) | Ribbon cable, 26-pin | 10 m | Shield if >1 m. |
| X23B (fuse monitoring equipment) | Ribbon cable, 10-pin | 10 m | Shield if >1 m. |
| X45 (voltage measurement equipment) | CAT5 cable, 8-pin | 15 m | Do not roll up the cable<br>Connect the cable shield at both ends of the cable<br>Provide the cable with insertion loss elements ("snap-on ferrites")<br>Type: Würth Elektronik<br>Article no.: 742 711 32 or comparable |
| XF1 (field) | Ribbon cable, 20-pin | 10 m | Shield if >1 m. |
| Current transformer (XB1) | Single wires (stranded wires), twisted-pair | 10 m | Shield if >2 m. |
| Heat sink temperature (XT5, XT6) | Single wires (stranded wires), twisted | 10 m | Shield if >2 m. |
| Firing pulse transformer control (XIMP_1 - XIMP11...16) (XIMP_6 - XIMP21...26) | 2 x LiyCY 8 x 2 x 0.5 (or 1) $mm^2$ | 10 m | Connect both ends of the shield. |
| | Or | | |
| | Single wires (stranded wires), twisted-pair | 3 m | Shield if >1 m. |
| Firing pulses (X11 ... X16, X21 ... X26) | Single wires (short-circuit proof routing), twisted-pair | 3 m | Do not shield! |
| Fuse monitoring equipment (XS1_1 ... XS1_12 etc.) | Single wires (short-circuit proof routing), installed in pairs (for each fuse being monitored) | 10 m | - |
| Voltage sensing devices (XU1, XV1, XW1, XC1, XD1 etc.) | Single wires (short-circuit proof routing),<br>U-V-W twisted, C-D twisted | 3 m | See also Chapter "Connecting the external power unit (Page 76)" |

### Example 4: Parallel connection of power units with a shared set of control electronics

# Short-circuit-proof routing

Figure 6-23 Division options – Example 4

**Notes:**

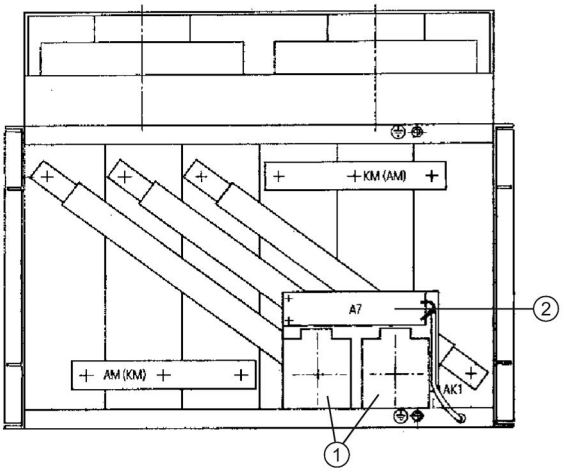
- Cables:
  The corresponding information in Examples 1 to 3 of this section applies to the cable types and permissible cable lengths.
- Please refer to the Chapter "Connecting the firing pulse transformers (Page 107)" for information on parallel connection.
- Please refer to the Chapter titled "Connecting fuse monitoring equipment (Page 110)" for information on fuse monitoring equipment.
- Please also note the information contained in Chapter "Parallel connection of power units (Page 111)".

## Example 5: Controlling a SITOR thyristor set 6QG12

The information on cables, cable lengths, and module division provided in Example 3 also largely applies to this example.

The firing pulse transformer module is completely divided up. The small individual boards containing the firing pulse transformers can be connected to the power unit instead of the old-style small firing pulse transformer boards. The fuse monitoring and voltage measurement equipment is mounted in the immediate vicinity of the SITOR set.

## Connecting current transformers

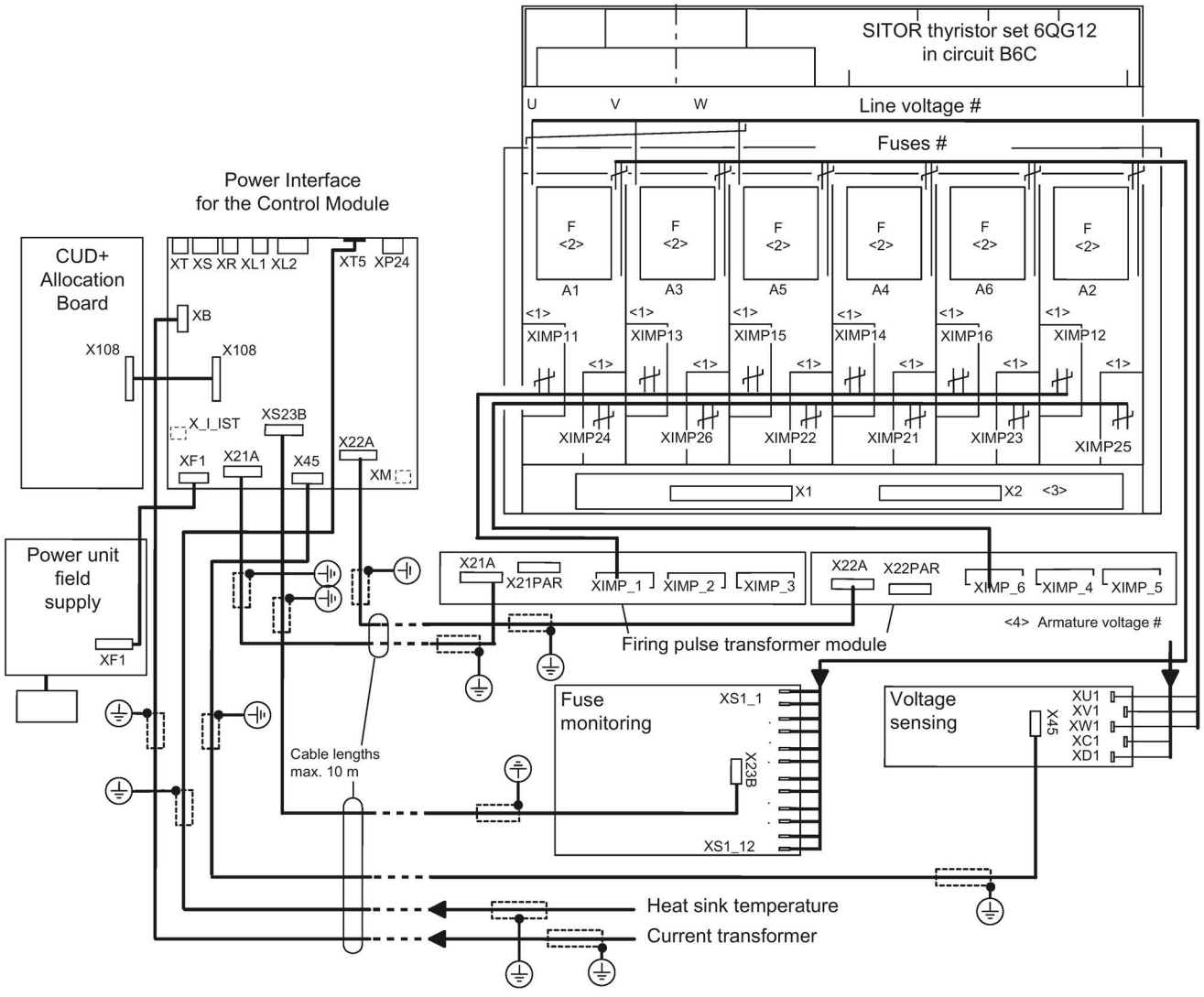



Rear view

① Current transformers

② Remove the connection between the current transformers and module A7 and connect the current transformer cables directly to the current transformers' screw terminals.

## Circuit (B6)A(B6)C (4-quadrant drive)




\# Short-circuit proof cable installation

<1> Firing pulse transformer module inserted into the available plastic holders (following the order of the terminal names shown in the figure).
Cables routed to the firing pulse transformers run from terminal strips XIMP_1 and XIMP_6 to XIMP11 (IMP11, P24) - XIMP26 (IMP26, P24).
Firing cables X11 (K, G) to X26 (K, G) routed to the thyristors not shown
(X11 to X16 each routed to thyristor V01 in the thyristor double block, X21 to X26 routed to thyristor V02)

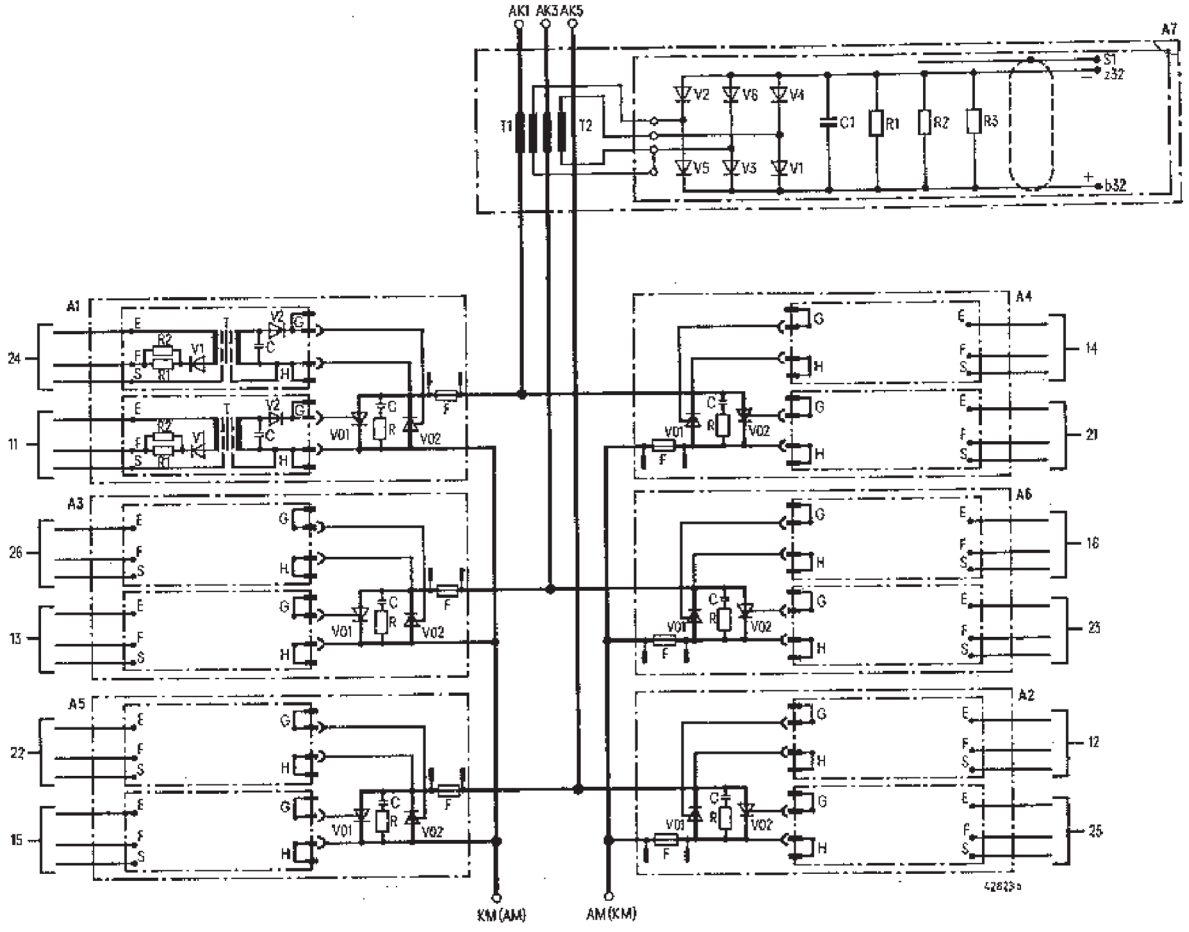
<2> Connection of the fuse monitoring equipment to the Faston tabs on the fuse holders.
The equipment for measuring the line voltage can be connected to the fuses in the thyristor blocks A1 (= AK1 = U), A3 (= AK3 = V), and A5 (= AK5 = W) (see circuit diagram below).

<3> Do not connect X1, X2

<4> Measurement of armature voltage: connection of KW (AW) - C and AW (KW) - D

Figure 6-24 Circuit (B6)A(B6)C (4-quadrant drive)

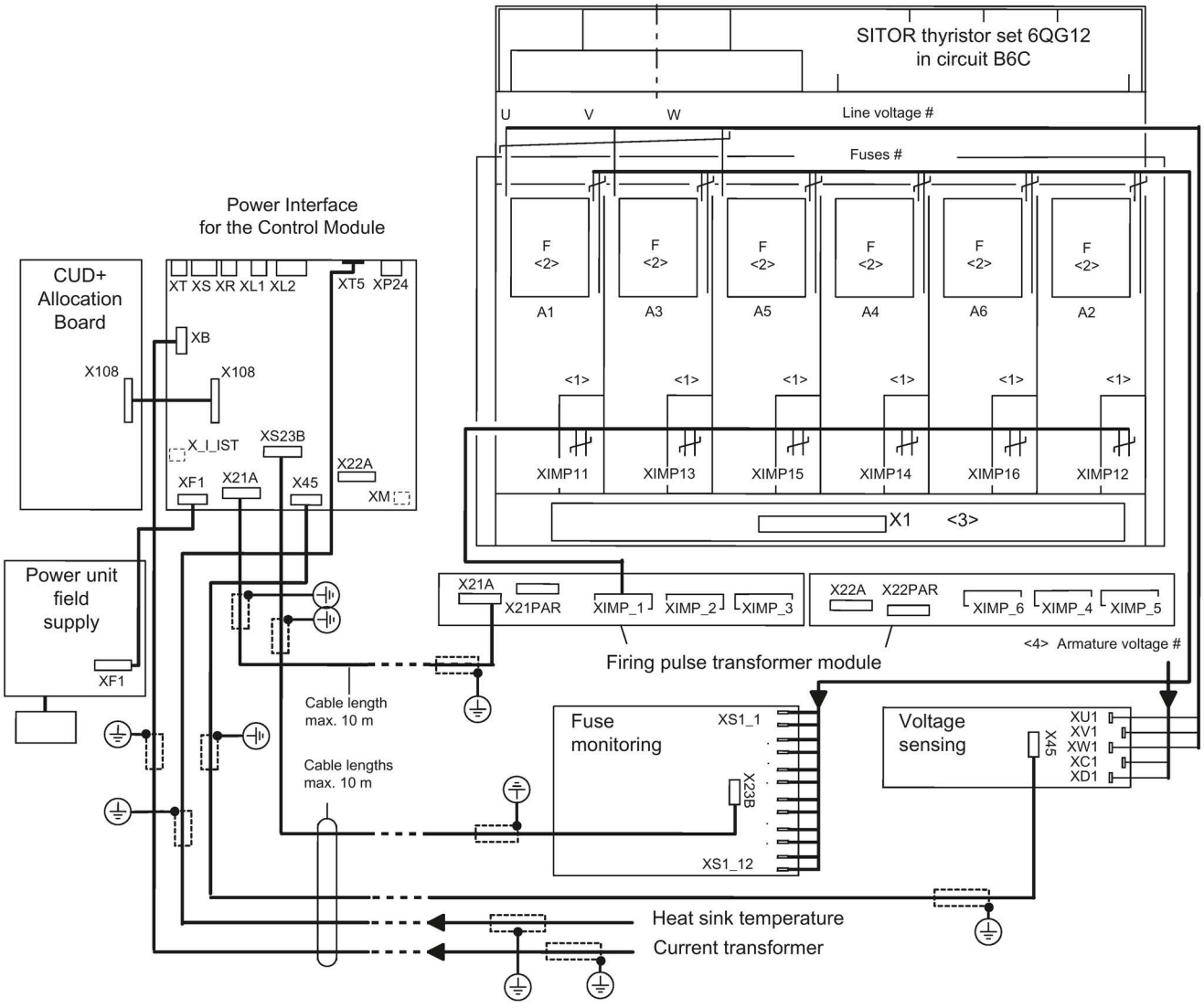
**For information: Circuit diagram, SITOR set (4Q) before being equipped with SINAMICS DCM Control Module**




SITOR sets 6QG12 in an anti-parallel connection of two three-phase current bridge circuits [(B6)A(B6)C] with a transformer module for measuring actual current values (if SITOR sets 6QG12 are being used without a transformer module for measuring actual current values, there is no need for an A7 module)

Figure 6-25 SITOR 4Q before modification

## Circuit B6C (2-quadrant drive)




\# Short-circuit proof cable installation

<1> Firing pulse transformer module inserted into the plastic holders available (following the order of the terminal names shown in the figure).
Cables routed to the firing pulse transformers run from terminal strips XIMP_1 to XIMP11 (IMP11, P24) - XIMP16 (IMP16, P24).
Firing cables X11 (K, G) to X16 (K, G) routed to the thyristors not shown
(X11 to X16 each routed to thyristor V01 in the thyristor double block, X21 to X26 routed to thyristor V02)

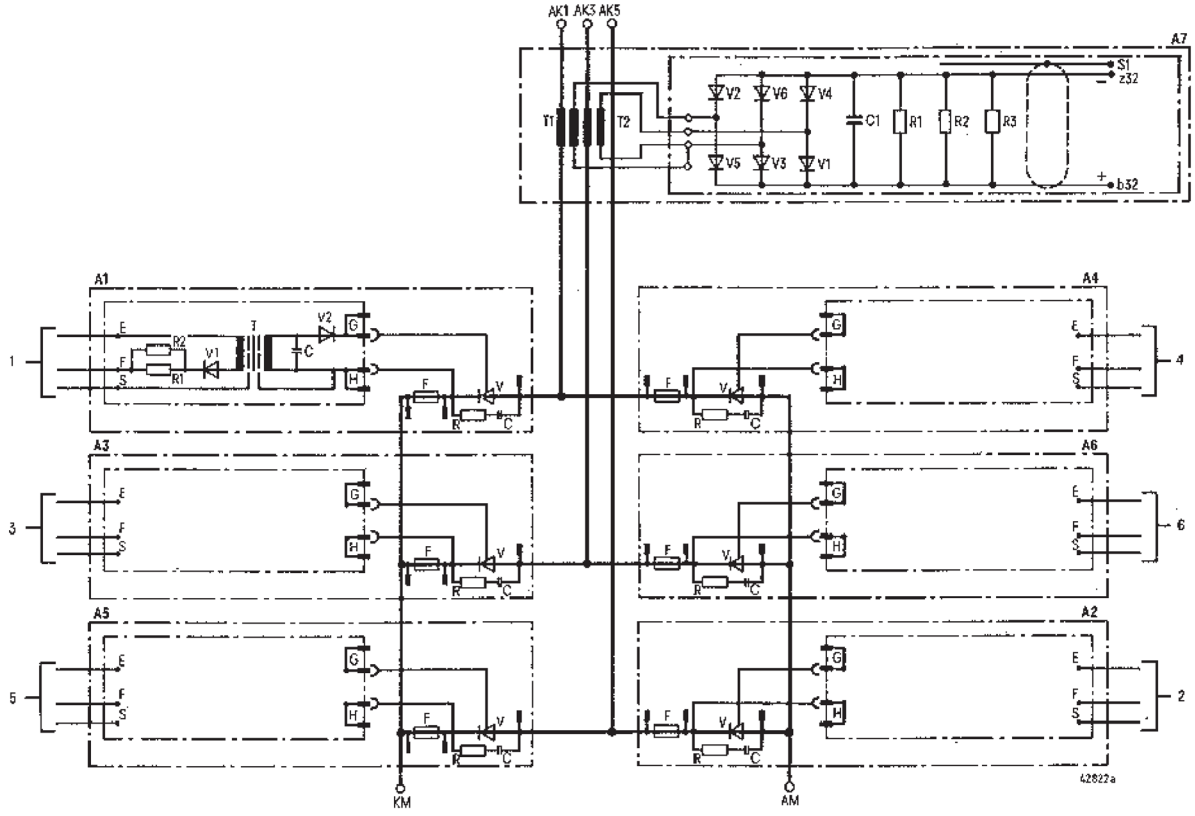
<2> Connection of the fuse monitoring equipment to the Faston tabs on the fuse holders.
The equipment for measuring the line voltage can be connected to the fuses in the thyristor blocks A1 (= AK1 = U), A3 (= AK3 = V), and A5 (= AK5 = W) (see circuit diagram below).

<3> Do not connect X1

<4> Measurement of armature voltage: Connection of KW - C and AW - D (see the circuit diagram below for details of how to connect to Faston tabs on the thyristor blocks).

Figure 6-26 Circuit B6C (2-quadrant drive)

**For information: Circuit diagram, SITOR set (2Q) before being equipped with SINAMICS DCM Control Module**




SITOR sets 6QG12 in a three-phase current bridge circuit [B6C] with a transformer module for measuring actual current values (if SITOR sets 6QG12 are being used without a transformer module for measuring actual current values, there is no need for an A7 module).

Figure 6-27 SITOR 2Q before modification

# 6.6 Measurement of the armature current

## 6.6.1 General information

### Measuring circuit on the power interface for the Control Module:

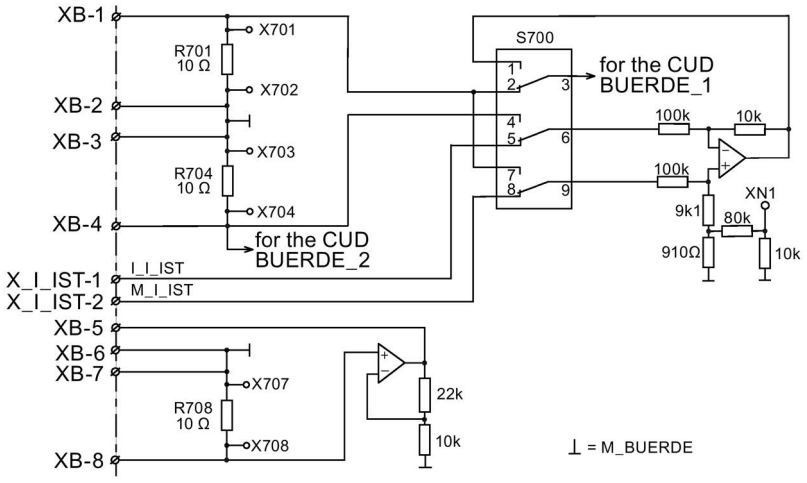
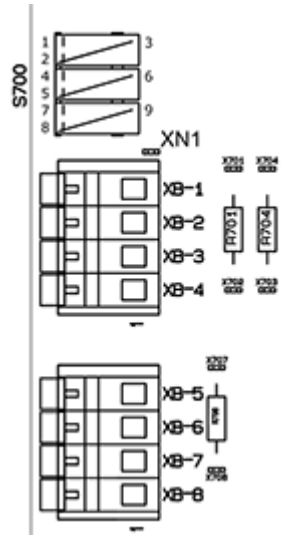
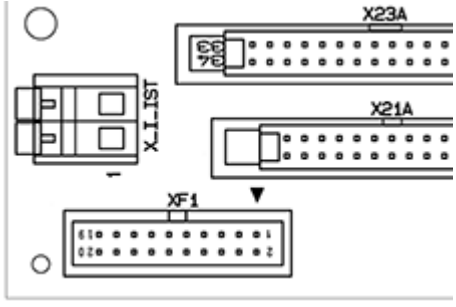



Figure 6-28 Current measurement

### Arrangement on the power interface for the Control Module:




Arrangement of terminals XB




Arrangement of X_I_IST

**Note**

In the previous diagrams, switch S700 is shown in the state when shipped from the factory. The disconnecting links for switch S700 must be soldered into the hooks to ensure the connection is secure.

## Dimensioning current transformers, load resistors

The digital-to-analog converter circuit on the CUD can process voltages of up to ±3 V (peak value). When dimensioning the current transformers and load resistors, it is important to ensure the voltage at signals BUERDE_1 and BUERDE_2 (see "Current measurement" figure) never exceeds this value, even at the highest expected overcurrent in the power unit. On delivery, actual current value measurement on the SINAMICS DCM Control Module is configured in such a way as to ensure an actual current value signal of 1 V at the rated device current. The difference amplifier in the "Current measurement" figure can also be used (with amplification of 0.1) to adjust the input voltage of existing measuring equipment with different scaling.

It is better to dimension the current transformers and load resistors in such a way as to ensure an average load voltage of no more than 1 V at the armature's rated DC current.

If an external load resistor is being used, ensure the wires between this resistor and terminals XB-1 to XB-8 are twisted and kept as short as possible. To prevent measuring errors, the external load resistor itself should be connected in accordance with the four-wire method (potential tap) and have as little inductance as possible.

With the four-wire method, the current to be measured is routed through the resistor. The resulting voltage (load voltage) is tapped at the connections at a distance specified by the manufacturer. This ensures measurements are as accurate as possible.

Only load resistors with a maximum power loss of at least 0.5 W can be soldered in at the soldering terminals parallel to the 10 Ω load resistors already installed. If 5 A current transformers are already present, 5 A/ 0.1 A matching transformers should be used. In such cases, the standard R701 and R708 load resistors can be used with 10 Ω each.

The maximum permissible current at input terminals XB1 to XB4, XB7, and XB8 is 1 A.

If two current transformers are already present in a V-circuit, these can be connected directly to terminals XB-1 to XB-4 without V-circuit in order to reduce the wait time for current reversal (higher dynamic response to torque changes). See next chapter.

Interposing current transformers may only be connected directly downstream of a current transformer and not downstream of a V-circuit!

## 6.6.2 Current measurement with two current transformers on the line side

(on delivery)

Configuration as shown in Chapter "Connecting the external power unit (Page 76)".

### Current transformer

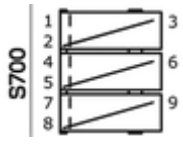
| | | | |
|---|---|---|---|
| XB-1 | k1 | Current transformer T1 signal | K line side |
| XB-2 | l1 | Ground reference | L device side |
| XB-3 | l2 | Ground reference | |
| XB-4 | k2 | Current transformer T2 signal | |

The current transformers must have no external connection to ground. Only terminals XB-2 and XB-3 may be used for this purpose.

Table 6- 5 Recommended current transformers

| Armature current | Ratio | Ordering data | | Primary side |
|---|---|---|---|---|
| | | Part number | MLFB | |
| Up to 600 A | 6000 : 1 | C771 | 6RY1702-0AA03 | Hole 31 × 5.5 mm |
| Up to 850 A | 8500 : 1 | C850 | 6RY1702-0AA06 | Hole ∅ 22 mm |
| Up to 1200 A | 12000 : 1 | C772 | 6RY1702-0AA04 | Hole 61 × 10.5 mm |
| Up to 1600 A | 16000 : 1 | C868 | 6RY1702-0AA07 | Hole ∅ 11 mm |
| Up to 2400 A | 24000 : 1 | C773 | 6RY1702-0AA05 | Cu cylinder piece<br>Height 45 mm, hole ∅ 12.2 mm |
| Up to 3000 A | 30000 : 1 | C740 | 6RY1702-0AA10 | Hole ∅ 12.2 mm |

S700 switch positions:




2 – 3 connected
5 – 6 connected
8 – 9 connected

The position of the S700 means that the difference amplifier on the power interface for the Control Module (see "Measuring circuit" figure) is not active. The load voltages from X3 are connected directly to the control electronics.

### Load resistors

$$R_B = \frac{U_B}{\ddot{u} \times I_d}$$

$R_B$ = Load resistor

$U_B$ = Load voltage (= mean value over 1 current crest, not the rms value or mean value over the entire period); recommended value = 1 V

ü = Transformation ratio of the current transformer (I2/I1) (in general, ü = 1/number of turns)

$I_d$ = Rated armature DC current

The values determined for the load resistances can be set by soldering additional resistors onto the soldering lugs parallel to R701 and R704 and, if necessary, by pulling out R701 and R704.

The influence of the magnetizing current can be taken into account in order to determine the load resistances accurately. If the magnetizing current is not taken into account, an excess current equivalent to "magnetizing current x number of turns" will flow through the cables over and above the specified value.

The magnetizing current is determined as follows:

The secondary current of the current transformer must flow through its ohmic resistor (at maximum operating temperature), load resistor, and any rectifier diodes connected in series. This results in a calculable voltage drop at the rated current (sine-wave). This voltage (50 Hz sine-wave) is then applied on the secondary side and the magnetizing current measured. This value is then used to calculate $R_B$.

It is also important to ensure that current transformers do not experience excessive saturation in the event of an overcurrent, as the magnetizing current will increase dramatically. It is also important to take temperature rise into account when operating at permanent load.

Load resistance taking the magnetizing current into account:

$$R_B = \frac{U_B}{\ddot{u} \times (I_d + \frac{I_m}{\ddot{u}})}$$

$I_m$ = Magnetizing current

**Parameter settings**

p51822 = Rated armature DC current

p51823 = Load voltage at rated armature current
(on delivery = 1,000.0 mV)

p51824 = 1: Current transformers in phases U and V
2: Current transformers in phases U and W (on delivery)
3: Current transformers in phases V and W
4: Current transformers externally interconnected in a V-circuit
5: Actual current value signal, bipolar (external shunt)

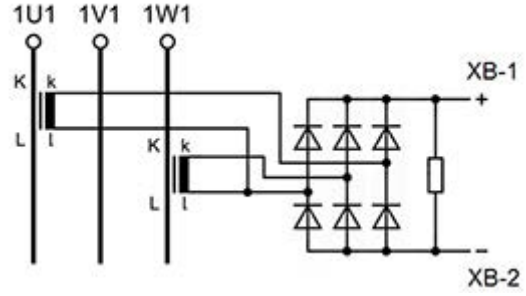
p51852 = 0: Internal measurement of armature actual current value
1: Measurement of armature actual current value via X177.1/2
2: Measurement of armature actual current value via X177.3/4
3: Measurement of armature actual current value via X177.5/6
4: Measurement of armature actual current value via X177.7/8

## 6.6.3 Current measurement via terminal block XB-1 to XB-4 with external measuring circuit

### 6.6.3.1 External current transformers in V-circuit with +1 V at rated armature DC current

#### Principle of operation of the V-circuit

Two current transformers (CTs), a rectifier bridge and an external load resistor are connected-up corresponding to the following diagram to measure the current.




It is important that the ends with the same name (lower case l) are connected together. This is then followed by a 3-phase bridge rectifier with a load resistor. As a consequence, any current can flow through the load resistor.

#### Advantage of the V-circuit

Due to the threshold voltage of the diodes, the CT (current transformer) is more quickly demagnetized.

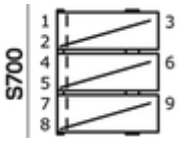
#### Disadvantage of the V-circuit

The demagnetization current of the CT is converted into an apparent armature current as a result of the rectifier diodes (in spite of armature current = 0). This makes it more difficult to identify a no-current interval to change the current flow direction. As a consequence, when using this circuit, a longer torque-free pause must be maintained than when directly measuring the armature current.

#### Connection

The output signal of the V-circuit is connected to terminals XB-1 (+) and XB-2 (-). Terminals XB-3 and XB-4 are not used.

S700 switch positions:




2 – 3 connected
5 – 6 connected
8 – 9 connected

Remove R701! The difference amplifier is not used.

**Parameter settings**

p51822 = Rated armature DC current
p51823 = Input voltage at rated armature current
p51824 = 4 (V-circuit)

**Load**

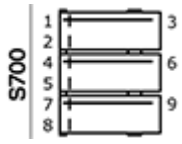
The load resistor for the open-delta connection should be located externally, but must not be grounded externally. Terminal XB-2 is used for grounding. R701 should be removed.

### 6.6.3.2 External current transformers in V-circuit with +10 V at rated armature DC current

**Connection**

The output signal of the V-circuit is connected to terminals XB-1 (+) and XB-2 (-), terminals XB-3 and XB-4 must be shorted.

S700 switch positions:




1 – 3 connected
4 – 6 connected
7 – 9 connected

Remove R701. The difference amplifier at the power interface is active. The input signal is reduced to a tenth of its value (10 V to 1 V at rated DC current).

**Parameter settings**

p51822 = Rated armature DC current
p51823 = Input voltage at rated armature current/10
p51824 = 4

**Load**

The load resistor for the open-delta connection should be located externally, but must not be grounded externally. Terminal XB-2 is used for grounding. R701 should be removed.

### 6.6.3.3 Differential input for +/-10 V at rated armature DC current

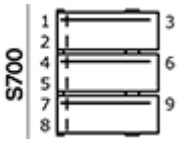
This connection option is intended for operation with an LEM transformer or shunt amplifier.

It should be remembered that many products are limited in terms of what they can control. Where this is the case, connection should be based on a 1 V input.

#### Connection

XB-1 positive (not inverted), XB-4 negative (inverted). External grounding at XB-4 is recommended. The signal has both polarities (switches pole during torque changes).

S700 switch positions:




1 – 3 connected
4 – 6 connected
7 – 9 connected

Remove R701 and R704. The difference amplifier has an attenuating effect (10:1).

#### Parameter settings

p51822 = Rated armature DC current
p51823 = Input voltage at rated armature current/10
p51824 = 5 (bipolar)

#### Load

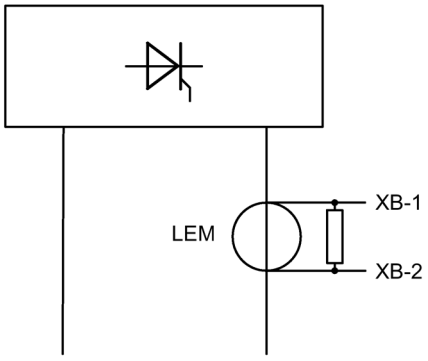
The load resistor of the LEM current transducer should be located externally and grounded with the power supply. Since shunt amplifiers generally have a ±10 V voltage output, they do not require a load.

### 6.6.3.4 Input for +/-1 V at rated armature DC current

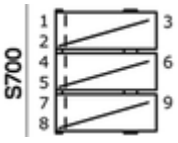
This connection option is intended for operation with an LEM transformer.

#### Connection

XB-1 positive (non inverting), XB-2 negative (inverting). The signal has both polarities (switches pole during torque changes).




S700 switch positions:




2 – 3 connected
5 – 6 connected
8 – 9 connected

Remove R701.

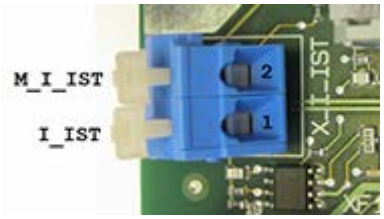
#### Parameter settings

p51822 = Rated armature DC current
p51823 = Input voltage at rated armature current
p51824 = 5 (bipolar)

#### Load

The load resistor should be located externally and grounded with the LEM transformer's power supply. The value should be dimensioned to produce a 1 V voltage at the rated current.

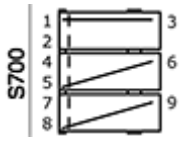
## 6.6.4 External current measurement via X21A or X_I_IST




For the arrangement of the terminals at the Power Interface of the SINAMICS DCM Control Module, see also the diagram in Chapter "General information (Page 97)".

X21A-23 and X_I_IST-1 = I_IST, negative actual current value
X21A-24 and X_I_IST-2 = M_I_IST, reference potential

S700 switch positions




1 – 3 connected
5 – 6 connected
8 – 9 connected

The difference amplifier is active. The input signal is inverted and reduced to a tenth of its value (-10 V to 1 V at rated DC current or -30 V to 3 V at the control limit).

**Parameter settings**

| | |
|---|---|
| p51822 = | Rated armature DC current |
| p51823 = | Input voltage at rated armature current/10 |
| p51824 = | 4 for unipolar (negative) actual current value signal<br>5 for bipolar actual current value signal |

## 6.6.5 Offset correction via XN1

For SITOR sets 6QGXX with shunt current measurement and both V/f and f/V conversion, the potentiometer (R202 on module 6QM400 for SITOR thyristor set 6QG22) on the secondary side should be calibrated to exactly match the zero point of the output voltage when the device is de-energized. Please refer to Chapter 6 for 6QG22, "Improving interference immunity and drift problems of the analog actual current value for SITOR electronics". If this potentiometer is not set correctly, not only will an offset error occur, but current measurement will be subject to a scaling error. In order to make additional adjustments to the offset for a precise zero current message, connector XN1 on the power interface for the Control Module must be connected to an analog output (±10 V) on the Control Module (CUD). The offset can be minimized by assigning output voltage parameters manually. This will not, however, rectify the scaling error referred to above.

### 6.6.6 Information on the differential input, control limits, and grounding

If the difference amplifier is used with an amplification of 0.1, a differential input voltage of up to ±30 V can be processed as a single-ended output voltage (up to ±3 V). The value ±3 V represents the control limits of the analog digital converter on the CUD.

If the output signal from external armature current measurement is scaled to ±10 V at rated current, it will not be possible to measure overcurrent. For example, if the output signal from armature current measurement is scaled to ±5 V at rated current, a current of 2 × $I_{RATED}$ can be measured.

It is vital for users of the SINAMICS DCM Control Module to realize that they need to check whether the method used for current measurement is really able to map the desired overcurrents and the expected peak values within the tolerance required. It is important to check the current measurement circuit to ensure that current mapping remains linear right through to the desired overcurrent capacity. If this is not the case, the capping of the actual value will result in current overshooting and, ultimately, in blown fuses.

The most common risk is overloading of the last operational amplifier in the measuring circuit. This problem can be avoided by scaling external current measurement to a sufficiently low value. For example, R642 needs to be shorted in 6QG22. Similarly, R71 needs to be jumpered with an additional 100 kΩ in 6QG35. This ensures there is controllability at anything up to 2 x rated current (±10 V).

The SINAMICS DCM Control Module is able to process load signals up to a peak value of ±3 V (= 3 × rated current). This means processing is possible up to a peak value of ±30 V when the differential input is being used.

If the V-circuit is being used with an external load resistor and there is no downstream amplifier, it is advisable to dimension the load resistor for 1 V at rated current. The R701 or R704 internal 10 Ω resistor should be removed to minimize the influence of the supply line and terminal resistance. Please take care when performing calculations if the resistor is still in place! In this case, the integrated load resistor of 10 Ω must be taken into consideration when calculating the external load resistor. Existing load resistors for 10 V at rated current can have their previous value and power loss reduced to a tenth. Terminals XB-1 and XB-2 are used for the connection, with XB-2 acting as the ground connection. EMC requirements mean there should be no other connection between the V-circuit and ground.

If a V-circuit for 10 V at rated current is to be connected without any changes, either terminals XB-1 and XB-4 (with the difference amplifier at 0.1) or terminals X_I_IST must be used. In such cases, one end of the load resistor should be grounded for EMC reasons.

If an external measuring circuit (LEM transformer) is connected, its electronic ground should be grounded for EMC reasons.

# 6.7 Connecting the firing pulse transformers

## 6.7.1 General information

The twelve firing pulse drivers for the firing pulse transformers are located on the "Power interface for the Control Module" module. The firing pulses for the first torque direction can be accessed via connector X21A and those for the second torque direction via connector X22A. Each firing pulse driver has an open drain output with a parallel diode downstream of the electronic ground. A further diode discharges shutdown overvoltages internally downstream of P44 (+44 V). The twelve firing pulse transformers (containing 33 Ω series resistors) are located on the "Firing pulse transformer module". Each is connected between P24 and the firing-circuit cable. Each of the twelve firing pulse drivers can control up to three firing pulse transformers (containing 33 Ω series resistors) in parallel. There is no short-circuit protection! The user is responsible for ensuring the outputs are not overloaded. The maximum power pulse current at each of these outputs is 2.5 A. The circuit as a whole is dimensioned for long pulses.

**Note**

**Restriction regarding dismantling in conjunction with functional safety**

In conjunction with the use of functional safety, it is **not** permissible that the firing pulse transformer module is removed.

## 6.7.2 Normal use (individual)

Connectors X21A and X22A are connected with the connectors of the same name on the "Firing pulse transformer module" via two 26-pin ribbon cables. The firing pulse transformers on the module with the same name are then connected. It is only necessary to use the ribbon cable for X21A for operation with just one current direction. If the "Firing pulse transformer module" has been divided (broken up), each firing pulse transformer must be connected to the terminal strip via two twisted cables.

## 6.7.3 Parallel connection of firing pulses

Up to three firing pulse transformers (containing 33 Ω series resistors) can be connected in parallel. This involves connecting additional "Firing pulse transformer modules" (firing pulse transformers) (spare part article number 6RY1703-0CM01) via ribbon cables or using two twisted cables to wire each individual firing pulse transformer in parallel with the terminal with the same name.

- Two or three firing pulse transformers can be connected in parallel to increase the firing current of the thyristors. This involves connecting the secondary sides of the firing pulse transformers in parallel for each firing pulse. The firing current actually achieved should be checked with a current probe and an oscilloscope.
- For operation with just one current direction (torque direction), the second half of the "Firing pulse transformer module" can be used for connecting a power unit in parallel or increasing the firing current. This involves connecting connector X21PAR on the "Firing pulse transformer module" with connector X22PAR via a 26-pin ribbon cable. Where this is the case, numbers X21 to X26 on the firing pulse transformers are no longer really applicable.

| NOTICE |
| --- |
| **Only connect a maximum of three firing pulse transformers to any one firing pulse output!** |
| There is a risk of the firing drivers on the "Power interface for the Control Module" module being damaged due to overload. |
| The power interface for the Control Module is protected by F400 fuses (1 A, time-lag). |

## 6.7.4 External amplification of firing pulses

No more than three power units can be connected in parallel unless external firing pulse amplifiers with their own 24 V supply are connected. The maximum possible load of the internal firing pulse drivers (open drain) is 2.5 A per pulse.

The associated cables for the electronic ground are also brought out at connectors X21A and X22A.

The P24 cables of connectors X21A and X22A must not be subjected to loads greater than 1 A (this is not normally connected either). The external firing pulse amplifiers must be provided with 24 V (22 V to 30 V) via their own power supply. The supply lines for the external firing pulse amplifiers must be sufficiently interference-proof to prevent thyristors misfiring under the prevailing conditions.

**Notes**

- External firing pulse amplifiers usually have integrated pull-up resistors at their inputs. If this is not the case or interference immunity needs to be increased, additional pull up resistors can be connected. However, the power pulse current must not exceed 1 A for each output.
- Where several firing pulse amplifiers with their own power supply are connected in parallel on the input side (e.g. SITOR sets), the inputs will need to be decoupled by isolation diodes. This is already the case with SITOR sets.

**Note**

**Restriction in conjunction with functional safety**

In conjunction with the use of functional safety, it is **not** permissible that external firing pulse amplifiers are used.

## 6.8 Connecting voltage measurement equipment

The following potentials from the power unit need to be connected to the "Voltage measurement" module:

- Line supply voltage 1U1, 1V1, and 1W1
- Output voltage 1C1 and 1D1

The mounting tabs are arranged in groups for the different line voltage ranges.

Table 6- 6 Connecting voltage measurement equipment, parameter settings

| Rated line voltage | Plug in at | Parameter [1] |
|---|---|---|
| < 6 V | 5.6 V | p51821 = 6 |
| 6 V - 50 V | 50 V | p51821 = 50 |
| 51 V - 125 V | 125 V | p51821 = 125 |
| 126 V - 250 V | 250 V | p51821 = 250 |
| 251 V - 575 V | 575 V | p51821 = 575 |
| 576 V - 1000 V | 1000 V | p51821 = 1,000 |
| [1] Index [0] for line voltage, index [1] for armature voltage | | |

Other parameters:

p50078[0] Actual rated input voltage, armature

p51820 Suitable rated supply voltage (rms value) for the power unit (thyristors' proof voltage)

The voltage level selected must be the same on the printed circuit board and in the firmware or the voltages measured will be highly inaccurate.

Voltage measurement equipment does not generate any ground leakage current.

## 6.9 Connecting fuse monitoring equipment

One or more fuse monitoring units can be used to monitor the fuses of one or more power units.

Fuse monitoring equipment does not generate any ground leakage current.

Just the same as for the voltage sensing, the cables must be inserted at the blade terminals for the particular line voltage range. Two adjacent blade terminals form a monitoring function.

Using the fuse monitoring unit, up to six individual fuses can be monitored, isolated from one another – or twelve fuses, if there are two for each phase. The module is connected at the Power Interface via X23B.

### Fuse monitoring equipment connected in parallel

Up to five fuse monitoring units can be connected in parallel to monitor additional fuses. In this way, up to 30 individual fuses can be monitored or 60 fuses if there are two for each phase.

The fuse monitoring units are connected through the fuse monitoring distributor available as an accessory.

All fuse monitoring units used are connected at the fuse monitoring distributor (connectors X23B to X23F). The fuse monitoring distributor is connected to the power interface for the Control Module via the ribbon cable provided (connector X23A).

The individual fuse monitoring modules can be activated by entering a "1" at p51831[0...4].

**Note**

In Chapter "Division options (Page 83)", the connection of the fuse monitoring unit to the power interface via X23B can be seen in the circuit diagrams for examples 1 to 3. Example 4 shows the use of the fuse monitoring distributor for connecting two fuse monitoring units to a power interface.

### Ordering modules

When delivered, the SINAMICS DCM Control Module contains a fuse monitoring unit.

Additional fuse monitoring units as well as the fuse monitoring distributor module are available as accessories.

See Chapter "Ordering information for options and accessories (Page 26)" for ordering data.

# 6.10 Parallel connection of power units

### Current splitting / symmetry

It is important to ensure the current is split correctly when connecting power units in parallel. Even distribution must be ensured to prevent power unit overloads. Appropriate derating measures should be implemented where necessary. In view of this, it is absolutely essential that all parallel firing pulse transformers/firing pulse amplifiers are of the same type and design. The split of current across the power units connected in parallel should be checked during commissioning and corrected, where necessary, by harmonizing source impedances (line reactors, supply lines, and transformers). If unexpected problems are encountered during this process, check whether the firing pulses at the thyristors are occurring simultaneously. The execution times for the firing pulses must not differ by more than 200 ns. It is recommended that the firing currents of those thyristors that are to fired simultaneously in a parallel connection, should be compared on an oscilloscope with two small current probes.
"Simulation mode" can be used for this purpose. It can be activated individually for each thyristor with parameter p51840. With electrical connections, the power unit should be safely disconnected to prevent accidents.

### Comments on voltage measurement/Synchronization

The best method is to connect voltage measurement equipment 1U1, 1V1, and 1W1 at the branching points of the line supply. The connection of motor voltages 1C1 and 1D1 is relatively unimportant.

### Comments on fuse monitoring

If possible, all the fuses of the devices connected in parallel should be monitored. It is particularly important to monitor the fuses at branches not measured by a current transformer. The SINAMICS DCM Control Module is unable to measure whether the current has been split evenly at these points.

**Note**

The currents (current splits) measured by the SINAMICS DCM Control Module itself are wholly dependent on the values determined by the current transformers. The device itself is not able to measure current splitting in the phase that runs through the current transformers (mainly 1V1).

Where only one set of SINAMICS DCM control electronics is being used, with firing pulses connected in parallel accordingly, it is not easy to determine how the current is split between the power units. One method is to measure the current at one device and work out the other currents, and thereby the total current, on the basis of the known current split. The other method involves using separate control electronics for each power unit capable of determining the allocated direct current. These currents can then be added together and the resulting values used elsewhere.

**⚠WARNING**

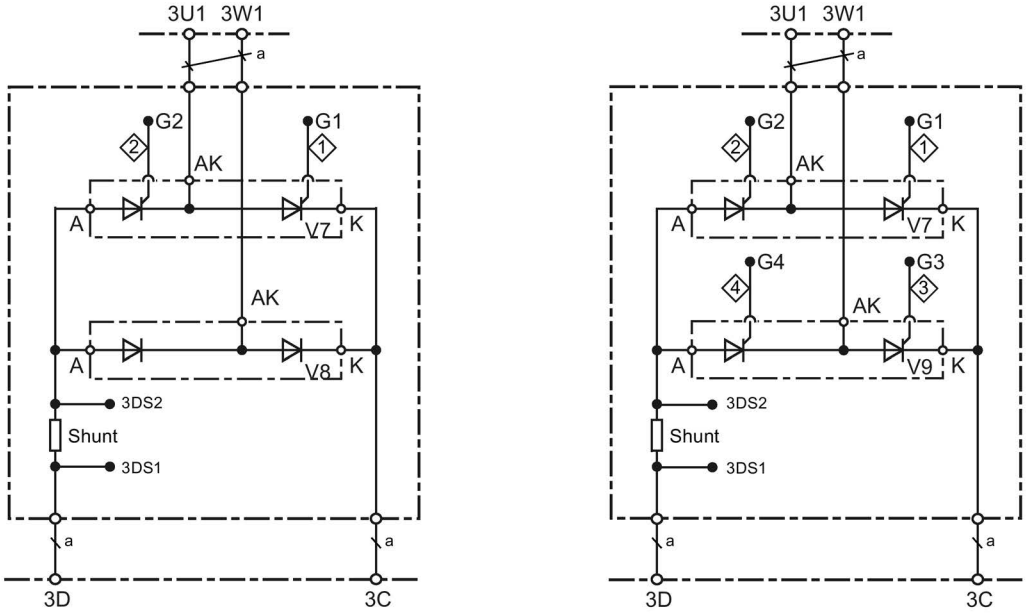
**Failure to observe general safety instructions and residual risks**

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

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

# 6.11 Field supply

## Power unit field supply




Gate cables: Betatherm 145 0.5 mm$^2$, UL
a = Betatherm 145 6 mm$^2$, UL

Figure 6-29 Power unit field supply

# 6.12 Line reactors

Line reactors should be dimensioned to produce a short-circuit voltage of between 4% and 10% (based on the rated field current and taking supply impedance into account).

Local regulations regarding line harmonic distortion need to be observed when selecting line reactors.

## Line reactor selection list

Table 6- 7 3-phase line reactors, rated voltage = 400 V AC, uk = 4%

| Article number | Rated current | Inductance | Copper losses | Total losses | SCCR | Weight | Rated insulation voltage |
|---|---|---|---|---|---|---|---|
| 6RX1800-4DK00 | 13 A AC | 2.315 mH | 22.8 W | 33.1 W | 2.0 kA (20 ms) | 2.9 kg | 600 V |
| 6RX1800-4DK01 | 25 A AC | 1.158 mH | 30.8 W | 53.2 W | 5.0 kA (20 ms) | 4.4 kg | 600 V |
| 6RX1800-4DK02 | 51 A AC | 0.579 mH | 43.5 W | 73.2 W | 6.5 kA (100 ms) | 10.9 kg | 600 V |
| 6RX1800-4DK03 | 76 A AC | 0.386 mH | 64.4 W | 118.5 W | 9.0 kA (100 ms) | 13.8 kg | 600 V |
| 6RX1800-4DK04 | 106 A AC | 0.278 mH | 51.3 W | 119.3 W | 15 kA (100 ms) | 23.9 kg | 600 V |
| 6RX1800-4DK05 | 174 A AC | 0.169 mH | 164.8 W | 206.4 W | 15 kA (100 ms) | 24.0 kg | 600 V |
| 6RX1800-4DK06 | 232 A AC | 0.127 mH | 197.4 W | 256.2 W | 20 kA (100 ms) | 26.8 kg | 600 V |
| 6RX1800-4DK07 | 332 A AC | 0.089 mH | 190.7 W | 251.1 W | 24 kA (200 ms) | 45.8 kg | 600 V |
| 6RX1800-4DK08 | 374 A AC | 0.079 mH | 186.7 W | 251.7 W | 24 kA (200 ms) | 56.8 kg | 600 V |
| 6RX1800-4DK10 | 498 A AC | 0.059 mH | 277.0 W | 357.4 W | 35 kA (200 ms) | 60.0 kg | 600 V |
| 6RX1800-4DK11 | 706 A AC | 0.042 mH | 329.4 W | 424.8 W | 55 kA (200 ms) | 81.6 kg | 1000 V |
| 6RX1800-4DK12 | 996 A AC | 0.030 mH | 390.3 W | 562.8 W | 75 kA (200 ms) | 100.1 kg | 1000 V |
| 6RX1800-4DK13 | 1328 A AC | 0.022 mH | 339.3 W | 554.5 W | 75 kA (200 ms) | 138.8 kg | 1000 V |
| 6RX1800-4DK14 | 1660 A AC | 0.018 mH | 369.3 W | 591.9 W | 75 kA (200 ms) | 210.7 kg | 1000 V |
| 6RX1800-4DK15 | 2490 A AC | 0.012 mH | 587.3 W | 1038.3 W | 75 kA (200 ms) | 205.6 kg | 1000 V |

Table 6- 8 3-phase line reactors, rated voltage = 480 V AC, uk = 4%

| Article number | Rated current | Inductance | Copper losses | Total losses | SCCR | Weight | Rated insulation voltage |
|---|---|---|---|---|---|---|---|
| 6RX1800-4FK00 | 13 A AC | 2.779 mH | 27.4 W | 39.2 W | 2.0 kA (20 ms) | 2.9 kg | 600 V |
| 6RX1800-4FK01 | 25 A AC | 1.389 mH | 34.8 W | 57.8 W | 5.0 kA (20 ms) | 6.0 kg | 600 V |
| 6RX1800-4FK02 | 51 A AC | 0.695 mH | 42.3 W | 77.2 W | 6.5 kA (100 ms) | 11.8 kg | 600 V |
| 6RX1800-4FK03 | 76 A AC | 0.463 mH | 56.3 W | 118.0 W | 9.0 kA (100 ms) | 16.3 kg | 600 V |
| 6RX1800-4FK04 | 106 A AC | 0.333 mH | 68.8 W | 152.9 W | 15 kA (100 ms) | 22.3 kg | 600 V |
| 6RX1800-4FK05 | 174 A AC | 0.202 mH | 204.6 W | 255.6 W | 15 kA (100 ms) | 26.0 kg | 600 V |
| 6RX1800-4FK06 | 232 A AC | 0.152 mH | 178.3 W | 231.4 W | 20 kA (100 ms) | 37.8 kg | 600 V |
| 6RX1800-4FK07 | 332 A AC | 0.106 mH | 193.7 W | 261.5 W | 24 kA (100 ms) | 56.1 kg | 600 V |
| 6RX1800-4FK08 | 374 A AC | 0.094 mH | 189.1 W | 279.2 W | 24 kA (100 ms) | 56.8 kg | 600 V |
| 6RX1800-4FK10 | 498 A AC | 0.071 mH | 313.8 W | 396.9 W | 35 kA (200 ms) | 78.1 kg | 1000 V |
| 6RX1800-4FK11 | 664 A AC | 0.053 mH | 255.6 W | 360.8 W | 75 kA (200 ms) | 96.6 kg | 1000 V |
| 6RX1800-4FK12 | 706 A AC | 0.050 mH | 293.9 W | 404.1 W | 75 kA (200 ms) | 96.6 kg | 1000 V |
| 6RX1800-4FK13 | 913 A AC | 0.039 mH | 375.6 W | 558.6 W | 75 kA (200 ms) | 114.5 kg | 1000 V |
| 6RX1800-4FK14 | 996 A AC | 0.035 mH | 332.7 W | 532.8 W | 75 kA (200 ms) | 127.8 kg | 1000 V |
| 6RX1800-4FK15 | 1328 A AC | 0.027 mH | 320.4 W | 573.7 W | 75 kA (200 ms) | 177.6 kg | 1000 V |
| 6RX1800-4FK16 | 1660 A AC | 0.021 mH | 436.5 W | 819.0 W | 75 kA (200 ms) | 161.0 kg | 1000 V |
| 6RX1800-4FK17 | 1326 A AC | 0.019 mH | 464.7 W | 819.9 W | 75 kA (200 ms) | 164.2 kg | 1000 V |
| 6RX1800-4FK18 | 2324 A AC | 0.015 mH | 671.8 W | 1056.7 W | 75 kA (200 ms) | 258.2 kg | 1000 V |

Table 6- 9 3-phase line reactors, rated voltage = 575 V AC, uk = 4%

| Article number | Rated current | Inductance | Copper losses | Total losses | SCCR | Weight | Rated insulation voltage |
|---|---|---|---|---|---|---|---|
| 6RX1800-4GK00 | 51 A AC | 0.832 mH | 56.8 W | 109.7 W | 6.5 kA (100 ms) | 13.6 kg | 600 V |
| 6RX1800-4GK01 | 106 A AC | 0.399 mH | 65.6 W | 156.7 W | 15 kA (100 ms) | 26.4 kg | 600 V |
| 6RX1800-4GK02 | 174 A AC | 0.243 mH | 150.0 W | 200.5 W | 15 kA (100 ms) | 34.5 kg | 600 V |
| 6RX1800-4GK03 | 332 A AC | 0.127 mH | 252.1 W | 327.3 W | 24 kA (200 ms) | 63.1 kg | 600 V |
| 6RX1800-4GK04 | 498 A AC | 0.085 mH | 330.3 W | 427.5 W | 35 kA (200 ms) | 86.0 kg | 1000 V |
| 6RX1800-4GK05 | 598 A AC | 0.071 mH | 339.6 W | 455.5 W | 55 kA (200 ms) | 89.8 kg | 1000 V |
| 6RX1800-4GK06 | 631 A AC | 0.067 mH | 322.8 W | 441.1 W | 55 kA (200 ms) | 95.7 kg | 1000 V |
| 6RX1800-4GK07 | 664 A AC | 0.064 mH | 380.7 W | 547.2 W | 75 kA (200 ms) | 108.4 kg | 1000 V |
| 6RX1800-4GK08 | 706 A AC | 0.060 mH | 392.7 W | 564.5 W | 75 kA (200 ms) | 120.6 kg | 1000 V |
| 6RX1800-4GK10 | 830 A AC | 0.051 mH | 308.1 W | 498.3 W | 75 kA (200 ms) | 134.8 kg | 1000 V |
| 6RX1800-4GK11 | 913 A AC | 0.046 mH | 320.7 W | 515.9 W | 75 kA (200 ms) | 143.9 kg | 1000 V |
| 6RX1800-4GK12 | 1245 A AC | 0.034 mH | 371.4 W | 605.4 W | 75 kA (200 ms) | 206.1 kg | 1000 V |
| 6RX1800-4GK13 | 1328 A AC | 0.032 mH | 503.1 W | 812.4 W | 75 kA (200 ms) | 160.9 kg | 1000 V |
| 6RX1800-4GK14 | 1660 A AC | 0.025 mH | 631.3 W | 993.1 W | 75 kA (200 ms) | 202.0 kg | 1000 V |
| 6RX1800-4GK15 | 1826 A AC | 0.023 mH | 614.7 W | 1006.9 W | 75 kA (200 ms) | 212.1 kg | 1000 V |
| 6RX1800-4GK16 | 2158 A AC | 0.020 mH | 534.6 W | 1073.7 W | 75 kA (200 ms) | 303.0 kg | 1000 V |
| 6RX1800-4GK17 | 2324 A AC | 0.018 mH | 556.2 W | 1110.0 W | 75 kA (200 ms) | 321.6 kg | 1000 V |

Table 6- 10 3-phase line reactors, rated voltage = 690 V AC, uk = 4%

| Article number | Rated current | Inductance | Copper losses | Total losses | SCCR | Weight | Rated insulation voltage |
|---|---|---|---|---|---|---|---|
| 6RX1800-4KK00 | 598 A AC | 0.085 mH | 388.2 W | 562.1 W | 55 kA (200 ms) | 108.9 kg | 1000 V |
| 6RX1800-4KK01 | 631 A AC | 0.080 mH | 402.0 W | 586.4 W | 75 kA (200 ms) | 113.3 kg | 1000 V |
| 6RX1800-4KK02 | 789 A AC | 0.064 mH | 362.7 W | 564.6 W | 75 kA (200 ms) | 141.9 kg | 1000 V |
| 6RX1800-4KK03 | 830 A AC | 0.061 mH | 350.7 W | 561.4 W | 75 kA (200 ms) | 153.4 kg | 1000 V |
| 6RX1800-4KK04 | 1245 A AC | 0.041 mH | 505.2 W | 845.7 W | 75 kA (200 ms) | 169.7 kg | 1000 V |
| 6RX1800-4KK05 | 1577 A AC | 0.032 mH | 716.8 W | 1093.8 W | 75 kA (200 ms) | 226.1 kg | 1000 V |
| 6RX1800-4KK06 | 1660 A AC | 0.031 mH | 596.0 W | 1011.8 W | 75 kA (200 ms) | 257.2 kg | 1000 V |
| 6RX1800-4KK07 | 2158 A AC | 0.024 mH | 484.8 W | 1185.6 W | 75 kA (200 ms) | 360.2 kg | 1000 V |

Table 6- 11 3-phase line reactors, rated voltage = 830/950 V AC, uk = 4%

| Article number | Rated current | Inductance | Copper losses | Total losses | SCCR | Weight | Rated insulation voltage |
|---|---|---|---|---|---|---|---|
| 830 V: | | | | | | | |
| 6RX1800-4LK00 | 789 A AC | 0.077 mH | 312.0 W | 532.1 W | 75 kA (200 ms) | 205.2 kg | 1000 V |
| 6RX1800-4LK01 | 1245 A AC | 0.049 mH | 692.4 W | 1061.9 W | 75 kA (200 ms) | 222.4 kg | 1000 V |
| 6RX1800-4LK02 | 1577 A AC | 0.039 mH | 479.4 W | 1059.6 W | 75 kA (200 ms) | 308.5 kg | 1000 V |
| 6RX1800-4LK03 | 1826 A AC | 0.033 mH | 585.6 W | 1269.0 W | 75 kA (200 ms) | 372.5 kg | 1000 V |
| 950 V: | | | | | | | |
| 6RX1800-4MK00 | 1826 A AC | 0.038 mH | 534.9 W | 1303.5 W | 75 kA (200 ms) | 399.7 kg | 1000 V |

Table 6- 12 1-phase line reactors, rated voltage = 400 V AC, uk = 4%

| Article number | Rated current | Inductance | Weight | Rated insulation voltage |
|---|---|---|---|---|
| 6RX1800-4DE00 | 3 A AC | 16.977 mH | 0.7 kg | 600 V |
| 6RX1800-4DE01 | 5 A AC | 10.186 mH | 1.5 kg | 600 V |
| 6RX1800-4DE02 | 10 A AC | 5.093 mH | 2.0 kg | 600 V |
| 6RX1800-4DE03 | 15 A AC | 3.395 mH | 2.3 kg | 600 V |
| 6RX1800-4DE04 | 25 A AC | 2.037 mH | 3.0 kg | 600 V |
| 6RX1800-4DE05 | 30 A AC | 1.698 mH | 3.8 kg | 600 V |
| 6RX1800-4DE06 | 40 A AC | 1.273 mH | 5.2 kg | 600 V |
| 6RX1800-4DE07 | 85 A AC | 0.599 mH | 9.6 kg | 600 V |

### Connections:

3-phase reactors with rated current ≤85 A: Terminal blocks
3-phase reactors with rated current >85 A: Connecting lugs
1-phase reactors with rated current ≤30 A: Terminal blocks
1-phase reactors with rated current >30 A: Connecting lugs

### Information

- 3-phase line reactors with uk = 2% can be supplied on request.
- The line reactors are suitable for 50 Hz and 60 Hz operation.

  In 60 Hz operation, the next highest voltage class should be selected

  e. g. 480 V at 50 Hz, 575 V at 60 Hz.

### Standards, approvals

REACH, ROHS, CE, cULus

# 6.13 Fuses

## Field circuit

Table 6- 13 Recommended fuses for the field circuit

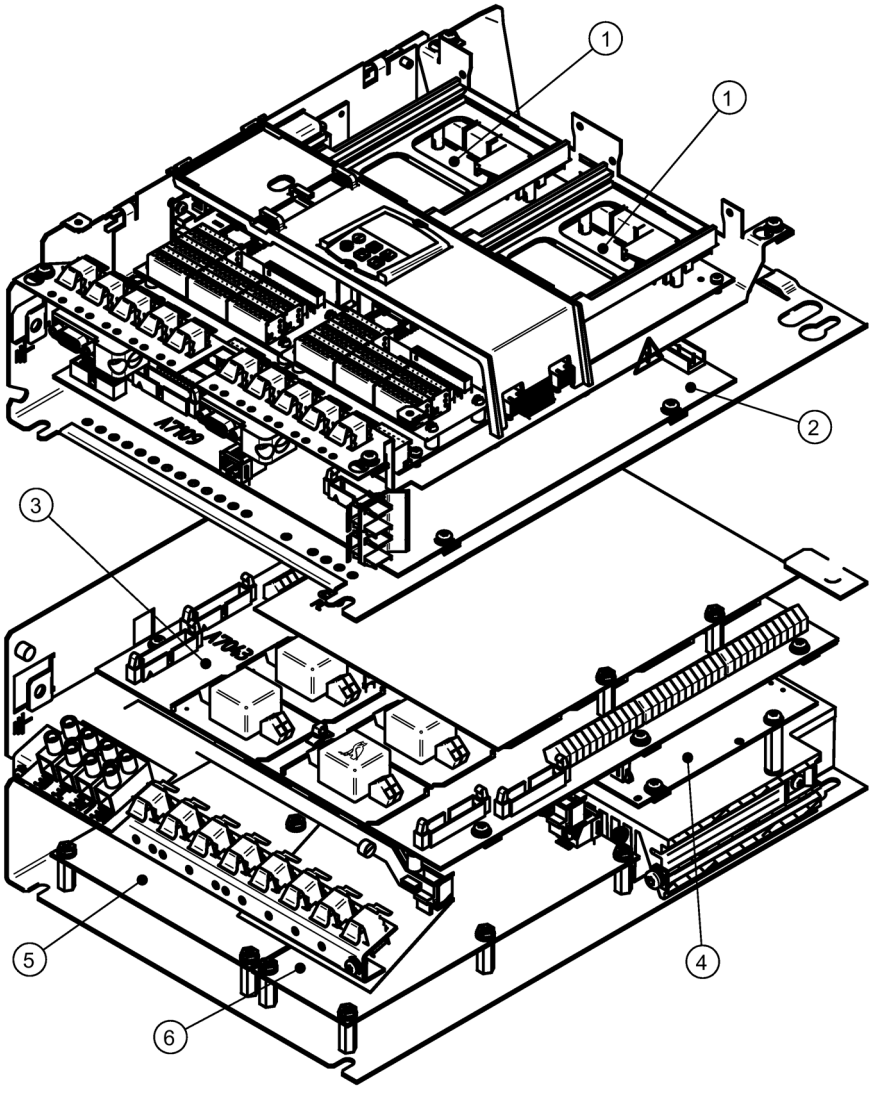
| Max. excitation current | Siemens fuse | | Bussmann fuse FWP 700V ЯU | |
|---|---|---|---|---|
| A | Article number | A | Order number | A |
| 3 | 5SD420 | 16 | FWP-5B | 5 |
| 5 | 5SD420 | 16 | FWP-5B | 5 |
| 10 | 5SD420 | 16 | FWP-15B | 15 |
| 15 | 5SD440 | 25 | FWP-20B | 20 |
| 25 | 5SD440 | 25 | FWP-30B | 30 |
| 30 | 5SD480 | 30 | FWP-35B | 35 |
| 40 | 3NE1802-0 | 40 | FWP-50B | 50 |

## Power interface for the Control Module

| Slot | Article number | Type |
|---|---|---|
| F200<br>T6.3 A/250 V | 6RY1802-0BA00 | T 6.3 |
| F400<br>T1 A / 250 V | 6RY1702-0BA00 | T 1 |

The slot for the fuses can be seen on Figure 6-34 Terminal/connector arrangement on the"Power interface for the Control Module" (Page 121).

## 6.14 Arrangement of printed circuit boards




① Control Unit (CUD) (Advanced CUD and CUD on the right are options)
② Power interface for the Control Module
③ Firing pulse transformer module
④ Power unit field supply
⑤ Fuse monitoring
⑥ Voltage measurement

Figure 6-30 Arrangement of printed circuit boards

# 6.15 Arrangement of customer connections (connector terminals, Faston mounting tabs)

## Control Unit (CUD) module

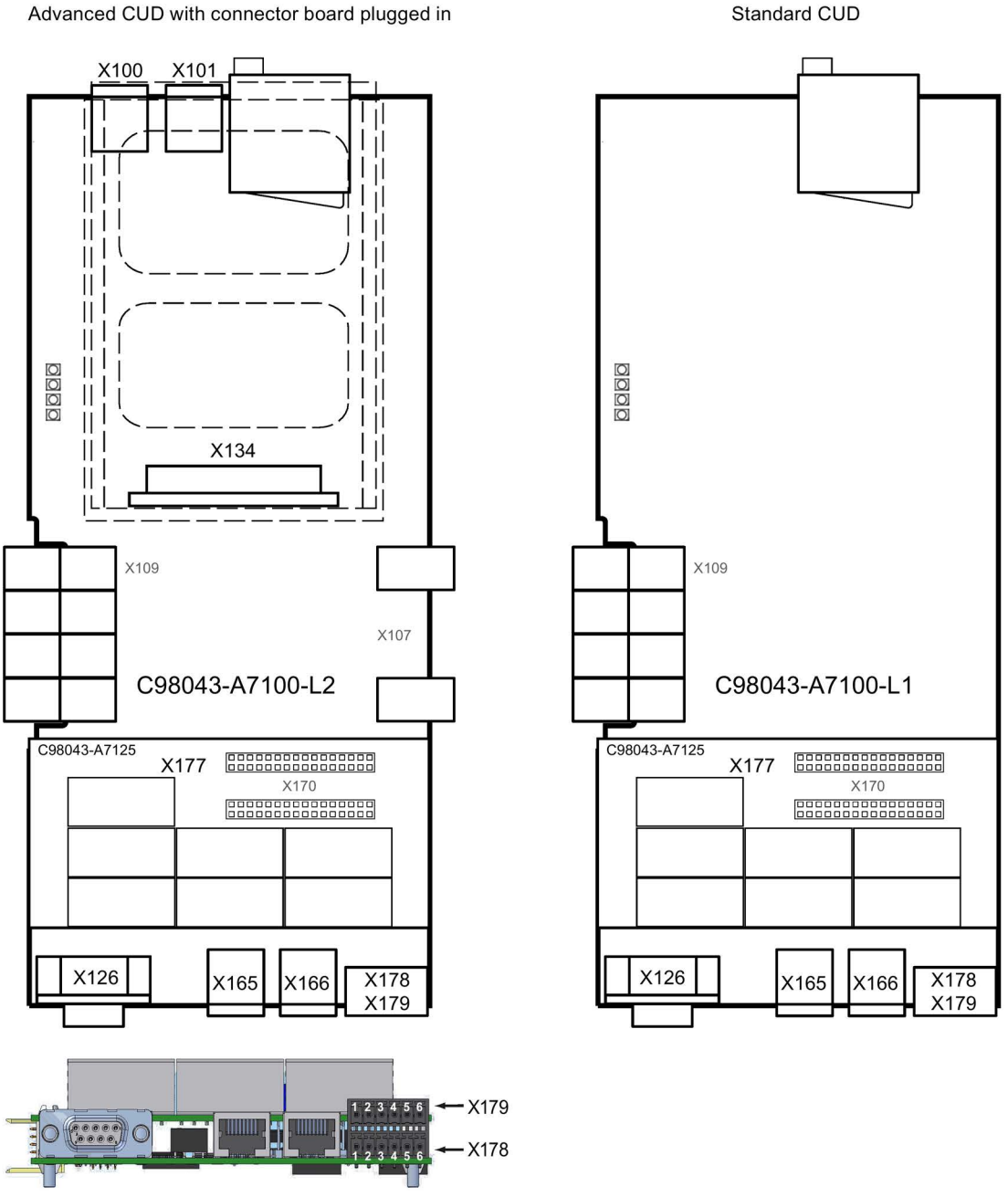



Figure 6-31 Terminal/connector arrangement on the "Control Unit (CUD)"

## Allocation Board module

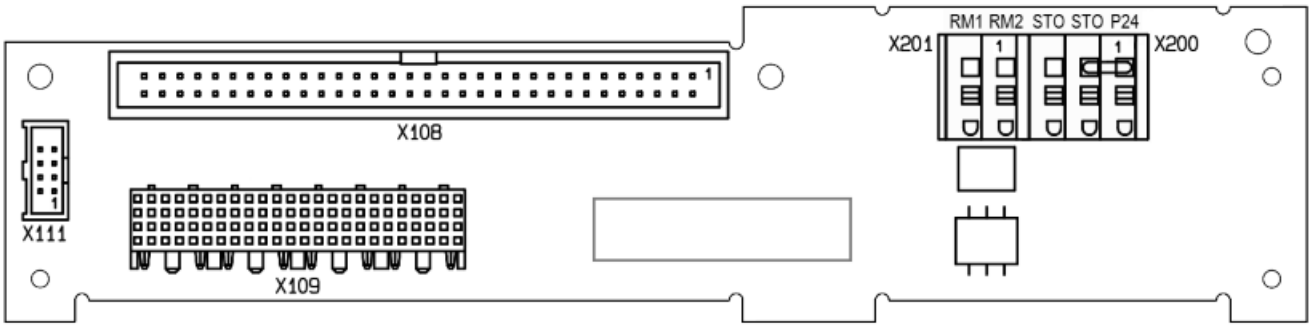



Figure 6-32 Terminal/connector assignment on the "Allocation Board"

**Note**

**Jumper STO to P24 for Functional Safety**

The jumper STO to P24 must be removed for use of the safety function and the wiring performed according to one of the applications in Chapter "Functional safety (Page 665)" with a safety relay.

## Control Unit (CUD) module, option G63

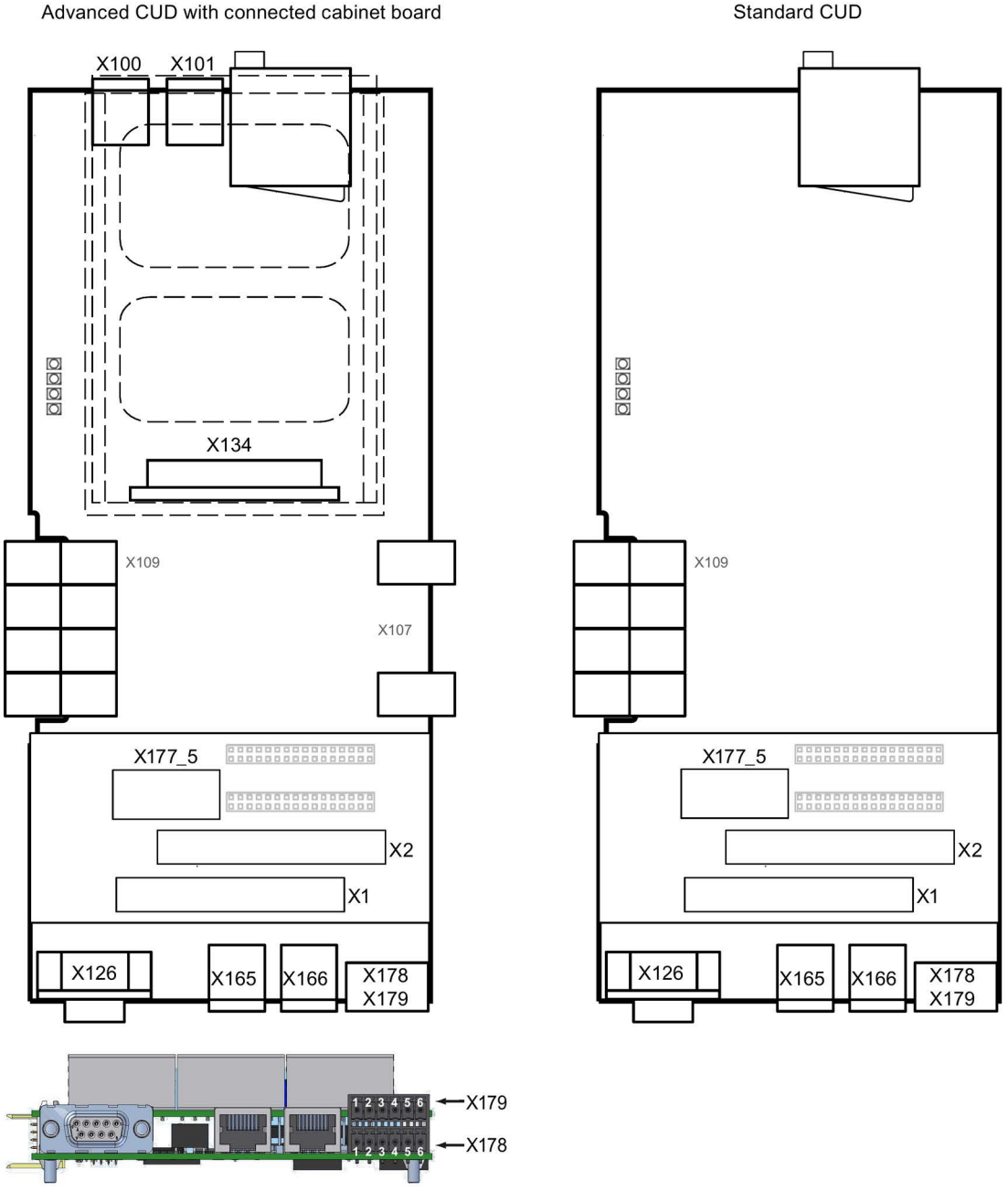



Figure 6-33 Terminal/connector arrangement on the "Control Unit (CUD)" – Option G63

## "Power interface for the Control Module" module

Figure 6-34 Terminal/connector arrangement on the "Power interface for the Control Module"

## Modules for option G63

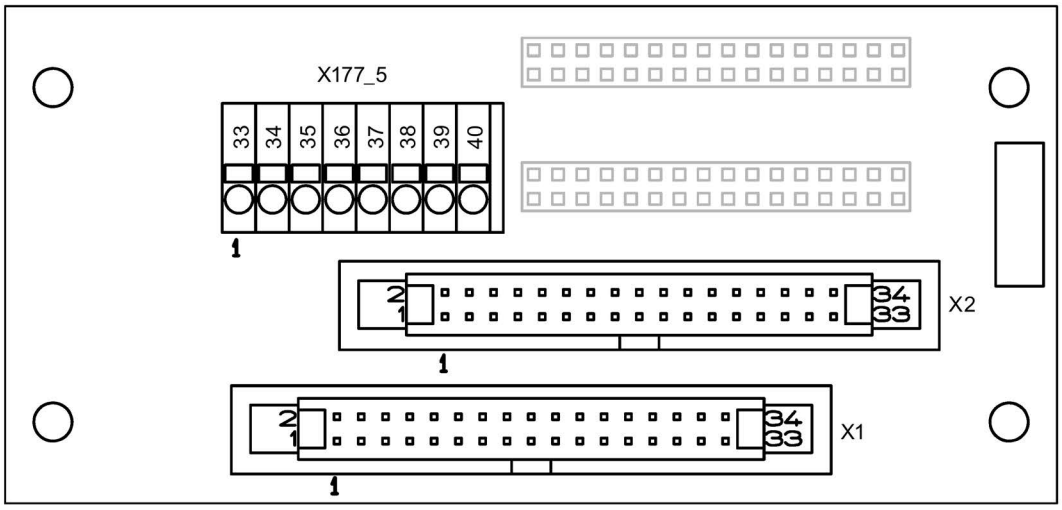



Figure 6-35 Terminal/connector arrangement on the "Cabinet Board"

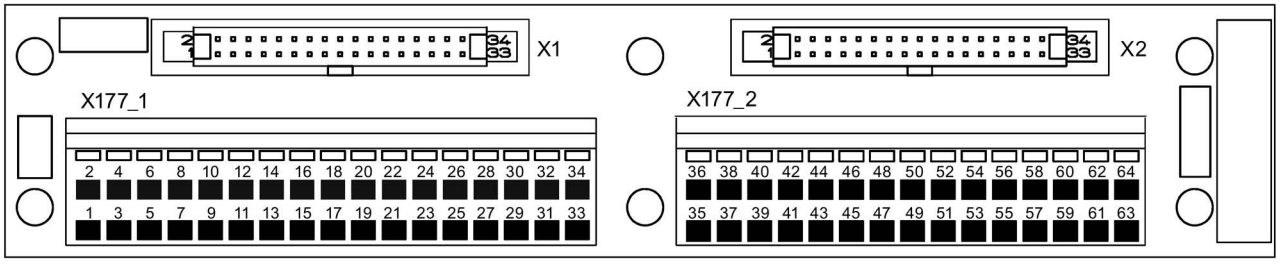



Figure 6-36 Terminal arrangement on the "Terminal Module Cabinet (TMC)"

## "Voltage measurement" module

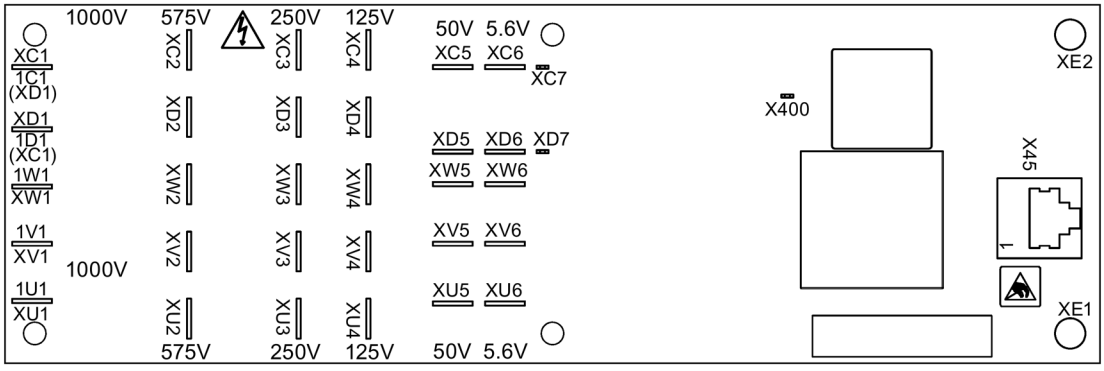



Figure 6-37 Terminal/connector arrangement on the "Voltage measurement"

## "Fuse monitoring" module

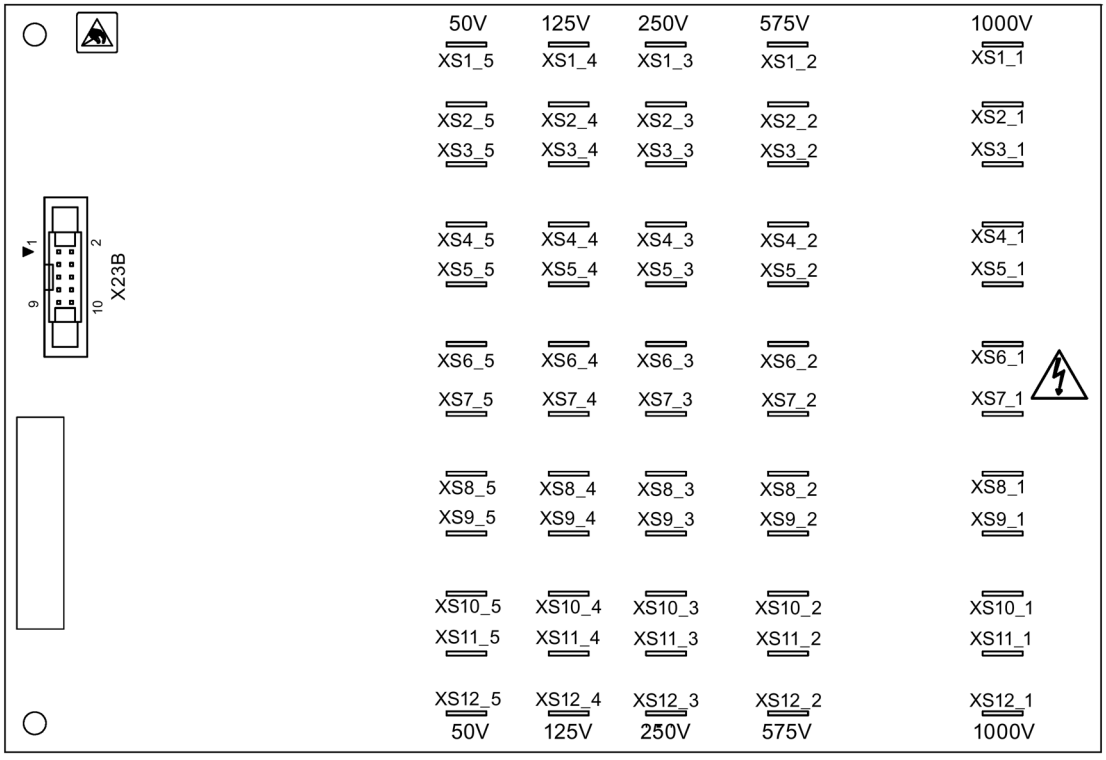
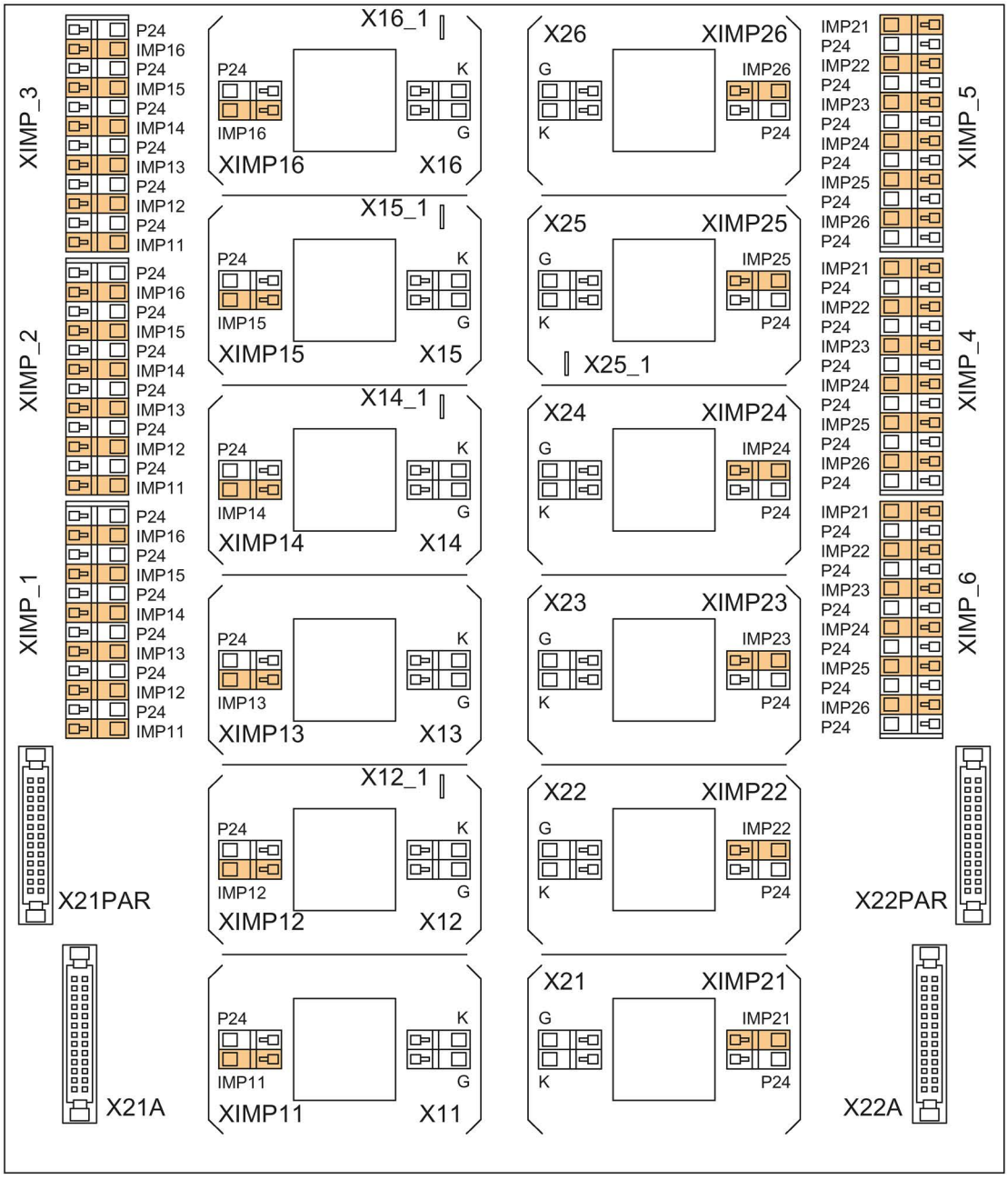



Figure 6-38 Terminal/connector arrangement on the "Fuse monitoring"

## "Firing pulse transformer module"




The following parallel connections are made in each case:

- The terminals with the same names on terminal strips XIMP_1, XIMP_2, and XIMP_3.
- The terminals with the same names on terminal strips XIMP_4, XIMP_5, and XIMP_6.
- X21A and X21PAR, X22A and X22PAR

Figure 6-39 Terminal/connector arrangement on the "Firing pulse transformer module"

## "Connector Board" module

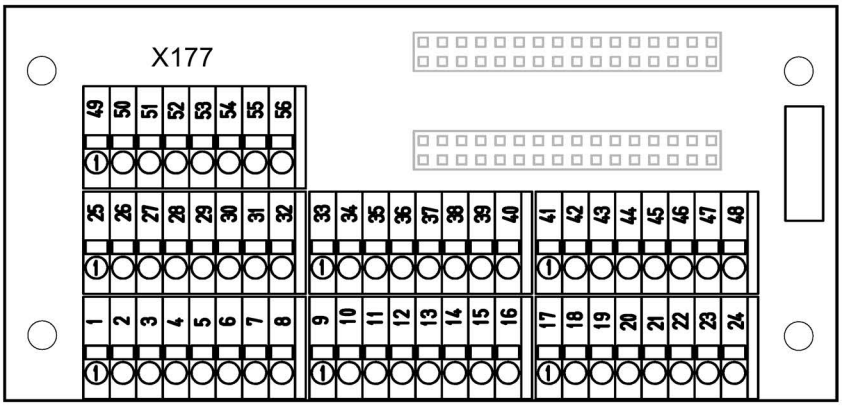



Figure 6-40 Terminal/connector arrangement on the "Connector Board"

## "Fuse monitoring distributor" module

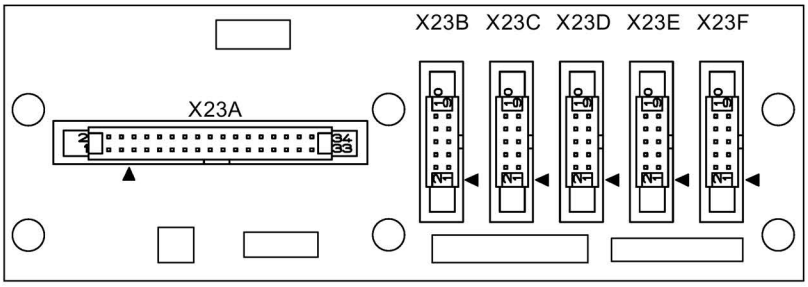



Figure 6-41 Connector arrangement on the "Fuse monitoring distributor"

### "40 A field module"

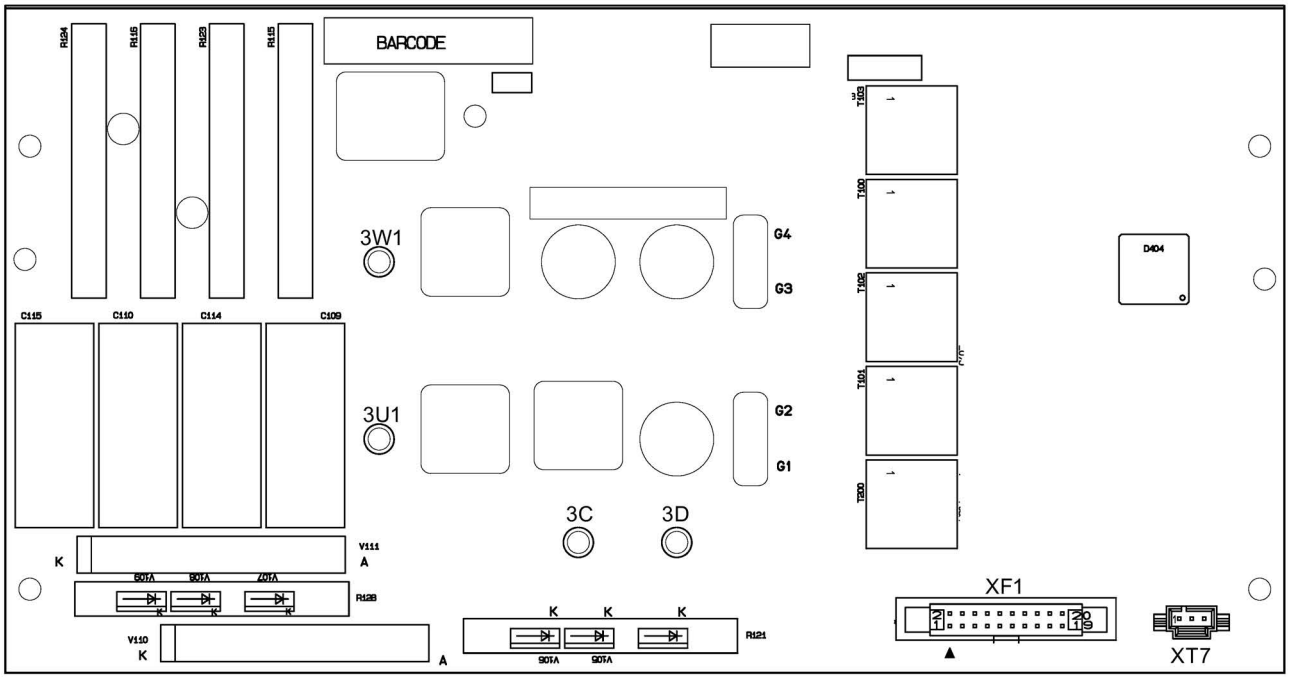



Figure 6-42 Terminals/connector arrangement of the "40 A field module"

## 6.16 Connector assignment (terminals, Faston mounting tabs, ribbon cables)

| NOTICE |
|---|
| **Damage or destruction of the device as a result of incorrect connection** |
| Connecting the unit incorrectly can lead to damage or destruction.<br>Power cables and busbars must be mechanically fastened in place outside of the unit. |

| NOTICE |
|---|
| **Dimensioning the connection cables** |
| The information regarding terminal connection options in the tables below is based on values from the terminal data sheets. The connecting cables must be dimensioned for the prevailing currents. |

## Overview

Table 6- 14 Terminals and connectors overview

| | |
|---|---|
| 3U1, 3W1, 3C, 3D | Field circuit |
| XP24V | Electronics power supply |
| X21A, X22A | Firing module |
| X23A | Fuse monitoring distributor |
| X23B | Fuse monitoring, individual |
| X45 | Voltage measurement |
| X100, X101 | DRIVE-CLiQ |
| X126 | PROFIBUS |
| X165, X166 | Parallel-connection interface |
| X177<br>for option G63:<br>X177_1, X177_2, X177_5 | Analog inputs, digital inputs, digital outputs, setpoints, reference voltage (P10/N10), serial interface (peer-to-peer), incremental encoder, analog outputs, temperature sensor |
| X178, X179 | Interface to AOP30, USS interface |
| XF1 | Field module |
| X_I_IST | External current actual value |
| XB-1 ... XB-8 | Current transformer |
| XL1 | Relay output for fan (up to 240 V) |
| XL2 | Fan monitoring |
| XM | Ground |
| XR1 | Relay output for line contactor (up to 240 V) |
| XS1 | Safety shutdown E-STOP |
| XT1 | Analog tachometer |
| XT5, XT6 | Temperature sensors |
| X200, X201 | Functional safety |

### 6.16.1 Connecting the protective conductor

The SINAMICS DCM Control Module has connecting lugs at the side of both cradles to connect the protective conductor.

In the delivery condition (both cradles assembled), the protective conductor should be connected to one of these lugs. Minimum cross section 4 $mm^2$.

If the two cradles are installed separately, then a protective conductor must be connected to both cradles.

**Note**

If the unit is stored for a longer period of time, a layer of corrosion can form on the bare metal surfaces of the cradles. Before connecting the protective conductor, this must be removed from the connection lugs.

## 6.16.2 Field circuit

Table 6- 15 Type of terminals for connecting the field circuit

| | |
|---|---|
| Type | 20E/4DS terminal strip |
| Connection capacity | Rigid/flexible ($mm^2/mm^2$): 6-16 / 6-10 |
| Stripped length | 8 mm |
| Tightening torque | 1.5 Nm |

Table 6- 16 Assignment of the connections for the field circuit

| Terminal | Function | Technical data |
|---|---|---|
| 3U1, 3W1 | Line supply connection | 2 AC 400 V (-20%), 2 AC 480 V (+10%) |
| 3C, 3D | Field winding connection | 325/373 rated V DC voltage<br>with 2-ph. 400/480 V AC line connection |

## 6.16.3 Electronic power supply

Table 6- 17 Terminal type, electronics power supply

| | |
|---|---|
| Type | Wago 256 spring-loaded terminal |
| Connection capacity | 0.08 … 2.5 $mm^2$, AWG 18-12 |
| Stripped length | 5-6 mm |

Table 6- 18 Assignment of terminals for the electronics power supply

| Terminal XP24V | Function | Technical data |
|---|---|---|
| +<br>- | 24 V infeed | 18 V to 30 V DC; current consumption 1 A ... 5 A<br>Recommended conductor cross-section 1.5 $mm^2$<br>Internal protection with F200 fuses (6.3 A, time-lag. See Chapter "Fuses (Page 116)"),<br>external protection 6 A ... 16 A, B or C characteristic |
| "Power interface for the Control Module" module | | |

## 6.16.4 Open-loop and closed-loop control section

Table 6- 19 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<br>flexible with ferrule with/without plastic sleeve:<br>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 $mm^2$ |
| **X178, X179:** | |
| Type | FMC 1.5 plug-in terminal |
| Connection capacity | Rigid/flexible/conductor sizes ($mm^2$/$mm^2$/AWG): 0.2-1.5 / 0.2-1.5 / 24-16<br>flexible with ferrule with/without plastic sleeve: 0.25-1.5 / 0.25-0.75 $mm^2$ |
| Stripped length | 10 mm |
| **XR1, XS1, XT1:** | |
| Type | MSTB 2.5/CIF plug-in terminal |
| Connection capacity | Rigid/flexible/conductor sizes ($mm^2$/$mm^2$/AWG): 0.2-2.5 / 0.2-2.5 / 24-12<br>flexible with ferrule with/without plastic sleeve: 0.25-2.5 / 0.25-2.5 $mm^2$ |
| Stripped length | 7 mm |
| Tightening torque | 0.5-0.6 Nm |
| **X126:** | |
| Type | Submin D, 9-pin |
| **X100, X101:** | |
| Type | Modular jack 8/4 (RJ45) |
| **XB-1... XB-8, X_I_IST, XM:** | |
| Type | Wago 256 spring-loaded terminal |
| Connection capacity | 0.08-2.5 $mm^2$, AWG 18-12 |
| Stripped length | 5-6 mm |
| **XT5, XT6:** | |
| Type | Faston connecting tabs, 2.8 × 0.8 mm |

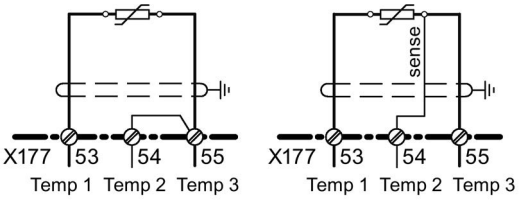
## Terminals on the Connector Board

Also refer to "Inputs/Outputs" in the section titled "Descriptions of functions".

Table 6- 20 Assignment, terminal X177

| Terminal X177 | Function | | Technical specifications |
|---|---|---|---|
| **Analog inputs (assignable inputs)** | | | |
| 1<br>2 | AI 3 +<br>AI 3 - | Analog input 3 | Input type (signal type):<br>Differential input ±10 V; 150 kΩ<br>Resolution approx. 5.4 mV (±11 bits)<br>Common-mode controllability: ±15 V |
| 3<br>4 | AI 4 +<br>AI 4 - | Analog input 4 | |
| 5<br>6 | AI 5 +<br>AI 5 - | Analog input 5 | |
| 7<br>8 | AI 6 +<br>AI 6 - | Analog input 6 | |
| **Digital inputs (assignable inputs)** | | | |
| 9<br>10 | 24 V<br>DC | 24 V supply (output) | 24 V DC, short-circuit proof<br>max. Load 200 mA (terminals 9 and 10 together),<br>internal supply referred to internal ground |
| 11 | DI 0 | Digital input 0 | H signal: +15 V to +30 V<br>L signal: -30 V to +5 V or terminal open<br>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/<br>DO 4 | Digital input/<br>output 4 | Type, input/output can be parameterized<br>Features, inputs:<br>H signal: +15 V to +30 V<br>L signal: 0 V to +5 V or terminal open<br>8.5 mA at 24 V<br>Features, outputs:<br>H signal: +20 V to +26 V<br>L signal: 0 to +2 V<br>short-circuit proof; max. current carrying capacity: 100 mA per DO; max. total load of all DO (CUD left X177:15-22 + CUD right X177:15-22): 800 mA<br>internal protection circuit (freewheeling diode)<br>If overload occurs: alarm A60018 |
| 16 | DI/<br>DO 5 | Digital input/<br>output 5 | |
| 17 | DI/<br>DO 6 | Digital input/<br>output 6 | |
| 18 | DI/<br>DO 7 | Digital input/<br>output 7 | |
| 19 | DO 0 | Digital output 0 | H signal: +20 V to +26 V<br>L signal: 0 to +2 V<br>short-circuit proof; max. current carrying capacity: 100 mA per DO; max. total load of all DO (CUD left X177:15-22 + CUD right X177:15-22): 800 mA<br>internal protection circuit (freewheeling diode)<br>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 | |

| Terminal X177 | Function | | Technical specifications |
|---|---|---|---|
| **Analog inputs, setpoint inputs (assignable inputs)** | | | |
| 25<br>26 | AI 0 +<br>AI 0 - | Analog input 0<br>Main setpoint | Input type (signal type), parameterizable:<br>- Differential input ±10 V; 150 kΩ<br>- Current input 0-20 mA; 300 Ω or 4-20 mA; 300 Ω<br>Resolution approx. 0.66 mV (±14 bits)<br>Common-mode controllability: ±15 V |
| 27<br>28 | AI 1 +<br>AI 1 - | Analog input 1 | |
| 29<br>30 | AI 2 +<br>AI 2 - | Analog input 2 | Input type (signal type):<br>Differential input ±10 V; 150 kΩ<br>Resolution approx. 0.66 mV (±14 bits)<br>Common-mode controllability: ±15 V<br>Note:<br>An external armature voltage actual value can also be connected at this input. See function diagram 6902 in the SINAMICS DCM List Manual. |
| **Reference voltage** | | | |
| 31<br>32 | P10<br>N10 | Reference voltage ±10 V (output) | Tolerance ±1% at 25 °C<br>Stability 0.1% per 10 °K<br>10 mA short-circuit proof |
| 33, 34 | M | Ground, analog | |
| **Serial interface, peer-to-peer RS485** | | | |
| 35, 36 | M | Ground, digital | |
| 37 | TX+ | Send cable + | 4-wire send cable, positive differential output |
| 38 | TX- | Send cable - | 4-wire send cable, negative differential output |
| 39 | RX+ | Receive cable + | 4-wire receive cable, positive differential output |
| 40 | RX- | Receive cable - | 4-wire receive cable, negative differential output |
| **Incremental encoder input** | | | |
| 41 | Incremental encoder supply | | +13.7 to +15.2 V, 300 mA short-circuit proof (electronically protected)<br>If overload occurs: alarm A60018 |
| 42 | Ground, incremental encoder | | |
| 43 | Track 1 positive connection | | Load: ≤ 5.25 mA at 15 V (without switching losses)<br>Pulse duty factor: 1:1<br>See below for data relating to cables, cable length, shield support, input pulse levels, hysteresis, track displacement, and pulse frequency. |
| 44 | Track 1 negative connection | | |
| 45 | Track 2 positive connection | | |
| 46 | Track 2 negative connection | | |
| 47 | Zero mark positive connection | | |
| 48 | Zero mark negative connection | | |
| **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 | |

| Terminal X177 | Function | | Technical specifications |
|---|---|---|---|
| **Connections for temperature sensor (motor interface 1)** | | | |
| 53 | Temp 1 | | Sensor acc. to p50490 (refer to SINAMICS DCM List Manual)<br>The cable to the temperature sensor on the motor must be shielded. The shield is to be connected to ground at both ends.<br>The cables for the Temp 1 and Temp 3 connections to the temperature sensor must be approximately the same length.<br>The sense cable (Temp 2) is used for compensating the cable resistances. If you are not using a sense cable, terminals 54 and 55 must be connected.<br>Connection with/without sense cable:<br>  |
| 54 | Temp 2 (sense cable) | | |
| 55 | Temp 3 | | |
| 56 | M | Ground, analog | |
| Connector board module | | | |

## Characteristic values for the incremental encoder evaluation electronics

For supported encoder types, refer to the description of parameter p0400 and Appendix A.2 in the SINAMICS DCM List Manual.

**Note**

Incremental encoder evaluation via terminals X177.41 to 48 does not support any SSI encoders.

A Sensor Module Cabinet-Mounted SMC30 is required for evaluating SSI encoders, see Chapter "Additional system components (Page 157)".

**NOTICE**

**Selecting the encoder type with p0400 does not result in any changes to the supply voltage for the incremental encoder (terminals X177.41 and 42).**

Terminal X177.41 always supplies +15 V. An external power supply is required for incremental encoders with other supply voltages (e.g. +5 V).

**Input pulse levels:**

Encoder signals (symmetrical/asymmetrical) up to a maximum of 27 V differential voltage can be processed by the evaluation electronics.

The encoder type is selected using p0400. The evaluation electronics are adjusted electronically to the encoder signal voltage:

| **Rated input voltage** | 5 V | 15 V |
|---|---|---|
| Encoder | TTL | HTL |
| Low signal level (differential voltage) | < 0.8 V | < 5.0 V |
| High signal level (differential voltage) | > 2.0 V | > 8.0 V |
| Hysteresis | > 0.2 V | > 1.0 V |
| Common-mode controllability | ±10 V | ±10 V |

If the incremental encoder does not supply any symmetrical encoder signals, it must be grounded with each signal cable twisted in pairs and connected to the negative connections of track 1, track 2, and zero mark.

**Switching frequency:**

The maximum frequency of the encoder pulses is 300 kHz. To ensure the encoder pulses are evaluated correctly, the minimum distance (Tmin) between two encoder signal edges (track 1, track 2), as listed in the table, must be adhered to.

| **Rated input voltage** | 5 V | | 15 V | | |
|---|---|---|---|---|---|
| Differential voltage [1] | 2 V | > 2.5 V | 8 V | 10 V | > 14 V |
| Tmin [2] | 630 ns | 380 ns | 630 ns | 430 ns | 380 ns |

[1] Differential voltage at the terminals of the evaluation electronics

[2] The phase error LG (deviation from 90°) that may occur as a result of the encoder and cable can be calculated on the basis of Tmin:
LG= ± (90° – fp × Tmin × 360°)
LG = phase fault
fp = pulse frequency
Tmin = minimum edge clearance
This formula only applies if the pulse duty factor of the encoder signals is 1:1.

If the incremental encoder is incorrectly matched to the encoder cable, disturbing cable reflections will occur at the receiving end. To ensure that encoder pulses of this type can be evaluated without errors, these reflections need to be damped. The limit values listed in the table below must be adhered to in order to prevent the resulting power losses in the evaluation electronics adaptor from being exceeded.

| fmax | 50 kHz | 100 kHz | 150 kHz | 200 kHz | 300 kHz |
|---|---|---|---|---|---|
| Differential voltage [3] | ≤ 27 V | ≤ 22 V | ≤ 18 V | ≤ 16 V | ≤ 14 V |

[3] Differential voltage of encoder pulses without load (= approximately the supply voltage of the incremental encoder)

**Cable, cable length, shield support:**

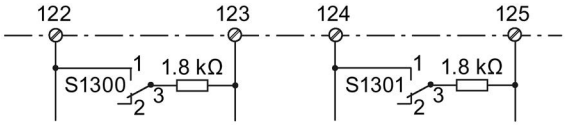
The encoder cable capacitance must be recharged at each encoder edge change. The rms value of this current is proportional to the cable length and pulse frequency, and must not exceed the current permitted by the encoder manufacturer. A suitable cable that meets the recommendations of the encoder manufacturer must be used, and the maximum cable length must not be exceeded. Generally speaking, a twisted cable pair with a single pair shield is sufficient for each track. This reduces crosstalk between the cables. Shielding all the pairs provides protection against interference pulses. The shield should be connected to the SINAMICS DC MASTER shield support over a large area.

**Note**

For connecting an incremental encoder see also Chapter "Applications (Page 661)".

## Terminals at the power interface

Table 6- 21 Terminals XR1, XS1, XT1, XL1, XL2, XM, X_I_IST, XB

| Terminal | Function | Technical data |
|---|---|---|
| **Analog tachometer XT1** | | |
| XT1-103 | Tachometer connection 8 to 270 V | ±270 V<br>Input resistance 159 kΩ<br>Resolution ±14 bits |
| XT1-104 | Ground, analog M | |
| **Safety shutdown E-STOP XS1** | | |
| XS1-105 | Input (switch) | Ie = 20 mA |
| XS1-106 | Supply (output) | 24 V DC, max. load 1 A, short-circuit proof |
| **Floating relay outputs XR1, XL1** | | |
| XR1-109<br>XR1-110 | Relay for line contactor | Current carrying capacity:<br>≤ 250 V AC, 4 A; cosφ = 1<br>≤ 250 V AC, 2 A; cosφ = 0.4<br>≤ 30 V DC, 2 A<br>Max. 4 A external protection, C characteristic recommended |
| XL1-120<br>XL1-121 | Relay for fan contactor | |
| **Monitoring inputs XL2** | | |
| XL2-122 +<br>XL2-123 - | Fan monitoring<br>(fault F60267)<br>Configuration with p51832 | Differential inputs<br>max. input voltage ±50 V<br>Common mode range -2 V to +50 V<br>L signal:<8 V, H signal: >11 V<br>input resistance 30 kΩ<br>switchable resistances 1.8 kΩ:<br>  |
| XL2-124 +<br>XL2-125 - | External monitoring<br>(fault F60203)<br>Configuration with p51833 | |
| **Electronics ground** | | |
| XM-M<br>XM-M | Electronics ground | |
| **Actual current value X_I_IST** | | |
| I_I_IST | Actual current value | Input for external actual current value<br>Analog 0 ... -10 V |
| M_I_IST | Ground reference for actual current value | |
| **Current transformer connections XB** | | |
| XB1 | Current transformer T1 - k1 | Configuration of current transformers in accordance with p51824 |
| XB2 | Current transformer T1 - I1<br>M_BUERDE | |
| XB3 | Current transformer T2 - I2<br>M_BUERDE | |
| XB4 | Current transformer T2 - k2 | |
| XB5 | Amplifier output from T3 | Configuration of current transformers in accordance with p51824 |
| XB6 | M_BUERDE | |
| XB7 | Current transformer T3 - I3<br>M_BUERDE | |
| XB8 | Current transformer T3 - k3 | |
| "Power interface for the Control Module" module | | |

## Serial interface to AOP30/USS interface

Table 6- 22 Terminal X178

| Terminal X178 | Function | Technical specifications |
|---|---|---|
| 1 | Supply (output) | 24 V DC short-circuit proof, maximum load 200 mA<br>Internal supply related to internal ground terminal |
| 2 | Ground, AOP M | |
| 3 | RX+/TX+ | Send and receive cable, RS485, two-wire<br>Positive differential input/output |
| 4 | RX-/TX- | Send and receive cable, RS485, two-wire<br>Negative differential input/output |
| 5 | Ground, digital M | |
| 6 | Ground, digital M | |
| "Control Unit (CUD)" module | | |

Table 6- 23 Terminal X179

| Terminal X179 | Function | Technical specifications |
|---|---|---|
| 1 | Supply (output) | 4.4 to 5.4 V DC short-circuit proof, maximum load 300 mA<br>Internal supply related to internal ground terminal |
| 2 | Ground, digital M | |
| 3 | TXD1 | Send cable, RS232 standard (V.24) |
| 4 | RXD1 | Receive cable, RS232 standard (V.24) |
| 5 | TXD2 | Send cable, RS232 standard (V.24) |
| 6 | RXD2 | Receive cable, RS232 standard (V.24) |
| "Control Unit (CUD)" module | | |

**Note**

Only one of the two interfaces – RS485 (X178-3, 4) or RS232 (X179-3, 4) – may be used.

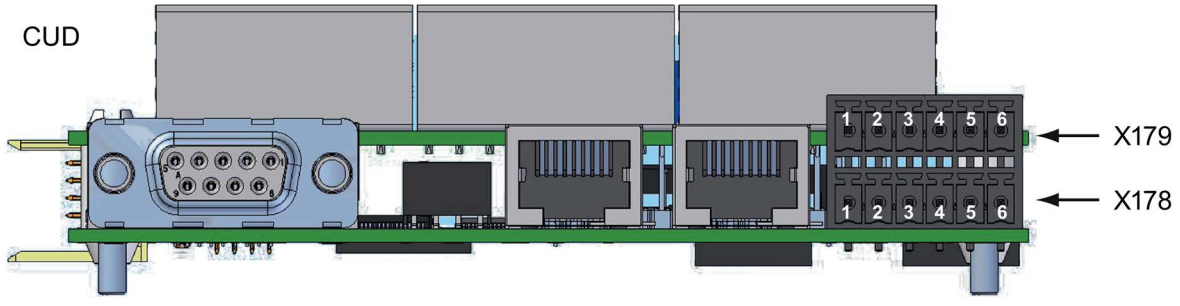
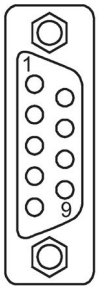



Figure 6-43 Arrangement X178 and X179

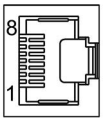
## PROFIBUS connection

Table 6- 24 PROFIBUS connector assignment

| Connector X126 | 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 |
| "Control Unit (CUD)" module | | | |

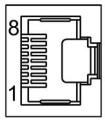
## DRIVE-CLiQ

Table 6- 25 DRIVE-CLiQ connector assignment

| Connector X100, X101 | 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 |
| | - | Shield | Permanently connected to ground |
| "Advanced CUD" module | | | |

## Parallel interface

Table 6- 26 Connector assignment, parallel interface

| Connector X165, X166 | Pin | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | SYNC_P | Synchronization + |
| | 2 | SYNC_N | Synchronization - |
| | 3 | CANH | CAN + |
| | 4 | - | Reserved, do not use |
| | 5 | - | Reserved, do not use |
| | 6 | CANL | CAN - |
| | 7 | - | Reserved, do not use |
| | 8 | - | Reserved, do not use |
| | - | Shield | Permanently connected to ground |
| Standard CUD, Advanced CUD module | | | |

## 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 6-20 Assignment, terminal X177 (Page 130).

Table 6- 27 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 V DC, short-circuit proof<br>Max. load 200 mA (terminals 9, 10, 57, 58, 59 and 60 combined),<br>internal supply to digital ground and analog ground |
| 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, main setpoint | 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 |

| Terminal X177_1, X177_2 | Function | | Description |
|---|---|---|---|
| 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 | RS485: TX+, TX- | Send cable +, - | See X177.37 and 38 |
| 39, 40 | RS485: RX+, RX- | Receive cable +, - | See X177.39 and 40 |
| 41, 42 | Incremental encoder supply | | See X177.41 and 42 |
| 43, 44 | Incremental encoder track 1 +/- | | See X177.43 and 44 |
| 45, 46 | Incremental encoder track 2 +/- | | See X177.45 and 46 |
| 47, 48 | Incremental encoder zero mark +/- | | See X177.47 and 48 |
| 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 V DC, short-circuit proof<br>Max. load 200 mA (terminals 9, 10, 57, 58, 59 and 60 combined),<br>internal supply to digital ground and analog ground |
| 61, 62, 63, 64 | M | Ground, digital | - |
| "Terminal Module Cabinet (TMC)" module | | | |

Table 6- 28 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 | RS485: TX+, TX- | Send cable +, - | See X177.37 and 38 |
| 39, 40 | RS485: RX+, RX- | Receive cable +, - | 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).

## Connectors at the power interface

Table 6- 29 Connectors XT5, XT6

| Terminal | Function | Technical data |
|---|---|---|
| **Temperature sensor input (XT5)** | | |
| XT5-1 | Electronic ground GND | Sensor in accordance with p51830[0..2] |
| XT5-3 | Heat sink temperature | |
| **Temperature sensor input (XT6)** | | |
| XT6-1 | Electronic ground GND | Sensor in accordance with p51830[0..2] |
| XT6-3 | Heat sink temperature | |
| **Zero calibration of actual current value measurement (XN1)** | | |
| XN1 | Infeed point for zero calibration | Please refer to the section titled "Measurement of the armature current" |
| **Ground (X600)** | | |
| X600 | Ground, e.g. for zero calibration via XN1 | |
| **Soldering lugs for load resistor R701 (X701, X702)** | | |
| X701 | Connection to XB-1 | |
| X702 | Connection to XB-2 | |
| **Soldering lugs for load resistor R704 (X703, X704)** | | |
| X703 | Connection to XB-3 | |
| X704 | Connection to XB-4 | |
| **Soldering lugs for load resistor R708 (X707, X708)** | | |
| X707 | Connection to XB-7 | |
| X708 | Connection to XB-8 | |
| "Power interface for the Control Module" module | | |

## Memory card slot

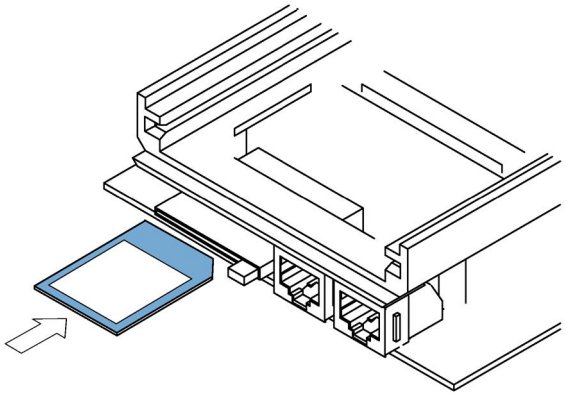


Figure 6-44 "Control Unit (CUD)" module, memory card slot

**NOTICE**

**Using the memory card**

- The memory card may only be inserted as shown in the previous figure.
- The memory card must not be removed or inserted while data is being saved. Procedure to safely remove the memory card, see Chapter "Operation", Section "Memory card functions".
- If you are returning a defective "Control Unit (CUD)" module, do not return the memory card along with it – instead, keep it so that you can use it in the replacement module.

A memory card is not required for the standard drive operation.

The memory card is needed in the following applications:

- Saving parameters
  Parameters are saved on the memory card and can simply be copied onto a new CUD if it needs to be replaced.
- Firmware update
  It is easy to perform a firmware update using a memory card.
- Loading additional languages onto the Advanced Operator Panel AOP30.
- Performing an offline long-time trace. See also Chapter "Diagnostic memory (Page 594)"
- Loading the DCC block library into the drive
- SINAMICS Link function: The SINAMICS Link function requires that the memory card is always inserted.
- Modbus TCP function: The Modbus TCP function requires that the memory card is always inserted.
- Saving the Diagstor.spd diagnostics file to the \USER\SINAMICS\DATA\LOG directory. See also Chapter "Trend recorder function (Page 595)"

## 6.16.5 Voltage measurement equipment

Connection type: Faston mounting tabs, 4.8 mm

Table 6- 30 Voltage measurement connections

| Connection | Function | Technical data, comments |
|---|---|---|
| XU1<br>XV1<br>XW1 | Measurement of the line voltage<br>Phases U-V-W<br>(1000 V) | Rated line voltage (armature) >575 V to 1000 V<br>(p51821 = 1,000) |
| XC1<br>XD1 | Measurement of the armature voltage<br>(1000 V) | Rated line voltage (armature) >575 V to 1000 V<br>(p51821 = 1,000) |
| XU2<br>XV2<br>XW2 | Measurement of the line voltage<br>Phases U-V-W<br>(575 V) | Rated line voltage (armature) >250 V to 575 V<br>(p51821 = 575) |
| XC2<br>XD2 | Measurement of the armature voltage<br>(575 V) | Rated line voltage (armature) >250 V to 575 V<br>(p51821 = 575) |
| XU3<br>XV3<br>XW3 | Measurement of the line voltage<br>Phases U-V-W<br>(250 V) | Rated line voltage (armature) >125 V to 250 V<br>(p51821 = 250) |
| XC3<br>XD3 | Measurement of the armature voltage<br>(250 V) | Rated line voltage (armature) >125 V to 250 V<br>(p51821 = 250) |
| XU4<br>XV4<br>XW4 | Measurement of the line voltage<br>Phases U-V-W<br>(125 V) | Rated line voltage (armature) >50 V to 125 V<br>(p51821 = 125) |
| XC4<br>XD4 | Measurement of the armature voltage<br>(125 V) | Rated line voltage (armature) >50 V to 125 V<br>(p51821 = 125) |
| XU5<br>XV5<br>XW5 | Measurement of the line voltage<br>Phases U-V-W<br>(50 V) | Rated line voltage (armature) >5.6 V to 50 V<br>(p51821 = 50) |
| XC5<br>XD5 | Measurement of the armature voltage<br>(50 V) | Rated line voltage (armature) >5.6 V to 50 V<br>(p51821 = 50) |
| XU6<br>XV6<br>XW6 | Measurement of the line voltage<br>Phases U-V-W<br>(5.6 V) | Rated line voltage (armature) ≤5.6 V<br>(p51821 = 6) |
| XC6<br>XD6 | Measurement of the armature voltage<br>(5.6 V) | Rated line voltage (armature) ≤5.6 V<br>(p51821 = 6) |
| "Voltage measurement" module | | |

### 6.16.6 Fuse monitoring equipment

Connection type: Faston mounting tabs, 4.8 mm

Table 6- 31 Connections for fuse monitoring equipment

| Connection | Function | Technical data, comments |
|---|---|---|
| XS1_1<br>XS2_1 | Fuse 1<br>(1000 V) | Measurement cables for the fuses to be monitored at a rated line voltage >575 V to 1,000 V*)<br>Resistance between two associated connections: 388.4 kΩ **) |
| XS3_1<br>XS4_1 | Fuse 2<br>(1000 V) | |
| XS5_1<br>XS6_1 | Fuse 3<br>(1000 V) | |
| XS7_1<br>XS8_1 | Fuse 4<br>(1000 V) | |
| XS9_1<br>XS10_1 | Fuse 5<br>(1000 V) | |
| XS11_1<br>XS12_1 | Fuse 6<br>(1000 V) | |
| XS1_2<br>XS2_2 | Fuse 1<br>(575 V) | Measurement cables for the fuses to be monitored at a rated line voltage >250 V to 600 V*)<br>Resistance between two associated connections: 196.4 kΩ **) |
| XS3_2<br>XS4_2 | Fuse 2<br>(575 V) | |
| XS5_2<br>XS6_2 | Fuse 3<br>(575 V) | |
| XS7_2<br>XS8_2 | Fuse 4<br>(575 V) | |
| XS9_2<br>XS10_2 | Fuse 5<br>(575 V) | |
| XS11_2<br>XS12_2 | Fuse 6<br>(575 V) | |
| XS1_3<br>XS2_3 | Fuse 1<br>(250 V) | Measurement cables for the fuses to be monitored at a rated line voltage >125 V to 250 V*)<br>Resistance between two associated connections: 100.4 kΩ **) |
| XS3_3<br>XS4_3 | Fuse 2<br>(250 V) | |
| XS5_3<br>XS6_3 | Fuse 3<br>(250 V) | |
| XS7_3<br>XS8_3 | Fuse 4<br>(250 V) | |
| XS9_3<br>XS10_3 | Fuse 5<br>(250 V) | |
| XS11_3<br>XS12_3 | Fuse 6<br>(250 V) | |

| Connection | Function | Technical data, comments |
|---|---|---|
| XS1_4<br>XS2_4 | Fuse 1<br>(125 V) | Measurement cables for the fuses to be monitored at a rated line voltage >50 V to 125 V*)<br>Resistance between two associated connections: 52.4 kΩ **) |
| XS3_4<br>XS4_4 | Fuse 2<br>(125 V) | |
| XS5_4<br>XS6_4 | Fuse 3<br>(125 V) | |
| XS7_4<br>XS8_4 | Fuse 4<br>(125 V) | |
| XS9_4<br>XS10_4 | Fuse 5<br>(125 V) | |
| XS11_4<br>XS12_4 | Fuse 6<br>(125 V) | |
| XS1_5<br>XS2_5 | Fuse 1<br>(50 V) | Measurement cables for the fuses to be monitored at a rated line voltage = 10 V to 50 V*)<br>Resistance between two associated connections: 18.8 kΩ **) |
| XS3_5<br>XS4_5 | Fuse 2<br>(50 V) | |
| XS5_5<br>XS6_5 | Fuse 3<br>(50 V) | |
| XS7_5<br>XS8_5 | Fuse 4<br>(50 V) | |
| XS9_5<br>XS10_5 | Fuse 5<br>(50 V) | |
| XS11_5<br>XS12_5 | Fuse 6<br>(50 V) | |
| *) The fuse monitoring equipment is generally connected to the armature current circuit, although it can also be used for the field circuit, fan circuit, or the primary circuit of a heavy-current transformer. The connections used for fuse monitoring depend on the voltage prevailing at a blown fuse.<br>**) This resistor is in parallel with the fuse. A bridge rectifier is connected in series to this resistor; this means that the specified value cannot be correctly measured using a commercially available ohmmeter. | | |
| "Fuse monitoring" module | | |

Switching fuse monitoring on/off via p51831 (0=OFF, 1=ON).

## 6.16.7 Firing pulse transformers

Table 6- 32 Terminal type, firing pulse module

| XIMP_1 to XIMP_26, X11 to X26 | |
|---|---|
| Type | Wago 256 spring-loaded terminal |
| Connection capacity | 0.08 … 2.5 mm², AWG 18-12 |
| Stripped length | 5 - 6 mm |
| X12_1, X14_1, X15_1, X16_1, X25_1 | |
| Type | Faston mounting tabs, 6.3 mm |

The P24 on the "Power interface for the Control Module" is protected by F400 fuses (1 A, time-lag).

Table 6- 33 Firing pulse module connections

| Terminal, connection | Function | Technical data, comments |
|---|---|---|
| **XIMP_1 control for firing pulse transformers for the thyristors** | | |
| IMP11<br>P24 | For thyristor V11 | If the firing pulse transformer module is divided up (please refer to the section titled "Removal/Installation and division of modules"), the controls for the firing pulse transformers must be routed via these terminal connections.<br>This involves making the following connections:<br>XIMP_1 - IMP11 → XIMP11 - IMP11 (for thyristor V11)<br>XIMP_1 - P24 → XIMP11 - P24 (for thyristor V11)<br>XIMP_1 - IMP12 → XIMP12 - IMP12 (for thyristor V12)<br>XIMP_1 - P24 → XIMP12 - P24 (for thyristor V12)<br>etc. |
| IMP12<br>P24 | For thyristor V12 | |
| IMP13<br>P24 | For thyristor V13 | |
| IMP14<br>P24 | For thyristor V14 | |
| IMP15<br>P24 | For thyristor V15 | |
| IMP16<br>P24 | For thyristor V16 | |
| **XIMP_2** | | |
| Same as XIMP_1<br>The terminals on terminal strip XIMP_2 are parallel to the terminals on terminal strip XIMP_1 with the same name. | | |
| **XIMP_3** | | |
| Same as XIMP_1<br>The terminals on terminal strip XIMP_3 are parallel to the terminals on terminal strip XIMP_1 with the same name. | | |
| **XIMP_4 control for firing pulse transformers for the thyristors** | | |
| IMP21<br>P24 | For thyristor V21 | If the firing pulse transformer module is divided up (please refer to the section titled "Removal/Installation and division of modules"), the controls for the firing pulse transformers must be routed via these terminal connections.<br>This involves making the following connections:<br>XIMP_4 - IMP21 → XIMP21 - IMP21 (for thyristor V21)<br>XIMP_4 - P24 → XIMP21 - P24 (for thyristor V11)<br>XIMP_4 - IMP22 → XIMP22 - IMP22 (for thyristor V22)<br>XIMP_4 - P24 → XIMP22 - P24 (for thyristor V12)<br>etc. |
| IMP22<br>P24 | For thyristor V22 | |
| IMP23<br>P24 | For thyristor V23 | |
| IMP24<br>P24 | For thyristor V24 | |
| IMP25<br>P24 | For thyristor V25 | |
| IMP26<br>P24 | For thyristor V26 | |
| **XIMP_5** | | |
| Same as XIMP_4<br>The terminals on terminal strip XIMP_5 are parallel to the terminals on terminal strip XIMP_4 with the same name. | | |
| **XIMP_6** | | |
| Same as XIMP_4<br>The terminals on terminal strip XIMP_6 are parallel to the terminals on terminal strip XIMP_4 with the same name. | | |
| **XIMP11 control for firing pulse transformers for the thyristors** | | |
| IMP11<br>P24 | For thyristor V11 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X11** | | |
| G, K | Firing cable, thyristor V11 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |

| Terminal, connection | Function | Technical data, comments |
|---|---|---|
| **XIMP12 control for firing pulse transformers for the thyristors** | | |
| IMP12<br>P24 | For thyristor V12 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X12** | | |
| G, K | Firing cable, thyristor V12 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP13 control for firing pulse transformers for the thyristors** | | |
| IMP13<br>P24 | For thyristor V13 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X13** | | |
| G, K | Firing cable, thyristor V13 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP14 control for firing pulse transformers for the thyristors** | | |
| IMP14<br>P24 | For thyristor V14 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X14** | | |
| G, K | Firing cable, thyristor V14 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP15 control for firing pulse transformers for the thyristors** | | |
| IMP15<br>P24 | For thyristor V15 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X15** | | |
| G, K | Firing cable, thyristor V15 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP16 control for firing pulse transformers for the thyristors** | | |
| IMP16<br>P24 | For thyristor V16 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_1) |
| **X16** | | |
| G, K | Firing cable, thyristor V16 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP21 control for firing pulse transformers for the thyristors** | | |
| IMP21<br>P24 | For thyristor V21 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X21** | | |
| G, K | Firing cable, thyristor V21 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP22 control for firing pulse transformers for the thyristors** | | |
| IMP22<br>P24 | For thyristor V22 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X22** | | |
| G, K | Firing cable, thyristor V22 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP23 control for firing pulse transformers for the thyristors** | | |
| IMP23<br>P24 | For thyristor V23 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X23** | | |
| G, K | Firing cable, thyristor V23 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |

| Terminal, connection | Function | Technical data, comments |
|---|---|---|
| **XIMP24 control for firing pulse transformers for the thyristors** | | |
| IMP24<br>P24 | For thyristor V24 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X24** | | |
| G, K | Firing cable, thyristor V24 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP25 control for firing pulse transformers for the thyristors** | | |
| IMP25<br>P24 | For thyristor V25 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X25** | | |
| G, K | Firing cable, thyristor V25 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **XIMP26 control for firing pulse transformers for the thyristors** | | |
| IMP26<br>P24 | For thyristor V26 | Only to be connected if the firing pulse transformer module is divided up (see terminal strip XIMP_4) |
| **X26** | | |
| G, K | Firing cable, thyristor V26 | Firing pulse (see below) gate (G) to auxiliary cathode (K) |
| **Outputs for voltage measurement** | | |
| X12_1 | Armature line voltage W | When the firing cables are connected to the thyristors in the power unit, the line and armature voltages are automatically present at the firing pulse transformer module.<br>These voltages can then be routed from here (connections X12_1, etc.) to the voltage measurement equipment, without having to route any additional cables to the power unit.<br>See also Chapter "Connecting the external power unit". |
| X14_1 | Armature line voltage U | |
| X15_1 | Armature voltage 1C1 | |
| X16_1 | Armature line voltage V | |
| X25_1 | Armature voltage 1D1 | |
| "Firing pulse transformer module" | | |

## 6.16.8 Firing pulse

### Time sequence

The time sequence for firing pulses is set via parameter p51826:

p51826[0] Length of first pulse (factory setting = 50 µs)
p51826[1] Length of other pulses (factory setting = 35 µs)
p51826[2] Length of pause (factory setting = 70 µs)

### Notes

- If p51826[0] = 105 or p51826[1] = 105: Block pulse (without pulse chopping)
- If p51826[0] ≤ p51826[1] is set, p51826[0] will be ignored and the first pulse will have the same length as all the other pulses.
- p50079 is used for short pulse/long pulse selection.

p50079 = 0 Short pulses, pulse length 890 µs
p50079 = 1 Long pulses, pulse duration up to approx. 0.1 ms before the next pulse

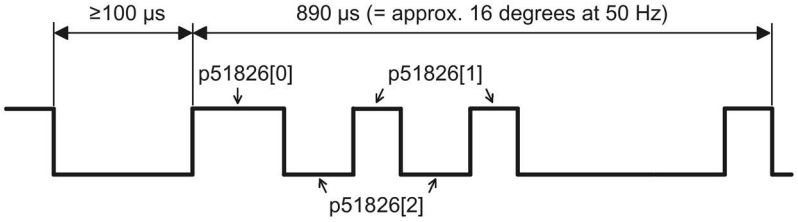
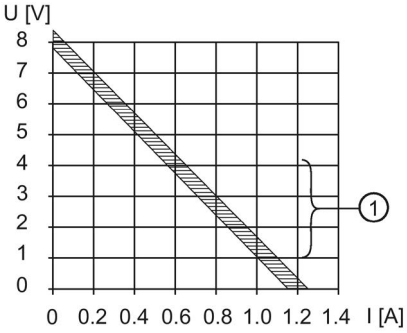



Figure 6-45 Firing pulse - time sequence

The pulse shape of the current depends on the length of the cable to the thyristor (cathode/gate). Cable inductance causes the rising edge of the current pulse to become slower as the cable length increases.

Relationship between firing current and output voltage (incl. tolerances):




① normal working range of thyristors is from 1 to 4.2 V

No-load voltage = 7.8 to 8.4 V

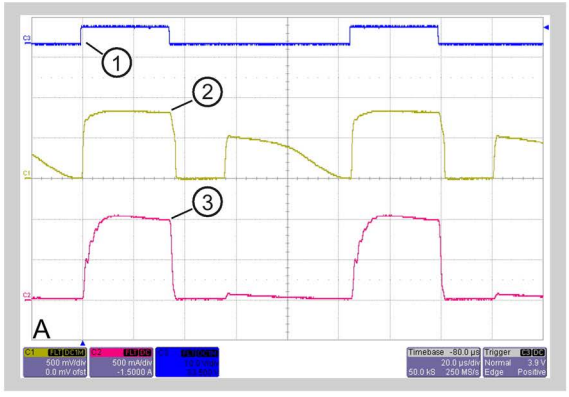
Short-circuit current = 1.15 to 1.25 A

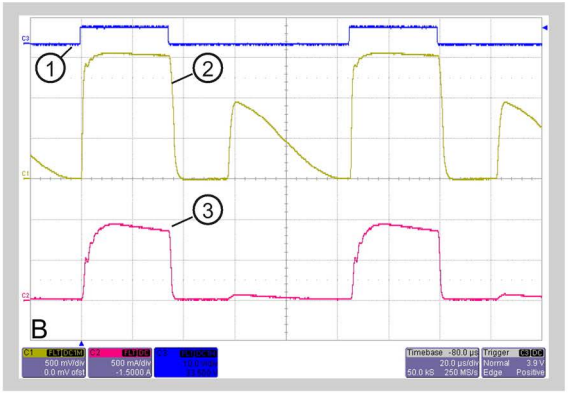
### Application

The firing condition for the thyristor used (minimum firing current) must be to the left of the firing circuit characteristic. The firing current can be determined graphically by finding the point at which the thyristor's input characteristic intersects with the firing circuit's output characteristic. It is important to remember that the thyristor's gate/cathode voltage drop increases as the temperature decreases.

### Examples of oscillograms

Firing voltage = gate/cathode voltage with 1 m twisted cable from the firing current circuit to the thyristor's gate connection




A Substitution load 20 Ω in parallel with 2 diodes

B Substitution load 20 Ω in parallel with 4 diodes

① Control signal

② Voltage at load (0.5 V/div)

③ Current through load (0.5 A/div)

Figure 6-46 Firing pulse – Oscillograms

## 6.16.9 Ribbon cables

### Firing pulse cable, torque direction 1, connectors X21A/X21PAR

Ribbon cable, 26-pin

Table 6- 34 Assignment X21A, X21PAR

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| Free | 1 | | |
| Free | 2 | | |
| Free | 3 | | |
| Electronic ground | 4 | M | |
| Thyristor firing pulse, armature 2 | 5 | IMP_12 | 24 V / 2 A pulse |
| 24 V supply, firing | 6 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 7 | M | |
| Thyristor firing pulse, armature 6 | 8 | IMP_16 | 24 V / 2 A pulse |
| 24 V supply, firing | 9 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 10 | M | |
| Thyristor firing pulse, armature 4 | 11 | IMP_14 | 24 V / 2 A pulse |
| 24 V supply, firing | 12 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 13 | M | |
| Thyristor firing pulse, armature 5 | 14 | IMP_15 | 24 V / 2 A pulse |
| 24 V supply, firing | 15 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 16 | M | |
| Thyristor firing pulse, armature 3 | 17 | IMP_13 | 24 V / 2 A pulse |
| 24 V supply, firing | 18 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 19 | M | |
| Thyristor firing pulse, armature 1 | 20 | IMP_11 | 24 V / 2 A pulse |
| 24 V supply, firing | 21 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 22 | M | |
| Actual current value | 23 | I_IST | analog ±10 V |
| Ground reference for actual current value | 24 | M_I_IST | analog ±10 V |
| Electronic ground | 25 | M | |
| Free | 26 | | |
| Power interface for the Control Module / firing pulse transformer module | | | |
| Connectors X21A and X21PAR are connected in parallel on the firing pulse transformer module, except for I_IST (pin 23) and M_I_IST (pin 24) | | | |

## Firing pulse cable, torque direction 2, connectors X22A/X22PAR

Ribbon cable, 26-pin

Table 6- 35 Assignment X22A, X22PAR

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| Free | 1 | | |
| Free | 2 | | |
| Free | 3 | | |
| Electronic ground | 4 | M | |
| Thyristor firing pulse, armature 2 | 5 | IMP_22 | 24 V / 2 A pulse |
| 24 V supply, firing | 6 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 7 | M | |
| Thyristor firing pulse, armature 6 | 8 | IMP_26 | 24 V / 2 A pulse |
| 24 V supply, firing | 9 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 10 | M | |
| Thyristor firing pulse, armature 4 | 11 | IMP_24 | 24 V / 2 A pulse |
| 24 V supply, firing | 12 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 13 | M | |
| Thyristor firing pulse, armature 5 | 14 | IMP_25 | 4 V / 2 A pulse |
| 24 V supply, firing | 15 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 16 | M | |
| Thyristor firing pulse, armature 3 | 17 | IMP_23 | 24 V / 2 A pulse |
| 24 V supply, firing | 18 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 19 | M | |
| Thyristor firing pulse, armature 1 | 20 | IMP_21 | 24 V / 2 A pulse |
| 24 V supply, firing | 21 | P24_Z | 24 V DC / 2 A |
| Electronic ground | 22 | M | |
| Free | 23 | | |
| Free | 24 | | |
| Electronic ground | 25 | M | |
| Free | 26 | | |
| Power interface for the Control Module / firing pulse transformer module | | | |
| Connectors X22A and X22PAR are connected in parallel on the firing pulse transformer module | | | |

## Power interface connecting cable - fuse monitoring equipment

Ribbon cable, 10-pin

Table 6- 36 Assignment X23B

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| 24 V supply | 1 | P24 | 22...26 V |
| 24 V supply | 2 | P24 | 22...26 V |
| Fuse monitoring | 3 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 4 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 5 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 6 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 7 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 8 | SICHERUNG_OK | 24 V logic |
| Ground | 9 | M | |
| Ground | 10 | M | |
| Power interface for the Control Module / fuse monitoring or fuse monitoring distributor | | | |

Ribbon cable, 34-pin

Table 6- 37 Assignment X23A

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| 24 V supply | 1 | P24 | 22...26 V |
| 24 V supply | 2 | P24 | 22...26 V |
| Fuse monitoring | 3 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 4 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 5 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 6 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 7 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 8 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 9 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 10 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 11 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 12 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 13 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 14 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 15 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 16 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 17 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 18 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 19 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 20 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 21 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 22 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 23 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 24 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 25 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 26 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 27 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 28 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 29 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 30 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 31 | SICHERUNG_OK | 24 V logic |
| Fuse monitoring | 32 | SICHERUNG_OK | 24 V logic |
| Ground | 33 | M | |
| Ground | 34 | M | |
| Power interface for the Control Module / fuse monitoring distributor | | | |

## Power interface connecting cable – Voltage measurement equipment

CAT5 cable, 8-pin

Table 6- 38 Assignment X45

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| RS485 signal data + | 1 | ANKER_RS485_SP | |
| RS485 signal data - | 2 | ANKER_RS485_SN | |
| 3.3 V supply | 3 | P3V3 | 3.3 V |
| RS485 signal direction + | 4 | ANKER_RS485_DP | |
| RS485 signal direction - | 5 | ANKER_RS485_DN | |
| Ground | 6 | M | |
| 16 V AC supply | 7 | HF16_1 | ±16 V HF |
| 16 V AC supply | 8 | HF16_2 | ±16 V HF |
| Power interface for the Control Module / voltage measurement | | | |

## Power interface connecting cable – Field supply

Ribbon cable, 20-pin

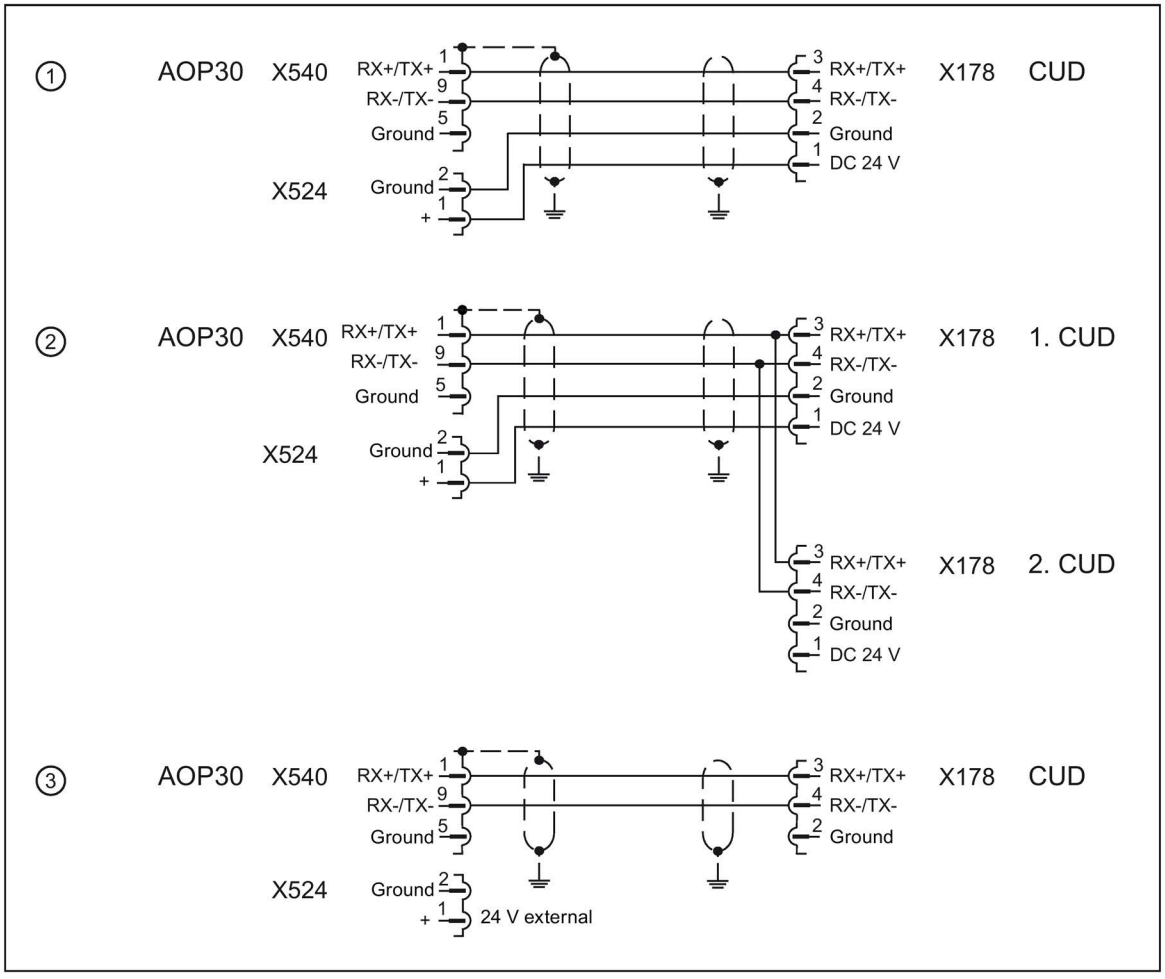
Table 6- 39 Assignment XF1

| Function | Pin | Signal name | Connection values / comments |
|---|---|---|---|
| Electronic ground | 1 | M | |
| 16 V AC supply | 2 | HF16_1 | ± 16 V HF |
| 16 V AC supply | 3 | HF16_2 | ± 16 V HF |
| Electronic ground | 4 | M | |
| Thyristor firing pulse, field 1 | 5 | IMP_F1 | CMOS 5 V |
| Electronic ground | 6 | M | |
| Thyristor firing pulse, field 2 | 7 | IMP_F2 | CMOS 5 V |
| Electronic ground | 8 | M | |
| RS485 signal data + | 9 | ANKER_RS485_SP | |
| RS485 signal data - | 10 | ANKER_RS485_SN | |
| 3.3 V supply | 11 | P3V3 | 3.3 V |
| RS485 signal direction + | 12 | ANKER_RS485_DP | |
| RS485 signal direction – | 13 | ANKER_RS485_DN | |
| Electronic ground | 14 | M | |
| +24 V firing supply | 15 | P24_ZV | 22...26 V |
| +24 V firing supply | 16 | P24_ZV | 22...26 V |
| Electronic ground | 17 | M | |
| Heat sink temperature sensor | 18 | KK_TEMP_FELD | Analog |
| Electronic ground | 19 | M | |
| Electronic ground | 20 | M | |
| Power interface for the Control Module / field supply power unit | | | |

## 6.16.10 Assignment of the RS485 cable to the AOP30

**Note**

A 24 V power supply is required to operate the AOP30. For a maximum cable length of 50 m, this can be taken from the CUD of the SINAMICS DCM. An external power supply must be used for cable lengths > 50 m.




① RS485 cable with 24 V DC power supply from the CUD – max. 50 m
② RS485 cable when operating with 2 CUDs, 24 V DC power supply from one CUD – max. 50 m
③ RS485 cable when supplying the AOP30 from an external 24 V DC source – max. 200 m

X524 Plug terminals
X178 Plug terminals
X540 9-pin Sub-D socket

Figure 6-47 Assignment, RS485 cable

## 6.16.11 Terminal assignment functional safety

Table 6- 40 Terminal type functional safety

| **X200, X201:** | |
|---|---|
| Type | PUSH IN connecting terminal LMF 5.08 |
| Clamping range | Min. 0.12-2.5 mm² / AWG 26-AWG 12 |
| Connection capacity | Rigid/flexible/conductor sizes (mm²/AWG): 0.2-2.5 / 26-12, with ferrule: 0.25 ... 2.5 mm² |
| Stripped length | 10 mm |
| Connection system | PUSH IN screwdriver blade 0.6 x 3.5 mm according to DIN 5264 standard |

Table 6- 41 Assignment of customer terminals on Allocation Board (overview)

| **Terminal** | **Function / Labeling** | **Technical specifications** |
|---|---|---|
| X200-1 | P24 | Output 20 to 26 V, short-circuit proof<br>can be continuously loaded up to 30 mA<br>Used for supplying X200-2, if STO is not used. |
| X200-2 | STO | Input (both terminals are connected)<br>H signal (no STO):+15 V to +30 V, input current 2 mA (typical)<br>L signal (STO): –30 V to +5 V or terminal open<br>Leakage current maximum 0.5 mA<br>Maximum cable length: 30 m<br>The input must be supplied from a PELV power supply.<br>Test pulses are not permitted. |
| X200-3 | STO | |
| X201-1 | RM2 | Feedback contact for safety relay<br>The contact is closed if the STO is selected.<br>Rated voltage 24 V, maximum current load 200 mA, leakage current maximum 0.5 mA.<br>Connection to diagnostic circuit of the safety relay (PELV circuit). |
| X201-2 | RM1 | |
| "Allocation Board" module | | |

**Note**

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

# Additional system components 7

**Note**

The components described here are used in several units in the SINAMICS family. The next chapter may, therefore, contain references to manuals for these units.

The SINAMICS DC MASTER supports the following components from the SINAMICS drive system:

| | |
|---|---|
| CBE20 | Communication Board Ethernet |
| SMC10, SMC30 | Sensor Module Cabinet-Mounted |
| TM15 | Terminal Module |
| TM31 | Terminal Module |
| TM150 | Terminal Module |

In order to operate the SINAMICS DC MASTER with these components, it must be equipped with (an) Advanced CUD(s); (see the list of options in Chapter "Ordering information for options and accessories (Page 26)").

The Communication Board CBE20 can be ordered as an option for the SINAMICS DC MASTER and is installed directly in the unit (in the OMI (Option Module Interface) slot of the CUD).

The SMC10, SMC30, TM15, TM31 and TM150 modules are installed separately and connected to the SINAMICS DC MASTER via the DRIVE-CLiQ interface.

**Note**

The modules SMC10, SMC30, TM15, TM31 and TM150 must not be connected with the DRIVE-CLiQ hubs DME20 and DMC20 during operation with SINAMICS DCM.

## DRIVE-CLiQ interface

On the SINAMICS DC MASTER, up to three terminal modules TM15/TM31/TM150 can be connected to the DRIVE-CLiQ in any desired combination and in addition one Sensor Module Cabinet-Mounted SMC10 or SMC30 can be connected.

The CUD features two DRIVE-CLiQ ports (X100, X101). Any combination of the modules can be connected in series or in parallel. The Sensor Modules SMC10 or SMC30 only have one DRIVE-CLiQ interface and are therefore always the last module on the bus.

# 7.1 Option Board: CBE20 Communication Board Ethernet

## 7.1.1 Description

The SINAMICS DC MASTER can be connected to PROFINET using the Communication Board Ethernet 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 option board has an X1400 interface with 4 ports for communication.

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

SINAMICS Link allows data to be directly exchanged between up to 64 CU320-2 PN or CU320-2 DP Control Units or CUD, see Chapter "Communication via SINAMICS Link (Page 480)".

For further information on EtherNet/IP, see Chapter "EtherNet/IP (Page 493)".

For further information on Modbus TCP, see Chapter "Communication via MODBUS TCP (Page 506)".

## 7.1.2 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.<br>• Only withdraw or insert the Option Board when the Control Unit is de-energized. |

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

## 7.1.3 Interface description

### 7.1.3.1 Overview

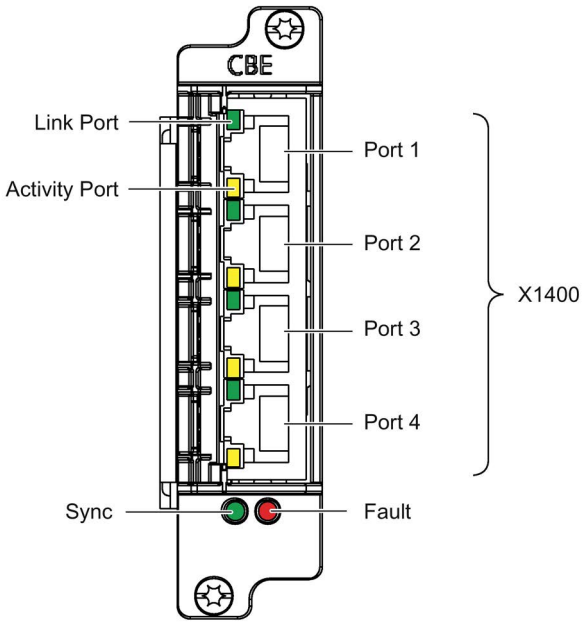


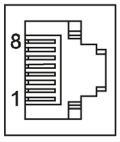

Figure 7-1 Interface description CBE20

#### MAC address

The MAC address of the Ethernet interface is located on the upper side of the board.

### 7.1.3.2 X1400 Ethernet interface

Table 7- 1 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 backshell | M_EXT | Screen, permanently connected |
| Connector type: RJ45 socket | | | |

For diagnostic purposes, the ports have one green and one yellow LED.

#### Cable and connector types

Information on PROFINET cables and connectors can be found in the following catalog:

Industrial Communication
Catalog IK PI, 2009 Edition,

## 7.1.4 Meaning of the LEDs

Table 7- 2 Meaning of the LEDs at ports 1 to 4 of the X1400 interface

| LED | Color | Status | 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. |
| 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. |

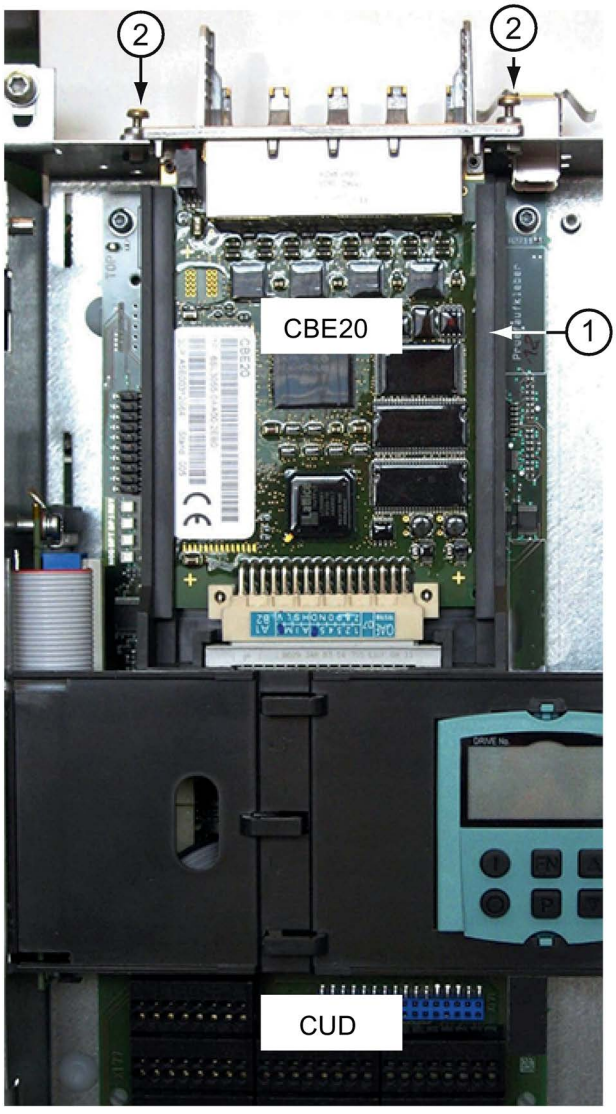
Table 7- 3 Meaning of the Sync and Fault LEDs on the CBE20

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

Table 7- 4 Meaning of the OPT LED on the Control Unit

| LED | Color | Status | Description, cause | Remedy |
|---|---|---|---|---|
| OPT | – | OFF | Electronics power supply is missing or outside permissible tolerance range.<br>CBE20 is either defective or not inserted. | – |
| | Green | Continuous light | CBE20 is ready and cyclic communication is taking place. | – |
| | | 0.5 Hz flashing light | CBE20 is ready but cyclic communication is not running.<br>Possible causes:<br>• Communication is being established.<br>• At least one fault is present. | – |
| | 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. | – |
| | | Flashing light 0.5 Hz | The firmware update into the CBE20 has been completed with an error.<br>Possible causes:<br>• The memory card for the control unit is defective.<br>• The CBE20 is defective.<br>In this state CBE20 cannot be used. | – |
| | | Flashing light 2 Hz | There is a communications error between the Control Unit and the CBE20.<br>Possible causes:<br>• The CBE20 was withdrawn after booting.<br>• The CBE20 is defective. | Correctly insert the board, if required, replace. |
| | Orange | 0.5 Hz flashing light | Firmware of the CBE20 currently being updated. | – |

## 7.1.5 Installation




Installing the CBE20

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

## 7.1.6 Technical data

Table 7- 5 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 |

# 7.2 SMC10 Sensor Module Cabinet-Mounted

## 7.2.1 Description

The Sensor Module Cabinet-Mounted SMC10 is an expansion module for snapping on to a standard mounting rail acc. to EN 60715. It evaluates encoder signals and transmits the speed, actual position value and the rotor position via DRIVE-CLiQ to the Control Unit.

The SMC10 is used to evaluate sensor signals from resolvers.

## 7.2.2 Interface description

### 7.2.2.1 Overview

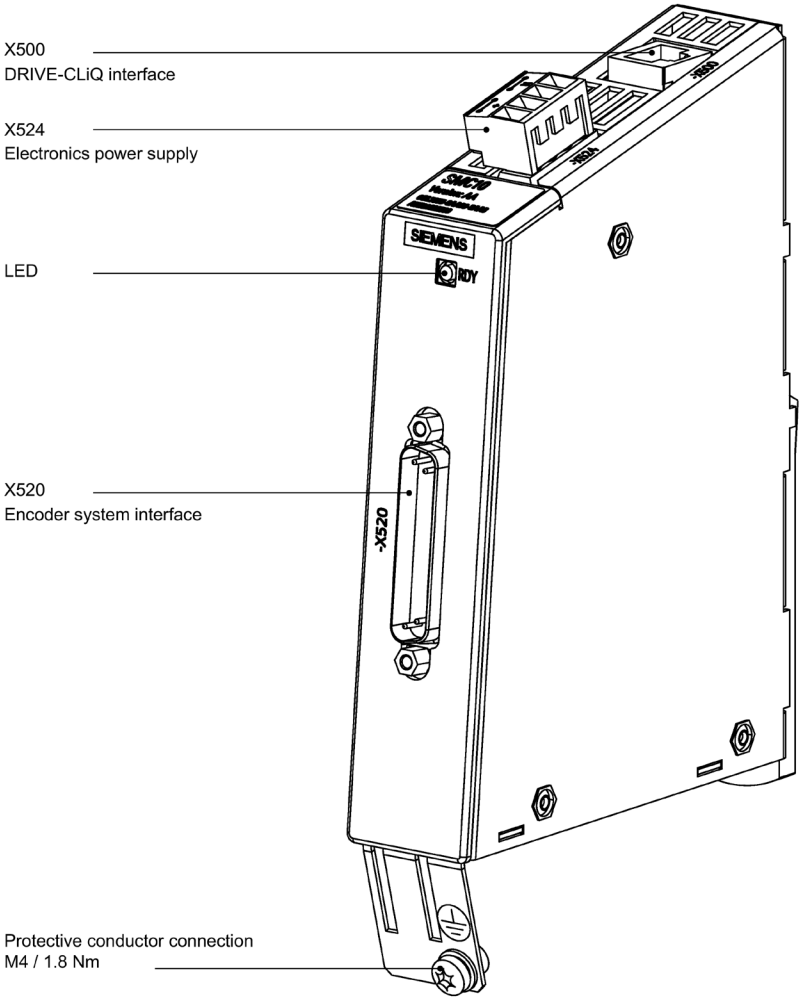
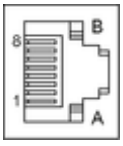



Figure 7-2 Interface overview for the SMC10

### 7.2.2.2 X500 DRIVE-CLiQ interface

Table 7- 6 X500: DRIVE-CLiQ interface

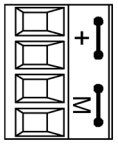
| Connector | Pin | Signal name | Technical data |
|---|---|---|---|
|  | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use | |
| | 8 | Reserved, do not use | |
| | A | Reserved, do not use | |
| | B | M (0 V) | Electronics ground |
| Connector type: DRIVE-CLiQ socket | | | |

The blanking cover for the DRIVE-CLiQ port is included in the scope of delivery.

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

### 7.2.2.3 X524 Electronics power supply

Table 7- 7 X524: Electronics power supply

| Connector | Terminal | Function | Technical data |
|---|---|---|---|
|  | + | Electronics power supply | Voltage: 24 V (20.4 … 28.8 V)<br>Current consumption: max. 0.35 A<br>Max. current via jumper in connector: 20 A (15 A according to UL/CSA) |
| | + | Electronics power supply | |
| | M | Electronics ground | |
| | M | Electronics ground | |
| Type: Screw terminal<br>Conductor cross sections that can be connected: Flexible, 0.08 mm² to 2.5 mm²<br>Stripped length: 8 to 9 mm<br>Tool: 0.4 × 2.0 mm screwdriver | | | |

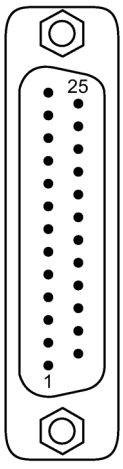
The maximum cable length that can be connected is 30 m.

**Note**

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

### 7.2.2.4 X520 encoder system interface

Table 7- 8 X520: Encoder system interface

| Connector | Pin | Signal name | Technical data |
|---|---|---|---|
|  | 1 | Reserved, do not use | |
| | 2 | Reserved, do not use | |
| | 3 | S2 | Resolver signal A (sin+) |
| | 4 | S4 | Inverted resolver signal A (sin-) |
| | 5 | Ground | Ground (for internal shield) |
| | 6 | S1 | Resolver signal B (cos+) |
| | 7 | S3 | Inverted resolver signal B (cos-) |
| | 8 | Ground | Ground (for internal shield) |
| | 9 | R1 | Resolver excitation positive |
| | 10 | Reserved, do not use | |
| | 11 | R2 | Resolver excitation negative |
| | 12 | Reserved, do not use | |
| | 13 | - | |
| | 14 | Reserved, do not use | |
| | 15 | Reserved, do not use | |
| | 16 | Reserved, do not use | |
| | 17 | Reserved, do not use | |
| | 18 | Reserved, do not use | |
| | 19 | Reserved, do not use | |
| | 20 | Reserved, do not use | |
| | 21 | Reserved, do not use | |
| | 22 | Reserved, do not use | |
| | 23 | Reserved, do not use | |
| | 24 | Ground | Ground (for internal shield) |
| | 25 | - | |
| Connector type: 25-pin SUB D connector | | | |
| Measuring current via temperature sensor connection: 2 mA | | | |

## 7.2.3 Connection example

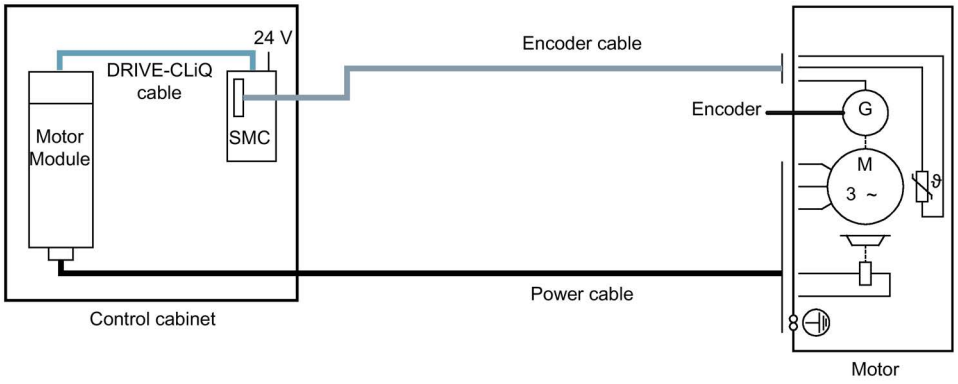



Figure 7-3 Connecting the encoder via a Sensor Module Cabinet-Mounted (SMC)

## 7.2.4 Meaning of the LED

### 7.2.4.1 Meaning of the LED on the Sensor Module Cabinet-Mounted SMC10

Table 7- 9 Meaning of the LEDs on the Sensor Module Cabinet-Mounted SMC10

| LED | Color | Status | Description, cause | Remedy |
|---|---|---|---|---|
| RDY 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.<br>**Note:**<br>The LED is activated irrespective of whether the corresponding messages have been reconfigured. | Remove and acknowledge the fault. |
| | Green/ red | Flashing light 0.5 Hz | Firmware is being downloaded. | – |
| | | Flashing light 2 Hz | Firmware download is complete. The system waits for POWER ON. | Carry out a POWER ON. |
| | Green/ orange<br>or<br>Red/ orange | Flashing light | Component recognition via LED is activated[1].<br>**Note:**<br>Both options depend on the LED status when component recognition is activated. | – |

[1] Parameters for activating the identification of components via LED are 1.p9210 and 1.p9211 (see DCM List Manual)

### 7.2.4.2 Cause and rectification of faults

#### Cause and rectification of faults

Additional information about the cause and how to resolve faults can be found here:

- SINAMICS DCM List Manual
- Chapter "Commissioning with the Starter commissioning tool"

## 7.2.5 Dimension drawing

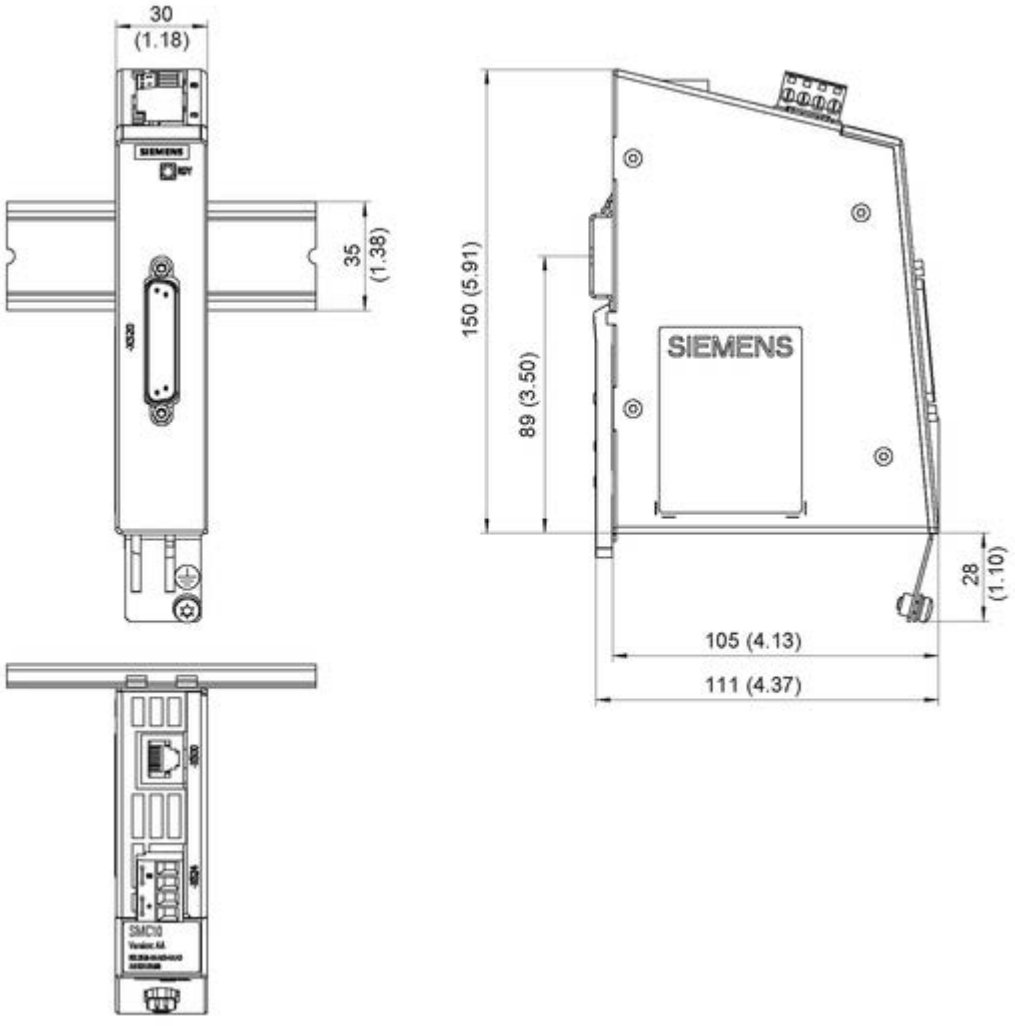



Figure 7-4 Dimension drawing of the Sensor Module Cabinet SMC10, all dimensions in mm and (inches)

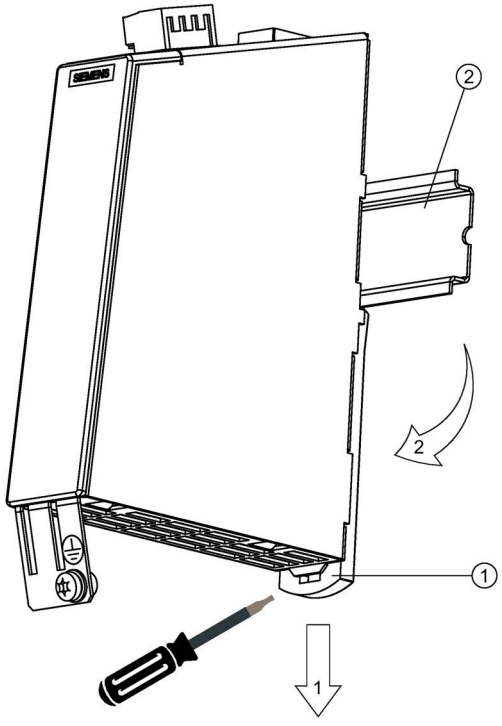
## 7.2.6 Mounting

### 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.

### Removal

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 Mounting rail

Figure 7-5 Removing from a DIN mounting rail

## 7.2.7 Technical data

Table 7- 10 Technical data

| 6SL3055-0AA00-5AAx | Unit | Value |
|---|---|---|
| **Electronics power supply** | | |
| Voltage | $V_{DC}$ | 24 (20.4 … 28.8) |
| Current (without encoder system) | $A_{DC}$ | ≤ 0.20 |
| Current (with encoder system) | $A_{DC}$ | ≤ 0.35 |
| Power loss | W | ≤ 10 |
| Max. cable length | m | 30 |
| **Specification** | | |
| Transformation ratio of the resolver (ü) | | 0.5 |
| Excitation voltage on the SMC10 when ü=0.5 | $V_{rms}$ | 4.1 |
| Amplitude monitoring threshold (secondary tracks) of the SMC10 | $V_{rms}$ | 1 |
| Excitation voltage (cannot be parameterized) | $V_{rms}$ | 4.1 |
| Excitation frequency (synchronized to the current controller clock cycle) | kHz | 5 to 16 |
| PE/ground connection | At the housing with M4 screw | |
| Max. encoder cable length | m | 130 |
| Ventilation clearances, above/below | mm | 50 |
| Weight | kg | 0.45 |

Table 7- 11 Max. frequency that can be evaluated (speed)

| Resolver | | Max. speed resolver / motor | | |
|---|---|---|---|---|
| Number of poles | Number of pole pairs | 8 kHz / 125 µs | 4 kHz / 250 µs | 2 kHz / 500 µs |
| 2-pole | 1 | 120000 rpm | 60000 rpm | 30000 rpm |
| 4-pole | 2 | 60000 rpm | 30000 rpm | 15000 rpm |
| 6-pole | 3 | 40000 rpm | 20000 rpm | 10000 rpm |
| 8-pole | 4 | 30000 rpm | 15000 rpm | 7500 rpm |

The ratio between the ohmic resistance R and the inductance L (the primary winding of the resolver) determines whether the resolver can be evaluated with the SMC10. See the figure below:

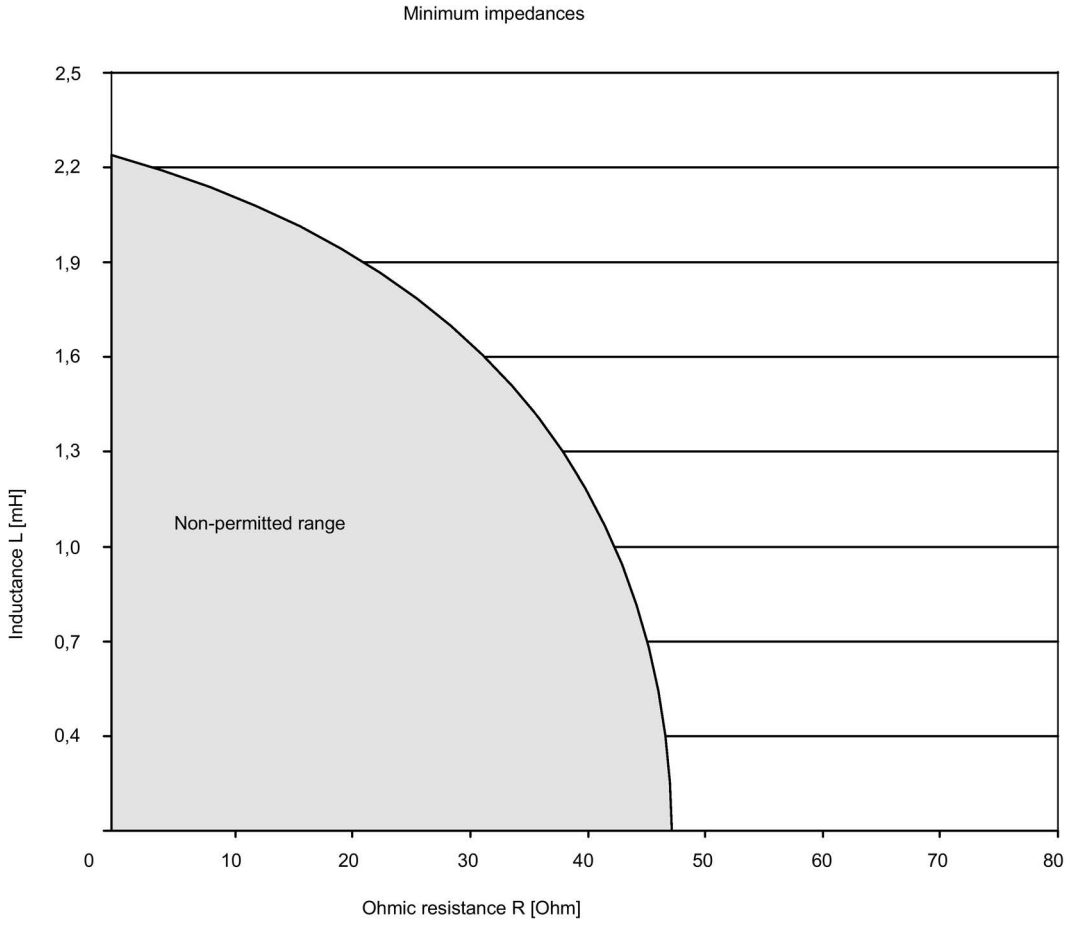



Figure 7-6 Rotor impedances that can be connected with excitation frequency f = 5000 Hz

To check as shown in the previous figure, the impedances $Z_{rs}$ or $Z_{ro}$ (impedance between R1 and R2 with short-circuited or open outputs) from the encoder manufacturer's data sheet must be used.

# 7.3 Sensor Module Cabinet-Mounted SMC30

### Supported types

The SINAMICS DC MASTER only supports the Sensor Module Cabinet-Mounted SMC30 with article number 6SL3055-0AA00-5CA2. Other types may not be used. You can easily identify whether the version is supported by the width of the module:

Table 7- 12 SMC30 types

| SMC30 article number | Width | Use with SINAMICS DC MASTER |
|---|---|---|
| 6SL3055-0AA00-5CA2 | 30 mm | Possible |
| 6SL3055-0AA00-5CA0 | 50 mm | Not possible |
| 6SL3055-0AA00-5CA1 | 50 mm | Not possible |

### Number of SMC30s connected

The SINAMICS DC MASTER supports the connection of **one** Sensor Module Cabinet-Mounted SMC30.

## 7.3.1 Description

The Sensor Module Cabinet-Mounted SMC30 evaluates encoder signals and transmits the speed, actual position value, and, if necessary, the motor temperature and reference point via DRIVE-CLiQ to the Control Unit.

The SMC30 is used to evaluate encoder signals from encoders with TTL, HTL, or SSI interfaces.

A combination of a TTL/HTL signal and SSI absolute signal is possible at terminals X521/X531 if both signals are derived from the same measured variable.

## 7.3.2 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 increased failures and reduced service life of the Sensor Module Cabinet-Mounted.

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

**NOTICE**

**Shield support**

When the encoder system is connected via terminals, make sure that the cable shield is connected to the component.

**Note**

**Encoder failures due to encoder signal disturbances**

Unfavorable material combinations generate static electricity between the belt pulley and the belt. This electrostatic charge (several kV) can discharge via the motor shaft and the encoder which leads to disturbance of the encoder signals (encoder error).

- Use an antistatic version of the belt (special conductive polyurethane mixture).

**⚠WARNING**

**Electric shock when disconnecting and connecting encoder cables during operation**

When disconnecting plug-in connections during operation, arcs can result in severe injury or death.

- Only disconnect or connect the encoder cables to Siemens motors in a voltage-free state if hot-plugging has not been specifically released. When using direct measuring systems (third-party encoders), ask the manufacturer whether hot-plugging is permitted.

**NOTICE**

**Damage when connecting an impermissible number of encoder systems**

Damage results when more than the maximum permissible number of encoder systems are connected to a Sensor Module.

- Only connect one encoder system to a Sensor Module.

**Note**

**Reduced interference immunity through equalization currents via the electronic ground**

Make sure there is no electrical connection between the encoder system housing and the signal lines and the sensor system electronics.

If this is not carefully observed, under certain circumstances the system will not be able to reach the required interference immunity level (there is then a danger of equalization currents flowing through the electronics ground).

**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.

**Note**

The safety instructions on the Sensor Module must be observed.

After the product has reached the end of its service life, the individual parts should be disposed of in compliance with local regulations.

## 7.3.3 Interface description

### 7.3.3.1 Overview

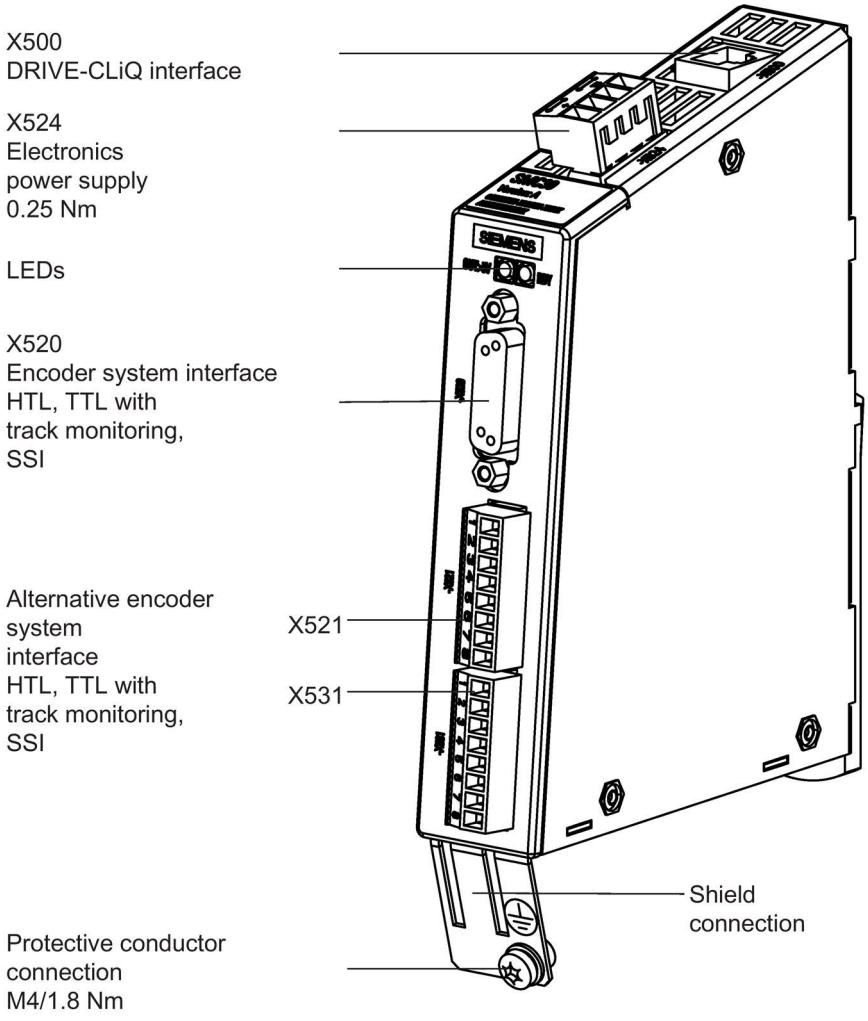
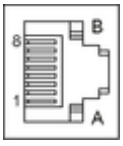



Figure 7-7 SMC30 interface description

### 7.3.3.2 X500 DRIVE-CLiQ interface

Table 7- 13 DRIVE-CLiQ interface X500

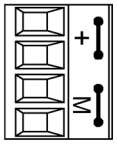
| Connector | Pin | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | TXP | Transmit data + |
| | 2 | TXN | Transmit data - |
| | 3 | RXP | Receive data + |
| | 4 | Reserved, do not use | |
| | 5 | Reserved, do not use | |
| | 6 | RXN | Receive data - |
| | 7 | Reserved, do not use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

The blanking cover for the DRIVE-CLiQ port is included in the scope of supply.

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

### 7.3.3.3 X524 electronic power supply

Table 7- 14 X524 terminal strip

| Connector | Terminal | Function | Technical specifications |
|---|---|---|---|
|  | + | Electronic power supply | Voltage: 24 V (20.4 – 28.8 V)<br>Power consumption: Max. 0.55 A<br>Max. current via the jumper in the connector: 20 A (15 A according to UL/CSA) |
| | + | Electronic power supply | |
| | M | Electronics ground | |
| | M | Electronics ground | |
| Type: Screw terminal<br>Conductor cross sections that can be connected: Flexible, 0.08 $mm^2$ to 2.5 $mm^2$<br>Stripped length: 8 to 9 mm<br>Tool: 0.4 × 2.0 mm screwdriver | | | |

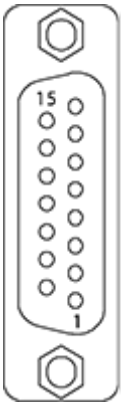
The maximum cable length that can be connected is 30 m.

**Note**

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

### 7.3.3.4 X520 encoder system interface

Table 7- 15 X520 encoder system interface

| Connector | Pin | Signal name | Technical specifications |
|---|---|---|---|
|  | 1 | Reserved | Do not use |
| | 2 | Clock | SSI clock |
| | 3 | Clock* | Inverse SSI clock |
| | 4 | P encoder 5 V/24 V | Encoder supply |
| | 5 | P encoder 5 V/24 V | |
| | 6 | P sense | Sense input, encoder supply |
| | 7 | M encoder (M) | Ground, encoder supply |
| | 8 | Reserved | Do not use |
| | 9 | M sense | Ground for sense input |
| | 10 | R | Reference signal R |
| | 11 | R* | Inverse reference signal R |
| | 12 | B* | Inverse incremental signal B |
| | 13 | B | Incremental signal B |
| | 14 | A*/data* | Inverted incremental signal A/inverted SSI data |
| | 15 | A/data | Incremental signal A/SSI data |
| Connector type: SUB-D female, 15-pin | | | |

**NOTICE**

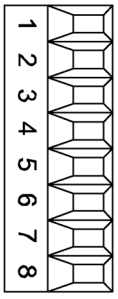
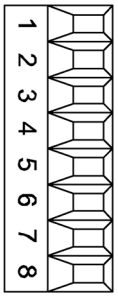
**Destruction of the encoder due to an incorrect supply voltage**

The encoder supply voltage can be assigned as 5 V or 24 V. The encoder may be destroyed if you enter the wrong parameters.

- Select the appropriate motor supply voltage.

### 7.3.3.5 X521/X531 alternative encoder system interface

Table 7- 16 X521/X531 alternative encoder system interface

| Connector | Terminal | Designation | Technical specifications |
|---|---|---|---|
| X521  | 1 | A | Incremental signal A |
| | 2 | A* | Inverse incremental signal A |
| | 3 | B | Incremental signal B |
| | 4 | B* | Inverse incremental signal B |
| | 5 | R | Reference signal R |
| | 6 | R* | Inverse reference signal R |
| | 7 | CTRL | Control signal |
| | 8 | M | Ground |
| | | | |
| X531  | 1 | P_encoder 5 V/24 V | Encoder supply |
| | 2 | M_Encoder | Ground, encoder supply |
| | 3 | - Temp | Temperature sensor KTY84-1C130 |
| | 4 | + Temp | Temperature sensor KTY84-1C130 |
| | 5 | Clock | SSI clock |
| | 6 | Clock* | Inverse SSI clock |
| | 7 | Data | SSI data |
| | 8 | Data* | Inverse SSI data |
| Max. connectable cross-section: 1.5 mm$^2$<br>Measuring current via the temperature sensor connection: 2 mA<br>When unipolar HTL encoders are used, A*, B*, and R* on the terminal block must be jumpered with M_Encoder (X531)[1]. | | | |

[1] Because the physical transmission properties are more robust, the bipolar connection should always be used. The unipolar connection should only be used if the encoder type does not output push-pull signals.

**⚠WARNING**

**Electric shock due to unconnected cable shields**

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

- Attach the cable shield to the component via terminals for the encoder system connection.

### Temperature sensor connection

For the evaluation of the temperature sensor, see function diagram 8030 in the SINAMICS DCM List Manual.

**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 may result in damage to the motor.

- Connect a KTY temperature sensor with the correct polarity.

**⚠WARNING**

**Electric shock in the event of voltage flashovers on the temperature sensor cable**

Flashover to the signal electronics can occur on motors without safe electrical separation of the temperature sensors.

- Only use temperature sensors that satisfy the specifications for electrical separation according to IEC 61800-5-1.

**Note**

The maximum length of the temperature sensor cable is 100 m. The cables must be shielded.

## 7.3.4 Connection examples

### Connection example 1: HTL encoder, bipolar, with reference signal

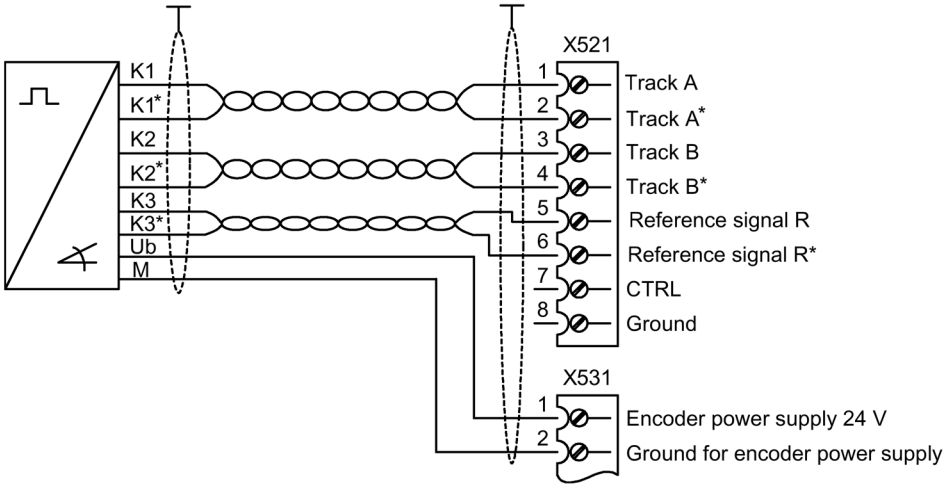



Figure 7-8 Connection example 1: HTL encoder, bipolar, with reference signal

Signal cables must be twisted in pairs in order to improve resistance to induced interference.

### Connection example 2: HTL encoder, unipolar, with reference signal

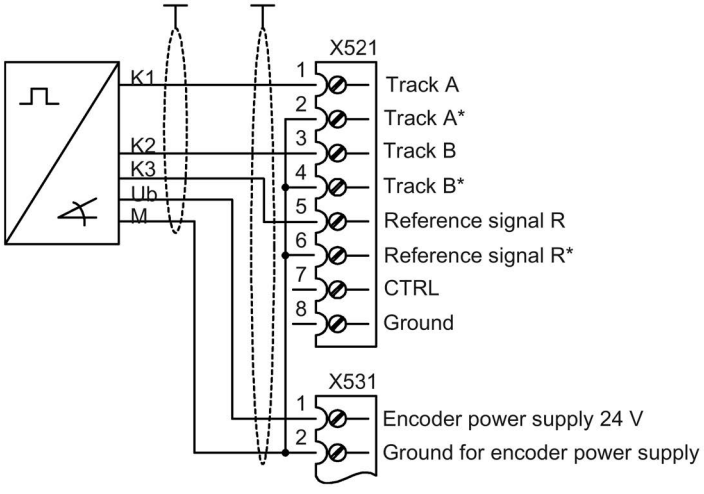



Figure 7-9 Connection example 2: HTL encoder, unipolar, with reference signal [1)]

[1)] Because the physical transmission properties are more robust, the bipolar connection should always be used. The unipolar connection should only be used if the encoder type does not output push-pull signals.

Figure 7-10 Connection example 2

**Note**

Diagram of the wire jumpers for connecting unipolar HTL encoders with reference signal.

## 7.3.5 Meaning of the LEDs

Table 7- 17 Meaning of LEDs on the Sensor Module Cabinet SMC30

| LED | Color | Status | Description, cause | Remedy |
|---|---|---|---|---|
| RDY<br>READY | - | Off | Electronics power supply is missing or outside permissible tolerance range. | – |
| | 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.<br>**Note:**<br>The LED is activated irrespective of whether the corresponding messages have been reconfigured. | Remedy and acknowledge fault |
| | Green/ red | 0.5 Hz flashing light | Firmware is being downloaded. | – |
| | Green/ red | 2 Hz flashing light | Firmware download is complete. Wait for POWER ON. | Carry out a POWER ON |
| | Green/ orange<br>or<br>Red/ orange | Flashing light | Component recognition via LED is activated (p0144).<br>**Note:**<br>Both options depend on the LED status when module recognition is activated via p0144 = 1. | – |
| OUT > 5 V | - | Off | Electronics power supply is missing or outside permissible tolerance range.<br>Power supply ≤ 5 V. | – |
| | Orange | Continuous light | Electronics power supply for encoder system available.<br>Power supply > 5 V.<br>**Important:**<br>Make sure that the connected encoder can be operated with a 24 V power supply. If an encoder that is designed for a 5 V supply is operated with a 24 V supply, this can destroy the encoder electronics. | – |

## 7.3.6 Dimension drawing

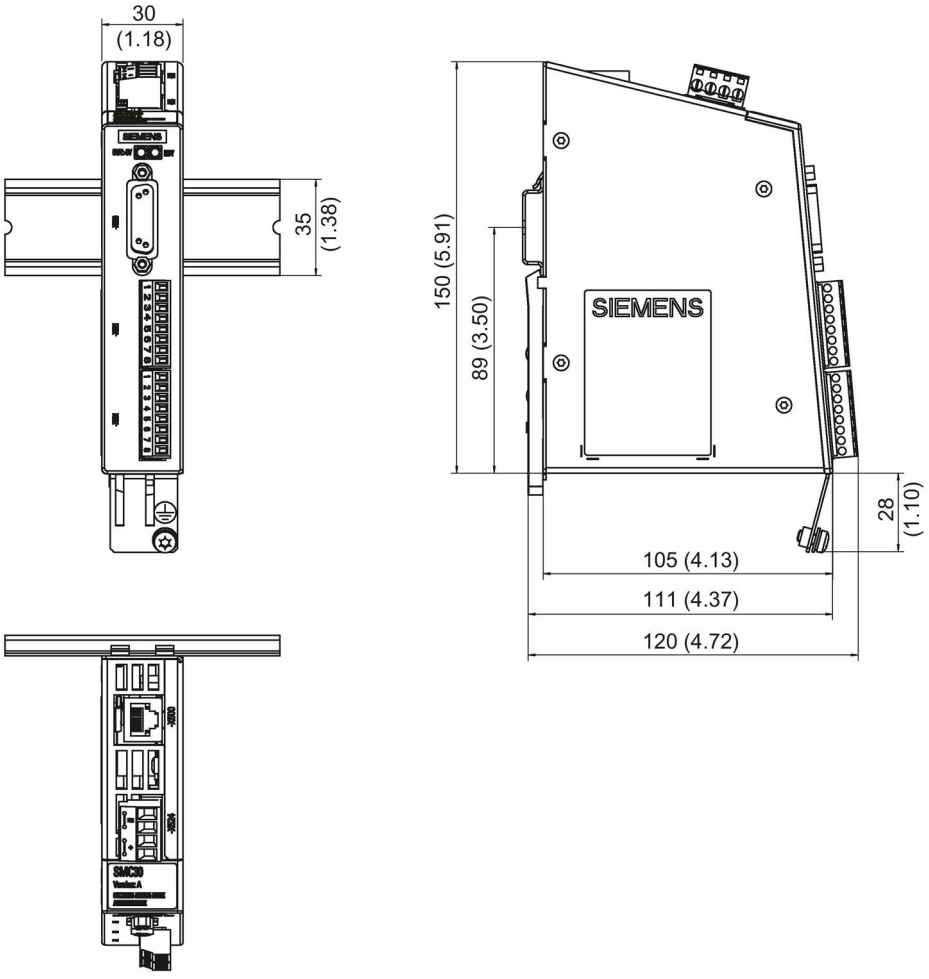



Figure 7-11 Dimension drawing of the Sensor Module Cabinet SMC30, all data in mm and (inches)

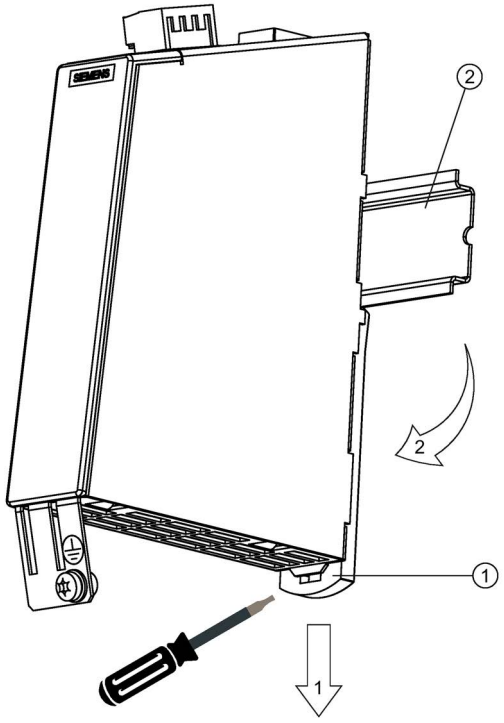
## 7.3.7 Mounting

### 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.

## Removal

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.

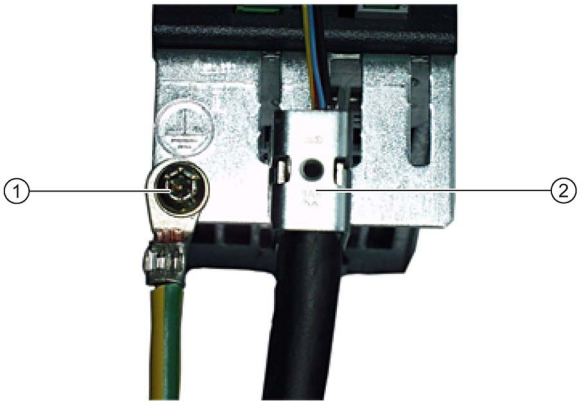



① Mounting slide
② Mounting rail

Figure 7-12 Removing from a DIN mounting rail

## 7.3.8 Protective conductor connection and shield support

Shield supports are only required if the system is connected to X521/X531.




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

Figure 7-13 Shield support and PE conductor connection

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

**Note**

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

**NOTICE**

**Damage or faulty operation due to incorrect shielding and impermissible 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.

## 7.3.9 Technical data

Table 7- 18 Technical data

| 6SL3055-0AA00-5CA2 | Unit | Value |
|---|---|---|
| **Electronic power supply** | | |
| Voltage | $V_{DC}$ | 24 DC (20.4-28.8) |
| Current (without encoder system) | $A_{DC}$ | ≤ 0.20 |
| Current (with encoder system) | $A_{DC}$ | ≤ 0.55 |
| Power loss | W | ≤ 10 |
| **Encoder system power supply** | | |
| Voltage | $V_{encoder}$ | 5 V DC (with or without Remote Sense) [1] or $V_{DC}$ - 1 V |
| Current | $A_{encoder}$ | 0.35 |
| Encoder frequency that can be evaluated ($f_{encoder}$) | kHz | ≤ 300 |
| SSI baud rate | kHz | 100-1000 [2] |
| PE/ground connection | | On enclosure with M4/1.8 Nm screw |
| Ventilation clearances, above/below | mm | 50 |
| Weight | | 0.45 |

[1] A controller compares the encoder system supply voltage - sensed via the Remote Sense cables - with the reference supply voltage of the encoder system, and adjusts the supply voltage for the encoder system at the output of the drive module until the required supply voltage is obtained directly at the encoder system (only for 5 V encoder system power supply). Remote Sense only to X520.

[2] See the diagram "Maximum cable lengths depending on the SSI baud rate for SSI encoders"

### Connectable encoder systems

Table 7- 19 Specification of encoder systems that can be connected

| Parameter | Designation | Threshold | Min. | Max. | Unit |
|---|---|---|---|---|---|
| High signal level (TTL bipolar at X520 or X521/X531) [1] | $U_{Hdiff}$ | | 2 | 5 | V |
| Low signal level (TTL bipolar at X520 or X521/X531) [1] | $U_{Ldiff}$ | | -5 | -2 | V |
| High signal level (HTL unipolar) | $U_H$ | High | 17 | $V_{CC}$ | V |
| | | Low | 10 | $V_{CC}$ | V |
| Low signal level (HTL unipolar) | $U_L$ | High | 0 | 7 | V |
| | | Low | 0 | 2 | V |
| High signal level (HTL bipolar) [2] | $U_{Hdiff}$ | | 3 | $V_{CC}$ | V |
| Low signal level (HTL bipolar) [2] | $U_{Ldiff}$ | | $-V_{CC}$ | -3 | V |
| High signal level (SSI bipolar at X520 or X521/X531) [1] | $U_{Hdiff}$ | | 2 | 5 | V |
| Low signal level (SSI bipolar at X520 or X521/X531) [1] | $U_{Ldiff}$ | | -5 | -2 | V |
| Signal frequency | $f_S$ | | - | 300 | kHz |
| Edge clearance | $t_{min}$ | | 100 | - | ns |

| Parameter | Designation | Threshold | Min. | Max. | Unit |
|---|---|---|---|---|---|
| "Zero pulse inactive time" (before and after A=B=high) | $t_{Lo}$ | | 640 | $(t_{ALo-BHi} - t_{Hi})/2$ 3) | ns |
| "Zero pulse active time" (while A=B=high and beyond) 4) | $t_{Hi}$ | | 640 | $t_{ALo-BHi} - 2*t_{Lo}$ 3) | ns |

1) Other signal levels according to the RS422 standard

2) The absolute level of the individual signals varies between 0 V and VCC of the encoder system.

3) $t_{ALo-BHi}$ is not a specified value, but is the time between the falling edge of track A and the next but one rising edge of track B.

4) Additional information on setting the "Zero pulse active time" can be found in the Function Manual: /FH1/ SINAMICS S120, tolerant encoder monitoring for SMC30.

Table 7- 20 Connectable encoders

| | X520 (SUB-D) | X521 (terminal) | X531 (terminal) | Track monitoring | Remote Sense 2) |
|---|---|---|---|---|---|
| HTL bipolar 24 V | No/yes | Yes | | No/yes | No |
| HTL unipolar 24 V 1) | No/yes | Yes (however, a bipolar connection is recommended)1) | | No | No |
| TTL bipolar 24 V | Yes | Yes | | Yes | No |
| TTL bipolar 5 V | Yes | Yes | | Yes | To X520 |
| SSI 24 V/5 V | Yes | Yes | | No | No |
| TTL unipolar | No | | | | |

1) Because the physical transmission properties are more robust, the bipolar connection should always be used. The unipolar connection should only be used if the encoder type does not output push-pull signals.

2) A controller compares the encoder system supply voltage – sensed via the Remote Sense cables – with the reference supply voltage of the encoder system, and adjusts the supply voltage for the encoder system at the output of the drive module until the required supply voltage is obtained directly at the encoder system (only for 5 V encoder system power supply).

## Maximum encoder cable length

Table 7- 21 Maximum encoder cable length

| Encoder type | Maximum encoder cable length in m |
|---|---|
| TTL1) | 100 |
| HTL unipolar2) | 100 |
| HTL bipolar | 300 |
| SSI | 100 |

1) For TTL encoders at X520 → Remote Sense → 100 m

2) Because the physical transmission properties are more robust, the bipolar connection should always be used. The unipolar connection should only be used if the encoder type does not output push-pull signals.

### SSI encoders

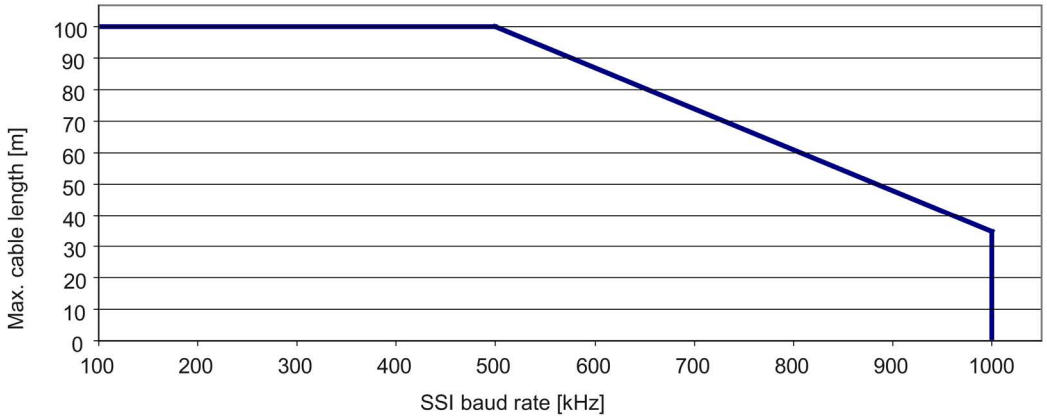



Figure 7-14 Maximum cable lengths depending on the SSI baud rate for SSI encoders

### Encoders with 5 V supply connected to X521/X531

For encoders with a 5 V supply at X521/X531, the cable length depends on the encoder current (for 0.5 mm² cable cross-sections):

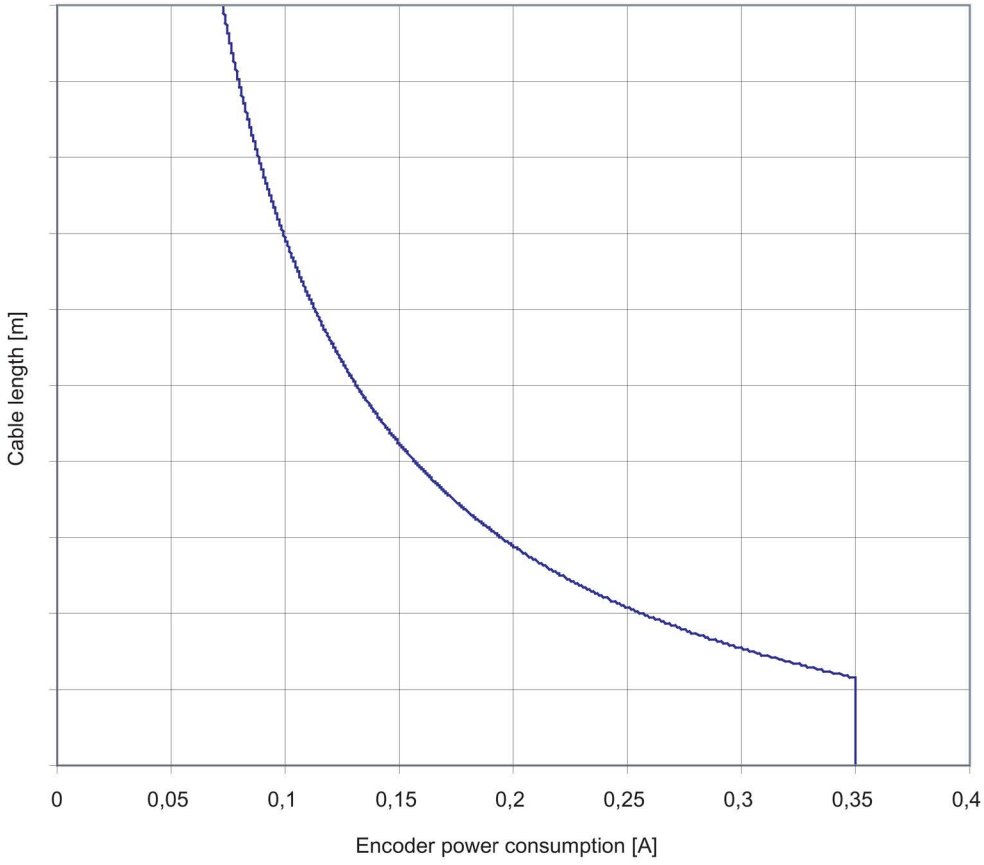



Figure 7-15 Max. cable length as a function of the encoder current drawn

For encoders without Remote Sense the permissible cable length is restricted to 100 m (reason: The voltage drop depends on the cable length and the encoder current).

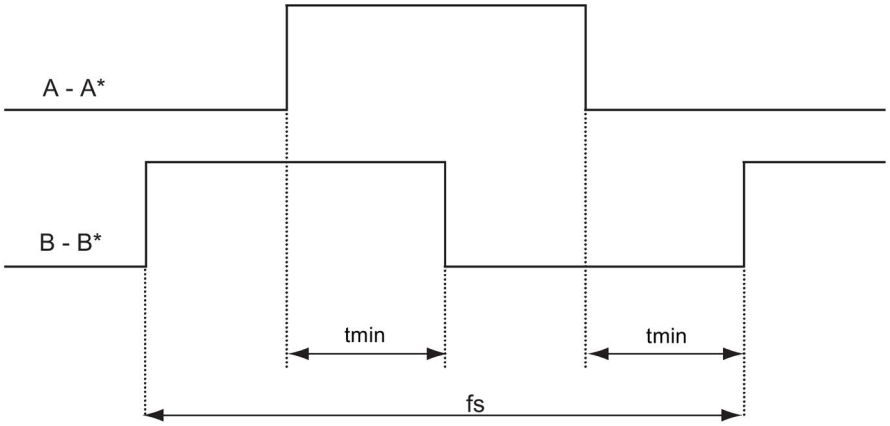



Figure 7-16 Signal characteristic of track A and track B between two edges: Time between two edges with incremental encoders

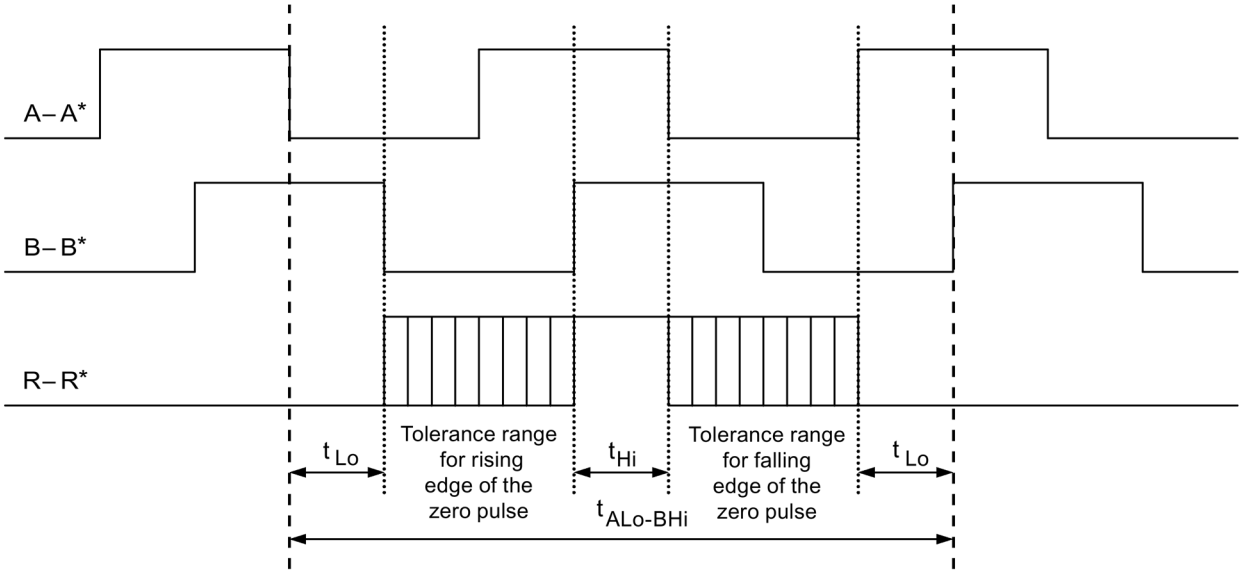



Figure 7-17 Position of the zero pulse to the track signals

# 7.4 Terminal Module TM15

## 7.4.1 Description

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

Table 7- 22 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) |

## 7.4.2 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**

**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.

## 7.4.3 Interface description

### 7.4.3.1 Overview

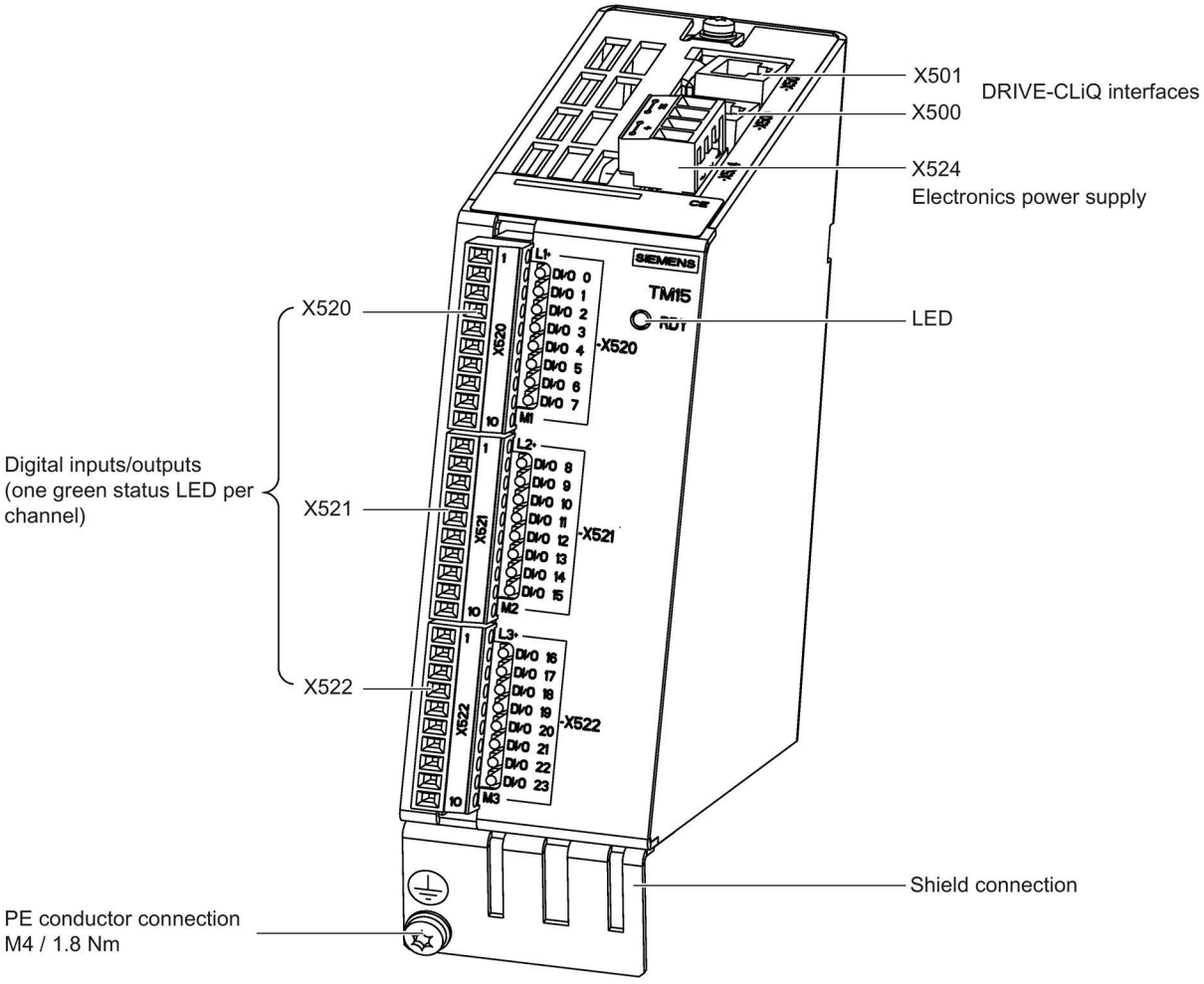


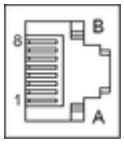

Figure 7-18 TM15 interface overview

### Terminal type

| **X520, X521, X522** | | |
|---|---|---|
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With end sleeve, without plastic sleeve<br>With end sleeve, with plastic sleeve | 0.08 $mm^2$ ... 1.5 $mm^2$<br>0.25 $mm^2$ ... 1.5 $mm^2$<br>0.25 $mm^2$ ... 0.5 $mm^2$ |
| Stripped length | 7 mm | |
| Tool | 0.4 × 2.0 mm screwdriver | |
| Tightening torque | 0.22 … 0.25 Nm | |
| **X524** | | |
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With end sleeve, without plastic sleeve<br>With end sleeve, with plastic sleeve<br>AWG / kcmil | 0.2 $mm^2$ ... 2.5 $mm^2$<br>0.2 $mm^2$ ... 2.5 $mm^2$<br>0.2 $mm^2$ ... 1.5 $mm^2$<br>22 ... 12 |
| Stripped length | 6 ... 7 mm | |
| Tool | 0.5 × 3.0 mm screwdriver | |
| Tightening torque | 0.4 … 0.5 Nm | |

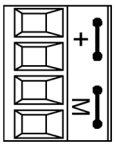
## 7.4.3.2 X500 and X501 DRIVE-CLiQ interface

Table 7- 23 DRIVE-CLiQ interfaces X500 and X501

| 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 |
| Blanking plate for DRIVE-CLiQ interfaces included in the scope of delivery;<br>blanking plate (50 pieces) Article number: 6SL3066-4CA00-0AA0 | | | |

### 7.4.3.3 X524 electronic power supply

Table 7- 24 Terminals for the X524 electronic power supply

| Connector | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | + | Electronic power supply | Voltage: 24 V DC (20.4-28.8 V)<br>Power consumption: max. 0.6 A [1)]<br>Max. current via jumper in connector: 20 A (15 A according to UL/CSA) |
| | + | Electronic 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.

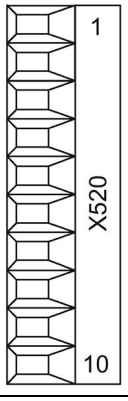
**Note**

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

The current consumption increases by the value for the DRIVE-CLiQ node. The digital outputs are supplied via terminals X520, X521, and X522.

### 7.4.3.4 X520 bidirectional digital inputs/outputs

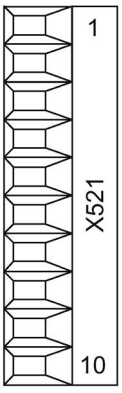
Table 7- 25 Screw terminal X520

| 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

### 7.4.3.5 X521 bidirectional digital inputs/outputs

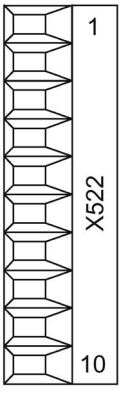
Table 7- 26 Screw terminal X521

| 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

### 7.4.3.6 X522 bidirectional digital inputs/outputs

Table 7- 27 Screw terminal X522

| 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

## 7.4.4 Connection example

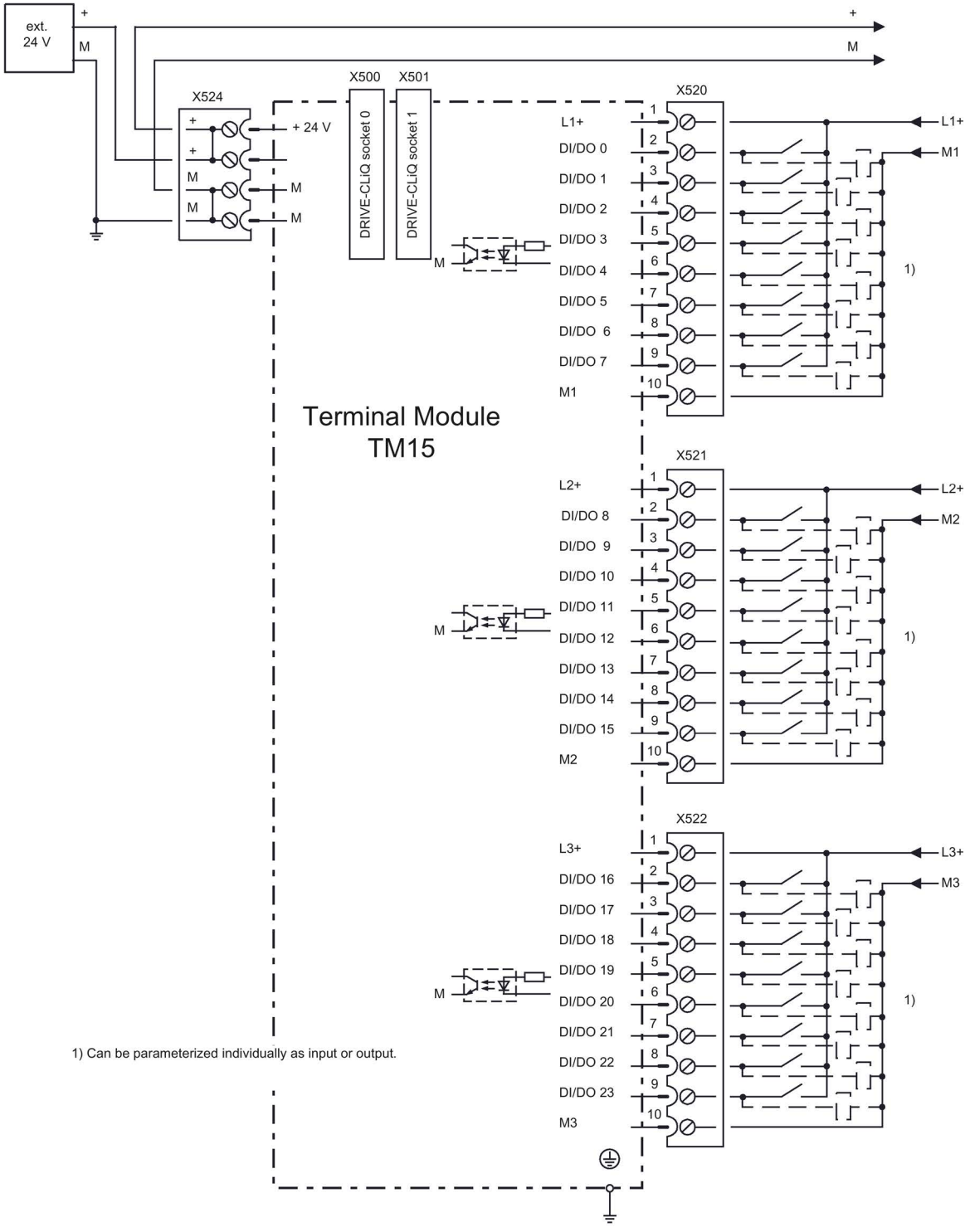



Figure 7-19 Example connection of TM15

## 7.4.5 Meaning of the LEDs on the Terminal Module TM15

Table 7- 28 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.<br>**Note:**<br>The LED is activated irrespective of whether the corresponding messages have been reconfigured. | Remove and acknowledge the fault. |
| | Green/ red | Flashing light 0.5 Hz | Firmware is being downloaded. | – |
| | | Flashing light 2 Hz | Firmware download has been completed. The system waits for POWER ON. | Carry out a POWER ON. |
| | Green/ orange<br>or<br>Red/ orange | Flashing light | Component recognition via LED is activated[1].<br>**Note:**<br>Both options depend on the LED status when component recognition is activated. | – |

[1] See SINAMICS DCM Parameter 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 DCM List Manual

## 7.4.6 Dimension drawing

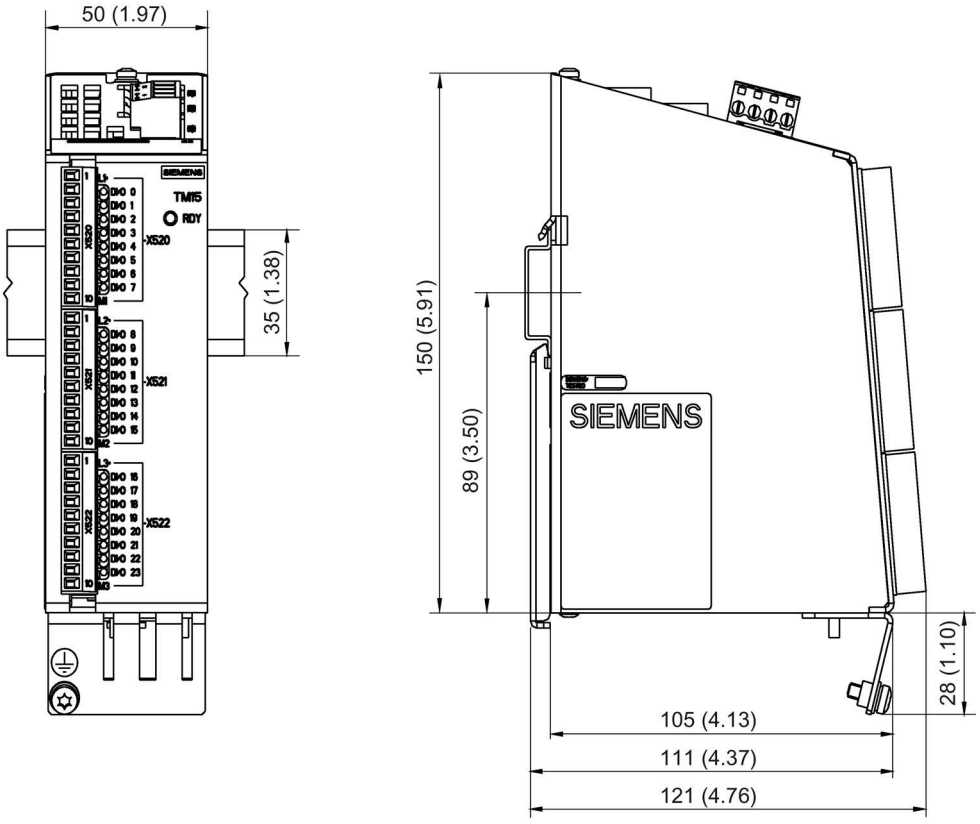



Figure 7-20 Dimension drawing of Terminal Module TM15, all data in mm and (inches)

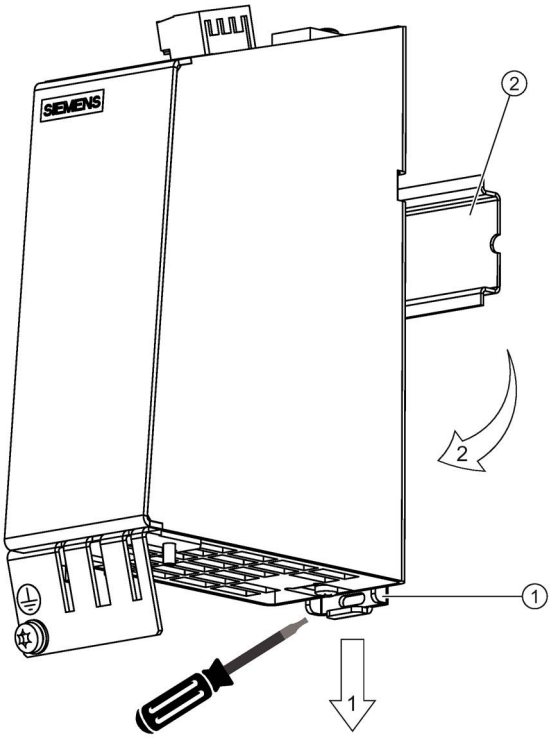
## 7.4.7 Installation

### 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.



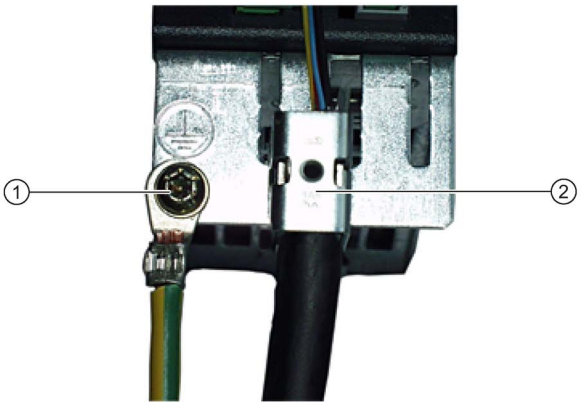

① Mounting slide
② Standard mounting rail

Figure 7-21 Removing from a mounting rail

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

Figure 7-22 Shield supports and protective conductor connection

**NOTICE**

**Damage or faulty operation due to incorrect shielding and impermissible 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 mounting depth of 4-6 mm.

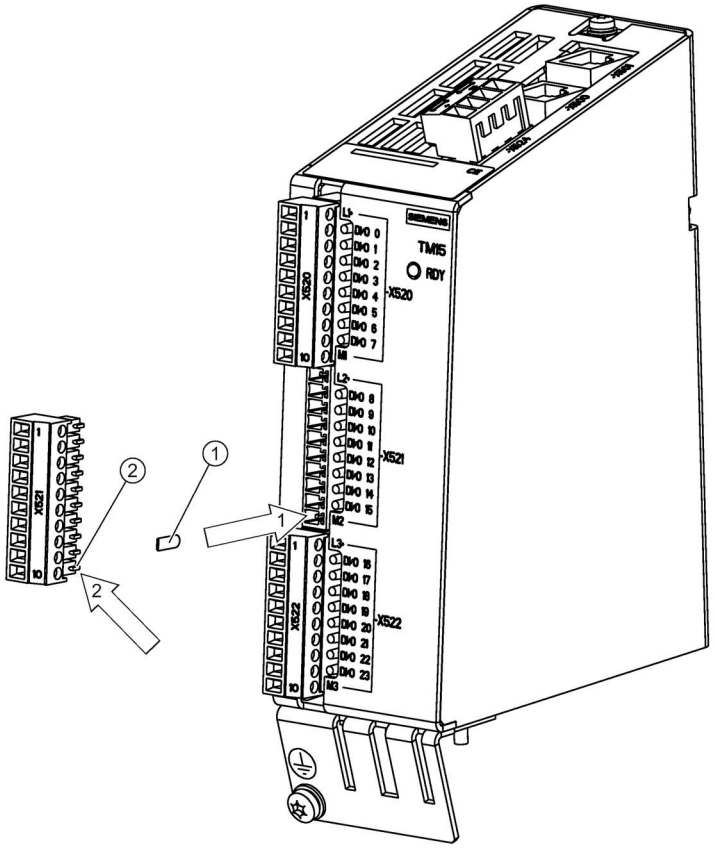
The TM15 enclosure is connected to the ground terminal of the module supply (terminal X524). If the ground terminal is actually grounded, then the enclosure is also grounded. An additional ground connection using the M4 screw is especially necessary if high potential bonding currents can flow (e.g. through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

## 7.4.9 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 7-23 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).

## 7.4.10 Technical data

Table 7- 29 Technical data

| 6SL3055-0AA00-3FAx | Unit | Value |
|---|---|---|
| **Electronic power supply**<br>Voltage<br>Current (without DRIVE-CLiQ or digital outputs)<br>Power loss | <br>$V_{DC}$<br>$A_{DC}$<br>W | <br>24 (20.4 – 28.8)<br>0.15<br>< 3 |
| Max. cable length | m | 30 |
| **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 to +30 |
| Low level (an open digital input is interpreted as "low") | $V_{DC}$ | -30 to +5 |
| High level | $V_{DC}$ | 15 to 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<br>"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<br>"1" → "0": 150 |
| Maximum | µs | "0" → "1": 100<br>"1" → "0": 225 |
| Min. output pulse<br>(100% amplitude, 0.5 A with resistive load) | µs | 125 (typ.)<br>350 (max.) |
| Switching frequency<br>For resistive load<br>For inductive load<br>For lamp load<br>Max. lamp load | <br>Hz<br>Hz<br>Hz<br>W | <br>max. 100<br>max. 0.5<br>max. 10<br>5 |
| Max. switching frequency<br>(100% amplitude, 50%/50% duty cycle;<br>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 |

| 6SL3055-0AA00-3FAx | Unit | Value |
|---|---|---|
| Voltage drop, output<br>(I/O power supply to the output) | $V_{DC}$ | 0.5 |
| Max. total current of outputs (per group)<br>up to 60 °C<br>up to 50 °C<br>up to 40 °C | <br>$A_{DC}$<br>$A_{DC}$<br>$A_{DC}$ | <br>2<br>3<br>4 |
| Response time | The response time for the digital inputs/outputs (TM15 DI/DO) consists of the following elements:<br>• Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle).<br>• Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle).<br>• Evaluation on the Control Unit (see function diagram)<br>For additional information:<br>SINAMICS DCM List Manual, Chapter "Function block diagrams" | |
| Weight | kg | 1.0 |
| Protective conductor connection | On enclosure with M4/1.8 Nm screw | |
| Approvals | UL and cULus, http://www.ul.com (www.ul.com)<br>File: E164110, Vol. 2, Sec. 9 | |

# 7.5 Terminal Module TM31

## 7.5.1 Description

The TM31 is a terminal expansion module for snapping onto a mounting rail according to EN 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 7- 30 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

The SINAMICS DC MASTER only supports one version of the Terminal Module TM31:

Table 7- 31 TM31 types

| TM31 article number | Use with SINAMICS DC MASTER |
|---|---|
| 6SL3055-0AA00-3AA0 | Not possible |
| 6SL3055-0AA00-3AA1 | Possible |

## 7.5.2 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.

## 7.5.3 Interface description

### 7.5.3.1 Overview

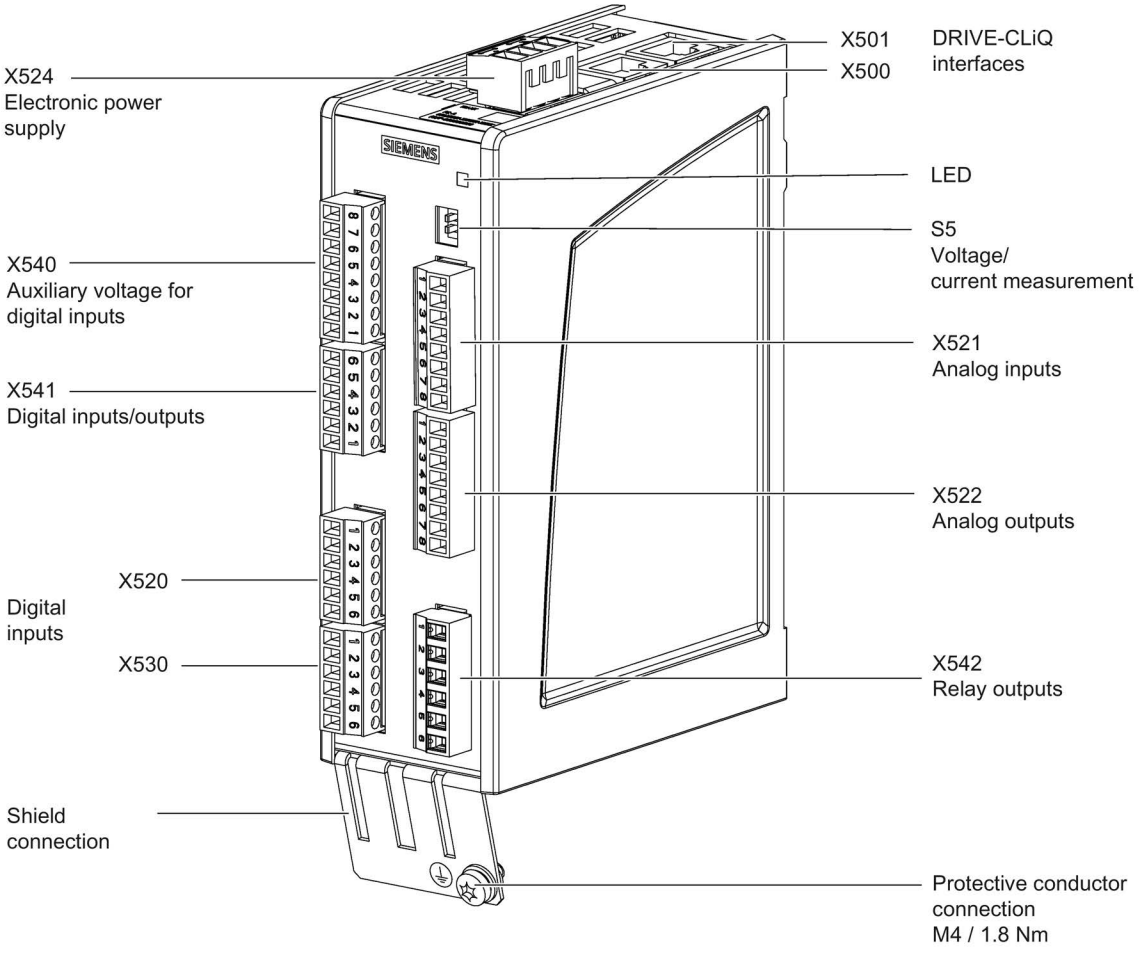


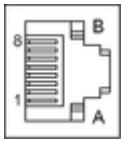

Figure 7-24 Interface description TM31

### Terminal type

| **X520, X521, X522, X530, X540, X541** | | |
|---|---|---|
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With end sleeve, without plastic sleeve<br>With end sleeve, with plastic sleeve | 0.08 $mm^2$ ... 1.5 $mm^2$<br>0.25 $mm^2$ ... 1.5 $mm^2$<br>0.25 $mm^2$ ... 0.5 $mm^2$ |
| Stripped length | 7 mm | |
| Tool | 0.4 × 2.0 mm screwdriver | |
| **X524** | | |
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With end sleeve, without plastic sleeve<br>With end sleeve, with plastic sleeve<br>AWG / kcmil | 0.2 $mm^2$ ... 2.5 $mm^2$<br>0.2 $mm^2$ ... 2.5 $mm^2$<br>0.2 $mm^2$ ... 1.5 $mm^2$<br>22 ... 12 |
| Stripped length | 6 ... 7 mm | |
| Tool | 0.5 × 3.0 mm screwdriver | |
| Tightening torque | 0.4 … 0.5 Nm | |
| **X542** | | |
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With end sleeve, without plastic sleeve<br>With end sleeve, with plastic sleeve | 0.2 $mm^2$ ... 2.5 $mm^2$<br>0.25 $mm^2$ ... 1 $mm^2$<br>0.25 $mm^2$ ... 1 $mm^2$ |
| Stripped length | 9 mm | |
| Tightening torque | 0.5 ... 0.6 Nm | |

## 7.5.3.2 X500/X501 DRIVE-CLiQ interfaces

Table 7- 32 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.

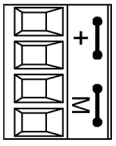
Blanking covers (50 x) Article number: 6SL3066-4CA00-0AA0

**Note**

The maximum DRIVE-CLiQ cable length is 100 m.

### 7.5.3.3 X524 electronic power supply

Table 7- 33 Terminals for the X524 electronic power supply

| Connector | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | + | Electronic power supply | Voltage: 24 V DC (20.4 – 28.8 V)<br>Power consumption: max. 1.7 A [1]<br><br>Max. current via jumper in connector:<br>20 A (15 A according to UL/CSA) |
| | + | Electronic 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.

### 7.5.3.4 X520, X530 digital inputs

Table 7- 34 Screw terminal X520

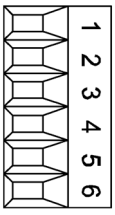
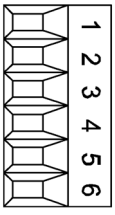
| Connector | Terminal | Designation [1] | Technical specifications |
|---|---|---|---|
|  | 1 | DI 0 | Voltage: -3 V to +30 V<br>Electrical isolation: Yes<br>Reference potential: M1<br>Input characteristic acc. to IEC 61131-2, type 1<br>Input voltage (including ripple)<br>"1" signal: 15 V to 30 V<br>"0"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

Table 7- 35 Screw terminal X530

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

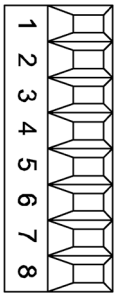
Terminal M1 or M2 must be connected in order that digital inputs (DI) can function.

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.

### 7.5.3.5 X521 analog inputs

Table 7- 36 X521 terminal strip

| Connector | Terminal | Designation [1] | Technical specifications |
|---|---|---|---|
|  | 1 | AI 0+ | The analog inputs can be toggled between current and voltage input using switches S5.0 and S5.1<br>**As voltage input:**<br>-10 V to +10 V; $R_i$ = 100 kΩ<br>Resolution: 11 bits + sign<br>**As current input:**<br>$R_i$ = 250 Ω<br>Resolution: 10 bits + sign |
| | 2 | AI 0- | |
| | 3 | AI 1+ | |
| | 4 | AI 1- | |
| | 5 | P10 | **Auxiliary voltage**:<br>P10 = 10 V<br>N10 = -10 V<br>Current-carrying capacity: max. 3 mA<br>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, then the component could be destroyed.

The common mode range must not be violated in order to avoid incorrect analog-digital conversion results.

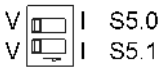
- The input voltage may only be in the range between -30 V and +30 V (destruction limit).
- The common mode voltage may only be in the range between -10 V and +10 V (error limit).
- The back EMF at the auxiliary voltage connections may only be in the range between -15 V and +15 V.

**Note**

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

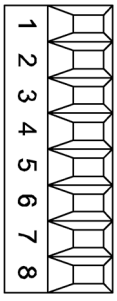
### 7.5.3.6 Analog inputs current/voltage switch

Table 7- 37 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 |

### 7.5.3.7 X522 analog outputs/temperature sensor

Table 7- 38 X522 terminal strip

| Connector | Terminal | Designation [1] | Technical specifications |
|---|---|---|---|
|  | 1 | AO 0V+ | You can set the following output signals using parameters:<br>**Voltage:** -10 V to 10 V (max. 3 mA)<br>**Current 1**: 4 to 20 mA (max. load resistance ≤ 500 Ω)<br>**Current 2:** -20 mA to 20 mA (max. load resistance ≤ 500 Ω)<br>**Current 3**: 0 to 20 mA (max. load resistance ≤ 500 Ω)<br>Resolution: 11 bits + sign<br>Sustained short-circuit-proof |
| | 2 | AO 0- | |
| | 3 | AO 0C+ | |
| | 4 | AO 1V+ | |
| | 5 | AO 1- | |
| | 6 | AO 1C+ | |
| | 7 | + Temp [2] | Temperature sensor KTY84-1C130 / PT1000 / PTC<br>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:
- KTY: ±7 °C (including evaluation)
- PT1000: ±5 °C (PT1000 tolerance class B according to EN 60751 including evaluation)
- PTC: ±5 °C (including evaluation)

**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**

**Damage to motor in the event of 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**

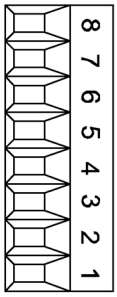
**Electric shock in the event of voltage flashovers at the temperature sensor**

Voltage flashovers in the signal electronics can occur in motors without safe electrical separation of the temperature sensors.

- Use temperature sensors that comply with the specifications relating to protective separation.

### 7.5.3.8 X540 auxiliary voltage for the digital inputs

Table 7- 39 Screw terminal X540

| Connector | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | 8 | +24 V | Voltage: +24 V DC<br>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**

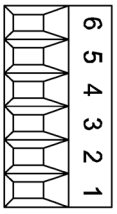
This power supply is only used for powering the digital inputs.

**Note**

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

### 7.5.3.9 X541 bidirectional digital inputs/outputs

Table 7- 40 Terminals for bidirectional digital inputs/outputs

| Connector | Terminal | Designation [1] | Technical specifications |
|---|---|---|---|
|  | 6 | M | **As input:**<br>Voltage: -3 V to 30 V<br>Potential distribution: no<br>Reference potential: M<br>Input characteristic acc. to IEC 61131-2, type 1<br>Input voltage (including ripple)<br>"1" signal: 15 … 30 V<br>"0" signal: -3 … +5 V<br>Input current<br>At 24 V DC: typ. 9 mA<br>For "1" signal: > 0.5 mA<br>Input delay:<br>- For "0" → "1": typ. 50 µs<br>- For "1" → "0" typ. 100 µs<br>**As output:**<br>Voltage: 24 V DC<br>Electrical isolation: no<br>Reference potential: M<br>Output voltage<br>"1" signal, with load: > X524.+ -2 V<br>**Output current**<br>For each output: ≤ 0.5 A<br>Sum of all 4 outputs: ≤ 2 A<br>Residual current for "0" signal: < 0.5 mA<br>Short-circuit protection, automatic restart after a short-circuit<br>Load types: ohmic, capacitive, inductive<br>**Output delay**<br>- For "0" → "1": typ. 150 µs / max. 500 µs (ohmic load)<br>- For "1" → "0": typ. 50 µs (ohmic load)<br>**Switching frequency**<br>For ohmic load: Max. 100 Hz<br>For inductive load: Max. 0.5 Hz<br>For lamp load: max. 10 Hz<br>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:<br>Voltage: +24 V DC<br>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**

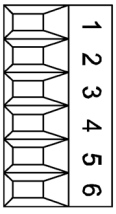
An open input is interpreted as "low".

**Note**

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

### 7.5.3.10 X542 relay outputs

Table 7- 41 X542 terminal strip

| Connector | Terminal | Designation [1] | Technical specifications |
|---|---|---|---|
|  | 1 | DO 0.NC | Contact type: Two-way contact max. load current: 8 A<br>Max. switching voltage: 250 $V_{AC}$. 30 $V_{DC}$<br>Max. switching capacity at 250 $V_{AC}$: 2000 VA (cosφ = 1)<br>Max. switching capacity at 250 $V_{AC:}$ 750 VA (cosφ = 0.4)<br>Max. Switching capacity at 30 $V_{DC}$: 240 W (resistive load)<br>Required minimum current: 100 mA<br>Output delay: ≤ 20 ms [2]<br>Overvoltage category: Class II acc. to EN 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

## 7.5.4 Connection example

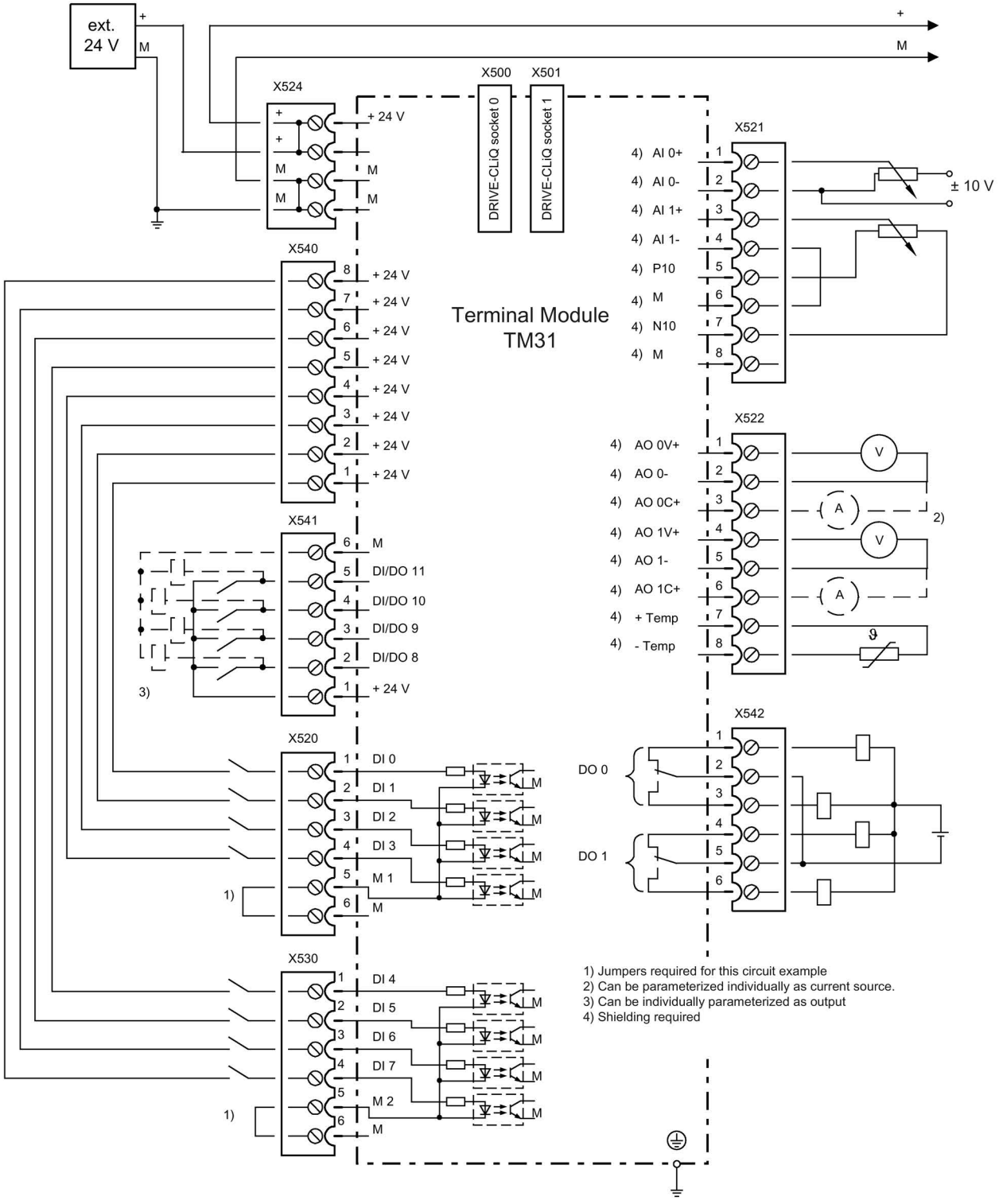



Figure 7-25 TM31 connection example

## 7.5.5 Meanings of the LEDs on the Terminal Module TM31

Table 7- 42 Meanings of the LEDs on the Terminal Module TM31

| LED | Color | Status | Description, cause | Remedy |
|---|---|---|---|---|
| READY | - | Off | The electronic 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.<br>**Note:**<br>The LED is activated irrespective of whether the corresponding messages have been reconfigured. | Remove and acknowledge the fault. |
| | Green/ red | Flashing light 0.5 Hz | Firmware is being downloaded. | – |
| | | Flashing light 2 Hz | Firmware download has been completed. The system waits for POWER ON. | Carry out a POWER ON. |
| | Green/ orange<br>or<br>Red/ orange | Flashing light | Component recognition via LED is activated[1].<br>**Note:**<br>Both options depend on the LED status when component recognition is activated. | – |

[1] See SINAMICS DCM Parameter 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 DCM List Manual

## 7.5.6 Dimension drawing

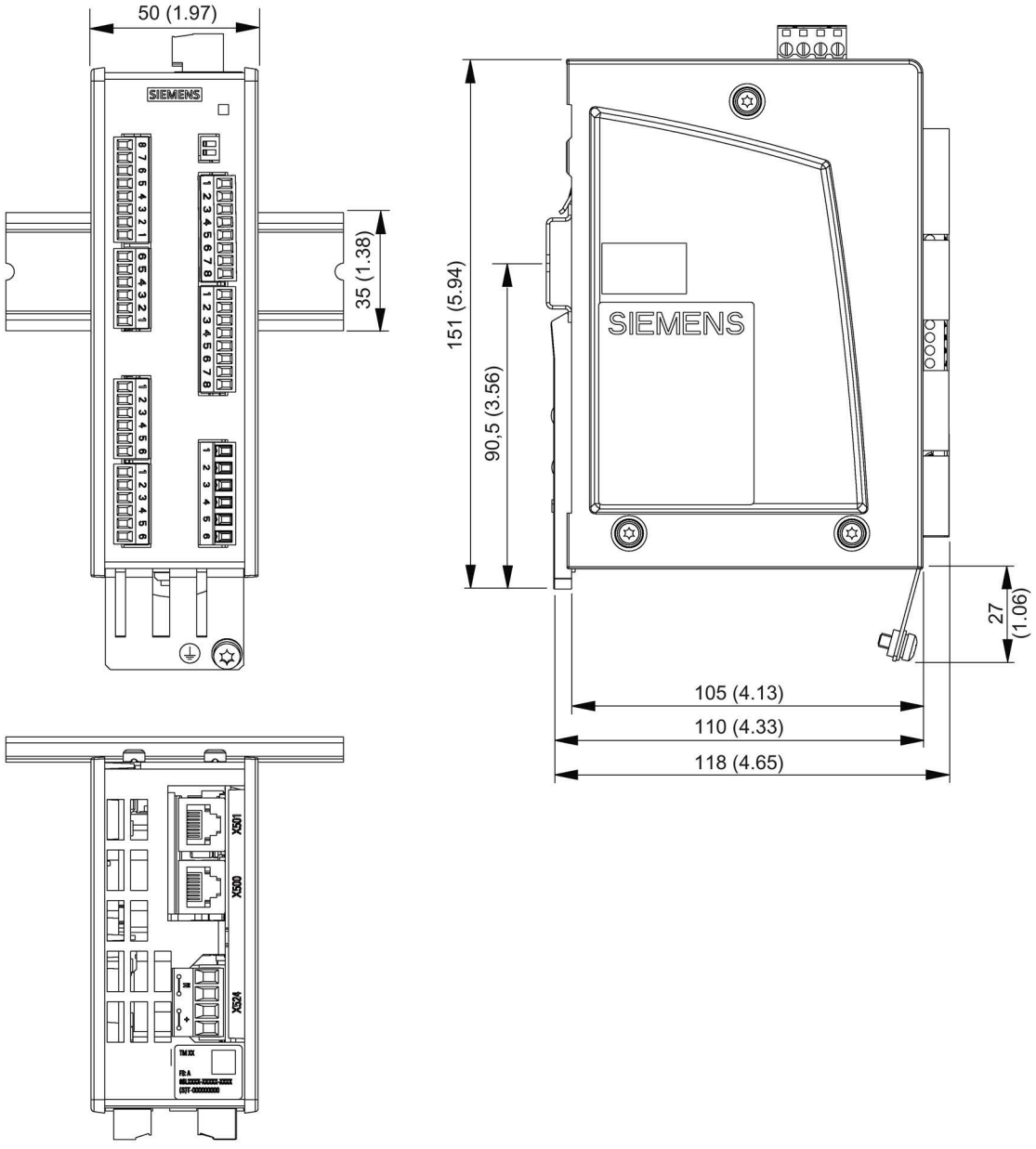



Figure 7-26 Dimension drawing of Terminal Module TM31, all data in mm and (inches)

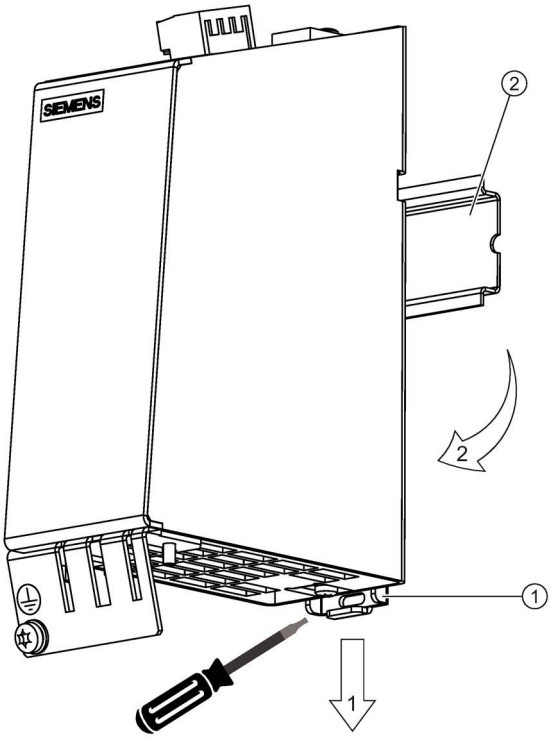
## 7.5.7 Installation

### 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.



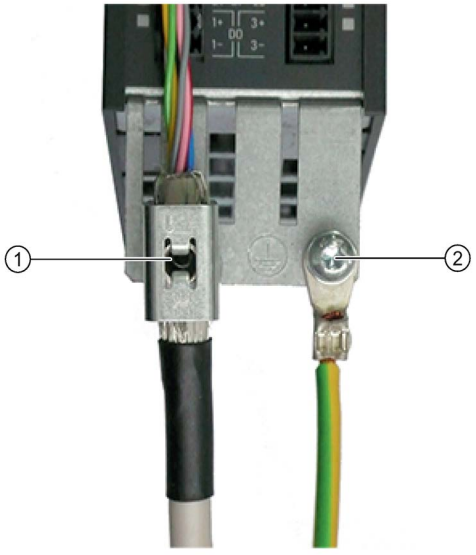

① Mounting slide
② Standard mounting rail

Figure 7-27 Removing from a mounting rail

## 7.5.8 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 7-28 Shield supports

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

## 7.5.9 Connector coding

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

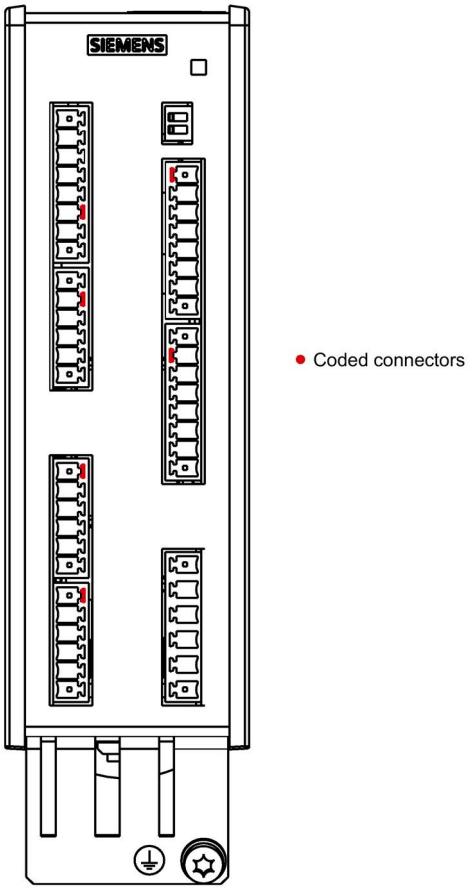



Figure 7-29 Example of connector coding at the TM31

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

## 7.5.10 Technical data

Table 7- 43 Technical data

| 6SL3055-0AA00-3AA1 | Unit | Value |
|---|---|---|
| Electronic power supply | | |
| Voltage | $V_{DC}$ | 24 DC (20.4 – 28.8) |
| Current (without DRIVE-CLiQ or digital outputs) | $A_{DC}$ | 0.5 |
| Power loss | W | <10 |
| PE/ground connection | On enclosure with M4/1.8 Nm screw | |
| Response time | The response time for the digital inputs/outputs and the analog inputs/outputs consists of the following elements:<br>• Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle).<br>• Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle)<br>• Evaluation on the Control Unit (see function diagram)<br>Further information: SINAMICS DCM List Manual, Chapter "Function diagrams" | |
| PE/ground connection | At the housing with M4 screw | |
| Maximum cable lengths:<br>Electronics power supply<br>DRIVE-CLiQ cables<br>Inputs/outputs | <br>m<br>m<br>m | <br>30<br>100<br>30 |
| Ventilation clearances, above/below | mm | 50 |
| Weight | kg | 0.49 |

# 7.6 Terminal Module TM150

## 7.6.1 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 (EN 60715).

The TM150 contains the following interfaces:

Table 7- 44 Overview of the TM150 interfaces

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

## 7.6.2 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.

## 7.6.3 Interface description

### 7.6.3.1 Overview

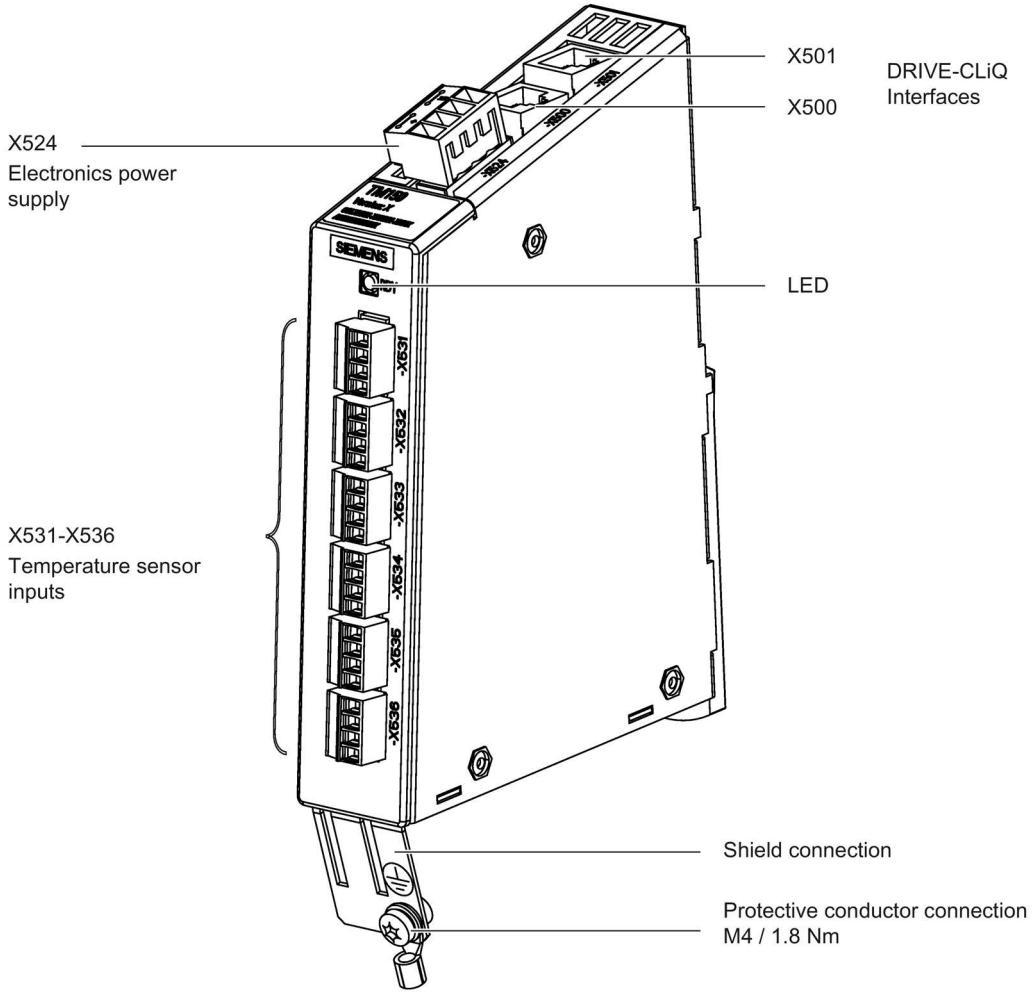


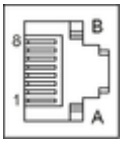

Figure 7-30 Interface overview of Terminal Module TM150

### Terminal type

| | | |
|---|---|---|
| **X524** | | |
| Terminal type | Screw terminal | |
| Connectable conductor cross-section | Rigid, flexible<br>With wire-end ferrule without plastic sleeve<br>With wire-end ferrule with plastic sleeve<br>AWG / kcmil | 0.2 ... 2.5 $mm^2$<br>0.2 ... 2.5 $mm^2$<br>0.5 ... 1.5 $mm^2$<br>22 ... 12 |
| Stripped length | 6 ... 7 mm | |
| Tool | 0.5 × 3 mm screwdriver | |
| Tightening torque | 0.4 to 0.5 Nm | |
| **X531 - X536** | | |
| Terminal type | Spring-loaded terminal | |
| Connectable conductor cross-section | Rigid<br>Flexible<br>Flexible with wire-end sleeve without plastic sleeve<br>Flexible with wire-end ferrule with plastic sleeve<br>AWG / kcmil | 0.2 ... 1.5 $mm^2$<br>0.2 ... 1.5 $mm^2$<br>0.25 ... 1.5 $mm^2$<br>0.25 ... 0.75 $mm^2$<br>24 … 16 |
| Stripped length | 10 mm | |

## 7.6.3.2 X500 and X501 DRIVE-CLiQ interfaces

Table 7- 45 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 |
| Connector type | DRIVE-CLiQ socket | | |

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

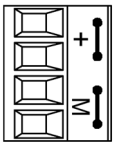
Blanking covers (50 pcs) Article number: 6SL3066-4CA00-0AA0

**Note**

The maximum DRIVE-CLiQ cable length is 100 m.

### 7.6.3.3 X524 Electronics power supply

Table 7- 46 X524: Electronic power supply

| Connector | Terminal | Designation | Technical specifications |
|---|---|---|---|
|  | + | Electronic power supply | Voltage: 24 V DC (20.4 V-28.8 V)<br>Current consumption (max./typ.): 0.5 A / 0.1 A |
| | + | Electronic power supply | Max. current via jumper in connector: 20 A<br>(15 A according to UL/CSA) |
| | M | Electronics ground | |
| | M | Electronics ground | |

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

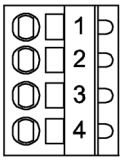
**Note**

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.

### 7.6.3.4 X531-X536 temperature sensor inputs

Table 7- 47 X531-X536: Temperature sensor inputs

| Connector | Terminal | Function<br>1x2- / 2x2-wire | Function<br>3 and 4-wire | Technical specifications |
|---|---|---|---|---|
|  | 1 | + Temp<br>(channel x) | +<br>(channel x) | Temperature sensor connection for sensors with 1x2 wires<br>Connection of the 2nd measurement cable for sensors with 4-wires |
| | 2 | - Temp<br>(channel x) | -<br>(channel x) | Temperature sensor connection for sensors with 1x2 wires<br>Connection of the 1st measurement cable for sensors with 3 and 4-wires. |
| | 3 | + Temp<br>(channel y) | + $I_c$<br>(constant current, positive, channel x) | Temperature sensor connection for sensors with 2x2, 3 and 4-wires |
| | 4 | - Temp<br>(channel y) | - $I_c$<br>(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 7- 48 Channel assignment

| Terminal | Channel number [x]<br>for 1x2, 3 and 4-wires | Channel number [y]<br>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 may result in 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 mm².

## 7.6.4 Connection examples

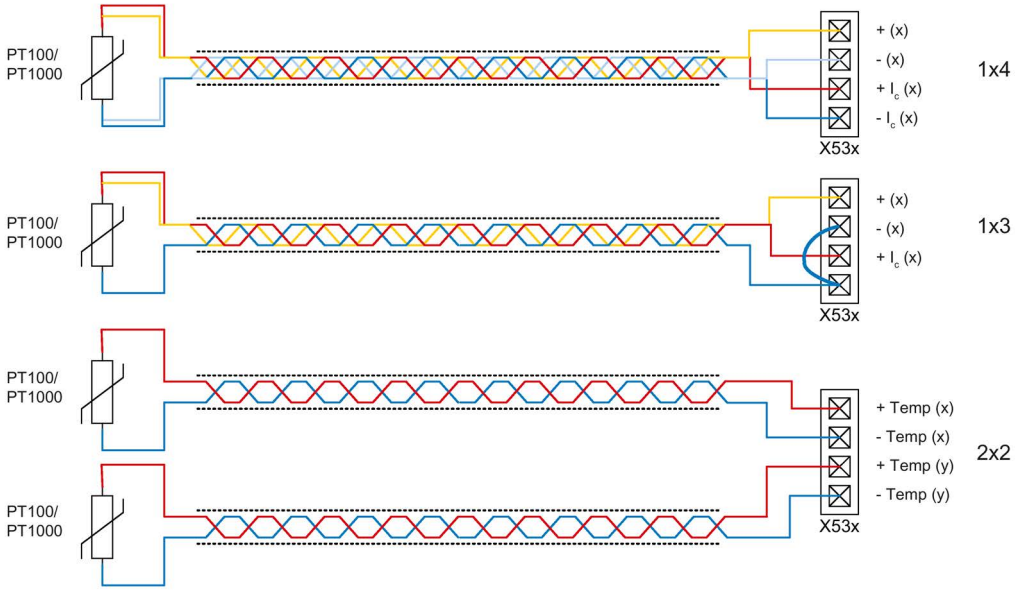



Figure 7-31 Connecting a PT100/PT1000 with 2x2, 3 and 4-wires to the temperature sensor inputs X53x of Terminal Module TM150

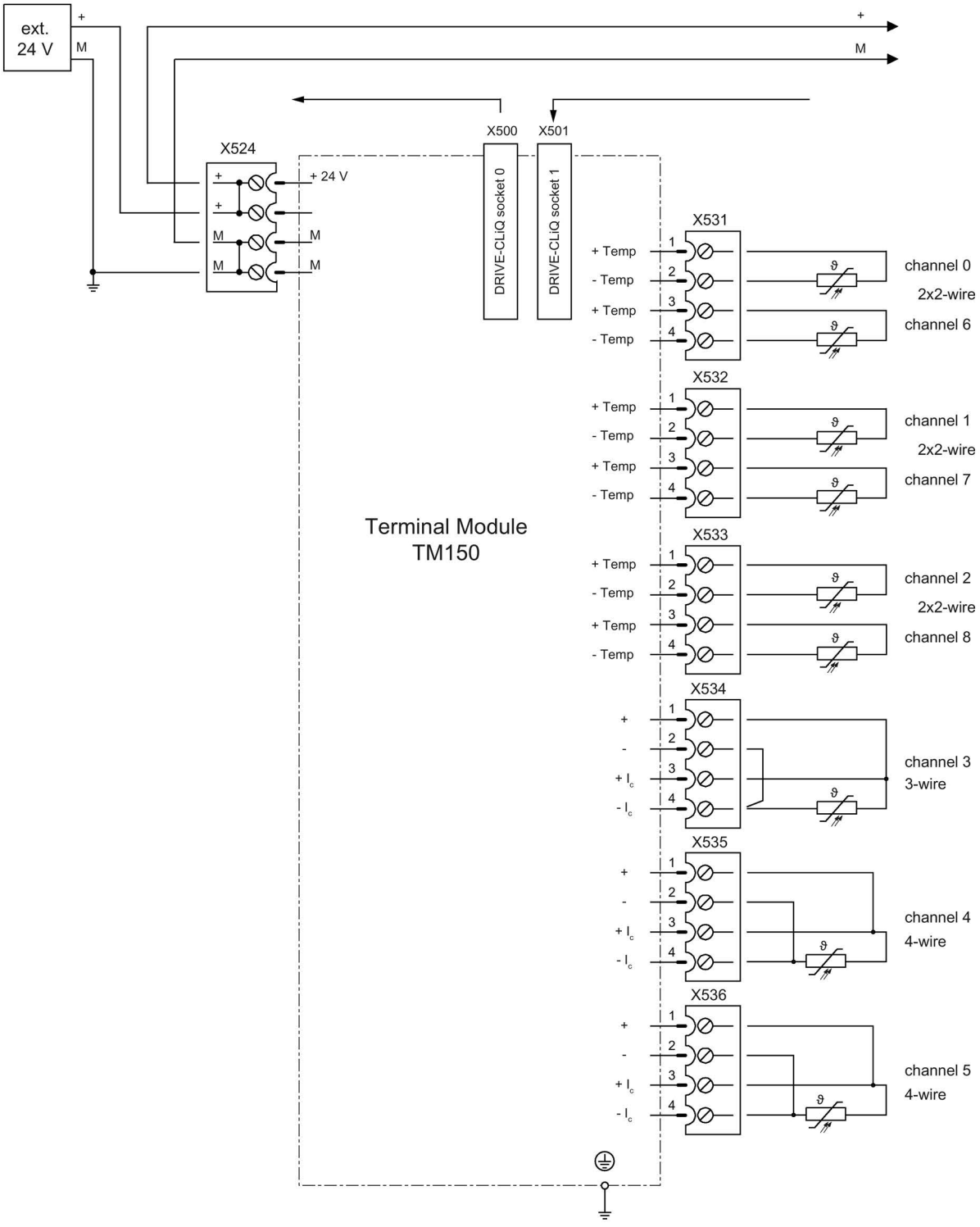



Figure 7-32 Connection example for a Terminal Module TM150

## 7.6.5 Meaning of the LEDs on the Terminal Module TM150

Table 7- 49 Meaning of the LEDs at the Terminal Module TM150

| LED | Color | State | Description, cause | Remedy |
|---|---|---|---|---|
| READY | – | Off | Electronic 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.<br>**Remark:**<br>LED is controlled irrespective of the corresponding messages being reconfigured. | Remedy and acknowledge fault |
| | Green/ Red | Flashing light 0.5 Hz | Firmware is being downloaded. | – |
| | | Flashing light 2 Hz | Firmware has been downloaded.<br>Wait for POWER ON. | Carry out a POWER ON |
| | Green/ orange or red/ orange | Flashing light 2 Hz | Component recognition via LED is activated (p0154).<br>**Remark:**<br>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 DCM List Manual

## 7.6.6 Dimension drawing

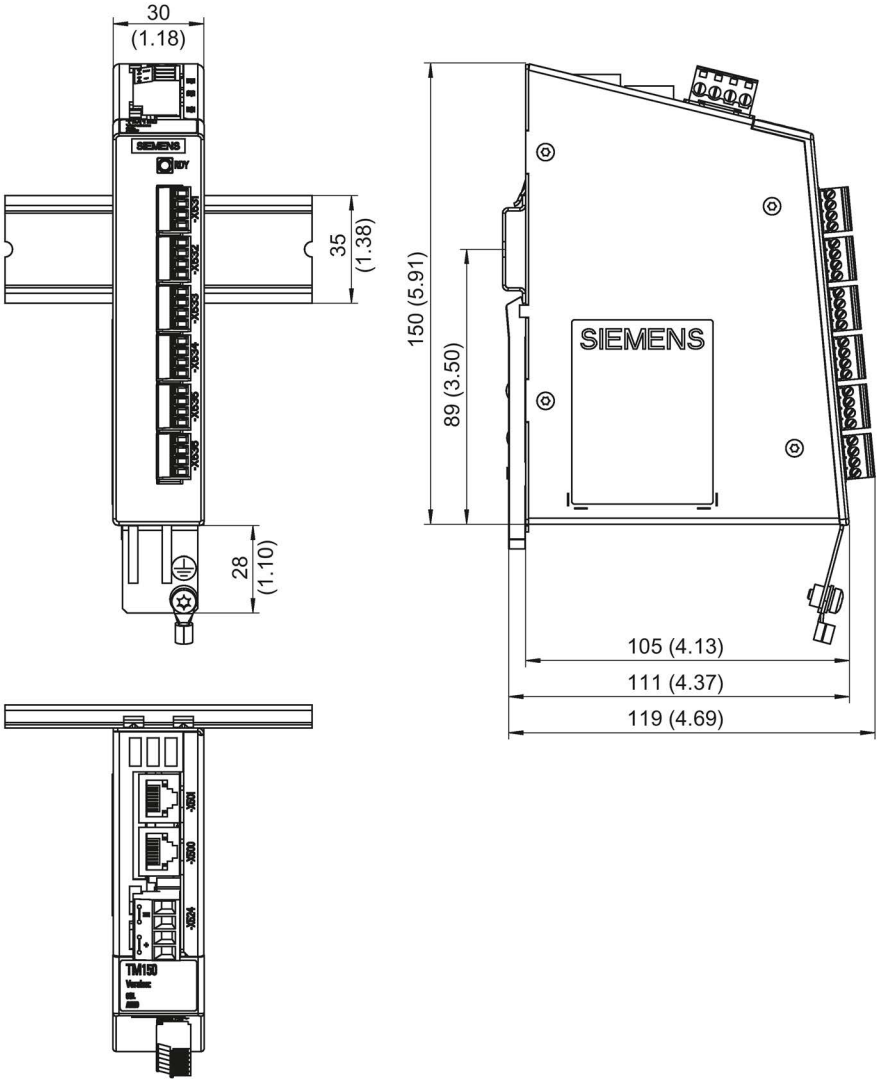



Figure 7-33 Dimension drawing of Terminal Module TM150, all data in mm and (inches)

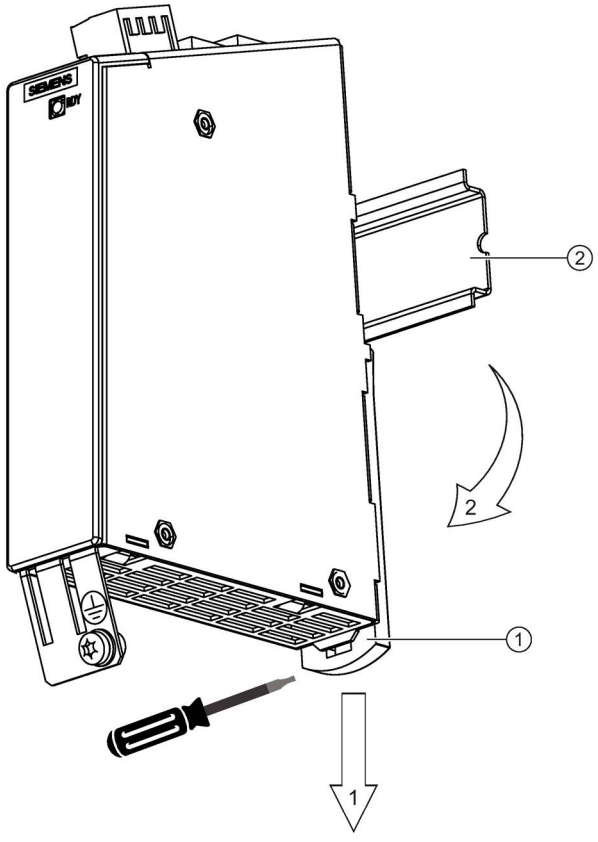
## 7.6.7 Installation

### 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.

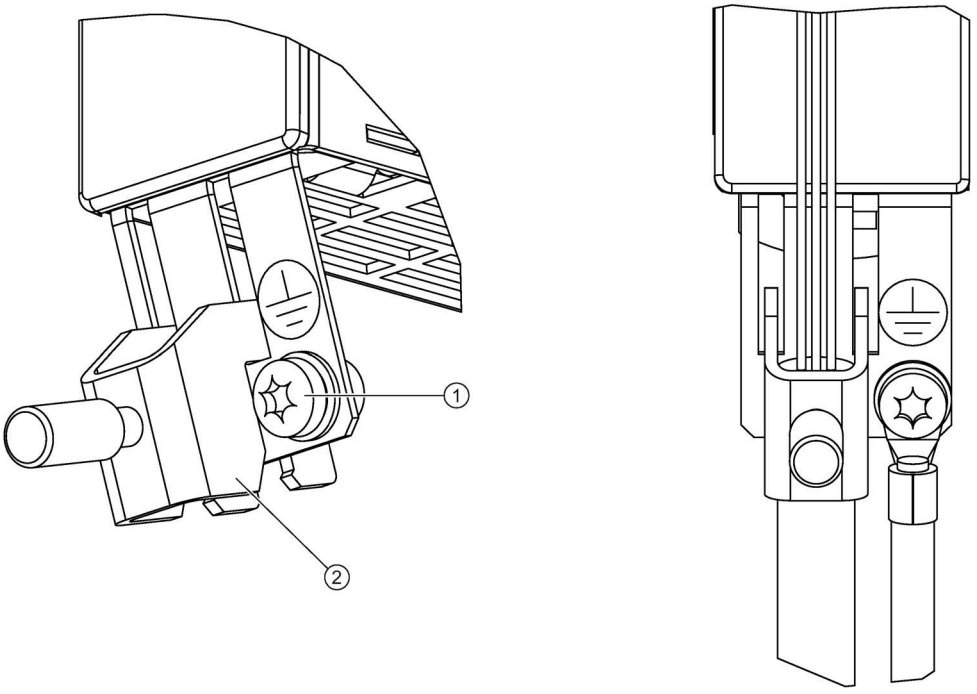



① Mounting slide
② Standard mounting rail

Figure 7-34 Removing a TM150 from a mounting rail

## 7.6.8 Protective conductor connection and shield support

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




① Protective conductor connection M4 / 1.8 Nm
② Shield connection terminal, Weidmüller company, type: KLBÜ CO1, Order number: 1753311001

Figure 7-35 Shield support and protective conductor connection of the TM150

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

## 7.6.9 Technical data

Table 7- 50 Technical data

| 6SL3055-0AA00-3LA0 | Unit | Value |
|---|---|---|
| Voltage<br>Current (without DRIVE-CLiQ)<br>Power loss | $V_{DC}$<br>$A_{DC}$<br>W | 24 V DC (20.4-28.8)<br>0.07<br>1.6 |
| PE/ground connection | On enclosure with M4/1.8 Nm screw | |
| Maximum cable length | m | 50 |
| Ventilation clearances, above/below | mm | 50 |
| Weight | kg | |

**Note**

In order to guarantee the degree of protection, all of the connectors must be correctly screwed into place and appropriately locked.

# Commissioning

# 8

**⚠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.
- When assessing the risk, take into account remaining risks.

**Note**

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

An active saving process is indicated by the following actions:

- The RDY-LED flashes (see Chapter "Description of the LEDs on the CUD (Page 597)")
- The BOP20 flashes

Interrupting the power supply while saving can lead to the loss of the current device parameter assignments. See also Chapter "Memory card functions (Page 327)".

# 8.1 Commissioning checklist

## Preparation

- Read the safety instructions in Chapter "Safety instructions (Page 17)".
- Read Chapter "Transport, unpacking, installation (Page 39)".
- Read through the entire checklist together with another person before starting work on the device.
- Before commissioning the converter, as a minimum, check the following points:

## Mechanical installation

Use the following checklist to guide you through the mechanical installation procedure for the device.

**Note**

**Checking the checklist**

Check the boxes accordingly in the right-hand column if the activity applies to the cabinet unit in your scope of supply. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

| Item | Activity | Available | Completed |
|---|---|---|---|
| 1 | The device is properly mounted on a vertical wall/panel made of non-flammable material. | ☐ | ☐ |
| 2 | All shield connections are tight (see Chapter "Connecting (Page 55)"). | ☐ | ☐ |
| 3 | All cable connections are tight (see Chapter "Connecting (Page 55)"). | ☐ | ☐ |
| 4 | The ambient conditions are complied with (see Chapter "Environmental conditions (Page 37)"). | ☐ | ☐ |
| 5 | The cooling air can flow unobstructed. | ☐ | ☐ |
| 6 | The motor and the driven machine are ready to run. | ☐ | ☐ |

## Electrical installation

Use the following checklist to guide you through the electrical installation procedure for the device.

**Note**

**Checking the checklist**

Check the boxes accordingly in the right-hand column if the activity applies to the cabinet unit in your scope of supply. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

| Item | Activity | Available | Completed |
|---|---|---|---|
| 1 | The converter devices have been properly grounded. | ☐ | ☐ |
| 2 | The line connections (1U1, 1V1, 1W1), motor connections (1C1, 1D1) and the field connections (3C, 3D) are correctly established. | ☐ | ☐ |
| 3 | All control cables have been correctly connected (see Chapter "Connecting (Page 55)"). | ☐ | ☐ |
| 4 | The correct commutating reactors have been installed and connected (see Chapter "Line reactors (Page 112)"). | ☐ | ☐ |
| 5 | The correct semiconductor protection fuses and cable protection fuses have been installed (see Chapter "Fuses (Page 116)"). | ☐ | ☐ |
| 6 | There are no tools, foreign bodies or metal chips in the converter. | ☐ | ☐ |
| 7 | The correct covers are in place and correctly mounted. | ☐ | ☐ |
| 8 | A higher-level Emergency Stop device to avoid hazardous situations is absolutely mandatory for all applications. This is available, is functioning and is operational. | ☐ | ☐ |
| 9 | The line voltage corresponds to the rated input voltage of the converter. | ☐ | ☐ |
| 10 | A clockwise phase sequence is connected at the fan power supply (4U1, 4V1, 4W1). (connection is only available only for devices with radial fan (3~AC 400 V)). The fan rotates counterclockwise when viewed from above. | ☐ | ☐ |
| 11 | If the digital inputs for ON/OFF1 OR operating enable (X177 terminal 12 or 13) are not used on the hardware side, they must be permanently supplied with +24 V. | ☐ | ☐ |

## Restoring the factory settings

The commissioning steps listed in "Commissioning using the BOP20 Operator Panel (Page 239)", "Commissioning using the AOP30 Operator Panel (Page 247)" and "Commissioning with the STARTER commissioning tool (Page 253)" assume that all parameters are set to the factory settings. This is the case when the device is initially shipped. If the parameters have already been changed, or if you are not certain that all of the parameters are at their factory settings, then run the "Restore factory setting" function!

With the basic operator panel BOP20:
(1)p0009 = 30
(1)p0976 = 1
SINAMICS DCM resets all of the parameters to the factory setting, and executes a power on. The parameters must then be permanently saved by pressing the P button for a longer period of time (at least 3 seconds, however until the display starts to flash).

## 8.2 Switching on

After the device is turned on (POWER ON), the drive powers up. Power-up up to operating state 7.0 in the SINAMICS DCM with the parameters saved (RAM to ROM was carried out) takes approx. 45 s. Power-up without the saved parameters (first commissioning) takes approx. 60 s.

Table 8- 1 SINAMICS DCM ramp-up times

| BOP20 display | CUD LED status | Ramp-up time [1] |
|---|---|---|
| Light on the BOP20 | RDY: Red<br>DP1: Red | POWER ON |
| - | RDY: Orange<br>DP1: - | 15 s |
| Display "run up" | RDY: Orange<br>DP1: - | 35 s |
| Operating state 12.4 | RDY: Green<br>DP1: - | 40 s |
| Operating state 7.0 | RDY: Green<br>DP1: - | 45 s |
| [1] Power-up with saved parameters (RAM to ROM was carried out) | | |

The status of the LEDs on the CUD (see also Chapter "Description of the LEDs on the CUD (Page 597)") can only be seen when the device cover is open.

**Note**

If options are being used (DCC, CBE20, SMC10, SMC30, TM15, TM31, TM150 etc.) and in the case of certain device configurations, the duration of the power-up increases.

**Note**

If an external memory card with previously saved data is plugged into the drive during power-up, the drive powers up based on the parameter assignments saved on the card (see also Chapter "Memory card functions (Page 327)").

# 8.3 Commissioning using the BOP20 Operator Panel

## 8.3.1 Preconditions

### Fundamentals of SINAMICS

If you are not yet familiar with SINAMICS basics (parameters, drive objects, BICO technology, etc.), please read Chapter "Basic information (Page 317)" before starting commissioning.

### BOP20 operator panel

If you are not yet familiar with the BOP20 operator panel, please read Chapter "Parameterizing using the BOP20 (Basic Operator Panel 20) (Page 336)" before starting commissioning.

### Parameter notation

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).

## 8.3.2 Commissioning steps

Note:
Parameters with [D] are data-set dependent. Commissioning must be carried out for each data set.

### 〈1〉Access authorization

In order to be able to set the access authorization, drive object 1 (DO1) must be activated at the BOP20, see Chapter "Displays and using the BOP20 (Page 341)".

Access level
(1)p0003 = 1 Standard
(1)p0003 = 2 Advanced
(1)p0003 = 3 Expert

### 〈2〉Define the external power unit

| | |
|---|---|
| p51819[0] | Transformation ratio for armature voltage transformer |
| p51819[1] | Transformation ratio for field voltage transformer |
| p51820 | Rated armature supply voltage |
| p51821[0] | Connection of line measurement cables |
| p51821[1] | Connection of armature measurement cables |
| p51822 | Rated armature DC current |
| p51823 | Load voltage at rated armature current |
| p51824 | Current transformer configuration |
| p51825 | Type of power unit |
| p51826[0] | Length of first pulse |
| p51826[1] | Length of other pulses |
| p51829 | Heat sink temperature threshold |
| p51830 | Sensor for heat sink temperature |
| p51831 | Fuse monitoring |
| p51832 | Monitoring of device fan |
| p51833 | External fault |
| p51834 | Source of fan relay output |
| p51835[0] | Monitoring of device fan's ON delay |
| p51835[1] | Fault involving device fan's ON delay |
| p51835[2] | Alarm involving device fan's ON delay |

### 〈3〉 Adjust the rated device currents

The **rated armature DC current for the device** must be adjusted by setting p50076[0] (in %) or p50067 if:

Maximum armature current < 0.5 × rated armature DC current for the device

The **rated field DC current for the device** must be adapted by setting p50076[1] (in %) if:

Maximum field current < 0.5 × rated field DC current for the device

It is recommended to always adjust parameter p50076.x. As many display parameters in % relate to the rated device current, these are re-standardized by adjusting the armature or field current of the motor. This enables better interpretation of them, e.g. in the trace.

### 〈4〉 Adjust to the actual device supply voltage

| | |
|---|---|
| p50078[0] | Rated value for armature supply voltage (in volts) |
| p50078[1] | Rated value for field supply voltage (in volts) |

### 〈5〉 Enter the motor data

The motor data must be entered into the following parameters as specified on the motor rating plate (see also the Chapter "Thermal overload protection for the DC motor ($I^2t$ monitoring of the motor) (Page 550)" and "Speed-dependent current limitation (Page 556)").

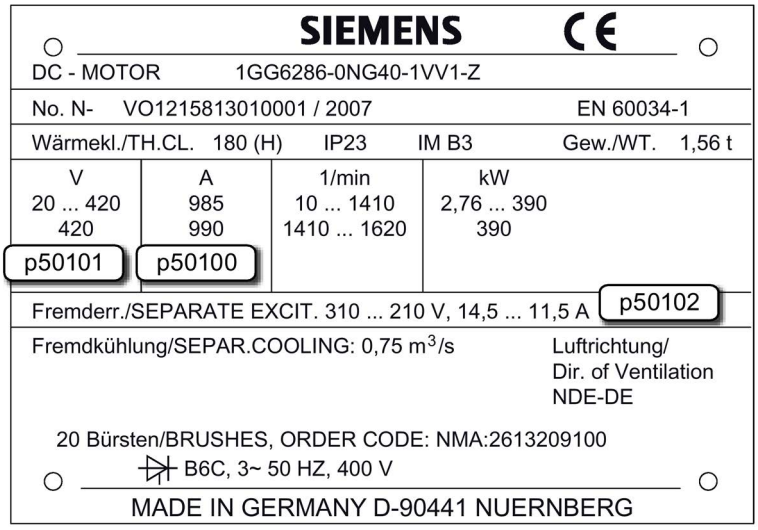



Figure 8-1 Example of a rating plate

| | |
|---|---|
| p2003 | Rated torque = (kW x 9555) / rated speed |
| p50100[D] | Rated armature current (in amperes) |
| p50101[D] | Rated armature voltage (in volts) |
| p50102[D] | Rated excitation current (in amperes) |
| p50104[D] | Speed n1 (in rpm) |
| p50105[D] | Armature current I1 (in amperes) |
| p50106[D] | Speed n2 (in rpm) |
| p50107[D] | Armature current I2 (in amperes) |
| p50108[D] | Maximum operating speed n3 (in rpm) |
| p50109[D] | 1 = Speed-dependent current limitation active |
| p50114[D] | Motor thermal time constant (in seconds) |

## 〈6〉Data for actual speed value acquisition

### 〈6.1〉Operation with analog tachometer

p50083[D] = 1 The actual speed value comes from the "Main actual value" (r52013) channel (terminals XT.103, XT.104).

p50741[D] Tachometer voltage at maximum speed (-270.00 to +270.00 V)

Remark:
The value set here determines the 100% speed for the closed-loop speed control.

p2000 Speed in rpm for tachometer voltage set on p50741[0]

Comment 1:
Parameter p2000 is used to convert from a "physical speed" (rpm) into a "relative speed" (%) and vice versa.

This conversion is required for:

- Speed setpoint input via the control panel in STARTER
- Speed setpoint input via the operating screen form at the AOP30
- Calculating the display values r020, r021, r060 and r063

Remark 2:
Parameter p2000 and parameters r020, r021, r060 and r063 are not data-set dependent. This is the reason why the physical speed can only be displayed correctly for one data set (DDS).

### 〈6.2〉Operation with incremental encoder

p50083[D] = 2 The actual speed value comes from an incremental encoder (r0061) connected to terminal block X177.

p0400[0] Encoder type selection

p2000 Speed in rpm at 100% speed

Remark:
The value set here determines the 100% speed for the closed-loop speed control.

### 〈6.3〉 Operation without tachometer (closed-loop EMF control)

p50083[D] = 3 The actual speed value comes from the "Actual EMF value" channel (r52287), but is evaluated with p50115.

p50115[D] EMF at 100% speed
(1.00 to 140.00% of device rated supply voltage (p50078[0]))

Remark:
The value set here determines the 100% speed for the closed-loop speed control.

p2000 Speed in rpm for EMF set on p50115[0]

Comment 1:
Parameter p2000 is used to convert from a "physical speed" (rpm) into a "relative speed" (%) and vice versa.

This conversion is required for:

- Speed setpoint input via the control panel in STARTER
- Speed setpoint input via the operating screen form at the AOP30
- Calculating the display values r020, r021, r060 and r063

Remark 2:
Parameter p2000 and parameters r020, r021, r060 and r063 are not data-set dependent. This is the reason why the physical speed can only be displayed correctly for one data set (DDS).

### 〈6.4〉 Freely-wired actual value

p50083[D] = 4 The actual value input is defined with p50609[C]

p50609[C] Number of the parameter that is switched to the actual speed controller value

p2000 Speed in rpm at which the parameter selected on p50609[0] accepts the value 100%

Comment 1:
Parameter p2000 is used to convert from a "physical speed" (rpm) into a "relative speed" (%) and vice versa.

This conversion is required for:

- Speed setpoint input via the control panel in STARTER
- Speed setpoint input via the operating screen form at the AOP30
- Calculating the display values r020, r021, r060 and r063

Remark 2:
Parameter p2000 and parameters r020, r021, r060 and r063 are not data-set dependent. This is the reason why the physical speed can only be displayed correctly for one data set (CDS).

#### 〈6.5〉Operation with incremental encoder and SMC30

| | |
|---|---|
| p50083[D] = 5 | The actual speed value comes from an incremental encoder connected to an SMC30 (r3770). |
| p0400[1] | Encoder type selection |
| p2000 | Speed in rpm at 100% speed<br>Remark:<br>The value set here determines the 100% speed for the closed-loop speed control. |

#### 〈6.6〉Operation with resolver and SMC10

| | |
|---|---|
| p50083[D] = 5 | A DRIVE-CLiQ encoder supplies the speed actual value |
| p0400[1] | Encoder type selection |
| p2000 | Speed in rpm at 100% speed<br>Comment:<br>The value set here defines the 100% speed for the closed-loop speed control. |

### 〈7〉Data for field

#### 〈7.1〉Control of the field

| | |
|---|---|
| p50082 = 0 | Internal field is not used<br>(e.g. in the case of permanent-magnet motors) |
| p50082 = 1 | The field is activated with the line contactor<br>(field pulses are activated or deactivated at the same time as the line contactor) |
| p50082 = 2 | Automatic switching-in of the standstill field set using p50257 after a time that can be parameterized using p50258 has elapsed, once operating state o7 or higher has been reached |
| p50082 = 3 | Field current permanently switched on |
| p50082 = 4 | Field with Auxiliaries ON signal activated |

#### 〈7.2〉Field weakening

| | |
|---|---|
| p50081 = 0 | No speed-dependent or EMF-dependent field weakening |
| p50081 = 1 | Field-weakening operation by means of internal closed-loop EMF control, i.e. at speeds above the motor's rated speed (= "cut-in speed"), the motor EMF is constantly kept at setpoint EMFset (r52289) = p50101 – p50100 x p50110 |

### 〈8〉Set basic technological functions

#### 〈8.1〉Current limits

| | |
|---|---|
| p50171[D] | System current limit in torque direction I (as % of p50100) |
| p50172[D] | System current limit in torque direction II (as % of p50100) |

**〈8.2〉Torque limits**

p50180[D] Torque limit 1 in torque direction I (as % of rated motor torque)

p50181[D] Torque limit 1 in torque direction II (as % of rated motor torque)

**〈8.3〉Ramp-function generator**

p50303[D] Ramp-up time 1 (in seconds)

p50304[D] Ramp-down time 1 (in seconds)

p50305[D] Initial rounding 1 (in seconds)

p50306[D] Final rounding 1 (in seconds)

## 〈9〉Complete quick commissioning

Set p3900 = 3.

This triggers the calculation of the motor data (Ra, La, Lf) as well as the calculation of the controller parameters resulting from the data that was entered in the previous steps.

p3900 is then reset to 0 and quick commissioning is ended, i.e. p0010 is reset to 0.

## 〈10〉Execute optimization runs

Perform the optimization runs one after the other:

p50051 = 23 Optimization of armature current control for inductive load

p50051 = 24 Optimization of closed-loop field-current control

p50051 = 25 Optimization of closed-loop armature current control

p50051 = 26 Optimization of speed control

p50051 = 27 Optimization of closed-loop EMF control (incl. field characteristic plotting)

p50051 = 28 Plotting the friction characteristic

p50051 = 29 Optimization of closed-loop speed control for drives with a mechanical system capable of oscillation

For further details, see Chapter "Drive optimization (Page 303)".

If an optimization run is not carried out, the motor control uses the motor characteristic values calculated from the rating plate data rather than the measured values.

**⚠WARNING**

**Unexpected motor movement during optimization runs**

Optimization runs cause movement of the drive which can result in death, severe injury or material damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY STOP functions are fully functional when commissioning the drive.

### 〈11〉 Checking and potential fine adjustment of maximum speed

Once the optimization runs have been executed, the maximum speed needs to be checked and, if necessary, the setting for it corrected.

If the maximum speed has now shifted by more than around 10%, the control response of the speed control loop will need to be checked; it may be necessary to repeat the optimization run for the speed controller or carry out re-optimization manually.

The optimization runs for field weakening and for friction and moment of inertia compensation must be repeated if there is any change to the maximum speed.

### 〈12〉 Checking the drive settings

The optimization runs do not produce the best results for every application, so in all cases it is necessary to check the controller settings using the appropriate tools (oscilloscope, STARTER trace, and so on). Some cases may require manual re-optimization.

### 〈13〉 Manual (re-)optimization (where required)

If the result of the optimization runs is not satisfactory, then manual post or new optimization can be performed.

The procedure is described in Chapter "Manual optimization (Page 311)".

### 〈14〉 Saving non-volatile set values

Previously, all changes in the set values were made in the RAM (Random Access Memory). If the device is switched off in this state, all settings made previously are lost. To permanently store the settings in the ROM (non-volatile memory), a RAM to ROM must be triggered by setting p0977 to 1 (p0977 is allocated to the DO 1). The saving process is indicated by the flashing of BOP20 (and the RDY LED on the CUD) and takes approx. 45 s. After the saving process has been completed, the settings are backed up in the ROM.

The drive can now be switched off (POWER OFF) without losing the settings that have been made. See also Chapter "Memory card functions (Page 327)".

### 〈15〉Documentation of set values

The following facilities are available so that the settings made can be recorded outside the unit:

- External memory card was inserted during the RAM to ROM (p0977=1). The parameters were therefore also transferred to the external CompactFlash Card.
- Write the parameters to a CompactFlash Card (p0804).
- Document the parameters in a STARTER project (load to PG). See also Chapter "Memory card functions (Page 327)" and "Commissioning with the STARTER commissioning tool (Page 253)".

## 8.4 Commissioning using the AOP30 Operator Panel

### 8.4.1 First commissioning

**Note**

To operate the AOP30, p2030=3 must be set.

#### 8.4.1.1 First power-up

**Start screen**

When the system is switched on for the first time, the Control Unit (CUD) is initialized automatically. The following screen is displayed:

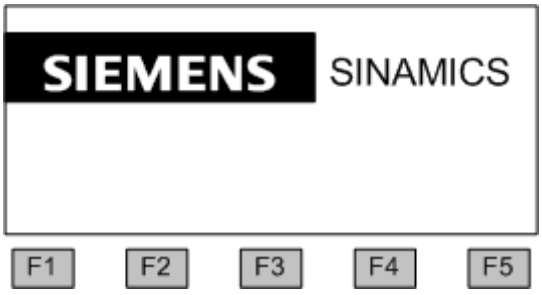



Figure 8-2 Splash screen

While the system is powering up, the parameter descriptions are loaded to the operator panel (Remark: The memory card does not have to be inserted)

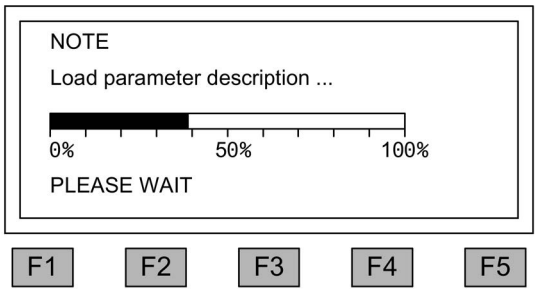
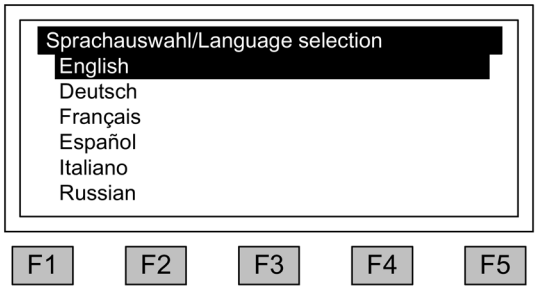



Figure 8-3 Loading of the parameter description during the system power-up

## Selecting the language

When the system is first powered up, a screen for selecting the language appears.




You can select the language in the dialog screen.

To change the language, use <F2> or <F3>.
To select the language, use <F5>.

Once the language has been selected, the powering-up process continues.

Once the system has successfully powered up, the drive has to be commissioned when the system is switched on for the first time after it has been delivered. The converter can then be switched on.

When the system is then powered up again, it can be operated immediately.

## Navigation within the dialog screens

Within a dialog screen, the selection boxes can usually be selected using the <F2> and/or <F3> keys. Selection boxes are generally texts surrounded by a frame. When they are selected, they are highlighted by means of white text on a black background.
The current value of a highlighted selection box can usually be changed by pressing <F5> "OK" and/or "Change". Another entry field then appears; the value you want can be entered directly in this using the numerical keypad or can be selected from a list.

In the wizard, you can change from a dialog screen to the next or previous screen by selecting the "Continue" or "Back" selection boxes and then confirming by pressing <F5> "OK".
If a screen contains particularly important parameters, the selection box "Continue" only appears at the bottom of the screen. This is because every single parameter in this dialog screen has to be checked thoroughly and/or corrected before the next screen can be accessed.

### 8.4.1.2 Full drive commissioning

#### Entering power unit data

| | |
|---|---|
| p51819[0] | Transformation ratio for armature voltage transformer |
| p51819[1] | Transformation ratio for field voltage transformer |
| p51820 | Rated armature supply voltage |
| p51821[0] | Connection of line measurement cables |
| p51821[1] | Connection of armature measurement cables |
| p51822 | Rated armature DC current |
| p51823 | Load voltage at rated armature current |
| p51824 | Current transformer configuration |
| p51825 | Type of power unit |
| p51826[0] | Length of first pulse |
| p51826[1] | Length of other pulses |
| p51829 | Heat sink temperature threshold |
| p51830 | Sensor for heat sink temperature |
| p51831 | Fuse monitoring |
| p51832 | Monitoring of unit fan |
| p51833 | External fault |
| p51834 | Source of fan relay output |
| p51835[0] | Monitoring of unit fan's ON delay |
| p51835[1] | Fault involving unit fan's ON delay |
| p51835[2] | Alarm involving unit fan's ON delay |

#### Adjust the rated device currents

The **rated armature DC current for the device** must be adjusted by setting p50076[0] (in %) or p50067 if:

Maximum armature current < 0.5 × rated armature DC current for the device

The **rated field DC current for the device** must be adapted by setting p50076[1] (in %) if:

Maximum field current < 0.5 × rated field DC current for the device

#### Adapt to the actual device supply voltage

| | |
|---|---|
| p50078[0] | Rated value for armature supply voltage (in volts) |
| p50078[1] | Rated value for field supply voltage (in volts) |

## Acquiring the motor data

The motor data can be taken from the motor rating plate.

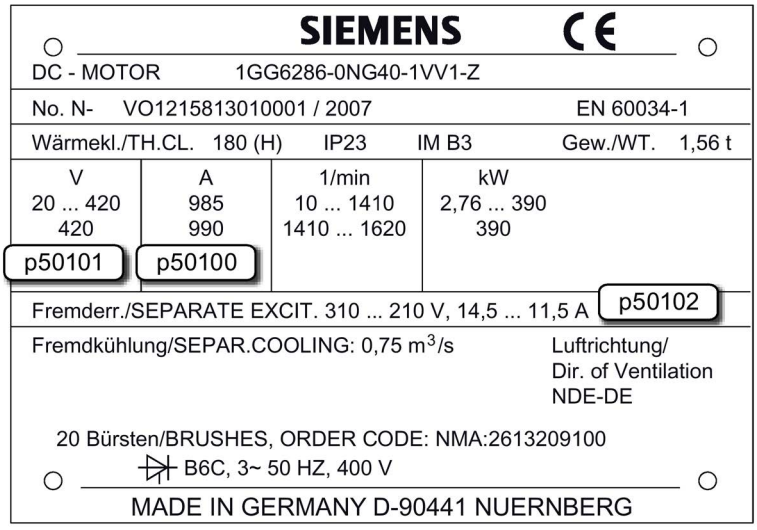



Figure 8-4 Example of a rating plate

| | |
|---|---|
| p2003 | Rated torque = (kW x 9555) / rated speed |
| p50100[D] | Rated armature current |
| p50101[D] | Rated armature voltage |
| p50102[D] | Rated excitation current |
| p50103[D] | Minimum excitation current (optional) |
| p50114[D] | Thermal time constant for motor<br>See the section titled "Thermal overload protection for the DC motor ($I^2t$ monitoring of the motor)" |

When you have finished entering the motor data, select "Next" below the final parameter value and activate with <F5> (OK).

## Encoder selection

| | |
|---|---|
| p50083[D] | Actual speed controller value selection |

## Analog tachometer screen

| | |
|---|---|
| p50741[D] | Tachometer voltage at maximum speed |
| p2000 | Reference speed |

### Pulse encoder screen

| | |
|---|---|
| p0400[E] | Encoder type selection |
| p0404[E] | Encoder configuration active |
| p0405[E] | Square-wave encoder A/B |
| p0408[E] | Rotary encoder pulse no. |
| p2000 | Reference speed |

### EMF controlled screen

| | |
|---|---|
| p50115[D] | EMF at maximum speed |
| p2000 | Reference speed |

### Freely wired screen

| | |
|---|---|
| p50609[C] | Actual speed controller value signal source |
| p2000 | Reference speed |

### DRIVE-CLiQ encoder screen

| | |
|---|---|
| p0400[E] | Encoder type selection |
| p0404[E] | Encoder configuration active |
| p0405[E] | Square-wave encoder A/B |
| p0408[E] | Rotary encoder pulse no. |
| p2000 | Reference speed |

### Data on field

| | |
|---|---|
| p50081 | Field weakening |
| p50082 | Field operating mode |

### Basic commissioning

| | |
|---|---|
| p50171 | Current limit, torque direction I |
| p50172 | Current limit, torque direction II |
| p50180 | Torque limit I |
| p50181 | Torque limit II |
| p50303 | Ramp-up time 1 |
| p50304 | Ramp-down time 1 |
| p50305 | Initial rounding 1 |
| p50306 | Final rounding 1 |

### Final confirmation

Confirm the parameters you have entered to save them. Once you have selected "Next" and activated your entries with <F5>, the parameters you entered will be permanently saved and the calculations required for closed-loop control carried out.

### Optimization runs

Perform the optimization runs one after the other:

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

| | |
|---|---|
| p50051 = 23 | Optimization of armature current control for inductive load |
| p50051 = 24 | Optimization of closed-loop field-current control |
| p50051 = 25 | Optimization of closed-loop armature current control |
| p50051 = 26 | Optimization of speed control |
| p50051 = 27 | Optimization of closed-loop EMF control (incl. field characteristic plotting) |
| p50051 = 28 | Plotting the friction characteristic |
| p50051 = 29 | Optimization of closed-loop speed control for drives with a mechanical system capable of oscillation |

For further details, see Chapter "Drive optimization (Page 303)".

If an optimization run is not carried out, the motor control uses the motor characteristic values calculated from the rating plate data rather than the measured values.

**⚠WARNING**

**Unexpected motor movement during optimization runs**

Optimization runs cause movement of the drive which can result in death, severe injury or material damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY STOP functions are fully functional when commissioning the drive.

## 8.4.2 Status after commissioning

**LOCAL mode (control via operator panel)**

- You switch to LOCAL mode by pressing the "LOCAL/REMOTE" key.
- Control (ON/OFF) is carried out via the "ON" and "OFF" keys.
- You can set the setpoint using the "Increase" and "Decrease" keys or by entering the appropriate numbers on the operation screen using the numeric keypad.

### 8.4.3 Resetting parameters to factory settings

The factory settings represent the defined original status of the device on delivery.

Resetting the parameters to the factory settings means that all the parameter settings made since the system was delivered are reset.

**Setting the parameter filter to "Parameter reset"**

<MENU> <Commissioning/Service> <OK> <Device commissioning> <OK> <30: Parameter Reset> <OK>

**Restoring all parameters to their factory settings**

All of the unit parameters are reset to their factory settings. The AOP30 is powered down and back up again during this process.

## 8.5 Commissioning with the STARTER commissioning tool

### 8.5.1 STARTER commissioning tool

#### Description

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

**Note**

This chapter described 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 that 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.

From version V4.2, SCOUT has also been released for commissioning SINAMICS DCM.

### 8.5.1.1 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.

### 8.5.1.2 Layout of the STARTER user interface

STARTER provides these 4 operating areas:

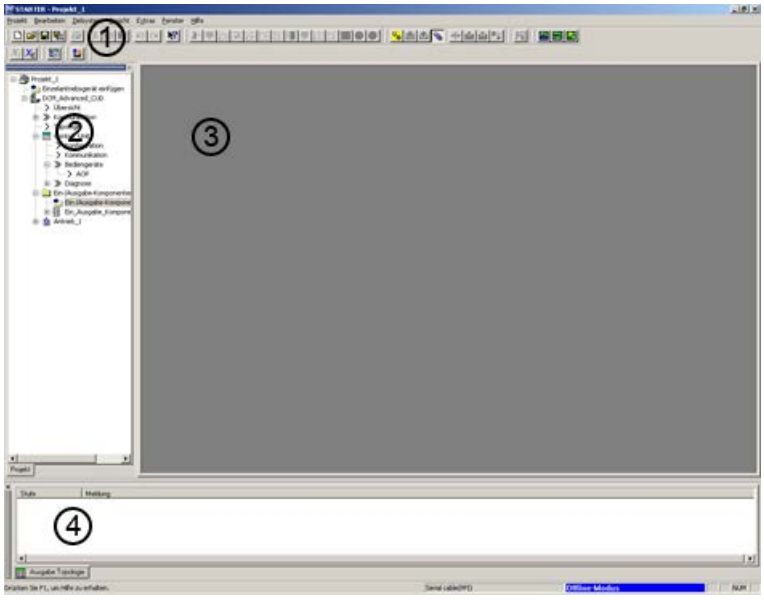



Figure 8-5 STARTER operating areas

| 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. |

## 8.5.2 Procedure for commissioning with STARTER

### 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 a deliberate procedure!
Target: 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).

### 8.5.2.1 Creating the project

Click the STARTER icon on the desktop or select the menu command Start > Simatic > STEP 7 > STARTER in the Windows start menu to start the STARTER commissioning tool.

The following main screen with the interactive dialogs appears after starting for the first time:

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below as numbered step sequences.

## Accessing the STARTER project wizard

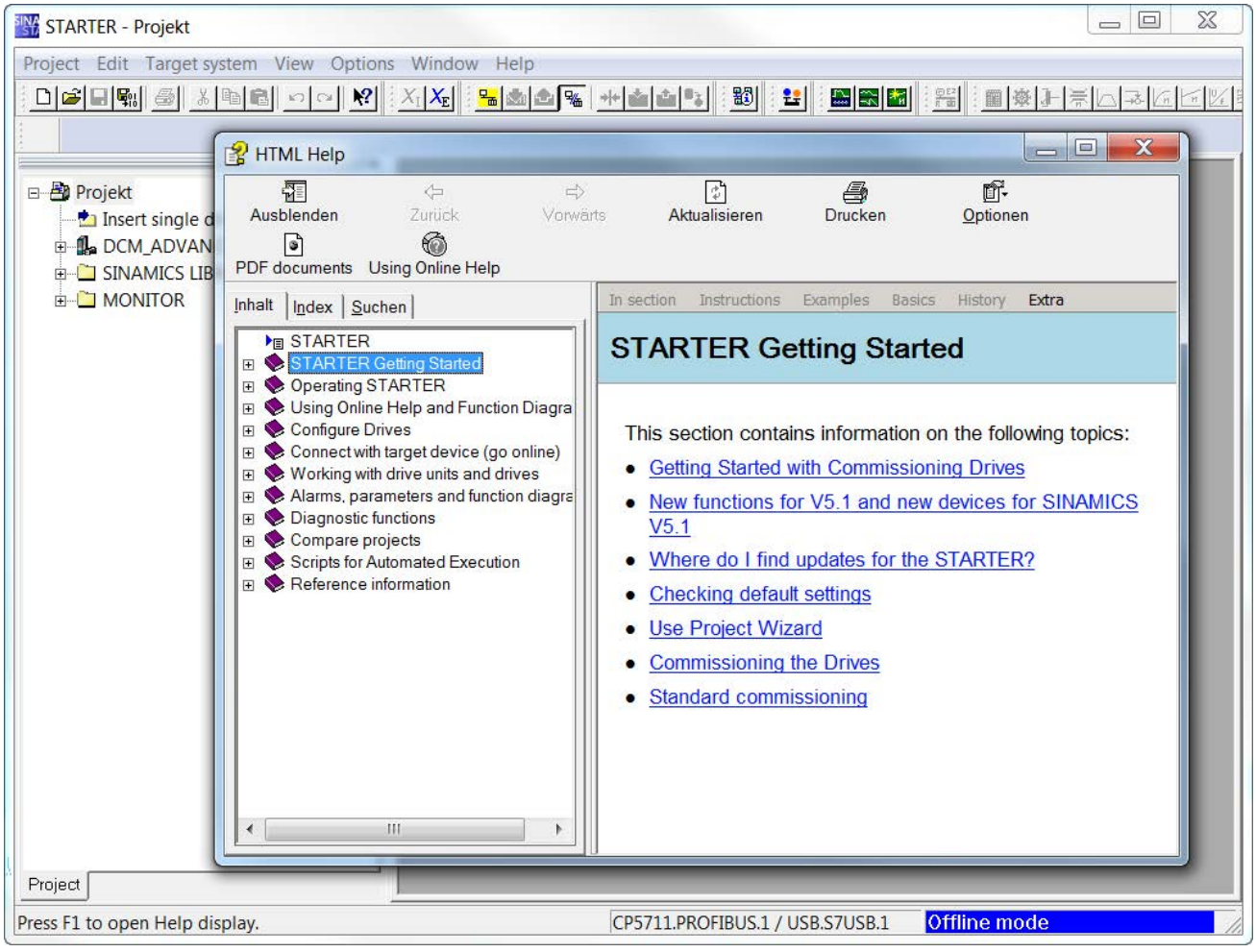



Figure 8-6 Main screen of the STARTER parameter assignment and commissioning tool

⇒ Hide "STARTER Getting Started Drive Commissioning" with **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 call up the project Wizard by choosing **Project > New with Wizard**.

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

Online help can be restarted at any time via **Help > Getting Started**.

STARTER features a detailed online help function.

---

## The STARTER project wizard

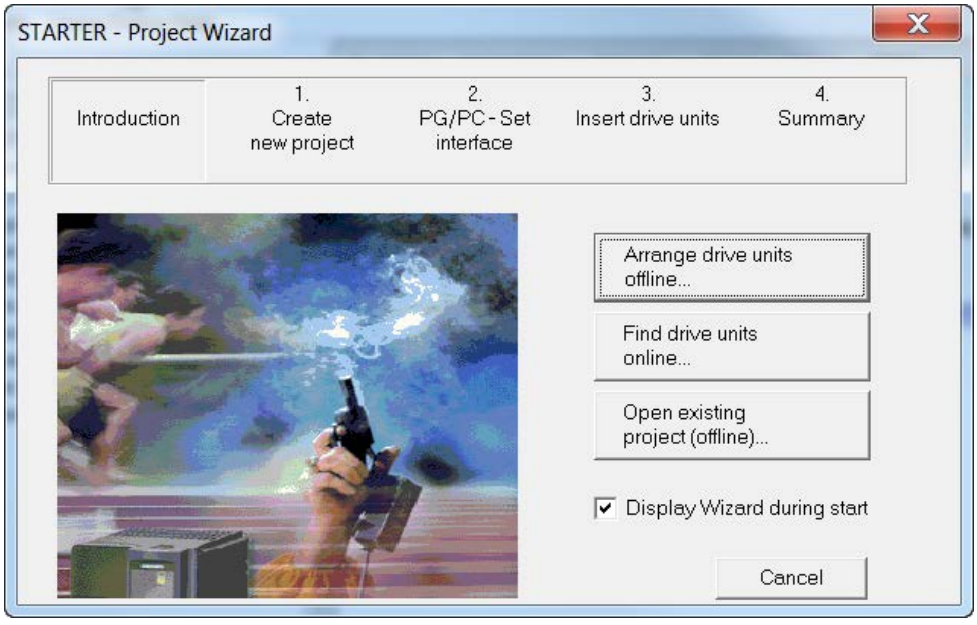



Figure 8-7 STARTER project wizard

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

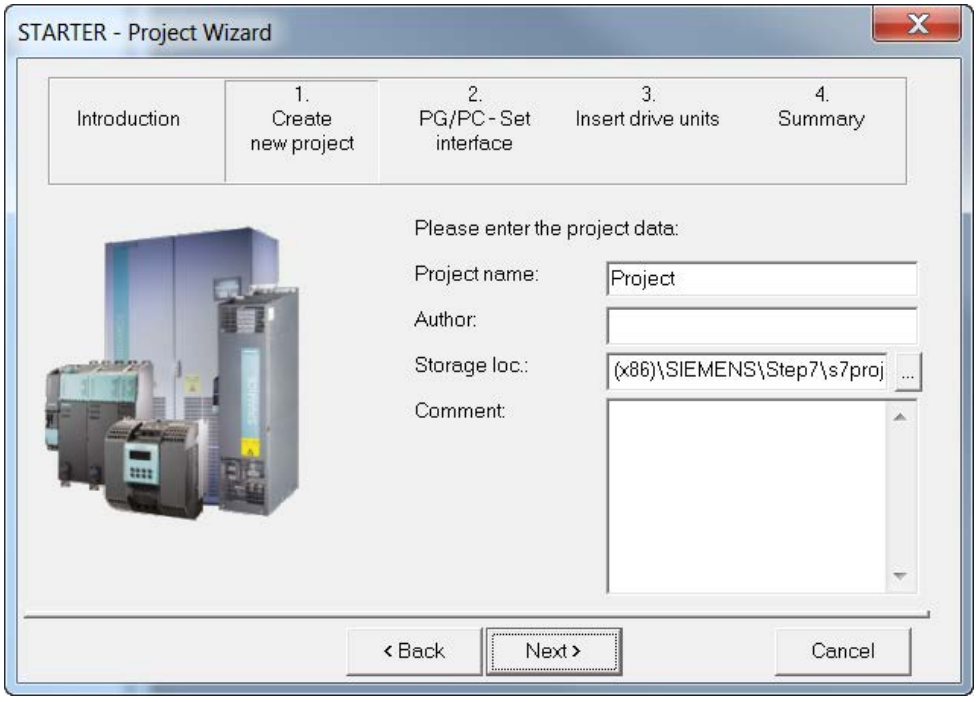



Figure 8-8 Creating a new project

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

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

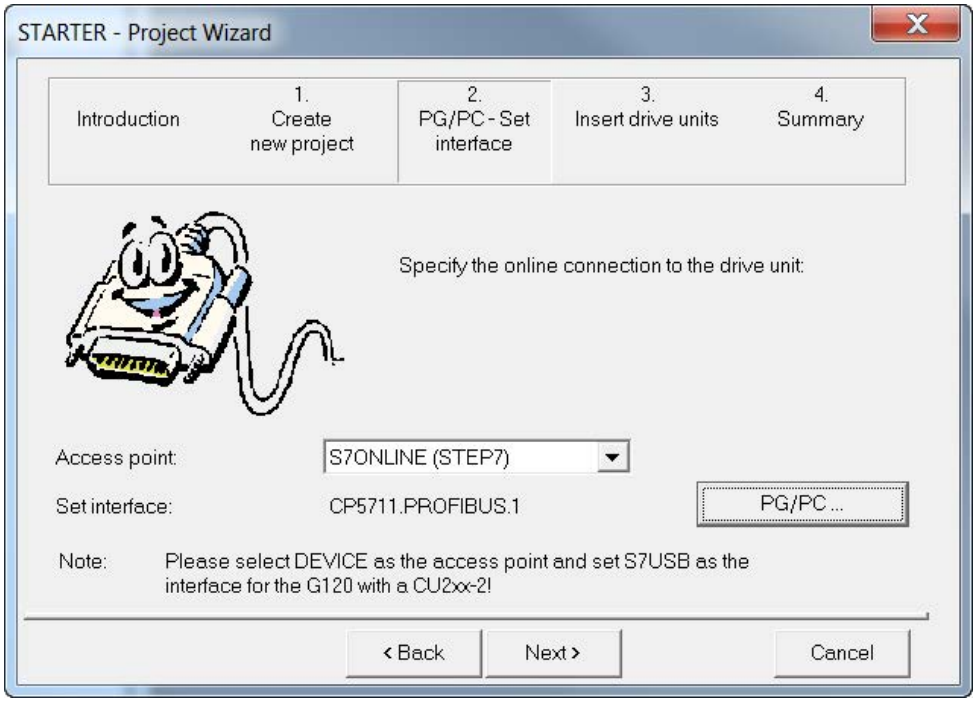



Figure 8-9 Setting up the interface

⇒ 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.

**Note**

**Connection via PROFINET IO with CBE20**

To establish the connection via the additional module CBE20, see Chapter "General information about PROFINET IO (Page 459)".

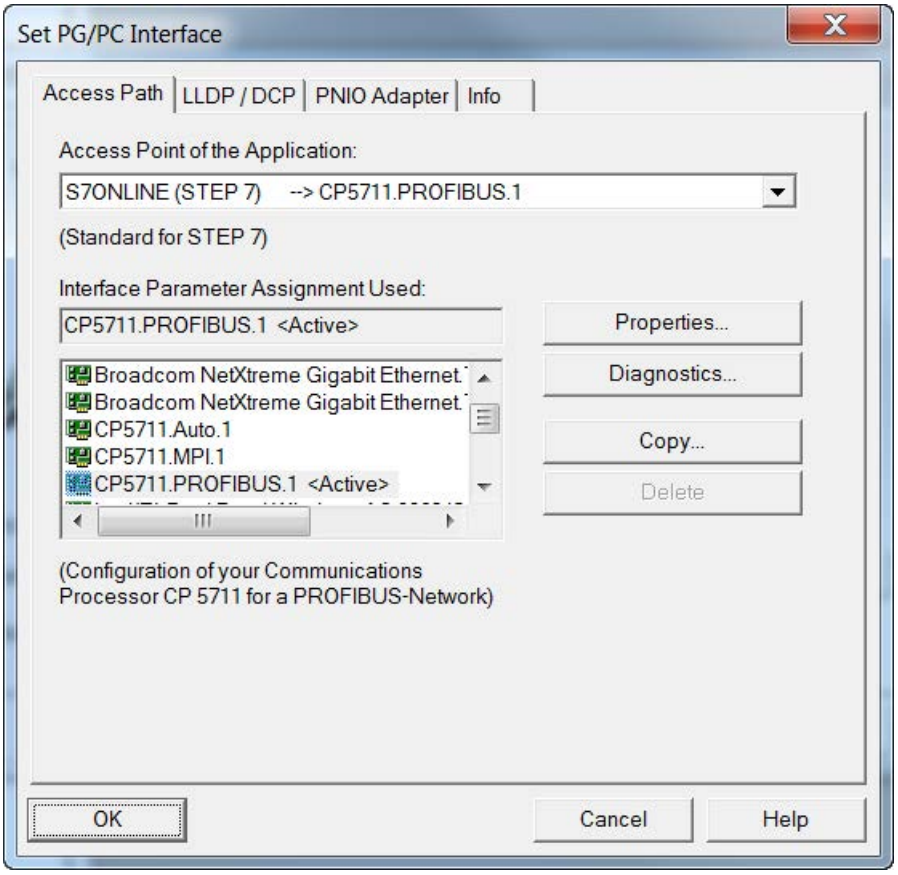



Figure 8-10 Setting the interface

**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.

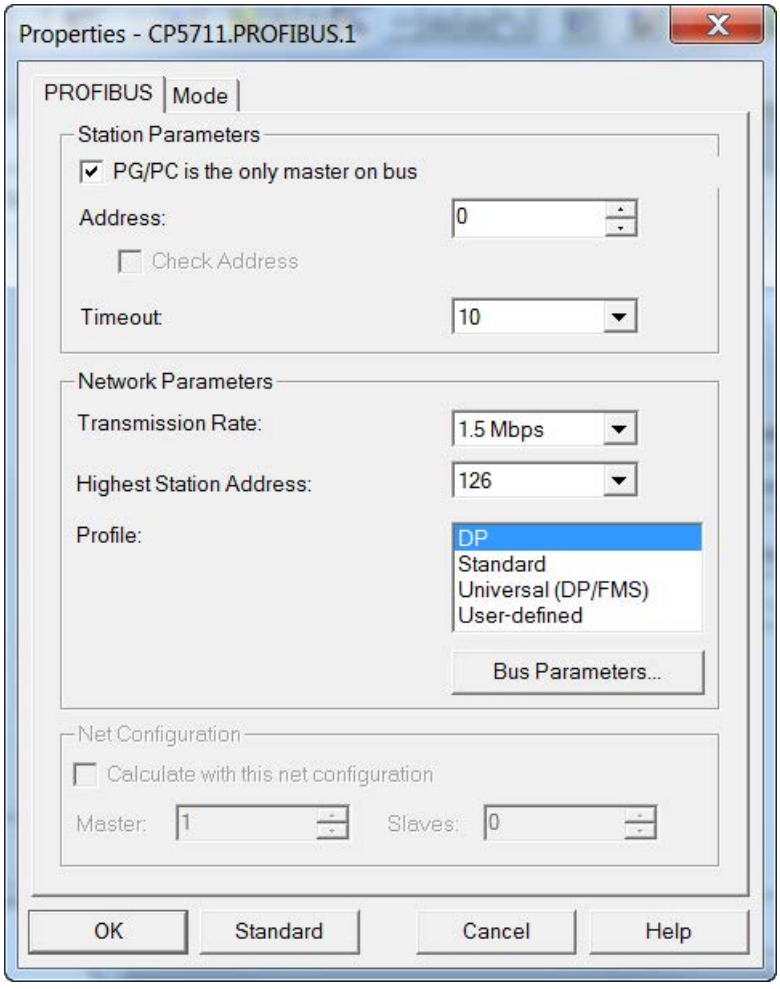



Figure 8-11 Setting the interface - properties

**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.

When required, a manual address entry can also be used to enter an already assigned address.

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

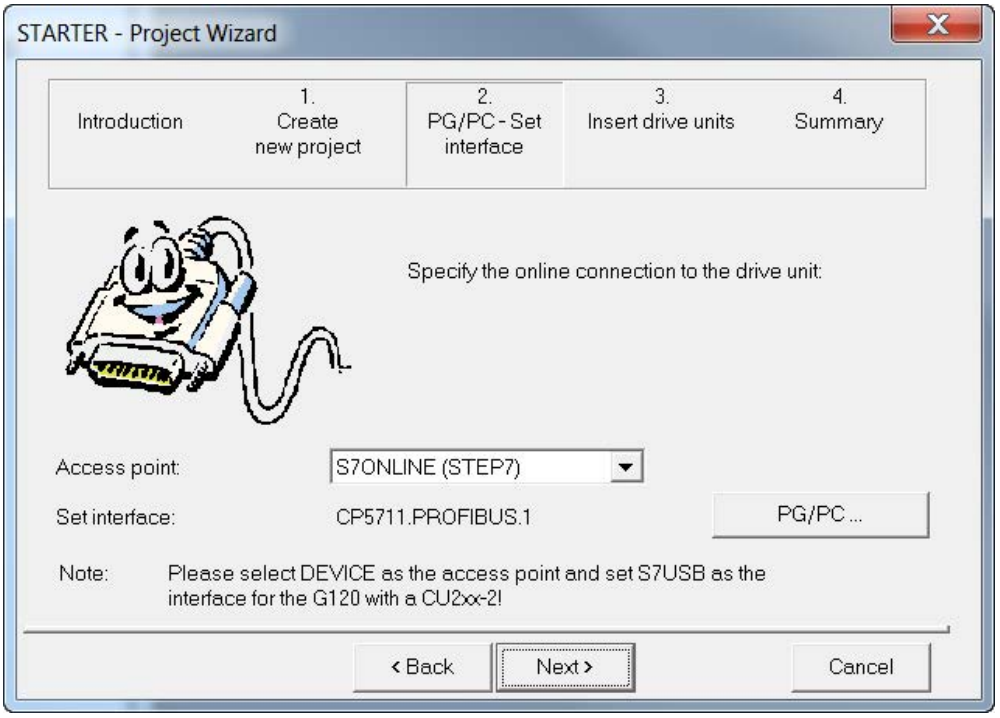



Figure 8-12 Complete setting the interface

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

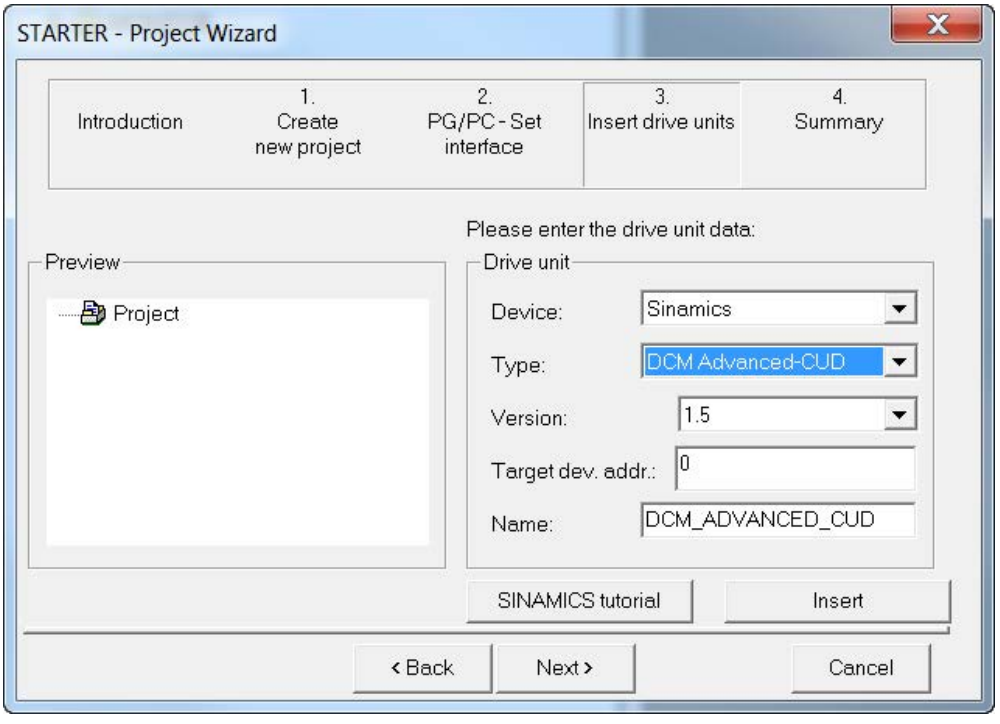



Figure 8-13 Inserting a drive unit

⇒ Select the following data from the list fields:

| | |
|---|---|
| **Unit:** | SINAMICS |
| **Type:** | DCM Standard CUD for one standard CUD in the left-hand slot |
| | DCM Advanced CUD for one Advanced CUD in the left-hand slot |
| | DCM Standard CUD [2] for a Standard CUD in the right-hand slot |
| | DCM Advanced CUD [2] for an Advanced CUD in the right-hand slot |
| **Version:** | Actual version |
| **Target device address:** | The corresponding bus address of the drive (126 is preset in the drive device) |
| **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.

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 or AOP30.

**Note**

A second CUD for expanding the computing capacity is created in the STARTER as an independent device, type "DCM Standard (Advanced) CUD [2]".
Explanation: "[2]" is the SINAMICS nomenclature for indexed data. In this case, it is used as a name - independent of any language for a second CUD inserted in the right-hand slot.

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

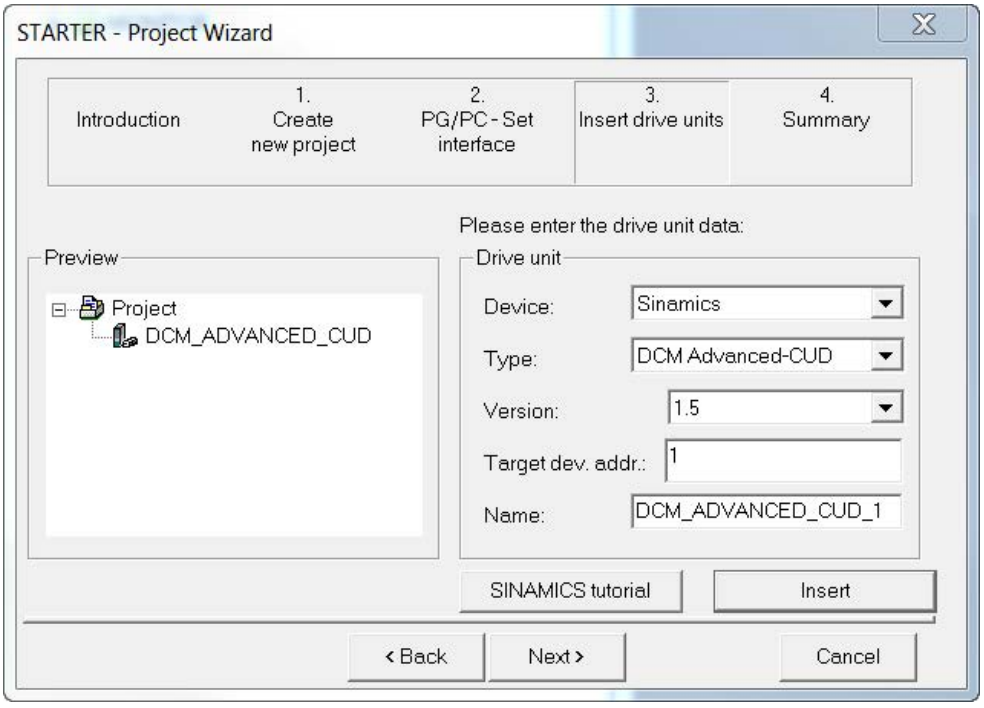



Figure 8-14 Drive unit inserted

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

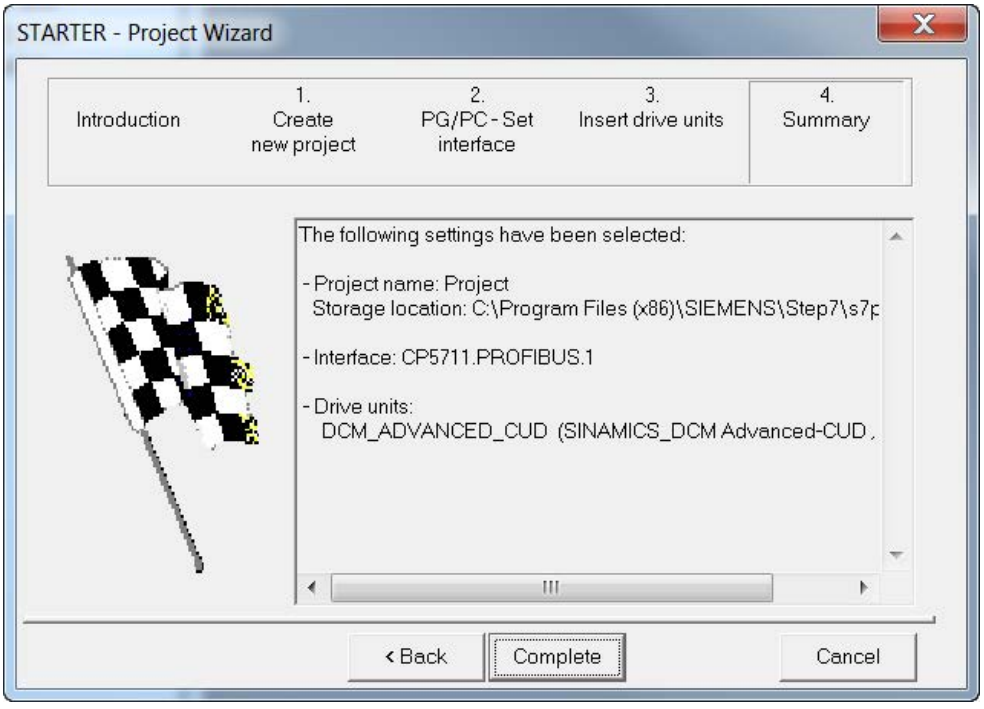



Figure 8-15 Summary

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

### 8.5.2.2 Configuring a drive unit

**Note**

The STARTER must be offline for the sequence described below.

As a general rule, the drive unit can also be added to the project in online mode of the STARTER via "Browse accessible nodes".

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

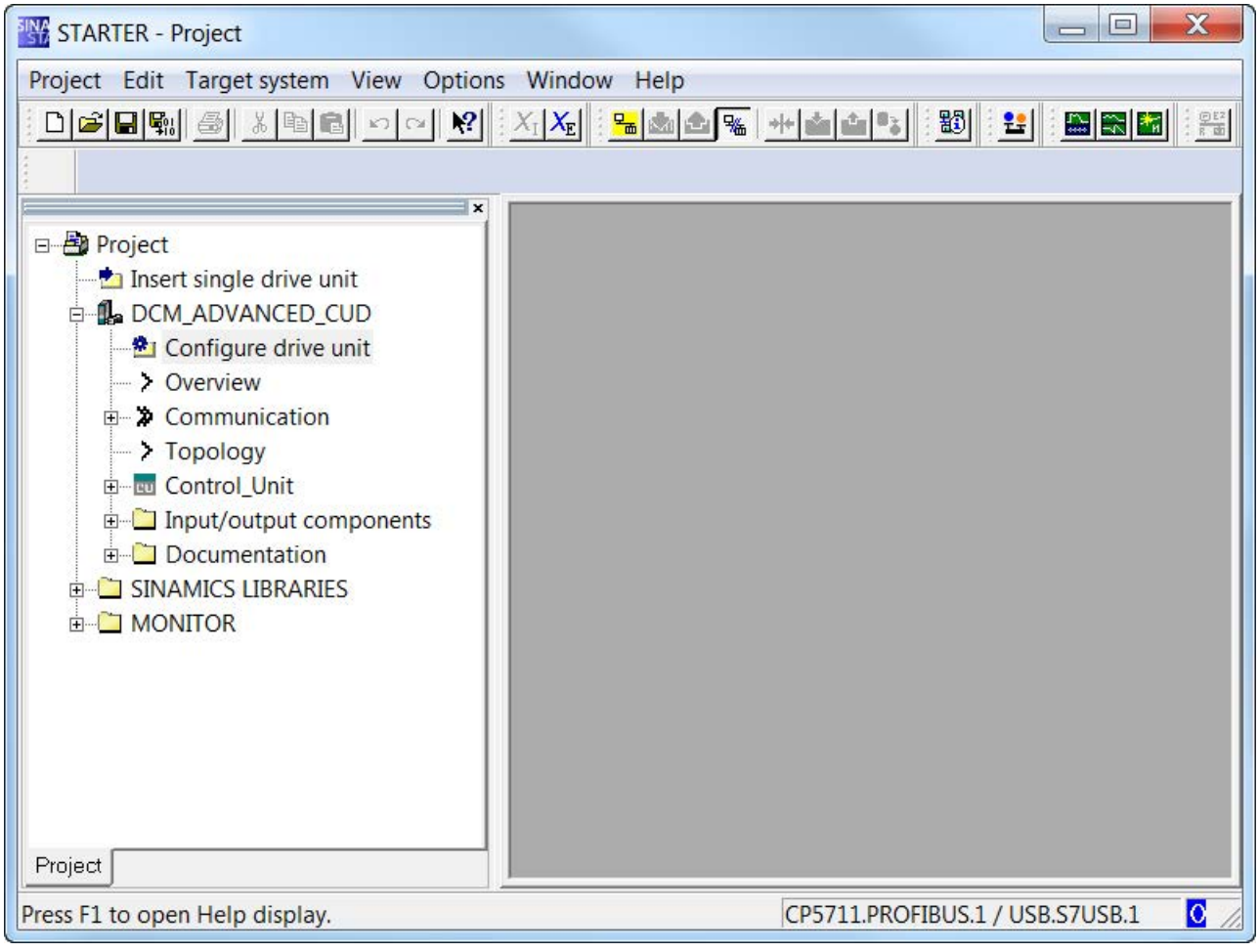



Figure 8-16 Configuring the project navigator drive unit

⇒ 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**

## Activating the option module

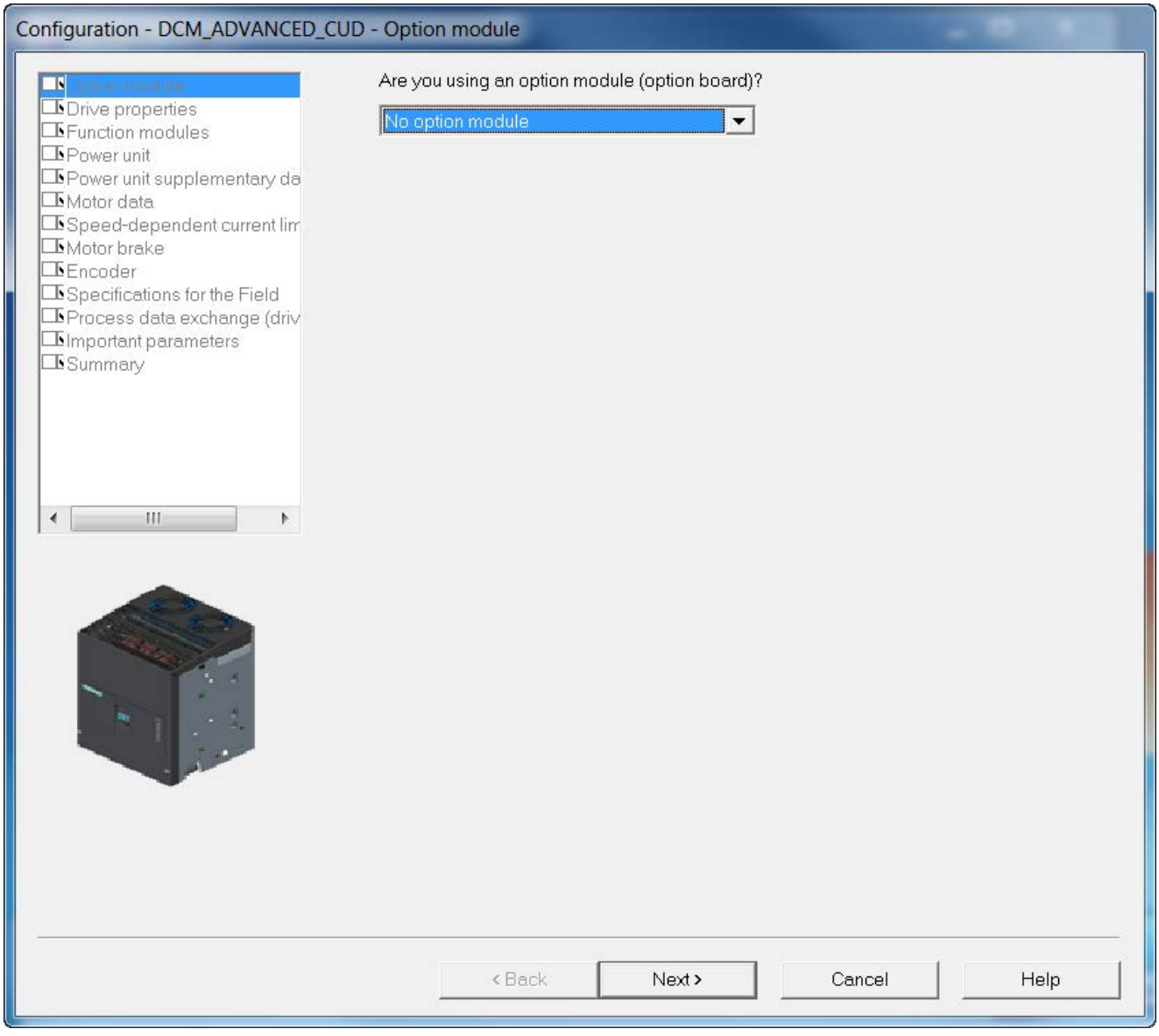



Figure 8-17 Activating the option modules

⇒ If you have inserted a PROFINET CBE20 module (option G20), then the module needs to be activated here (see Chapter "CBE20 Communication Board Ethernet (Page 300)").

⇒ Click **Next >**

## Configuring the drive unit properties

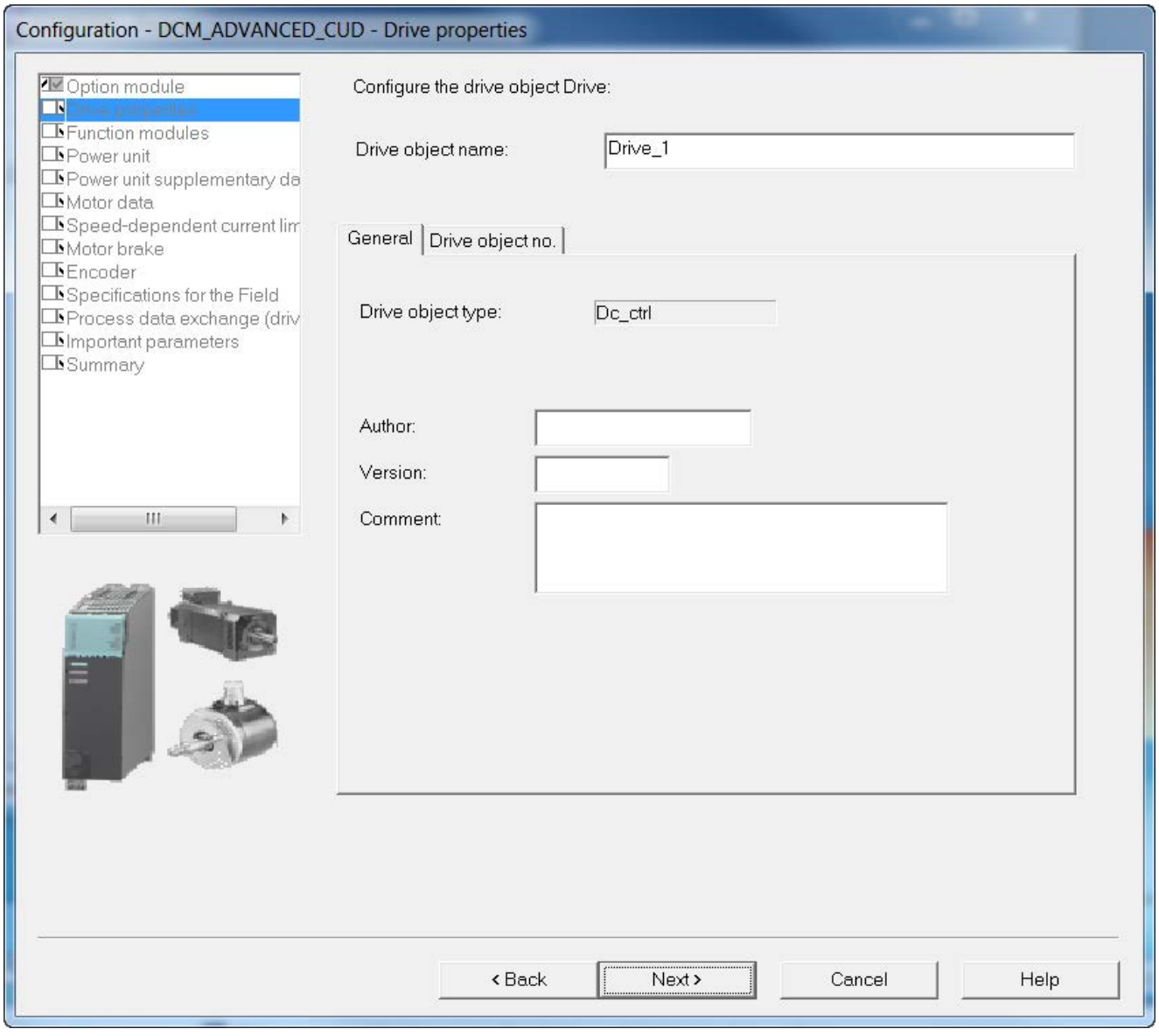



Figure 8-18 Configuring the drive unit properties

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

⇒ Click **Next >**

## Selecting the function modules

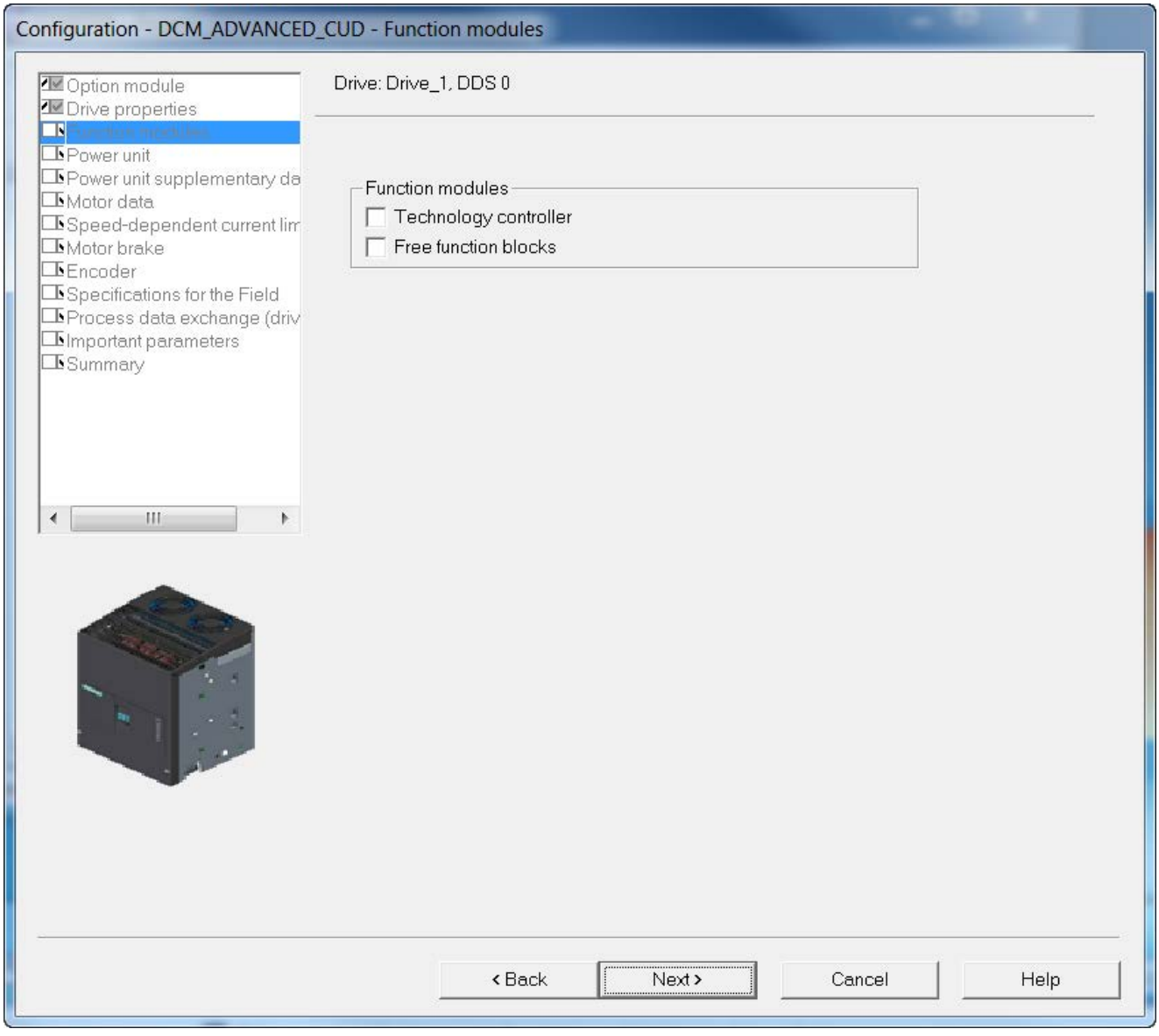



Figure 8-19 Selecting options

⇒ When required, select the function module that you wish to activate.

⇒ Click **Next >**

## Selecting the device

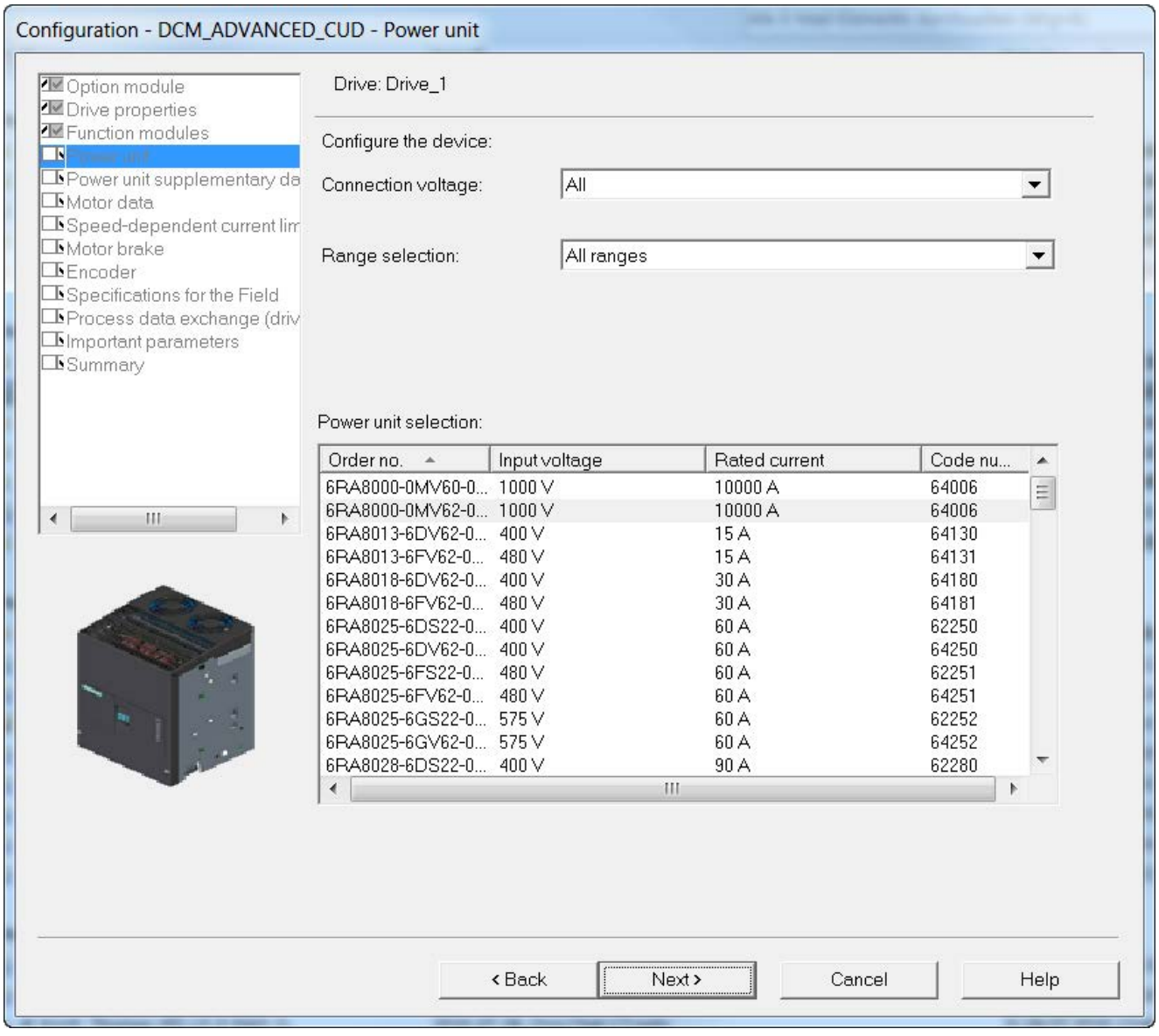



Figure 8-20 Selecting the device

With the fields **Supply voltage:** and **Range selection:** (2-quadrant operation/4-quadrant operation), you can filter the list under **Select power unit**: ...

You can find SINAMICS DCM Control Modules under 1000 V / 10000 A with article number 6RA8000-0MV62-0AA0.

⇒ Select the device.

⇒ Click **Next >**

## Entering additional power unit data

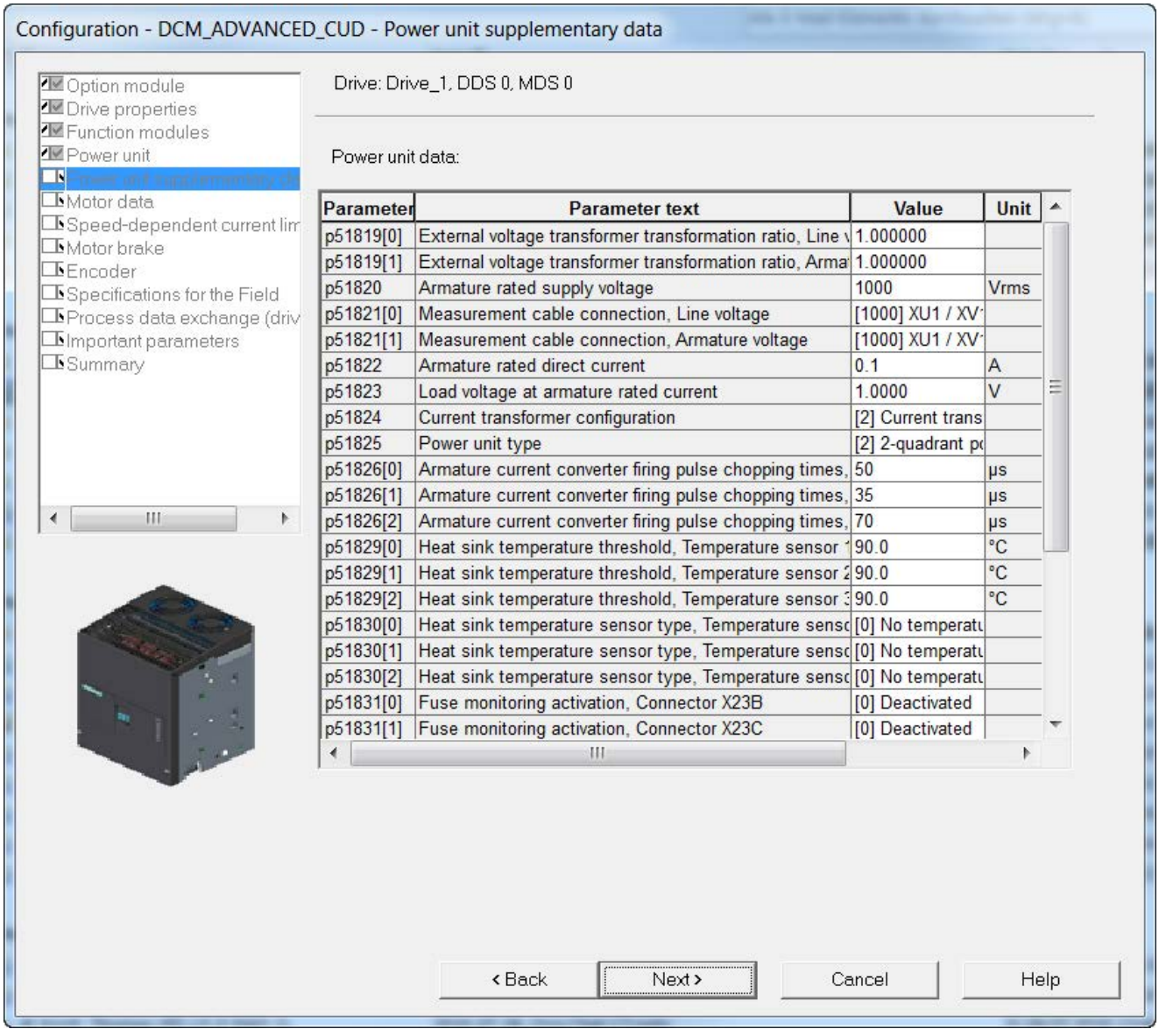



Figure 8-21 Entering additional power unit data

⇒ Enter the required power unit data here.

⇒ Click **Next >**

## Adapting unit data and entering motor data

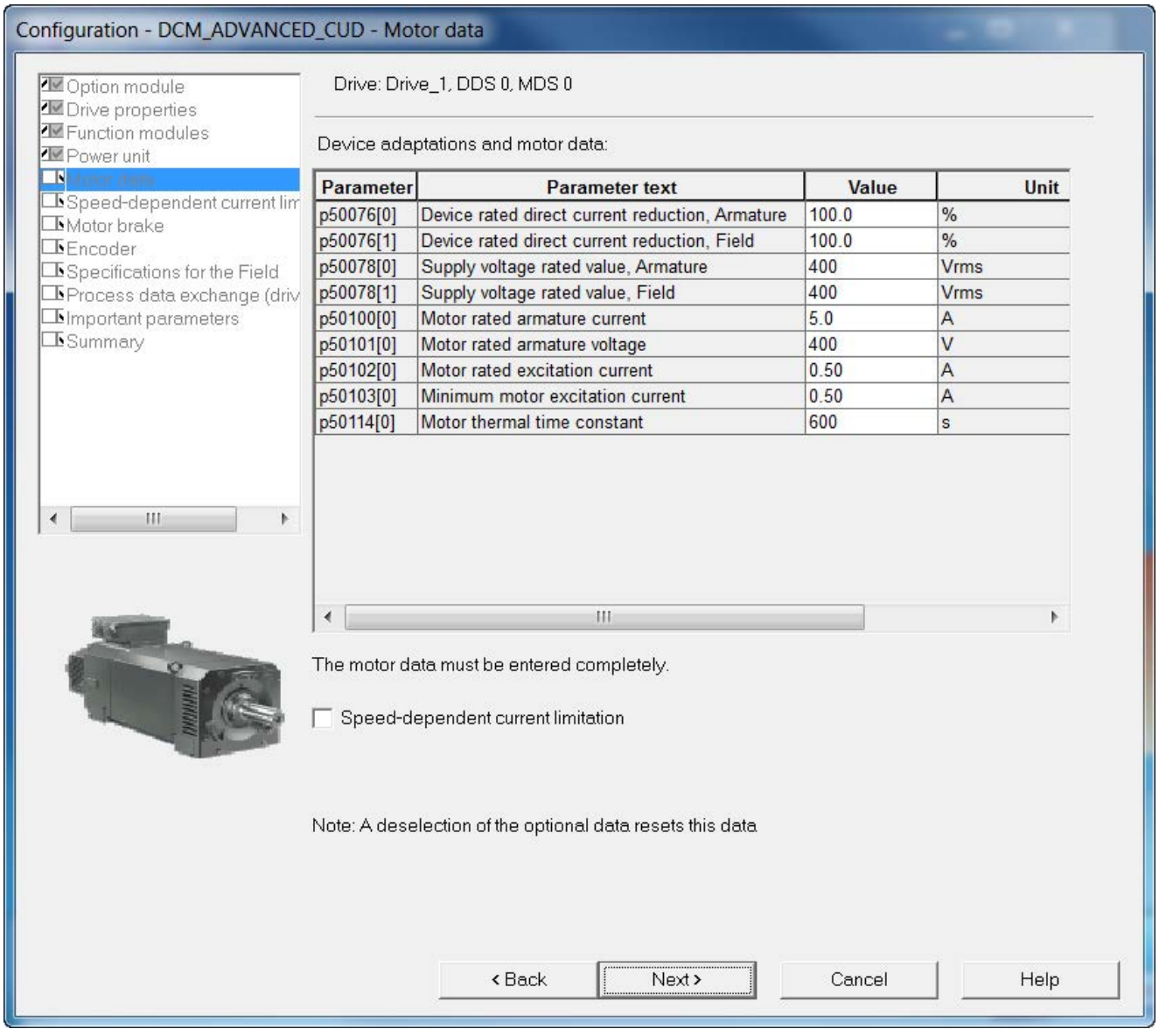



Figure 8-22 Motor data

⇒ Adapt the rated armature DC current for the unit by making a setting at p50076[0] (in %) or p50067 if:

Maximum armature current < 0.5 × rated armature DC current for the unit

⇒ Adapt the rated armature DC current field for the unit by making a setting at p50076[1] (in %) if:

Maximum field current < 0.5 × rated field DC current for the unit

⇒ Enter the actual supply voltage for the unit p50078.

⇒ Here, enter the **motor data** as a stamped on the motor rating plate.

**Note**

For 2Q devices, the rated DC voltage of the SINAMICS DCM specified in the technical data, can only be achieved if the $\alpha_G$ limit (p50150) is set to 5°. The factory setting is 30°. In order to reach the rated motor voltage (p50101[D]), the $\alpha_G$ limit must also be changed to 5°.

⇒ If you select **speed-dependent current limiting**, then in another setting form you can set the required values (parameters p50104 ... p50109).

⇒ Click **Next >**

| NOTICE |
| --- |
| **Ensure protection against overload** |
| The data are very important for protecting against overload and must be entered correctly. |

## Brake control

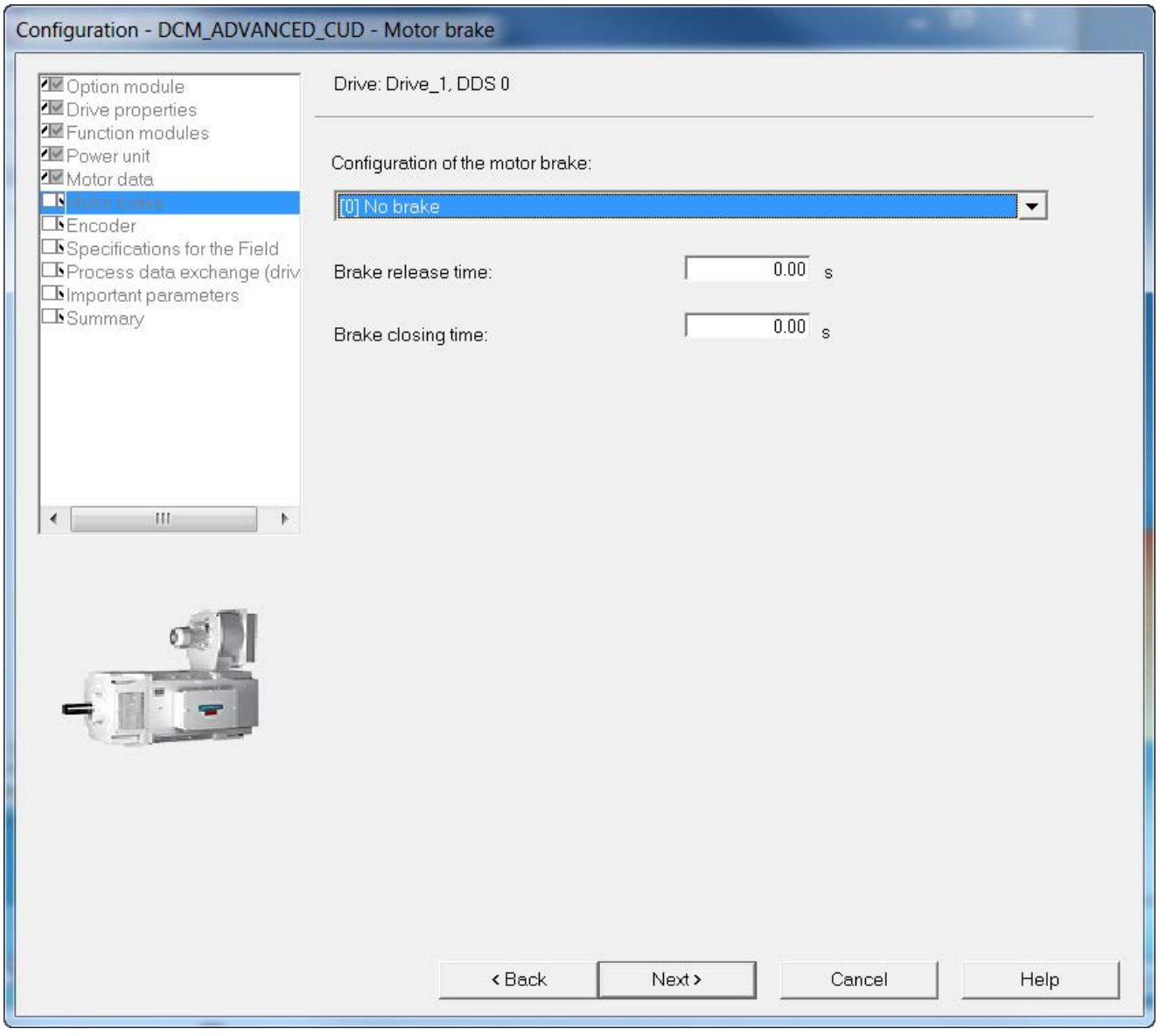



Figure 8-23 Configuring a motor brake

⇒ Under configuration of the motor brake, select the corresponding setting for your device configuration:

- [0] No brake
- [1] Holding brake
- [2] Operating brake

⇒ When selecting a motor brake, additionally set the **release time** and the **closing time**.

⇒ Click **Next >**

## Defining the actual value source

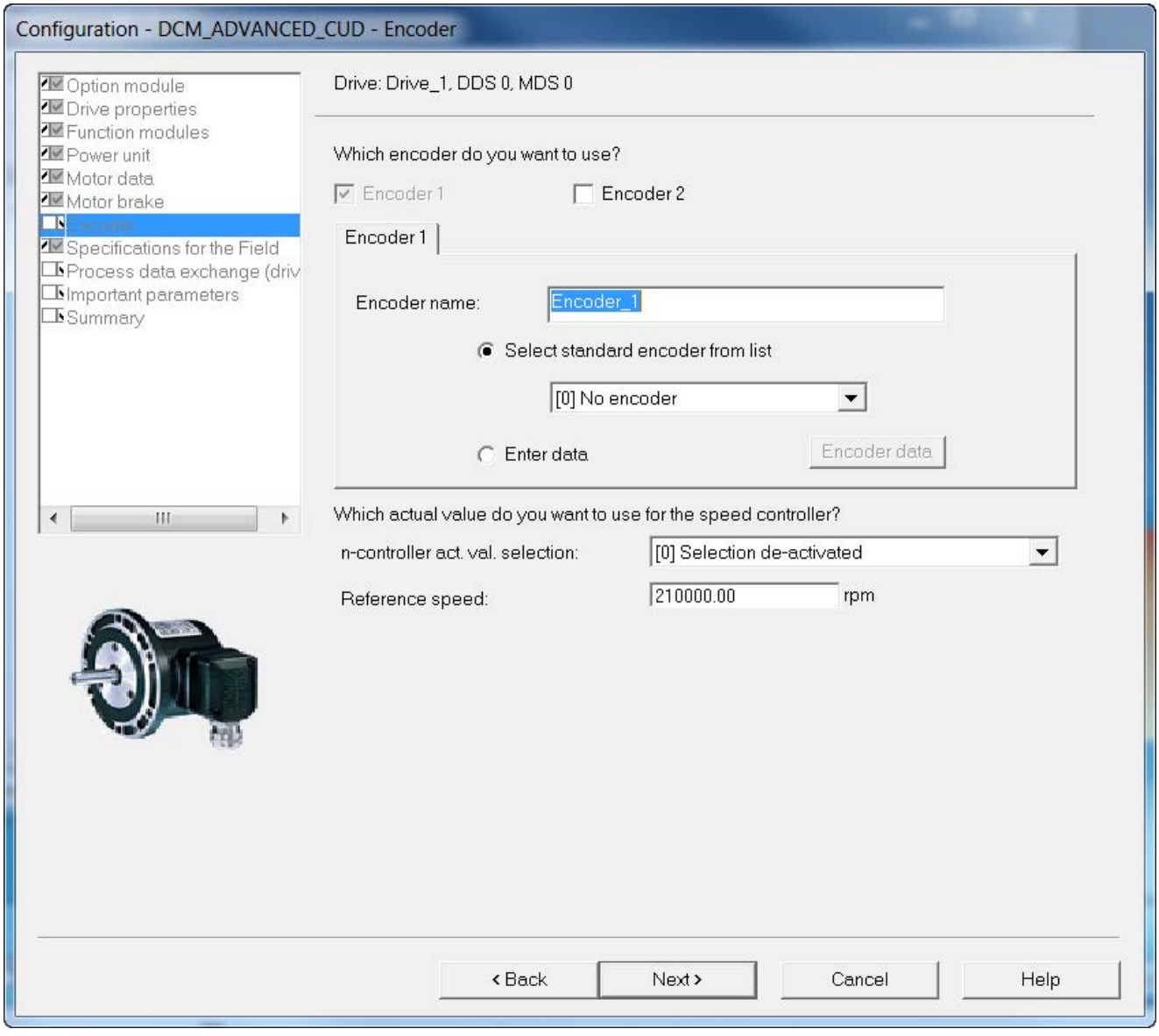



Figure 8-24 Defining the actual value source

"Encoder 1" is the encoder evaluation on the CUD.

"Encoder 2" is the evaluation of an optional encoder using SMC10 or SMC30.

⇒ Under **n-controller act. val. selection**, select the encoder type or the other actual value source:

- [0] Selection deactivated
- [1] Analog tachometer
- [2] Pulse encoder
- [3] EMF actual value internal
- [4] Free interconnection via p50609
- [5] DRIVE-CLiQ encoder

The drive cannot be operated if no selection is made.

⇒ Enter the **reference speed**. To display on the AOP30 or to transfer the speed factors via PROFIdrive, the physical speed at 100% is specified here.

The following settings are required, depending on the **n-controller act. val. selection**.

**[1] Analog tachometer**

The analog tachometer is connected to the CUD via terminals XT1-103, XT1-104.

⇒ Enter the **tachometer voltage at maximum speed**.

⇒ Click **Continue >**

**[2] Pulse encoder**

The pulse encoder is connected to the CUD via terminals X177:41 ... 48.

⇒ To select a predefined encoder configuration click on the radio button **Select standard encoder from list**, and select one of the encoders that is listed.
The following encoder types can be evaluated via the CUD:

- [3001] 1024 HTL A/B R
- [3002] 1024 TTL A/B R
- [3003] 2048 HTL A/B R
- [3005] 1024 HTL A/B
- [3006] 1024 TTL A/B
- [3007] 2048 HTL A/B
- [3008] 2048 TTL A/B
- [3009] 1024 HTL A/B unipolar
- [3011] 2048 HTL A/B unipolar

⇒ To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following input screen is displayed for you to enter the required data.

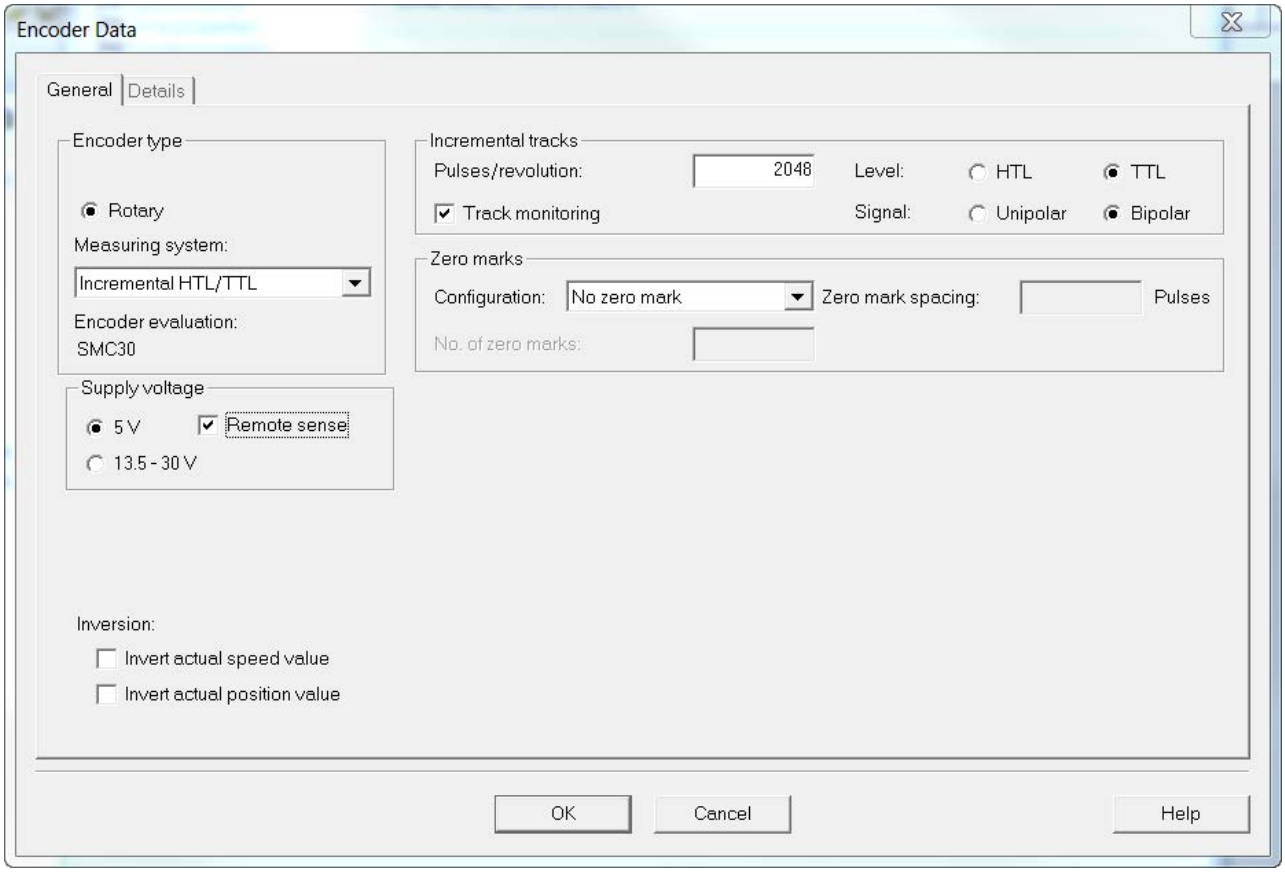



Figure 8-25 Entering encoder data - pulse encoder via CUD

⇒ Appropriately set the **measuring system** (predominantly "incremental HTL/TTL"), the **incremental tracks**, the **level** and the **zero marks**.

| NOTICE |
| --- |
| **Pulse encoder power supply at terminal X177.41 of the CUD**<br>Terminal X177.41 always provides +15 V to supply the incremental encoder. This is independent of the setting selected under **voltage supply**. |

⇒ Click on **OK**

⇒ Click on **Next >**

**[3] EMF actual value internal**

⇒ Enter the **EMF at maximum speed**.
(the EMF should be specified as the percentage of the voltage specified in the screen form).

⇒ Click on **Next >**

**[4] Free interconnection via p50609**

⇒ Enter the source with the actual value via the BICO interconnection.

⇒ Click on **Next >**

**[5] DRIVE-CLiQ encoder: Resolver via Sensor Module Cabinet SMC10**

The resolver is connected via the Sensor Module Cabinet SMC10.

⇒ Select **encoder 2** to activate the evaluation of the encoder via the Sensor Module Cabinet SMC10.

⇒ To select a predefined encoder configuration click on the radio button **Select standard encoder from list**, and select one of the encoders that is listed.
The following resolvers can be evaluated via the Sensor Module Cabinet SMC10:

- [1001] Resolver 1-speed
- [1002] Resolver 2-speed
- [1003] Resolver 3-speed
- [1004] Resolver 4-speed

⇒ To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following input screen is displayed for you to enter the required data.

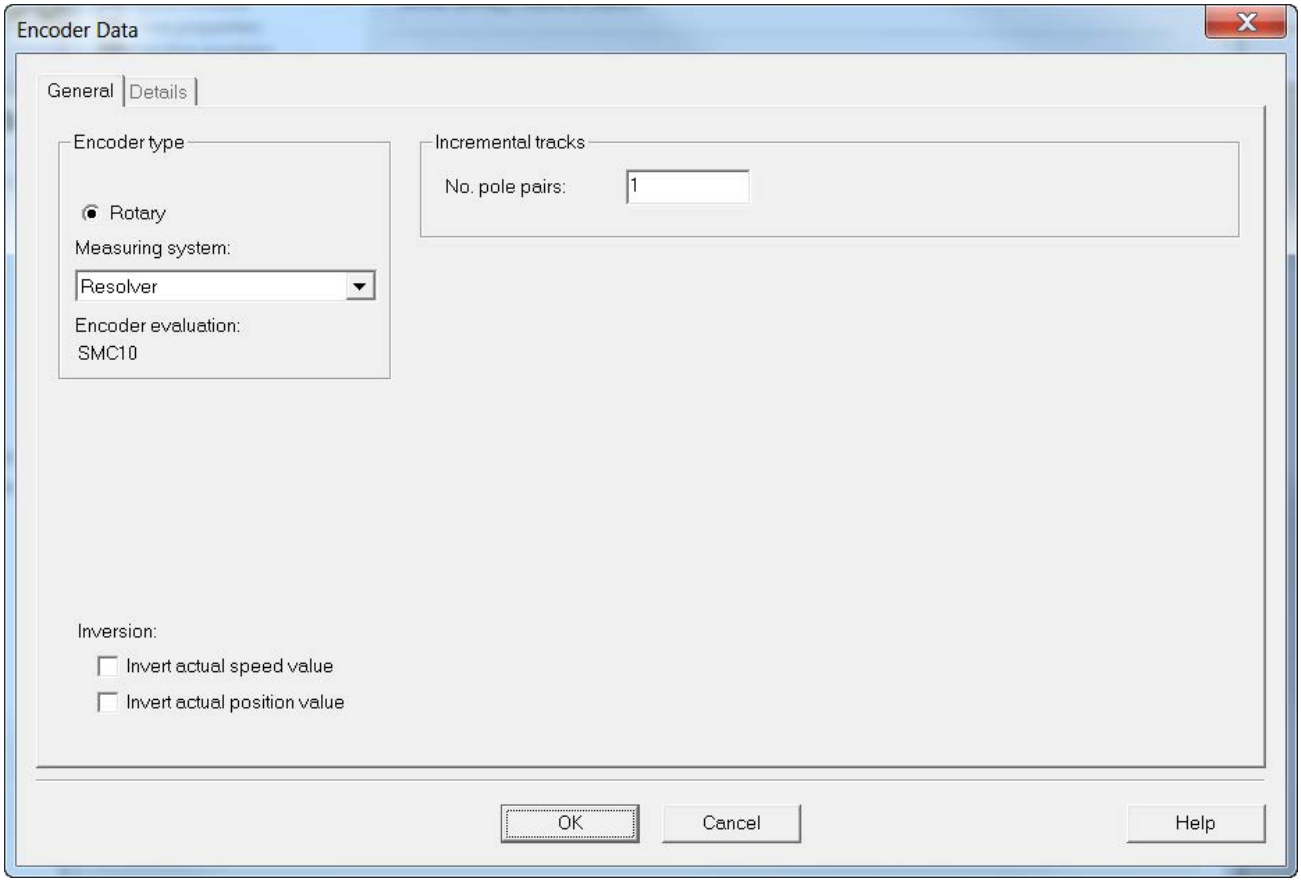



Figure 8-26 Entering encoder data - resolver via SMC10

⇒ Enter the pole pair number.

⇒ Click on **OK**

**Note**

**Encoder configuration using the expert list**

If the existing encoder type is not in the selection list, then the encoder must be manually configured using the Expert list:
p0400[1] = 9999 (user-defined)
p0404[1] = (bit field)

⇒ Click on **Next >**

**[5] DRIVE-CLiQ encoder: Pulse encoder via Sensor Module Cabinet SMC30**

The pulse encoder is connected via the Sensor Module Cabinet SMC30.

⇒ Select **encoder 2** to activate the evaluation of the encoder via the Sensor Module Cabinet SMC30.

⇒ To select a predefined encoder configuration click on the radio button **Select standard encoder from list**, and select one of the encoders that is listed.
The following resolvers can be evaluated via the Sensor Module Cabinet SMC30:

- [3001] 1024 HTL A/B R
- [3002] 1024 TTL A/B R
- [3003] 2048 HTL A/B R
- [3005] 1024 HTL A/B
- [3006] 1024 TTL A/B
- [3007] 2048 HTL A/B
- [3008] 2048 TTL A/B
- [3009] 1024 HTL A/B unipolar
- [3011] 2048 HTL A/B unipolar
- [3020] 2048 TTL A/B R, with sense
- [3081] SSI, singleturn, 24 V
- [3082] SSI, multiturn 4096, 24 V
- [3088] 1024, HTL, A/B, SSI, singleturn
- [3090] 4096, HTL, A/B, SSI, singleturn

⇒ To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following input screen is displayed for you to enter the required data.

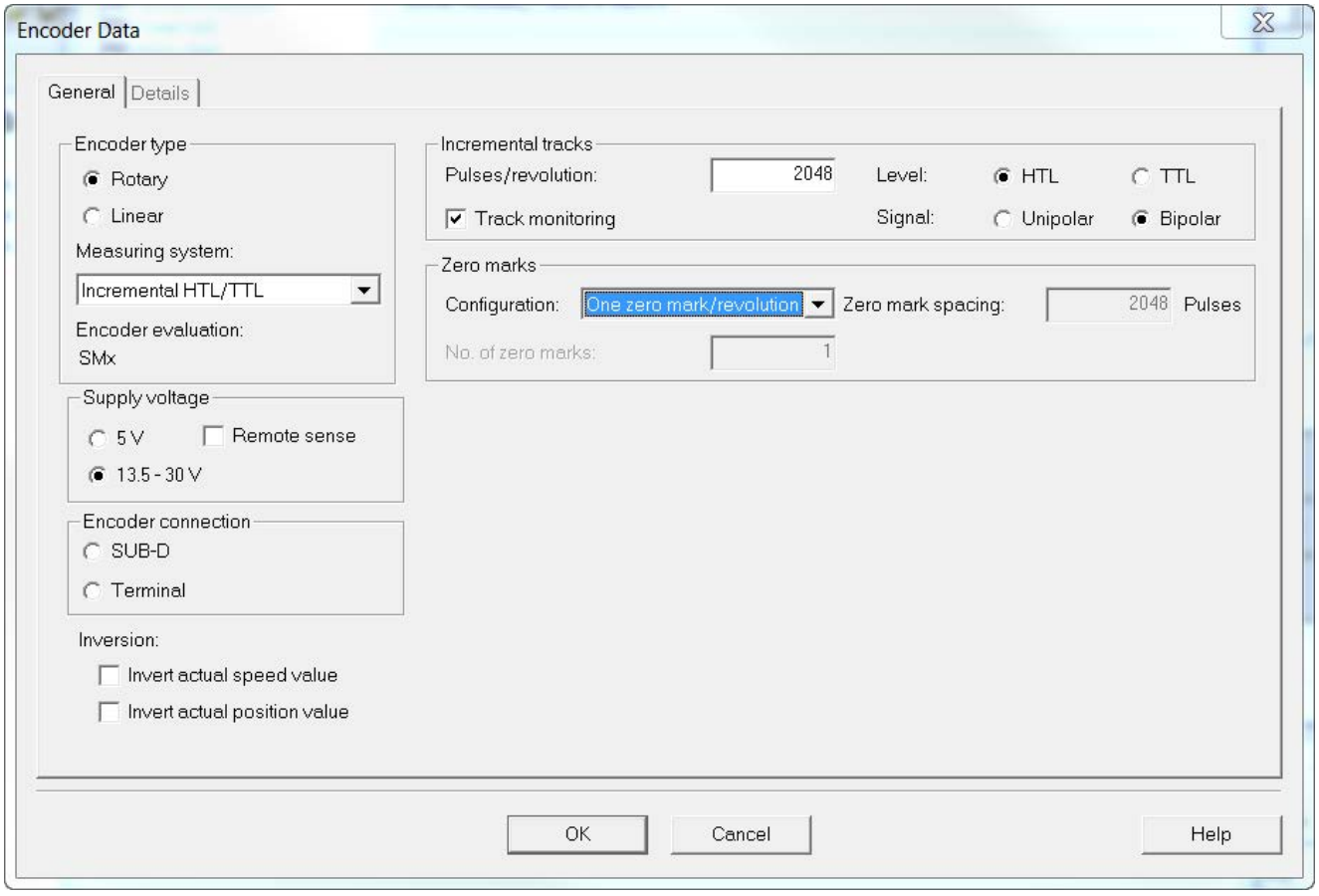



Figure 8-27 Entering encoder data - pulse encoder via SMC30

⇒ Select the **encoder connection** (SUB-D /terminal).

⇒ Enter the required encoder data.

⇒ Click on **OK**

| NOTICE |
| --- |
| **Material damage when selecting the incorrect encoder supply voltage**<br>Once the encoder has been commissioned, the supply voltage (5 V / 13.5 - 30 V) set for the encoder is activated on the SMC30 Module. If a 5 V encoder is connected and the supply voltage has not been set correctly, the encoder may be damaged.<br>• Set the correct supply voltage for the connected encoder. |

⇒ Click on **Next >**

## Data on field

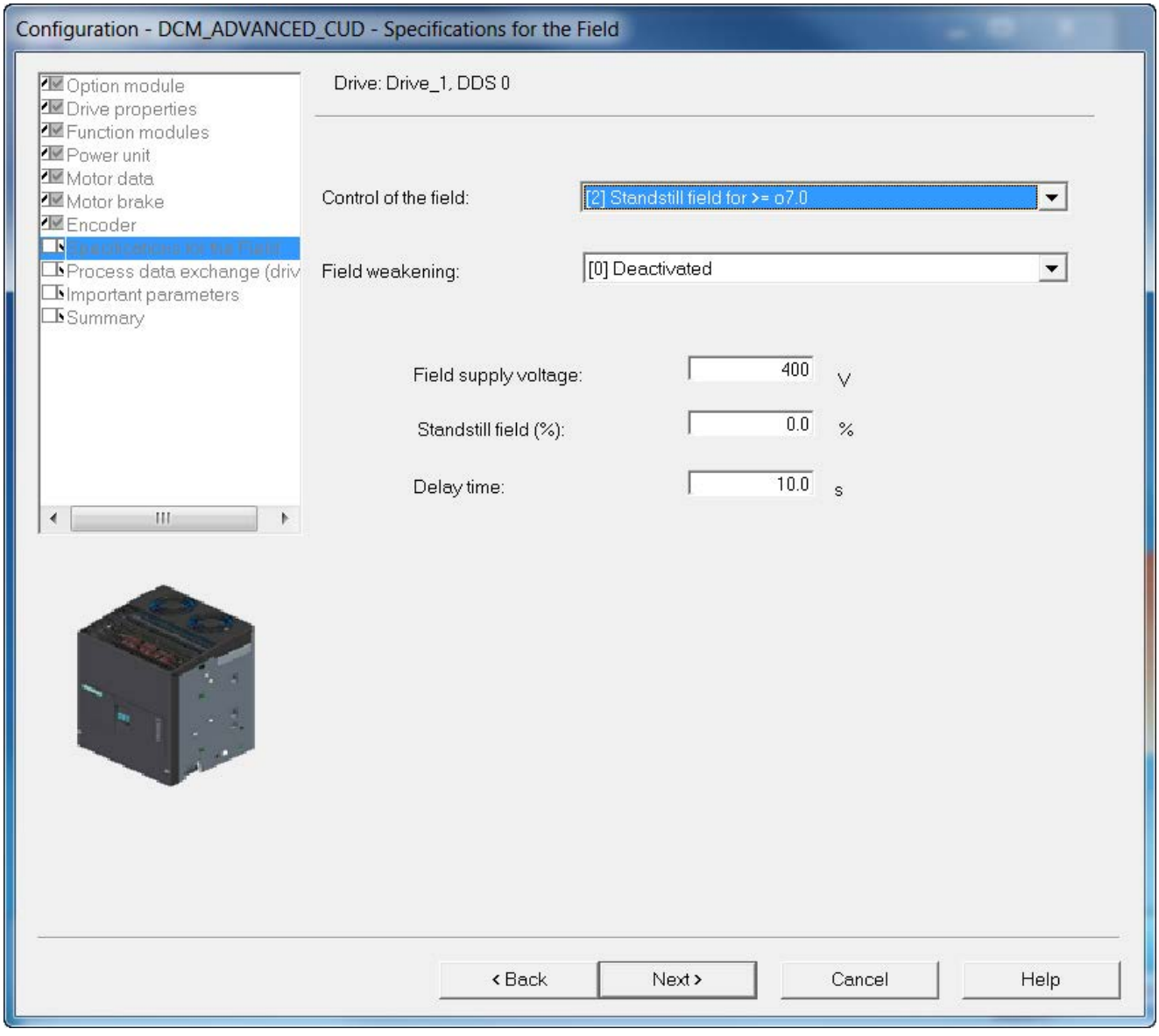



Figure 8-28 Data on field

⇒ Select the **field control:**

- [0] No field
- [1] Field also switched with the main contactor
- [2] Standstill field at >= o7.0 (factory setting)
- [3] Field is continuously switched on
- [4] Field also switched with signal auxiliaries ON
- [21] External field device, otherwise the same as position 1
- [22] External field device, otherwise the same as position 2
- [23] External field device, otherwise the same as position 3
- [24] External field device, otherwise the same as position 4

⇒ Select whether the EMF-dependent field weakening should be activated or deactivated.

**Note**

If **Field weakening** is activated, then a valid field characteristic must be available (p50117 = 1), otherwise, the optimization run for field weakening (p50051 = 27) must be carried out.

⇒ Depending on the selection under **Field control**, the values for **field supply voltage**, **standstill field (%)** and **delay time** can be set.

⇒ Click **Next >**

## Selecting process data exchange

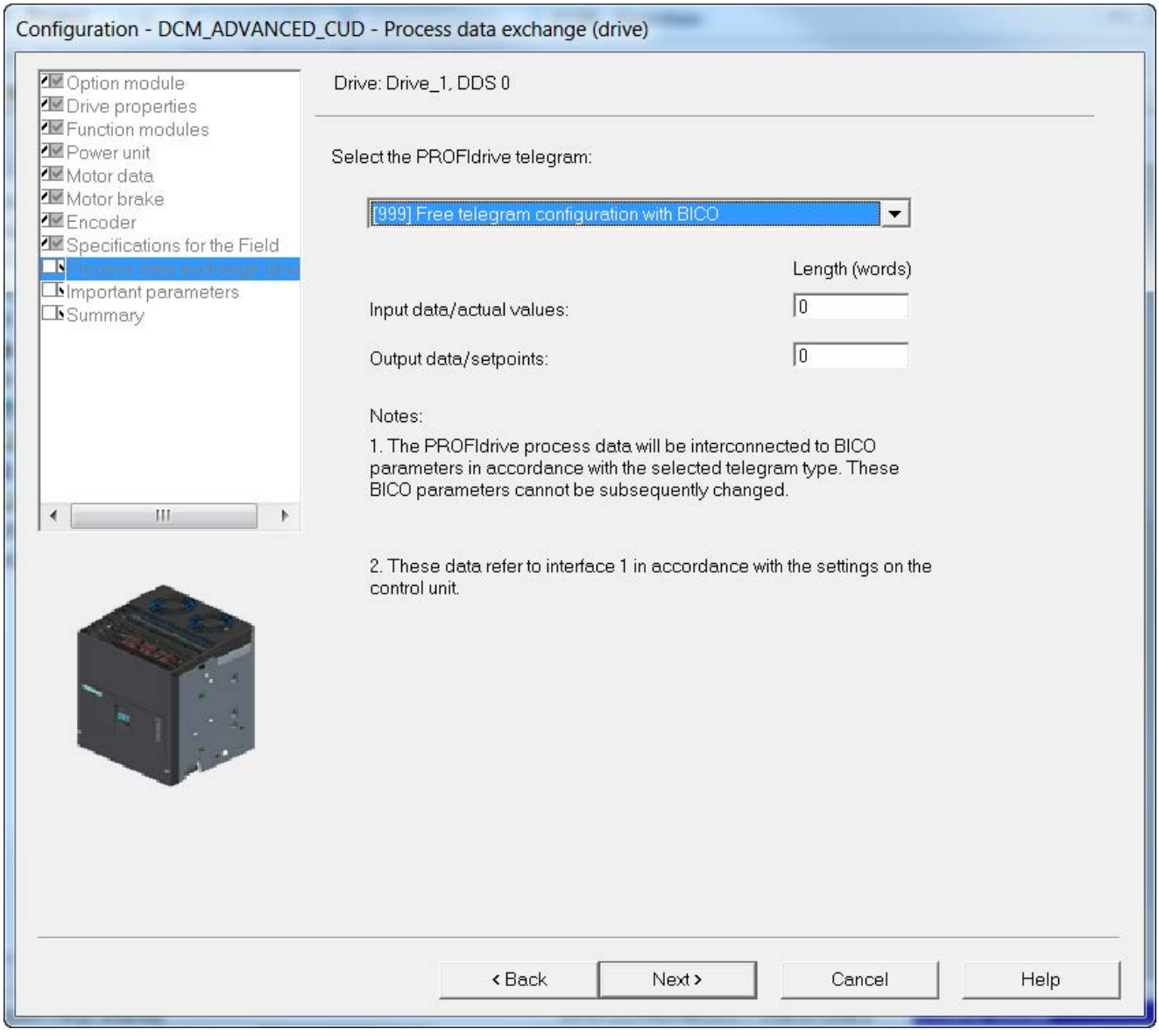



Figure 8-29 Selecting process data exchange

⇒ Select the PROFIdrive telegram type.

- 1: Standard telegram 1, PZD-2/2
- 3: Standard telegram 3, PZD-5/9
- 4: Standard telegram 4, PZD-6/14
- 20: SIEMENS telegram 20, PZD-2/6
- 220: SIEMENS telegram 220, PZD-10/10
- 352: SIEMENS telegram 352, PZD-6/6
- 999: Free telegram configuration with BICO (default setting)

**Note**

If a standard telegram is selected, BICO interconnections are triggered which cannot be re-parameterized. If, e.g. p0840 is to be changed again, a switchover to free telegram configuration has to be made first.

⇒ Click **Next >**

## Entering important parameters

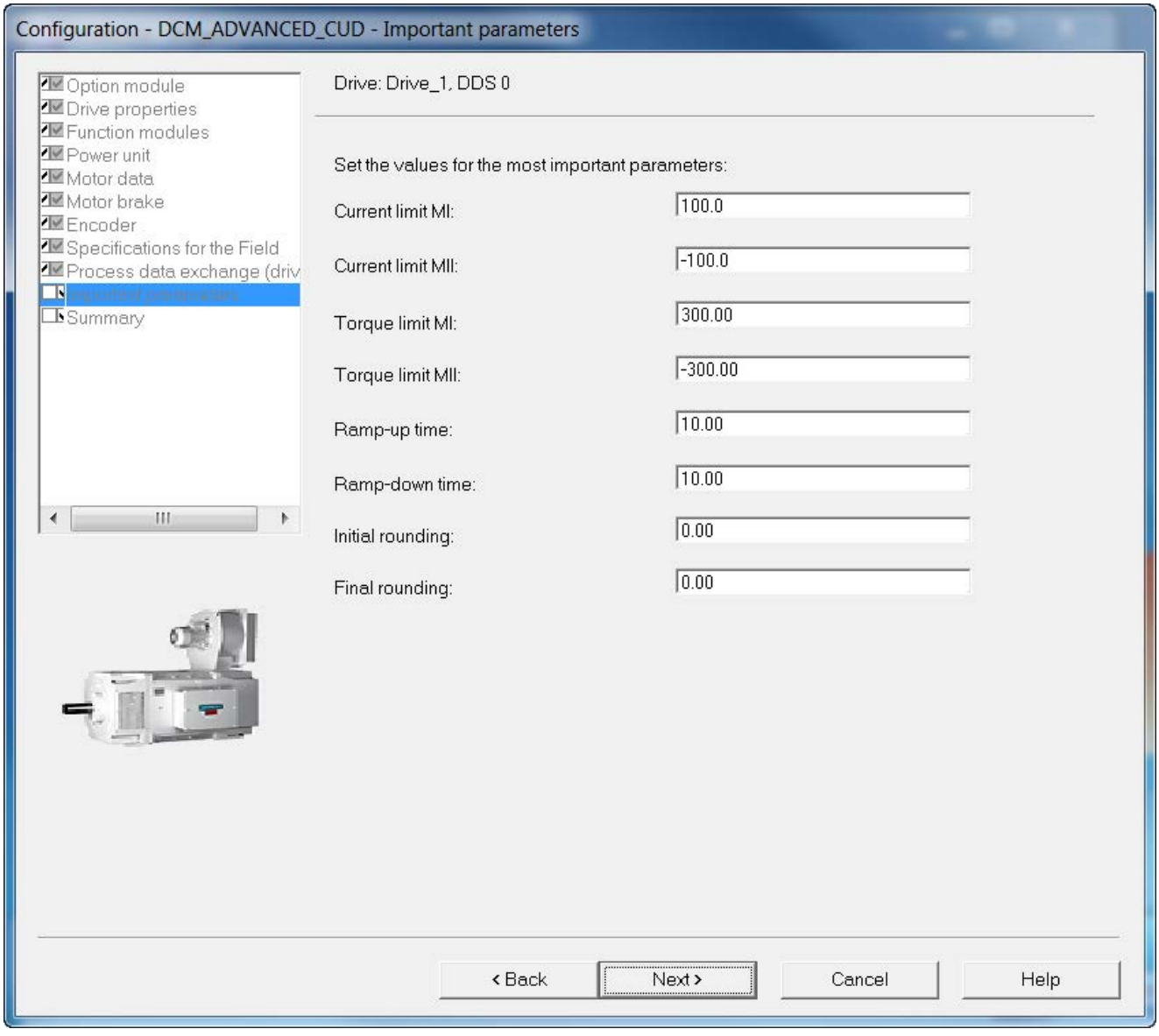



Figure 8-30 Entering important parameters

⇒ If necessary, enter important technological parameters.

**Note**

**Tooltips**

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

⇒ Click on **Next >**

## Summary

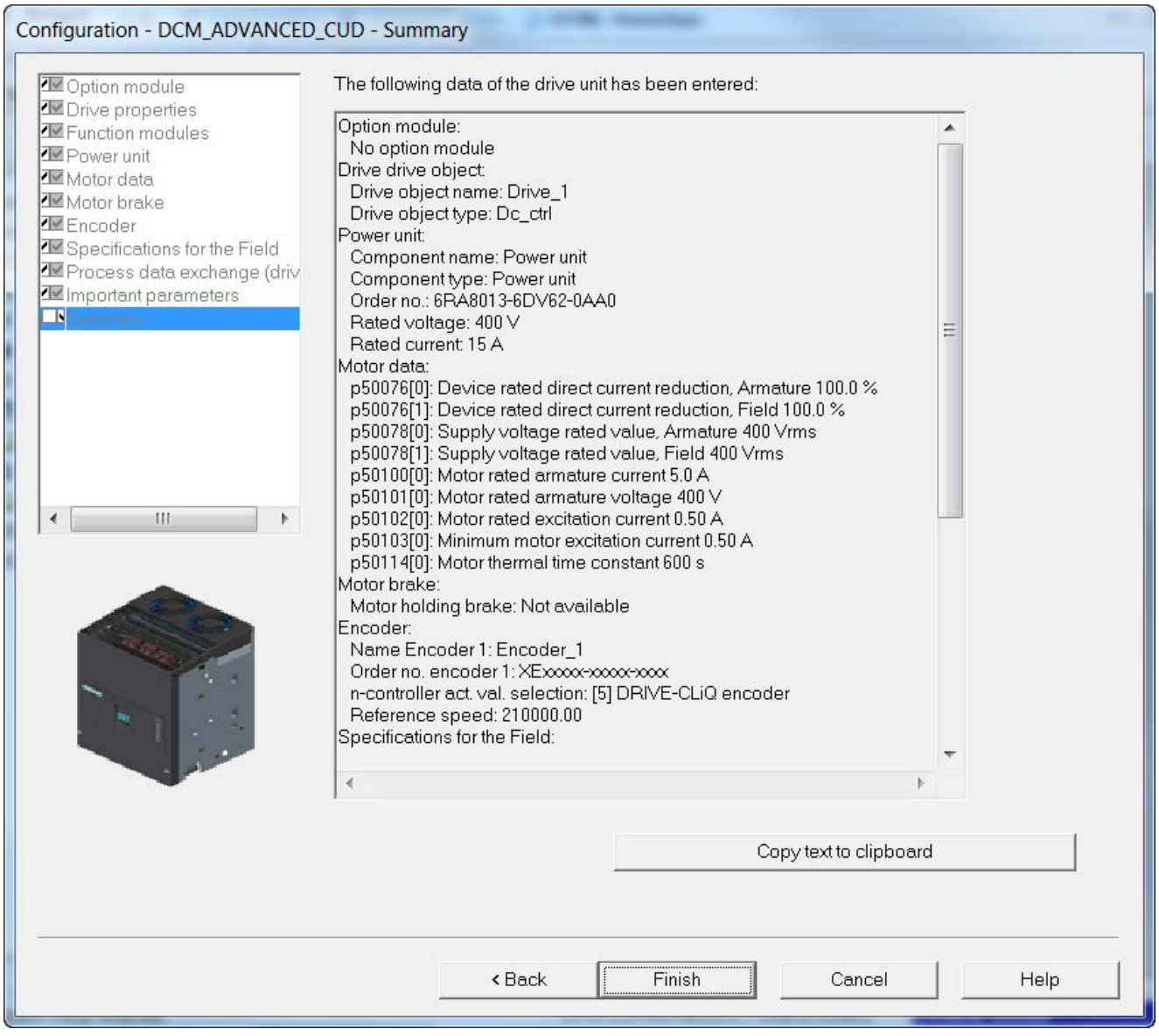



Figure 8-31 Summary

⇒ Use **Copy text to clipboard** to insert the summary of the data of your drive unit displayed in the window for later use in text processing.

⇒ Click **Finish**.

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

### 8.5.2.3 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 DCM_ADVANCED_CUD as drive unit in the following screen and confirm with OK:

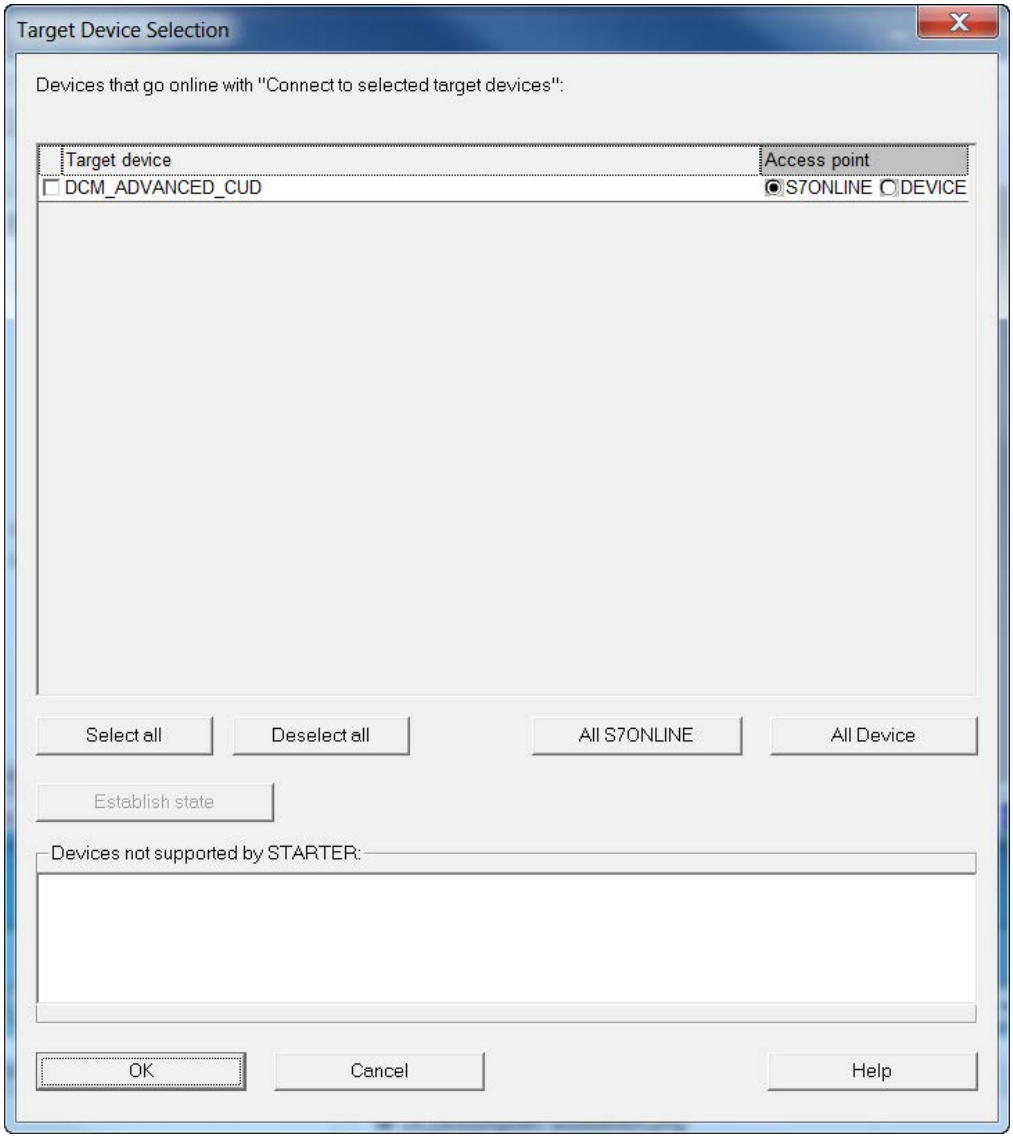



Figure 8-32 Target device selection

- **Step 3**

  Select the menu command **Download:**

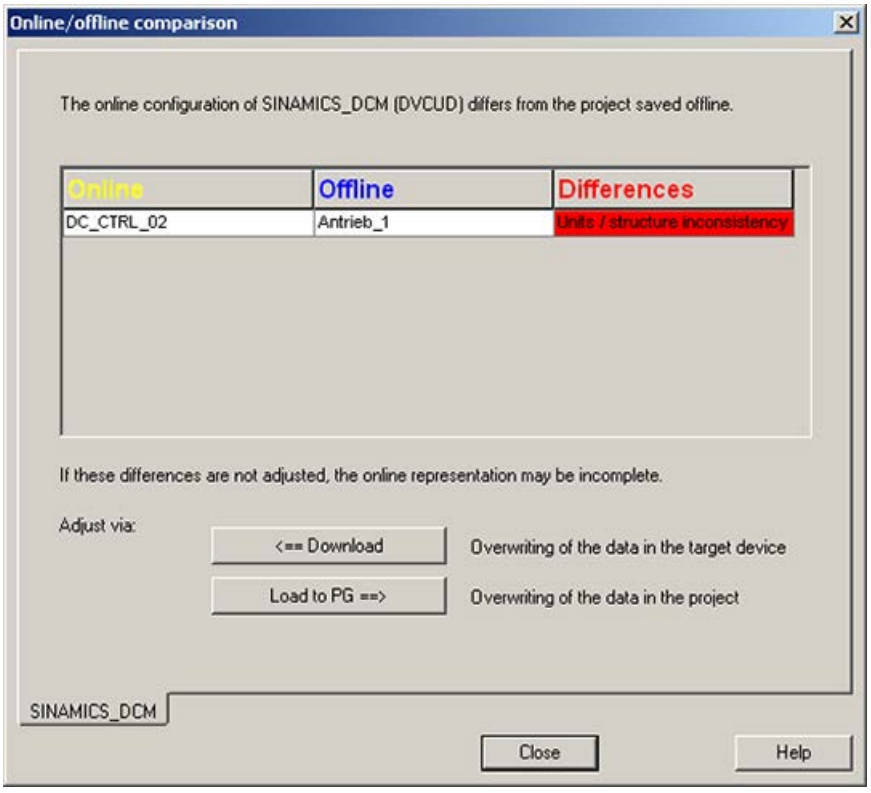



Figure 8-33 Online/offline comparison

- **Step 4**

  Activate the checkboxes if the DCC charts are also to be stored in the device and Copy RAM to ROM is to be performed after the download.

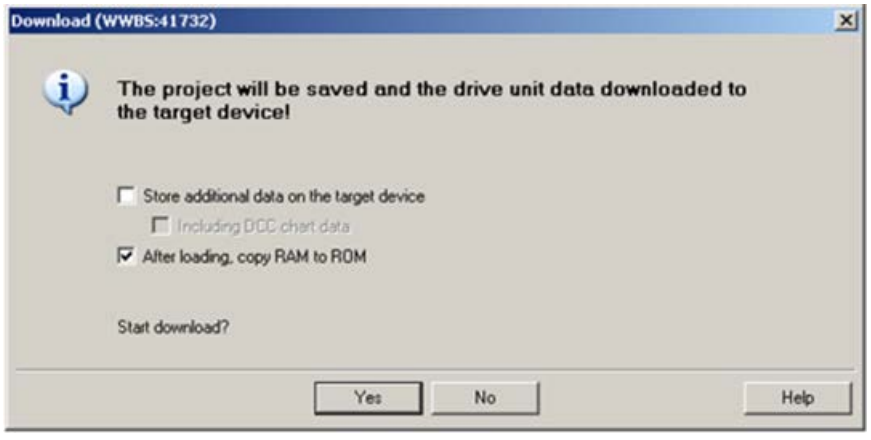



Figure 8-34 Downloading to the target device

**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 Chapter "Memory card functions (Page 327)").

  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 button for copying **RAM to ROM** can only be activated if the drive unit has been marked 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

## 8.6 Activating function modules

Subfunctions can be activated in the SINAMICS family drives 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 DC MASTER, the following subfunctions are modeled as function module.

- Technology controller
- Free function blocks
- PROFINET interface

### 8.6.1 Activating offline with STARTER

Function modules can be set 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":

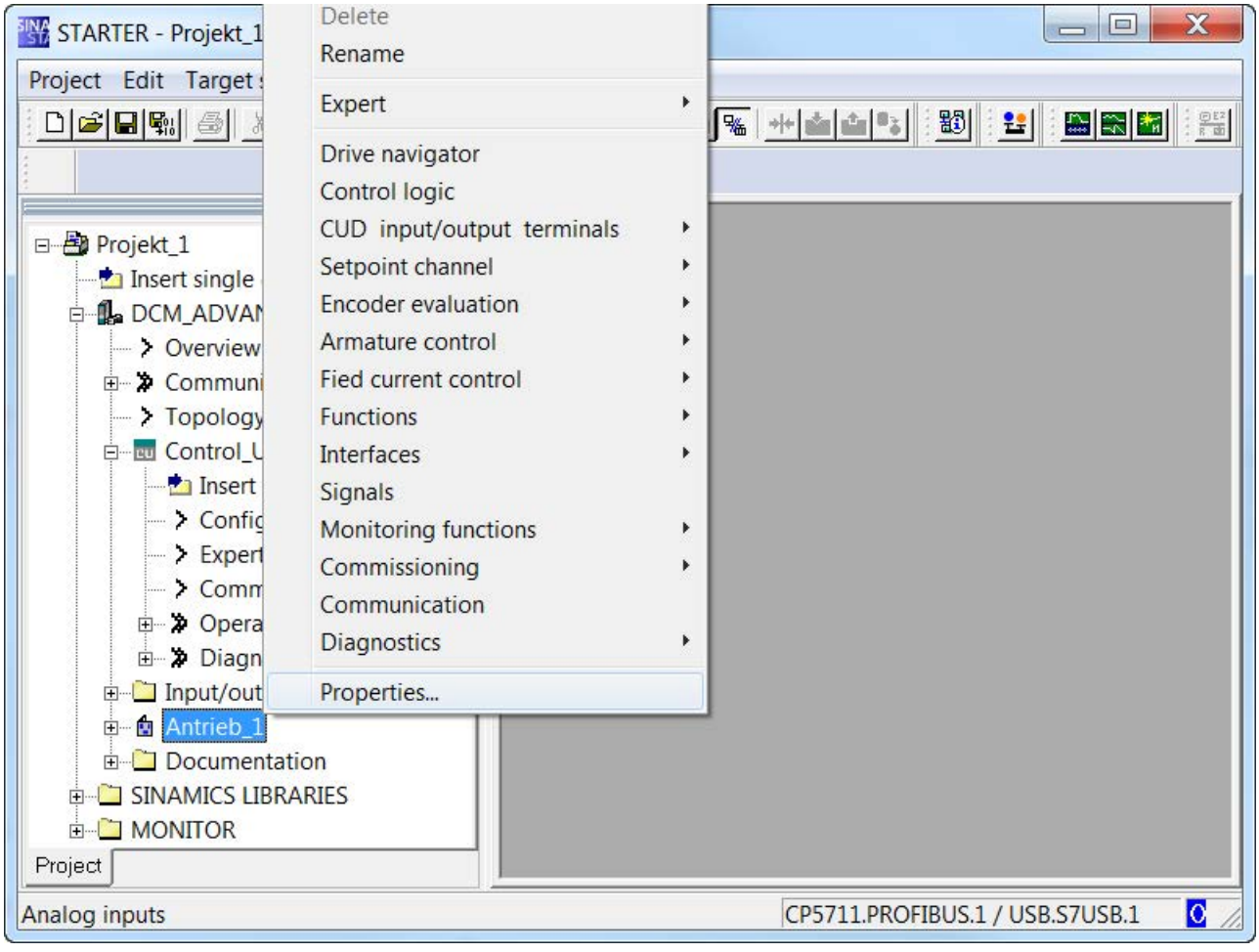



Figure 8-35 Properties

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

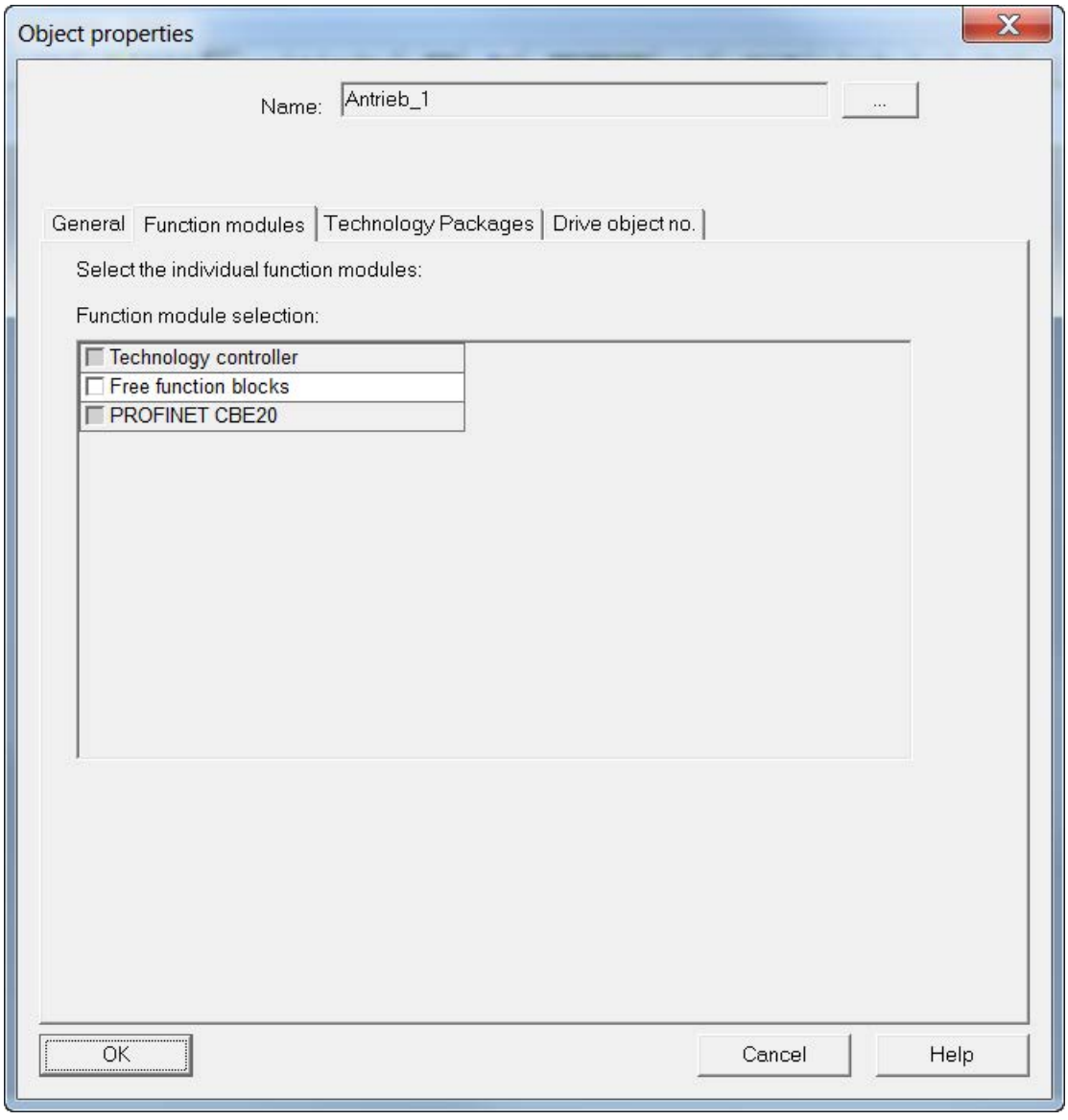



Figure 8-36 Selecting the function modules

Accept the settings by clicking **OK**.

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

## 8.6.2 Activating online through 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. Here the index corresponds to the DO.

- Index 0 stands for the CU
- Index 1 stands for the first DO – in the default setting, for the closed-loop control DO DC_CTRL
- Index 2 stands for the optional first TMxx, etc.

| Sub-function | p0108 bit |
|---|---|
| Technology controller | 16 |
| Free function blocks | 18 |
| PROFINET interface | 31 |

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

On BOP20 or AOP30 parameter assignment is made at DO1 (CU_DC)

- p0009 = 2
- p0108[i] Set bits corresponding to "1" or "0"
- p0009 = 0

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

**Note**

Changing the parameters – The quantity structure is copied to the optional AOP30 by "relearning" the existing parameters. This takes a few minutes.

## 8.7 Commissioning optional additional modules

Additional modules can be integrated via DRIVE-CLiQ (TM15, TM31, TM150, SMC10, SMC30) - or via the option slot of the Control Unit CUD (CBE20).

The components must be logged in to the firmware during a first commissioning.

That can be done:

- Offline by inserting the components into the project in STARTER and loading the project into the drive
- By adding the components through the parameter assignments on BOP20 / AOP30

## 8.7.1 Terminal Modules (TM31, TM15, TM150)

### 8.7.1.1 Commissioning with STARTER

**Requirement**

The project must be consistent with the drive before adding the TMxx. Carry out "Load to the PG" and then go offline.

An input/output component can only be inserted in the offline state.

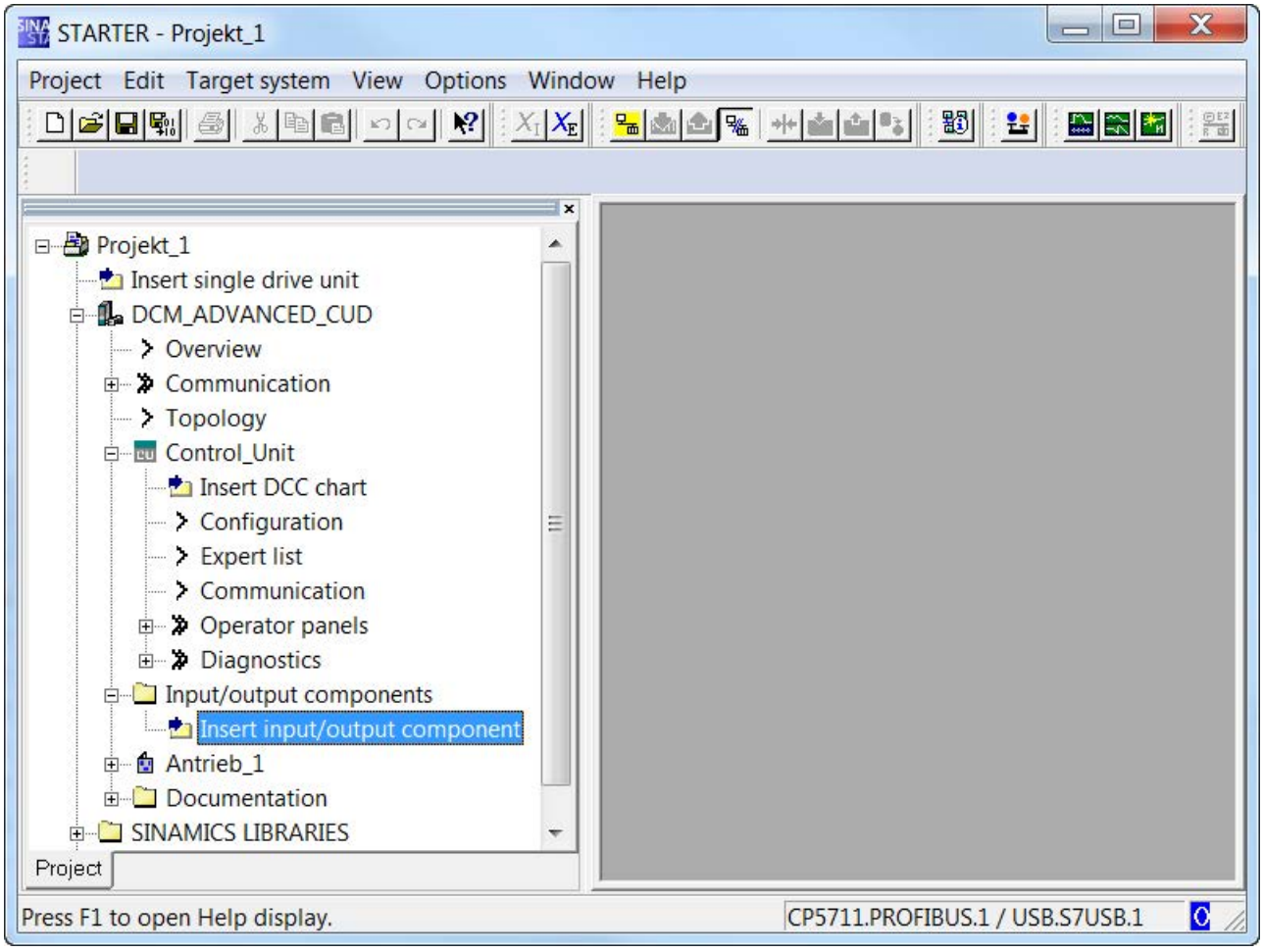



Figure 8-37 Inserting input/output components

- Double-click "Insert input/output component".

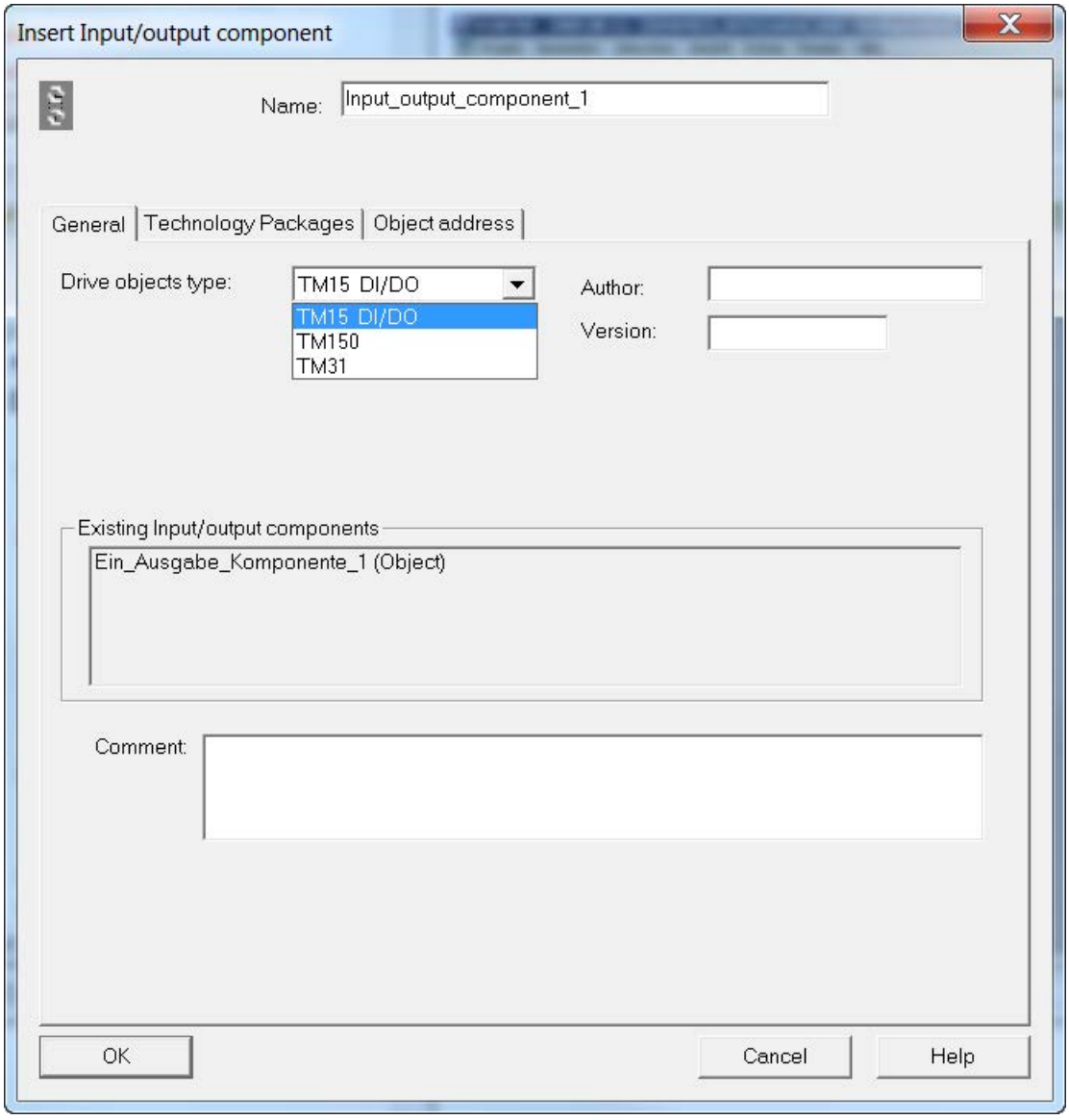



Figure 8-38 Selecting input/output components

- Select the desired type.
- Overwrite the text in the "Name:" field with the name selected for the I/O component (e.g. TM31_1).

- In the topology view, check at which interface of the Control Unit input/output components should be connected, and connect them there.
  [0] = X100, [1] = X101.

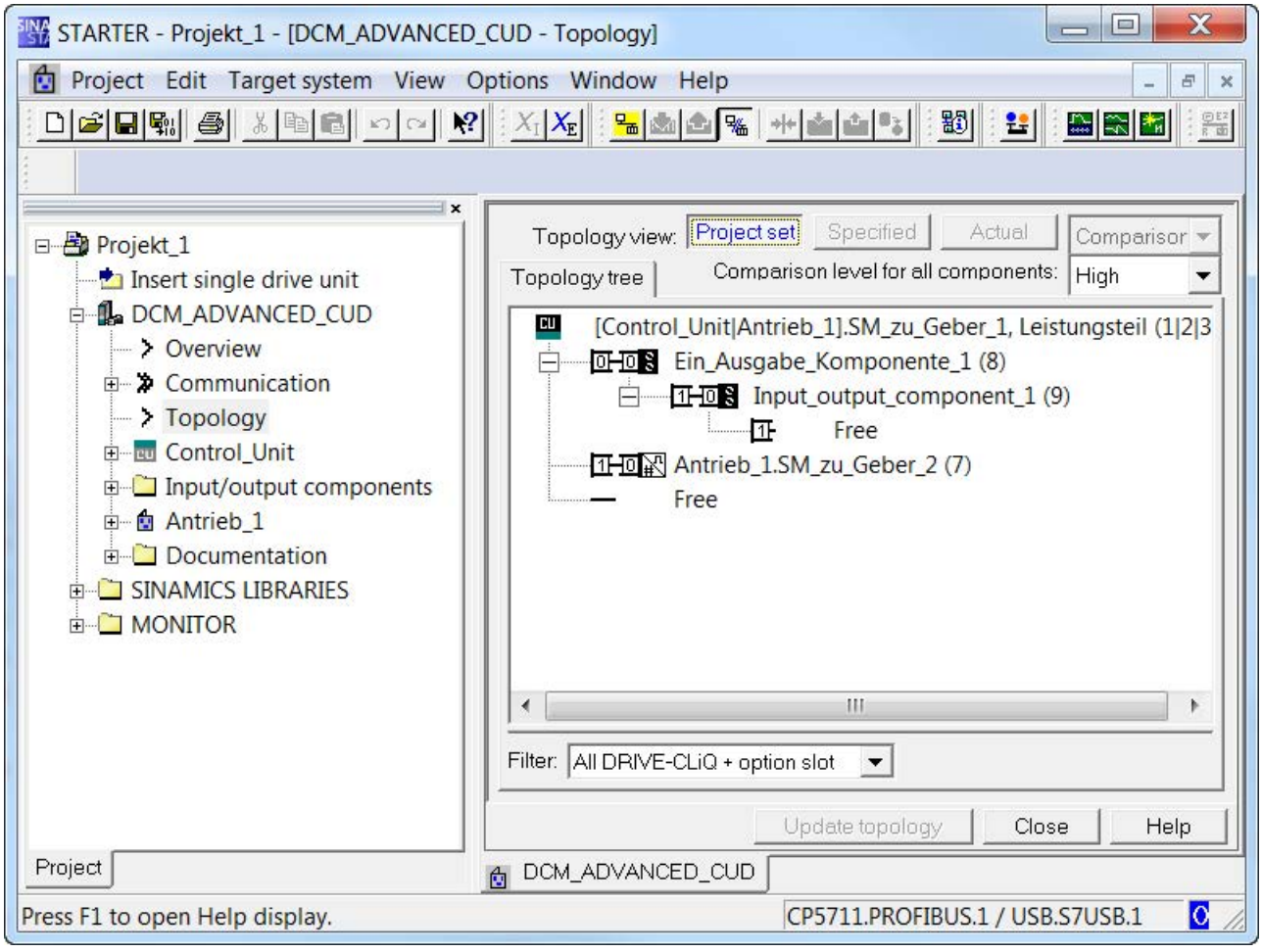



Figure 8-39 Topology

- Re-connect to the target device.
- Load the project into the drive with "Load to target device".
- Persistently save with RAM → ROM.
- The LED on the Terminal Module now lights up green and you can access the parameters of the additional DOs.

#### 8.7.1.2 Commissioning via parameter assignment

With the electronics power supply switched-off, plug in the Terminal Module with DRIVE-CLiQ at X100 or X101.

Accept the additional components by writing the following parameter to the CU.

**Note**

When powering up on a drive for the first time, the firmware will, if required, be loaded into the Terminal Module. After successful loading, the LED on the TMxx flashes red/green and alarm A1007 is output. A power ON is required before the components can be used.

p0009 = 1
p9910 = 1 (= accept component)
p0009 = 0

This triggers the firmware to reboot, and the additional components are accepted.

If you then go online with an old STARTER project, the different topologies will be displayed offline and online. With "Load to PG" the changed topology can also be accepted by STARTER

### 8.7.2 Encoder evaluation (SMC10, SMC30)

When using the optional Sensor Module Cabinet SMC10, a resolver can be used as motor encoder or as second encoder.

When using the optional Sensor Module Cabinet SMC30, a pulse encoder can be used as motor encoder or as second encoder.

Subsequently adding or deleting an SMC10 or SMC30 to/from an existing project is only possible with the STARTER commissioning tool.

### 8.7.2.1 Add/commissioning (with STARTER)

An encoder evaluation can only be inserted in the offline state.

- Double-click on "Configuration".

  The drive configuration is shown in the operating area of Starter.

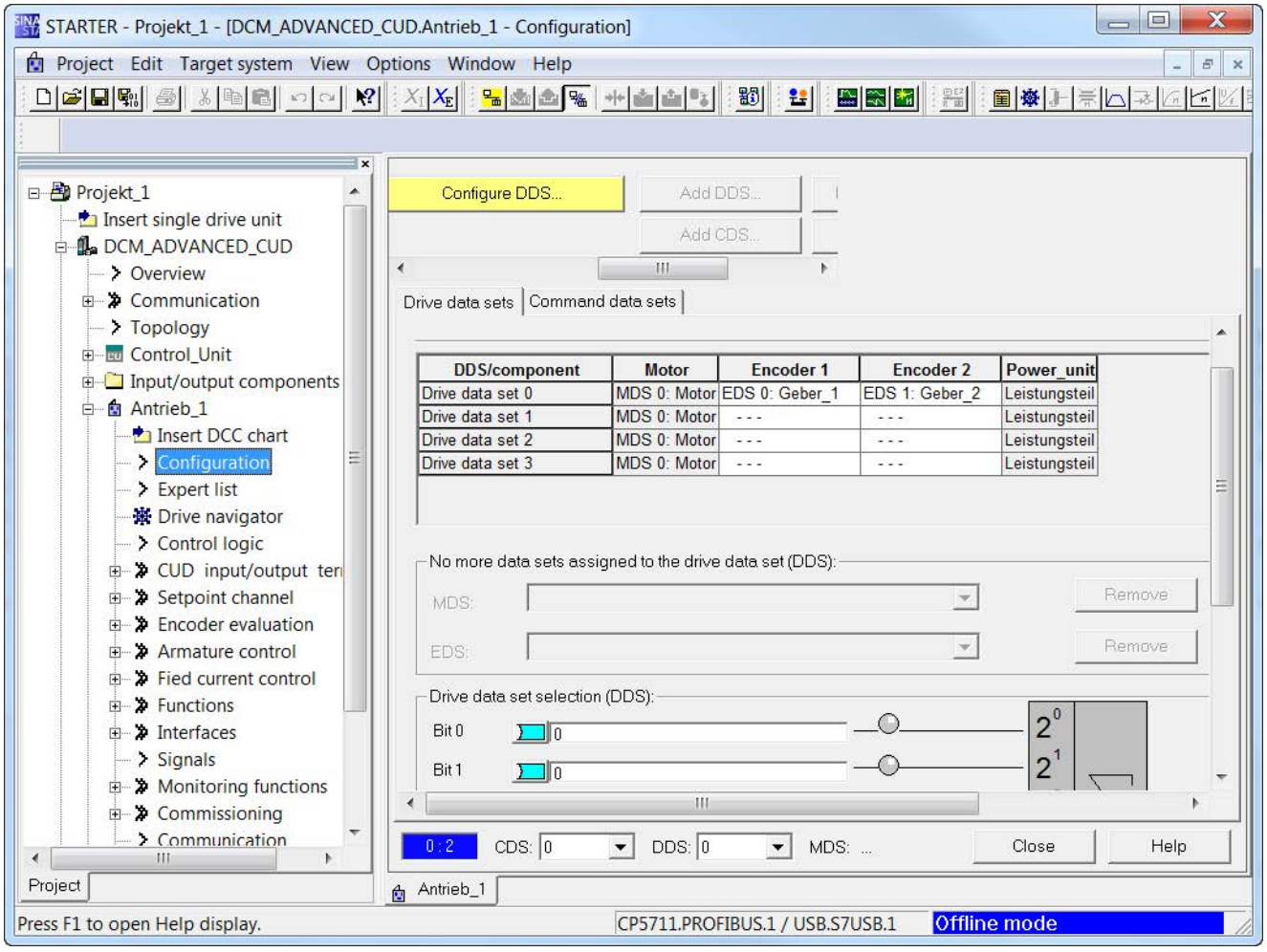



Figure 8-40 Configuration – Drive data sets

EDS and DDS can be set and DDS copied in the lower part of the **Drive data sets** tab.

- CDS can be selected and copied under the **Command data sets** tab:

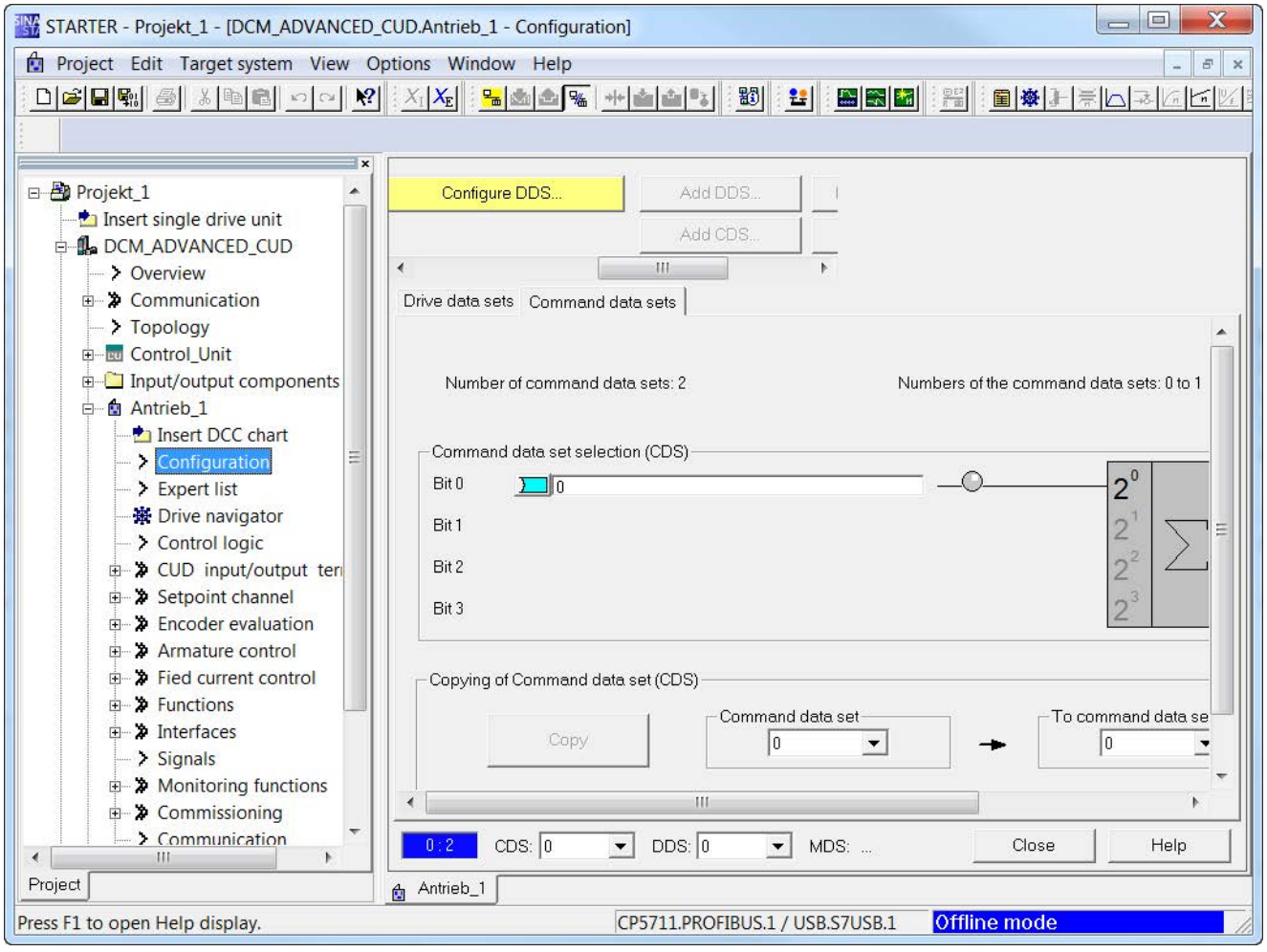



Figure 8-41 Configuration – Command data sets

- Click on button **Configure DDS**, the drive Wizard is displayed.

  Continue to the "Encoder" screen and there activate **encoder 2**.

  **SMC10: Resolver**

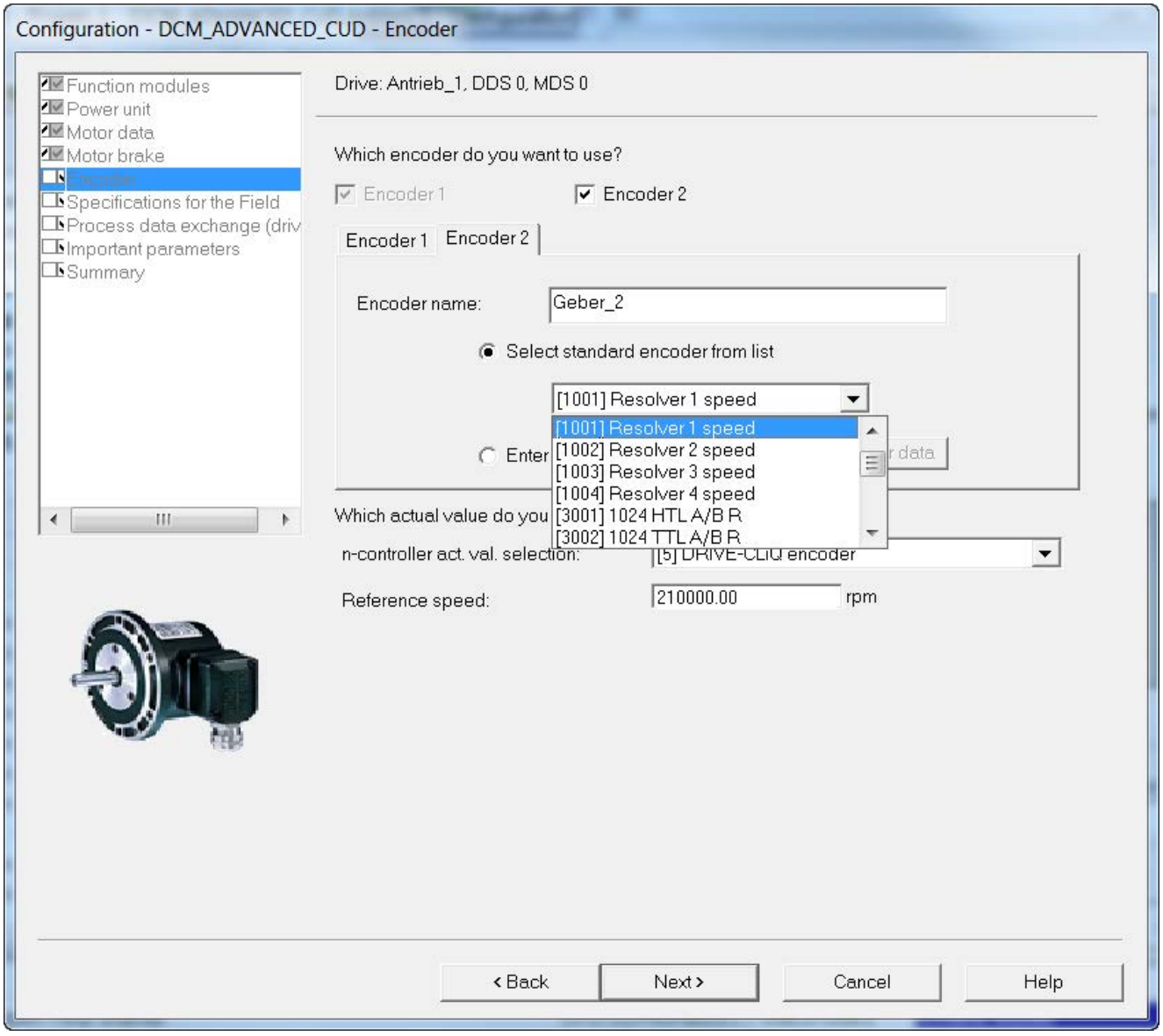



Figure 8-42 Selecting the resolver

### SMC30: Pulse encoder

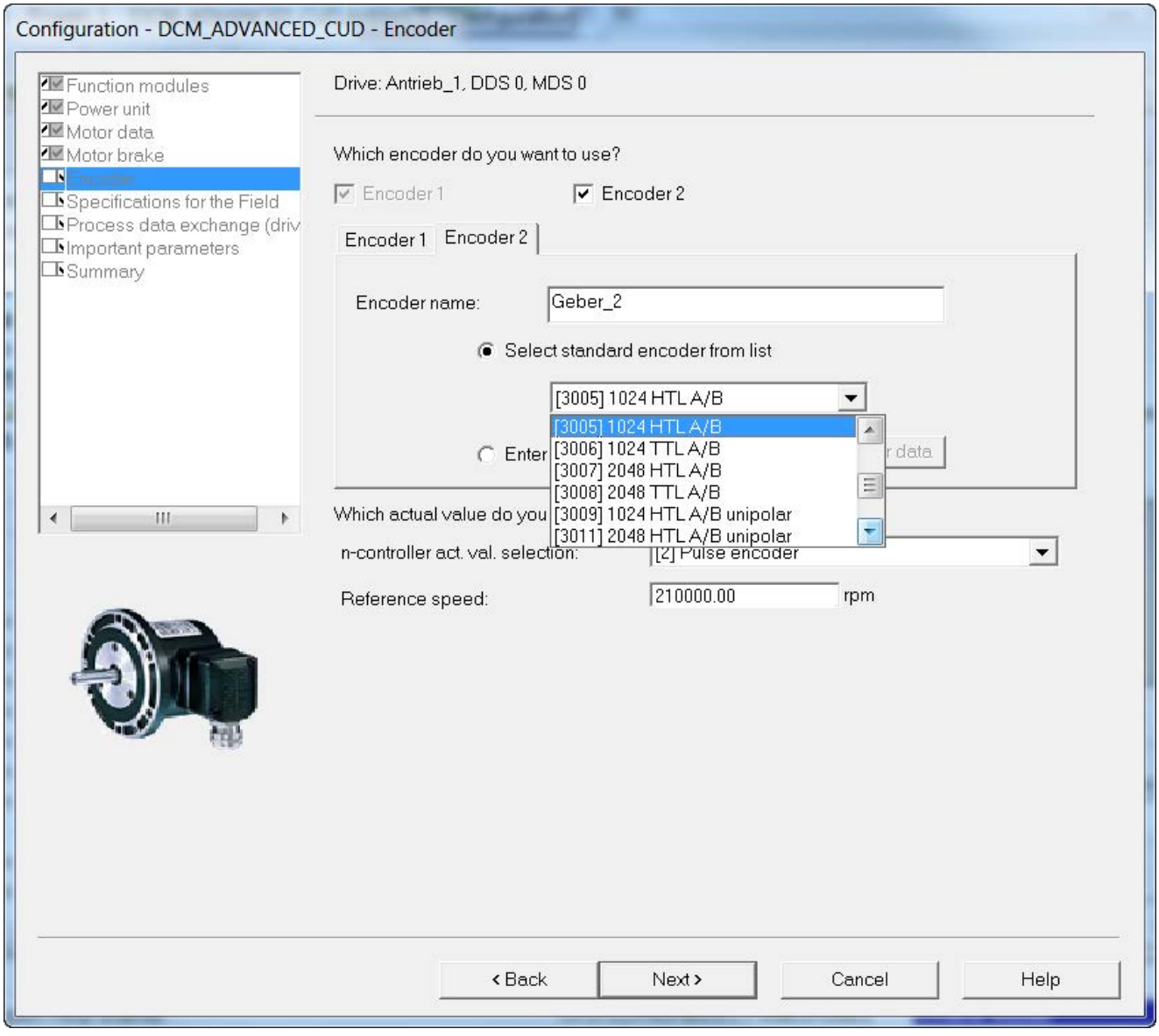



Figure 8-43 Selecting the pulse encoder

- To enter special encoder configurations, click the **Enter data** radio button followed by the **Encoder data** button - and then enter the encoder data.
- If the encoder connected at the SMC10 or SMC30 is also used as actual value for the closed-loop speed control, then under **n-controller act. val. selection**, select entry "[5] DRIVE-CLiQ encoder".
- Run through the wizard until the end and load the expanded project into the drive.

#### 8.7.2.2 Removal (with STARTER)

An encoder evaluation can only be inserted in the offline state.

- Start the drive wizard via "Configuration" -> "Configure DDS..."
- Work through the wizard with Continue > to the "Encoder" screen form and there, select encoder 2
- Work through the remainder of the wizard up to the end
- Withdraw the encoder evaluation SMC10 or SMC30
- Go online
- Load the project to the drive

## 8.7.3 CBE20 Communication Board Ethernet

### 8.7.3.1 Adding online into the drive

The CBE20 is automatically detected when plugged 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 453)".

**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).

### 8.7.3.2 Adding offline in STARTER

In Starter, CBE20 is added when working through the drive wizard.

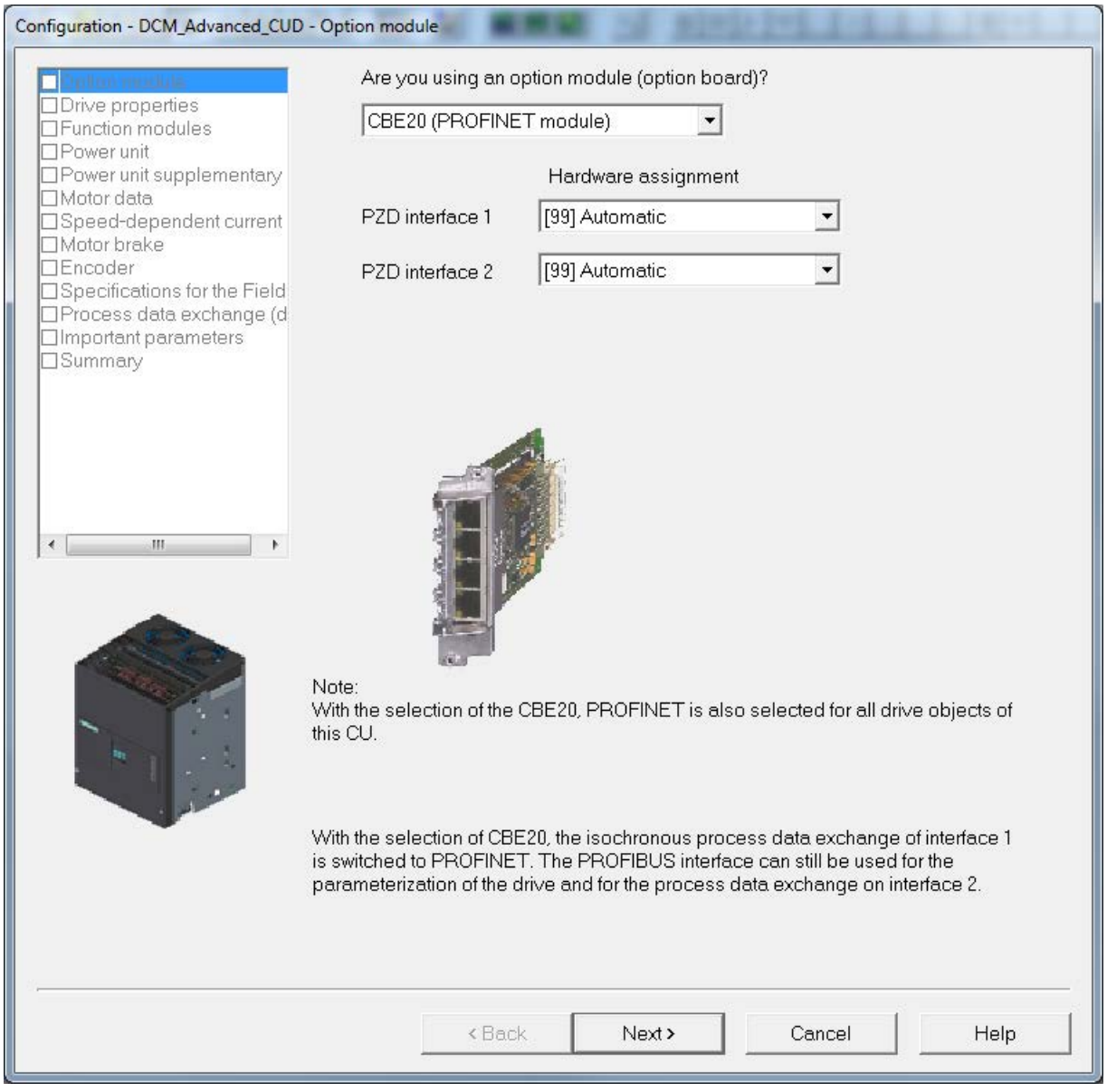



Figure 8-44 Activating the CBE20 option module

- Select the option module CBE20.
- Work through the wizard up to the end and load the expanded project into the drive.
- You can then access the parameters for the CBE20.

You can also subsequently activate option module CBE20.

- Start the configuration wizard via "Control Unit" -> Configuration" -> "Wizard..."
- In the "Option module" screen form, select CBE20
- Work through the remainder of the wizard up to the end
- Go online
- Load the project to the drive

### 8.7.3.3 Deleting from the drive online

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)

### 8.7.3.4 Deleting offline with STARTER

CBE20 can only be removed in the offline state.

- Start the configuration wizard via "Control Unit" -> Configuration" -> "Wizard..."
- In the "Option module" screen form, deselect CBE20
- Work through the remainder of the wizard up to the end
- Remove the CBE20 option board from the Control Unit
- Go online
- Load the project to the drive

# 8.8 Drive optimization

## Basic information

The individual control loops must be optimized when commissioning a drive.

4 control loops must be set or optimized:

- Field current closed-loop control
- Armature current closed-loop control
- Speed control
- EMF closed-loop control

SINAMICS DCM supports this task in 2 ways.

- Quick commissioning
  The controller parameters are calculated from the rated data of the motor and the power unit. No measurements are made. Only the parameters for the field current closed-loop control, the armature closed-loop control and the speed closed-loop control are determined. The parameters set during the quick commissioning allow reliable drive operation in the majority of cases.
- Optimization runs
  The controller parameters are determined from the rated data of the motor and the power unit and by evaluating measurement results. The parameters of all 4 control loops are determined. The parameters set using the optimization runs can be kept in the majority of cases. In exceptional cases, manual post-optimization is necessary (see the following Chapter "Manual optimization").

## Quick commissioning

| NOTICE |
| --- |
| **Both drive optimization types assume that all of the parameters are at their factory settings before the drive is optimized.**<br><br>This is the case when the device is originally shipped. If the parameters have already been changed, or if you are not certain that all of the parameters are at their factory settings, then run the "Restore factory setting" function!<br><br>With the basic operator panel BOP20:<br>(1)p0009 = 30<br>(1)p0976 = 1<br>SINAMICS DCM resets all of the parameters to the factory setting, and executes a power on. The parameters must then be permanently saved by pressing the P button for a longer period of time (at least 3 seconds, however until the display starts to flash). |

**Procedure**

- Start the quick commissioning with p0010 = 1 (= factory setting)
- Set all of the important parameters (see e.g. commissioning steps in Chapter "Commissioning using the BOP20" operator panel)
- Complete the quick commissioning with p3900 = 3 (calculations are performed, p0010 and p3900 are reset to 0)

**Commissioning using the BOP20 operator panel:**
This procedure is explicitly explained for the commissioning steps in Chapter "Commissioning using the BOP20 Operator Panel (Page 239)".

**Commissioning using the AOP30 operator panel:**
Quick commissioning is completed (p3900 = 3) as part of the final confirmation. (See Chapter "Full drive commissioning (Page 249)").

**Commissioning using the STARTER commissioning tool:**
The completion of quick commissioning (p3900 = 3) is selected as part of "Complete" of the Wizard "Configuring the drive unit". (See Chapter "Configuring a drive unit (Page 264)"). After successfully "Loading the project into the target system" (see Chapter "Starting the drive project (Page 284)"), quick commissioning is completed in the SINAMICS DCM.

## Optimization runs

**⚠WARNING**

**Unexpected motor movement during optimization runs**

Optimization runs cause movement of the drive which can result in death, severe injury or material damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY STOP functions are fully functional when commissioning the drive.

## Procedure

〈1〉 The drive must be in operating state o7.0 or o7.1 (enter SHUTDOWN!).

〈2〉 p50051 = 23 Optimization of the armature current control for induction load
p50051 = 24 Optimization of the field current control
p50051 = 25 Optimization of the armature current control
p50051 = 26 Optimization of the speed control
p50051 = 27 Optimization of the EMF control (incl. field characteristic recording)
p50051 = 28 Recording of the friction characteristic
p50051 = 29 Optimization of the speed control for drives with a mechanical system capable of oscillation

〈3〉 The SINAMICS DCM Control Module goes into operating state o7.4 for a few seconds, and then goes into o7.0 or o7.1 and waits for SWITCH ON and OPERATION ENABLE to be entered.
Enter the commands SWITCH ON and OPERATION ENABLE!
If the switch-on command is not entered within 30 s, this wait state is exited and fault message F60052 is output.

〈4〉 Execution of the optimization run starts once operating state <o1.0 (OPERATION) is reached.

〈5〉 When the optimization run has been completed, the drive goes into operating state o8.0

**Note**

The optimization runs should be performed in the order specified previously.

### Details on the individual optimization runs

p50051 = 23 **Optimization of armature current control for inductive load**

This optimization run sets the same parameters as for p50051 = 25. The optimization run uses an algorithm that is more suitable when it comes to feeding large inductances than for the algorithm used with p50051 = 25. As a consequence, for applications where the SINAMICS DCM does not feed a motor – but instead a lifting solenoid or the field of the synchronous generator – it is recommended that instead of p50051 = 25 this optimization run is executed.

p50051 = 24 **Optimization of closed-loop field-current control**
(duration of up to 1 min.)
This optimization run may also be executed without a mechanical load connected.
The following parameters are set automatically:
p50112, field resistance (Rf)
p50116, field inductance (Lf)
p50255, P gain of field-current controller (Kp)
p50256, integral time of field-current controller (Tn)
p51597 field inductance reduction factor

p50051 = 25 **Optimization of closed-loop armature current control**
(takes about 1 min.)
The current controller optimization run may also be executed without a mechanical load connected; if necessary, the drive should be locked.
The following parameters are set automatically:
p50110, armature resistance (Ra)
p50111, armature inductance (La)
p51591, non-linearity factor of armature inductance (La_fak)
p51592, armature commutation inductance (Lk)
p51594, filter inductance for 12-pulse operation (Ls)
p51595, filter inductance reduction factor (Ls_fak)
p51596, filter resistance in 12-pulse operation (Rs)
p50155, P gain of the armature current controller (Kp)
p50156, integral time of armature current controller (Tn)
p50191 filter time of the current setpoint

**⚠WARNING**

**Electric shock during optimization run**

The current limits set are not active during the current controller optimization run.
75% of the rated armature current for the motor flows for approximately 0.7 s.
If live components are touched then this can result in severe injury or death.

- Observe the general safety instructions.

**NOTICE**

**Lock motors**

Motors with a permanent field, a very high level of retentiveness, or a series field must be locked during this optimization run.

**Note**

The parameters determined are dependent on the motor temperature. The values set with the motor in the cold state can serve as a good default setting. For drives with a high dynamic performance, the optimization run p50051=25 should be repeated after operating the drive with a load (e.g. with the motor at the operating temperature).

p50051 = 26 **Optimization of the speed control**

(takes at least 6 s)

The dynamic performance of the speed control loop can be selected using p50236, whereby lower values represent a softer closed-loop control.

Before carrying out the speed controller optimization run, p50236 must be set and influences the setting of p50225, p50226, p50228 and p50540.

Where possible, the final mechanical load should be connected to the motor for the purpose of optimizing the speed controller, as the parameters set depend on the measured moment of inertia.

The following parameters are automatically set:
p50225, P gain of speed controller (Kp)
p50226, integral time of speed controller (Tn)
p50228, speed setpoint smoothing time constant
p50540, speed controller acceleration time

Remark:
The speed controller optimization run only takes into account the filtering, set using p50200, of the actual speed controller value and – if p50083 = 1 – the filtering, set using p50745, of the main actual value.
p50225 (gain) is limited to a value of 30.00. The speed controller optimization run always sets p50228 (speed setpoint filtering) to 0. If a Kp of 30.0 was determined by the optimization run, manual re-optimization is recommended (see Chapter "Optimizing the speed controller (Page 314)").

**⚠WARNING**

**Unexpected movement of the motor during optimization run**

During the speed controller optimization run, the motor is accelerated at a maximum of 45% of its rated armature current. The motor can reach speeds of up to approximately 20% of the maximum speed.

The movements of the drive can result in death, severe injury or material damage.

- Observe the general safety instructions.

p50051 = 27 **Optimization of the EMF control (incl. field characteristic recording)**

(duration, approx. 1 min)

This optimization run must be executed if field-weakening operation has been selected (p50081 = 1), if closed-loop torque control (p50170 = 1) or torque limiting (p50169 = 1) has been selected, or if a variable field current setpoint has been entered.

This optimization run may also be started without a mechanical load. The following parameters are set automatically:

| | |
|---|---|
| p50120 to p50139 | Field characteristic (magnetization characteristic) of motor |
| p50275 | P gain of EMF controller (Kp) |
| p50276 | Integral time of EMF controller (Tn) |

Remark:

In order to determine the magnetization characteristic, during this optimization run the field-current setpoint is reduced to a minimum value of 8% (starting from 100% of the motor's rated excitation current as specified in p50102). Setting p50103 to values < 50% of p50102 for the duration of this optimization run limits the value entered for the field-current setpoint to the minimum value specified in p50103. This may be necessary for uncompensated motors with an extremely high armature response.

The magnetization characteristic approaches 0 along a linear path (starting from the measuring point), with the minimum field-current setpoint.

To execute this optimization run, the minimum excitation current for the motor (p50103) must be set to a lower value than 50% of the motor's rated excitation current (p50102).

**⚠WARNING**

**Unexpected movement of the motor during optimization run**

During this optimization run, the drive accelerates to approx. 80% of the rated motor speed. The maximum armature voltage is 80% of the rated armature voltage of the motor (p50101).

The movements of the drive can result in death, severe injury or material damage.

- Observe the general safety instructions.

p50051 = 28 **Recording of the friction characteristic**

(duration, approx. 1 min)

The following parameters are set automatically:

p50520 to p50530 Friction characteristic

Remark 1:
The friction characteristic is only active in operation if it is manually activated with p50223 = 1!

Remark 2:
In order to execute this optimization run, the speed controller must not be parameterized as a pure P controller or as a controller with droop.

**⚠WARNING**

**Unexpected movement of the motor during optimization run**

During this optimization run, the drive accelerates up to its maximum speed.

The movements of the drive can result in death, severe injury or material damage.

- Observe the general safety instructions.

p50051 = 29 **Optimization of the speed control for drives with a mechanical system capable of oscillation**

(duration up to 10 min)

The following parameters are set automatically:

| | |
|---|---|
| p50225 | P gain of the speed controller (Kp) |
| p50226 | Integral time of the speed controller (Tn) |
| p50228 | Speed setpoint, smoothing time constant |
| p50540 | Speed controller acceleration time |

The frequency response of the controlled system for frequencies between 1 and 100 Hz is recorded during this optimization run.

For this purpose, the drive is first accelerated to a basic speed (p50565, factory setting = 20%). A sinusoidal speed setpoint with a low amplitude (p50566, factory setting = 1%) is then switched in. The frequency of this additional setpoint is changed in 1 Hz increments from 1 to 100 Hz. For each frequency, an average is generated over a specific time (p50567, factory setting = 1 s).

The value set at p50567 essentially defines the duration of this optimization run. For a setting of 1 s it takes about 3 to 4 min.

The measured frequency response of the controlled system forms the basis for determining its optimal speed controller setting.

**⚠WARNING**

**Uncontrolled motor movement**

For motors with a suspended or drawing load, uncontrolled movement can occur during the optimization run which can lead to death, serious injury or property damage.

- The optimization run must not be executed if the motor is connected to a mechanical load that is able to move it while it is in a torque-free state (e.g. a suspended or drawing load).

## Notes regarding optimization runs

For drives with limited travel distance, the optimization run for field weakening (p50051 = 27) should be interrupted by entering the SHUTDOWN command at the earliest after the 1st field weakening measuring point has been plotted or the friction characteristic has been plotted (p50051 = 28) and at the earliest after determining the measuring point at 10% of the maximum speed - without fault message F60052 being initiated. Once the optimization run in question (p50051 = 27 or p50051 = 28) has been restarted, it will resume at a more advanced point, meaning that it can be completed in several stages even in cases where the travel distance is limited.

In the following cases, each optimization run is completely executed again after a restart:

- If a fault occurs during the optimization run
- If the electronic supply is switched off prior to restarting the optimization run in question
- If a different drive data set from the previous one is selected
- If a different optimization run is started in the meantime

The parameters for the drive data set that has been selected in each case are optimized.

The drive data set selection must remain the same throughout the optimization runs to avoid a fault being output.

# 8.9 Manual optimization

Manual optimization is best performed using the STARTER commissioning tool.

STARTER provides the following functions for this purpose:

- Function generator
- Trace

## 8.9.1 Optimization of closed-loop armature current control

### Determining the armature circuit parameters (3 options)

1. **Determining the armature-circuit parameters according to the motor list**

   Take the armature circuit resistance (p50110) and armature circuit inductance (p50111) from the motor manufacturers data.

   Disadvantage: The data is very imprecise and/or the actual values deviate significantly.

   Feeder cable resistances are not taken in the armature-circuit resistance. Additional smoothing reactors and feeder cable inductances are not taken into account in the armature-circuit inductance.

2. **Roughly estimating the armature-circuit parameters from the rated data for the motor and line supply**

   $$p50110 = \frac{p50101}{10 \times p50100}$$

   p50110 = Armature-circuit resistance [Ω]
   p50101 = Rated armature voltage for motor [V]
   p50100 = Rated armature current for motor [A]

   The basis of this formula is that for the rated armature current, there is a drop of 10% of the rated armature voltage across the armature circuit resistance Ra.

   $$p50111 = \frac{1.4 \times r50071}{p50100}$$

   p50111 = Armature-circuit inductance [mH]
   r50071 = Rated armature supply voltage for units [V]
   p50100 = Rated armature current for motor [A]

   This formula is based on the empirical value: The transition point from discontinuous to continuous current is approximately 30% of the rated motor armature current.

3. **Determining the armature circuit parameters by measuring the current/voltage**

   - **Establish closed-loop current controlled operation**
     - p50084 = 2: Select closed-loop current controlled operation
     - p50153 = 0: Precontrol disabled
     - p50082 = 0: Switch-off the field to prevent motor from moving and, where necessary, lock the rotor of the DC motor if retentiveness is too high.
     - p50354 = 5%: Threshold for overspeed protection
     - Enter 0 for the main setpoint.
     - If "OPERATION ENABLE" has been applied and the "SHUTDOWN" command is entered, an armature current of approximately 0% will now flow.

- **Calculate the armature circuit resistance p50110 from the armature current and armature voltage**
  - Gradually increase the main setpoint (shown at r52011) until the actual armature current value (r50019 as a % of the unit's rated armature current) reaches approximately 70% of the motor's rated armature current.
  - Calculate the armature circuit resistance:
    Ra[Ω] = r50038 / (r50019 × p50100) = armature voltage [V] / armature current [A]
- **Calculate the armature circuit inductance p50111 from the armature current at the transition point from discontinuous to continuous current**
  - Make an oscilloscope trace of the armature current.
  - Starting from 0, gradually increase the main setpoint (shown at r52011) until the armature current reaches the transition point from discontinuous to continuous current.
  - Calculate the armature circuit inductance using the following formula:
    La[mH] = 0.4 × r50015 / (r50019 × p50100)
    = armature voltage [V] / armature current at the transition point from discontinuous to continuous current [A]

## Overall optimization of the armature circuit

- **Checking the precontrol characteristic**
  **Procedure**
  - Set the function generator to a triangular waveform (0% to 100%), period = 10000 ms
  - Supply point: p50601[4] (see function diagram 6855)
  - Set p50082 = 0 (field off)
  - p50153 = 3 (influence of EMF disabled)
  - Record signals r52121 (output, precontrol) and r52110 (output, armature current controller)
  - The parameters of the precontrol (Ra [p50110], La [p50111] and λa [p51591]) are correctly set if the armature current controller output has the lowest possible value (e.g. less than 5%) over the complete setpoint range.
- **Checking the step response**
  **Procedure**
  - Set the function generator to a squarewave, with
    Step height = e.g. 5%
    Offset = various values, e.g. 80%
    Period = 1000 ms
    Pulse width = 500 ms
  - Supply point: p50601[4] (see function diagram 6855)
  - Set p50082 = 0 (field off)
  - Record signals r52118 (Ia-set) and r52117 (Ia-act)
  - Change controller parameters Kp (p50155) and Tn (p50156) until the step response provides a satisfactory result.
  - In order to eliminate the influence of non-linearity of the armature circuit inductance and gating unit, the armature current controller adaptation can be activated (see function chart 6855).

## 8.9.2 Optimization of closed-loop field-current control

### Determining the field circuit resistance (2 options)

1. **Roughly estimate the field circuit resistance from the rated motor data**
   p50112 = rated excitation voltage/rated excitation current of motor
2. **Determine the field-circuit resistance by comparing the field current setpoint and actual value**
   - p50112 = 0: Results in a 180° field precontrol output and, therefore, field current actual value = 0
   - p50082 = 3: So that the field remains permanently switched on, even when the line contactor drops out
   - p50254 = 0 and p50264 = 0: Only field precontrol active; field-current controller disabled
   - Set p50102 to rated excitation current.
   - Increase p50112 until the actual field current (r50035 converted to amperes using r50073[1]) equals the required setpoint (p50102).
   - Set p50082 back to the system's operating value.

### Overall optimization of closed-loop field-current control

- **Checking the precontrol characteristic**
  **Procedure**
  - Set the function generator to a triangular waveform (0% to 100%), period = 10000 ms
  - Supply point: p50611[0] (see function diagram 6905)
  - Set p50082 = 3 (field continuously on)
  - Record the signals r52271 (output, precontrol) and r52260 (output, field current controller)
  - The parameters of the precontrol (Rf [p50112], Lf [p50116] and λf [p51597]) have been correctly set if the output of the field controller has the lowest possible value (e.g. less than 5%) over the complete setpoint range.
- **Checking the step response**
  **Procedure**
  - Set the function generator to a squarewave, with
    Step height = e.g. 5%
    Offset = various values, e.g. 80%
    Period = 1000 ms
    Pulse width = 500 ms
  - Supply point: p50611[0] (see function diagram 6905)
  - Set p50082 = 3 (field continuously on)
  - Record signals r52268 (If-set) and r52265 (If-act)
  - Change controller parameters Kp (p50255) and Tn (p50256) until the step response provides a satisfactory result.
  - The field current controller adaptation can be activated (see function chart 6908) to eliminate the influence of non-linearity of the field inductance and gating unit.

## 8.9.3 Optimizing the speed controller

### Basic information

The objective of the closed-loop control is to compensate the system deviation as a result of changes to the setpoint and disturbances.

The evaluation is performed in the time domain:

- The control loop fulfills the requirement for steady-state accuracy, if the system deviation as a result of a setpoint step (reference input) converges towards zero. The rise time $t_{an}$ and settling time $t_{aus}$ specify the speed.
- The overshoot defines the damping. For a step change of the setpoint or disturbance variable, the controlled variable must not excessively overshoot the steady-state final value.

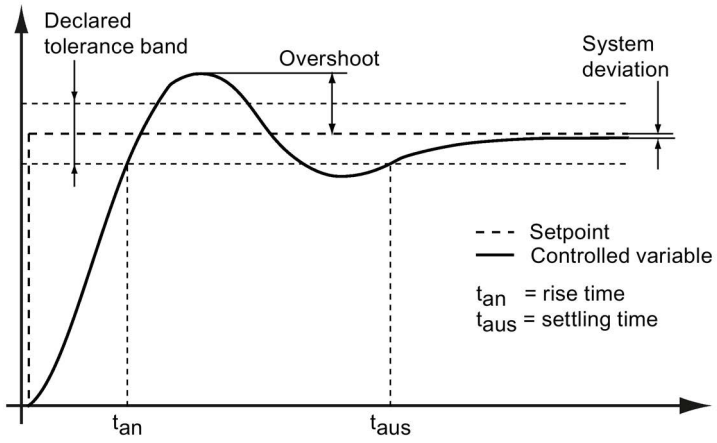



Figure 8-45 Setpoint step to evaluate a controller

## Controller optimization

### Procedure

- Set the function generator to a triangular waveform with
  step height = 5%
  offset = 10%
  period = 1000 ms
  pulse width = 500 ms
- Supply point: p50625[C] (see function diagram 6810)
- Record signals r52174 (n-set) and r52167 (n-act)

### Assessment

If the step response of the speed controller is recorded after performing the optimization run for the speed controller, then the significant increase of the setpoint step can be clearly seen - which is characteristic for optimization according to the symmetrical optimum.

A controller adjusted according to the symmetrical optimum has a significant overshoot, however, a favorable response to disturbances.
This optimization has especially established itself in drive technology as many systems require a good disturbance variable compensation. This is the reason why the optimization run for the speed controller sets the controller parameters according to the symmetrical optimum.

An improved response to setpoint changes with the response to disturbances remaining the same can be achieved using the reference model. See Chapter "Function descriptions", Section "Speed controller".

# Operation

# 9

## 9.1 Basic information

### 9.1.1 Parameter

#### 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: Ramping time of a ramp-function generator
- Display parameters (can only be read)
  These parameters are used to display internal variables.
  Example: Actual motor current

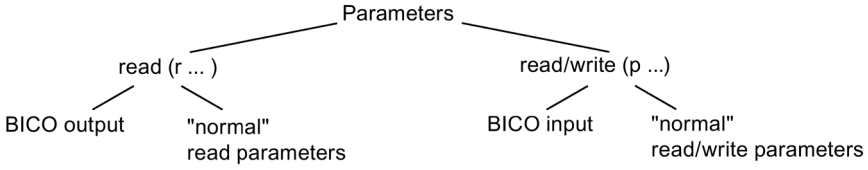



Figure 9-1 Parameter types

All these drive parameters can be read via PROFIBUS and changed by means of 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 various types of data set:
  - CDS: Command Data Set
    By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.
  - DDS: Drive Data Set
    The drive data set contains the parameters for switching between different automatic speed control configurations.

The CDS and DDS can be switched over during normal operation. Additional types of data set also exist, but these can only be activated indirectly by means of a DDS changeover.

- EDS - Encoder Data Set

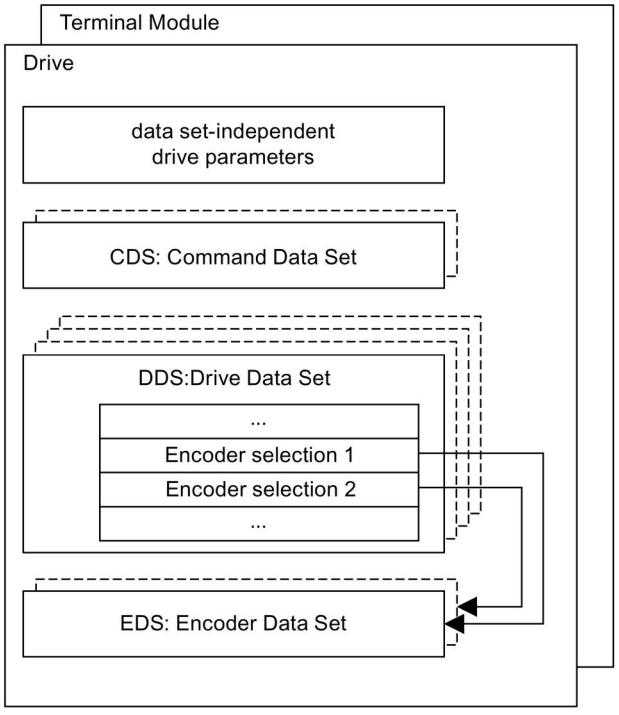



Figure 9-2 Parameter categories

## Saving parameters in a non-volatile memory

The modified parameter values are stored in the volatile RAM. When the drive system 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.

There are various methods:

- Save parameters using the BOP20:
  press the P button on the BOP20 until the display flashes.
  Flashing stops once the parameters have been saved.
- Saving parameters with STARTER
  See "Copy RAM to ROM" function
- Saving parameters
  p0977 = 1; automatically reset to 0

**Note**

The power supply to the Control Unit may first be switched off only after saving has finished (i.e. after saving has started, wait until the parameter has the value 0 again).

## Resetting parameters

The (loaded to the RAM) parameter values 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.

The parameter values are reset in the volatile memory (RAM). If the reset parameter values are also to be transferred into the ROM, then "Save parameters in a non-volatile memory" must be executed.

## Deleting all user data

User data includes:

- parameter values
- additional parameter data sets (see p0802, p0803, p0804)
- the DCC block library
- DCC charts

This data is 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 device automatically powers up during this time. As a result, the device 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 ramp-up after p0976 = 200, as usual, the data would be read from the memory card (see also Chapter "Memory card functions"). The device would power-up with the parameter assignment from the memory card.

## Access level

The parameters are subdivided into access levels. The SINAMICS DCM 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 9- 1 Access levels

| Access level | Comment |
|---|---|
| 0 User-defined | Parameter from the user-defined list (p0013) |
| 1 Standard | Parameters for the simplest possible operations (e.g. p50303 = ramp-function generator ramp-up time) |
| 2 Extended | Parameters for handling the basic functions of the device |
| 3 Expert | Expert knowledge is already required for these parameters (e.g. knowledge of assigning BICO parameters). |
| 4 Service | Please contact your local Siemens office for the password for parameters with access level 4 (Service). It must be entered into p3950. |

## 9.1.2 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 drive.

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

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
  - ON/OFF, enable signals (p0844, etc.)
  - Jog (p1055, etc.)
- Connector inputs for setpoints (analog signals)
  - Speed setpoint (p50433)
  - Torque setpoints (p50500, p50501)

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 selected data set

**Example: Switching between command data set 0 and 1**

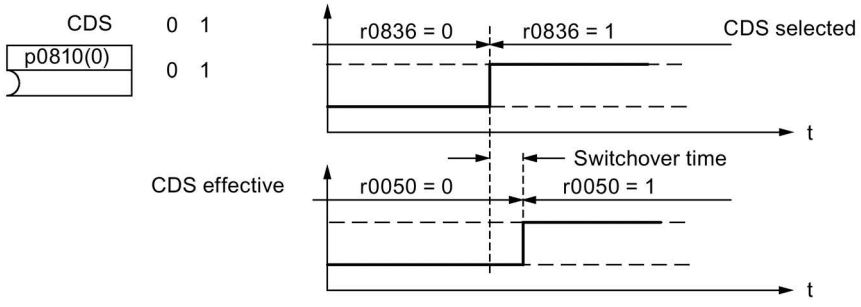



Figure 9-3 Switching the command data set (example)

## DDS: Drive data set

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

- Numbers of the assigned encoder data sets:
  - p0187 and p0188: Up to 2 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
  - Speed limits min./max. (p50512, p50513)
  - Characteristic data of ramp-function generator (p50295 ff)
  - Characteristic data of controller (p50540 ff)
  - ...

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

It is possible to parameterize several drive data sets. You can switch easily between different drive configurations (control type, motor, encoder) 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 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

## EDS: Encoder data set

An encoder data set contains various adjustable parameters for the connected encoder that are relevant for configuring the drive.

- Adjustable parameters, e.g.:
  - Encoder interface component number (p0141)
  - Encoder component number (p0142)
  - Encoder type selection (p0400)

The parameters that are grouped together in the encoder data set are identified in the parameter list by "EDS" and are provided with index [0...n].

A separate encoder data set is required for each encoder controlled by the Control Unit. Up to 2 encoder data sets are assigned to a drive data set via parameters p0187 and p0188.

It is only possible to switch an encoder data set by means of a DDS switchover. When a drive data set is selected, the assigned encoder data sets are selected automatically.

### Example of data set assignment

Table 9- 2 Example, data set assignment

| DDS | Encoder 1 (p0187) | Encoder 2 (p0188) |
|---|---|---|
| DDS 0 | EDS 0 | EDS 1 |
| DDS 1 | EDS 0 | EDS 0 |
| DDS 2 | EDS 0 | EDS 0 |
| DDS 3 | EDS 1 | - |

## 9.1.2.1 Function diagrams and parameters

### Function diagrams (see the SINAMICS DCM List Manual)

- 8560 Command data sets (CDS)
- 8565 Drive data sets (DDS)
- 8570 Encoder data sets (EDS)

### Overview of important parameters (refer to the SINAMICS DCM List Manual)

Adjustable parameters

- p0140 Encoder data sets (EDS) number
- p0170 Command data sets (CDS) number
- p0180 Drive data sets (DDS) number
- p0187 Encoder 1 encoder data set number
- p0188 Encoder 2 encoder data set number
- p0809 Copy command data set (CDS)
- p0810 BI: Command data set CDS bit 0
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1

### 9.1.2.2 Using data sets

#### 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

Starts copying.

Copying is finished when p0809[2] = 0.

#### Copying a 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

Starts copying.

Copying is finished when p0819[2] = 0.

#### Uncommissioned data sets

Drive commissioning can be completed even if uncommissioned data sets (EDS, DDS) are available.

Uncommissioned data sets are marked as "uncommissioned".

The attributes are displayed in STARTER or in the expert list or OPs.

Activating these data sets is not permitted and any attempt to do so will be rejected with an error.
Assigning these data sets to a drive data set (DDS) is only possible by means of a commissioning step (p0009 ≠ 0, p0010 ≠ 0).

**Note**

If there is no DDS dataset with the attribute "commissioned", the drive remains in a controller inhibit state.

## 9.1.3 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. automatic speed control), or can be added individually or in groups times (e.g. TM31).

Properties of a drive object:

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

### Drive objects in the SINAMICS DC MASTER

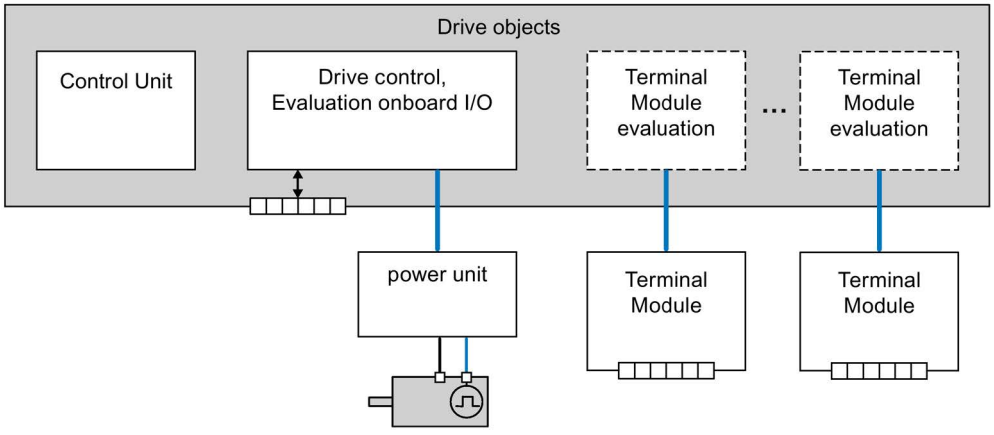



Figure 9-4 Drive objects

- Automatic speed control (DC_CTRL)
  Automatic speed control handles closed-loop control of the motor. The I/Os on the CUD are evaluated within this drive object.
- Control Unit (CU_DC)
  This drive object contains a variety of different system parameters.
- Evaluation of optional Terminal Module
  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 through parameters (see Chapter "AUTOHOTSPOT").

**Note**

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

## Overview of important parameters (refer to the SINAMICS DCM List Manual)

Adjustable parameters

- p0101 Drive object numbers
- p0107 Drive object type
- p0108 Drive object configuration

Display parameters

- r0102 Number of drive objects

## Standard drive objects

- Automatic speed control
- Control Unit

## 9.1.4 Memory card functions

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

### Basic information

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

- A volatile memory, the **RAM**, also called work memory
- A non-volatile memory, the **ROM**, also called **flash memory**
- An optionally available portable memory card

**Note**

Memory cards can be ordered as an option (S01/S02) or as accessories, see Chapter "Ordering information for options and accessories (Page 26)".

The functionality in SINAMICS DCM is not guaranteed for memory cards from other manufacturers!

SINAMICS DCM does not evaluate the position of the write protection slide switch.

Before removing the memory card from the slot, it is recommended that the "Safely remove memory card" function is selected using p9400 = 2. Wait for p9400 = 3 ("Card can be safely removed"). P9400 is set = 0 after the memory card has been removed ("No memory card inserted").

The work memory receives all project information and application programs while the device is being operated. To save the current data from the work memory, you must copy it to non-volatile memory **before** shutting down, see Chapter "Commissioning", "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 DCM drives
- For series commissioning

The memory card is needed:

- For installing firmware updates
- For using an AOP30 in languages other than German, English and Chinese
- To use the function "SINAMICS Link" (see Chapter "Communication via SINAMICS Link")
- To load the DCC block library into the drive

**Note**

The memory card supplied from Siemens as option S01 or S02 includes, when supplied, a dump of the internal device firmware. These files are required to update the firmware as well as to use the "SINAMICS Link" function. 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. Parameter data sets differ on the basis of drive configuration (power unit, motor, encoder, etc. used) and application (e.g. function modules, type of control).

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 to the memory card

There are three options for copying parameter data sets to the memory card:

- **The electronics power supply is switched off**
  - Insert the memory card that does **not** contain a parameter data set with index 0 into the CUD.
  - Switch on the electronics power supply
  - The parameter data set with index 0 is loaded from the ROM into the RAM
  - Then the complete and updated parameter data set with the index 0 is automatically copied to the memory card **without a prompt**.
- **The electronics power supply is switched on**
  - Insert a memory card into the CUD
  - Execute command "RAM to ROM" (using p0977=1 – or by pressing the "P" button on the BOP20 operator panel until the display starts to flash). The actual parameter data set is copied automatically, first to the ROM and then 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 electronics power supply is switched on**
  - The save operation is initiated via parameter:

    p0802 = 0 ... 100: Target on the memory card

    p0803 = 0/10/11/12: Source in the device memory

    p0804 = 2: Start data transfer

**Note**

If when switching on, a memory card with a parameter data set with index 0 is inserted in the CUD, the parameter data set with index 0 in the non-volatile memory of the CUD is overwritten with the parameter data set with index 0 on the memory card.

**Note**

When a memory card is inserted, the RAM to ROM command (p0977 = 1) will copy the parameter data set with the 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.

**Note**

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

**Note**

When options are being used (DCC, SMC10, SMC30, TM15, TM31, TM150 etc.) and with certain device configurations, storage can take several minutes.

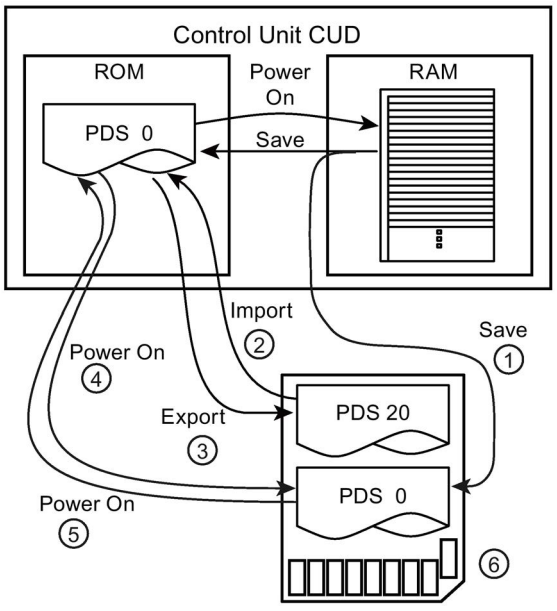
### Copying parameter data sets from the memory card to non-volatile memory

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

- **The electronics power supply is switched off**
  - Insert a memory card containing a parameter data set with the index 0 into the CUD.
  - Switch on the system. The new parameter data is copied to the RAM, and then "RAM to ROM" is automatically executed. The parameter data set with the index 0 which was previously in the ROM will be overwritten.
  - The system will then boot with the new parameter data set.
- **The electronics power supply is switched on**
  - The save operation is initiated via parameter:
    p0802 = 0 ... 100: Source on the memory card
    p0803 = 0/10/11/12: Target in the device memory (ROM)
    p0804 = 1: Start data transfer

**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 9-5 Copying parameter data sets

## Using the memory card for series commissioning

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

Procedure:

1. Completely commission a "sample" drive. As soon as all of the parameters have been correctly set, carry out "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.
5. Insert the card into a CUD that is switched-off and has still not been parameterized. Switch on the system (POWER ON).
6. When powering up, the parameter assignment is transferred into the CUD and copied into the ROM as well as into 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 powered-up. The CUD that was still not parameterized now has the same parameter assignment as the original "sample" drive.

**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, fault A1420 is output). This occurs, if e.g. a parameter set that was generated from a 30 A device is loaded into a 60 A device. In this state, the user can accept the parameter set by setting p9906 = 3. The system continues to power up.

The same procedure also applies if a parameter data set from a standard CUD is loaded into an Advanced-CUD - or vice versa. The power-up procedure stops with display "33" on the BOP; the parameter set is accepted using p9906 = 3 and the system continues to power up.

## Important parameters

p0977: Save all parameters (for more information, see the SINAMICS DCM 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"<br>Remove the memory card |
| p9400 = 100 | Feedback: "It is not possible to safely remove the memory card"<br>SINAMICS DCM 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.

## 9.1.5 BICO technology: Interconnecting signals

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

The drive unit 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.

### 9.1.5.1 Binectors, connectors

#### Binectors, BI: Binector input, BO: Binector output

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

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

Table 9- 3 Binectors

| Abbreviation | Symbol | Name | Description |
|---|---|---|---|
| BI | | Binector input (signal sink) | Can be interconnected to a binector output as source.<br>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 9- 4 Connectors

| Abbreviation | Symbol | Name | Description |
|---|---|---|---|
| CI | | Connector input (signal sink) | Can be interconnected to a connector output as source.<br>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. |

### 9.1.5.2 Interconnecting signals using BICO technology

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

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

- Binectors: Parameter number, bit number, and drive object ID
- Connectors with no index: Parameter number and drive object ID
- Connectors with index: Parameter number, index, and drive object ID
- Data type (signal source for connector output parameter)

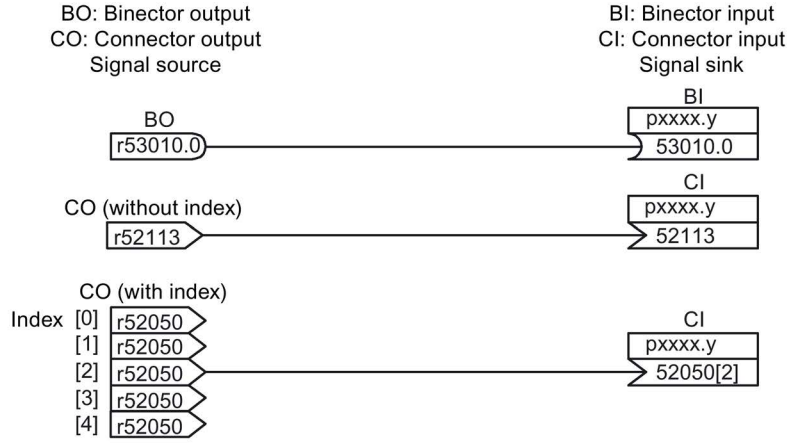



Figure 9-6 Interconnecting signals using BICO technology

**Note**

A connector input (CI) cannot be just interconnected with any connector output (CO, signal source). The same applies for binector input (BI) and binector output (BO).
For each CI and BI parameter, the parameter list shows under "data type" the information on the data type of the parameter and the data type of the BICO parameter.
For CO parameters and BO parameters, only the data type of the BICO parameter is shown.
*Notation:*
Data types BICO input: Data type parameter/Data type BICO parameter
Example: Unsigned32 / Integer16
Data types BICO output: Data type BICO parameter
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" section of the SINAMICS DCM List Manual.

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

### 9.1.5.3 Internal encoding of the binector/connector output parameters

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

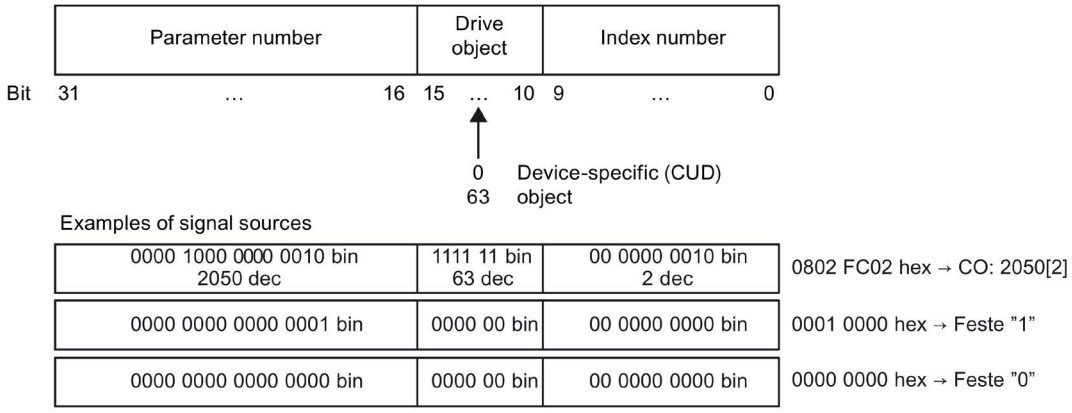



Figure 9-7 Internal encoding of the binector/connector output parameters

### 9.1.5.4 Example: Interconnecting digital signals

Suppose you want to operate a drive via terminals DI 0 and DI 3 on the CUD using jog 1 and jog 2.

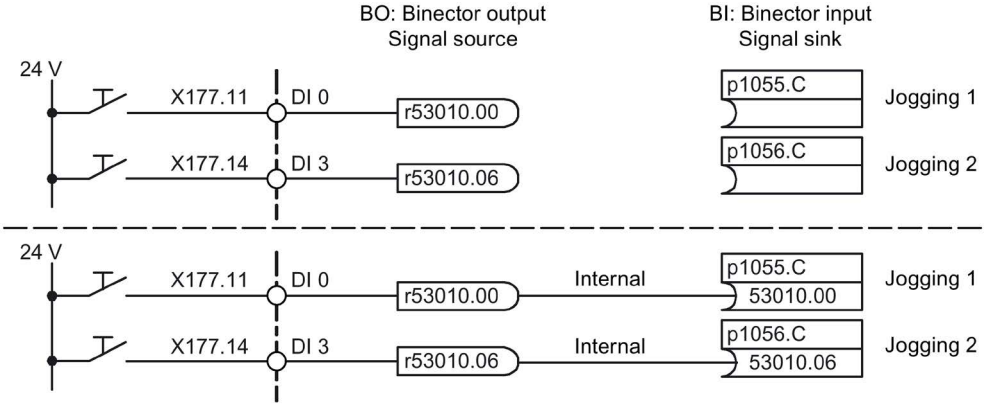



Figure 9-8 Interconnecting digital signals (example)

#### 9.1.5.5 Information on BICO technology

### Binector-connector converters and connector-binector converters

**Binector-connector converter**

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

**Connector-binector converter**

- A 32-bit integer double word or a 16-bit integer word is converted to individual digital signals.
- p2099[0...1] CI: 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
- p2930[0...n] CO: Fixed value_M_1

Example:

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

## 9.2 Parameterizing using the BOP20 (Basic Operator Panel 20)

### 9.2.1 General information about the BOP20

The BOP20 can be used to power drives up and down during the commissioning phase as well as display and modify parameters. Faults can be diagnosed as well as acknowledged.

## Overview of displays and keys

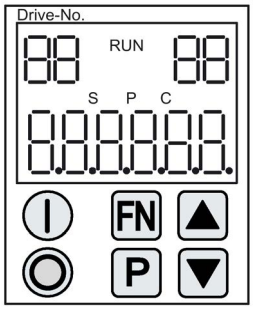



Figure 9-9 Overview of displays and keys

## Information on the displays

Table 9- 5 Displays

| Display | Meaning |
|---|---|
| Top left<br>2 digits | The active drive object of the BOP is displayed here.<br>The displays and key operations always refer to this drive object. |
| RUN | Is displayed, if at least one drive in the drive line-up is in the RUN state (in operation).<br>RUN is also displayed via bit r0899.2 of the drive. |
| Top right<br>2 digits | The following is displayed in this field:<br>• More than 6 digits: Characters that are present but cannot be seen (e.g. "r2" —><br>2 characters to the right are invisible, "L1" —> 1 character to the left is invisible)<br>• Faults: Selects/displays other drives with faults<br>• Designation of BICO inputs (bi, ci)<br>• Designation of BICO outputs (bo, co)<br>• Source object of a BICO interconnection with a drive object different than the active one |
| S | Is displayed if at least one parameter was changed and the value has not yet been transferred to the non-volatile memory. |
| P | Is displayed if, for a parameter, the value only takes effect after the P key is pressed. |
| 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 example |
| The currently displayed characters flash at 1 Hz | Saving "RAM to ROM" is active (e.g. initiated by p0977 = 1 or by pressing the P button for a longer period of time (3 s)) |

**Note**

During a data save operation initiated by the user, the electronic power supply for the SINAMICS DC MASTER must not be interrupted.

An active saving process is indicated by the following actions:

- The RDY LED flashes (see the "Description of functions" chapter, "Description of the LEDs on the CUD" section)
- The BOP20 flashes

Interrupting the electronic power supply while saving can lead to the loss of the actual device parameter assignment. Also refer to Chapter "Operation", Section "Memory card functions".

For certain user actions (e.g. restore factory setting) a two-digit number is displayed on the BOP20. This number provides information about the drive state. The significance of these numbers is provided in Appendix B.

## Information on the keys

Table 9- 6 Keys

| Key | Name | Meaning |
|---|---|---|
| | ON | Power up the drives for which the "ON/OFF1" command should come from the BOP.<br>Binector output r0019.0 is set using this key. |
| | OFF | Power down the drives for which the "ON/OFF1", "OFF2", or "OFF3" commands should come from the BOP.<br>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.<br>**Note**:<br>Whether these keys are active can be defined by assigning appropriate BICO parameters (e.g. it is possible to use these keys to control all of the existing drives at the same time). |
| | Functions | The meaning of these keys depends on the current display.<br>**Note**:<br>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.<br>If this key is pressed for 3 s, the "Copy RAM to ROM" function is executed. The "S" displayed on the BOP disappears. |
| | Increase | The keys depend on the current display and are used to either increase or decrease values. |
| | Decrease | |

## BOP20 functions

Table 9- 7 Functions

| Name | Description |
|---|---|
| Backlighting | The backlighting 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.<br>The higher the access level, the more parameters can be selected using the BOP. |
| Parameter filter | Using the parameter filter in p0004, the available parameters can be filtered according to their particular function. |
| Select status display | Actual values and setpoints are displayed on the status display.<br>The status display can be set via p0006. |
| User parameter list | Parameters can be selected for access using the user parameter list in p0013. |
| Hot swapping | The BOP can be unplugged and plugged while energized.<br>• The ON and OFF keys have a function.<br>When unplugging, the drives are stopped.<br>After plugging, the drives must be switched on again.<br>• The ON and OFF keys have no function<br>Unplugging and plugging has no effect on the drives. |
| Key operation | The following applies to the "P" and "FN" keys:<br>• When used in a combination with another key, "P" or "FN" must be pressed before the other key. |

## Overview of important parameters (refer to the SINAMICS DCM List Manual)

**All drive objects**

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

**Drive object, Control Unit (CU_DC)**

- r0002 Control Unit status display
- p0003 BOP access level
- p0004 BOP display filter
- p0007 BOP backlighting
- p0008 BOP drive object selection
- 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

**Drive object (DC_CTRL)**

- p0010 Commissioning, parameter filter

## 9.2.2 Displays and using the BOP20

### Characteristics

- Status display
- Changing the active drive object
- Displaying/changing parameters
- Displaying/acknowledging faults and alarms
- Controlling the drive using the BOP20

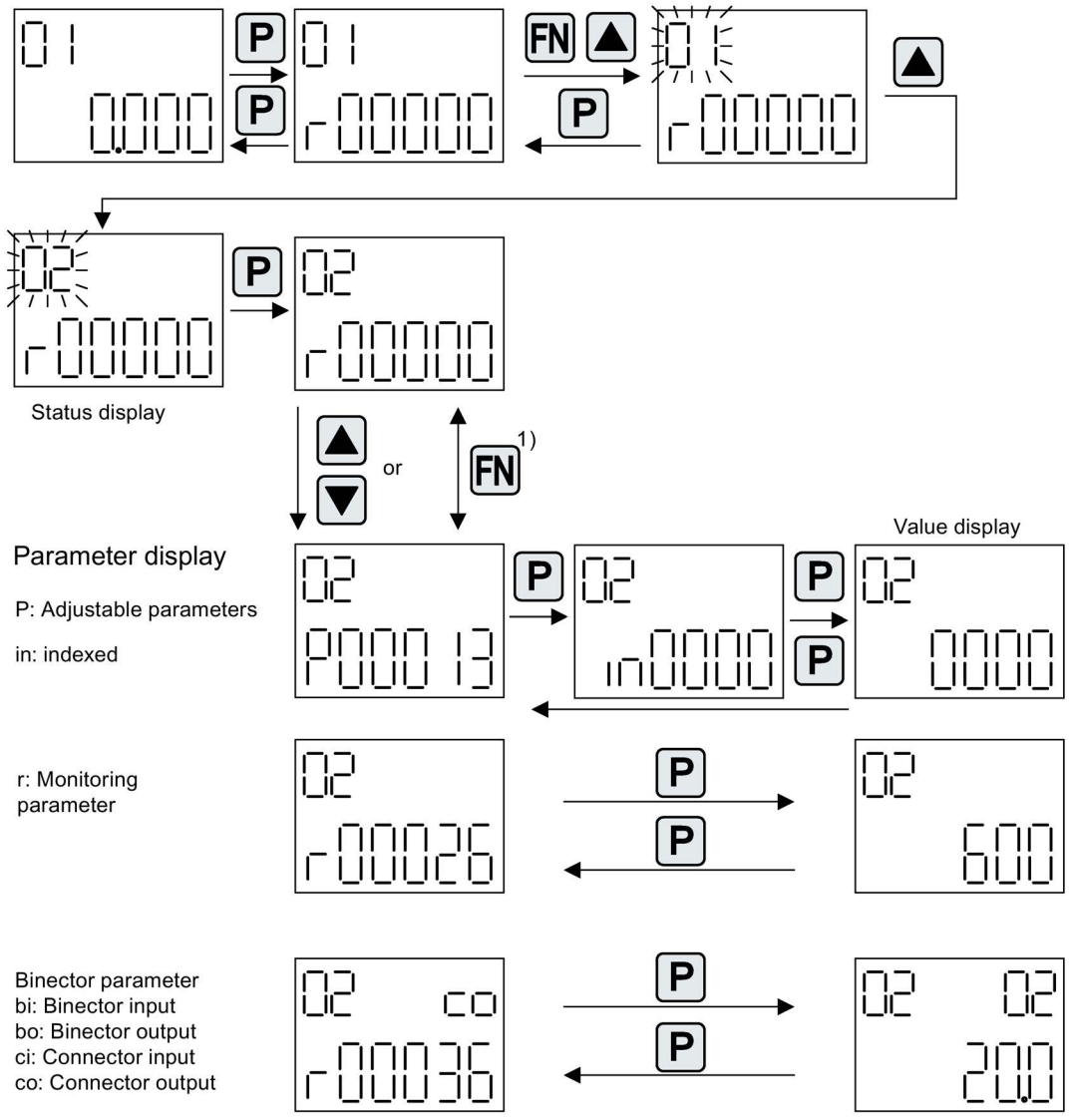
### Status display

The operating display for each drive object can be set using p0005 and p0006. Using the operating display, you can change into the parameter display or to another drive object. The following functions are possible:

- 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 -> "r00000" is displayed
  - Press the "P" key -> returns to the status display

## Parameter display

The parameters are selected in the BOP20 b their number. The parameter display is reached from the operating display by pressing the "P" key. Parameters can be searched for using the arrow keys. The parameter value is displayed by pressing 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 "r00000" 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 9-10 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.

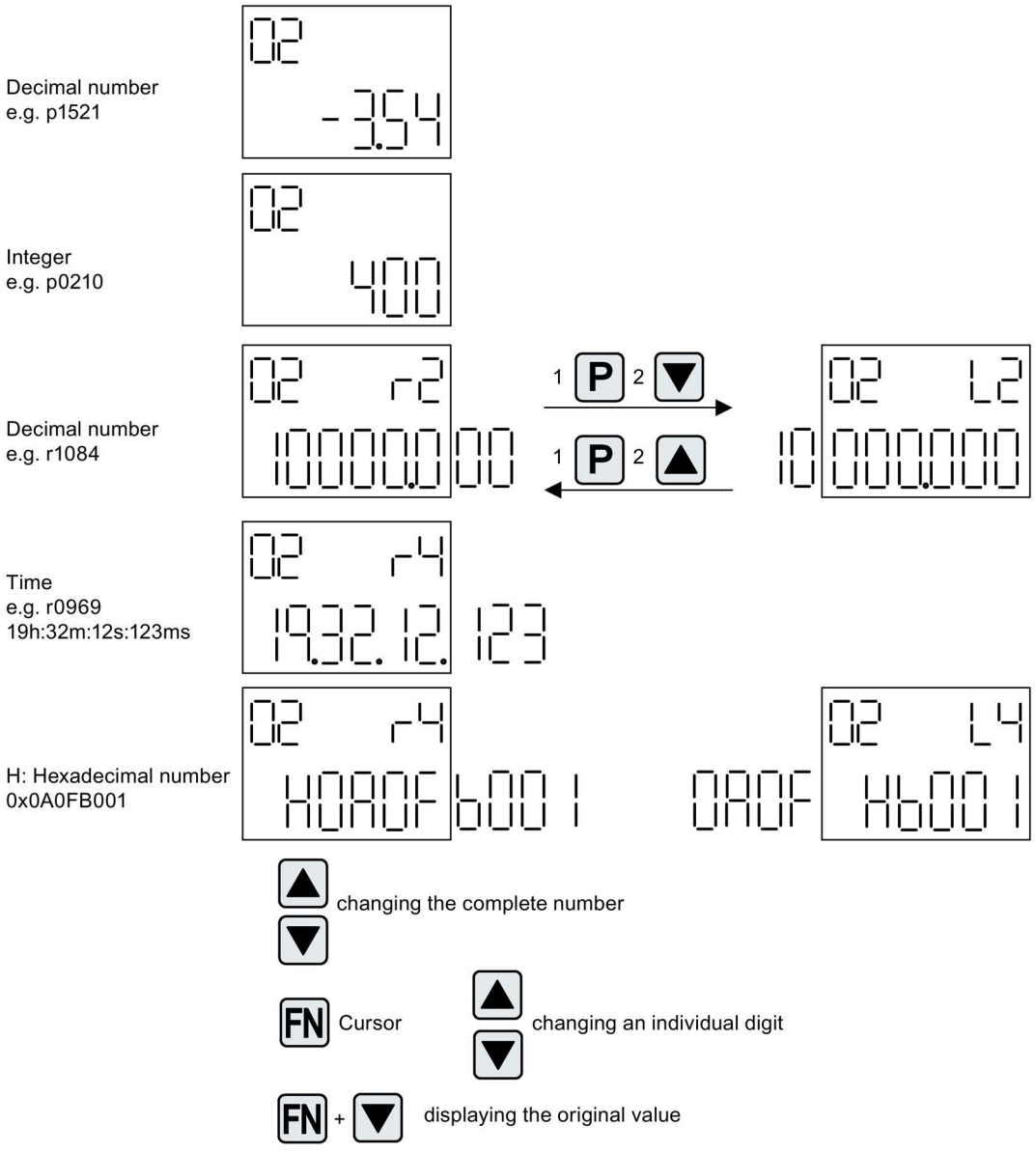



Figure 9-11 Value display

## Example: Changing a parameter

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

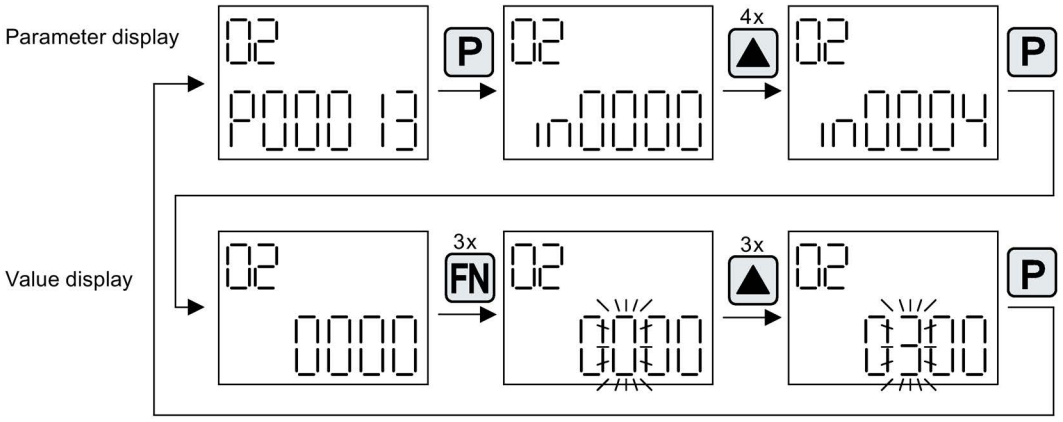



Figure 9-12 Example: Changing p0013[4] from 0 to 300

## 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.

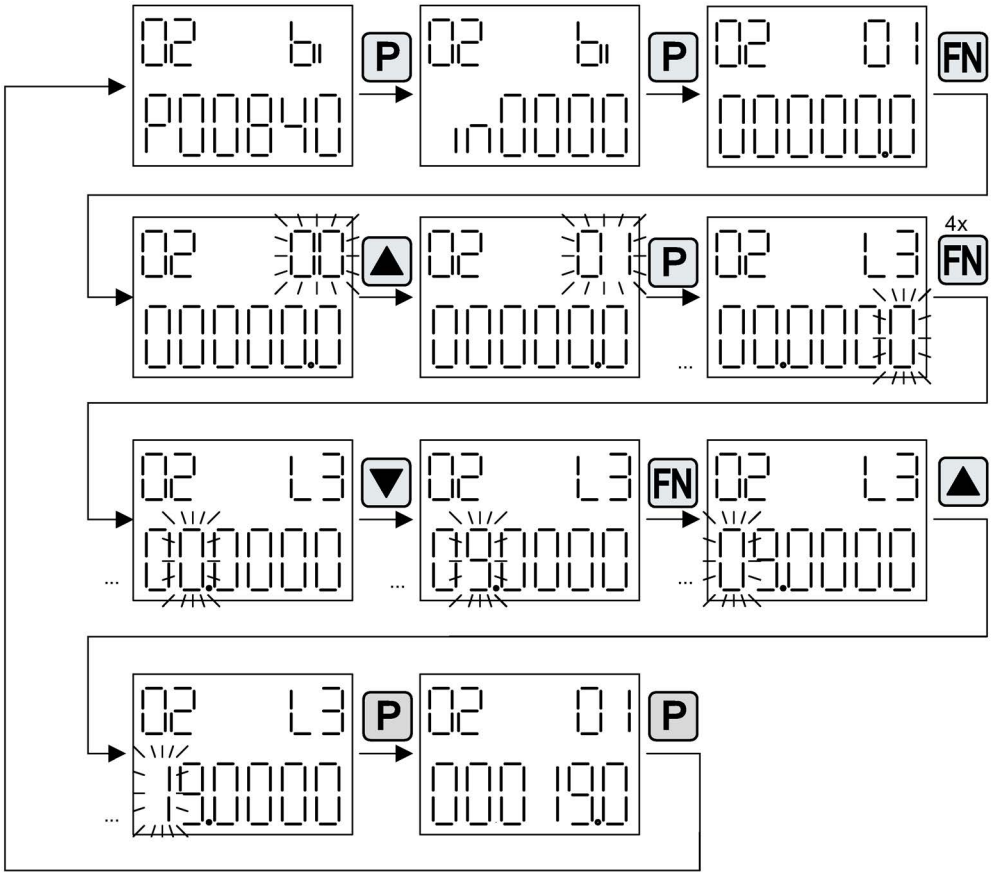



Figure 9-13 Example: Changing indexed binector parameters

## 9.2.3 Displaying faults and alarms

### Displaying faults

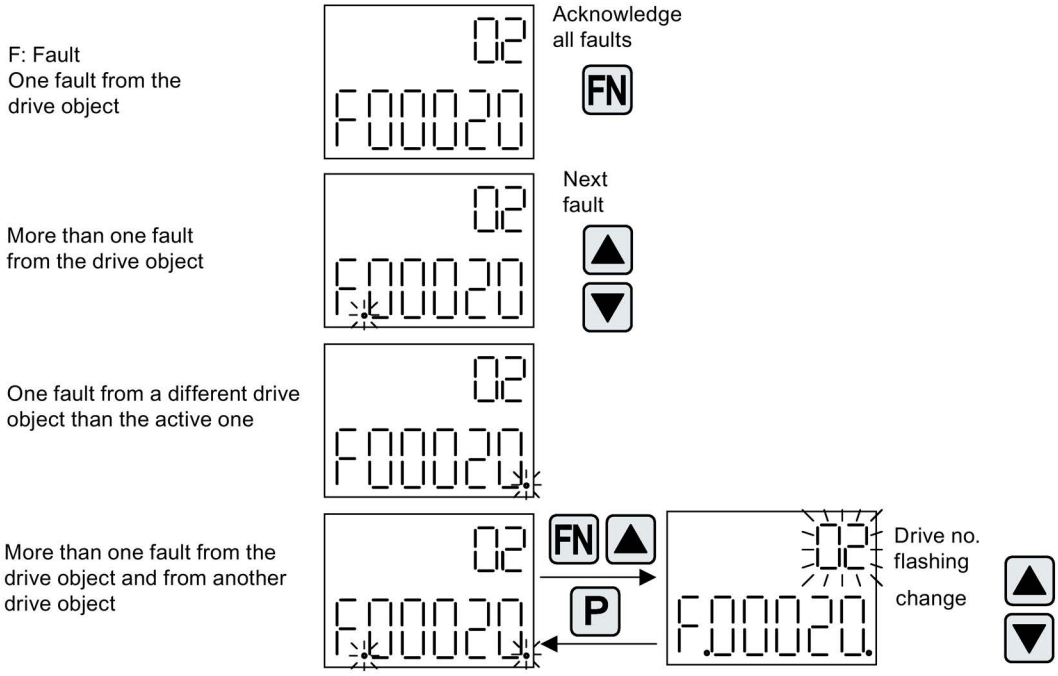



Figure 9-14 Faults

### Displaying alarms

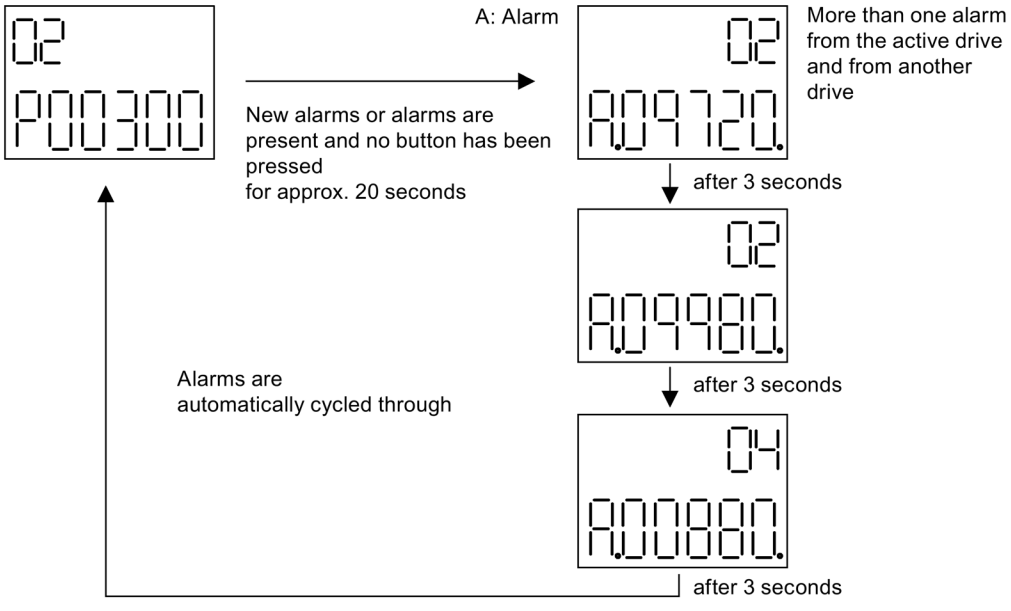



Figure 9-15 Alarms

## 9.2.4 Controlling the drive using the BOP20

When commissioning the drive, 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 of e.g. the drive.

The interconnections do not function if a standard PROFIdrive telegram was selected as its interconnection cannot be disconnected.

Table 9- 8 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 |
| 13 | Motorized potentiometer, raise | p1035 |
| 14 | Motorized potentiometer, lower | p1036 |

**Note**

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

## 9.3 Controlling via the AOP30 operator panel

**Note**

The OFF switch on the AOP30 operator panel does not have an EMERGENCY OFF function.

The OFF switch on the AOP30 operator panel does not have an STO function regarding functional safety.

**Note**

To operate the AOP30, p2030 = 3 must be set.

An operator panel is located in the cabinet door of the cabinet unit for operating, monitoring, and commissioning tasks. It has the following features:

- Graphical, backlit LCD for plain-text display and a "bar display" of process variables
- LEDs for displaying the operating states
- Help function describing the causes of and remedies for faults and alarms
- Keypad for controlling a drive under normal operating conditions
- LOCAL/REMOTE switchover for selecting the control terminal (master control assigned to operator panel or customer terminal block/PROFIBUS)
- Numeric keypad for entering setpoints or parameter values
- Function keys for prompted navigation through the menus
- Two-stage safety concept to protect against accidental or unauthorized changes to settings
- IP54 degree of protection (when installed)

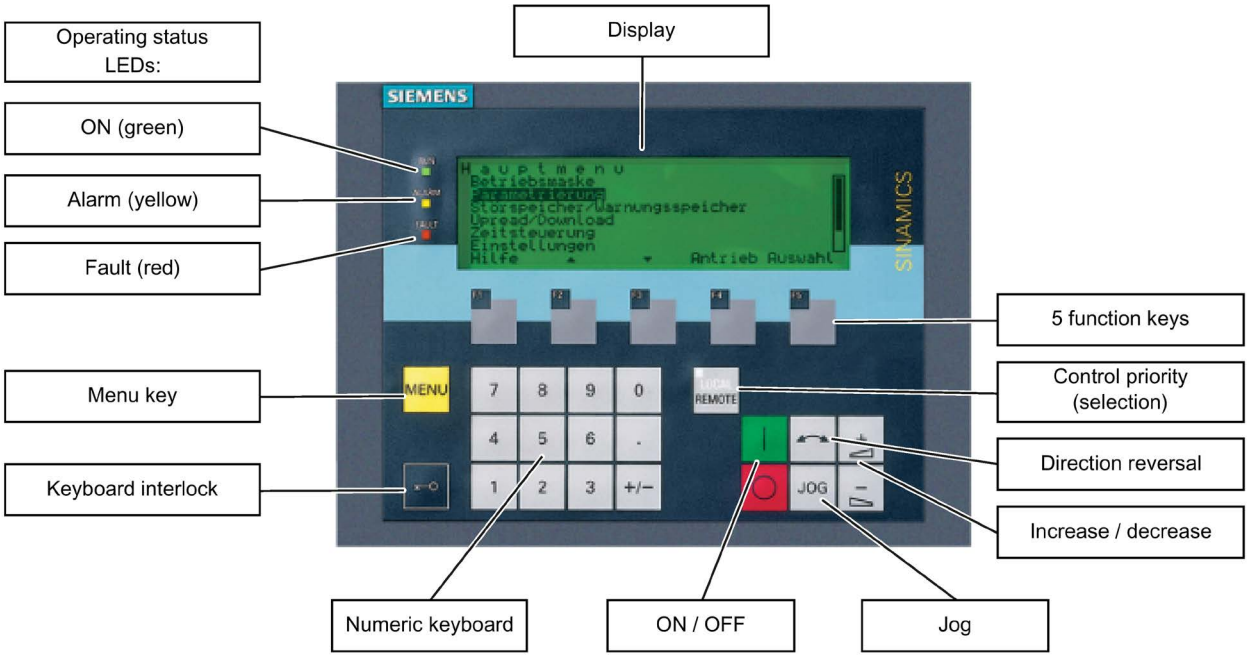



Figure 9-16 Components of the cabinet unit operator panel (AOP30)

## 9.3.1 Overview and menu structure

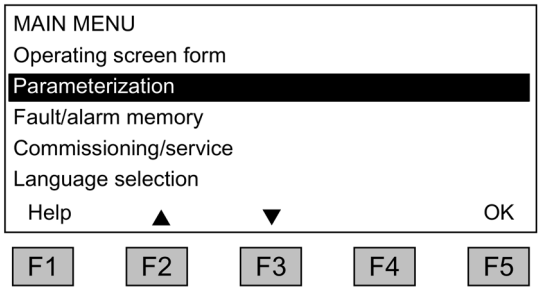
### Description

The operator panel can be used for:

- Assigning parameters (commissioning)
- Monitoring status variables
- Controlling the drive
- Diagnosing faults and alarms

All the functions can be accessed via a menu.

Your starting point is the main menu, which you can always call up using the yellow MENU key:




Dialog screen for the main menu:
This can be accessed with the "MENU" key.

Press "F2" or "F3" to navigate through the menu options in the main menu.

## Menu structure of the operator panel

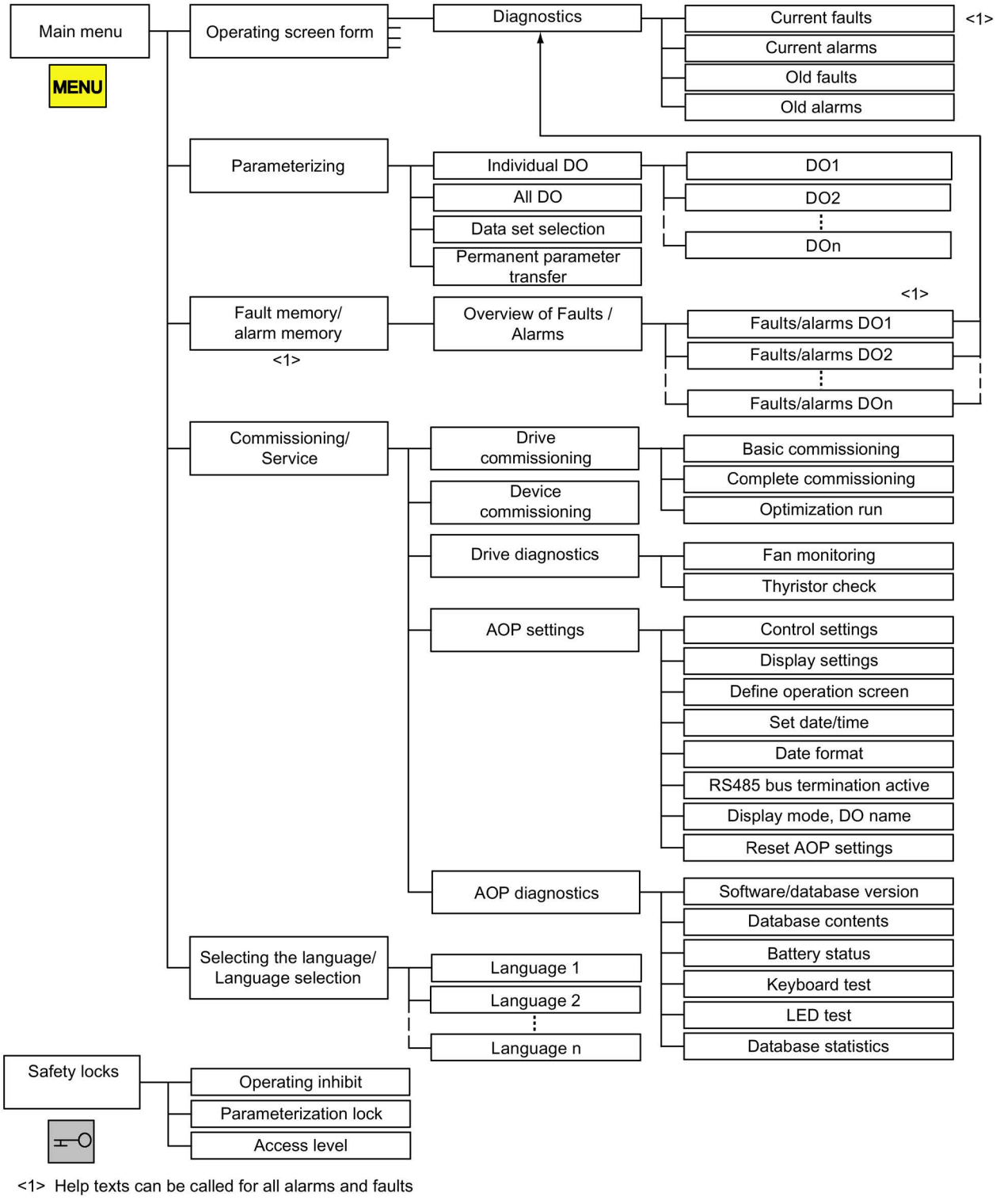



Figure 9-17 Menu structure of the AOP30 operator panel

## 9.3.2 Menu: Operation screen

### Description

The operation screen displays the most important status variables for the drive unit:

In the factory setting, it displays the operating state of the drive, the direction of rotation, the time, as well as four drive variables (parameters) in numerical format and two values in the form of a bar display for continuous monitoring.

You can call up the operation screen in one of three ways:

1. Automatically after ramping-up is complete
2. From the main menu, by selecting the "Operation screen" menu command and F5 ("OK")
3. From the "Fault/alarm overview" screen, by selecting F4 ("Tools+"/"Back") and F5 ("OK") if the jump is from the operation screen into this screen

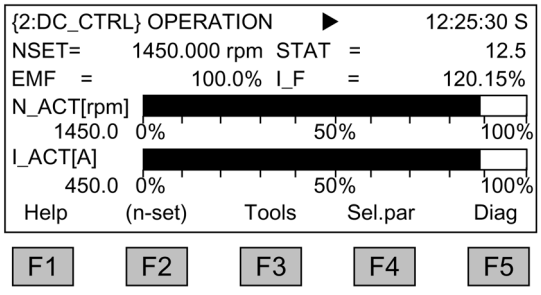



Figure 9-18 Operation screen

If a fault was registered during ramping-up, the system automatically branches from the operation screen into which the jump was made following the ramping-up process into the fault screen. This also happens if the system is on the operation screen and the first fault is registered here.

You can use F2 in the LOCAL state to enter the setpoint via the numeric keypad, if the drive is in the OPERATION state or the system setting "Save AOP setpoint" is set to YES.

You can switch to an alternative operation screen with F3 "Tools." It is used to display technological variables and can be defined or changed at "Menu" – "Commissioning / service" – "AOP settings" – "Define operation screen".

The individual parameters of the operation screen can be selected using F4 ("Sel. par"). F1 ("Help+") can be used to display the corresponding parameter number of the short identifier and call up a description of the parameter.

### Setting options

When you choose Commissioning / service – AOP settings – Define operation screen, you can adjust the display type and the values displayed as required (see Chapter "AOP settings" (Page 355)).

### 9.3.3 Parameterization menu

You can adjust the unit settings in the Parameterization menu.

Two display types can be selected in the AOP:

1. All parameters
   All the parameters present in the unit are listed with this option. The DO to which the parameter currently selected belongs (inverted) is displayed in curly brackets in the top left of the screen. With this display type, the response time for turning a page is dependent on the number of DOs and is generally longer than with parameter lists that only display one DO.
2. DO selection
   With this display type, you can pre-select a DO so that only the parameters for this DO are listed. (The expert list in STARTER is only displayed in this DO view.)

In both cases, the set access level governs which parameters are displayed. You can set the access level in the menu for safety inhibits, which can be called up using the key button.

The parameters for access levels 1 and 2 are sufficient for simple applications.

At access level 3 ("Expert"), you can change the structure of the function by interconnecting BICO parameters.

**The Parameterization menu offers four options:**

- **Individual DO**

  Shows the parameters of a DO to be selected in advance

- **All DOs**

  Shows the parameters of all DOs in list format (as described previously)

- **Data set selection**

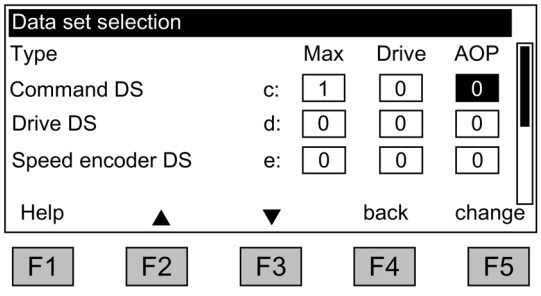



Figure 9-19 Data set selection

In the "AOP" column of the "Data set selection" screen, you can choose which of the data sets selected is currently displayed on the operator panel. The data set numbers that are set in the drive (i.e. are currently active) are displayed in the "Drive" column. The "Max" column shows the maximum data set number to be entered for the AOP30 display.

In parameter lists, data set parameters are indicated by the letter c, d, or e between the parameter number and parameter designator. The number at the right of the first row from the top shows which data set a highlighted parameter comes from.

In the commissioning wizard, the drive is commissioned using the data set selected on this screen in the AOP column.

The data set selection dialog appears whenever a data set parameter is changed in the parameter list. The data set selected in the data set selection screen is a default setting.

- **Permanent parameter transfer**

  Parameter changes in the SINAMICS DC MASTER are only made temporarily in the RAM. If a parameter assignment is intended to be permanent, it is possible to trigger a save process at this point. Depending on the configuration, this can take from 45 s to several minutes.

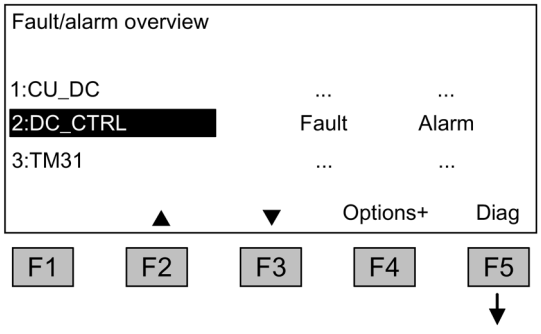
  Also refer to Chapter "Operation", Section "Memory card functions".

## 9.3.4 Menu: Fault/alarm memory

When you select this menu, a screen appears containing an overview of faults and alarms that are present.

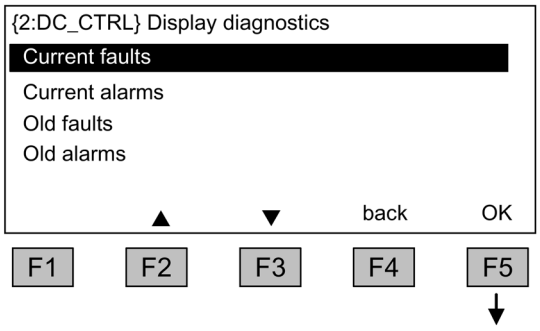
For each drive object, the system indicates whether any faults or alarms are present. ("Fault" or "Alarm" appears next to the relevant drive object).

In the graphic below, you can see that at least one active fault/alarm is present for the "DC_CTRL" drive object. No faults or alarms are indicated for the other drive two objects.



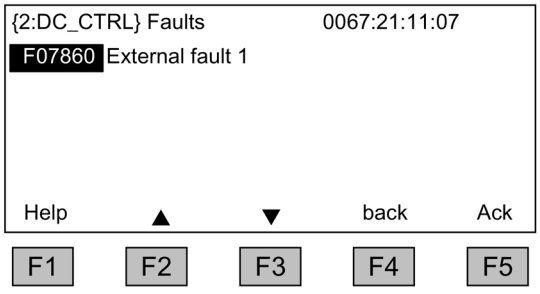

**Overview of Faults / Alarms**

When you navigate to the line with active alarms/faults and then press the F5 <Diag> key, the system displays a screen in which you may select the current or old alarms/faults.




**Display diagnostics**

When you navigate to the required line and then press the F5 <OK> key, the corresponding faults/alarms are displayed. The list of current faults is selected here as an example.




**Current faults display**

A maximum of eight current faults are displayed along with their fault number and a description of the fault.

To display additional help regarding the cause of the problem and how to solve it, choose F1 <Help>.

To acknowledge the faults, choose F5 <Ack>. If a fault cannot be acknowledged, the fault remains.

## 9.3.5 Menu: Commissioning/Service

### 9.3.5.1 Drive commissioning

Selecting this option enables you to re-commission the drive from the main menu, using the AOP wizard.

**Basic commissioning**

A few key parameters (such as the maximum speed, ramp-up time, and ramp-down time) are requested. The changes can then be permanently saved in the final confirmation screen.

**Complete commissioning**

Complete commissioning, with entry of the motor and encoder data, is carried out. Following this, key motor parameters are recalculated on the basis of the motor data. The parameter values calculated during the previous commissioning process are lost. The calculated values are then overwritten during a subsequent optimization run.

**Optimization run**

The selection screen for the optimization runs appears.

### 9.3.5.2 Device commissioning

In this menu, you can enter the device commissioning status directly. This is the only way to reset parameters to the factory setting, for example.

### 9.3.5.3 AOP settings

#### Control settings

This defines the settings for the control keys in LOCAL mode (see the section titled "Operation/Operation via the operator panel") as well as additional settings that are relevant for drive control.

#### Display settings

In this menu, you set the lighting, brightness, and contrast for the display.

#### Define operation screen

In this menu, you can switch between five operation screens. You can set the parameters to be displayed.

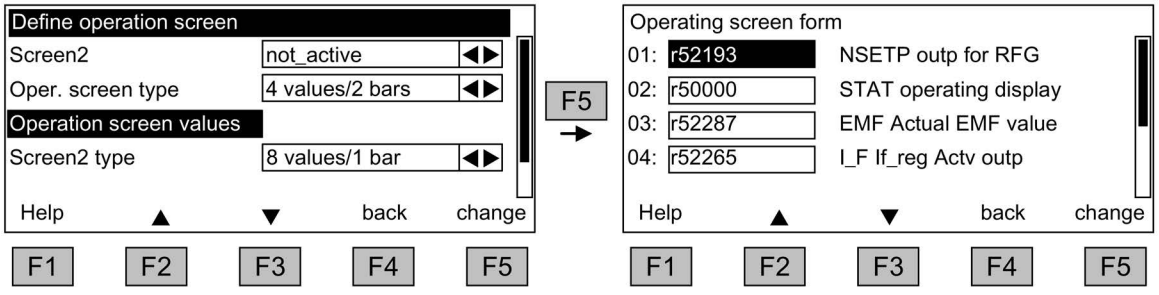



Figure 9-20 Define operation screen

The following screenshot shows how entries are assigned to the screen positions:

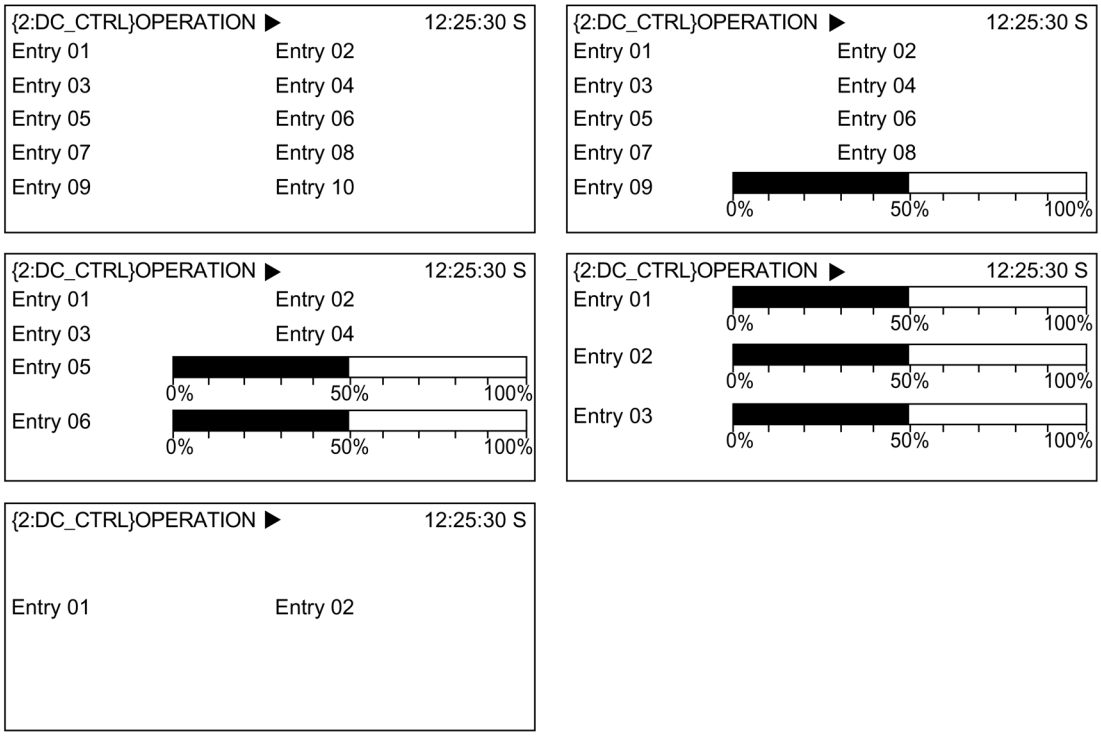



Figure 9-21 Positions of entries on the operation screen

### 9.3.5.4 Lists of signals for the operation screen

The following tables list some of the main signals for the operation screen along with their associated reference variables and default settings for quick commissioning.

## DC_CTRL object

Table 9- 9 List of signals for the operation screen – DC_CTRL object

| Signal | | Parameter | Short name | Unit | Scaling (100%=...) see table below |
|---|---|---|---|---|---|
| Factory setting (entry no.) | | | | | |
| N setpoint following limitations | (1) | r50029 | NSET | rpm | p2000 |
| Status display | (2) | r50000 | STAT | - | - |
| Actual EMF value | (3) | r52287 | EMF | % | - |
| Field current actual value | (4) | r52265 | I_F | % | - |
| Speed actual value | (5) | r00021 | N_ACT | rpm | p2000 |
| Actual armature current value | (6) | r00027 | I_ACT | A | p2002 |
| Armature firing angle | (7) | r50018 | ALF_A | ° | - |
| Field firing angle | (8) | r50034 | ALF_F | ° | - |
| Motor temperature rise | (9) | r50014.0 | TEMP | % | - |
| Thyristor temperature rise | (10) | r50014.1 | TEMP1 | % | - |
| **For diagnostic purposes** | | | | | |
| Speed setpoint smoothed | | r0020 | NSET | rpm | p2000 |
| Actual speed value, motor encoder | | r0061 | N_ACT | rpm | p2000 |
| Actual speed value following smoothing | | r0063 | N_ACT | rpm | p2000 |
| **For further diagnostic purposes** | | | | | |
| PROFIBUS setpoint | | r2050 | PBSET | rpm | p2000 |

## Scalings for DC_CTRL object

Table 9- 10 Scalings for DC_CTRL object

| Variable | Scaling parameter | Default for quick commissioning |
|---|---|---|
| Reference speed | 100% = p2000 | p2000 |
| Reference voltage | 100% = p2001 | p2001 = 1,000 V |
| Reference current | 100% = p2002 | p2002 = Current limit (p0640) |
| Reference torque | 100% = p2003 | p2003 = 2 × rated motor torque |
| Reference power | 100% = r2004 | r2004 = (p2003 × p2000 × π) / 30 |
| Reference temperature | 100% = 100 °C | - |

## TM31 object

Table 9- 11 List of signals for the operation screen – TM31 object

| Signal | Parameter | Short name | Unit | Scaling (100% = ...) |
|---|---|---|---|---|
| Analog input 0 [V, mA] | r4052[0] | AI_UI | V, mA | V: 100 V / mA: 100 mA |
| Analog input 1 [V, mA] | r4052[1] | AI_UI | V, mA | V: 100 V / mA: 100 mA |
| Analog input 0, scaled | r4055[0] | AI_% | % | V: 100 V / mA: 100 mA |
| Analog input 1, scaled | r4055[1] | AI_% | % | V: 100 V / mA: 100 mA |

## Setting the date/time

**Settings: MENU – Commissioning/Service – AOP settings**

For date stamping in the case of fault codes and alarms, and for AOP time display on the operation screen

The AOP30 contains a battery-buffered real-time clock.

You set the date and time on this screen.

**Synchronization**

You can also set whether and/or how the AOP30 and drive unit are to be synchronized. Synchronizing the AOP with the drive enables fault codes and alarms to be date-stamped and time-stamped (in the default setting, time-stamping occurs in accordance with the CU runtime).

- None (factory setting)
  The AOP30 and drive unit times are not synchronized.
- AOP → Drive
  - Activating this option synchronizes the AOP and drive unit immediately, whereby the current AOP time is transferred to the drive unit.
  - The current AOP30 time is transferred to the drive unit every time the AOP30 is started.
  - At 02:00 (AOP time) every day, the current AOP30 time is transferred to the drive unit.
- Drive → AOP
  - If a time-of-day master is connected to the drive, then activating this option enables the AOP and drive unit to be synchronized immediately, whereby the current drive unit time is transferred to the AOP30.
  - The current drive unit time is transferred to the AOP30 every time the AOP30 is restarted.
  - At 02:00 (AOP time) every day, the current drive unit time is transferred to the AOP30.

### Date format

The date format can be set in this menu:

- DD.MM.YYYY: European date format
- MM/DD/YYYY: North American date format

### RS485 bus termination active

Settings are not effective: The RS485 bus termination is continuously active.

### DO name display mode

A user-definable DO name can be activated/deactivated on this screen.

In the drive, there is the option of entering a user-defined, 25-character DO name for each DO, using the configuration software.

The possible number of characters in a DC name display is limited by the screen in question:

1. DO name in screens displaying the current DO
   Examples of screens in this category are operation screens, parameter lists, quick commissioning wizard screens, etc.
   The maximum text length is 7 characters. Example {2:DC_CTRL}
   Texts of up to 7 characters in length are displayed in full. The first 6 characters of texts that are 8 to 25 characters in length are displayed with "..." as the 7th character.
2. DO names in the overview of faults and alarms (alarm overview)
   The maximum text length is 12 characters. Example 2: HOIST 1234
   Texts of up to 12 characters in length are displayed in full.
   The first 11 characters of texts that are 13 to 25 characters in length are displayed with "..." as the 12th character.

Texts that have been shortened can be displayed in full for around 3 seconds by pressing the "+/-" button, provided that the "User-definable DO name" function is activated.

### Reset AOP settings

When you choose this menu option, the AOP factory settings for the following are restored:

- Language
- Display (brightness, contrast)
- Operation screen
- Control settings

**Note**

When you reset parameters, all settings that are different from the factory settings are immediately reset on the operator panel. This may cause the unit to switch to an unwanted operating state. For this reason, you should always take great care when resetting parameters.

### 9.3.5.5 AOP30 diagnostics

#### Software/database version

This menu command shows the versions of the software and database.

The database version must be compatible with the drive software version (refer to parameter r0018).

#### Database contents

Shows detailed information on the drive objects (DOs) present in the system

#### Battery status

This menu displays the battery voltage (in volts and as a bar chart). The battery ensures that the data in the database and the current time are retained.

When the battery voltage is represented as a percentage, a battery voltage of ≤ 2 V is equal to 0%, and a voltage of ≥ 3 V to 100%.

The data is secure up to a battery voltage of 2 V.

- If the battery voltage is ≤ 2.45 V, the message "Replace battery" is displayed in the status bar.
- If the battery voltage is ≤ 2.30 V, the system displays the following message: "Alarm, weak battery".
- If the battery voltage is ≤ 2 V, the system displays the following message: "Caution: The battery is dead".
- If the time and/or database are unavailable due to lack of voltage after a prolonged system downtime, the loss is established by means of a CRC check when the system is switched on again. This triggers a message instructing the user to replace the battery and then load the database and/or set the time.

For instructions on how to change the battery, see "Maintenance and servicing".

#### Keyboard test

On this screen, you can check that the keys are functioning properly. Keys that you press are represented on a symbolic keyboard on the display. You can press keys in any order you wish. You cannot exit the screen (F4 – "Back") until you have pressed each key at least once.

**Note**

Alternatively, you can exit the keyboard test screen by pressing any key and holding it down.

#### LED test

On this screen, you can check that the 4 LEDs are functioning properly.

#### Database statistics

Data related to the database is displayed here (e.g. free memory for additional DOs).

### 9.3.6 Sprachauswahl/Language selection

The operator panel downloads the texts for the different languages from the drive.

In the delivery condition without a memory card, you can toggle between German and English. With memory card (from V1.2), French, Italian, Spanish and Russian are also automatically available. The memory card must remain inserted for operation with these languages. The software provided for the update also includes all of the language packages that are available.

You can change the language of the operator panel via the "Sprachauswahl/Language selection" menu.

**Note**

Languages in addition to those that are currently available for the operator panel are available on request.

### 9.3.7 Operation via the operator panel (LOCAL mode)

You activate the control keys by switching to LOCAL mode. If the green LED in the LOCAL/REMOTE key does not light up, the key is not active.

**Note**

If the "OFF in REMOTE" function is activated, the LED in the LOCAL/REMOTE key flashes.

All of the supplementary setpoints are deactivated for LOCAL master control.

After the master control has been transferred to the operator panel, none of the BICO interconnections at bit 0 to bit 10 of the control word for the sequence control are active (refer to function diagram 2501).

#### 9.3.7.1 LOCAL/REMOTE key

**Activate LOCAL mode:** Press the LOCAL key

**LOCAL mode**: LED lights up

**REMOTE mode**: LED does not light up; the ON, OFF, JOG, direction reversal, faster, and slower keys are not active.

**Settings: Menu – Commissioning/Service – AOP settings – Control settings**

**Save LOCAL mode** (factory setting: Yes)

- **Yes**: The "LOCAL" or "REMOTE" operating state is saved when the power supply is switched off and restored when the power supply is switched back on.
- **No**: The "LOCAL" or "REMOTE" operating state is not saved. "REMOTE" is activated when the power supply is switched on.

**OFF in REMOTE** (factory setting: No)

- **Yes**: The OFF key functions in REMOTE mode even if the drive is being controlled by external sources (PROFIBUS, customer terminal strip, NAMUR terminal strip). WARNING: This function is not an EMERGENCY STOP function.
- **No**: The OFF key only functions in LOCAL mode.

**LOCAL/REMOTE also during operation** (factory setting: No)

- **Yes**: You can switch between LOCAL and REMOTE when the drive is switched on (motor is running).
- **No**: Before switching to LOCAL, a check is carried out to determine whether the drive is in the "Operation" status. If it is, switchover is prevented and the error message "Local mode during operation not possible" is output. Before the system switches to REMOTE, the drive is switched off and the setpoint is set to 0.

### 9.3.7.2 ON key/OFF key

**ON key**: Active in LOCAL if no operator inhibit lock is activated

**OFF key**: Always active in LOCAL; active in REMOTE under certain conditions (if the system setting "OFF in REMOTE" is set to "Yes")

OFF key acts as

- **OFF1**: Ramp-down on the down ramp (p50303)
  At speed 0: Disconnection (only if line contactor is present)
- **OFF2**: Immediate pulse inhibit, motor coasts down
- **OFF3**: Ramp-down on the quick stop ramp (p50296)

Factory setting: OFF1

### 9.3.7.3 CCW/CW changeover

**Settings: Menu – Commissioning/Service – AOP settings – Control settings**

**CCW/CW changeover** (factory setting: No)

- **Yes**: CCW/CW changeover by means of the CCW/CW key functions in LOCAL mode
- **No**: The CCW/CW key is inactive.

For safety reasons, the CCW/CW key is disabled in the factory setting (normally pumps and fans must only be operated in one direction).

The direction of rotation that is currently selected is indicated on the operation screen by means of an arrow next to the operating state.

### 9.3.7.4 Jogging

**Settings: Menu – Commissioning/Service – AOP settings – Control settings**

JOG key active (factory setting: No)

- **Yes**: In "LOCAL" mode, the JOG key is active in the state "Ready for Switching On" (not in "Operation").
- **No**: The JOG key is not active.

See also function diagram 3125 in the SINAMICS DCM List Manual.

The speed for the JOG function is entered using parameter p50436.

### 9.3.7.5 Increase setpoint/Decrease setpoint

You can use the Increase and Decrease keys to enter the setpoint with a resolution of 1% of the maximum speed.

Alternatively, the setpoint can also be entered via the numeric keypad. To do this, press F2 while on the operation screen. The system displays an inverted edit field for entering the required speed. Enter the required value using the numeric keypad. Press F5 ("OK") to confirm the setpoint.

Any speed between 0 and the maximum speed (p2000) can be entered using the numeric keypad.

Setpoint entry in LOCAL mode is unipolar. You can change the direction of rotation by pressing the key that allows you to switch between CCW/CW rotation.

- CW rotation and "Raise key" mean:
  The displayed setpoint is positive and the speed is increased.
- CCW rotation and "Increase" key mean:
  The setpoint displayed is negative and the speed is increased.

### 9.3.7.6 AOP setpoint

**Settings: MENU – Commissioning / Service – AOP Settings – Control Settings**

**Save AOP setpoint** (factory setting: No)

- **Yes**: In LOCAL mode, the last setpoint (once you have released the Increase or Decrease key or confirmed a numeric entry) is saved.
  The next time you switch the system ON in LOCAL mode, the saved value is selected. This is also the case if you switched to REMOTE in the meantime or the power supply was switched off.
  When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the motorized potentiometer setpoint and saved.
  If the system is switched from REMOTE to LOCAL mode while the drive is switched off, the motorized potentiometer setpoint that was last saved is used.
- **No**: On power-up in LOCAL mode, the speed is always set to the value entered under "AOP starting setpoint". When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the AOP setpoint.

**AOP setpoint ramp-up time** (factory setting: 20 s)
Defines the speed at which the setpoint specified by the AOP is increased when the "+" key is pressed.

**AOP setpoint ramp-down time** (factory setting: 30 s)
Defines the speed at which the setpoint specified by the AOP is decreased when the "-" key is pressed.

**AOP starting setpoint** (factory setting: 0.000 rpm)
The AOP starting setpoint is the speed setpoint which is active when the drive is switched on (with the "ON" key on the AOP30); The "Save setpoint" system setting must be set to "No" for this purpose (see also the description of the "Save AOP setpoint" system setting).

**Note**

The internal drive ramp-function generator is always active.

### 9.3.7.7 Inhibiting AOP LOCAL mode

**Settings: MENU – Commissioning / Service – AOP Settings – Control Settings**

**Inhibit AOP local mode** (factory setting: No)

- **Yes**: Deactivates the "Control via operator panel" function, thereby disabling the LOCAL/REMOTE key.
- **No**: Activates the LOCAL/REMOTE key.

**Note**

LOCAL functionality can also be inhibited on the drive by means of the p0806 parameter (BI: Inhibit master control).

### 9.3.7.8 Acknowledging errors via the AOP

**Settings: MENU – Commissioning / Service – AOP Settings – Control Settings**

**Acknowledge fault from the AOP** (factory setting: Yes)

- **Yes**: Errors can be acknowledged via the AOP.
- **No**: Faults cannot be acknowledged via the AOP.

### 9.3.7.9 Timeout monitoring

In "LOCAL" mode or if "OFF in REMOTE" is active, the drive is shut down after 1 s, if the data cable between the AOP and drive is disconnected.

### 9.3.7.10 Operator inhibit lock/Parameters disable

**Operator inhibit lock/Parameters disable**

To prevent the control keys from being operated and parameters from being changed unintentionally, you can activate an operator inhibit lock/parameters disable using a key-operated pushbutton. Two key icons appear at the top right of the display when these safety inhibits are enabled.

Table 9- 12 Operator inhibit lock/parameters disable

| Inhibit type | Online mode | Offline mode |
|---|---|---|
| No safety inhibit | | |
| Operator lock | | |
| Parameter disable | | |
| Operator inhibit lock + parameters disable | | |

## Settings

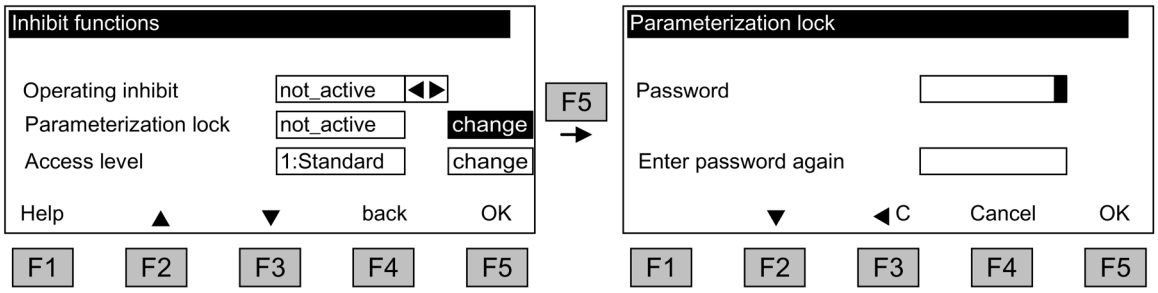



Figure 9-22 Setting safety inhibits

The "Operator inhibit lock" setting can be changed directly via <F5> ("Change") once you have selected the selection box.

When "Parameters disable" is activated, you may enter a numeric password (twice). You must also enter this password when deactivating "Parameters disable".

**Operator inhibit lock** (factory setting: Not active)

- **Active**: The parameters can still be viewed, but a parameter value cannot be saved (message: "Note: Operator inhibit lock active"). The OFF key (red) is enabled. The LOCAL/REMOTE, ON (green), JOG, CW/CCW, INCREASE, and DECREASE keys are disabled.

**Parameters disable** (factory setting: Not active)

- **Active**: Parameters cannot be changed unless a password is entered. Parameters are assigned in the same way as in the operator inhibit lock state. If you try to change parameter values, the message "Note: Parameters disable active" is displayed. All the control keys, however, remain enabled.

**Access level** (factory setting: Expert):

The different parameters required for this complex application are filtered so that they can be displayed as clearly as possible. You select them according to the access level.

An expert level, which must only be used by expert personnel, is required for certain actions.

## 9.3.8 Faults and alarms

### Displaying faults and alarms

If a fault occurs, the drive displays the fault(s) and/or alarm(s) on the operator panel. Faults are indicated by means of the red "FAULT" LED lighting up.

The "Fault/alarm overview" also appears automatically in the following two cases:

1. When a fault is registered while the system is ramping up
2. If the first fault is registered on the operation screen

You can use the F1 (Help) function on the screen to call up information about the cause of the fault and how to remedy it. You can use F5 (Ack.) to acknowledge a stored fault.

Any alarms that are pending are indicated by means of the yellow "ALARM" LED lighting up. Additionally, a note relating to the cause of the alarm is displayed in the status bar of the operator panel.

### What is a fault?

A fault is a message from the drive indicating an error or other exceptional (unwanted) status. This could be caused by a fault within the converter or an external fault triggered, for example, by the winding temperature monitoring function for the motor. The faults are displayed and can be reported to a higher-level control system via PROFIBUS.

### What is an alarm?

An alarm is the response to a fault condition identified by the drive. It does not result in the drive being switched off and does not have to be acknowledged. Alarms are "self-acknowledging"; that is, they are reset automatically when the cause of the alarm has been eliminated.

### Displaying faults and alarms

Every fault and alarm is entered in the fault/alarm buffer along with the time at which it occurred. This time stamp can take two forms:

- Number of days, hours, minutes, and seconds since the AOP was first switched on (format **DDDD: HH:MM:SS**) (no "AOP→ Drive" time synchronization)
- System time (format **YY:MM:DD HH:MM:SS** = Year:Month:Day Hour:Minute:Second), in cases where a time-of-day master is present in the system (if "AOP → Drive" time synchronization is active, for example).

You can call up an overview screen that displays the current status of faults and/or alarms for every drive object in the system by choosing MENU – Fault/alarm memory.

A shortcut menu offering the "Back" and "Ack." options appears when you press F4 ("Tools+"). (You can use F4 to exit the shortcut menu.) The function required can be selected using F2 and F3 and executed by pressing F5 ("OK").
The "Ack." function sends an acknowledgement signal to each drive object.
The red FAULT LED goes out once all the faults have been acknowledged.

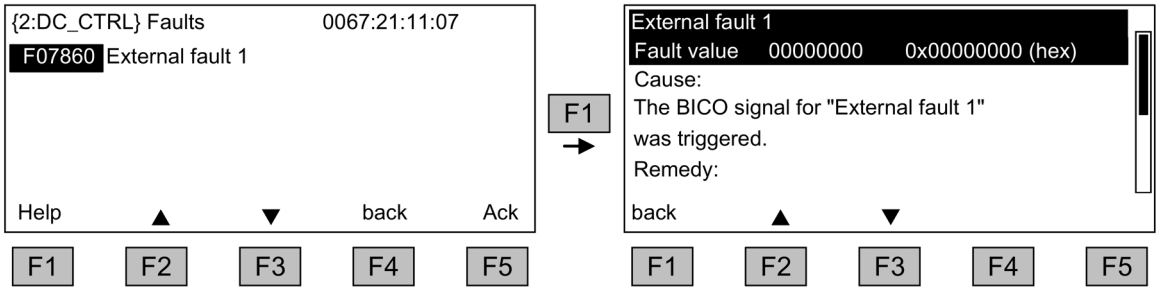



Figure 9-23 Fault screen

You can use F5 (Ack.) to acknowledge a stored fault.

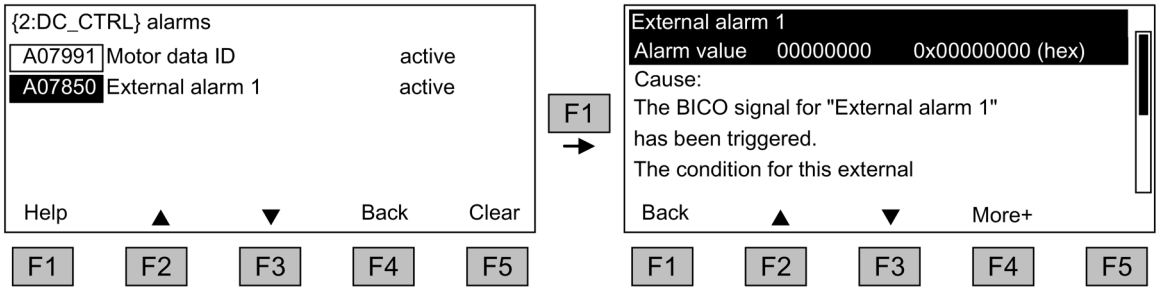



Figure 9-24 Alarm screen

Alarms that are no longer active are removed from the alarm memory with F5 (Clear).

The screen can be updated via a submenu with F4 (More+).

## 9.3.9 Saving the parameters permanently

### Description

If parameters are changed using the operator panel (confirm with OK in the Parameter editor), the new values are initially stored in the volatile memory (RAM) of the converter. An "S" flashes in the top right of the AOP display until they are saved permanently. This indicates that at least 1 parameter has been changed and not yet stored permanently.

2 methods are available for permanently saving parameters that have been changed:

- To store the parameters permanently, choose <MENU> <Parameterization> <OK> <Permanent parameter transfer>.
- When confirming a parameter setting with the OK key, press it for > 1 s. The system displays a message asking you whether the setting is to be saved in the EEPROM. If you press "Yes", the system saves the setting in the EEPROM. If you press "No", the setting is not saved permanently and the "S" starts flashing to indicate this fact.

In both cases, **all** changes that have not yet been saved permanently are stored in the EEPROM. Depending on the configuration, this can take from 45 s to several minutes. Also refer to the "CompactFlash Card functions" chapter.

**Note**

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

An active saving process is indicated by the following actions:

- The RDY-LED flashes (see Chapter "AUTOHOTSPOT")
- The BOP20 flashes

Interrupting the power supply while saving can lead to the loss of the current device parameter assignments. See also Chapter "AUTOHOTSPOT".

## 9.3.10 Parameterization errors

If an error is made when reading or writing parameters, a popup window explaining the cause of the problem in plain text appears.

Example: Parameter write error
Value limit exceeded

### 9.3.11 Assigning parameters to make AOP30 time-of-day master

The AOP30 contains an integrated real-time clock. The SINAMICS DCM system time can be synchronized with this real-time clock.

Activate this function:

- On the AOP30 in the "Menu" – "Commissioning / Service" – "AOP settings" – "Date and Time" menu command activate to "AOP sets clock in SINAMICS".

  The current time in the AOP30 is then written into the drive.

In the display for faults and alarms, the time stamp is now displayed in the format YY-MM-DD hh:mm in real-time. The time stamp mode and the current time can be read from the parameters p3100, p3102 and p3103. For details, please see the SINAMICS DCM List Manual.

The current time is resynchronized at each power-up. (The AOP30 must be switched on together with the drive). During uninterrupted duty, synchronization takes place every day at 02:00.

# Descriptions of functions 10

## 10.1 Inputs/Outputs

### 10.1.1 Overview of inputs/outputs

Table 10- 1 Overview of inputs and outputs

| Component | Digital | Analog |
|---|---|---|
| CUD | • 4 inputs (2 inputs freely available, 2 inputs with ON/OFF1 and controller enable pre-assigned)<br>• 4 bidirectional inputs/outputs<br>• 4 outputs<br>• 1 incremental encoder input | • 7 inputs<br>• 2 outputs<br>• 1 temperature sensor input |
| Power interface | • 1 E-Stop input<br>• 1 line contactor relay output<br>• 1 fan control relay output<br>• 1 fan monitoring input<br>• 1 external fault input | • 1 analog tachometer input<br>• 2 temperature sensor inputs<br>• 2 current transformer inputs |
| TM15 | • 24 bidirectional inputs/outputs | - |
| TM31 | • 8 inputs<br>• 4 bidirectional inputs/outputs<br>• 2 relay outputs | • 2 inputs<br>• 2 outputs<br>• 1 temperature sensor input |
| TM150 | - | • 12 inputs for max. 12 temperature sensors (PT100, PT1000, KTY84, PTC, bimetal contact)<br>Number depending on connection type |
| Technical data for inputs and outputs:<br>• For the CUD and power interface, see Chapter "Connecting (Page 55)".<br>• For the TM15, TM31 and TM150, see Chapter "Additional system components (Page 157)" | | |

### 10.1.2 Digital inputs/outputs

#### Function diagrams in the SINAMICS DCM List Manual

| | |
|---|---|
| 2050 | Digital inputs DI 0 ... DI 3 |
| 2055 | Digital outputs DO 0 ... DO 3 |
| 2060 | Digital inputs/outputs, bi-directional DI/DO 4 and DI/DO 5 |
| 2065 | Digital inputs/outputs, bi-directional DI/DO 6 and DI/DO 7 |
| 2070 | E-Stop (XS1) |
| 8047 | Unit fan (XV1, XV2, XV3) |

## 10.1.3 Analog inputs

### Properties

Table 10- 2 Properties of the analog inputs

| Inputs | Properties |
|---|---|
| AI 0, AI 1 | • Differential inputs<br>• Voltage inputs -10 to +10 V or<br>Current inputs -20 to +20 mA or 4 to 20 mA<br>• Hardware input filter: T = 1 ms<br>• Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format. |
| AI 2 | • Differential input<br>• Voltage input -10 to +10 V<br>• Hardware input filter: T = 1 ms<br>• Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format.<br>An external armature current actual value can also be connected to this input (see FP6902). |
| The 3 inputs AI 0, AI 1 and AI 2 of a CUD on the left and the 3 inputs AI 0, AI 1 and AI 2 of a CUD on the right can be operated so that they are averaged during the same measuring interval. The 6 mean values are provided on 6 BICOs (see FP2083). | |
| AI 3, AI 4, AI 5, AI 6 | • Differential inputs<br>• Voltage inputs -10 to +10 V<br>• Hardware input filter: T = 100 µs<br>• Sampling measuring procedure. Sampling time = 250 µs. The mean value taken from 4 sampling values is provided in BICO format.<br>An external actual armature current value can also be connected to these inputs (see FP6850). |
| Power interface tachometer input XT1.103/104 | • Input referred to ground<br>• High-voltage input -270 V .. +270 V<br>• Hardware input filter: T = 1 ms<br>• Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format.<br>This input is designed for connecting an analog tachometer, but can also be used in other ways. |
| Power interface XT5, XT6 | • Input referred to ground<br>• Connection, NTC 6.8 kΩ, NTC 10 kΩ |
| Power interface X7, X8 | • Input referred to ground<br>• Current transformer connection<br>• Internal 10 Ω load resistors |

### Function diagrams

| | |
|---|---|
| 2075 | Analog inputs, AI 0 and XT1.103/104 |
| 2080 | Analog inputs, AI 1 and AI 2 |
| 2085 | Analog inputs, AI 3 and AI 4 |
| 2090 | Analog inputs, AI 5 and AI 6 |
| 8048 | Internal unit monitoring functions (XT5,XT6) |

### 10.1.4 Analog outputs

See function diagram 2095 in the SINAMICS DCM Parameter Manual

## 10.2 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:
IT security (http://www.industry.siemens.com/topics/global/en/industrial-security)

## 10.3 Communication according to PROFIdrive

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 10- 3 PROFIdrive device classes

| PROFIdrive | PROFIBUS DP | PROFINET IO |
|---|---|---|
| Peripheral device (P device) | DP slave (I slaves) | 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 |

## Properties of the Controller, Supervisor and drive units

Table 10- 4 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: Slave, 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, operator control and monitoring while the bus is in operation – and
  devices, which only exchange non-cyclic data with drive units and controllers.

  Examples: Programming devices, human machine interfaces

## Communication services

Two communication services are defined in the PROFIdrive profile; namely, cyclic data exchange and acyclic data exchange.

- 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. 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.
- Alarm channel
  Alarms are output on an event-driven basis, and show the occurrence and expiry of error states.

## Interface IF1 and IF2

The Control Unit CUD can communicate via two separate interfaces (IF1 and IF2).

Table 10- 5 Properties of IF1 and IF2

| | IF1 | IF2 |
|---|---|---|
| PROFIdrive | Yes | No |
| Standard telegrams | Yes | 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**

For additional information on the IF1 and IF2 interfaces, see Chapter "Parallel operation of communication interfaces (Page 406)".

## 10.3.1 Application classes

There are different application classes for PROFIdrive according to the scope and type of the application processes. PROFIdrive features a total of six application classes, two of which are discussed here.

### Application class 1 (standard drive)

In the most basic case, the drive is controlled via a speed setpoint by means of PROFIBUS/ PROFINET. In this case, speed control is fully handled in the drive controller. Typical application examples include simple frequency converters for controlling pumps and fans.

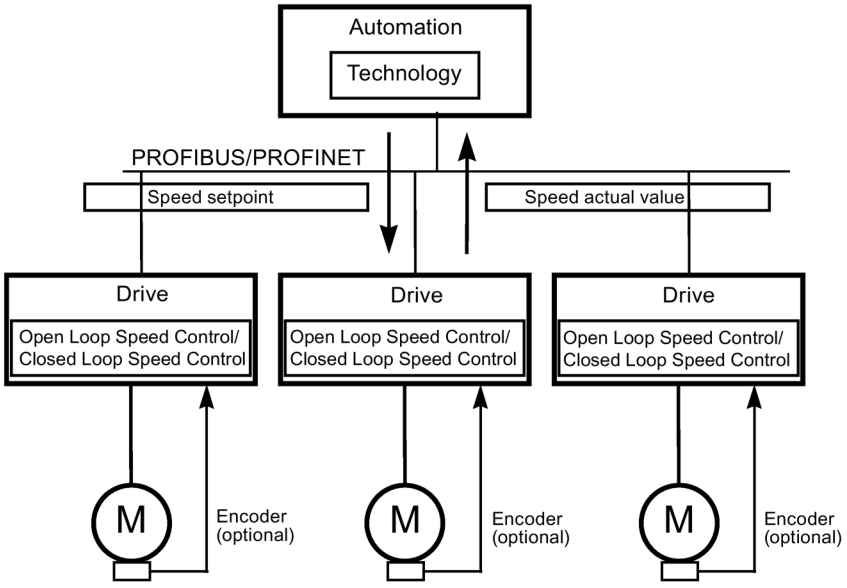



Figure 10-1 Application class 1

## Application class 2 (standard drive with technology function)

The total process is subdivided into a number of small subprocesses and distributed among the drives. This means that the automation functions no longer reside exclusively in the central automation device but are also distributed in the drive controllers.
Of course, this distribution assumes that communication is possible in every direction, i.e. also cross-communication between the technology functions of the individual drive controllers. Specific applications include setpoint cascades, winding drives, and speed synchronization applications for continuous processes with a continuous web.

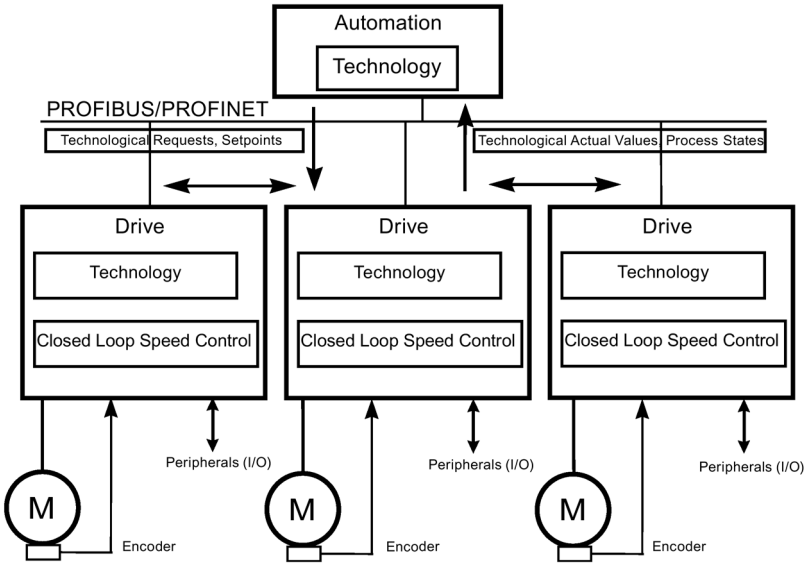



Figure 10-2 Application class 2

## Selection of telegrams as a function of the application class

The telegrams listed in the table below (see also Chapter "Telegrams and process data (Page 378)") can be used in the following application classes:

Table 10- 6 Selection of telegrams as a function of the application class

| Telegram (p0922 = x) | Description | Class 1 | Class 2 |
|---|---|---|---|
| 1 | Speed setpoint, 16-bit | x | x |
| 3 | Speed setpoint, 32-bit with 1 position encoder | | x |
| 4 | Speed setpoint, 32-bit with 2 position encoders | | |
| 20 | Speed setpoint, 16-bit VIK-NAMUR | x | x |
| 220 | Speed setpoint, 32-bit for metal industry | x | |
| 352 | Speed setpoint, 16-bit, PCS7 | x | x |
| 999 | Free telegrams | x | x |

## 10.3.2 Cyclic communication

Cyclic communication is used to exchange time-critical process data.

### 10.3.2.1 Telegrams and process data

When a telegram is selected via p0922, the drive unit (Control Unit) process data that is transferred is determined.

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

  The standard telegrams are structured in accordance with the PROFIdrive profile. The internal process data links are set up automatically in accordance with the telegram number setting.

  The following standard telegrams can be set via p0922:

  – 1 Speed setpoint, 16-bit
  – 3 Speed setpoint, 32-bit with 1 position encoder
  – 4 Speed setpoint, 32-bit with 2 position encoders
  – 20 Speed setpoint, 16-bit VIK-NAMUR

- Manufacturer-specific telegrams

  The manufacturer-specific telegrams are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the telegram number setting.

  The following vendor-specific telegrams can be set via p0922:

  – 220 Speed setpoint, 32-bit for metal industry
  – 352 Speed setpoint, 16-bit, PCS7
  – 390 Control Unit with digital inputs/outputs

- 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.

| | DC_CTRL | CU_DC | TM31, TM15DI_DO, TM150 | ENCODER |
|---|---|---|---|---|
| **Receive process data** | | | | |
| DWORD connector output | r2060[0 ... 62] | - | - | r2060[0 ... 2] |
| WORD connector output | r2050[0 ... 63] | r2050[0 ... 19] | r2050[0 ... 4] | r2050[0 ... 3] |
| Binector output | r2090.0 ... 15<br>r2091.0 ... 15<br>r2092.0 ... 15<br>r2093.0 ... 15 | | r2090.0 ... 15<br>r2091.0 ... 15 | r2090.0 ... 15<br>r2091.0 ... 15<br>r2092.0 ... 15<br>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] | - | - | p2061[0 ... 10] |
| WORD connector input | p2051[0 ... 63] | p2051[0 ... 24] | p2051[0 ... 4] | p2051[0 ... 11] |
| Free connector-binector converter | p2099[0 ... 1] / r2094.0 ... 15, r2095.0 ... 15 | | | |

## Notes on telegram interconnections

- When you change p0922 = 999 (factory setting) to p0922 ≠ 999, the telegrams are interconnected and blocked automatically.
- Exceptions to this are the telegrams 20, 220, and 352. Here, selected PZDs can be interconnected as required in the send/receive telegram.
- When you change p0922 ≠ 999 to p0922 = 999, the previous telegram interconnection is retained and can be changed.
- If p0922 = 999, a telegram can be selected in p2079. A telegram interconnection is automatically made and blocked. The telegram can also be extended.

This is an easy method for creating extended telegram interconnections on the basis of existing telegrams.

### Notes on the telegram structure

- The parameter p0978 contains the drive objects that use a cyclic PZD exchange. A zero is used to demarcate the drive objects that do not exchange PZD.
- 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:
  - Interconnect PZD receive word 1 as control word 1 (STW1).
  - Interconnect PZD send word 1 as status word 1 (STW1). (Use WORD format for PZD1)
- One PZD = one word.
- Only one of the interconnection parameters (p2051 or p2061) can have the value ≠ 0 for a PZD word.
- Physical word and double word values are inserted in the telegram as referenced variables.

  They refer to 100% = 16384 = pxxxx. However, you must take into account the internal scaling of individual physical variables, e.g. r0080 torque, see SINAMICS DCM List Manual.
- The reference variable is specified for each BICO in the parameter list. Most BICOs have the unit "%".
  The following then applies: Telegram content = 4000 hex (or 4000 0000 hex for double words) corresponds to the value 100%.

### Structure of the telegrams

You can find the structure of the telegrams in the SINAMICS DCM List Manual in the following function diagram:

- 2420: PROFIdrive – Telegrams and process data

| Drive object | Telegrams (p0922) |
|---|---|
| DC_CTRL | 3, 4, 999 |
| ENC | 81, 82, 83, 999 |
| TM15DI_DO | No predefined telegram. |
| TM31 | No predefined telegram. |
| TM150 | No predefined telegram. |
| CU_DC | 390, 999 |

Depending on the drive object, the following maximum number of process data can be transferred for a user-defined telegram structure:

| Drive objects | Maximum number of PZD | |
|---|---|---|
| | Send | Receive |
| DC_CTRL | 64 | 64 |
| ENC | 12 | 4 |
| TM15DI_DO | 5 | 5 |
| TM31 | 5 | 5 |
| TM150 | 5 | 5 |
| CU_DC | 25 | 20 |

### Function diagrams (see the SINAMICS DCM List Manual)

- 2410 PROFIdrive – PROFIBUS (PB) / PROFINET (PN), addresses and diagnostics
- 2498 PROFIdrive – I_DIGITAL interconnection

## 10.3.2.2 Description of control words and setpoints

### Overview of control words and setpoints

Table 10- 7 Overview of control words and setpoints, see function diagram [2440]

| Abbreviation | Name | Signal number | Data type [1] | Interconnection parameter [2] |
|---|---|---|---|---|
| STW1 | Control word 1 for telegram 1, 3, 4, 20, 352 | 1 | U16 | (bit-by-bit) |
| STW2 | Control word 2 for telegram 3, 4 | 3 | U16 | (bit-by-bit) |
| NSET_A | Speed setpoint A (16-bit) | 5 | I16 | p1070 |
| NSET_B | Speed setpoint B (32-bit) | 7 | I32 | p50621 |
| G1_STW | Encoder 1 control word | 9 | U16 | p0480[0] |
| G2_STW | Encoder 2 control word | 13 | U16 | p0480[1] |
| A_DIGITAL | Digital output (16-bit) | 22 | U16 | (bit-by-bit) |
| M_LIM | Torque limit | 310 | U16 | p50605[0]<br>p50500[0] |
| M_ADD | Supplementary torque | 311 | U16 | p50619 |
| STW1_BM | Control word 1, variant for BM | 322 | U16 | (bit-by-bit) |
| STW2_BM | Control word 2, variant for BM | 324 | U16 | (bit-by-bit) |
| CU_STW1 | Control word 1 for Control Unit | 500 | U16 | (bit-by-bit) |

[1] Data type to PROFIdrive Profile V4:
I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32
[2] Bit-by-bit interconnection: Refer to the following pages.

## STW1 (control word 1)

See function diagram [2442].

Table 10- 8 Control word 1 (STW1)

| Bit | Meaning | Explanation | Operating condition | BICO |
|---|---|---|---|---|
| 0 | 0 = OFF1 (OFF1) | 0: Deceleration on the down ramp, then pulse inhibit, line contactor (if present) is opened | 1 | BI: p0840 |
| | 0 → 1 = ON | Pulse enable possible | | |
| 1 | 0 = Coast down (OFF2) | 0: Pulse inhibit, line contactor (if present) is opened | 1 | BI: p0844<br>BI: p0845 |
| | 1 = Do not coast down | Enable possible | | |
| | Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845. | | | |
| 2 | 0 = Quick stop (OFF3) | 0: Deceleration on the quick stop ramp, then pulse inhibit, line contactor (if present) is opened. | 1 | BI: p0848 |
| | 1 = No quick stop | Enable possible | | |
| | Note: Control signal OFF3 is generated by ANDing BI: p0848 and BI: p0849. | | | |
| 3 | 0 = Inhibit operation | 0: Pulse inhibit. The motor coasts down. The "Ready for Operation" state remains set. | 1 | BI: p0852 |
| | 1 = Enable operation | 1: Pulse enable, ramp-up with active setpoint | | |
| 4 | 0 = Inhibit ramp-function generator | 0: The ramp-function generator output is set to setpoint "0". | 1 | BI: p1140 |
| | 1 = Enable ramp-function generator | | | |
| 5 | 0 = Stop ramp-function generator | 0: The current setpoint is frozen at the ramp-function generator output. | 1 | BI: p1141 |
| | 1 = Start ramp-function generator | | | |
| 6 | 1 = Enable speed setpoint | 1: The speed setpoint at the input of the ramp-function generator is enabled. | 1 | BI: p1142 |
| | 0 = Inhibit speed setpoint | 0: The speed setpoint at the input of the ramp-function generator is set to zero. The drive brakes in accordance with the set ramp-down time. | | |
| 7 | 0 → 1 = Acknowledge fault | A positive edge change acknowledges all the current faults. | - | BI: p2103 |
| | Note: Acknowledgement is realized with a 0/1 edge via BI: p2103 or BI: p2104 or BI: p2105. | | | |
| 8 | Reserved | | - | - |
| 9 | Reserved | | - | - |
| 10 | 1 = Control via PLC | 1: PROFIBUS control words and setpoints are analyzed. | 1 | BI: p0854 |
| | | 0: PROFIBUS control words and setpoints are not analyzed. | | |
| | Note: This bit should not be set to "1" until the PROFIBUS slave has returned an appropriate status via ZSW1.9 = "1". | | | |

| Bit | Meaning | Explanation | Operating condition | BICO |
|---|---|---|---|---|
| 11 | 1 = setpoint inversion | 1: Setpoint is inverted | - | BI: p1113 |
| | | 0: The setpoint is not inverted | | |
| 12 | Reserved | | - | - |
| 13 | 1 = Motorized potentiometer, higher | Only when p0922 = 1 or 352, otherwise reserved | - | BI: p1035 |
| 14 | 1 = Motorized potentiometer, lower | Only when p0922 = 1 or 352, otherwise reserved | - | BI: p1036 |
| | Note:<br>If "Motorized potentiometer, higher" and "Motorized potentiometer, lower" are both 0 or 1 at the same time, the current setpoint is frozen. | | | |
| 15 | 1 = CDS bit 0<br>(only with telegrams p0922 = 20!) | 1: Command data set changeover (CDS) bit 0 is active. | - | BI: p0810 |
| | | 0: Command data set changeover (CDS) bit 0 is inactive. | | |
| | Reserved | When p0922 = 1 or 352 | - | - |

## STW2 (control word 2)

See function diagram [2444].

Table 10- 9 Control word 2 (STW2)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | Drive data set selection DDS, bit 0 | p0820[0] = r2093.0 |
| 1 | Drive data set selection DDS, bit 1 | p0821[0] = r2093.1 |
| 2 to 11 | Reserved | - |
| 12 | Master sign-of-life bit 0 | p2045 = r2050[3] |
| 13 | Master sign-of-life bit 1 | |
| 14 | Master sign-of-life bit 2 | |
| 15 | Master sign-of-life bit 3 | |

## STW1_BM (control word 1, metal industry)

See function diagram [2425].

Table 10- 10 Description of STW1_BM (control word 1, metal industry)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | 0 = OFF (OFF1)<br>↑ = ON | p0840[0] = r2090.0 |
| 1 | 0 = OFF2 (immediate pulse cancellation with switching on inhibited)<br>1 = No OFF2 (enable is possible) | p0844[0] = r2090.1 |
| 2 | 0 = OFF3 (braking along the OFF3 ramp, then pulse suppression with switching on inhibited)<br>1 = No OFF3 (enable is possible) | p0848[0] = r2090.2 |
| 3 | 0 = Inhibit operation<br>1 = Enable operation | p2816[0] = r2090.3 |
| 4 | 0 = Set ramp-function generator zero<br>1 = Enable ramp-function generator | p1140[0] = r2090.4 |
| 5 | 0 = Freeze ramp-function generator<br>1 = Continue ramp-function generator | p1141[0] = r2090.5 |
| 6 | 0 = Speed setpoint = 0<br>1 = Speed setpoint enable | p1142[0] = r2090.6 |
| 7 | ↑ = Acknowledge fault | p2103[0] = r2090.7 |
| 8 | Reserved | - |
| 9 | Reserved | - |
| 10 | 1 = Control via PL [1)] | p0854[0] = r2090.10 |
| 11 to 15 | Reserved [2)] | - |

1) STW1.10 must be set in order for the drive object to accept the process data (PZD).

2) Interconnection is not disabled.

## STW2_BM (control word 2, metal industry)

See function diagram [2426].

Table 10- 11 Description of STW1_BM (control word 1, metal industry)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | Command data set selection CDS bit 0 | p0810 = r2093.0 |
| 1 | Reserved | - |
| 2 | Drive data set selection, CDS bit 0 [1)] | p0820[0] = r2093.2 |
| 3 | Drive data set selection, CDS bit 1 [1)] | p0821[0] = r2093.3 |
| 4 | Reserved | - |
| 5 | 1 = Bypass ramp-function generator | p50641[0] = r2093.5 |
| 6 | Reserved | - |
| 7 | 1 = Speed controller integration value set | p50695[0] = r2093.7 |
| 8 | 1 = Enable droop | p50684[0] = r2093.8 |
| 9 | 1 = Enable speed controller [1)] | p0856[0] = r2093.9 |
| 10 | Reserved [1)] | - |
| 11 | 0 = Speed-controlled mode<br>1 = Torque-controlled mode | p50687[0] = r2093.11 |
| 12 | Reserved [1)] | - |
| 13 | Reserved [1)] | - |
| 14 | Reserved [1)] | - |
| 15 | Controller sign-of-life toggle bit | p2081[15] = r2093.15 |

[1)] Interconnection is not disabled.

## NSET_A (speed setpoint A (16-bit))

- Speed setpoint with a 16-bit resolution with sign bit.
- Bit 15 determines the sign of the setpoint:
  - Bit = 0 → Positive setpoint
  - Bit = 1 → Negative setpoint
- The speed is normalized via p2000.

  NSET_A = 4000 hex or 16384 dec ≙ speed in p2000

### NSET_B (speed setpoint B (32-bit))

- Speed setpoint with a 32-bit resolution with sign bit.
- Bit 31 determines the sign of the setpoint:
  - Bit = 0 → Positive setpoint
  - Bit = 1 → Negative setpoint
- The speed is normalized via p2000.

  NSET_B = 4000 0000 hex or 1 073 741 824 dec ≙ speed in p2000

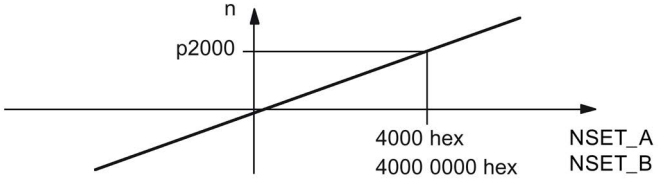



Figure 10-3 Normalization of speed

**Note**

**Operation of motors in the field-weakening range**

If the motors are to be operated in the field-weakening range > 2:1, the value of parameter p2000 must be set ≤ 1/2 x maximum speed of the drive object.

### Gn_STW (encoder n control word)

This process data belongs to the encoder interface.

### A_DIGITAL
### CU_STW1

This process data is part of the central process data.

### 10.3.2.3 Description of status words and actual values

**Note**

The reference parameter is also specified for the relevant process data. The process data is generally normalized in accordance with parameters p2000 to r2004.

The following scalings apply:

- A temperature of 100 °C corresponds to 100%
- An electrical angle of 90° also corresponds to 100%.

## Overview of status words and actual values

Table 10- 12 Overview of status words and actual values, see function diagram [2450]

| Abbreviation | Name | Signal number | Data type [1] | Interconnection parameter |
|---|---|---|---|---|
| ZSW1 | Status word 1 | 2 | U16 | r2089[0] |
| ZSW2 | Status word 2 | 4 | U16 | r2089[1] |
| NACT_A | Speed setpoint A (16-bit) | 6 | I16 | r0063 |
| G1_ZSW | Encoder 1 status word | 10 | U16 | r0481[0] |
| G1_XIST1 | Encoder 1 actual position value 1 | 11 | U32 | r0482[0] |
| G1_XIST2 | Encoder 1 actual position value 2 | 12 | U32 | r0483[0] |
| G2_ZSW | Encoder 2 status word | 14 | U16 | r0481[1] |
| G2_XIST1 | Encoder 2 actual position value 1 | 15 | U32 | r0482[1] |
| G2_XIST2 | Encoder 2 actual position value 2 | 16 | U32 | r0483[1] |
| E_DIGITAL | Digital input (16-bit) | 21 | U16 | r2089[2] |
| IAIST_GLATT | Absolute actual current value, smoothed | 51 | I16 | r0027 |
| MIST_GLATT | Actual torque value, smoothed | 53 | I16 | r0080 |
| PIST_GLATT | Active power, smoothed | 54 | I16 | r0032 |
| NACT_A_GLATT | Actual speed value, smoothed | 57 | I16 | r0021 |
| MELD_NAMUR | VIK-NAMUR message bit bar | 58 | U16 | r3113 |
| FAULT_CODE | Fault code | 301 | U16 | r2131 |
| WARN_CODE | Alarm code | 303 | U16 | r2132 |
| ZSW1_BM | Status word 1, variant for BM | 323 | U16 | r2089[0] |
| ZSW2_BM | Status word 2, variant for BM | 325 | U16 | r2089[1] |
| CU_ZSW1 | Status word 1 for Control Unit | 501 | U16 | r2089[1] |

[1] Data type according to PROFIdrive profile V4:
I16 = Integer16, I32 = Integer32, U16 = Unsigned16, U32 = Unsigned32

## ZSW1 (status word 1)

See function diagram [2452].

Table 10- 13 Description of status word 1 (ZSW1)

| Bit | Meaning | Explanation | | Parameter |
|---|---|---|---|---|
| 0 | Ready for switching on | 1 | Ready for switching on<br>Power supply on, electronics initialized, line contactor released if necessary, pulses inhibited | BO: r0899.0 |
| | | 0 | Not ready for switching on | |
| 1 | Ready for operation | 1 | Ready for operation<br>Line voltage applied, i.e. line contactor closed (if present), field being built up | BO: r0899.1 |
| | | 0 | Not ready for operation<br>Reason: No ON command has been issued. | |
| 2 | Operation enabled | 1 | Operation enabled<br>Enable electronics and pulses, then ramp up to active setpoint | BO: r0899.2 |
| | | 0 | Operation disabled | |
| 3 | Fault active | 1 | Fault active<br>The drive is faulty and, therefore, out of service. The drive switches to "switching on inhibited" once the fault has been acknowledged and the cause has been remedied. The active faults are stored in the fault buffer. | BO: r2139.3 |
| | | 0 | No fault active<br>There are no faults in the fault buffer. | |
| 4 | Coasting down not active (OFF2 inactive) | 1 | Coasting down (OFF2) not active | BO: r0899.4 |
| | | 0 | Coasting down active (OFF2)<br>An OFF2 command is active. | |
| 5 | Quick stop not active (OFF3 inactive) | 1 | Quick stop (OFF3) not active | BO: r0899.5 |
| | | 0 | Quick stop active (OFF3)<br>An OFF3 command is active. | |
| 6 | Switching on inhibited active | 1 | Switching on inhibited<br>Switching back on is only possible by means of OFF1 and then ON. | BO: r0899.6 |
| | | 0 | No switching on inhibited<br>Switching on is possible. | |
| 7 | Alarm active | 1 | Alarm active<br>The drive is operational again. No acknowledgement necessary.<br>The active alarms are stored in the alarm buffer. | BO: r2139.7 |
| | | 0 | No alarm active<br>No alarms in the alarm buffer. | |
| 8 | Speed setpoint/actual value deviation in tolerance | 1 | Setpoint/actual value monitoring in tolerance band<br>Actual value within tolerance band; dynamic overshoot or undershoot permitted for t < tmax, tmax can be parameterized. See FP8020 and FP2534 | BO: r2197.7 |
| | | 0 | Setpoint/actual value monitoring not within tolerance band | |

| Bit | Meaning | Explanation | | Parameter |
|---|---|---|---|---|
| 9 | Control request<br>"1" is always present | 1 | The automation system is requested to assume control. | BO: r0899.9 |
| | | 0 | Control is only possible at the unit itself | |
| 10 | n setpoint reached or exceeded | 1 | n setpoint reached or exceeded | BO: r2199.1 |
| | | 0 | n setpoint not reached | |
| | Note:<br>The message is parameterized as follows: p50373 (threshold value), p50374 (hysteresis)<br>See FP8020 and FP2537 | | | |
| 11 | I or M limit not reached (when p0922 = 1 or 352) | 1 | I or M limit not reached | BO: r1407.7 (inverted) |
| | | 0 | I or M limit reached or exceeded | |
| | I or M limit not reached (when p0922 = 20) | 1 | I or M limit not reached | BO: r0056.13 (inverted) |
| | | 0 | I or M limit reached or exceeded | |
| 12 | Holding brake released (when p0922 = 1 or 352) | 1 | Holding brake is released | BO: r0899.12 |
| | | 0 | Holding brake is closed | |
| | Reserved (when p0922 = 20) | | | |
| 13 | No motor overtemperature alarm | 1 | Alarm overtemperature motor not pending | BO: r2135.14 (inverted) |
| | | 0 | Motor overtemperature alarm pending | |
| 14 | Motor rotates forward (n_act ≥ 0) | 1 | Motor rotates forward (n_act ≥ 0) | BO: r2197.3 |
| | | 0 | Motor does not rotate forward (n_act < 0) | |
| 15 | Reserved (when p0922 = 1 or 352) | | | |
| | CDS display (when p0922 = 20) | 1 | CDS selection bit 0 selected | BO: r0836.0 |
| | | 0 | CDS selection bit 0 not selected | |

## ZSW2 (status word 2)

See function diagram [2454].

Table 10- 14 Status word 2 (ZSW2)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | 1 = Drive data set selection DDS effective, bit 0 | p2081[0] = r0051.0 |
| 1 | 1 = Drive data set selection DDS effective, bit 1 | p2081[1] = r0051.1 |
| 2 | Reserved | - |
| 3 | Reserved | - |
| 4 | Reserved | - |
| 5 | 1 = Alarm class bit 0 | p2081[5] = r2139.11 |
| 6 | 1 = Alarm class bit 1 | p2081[6] = r2139.12 |
| 7 | Reserved | - |
| 8 | Reserved | - |
| 9 | Reserved | - |
| 10 | 1 = Enable pulses | p2081[10] = r0899.11 |
| 11 to 15 | Reserved | - |

## ZSW1_BM (status word 1, metal industry)

See function diagram [2428].

Table 10- 15 Status word 1, metal industry (ZSW1 BM) [1)]

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | 1 = Ready to switch on | p2080[0] = r0899.0 |
| 1 | 1 = Ready | p2080[1] = r0899.1 |
| 2 | 1 = Enable operation 1 | p2080[2] = r2811.0 |
| 3 | 1 = Fault present | p2080[3] = r2139.3 |
| 4 | 0 = Coast to stop active (OFF2) | p2080[4] = r0899.4 |
| 5 | 0 = Quick stop active (OFF3) | p2080[5] = r0899.5 |
| 6 | 1 = Switching on inhibited active | p2080[6] = r0899.6 |
| 7 | 1 = Alarm present | p2080[7] = r2139.7 |
| 8 | 1 = Speed setpoint/actual-value deviation in tolerance | p2080[8] = r2197.7 |
| 9 | 1 = Control requested [2)] | p2080[9] = r0899.9 |
| 10 | 1 = n comparison value reached or exceeded | p2080[10] = r2199.1 |
| 11 | 1 = Torque limit not reached | p2080[11] = r1407.7 |
| 12 | 1 = Open holding brake | p2080[12] = r0899.12 |
| 13 to 15 | Reserved [3)] | - |

1) ZSW1 BM is formed via binector-connector converter (BI: p2080[0...15], inversion: p2088[0].0...p2088[0].15).

2) The drive object is ready for acceptance.

3) Interconnection is not disabled.

## ZSW2_BM (status word 2, metal industry)

See function diagram [2429].

Table 10- 16 Status word 2, metal industry (ZSW2 BM)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 to 4 | Reserved [1)] | - |
| 5 | 1 = Alarm class bit 0 | p2081[5] = r2139.11 |
| 6 | 1 = Alarm class bit 1 | p2081[6] = r2139.12 |
| 7 | Reserved | - |
| 8 | Reserved | - |
| 9 | 1 = Speed setpoint limited | p2081[9] = r1407.11 |
| 10 | 1 = Upper torque limit reached | p2081[10] = r1407.8 |
| 11 | 1 = Lower torque limit reached | p2081[11] = r1407.9 |
| 12 | 1 = Encoderless operation because of fault | p2081[12] = r1407.13 |
| 13 | Reserved | - |
| 14 | Reserved | - |
| 15 | Controller sign of life toggle bit | p2081[15] = r2093.15 |

1) Interconnection is not disabled.

### NACT_A (speed setpoint A (16-bit))

- Actual speed value with 16-bit resolution.
- The speed actual value is normalized in the same way as the setpoint (see NSET_A).

### NACT_B (speed setpoint B (32-bit))

- Actual speed value with 32-bit resolution.
- The speed actual value is normalized in the same way as the setpoint (see NSET_B).

### Gn_ZSW (encoder n status word)
### Gn_XIST1 (encoder n actual position value 1)
### Gn_XIST2 (encoder n actual position value 2)

This process data belongs to the encoder interface.

### E_DIGITAL
### CU_ZSW1

This process data is part of the central process data.

### IAIST_GLATT

The absolute current actual value smoothed with p0045 is displayed.

### MIST_GLATT

The actual torque value smoothed with p0045 is displayed.

### PIST_GLATT

The active power smoothed with p0045 is displayed.

### NACT_A_GLATT

The actual speed value smoothed with p0045 is displayed.

### MELD_NAMUR

Display of the NAMUR message bit bar.

### WARN_CODE

Display of the alarm code (see function diagram [8065]).

### FAULT_CODE

Display of the fault code (see function diagram [8060]).

### 10.3.2.4 Control and status words for encoders

The process data for the encoders is available in various telegrams. For example, telegram 3 is provided for speed control with 1 position encoder and transmits the process data of encoder 1.

The following process data is available for the encoders:

- Gn_STW encoder n control word (n = 1, 2)
- Gn_ZSW encoder n status word
- Gn_XIST1 encoder n act. pos. value 1
- Gn_XIST2 encoder n act. pos. value 2

**Note**

Encoder 1: Motor encoder

Encoder 2: Direct measuring system

#### Example of encoder interface

Figure 10-4 Example of encoder interface (encoder-1: two actual values, encoder -2: one actual value)

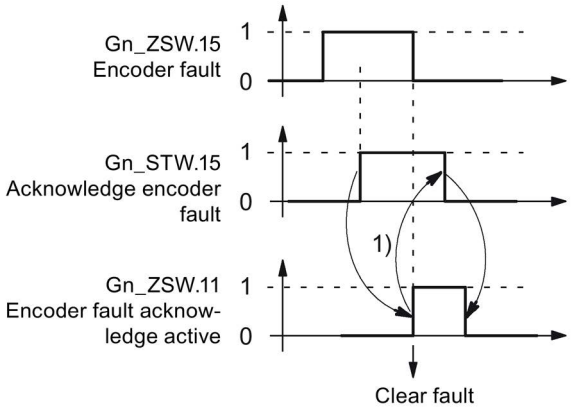
#### Encoder n control word (Gn_STW, n = 1, 2)

The encoder control word controls the encoder functions.

See function diagram [4720].

Table 10- 17 Description of the individual signals in Gn_STW

| Bit | Name | | Signal status, description | | |
|---|---|---|---|---|---|
| 0<br>1<br>2<br>3 | Find reference mark or flying measurement | Functions | If bit 7 = 0, then find reference mark request applies: | | |
| | | | Bit | Meaning | |
| | | | 0 | Function 1 | Reference mark 1 |
| | | | 1 | Function 2 | Reference mark 2 |
| | | | 2 | Function 3 | Reference mark 3 |
| | | | 3 | Function 4 | Reference mark 4 |
| | | | If bit 7 = 1, then find flying measurement request applies: | | |
| | | | 0 | Function 1 | Probe 1 rising edge |
| | | | 1 | Function 2 | Probe 1 falling edge |
| | | | 2 | Function 3 | Probe 2 rising edge |
| | | | 3 | Function 4 | Probe 2 falling edge |
| | | | **Note:** | | |
| | | | • Bit x = 1<br>Bit x = 0 | | Request function<br>Do not request function |
| | | | • If more than 1 function is activated, then the following applies:<br>The values for all functions cannot be read until each activated function has terminated and this has been confirmed in the corresponding status bit (ZSW.0/.1/.2/.3 "0" signal again).<br>• Reference mark search<br>It is possible to search for a reference mark.<br>• External zero mark<br>• Flying measuring<br>Positive and negative edges can be simultaneously selected. | | |
| 4<br>5<br>6 | | Command | Bit 6, 5, 4 | | Meaning |
| | | | 000 | | No function |
| | | | 001 | | Activate selected function |
| | | | 010 | | Read generated value |
| | | | 011 | | Cancel function |
| | | | (x: Function selected using bit 0 to 3) | | |
| 7 | | Mode | 1 | Not permitted | |
| | | | 0 | Reference mark search (fine resolution via p0418) | |
| 8... 12 | Reserved | | - | | |
| 13 | Request cyclic absolute value | | 1 | Request cyclic transfer of the absolute actual position value in Gn_XIST2.<br>Used for (e.g.):<br>• Additional measuring system monitoring<br>• Synchronization during ramp-up | |
| | | | 0 | No request | |
| 14 | Parking encoder | | 1 | Request parking encoder (handshake with Gn_ZSW bit 14) | |
| | | | 0 | No request | |

| Bit | Name | Signal status, description | |
|---|---|---|---|
| 15 | Acknowledge encoder error | 0/1 | Request to reset encoder errors |
| | | |  <br>1) Signal must be reset by user. |
| | | 0 | No request |

## Example: Reference mark search

Assumptions for the example:

- Distance-coded reference mark
- Two reference marks (function 1/function 2)
- Position control with encoder 1

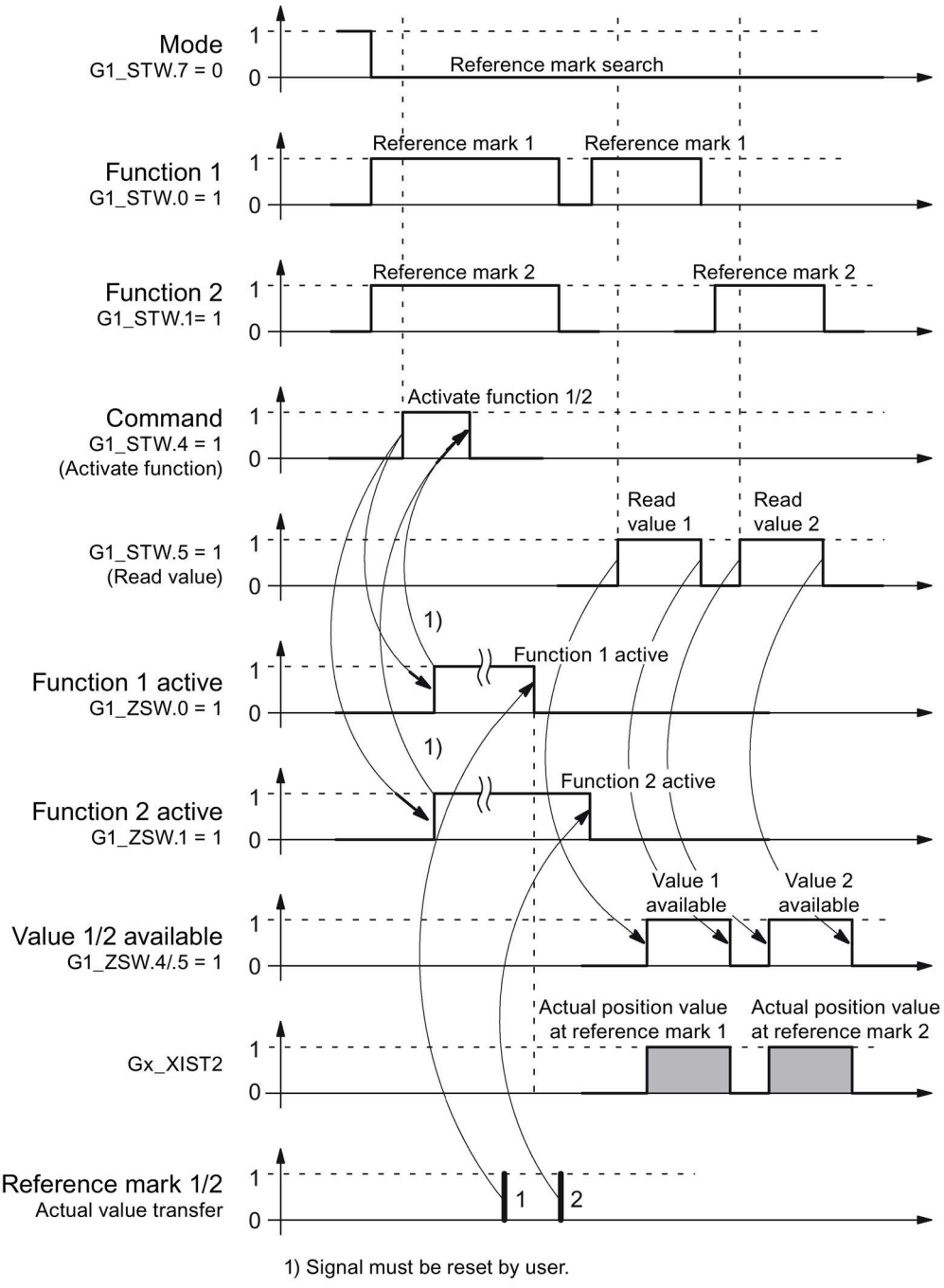



Figure 10-5 Sequence chart for "Reference mark search"

## Encoder 2 control word (G2_STW)

- See G1_STW

## Encoder n status word (Gn_ZSW, n = 1, 2)

The encoder status word is used to display states, errors and acknowledgements.

See function diagram [4730]

Table 10- 18 Description of the individual signals in Gn_ZSW

| Bit | Name | | Signal status, description | | |
|---|---|---|---|---|---|
| 0<br>1<br>2<br>3 | Reference mark search | Status: Function 1 - 4 active | Valid for "Reference mark search" and "Flying measurement" | | |
| | | | Bit | Meaning | |
| | | | 0 | Function 1 | Reference mark 1 |
| | | | 1 | Function 2 | Reference mark 2 |
| | | | 2 | Function 3 | Reference mark 3 |
| | | | 3 | Function 4 | Reference mark 4 |
| | | | **Note:**<br>• Bit x = 1 function active<br>Bit x = 0 function inactive | | |
| 4<br>5<br>6<br>7 | | Status: Value 1 - 4 available | Applies to reference mark search | | |
| | | | Bit | Meaning | |
| | | | 4 | Value 1 | Reference mark 1<br>Probe 1 rising edge |
| | | | 5 | Value 2 | Reserved |
| | | | 6 | Value 3 | Reserved |
| | | | 7 | Value 4 | Reserved |
| | | | **Note:**<br>• Bit x = 1 value available<br>Bit x = 0 value not available<br>• Only one single value can be retrieved.<br>Reason: There is only one common status word Gn_XIST2 to read the values. | | |
| 8 | | Reserved | 1 | Reserved | |
| | | | 0 | Reserved | |
| 9 | Reserved | | 1 | Reserved | |
| | | | 0 | Reserved | |
| 10 | Reserved | | - | | |
| 11 | Encoder fault acknowledge active | | 1 | Encoder fault acknowledge active<br>**Note:**<br>See at STW.15 (acknowledge encoder error) | |
| | | | 0 | No acknowledgement active | |
| 12 | Reserved | | - | | |

| Bit | Name | Signal status, description | |
|---|---|---|---|
| 13 | Transmit absolute value cyclically | 1 | Acknowledgement for Gn_STW.13 (request absolute value cyclically)<br>**Note:**<br>Cyclic transmission of the absolute value can be interrupted by a function with higher priority.<br>• See Gn_XIST2 |
| | | 0 | No acknowledgement |
| 14 | Parking encoder | 1 | Parking encoder active (i.e. parking encoder switched off) |
| | | 0 | No active parking encoder |
| 15 | Encoder fault | 1 | Error from encoder or actual-value sensing is active.<br>**Note:**<br>The error code is stored in Gn_XIST2. |
| | | 0 | No error is active. |

## Encoder 1 actual position value 1 (G1_XIST1)

- Resolution: Encoder lines • 2n

  n: Fine resolution, no. of bits for internal multiplication

  The fine resolution is specified via p0418.
- Used to transfer the cyclic actual position value to the controller.
- The transferred value is a relative, free-running actual value.
- Any overflows must be evaluated by the master controller.

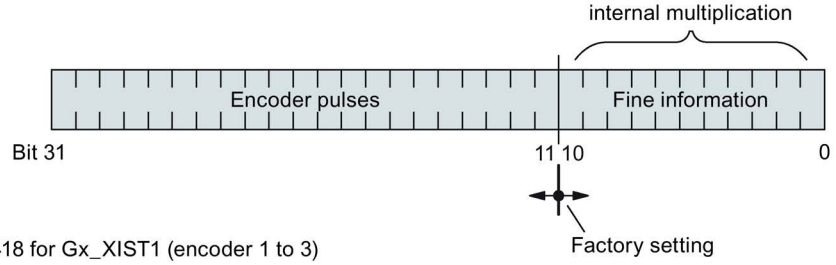



Figure 10-6 Subdivision and settings for Gx_XIST1

- Encoder lines of incremental encoder
  – For encoders with sin/cos 1Vpp:

    Encoder lines = no. of sinusoidal signal periods
- After power-up: Gx_XIST1 = 0
- An overflow in Gx_XIST1 must be viewed by the master controller.
- There is no modulo interpretation of Gx_XIST1 in the drive.

## Encoder 1 actual position value 2 (G1_XIST2)

Different values are entered in Gx_XIST2 depending on the function.

- Priorities for Gx_XIST2

The following priorities should be considered for values in Gx_XIST2:

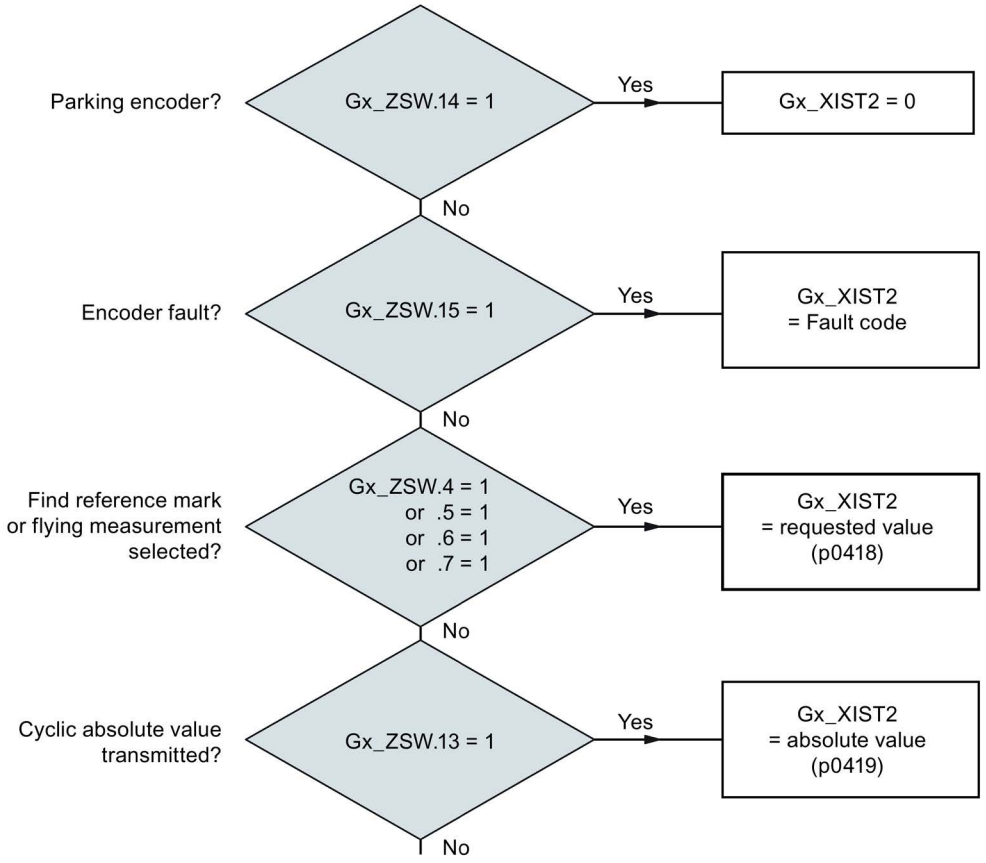



Figure 10-7 Priorities for functions and Gx_XIST2

- Resolution: Encoder pulses • 2n

  n: Fine resolution, no. of bits for internal multiplication

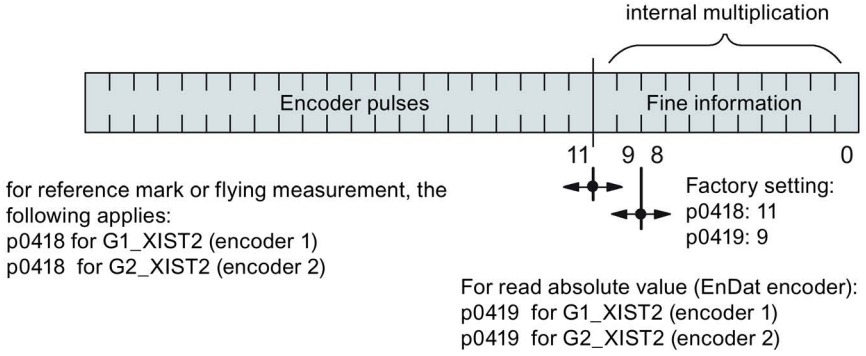



Figure 10-8 Subdivision and settings for Gx_XIST2

- Encoder lines of incremental encoder
  - For encoders with sin/cos 1Vpp:

    Encoder lines = no. of sinusoidal signal periods

## Error code in Gn_XIST2

Table 10- 19 Error code in Gn_XIST2

| n_XIST2 | Meaning | Possible causes / description |
|---|---|---|
| 1 | Encoder fault | One or more existing encoder faults.<br>Detailed information in accordance with drive messages. |
| 2 | Zero mark monitoring | – |
| 3 | Abort parking sensor | • Parking drive object already selected. |
| 4 | Abort find reference mark | • A fault exists (Gn_ZSW.15 = 1)<br>• Encoder has no zero mark (reference mark)<br>• Reference mark 2, 3 or 4 is requested<br>• Switchover to "Flying measurement" during search for reference mark<br>• Command "Read value x" set during search for reference mark<br>• Inconsistent position measured value with distance-coded reference marks. |
| 5 | Abort retrieve reference value | • More than four values requested<br>• No value requested<br>• Requested value not available |
| 6 | Abort flying measurement | • No probe configured p0488, p0489<br>• Switch over to "reference mark search" during flying measurement<br>• Command "Read value x" set during flying measurement |
| 7 | Abort get measured value | • More than one value requested<br>• No value requested<br>• Requested value not available<br>• Parking encoder active<br>• Parking drive object active |
| 8 | Abort absolute value transmission on | • Absolute encoder not available<br>• Alarm bit absolute value protocol set |
| 3841 | Function not supported | – |

## Encoder 2 status word (G2_ZSW)

- See Gn_ZSW

### Encoder 2 actual position value 1 (G2_XIST1)

- See Gn_XIST1

### Encoder 2 actual position value 2 (G2_XIST2)

- See Gn_XIST2

### Function diagrams (see the SINAMICS DCM List Manual)

- 4720 Encoder evaluation – Encoder interface, receive signals, encoders 1 ... 2
- 4730 Encoder evaluation – Encoder interface, send signals, encoders 1 ... 2
- 4735 Encoder evaluation – Reference mark search with external zero mark, encoders 1 ... 2

### Overview of important parameters (see SINAMICS DCM List Manual)

**Adjustable parameter drive, CU_S parameter is marked**

- p0418[0...15] Fine resolution Gx_XIST1 (in bits)
- p0419[0...15] Fine resolution absolute value Gx_XIST2 (in bits)
- p0480[0...2] CI: Encoder control word Gn_STW signal source

**Display parameters drive**

- r0481[0...2] CO: Encoder status word Gn_ZSW
- r0482[0...2] CO: Encoder actual position value Gn_XIST1
- r0483[0...2] CO: Encoder actual position value Gn_XIST2
- r0487[0...2] CO: Diagnostic encoder control word Gn_STW
- r0979[0...30] PROFIdrive encoder format

### 10.3.2.5 Extended encoder evaluation

The standard parameter r0979[0...30] describes the assignment from the telegram configuration view.

Index 1 describes the encoder type. Subindex 1 provides further properties of the encoder:

Table 10- 20 r0979 subindex 1

| Bit | Signal | Description |
|---|---|---|
| 0 | = 0<br>= 1 | Rotating encoder<br>Linear encoder |
| 1 | = 0<br>= 1 | No fine resolution possible<br>Fine resolution possible |
| 2 | = 0<br>= 1 | 64-bit not possible<br>Reserved |
| 3 - 28 | | In accordance with the PROFIdrive profile definition |
| 29 | = 0<br>= 1 | Encoder switchable<br>Encoder not switchable |
| 30 | = 0<br>= 1 | Interface information still to be received<br>No further interface information will be received |
| 31 | = 0<br>= 1 | Data in the substructure is invalid<br>Data in the substructure is valid |

### 10.3.2.6 Central control and status words

## Description

The central process data exists for different telegrams. For example, telegram 390 is used for transferring digital inputs and digital outputs.

The following central process data is available:

**Receive signals:**

- CU_STW1 Control Unit control word
- A_DIGITAL digital outputs

**Transmit signals:**

- CU_ZSW1 Control Unit status word
- E_DIGITAL digital inputs
- E_DIGITAL_1 digital inputs

## CU_STW1 (control word for Control Unit, CU)

See function diagram [2495].

Table 10- 21 Description of CU_STW1 (control word for Control Unit)

| Bit | Meaning | Remarks | | Interconnection parameter |
|---|---|---|---|---|
| 0 | Reserved | – | – | – |
| 1 | RTC PING | – | This signal is used to set the UTC time using the PING event. | p3104 = r2090.1 |
| 2...6 | Reserved | – | – | – |
| 7 | Acknowledge faults | | Acknowledge faults | p2103[0] = r2090.7 |
| 8...9 | Reserved | - | - | - |
| 10 | Control transferred | 0 | The CU has control<br>Once the propagated faults have been acknowledged at all drive objects, the fault is also implicitly acknowledged at drive object 1 (DO1 ≙ CU). | p3116 = r2090.10 |
| | | 1 | External control has control<br>The propagated faults must be acknowledged at all drive objects and must also be explicitly acknowledged at drive object 1 (DO1 ≙ CU). | |
| 11...15 | Reserved | – | | - |

## A_DIGITAL (digital outputs)

This process data can be used to control the Control Unit outputs.
See function diagram [2497].

Table 10- 22 Description of A_DIGITAL (digital outputs)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0 | Digital output 0 (DO 0) | p50771[0] = r2091.0 |
| 1 | Digital output 1 (DO 1) | p50772[0] = r2091.1 |
| 2 | Digital output 2 (DO 2) | p50773[0] = r2091.2 |
| 3 | Digital output 3 (DO 3) | p50774[0] = r2091.3 |
| 4...15 | Reserved | - |

## CU_ZSW1 (status word of the DO1 telegram (telegrams 39x))

See function diagram [2496].

Table 10- 23 Description of CU_ZSW1 (status word of the CU)

| Bit | Meaning | Interconnection parameter |
|---|---|---|
| 0...2 | Reserved | - |
| 3 | 1 = Fault present. The active faults are stored in the fault buffer.<br>0 = No fault present. There are no faults in the fault buffer. | p2081[3] = r2139.3 |
| 4...6 | Reserved | - |
| 7 | 1 = Alarm present. The active alarms are stored in the alarm buffer.<br>0 = No alarm present. There are no alarms in the alarm buffer. | p2081[7] = r2139.7 |
| 8 | 1 = Synchronize system time. | p2081[8] = r0899.8 |
| 9 | 1 = No group alarm present. | p2081[9] = r3114.9 |
| 10 | 1 = No group fault present. | p2081[10] = r3114.10 |
| 11 | Reserved, always "1" | - |
| 12...15 | Reserved | - |

## E_DIGITAL (digital inputs)

See function diagram [2498].

Table 10- 24 Description of E_DIGITAL (digital inputs)

| Bit | Meaning | Interconnection parameter [1)] |
|---|---|---|
| 0 | CUD digital input 4 (DI 4) [2)] | p2082[0] = r53010.8 |
| 1 | CUD digital input 5 (DI 5) [2)] | p2082[1] = r53010.10 |
| 2 | CUD digital input 6 (DI 6) [2)] | p2082[2] = r53010.12 |
| 3 | CUD digital input 7 (DI 7) [2)] | p2082[3] = r53010.14 |
| 4...7 | Reserved | - |
| 8 | CUD digital input 0 (DI 0) | p2082[8] = r53010.0 |
| 9 | CUD digital input 1 (DI 1) | p2082[9] = r53010.2 |
| 10 | CUD digital input 2 (DI 2) | p2082[10] = r53010.4 |
| 11 | CUD digital input 3 (DI 3) | p2082[11] = r53010.6 |
| 12...15 | Reserved | - |

1) Default can be freely changed.

2) Can be set via p50789[0…3] as digital input or digital output.

### 10.3.2.7 Diagnostics channel for cyclic communication

Alarms and faults can be transferred via two independent diagnostic channels DS0 and DS1. The information transferred is saved in parameters r0945[8] for faults and in r2122[8] for alarms. This allows the alarms and faults from a SINAMICS drive to be integrated into the system diagnostics of a higher-level controller and automatically displayed on an HMI. This function is certified for PROFINET and PROFIdrive.

The function is activated via the appropriate parameterization in the configuration tool being used, e.g. using HW Config or TIA Portal. The functionality is then transferred at the next power up to drive.

The messages of the diagnostic channels depend on the bus system being used for data transfer.

Table 10- 25 Messages in relation to bus system

| | | PROFIdrive error classes | | SINAMICS messages | | |
|---|---|---|---|---|---|---|
| | | Faults | Alarms | Faults | Alarms | Fault/alarm |
| PN | GSD | Yes | Yes | No | No | Is detected and localized |
| | TIA | Yes | Yes | Yes | Yes | Is detected and localized, allows problems to be directly resolved |

- The alarms and faults correspond to the error classes defined in the PROFIdrive profile.
- You can select whether alarms and faults are transferred to a higher-level controller either as SINAMICS messages or using the error classes of the PROFIdrive profile.
- The alarms and faults can be mapped with standard resources (e.g. GSDML)
- The alarms or faults are logically and locally signaled:
  - With alarm or fault number
  - With assignment of the drive object, message value and hardware component assignment
  - In a user-friendly way with plain message texts
  - Display with user-defined names for drive objects and components
  - SINAMICS transfers the messages in the order that they have occurred
  - SINAMICS does not record any time stamps
  - The time stamps are generated from the higher-level controller when the messages are received
  - To transfer the SINAMICS messages, the extended channel diagnostics is used
- The existing mechanisms of TIA and S7 Classic can be used.
- The messages are compatible with PROFINET controllers.

- Alarms or faults are acknowledged using the already known acknowledgment routes.
- Transfer possible via interface IF1 and/or IF2

**Note**

**Restriction in the case of shared device**

If Shared device is activated, only one of the controllers can receive diagnoses.

### Transmission in the case of cyclic communication

- For PROFINET, there is a unique assignment of the drive objects to the slots of the cyclic communication. The diagnostics is issued at the MAP/PAP-submodule.

### Transmission in the case of acyclic communication

- There is no slot or subslot configured at which diagnostics can be issued.
- Faults or alarms that occur are routed along the BICO connections to the drive objects.

### Display of error classes according to PROFIdrive

- For transfer with PROFINET, the PROFIdrive error class and the extended channel diagnostics.

## 10.3.3 Parallel operation of communication 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).

Cyclic process data (setpoints / actual values) are processed using interfaces IF1 and IF2. The following interfaces are used:

- Onboard interfaces of the Control Unit for PROFIBUS DP
- An additional interface (COMM-BOARD) for PROFINET or Ethernet/IP (CBE20 Communication Board Ethernet) for insertion in the Control Unit as an option.

Parameter p8839 is used to set the parallel use of the Control Unit onboard interfaces and 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 Communication Board Ethernet); PROFIBUS (only DO Drive, max. 16 PZD) 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 10- 26 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) | Yes | 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 DC_CTRL | 64 / 64 | 64 / 64 |
| Max. PZD (16-bit) setpoint / actual value encoder | 4 / 12 | 4 / 12 |
| 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 (device) | 20 / 25 | 20 / 25 |

Table 10- 27 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, PROFINET or USS) | Control Unit onboard | -- |
| CUD with CBE20 Communication Board Ethernet | COMM BOARD | Control Unit onboard PROFIBUS or Control Unit onboard USS |

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)] Significance of 88xx identical to 20xx

**Note**

Using the HW Config configuration tool, a PROFIBUS/PROFINET slave with two interfaces cannot be shown. In parallel operation, this is the reason that SINAMICS appears twice in the project or in two projects, although physically it is just one device.

## Parameter

| 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 SINAMICS DCM 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

## 10.3.4 Acyclic communication

### 10.3.4.1 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, for example, in online mode via PROFIBUS.

- 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**

Please refer to the following documentation for a detailed description of acyclic communication:
Reference: PROFIdrive Profile V4.2, October 2015, Order No: 3.172

**Note**

**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.

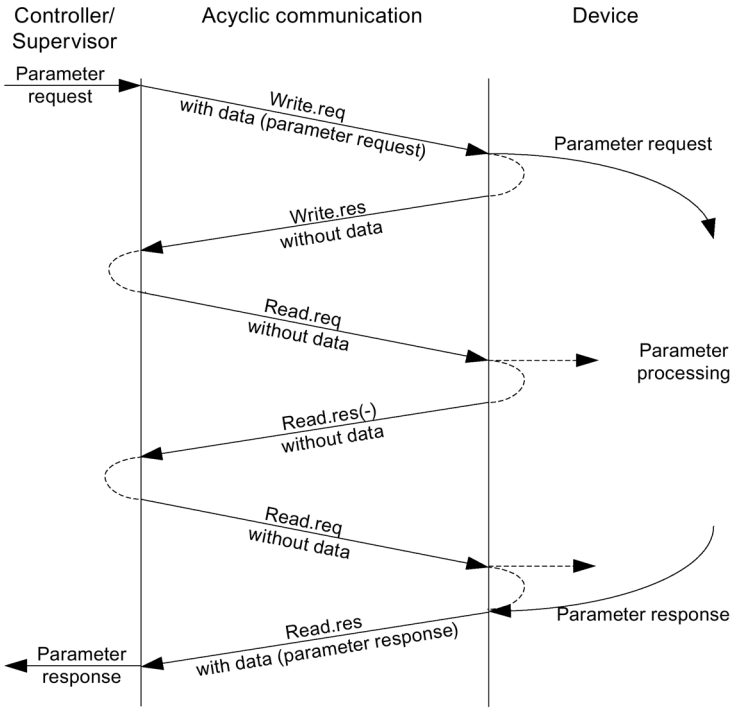



Figure 10-9 Reading and writing data

## Properties of the parameter channel

- One 16-bit address exists for each parameter number and subindex.
- Concurrent access by several 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 (no pipelining).
- A parameter request/response must fit into a data set (max. 240 bytes).
- The request or the response header is user data.

### 10.3.4.2 Structure of orders and responses

## Structure of parameter request and parameter response

Table 10- 28 Parameter request

| | **Parameter request** | | | **Offset** |
|---|---|---|---|---|
| Values for write access only | Request header | Request reference | Request ID | 0 |
| | | Axis | 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 10- 29 Parameter response

| | **Parameter response** | | | **Offset** |
|---|---|---|---|---|
| Values for read access only<br>Error values for negative response only | Response header | Request reference mirrored | Response ID | 0 |
| | | Axis 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 DPV1 parameter request and response

Table 10- 30 Fields

| Field | Data type | Values | Remark |
|---|---|---|---|
| Request reference | Unsigned8 | 0x01 ... 0xFF | |
| | Unique identification of the request/response pair for the master. The master changes the request reference with each new request. The slave mirrors the request reference in its response. | | |
| Request ID | Unsigned8 | 0x01<br>0x02 | Read request<br>Write request |
| | Specifies the type of request.<br>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 | 0x01<br>0x02<br>0x81<br>0x82 | Read request (+)<br>Write request (+)<br>Read request (-)<br>Write request (-) |
| | Mirrors the request identifier and specifies whether request execution was positive or negative.<br>Negative means:<br>Cannot execute part or all of request.<br>The error values are transferred instead of the values for each subresponse. | | |
| Drive object number | Unsigned8 | 0x00 ... 0xFF | 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 | 0x01 ... 0x27 | No. 1 ... 39<br>Limited by DPV1 telegram length |
| | Defines the number of adjoining areas for the parameter address and/or parameter value for multi-parameter requests.<br>The number of parameters = 1 for single requests. | | |
| Attribute | Unsigned8 | 0x10<br>0x20<br>0x30 | Value<br>Description<br>Text (not implemented) |
| | Type of parameter element accessed. | | |
| Number of elements | Unsigned8 | 0x00<br>0x01 ... 0x75 | Special function<br>No. 1 ... 117<br>Limited by DPV1 telegram length |
| | Number of array elements accessed. | | |
| Parameter number | Unsigned16 | 0x0001 ... 0xFFFF | No. 1 ... 65535 |
| | Addresses the parameter to be accessed. | | |
| Subindex | Unsigned16 | 0x0000 ... 0xFFFF | No. 0 ... 65535 |
| | Addresses the first array element of the parameter to be accessed. | | |

| Field | Data type | Values | Remark |
|---|---|---|---|
| Format | Unsigned8 | 0x02<br>0x03<br>0x04<br>0x05<br>0x06<br>0x07<br>0x08<br>Other values | Data type integer8<br>Data type integer16<br>Data type integer32<br>Data type unsigned8<br>Data type unsigned16<br>Data type unsigned32<br>Data type floating point<br>See PROFIdrive profile V3.1 |
| | | 0x40<br><br>0x41<br>0x42<br>0x43<br>0x44 | Zero (without values as a positive subresponse to a write request)<br>Byte<br>Word<br>Double word<br>Error |
| | The format and number specify the adjoining space containing values in the telegram.<br>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 | 0x00 ... 0xEA | No. 0 ... 234<br>Limited by DPV1 telegram length |
| | Specifies the number of subsequent values. | | |
| Error values | Unsigned16 | 0x0000 ... 0x00FF | Significance of the error values<br>→ refer to the following table "Error values in the DPV1 parameter responses" |
| | The error values in the event of a negative response.<br>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 | 0x0000 ... 0x00FF | |
| | The values of the parameter for read or write access.<br>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. | | |

## Error values in DPV1 parameter responses

Table 10- 31 Error values in DPV1 parameter responses

| Error value | Meaning | Remark | Additional info |
|---|---|---|---|
| 0x00 | Illegal parameter number. | Access to a parameter that does not exist. | – |
| 0x01 | Parameter value cannot be changed. | Modification access to a parameter value that cannot be changed. | Subindex |
| 0x02 | Lower or upper value limit exceeded. | Modification access with value outside value limits. | Subindex |
| 0x03 | Invalid subindex. | Access to a subindex that does not exist. | Subindex |
| 0x04 | No array. | Access with subindex to non-indexed parameter. | – |
| 0x05 | Wrong data type. | Modification access with a value that does not match the data type of the parameter. | – |
| 0x06 | Illegal set operation (only reset allowed). | Modification access with a value not equal to 0 in a case where this is not allowed. | Subindex |
| 0x07 | Description element cannot be changed. | Modification access to a description element that cannot be changed. | Subindex |
| 0x09 | No description data available. | Access to a description that does not exist (the parameter value exists). | – |
| 0x10 | Read job will not be executed. | The read request is refused because know-how protection is active. | |
| 0x0B | No operating priority. | Modification access with no operating priority. | – |
| 0x0F | No text array exists. | Access to a text array that does not exist (the parameter value exists). | – |
| 0x11 | Request cannot be executed due to operating status. | Access is temporarily not possible for unspecified reasons. | – |
| 0x14 | 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 |
| 0x15 | Response too long. | The length of the present response exceeds the maximum transfer length. | – |
| 0x16 | Illegal parameter address. | Illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these. | – |
| 0x17 | Illegal format. | Write request: Illegal or unsupported parameter data format. | – |
| 0x18 | 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. | – |
| 0x19 | Drive object does not exist. | You have tried to access a drive object that does not exist. | – |
| 0x20 | Parameter text cannot be changed | – | – |
| 0x21 | Service not supported. | Illegal or unknown request ID | – |
| 0x65 | 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 |
|---|---|---|---|
| 0x6B | Write access for the enabled controller. | Write access is possible while the device is in the "Controller enable" state.<br>Pay attention to the parameter attribute "changeable" in the SINAMICS DCM List Manual (C1, C2, U, T). | – |
| 0x6C | Parameter %s [%s]: Unknown unit. | – | – |
| 0x6D | Parameter %s [%s]: Write access only in the commissioning state, encoder (p0010 = 4). | – | – |
| 0x6E | Parameter %s [%s]: Write access only in the commissioning state, motor (p0010 = 3). | – | – |
| 0x6F | Parameter %s [%s]: Write access only in the commissioning state, power unit (p0010 = 2). | – | – |
| 0x70 | Parameter %s [%s]: Write access only in the quick commissioning mode (p0010 = 1). | – | – |
| 0x71 | Parameter %s [%s]: Write access only in the ready mode (p0010 = 0). | – | – |
| 0x72 | Parameter %s [%s]: Write access only in the commissioning state, parameter reset (p0010 = 30). | – | – |
| 0x73 | Parameter %s [%s]: Write access only in the commissioning state, Safety (p0010 = 95). | – | – |
| 0x74 | Parameter %s [%s]: Write access only in the commissioning state, tech. application/units (p0010 = 5). | – | – |
| 0x75 | Parameter %s [%s]: Write access only in the commissioning state (p0010 not equal to 0). | – | – |
| 0x76 | Parameter %s [%s]: Write access only in the commissioning state, download (p0010 = 29). | – | – |
| 0x77 | Parameter %s [%s] must not be written during download. | – | – |
| 0x78 | Parameter %s [%s]: Write access only in the commissioning state, drive configuration (device: p0009 = 3). | – | – |
| 0x79 | Parameter %s [%s]: Write access only in the commissioning state, define drive type (device: p0009 = 2). | – | – |

| Error value | Meaning | Remark | Additional info |
|---|---|---|---|
| 0x7A | Parameter %s [%s]: Write access only in the commissioning state, data record base configuration (device: p0009 = 4). | – | – |
| 0x7B | Parameter %s [%s]: Write access only in the commissioning state, device configuration (device: p0009 = 1). | – | – |
| 0x7C | Parameter %s [%s]: Write access only in the commissioning state, device download (device: p0009 = 29). | – | – |
| 0x7D | Parameter %s [%s]: Write access only in the commissioning state, device parameter reset (device: p0009 = 30). | – | – |
| 0x7E | Parameter %s [%s]: Write access only in the commissioning state, device ready (device: p0009 = 0). | – | – |
| 0x7F | Parameter %s [%s]: Write access only in the commissioning state, device (device: p0009 not equal to 0). | – | – |
| 0x81 | Parameter %s [%s] must not be written during download. | – | – |
| 0x82 | Transfer of master control is blocked by BI: p0806. | – | – |
| 0x83 | Parameter %s [%s]: Requested BICO interconnection not possible. | BICO output does not supply float values. The BICO input, however, requires a float value. | – |
| 0x84 | Parameter %s [%s]: Parameter change inhibited (refer to p0300, p0400, p0922) | – | – |
| 0x85 | Parameter %s [%s]: Access method not defined. | – | – |
| 0x87 | Write job will not be executed.. | The write request is rejected because know-how protection is active. | – |
| 0xC8 | Below currently valid limit. | Modification request for a value that, although within "absolute" limits, is below the currently valid lower limit. | – |
| 0xC9 | 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). | – |
| 0xCC | Write access not permitted. | Write access is not permitted because an access code is not available. | – |

#### 10.3.4.3 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.

#### 10.3.4.4 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 (ZSW1.3 = "1") on object drive 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 |
| | Axis = 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.
- Axis:

  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 ZSW1.3 = "1" → Initiate parameter request.

## Evaluate parameter response

| Parameter response | | | Offset |
|---|---|---|---|
| Response header | Request reference mirrored = 25 hex | Response ID = 01 hex | 0 + 1 |
| | Axis 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.
- Axis 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.

### 10.3.4.5 Example 2: Write parameters (multi-parameter request)

#### Requirements

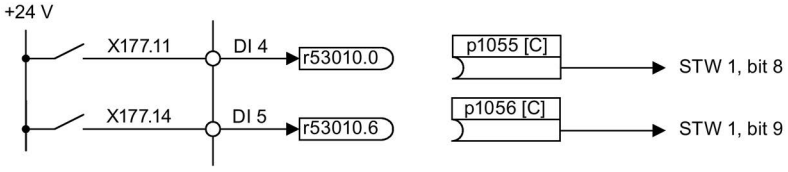
- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data sets in conformance with PROFIdrive DPV1.

#### Task description

Jog 1 and 2 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: p1055 = r53010.0 Jog bit 0
- BI: p1056 = r53010.6 Jog bit 1
- p50436[0] = 5% Jog 1 speed setpoint
- p50436[1] = 10% Jog 2 speed setpoint

The request is to be handled using a request and response data block.




Input in BI: p1055 and BI: p1056

Object
0: Device
2: DC_CTRL
63: Wiring on itself

| Parameter number | Index number | | |
|---|---|---|---|
| r53010 | 2 | 0 | = CF12 0400 Hex |
| r53010 | 2 | 6 | = CF12 0406 Hex |
| 31 ... 16 | 15 ... 10 | 9 ... 0 | |

Figure 10-10 Task description for multi-parameter request (example)

#### Basic procedure

1. Create a request to write the parameters.
2. Invoke the request.
3. Evaluate the response.

## 1. Creating a request

Table 10- 32 Parameter request

| **Parameter request** | | | **Offset** |
|---|---|---|---|
| Request header | Request reference = 40 hex | Request ID = 02 hex | 0 + 1 |
| | Axis = 02 hex | Number of parameters = 04 hex | 2 + 3 |
| 1st parameter address | Attribute = 10 hex | Number of elements = 01 hex | 4 + 5 |
| | Parameter no. = 1055 dec | | 6 |
| | Subindex = 0 dec | | 8 |
| 2nd parameter address | Attribute = 10 hex | Number of elements = 01 hex | 10 + 11 |
| | Parameter no. = 1056 dec | | 12 |
| | Subindex = 0 dec | | 14 |
| 3rd parameter address | Attribute = 10 hex | Number of elements = 01 hex | 16 + 17 |
| | Parameter no. = 53436 dec | | 18 |
| | Subindex = 0 dec | | 20 |
| 4th parameter address | Attribute = 10 hex | Number of elements = 01 hex | 22 + 23 |
| | Parameter number = 50436 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 = 0400 hex | | 32 |
| 2nd parameter value(s) | Format = 07 hex | Number of values = 01 hex | 34 + 35 |
| | Value = CF12 hex | | 36 |
| | Value = 0406 hex | | 38 |
| 3rd parameter value(s) | Format = 08 hex | Number of values = 01 hex | 40 + 41 |
| | Value = 40A0 hex | | 42 |
| | Value = 0000 hex | | 44 |
| 4th parameter value(s) | Format = 08 hex | Number of values = 01 hex | 46 + 47 |
| | Value = 4120 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.
- Axis:
  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 (p1055, p1056, p50436).
- 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 |
| | Axis 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
- Axis mirrored:
  02 hex → The value matches the value from the request.
- Number of parameters:
  04 hex → The value matches the value from the request.

# 10.4 Communication via PROFIBUS DP

## 10.4.1 PROFIBUS connection

**⚠WARNING**

**Electric shock during connection while voltage is present**

When connecting the PROFIBUS cable while voltage is present, there is a danger of coming into contact with live components behind the terminal.

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

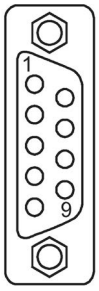
The PROFIBUS connection and diagnostics LEDs are located on the Control Unit (CUD).

The PROFIBUS connection is via a 9-pin Sub-D socket X126. The connections are electrically isolated.

See also Figure 6-31 Terminal/connector arrangement on the "Control Unit (CUD)" (Page 118) and Chapter "Description of the LEDs on the CUD (Page 597)".

### PROFIBUS connection

Table 10- 33 PROFIBUS connector assignment

| Connector X126 | 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 |
| "Control Unit (CUD)" module | | | |

## Bus connector

The cables must be connected using PROFIBUS bus connectors as these contain the necessary bus terminating resistors.

Suitable PROFIBUS bus connector: Article No. 6GK1500-0FC10

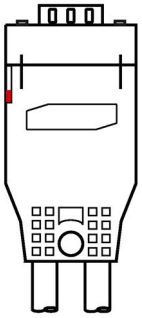


Figure 10-11 PROFIBUS bus connector

## 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 transmitted properly.

Principle: 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.

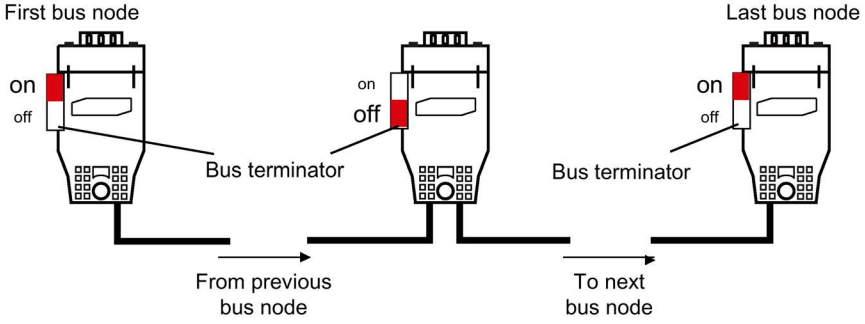



Figure 10-12 Position of the bus terminating resistors

## 10.4.2 General information about PROFIBUS

### 10.4.2.1 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 EN 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 CAN bus nodes**<br>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 slave

- Master and slave properties

| Properties | Master | Slave |
| --- | --- | --- |
| 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 slaves 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 slaves in acyclic mode.

    Examples: Programming devices, human machine interfaces

- Slaves

  With respect to PROFIBUS, the SINAMICS drive unit is a slave.

### 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 slaves in a master/slave 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.

### 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. HW Config), 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_DC)
- Terminal Module 15 (TM15)
- Terminal Module 31 (TM31)
- Terminal Module 150 (TM150)
- DC drive control (DC_CTRL)

**Note**

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

The structure of the telegram 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_DC, DC_CTRL
- Configuration with DC_CTRL, TM31, TM31
- etc.

### 10.4.2.2 Example of a telegram structure for cyclic data acquisition

#### Task

The drive system comprises the following drive objects:

SINAMICS DCM with the objects

- CU_DC
- DC_CTRL

#### Configuration settings (e.g. HW Config for SIMATIC S7)

The components are mapped to objects for configuration.

Due to the telegram structure shown, the objects in the "DP slave properties" overview must be configured as follows:

- CU_DC Standard telegram 390
- DC_CTRL Standard telegram 352

**DP slave properties – Overview - Drive-ES / STARTER**

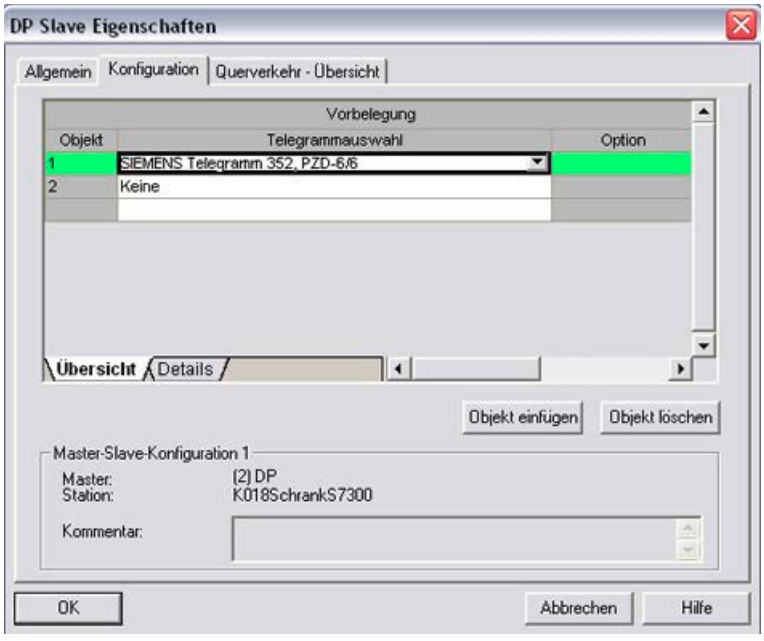



Figure 10-13 Slave properties – Overview

When you click "Details", the properties of the configured telegram structure are displayed (e.g. I/O addresses, axis separator).

**DP slave properties – Details**

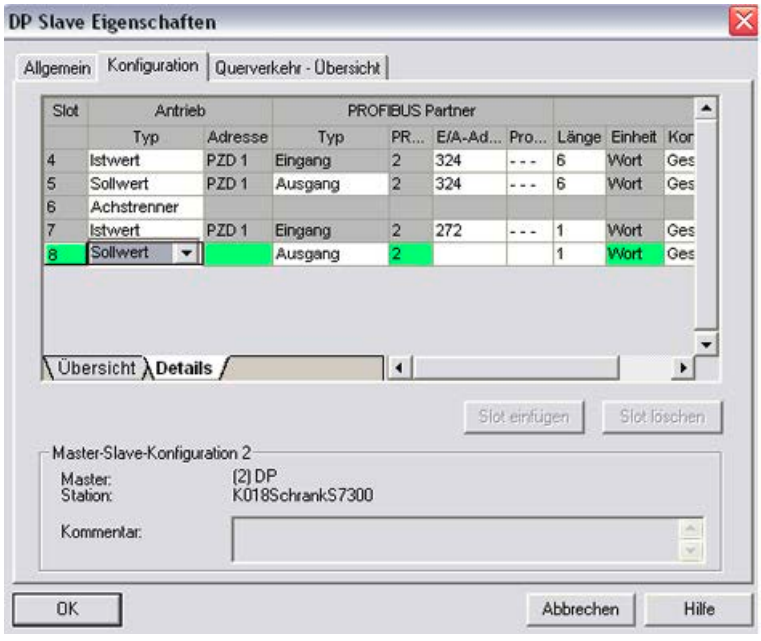



Figure 10-14 Slave properties – Details

The axis separator separates the objects in the telegram as follows:

- Slot 4 and 5: Object 2 → DC_CTRL
- Slot 7 and 8: Object 1 → CU_DC

## 10.4.3 Commissioning PROFIBUS

### 10.4.3.1 Setting the PROFIBUS interface

#### Interfaces and diagnostic LED

See Chapter "PROFIBUS connection (Page 423)".

**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 at parameter p0918.

The factory setting is

- For the left CUD: 126
- For the right CUD: 125

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 (only possible on the left CUD)
- Using the AOP30 (if available)
- Using STARTER

You must switch to DO 1 (CU) 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.

### 10.4.3.2 PROFIBUS interface during operation

#### Generic station description file

A generic station description file clearly and completely defines the properties of a PROFIBUS slave.

The GSD files can be found:

- On the Internet. For the link, see "Preface (Page 3)"
- On the memory card in the directory \\SIEMENS\SINAMICS\DATA\CFG\.
  - Universal module
  - Axis separator
  - Standard telegram1, PZD-2/2
  - Standard telegram20, PZD-2/6
  - SIEMENS telegram 220, PZD-10/10
  - SIEMENS telegram 352, PZD-6/6
  - Free telegram, PZD-4/4
  - Free telegram, PZD-8/8
  - Free telegram, PZD-16/16
  - Free telegram, PZD-32/32
  - Free telegram, PZD-64/64
  - Slave-to-slave, PZD-1
  - Slave-to-slave, PZD-2
  - Slave-to-slave, PZD-4
  - Slave-to-slave, PZD-8

The SINAMICS S DXB GSD file contains among other things standard telegrams, free telegrams and slave-to-slave telegrams for configuring direct data exchange. With the aid of these telegram parts and an axis separator, a telegram for the drive unit must be composed for each drive object.

Processing a GSD file in HW Config is covered in the SIMATIC documentation. Suppliers of PROFIBUS components can provide their own bus configuration tool. The description of the respective bus configuration tool is described in the relevant documentation.

#### Note for commissioning for VIK-NAMUR

To be able to operate a SINAMICS drive as a VIK-NAMUR drive, standard telegram 20 must be set and the VIK-NAMUR identification number activated via p2042 =1.

### Device identification

Identification for individual slaves facilitates diagnostics and provides an overview of the nodes on the PROFIBUS.

The information for each slave 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 423)".

## 10.4.3.3 Commissioning PROFIBUS

### Preconditions and assumptions for commissioning

PROFIBUS slave

- The PROFIBUS address to be set for the application is known.
- The telegram type for each drive object is known by the application.

PROFIBUS master

- The communication properties of the SINAMICS DCM slave must be available in the master (GSD file or Drive ES slave OM).

### Commissioning steps (example with SIMATIC S7)

1. Set the PROFIBUS address on the slave.
2. Set the telegram type on the slave.
3. Perform the following in the HW Config:
   - Connect the drive unit to PROFIBUS and assign the address.
   - Set the telegram type.

     The same telegram type as on the slave should be set for every drive object exchanging process data via PROFIBUS.

     The master can send more process data than the slave 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 be defined on a node or object (e.g. infeed controlled via terminals).
4. Assign the I/O addresses according to the user program.

## 10.4.3.4 Diagnostics options

The standard slave diagnostics can be read online in the HW config.

## 10.4.3.5 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 sub-index = 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 10- 34 Additional parameters

| Field | Value |
|---|---|
| Network parameter profile | DP |
| Network parameter baud rate | Any |
| Communication partner address | PROFIBUS address of the drive unit |
| Communication partner slot/rack | Don't care, 0 |

Table 10- 35 Variables: "General" tab

| Field | Value |
|---|---|
| Name | Any |
| Controller | Any |
| Type | Depending on the addressed parameter value, e.g.:<br>INT: for integer 16<br>DINT: for integer 32<br>WORD: for unsigned 16<br>REAL: for float |
| Area | DB |
| DB<br>(data block number) | Parameter number<br>1 ... 65535 |
| DBB, DBW, DBD<br>(data block offset) | Drive object No. and sub-index<br>bit 15 ... 10: Drive object No. 0 ... 63<br>bit 9 ... 0: Sub-index 0 ... 1023<br>or expressed differently<br>DBW = 1024 * drive object No. + sub-index |
| 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 Cpoint-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.

### 10.4.3.6 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 a quick stop, for example.

  Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 triggers fault response OFF3 (quick stop) on the DO DC_CTRL. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.

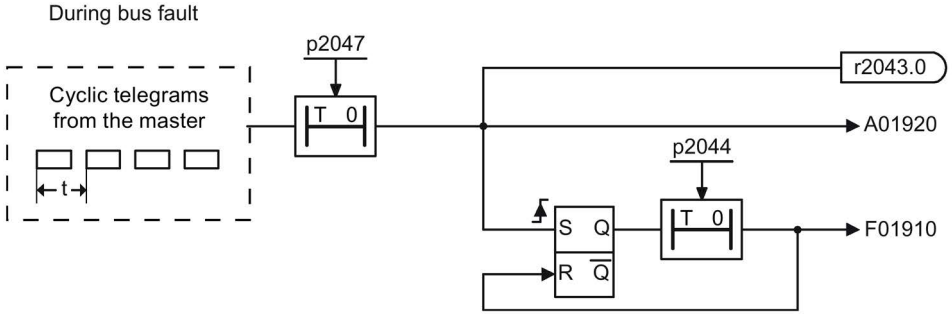



Figure 10-15 Monitoring of telegram failure with a bus fault

- Telegram failure with a CPU stop

  After telegram failure, bit r2043.0 is set to "1". Binector output r2043.0 can be used for a quick stop, for example.

  Once the delay time p2044 has elapsed, fault F01910 is output. Fault F01910 triggers fault response OFF3 (quick stop) on the DO DC_CTRL. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIdrive.

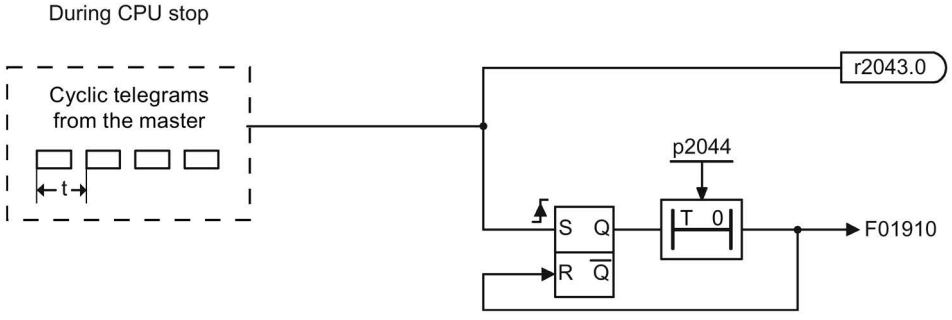



Figure 10-16 Monitoring telegram failure for a CPU stop

### Example: Quick stop at telegram failure

**Settings:**

- CU p2047 = 20 ms
- DC_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 switches to "1".

   Alarm A01920 and fault F01910 are output at the same time for the DC_CTRL drive objects.
2. When F01910 is output, an OFF3 is triggered for the drive.

**Note**

The additional monitoring time p2047 is only useful for cyclic communication.

## 10.4.4 Direct data exchange

For PROFIBUS DP, the master interrogates all of the slaves one after the other in a DP cycle. In this case, the master transfers its output data (setpoints) to the particular slave and receives as response the input data (actual values). Fast, distributed data transfer between drives (slaves) is possible using the "direct data exchange" function without direct involvement from the master.

The following terms are used for the function described in this chapter:

- Direct data exchange
- Data Exchange Broadcast (DXB.req)
- Direct data exchange (is used in the following)

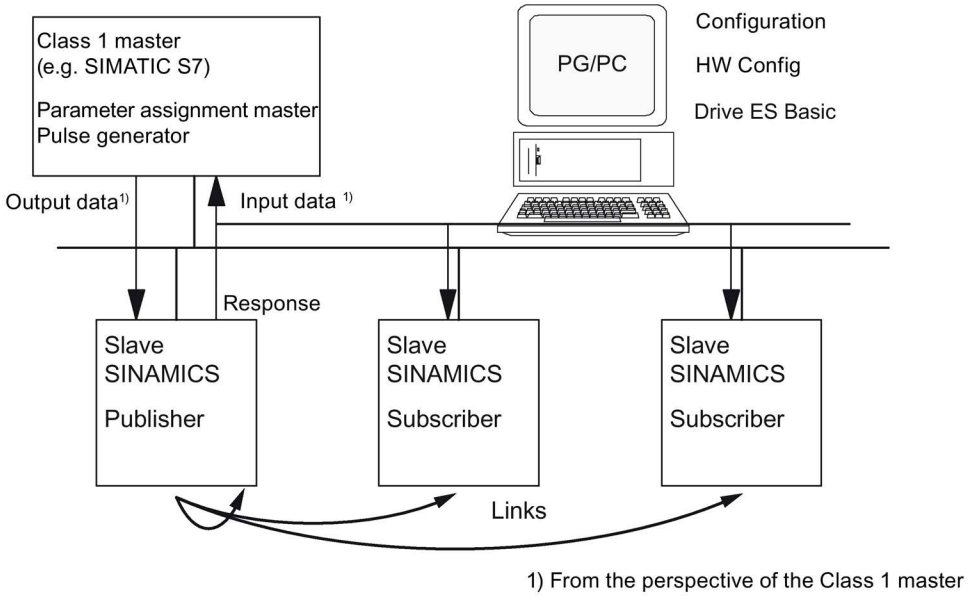



Figure 10-17 Direct data exchange with the publisher-subscriber model

### Publisher

With the "direct data exchange" function, at least one slave 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
- Firmware as of Version 1.2
- 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 applications can be implemented using the "direct data exchange" function:

- Axis couplings
- Specifying binector connections from another slave

### 10.4.4.1 Setpoint assignment in the subscriber

#### Information about setpoints

- Number of setpoint

  When bus communication is being established, the master signals the slave 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 slave".

- Operation as "standard" slave

  The drive unit (slave) only receives its setpoints as output data from the master.

- Operation as subscriber

  When a slave is operated as a subscriber, some of the setpoints are defined by one or more publishers rather than by the master.

  The slave is informed of the assignment via the parameterization and configuration telegram when bus communication is being established.

### 10.4.4.2 Activating/parameterizing slave-to-slave communication

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 slaves 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

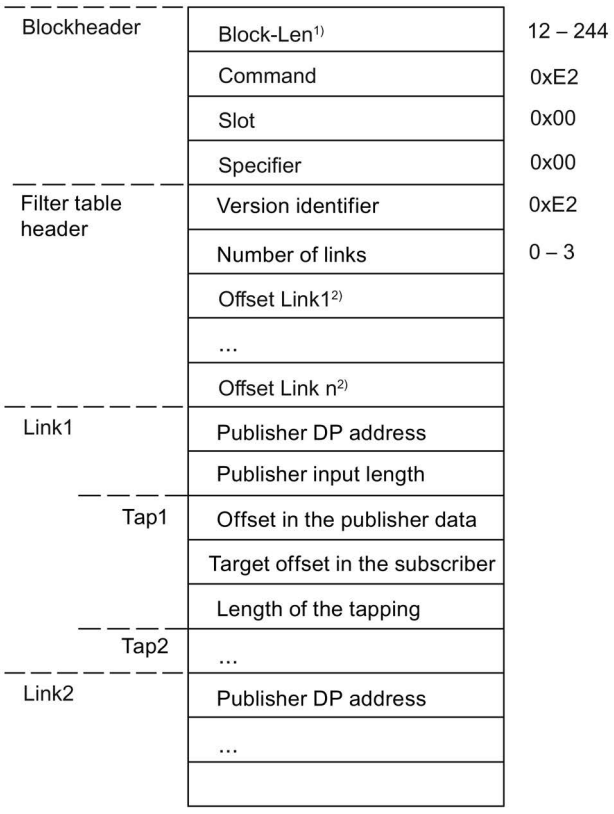
The slave, which is to be used as subscriber, requires a filter table. The slave must know which setpoints are received from the master and which are received from a publisher.

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 (SetPrm)

The filter table is transferred, as a dedicated block from the master to the slave with the parameterizing telegram when a bus communication is established.




1) Specified in bytes
2) Calculated as of version identifier

Figure 10-18 Filter block in the parameterizing telegram (SetPrm)

## Configuration telegram (ChkCfg)

Using the configuration telegram, a slave 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 into the drive devices that operate as subscribers.

### 10.4.4.3 Commissioning of the PROFIBUS slave-to-slave communication

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.

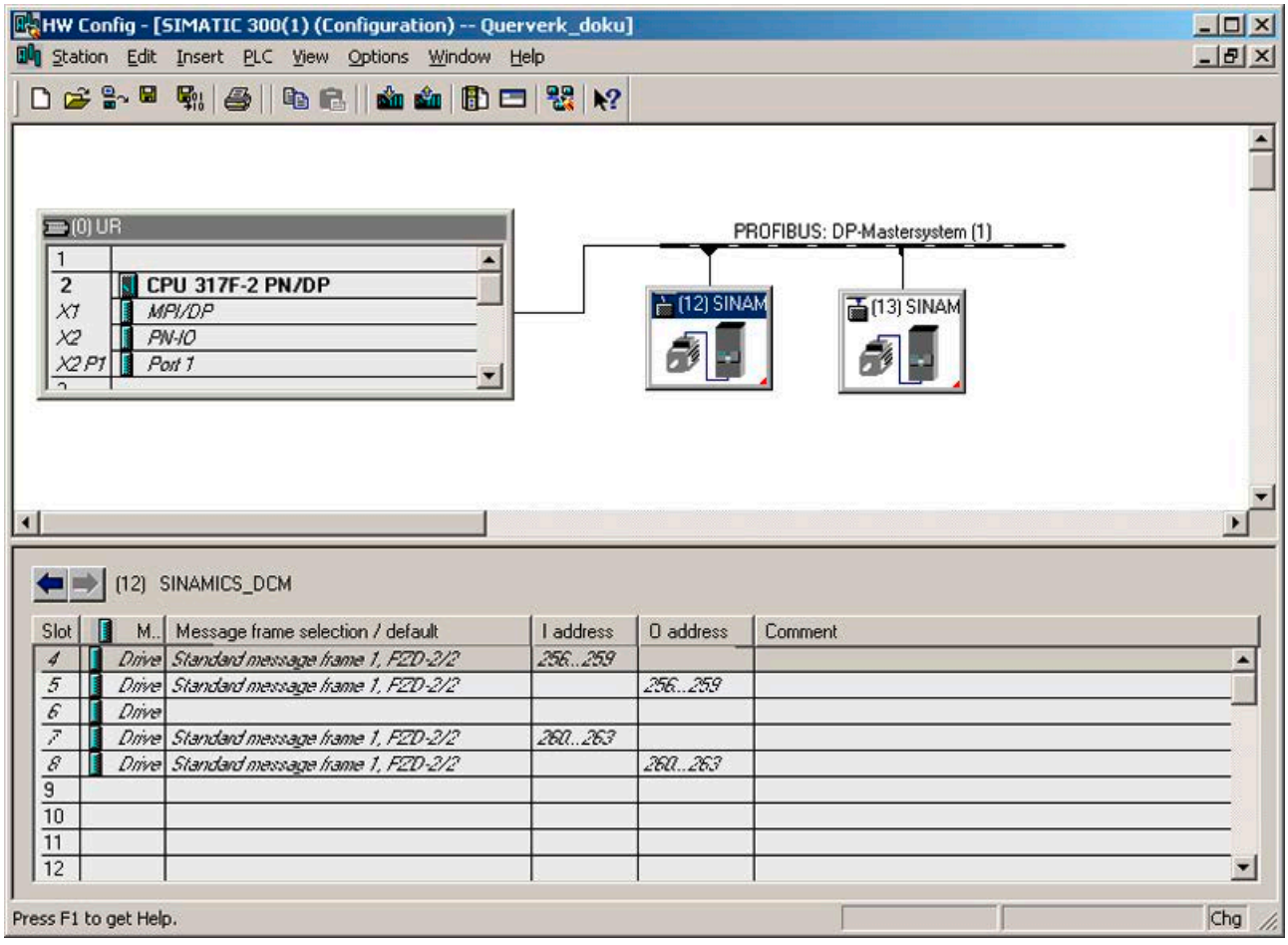



Figure 10-19 Example project of a PROFIBUS network in HW Config

## Procedure

1. Select a slave (e.g. SINAMICS DCM) and use its properties to configure the telegram for the connected drive object.
2. In the "Configuration" tab of the drive unit, select e.g. the standard telegram 1 for the associated drive in the telegram selection.

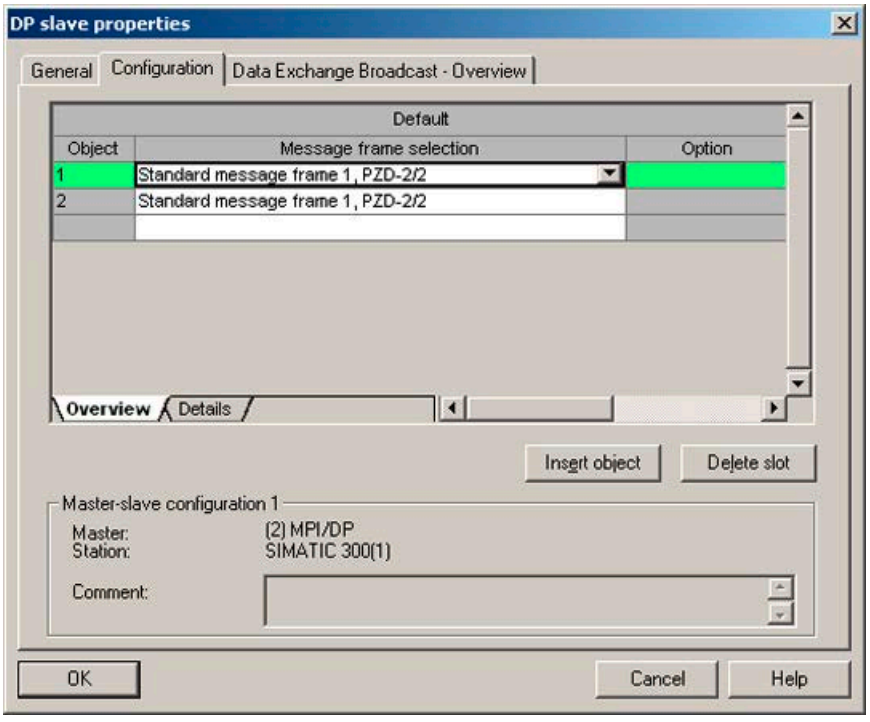



Figure 10-20 Telegram selection for drive object

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.

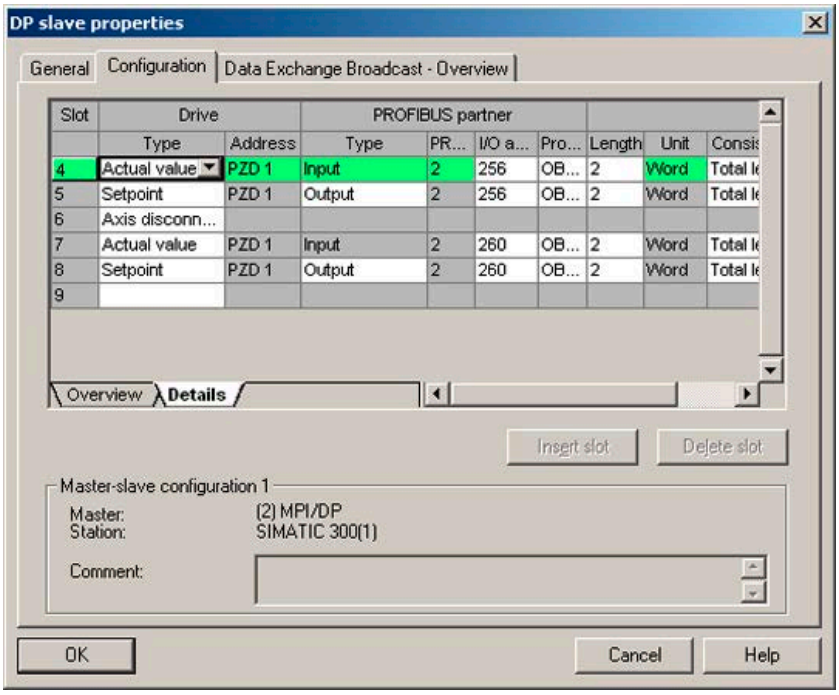



Figure 10-21 Detail view of slave configuration

4. The "Insert slot" button can be used to create a new setpoint slot for the SINAMICS DCM drive object.

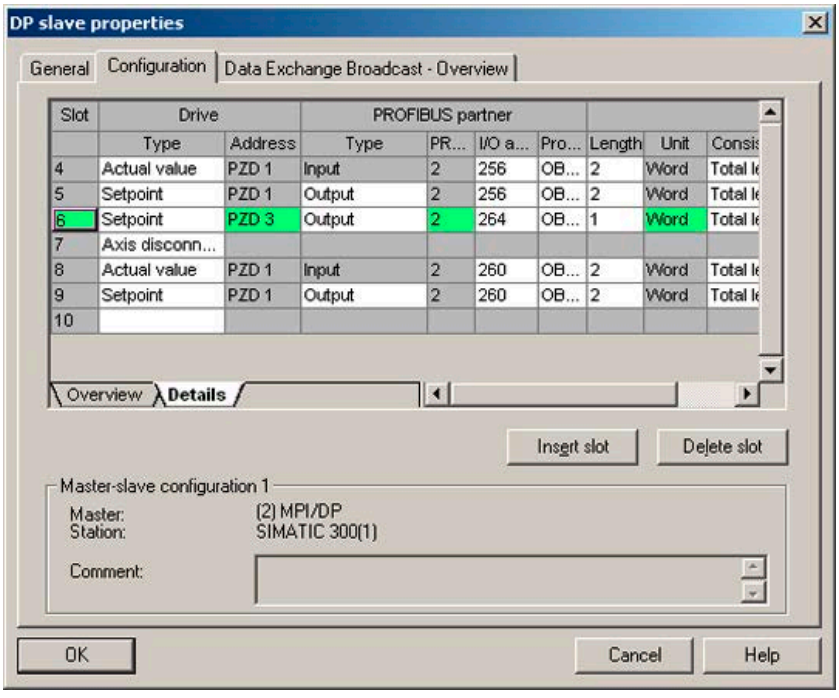



Figure 10-22 Insert new slot

5. Assign the setpoint slot the type "direct data exchange".
6. Select the publisher DP address in the "PROFIBUS address" column.
   All PROFIBUS DP slaves from which actual value data can be requested are listed here. 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 each DO.
   Select the start address of the DO data to be read. This is 200 in the example.
   If the complete data of the publisher is not read, set this via 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.

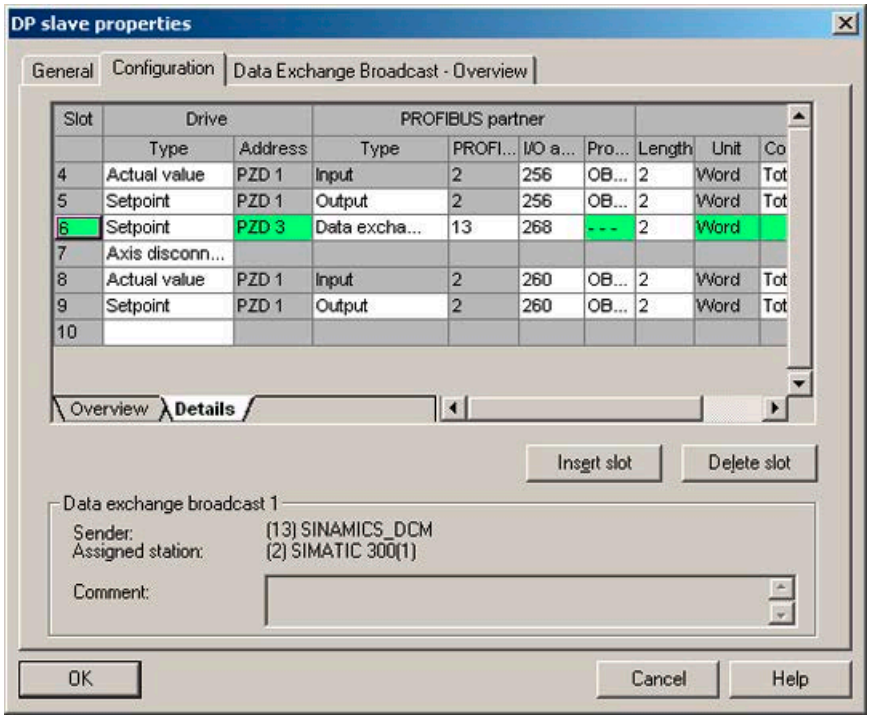



Figure 10-23 Configuring the direct data exchange nodes

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.

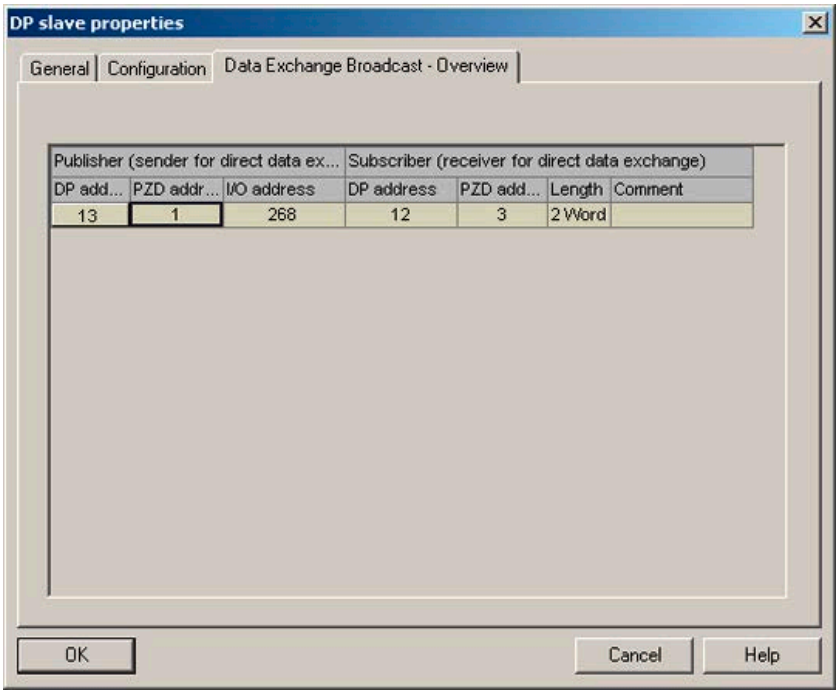



Figure 10-24 Direct data exchange – Overview

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.

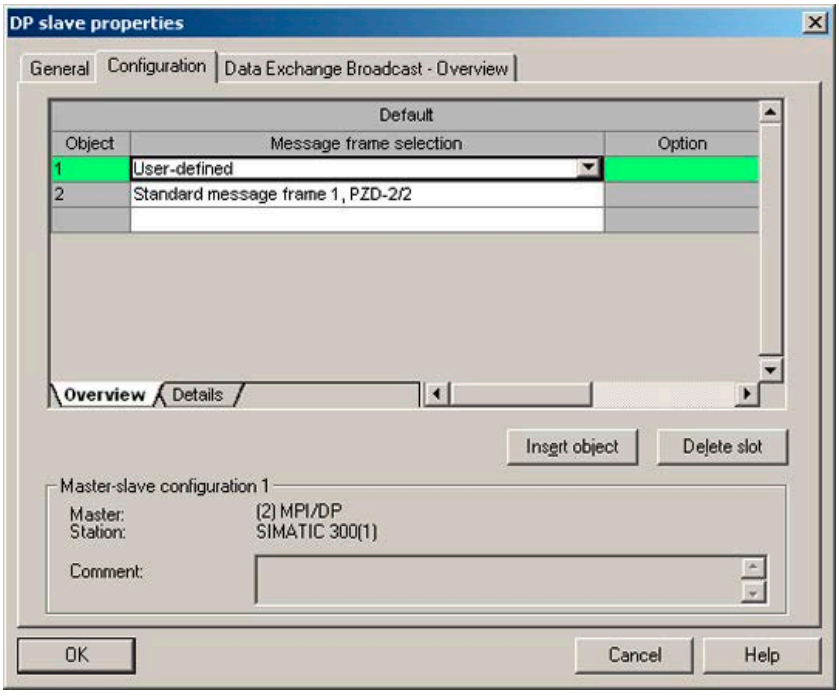



Figure 10-25 Telegram assignment for direct data exchange

10. The details after the creation of the direct data exchange link for the drive object of the SINAMICS DCM are as follows:

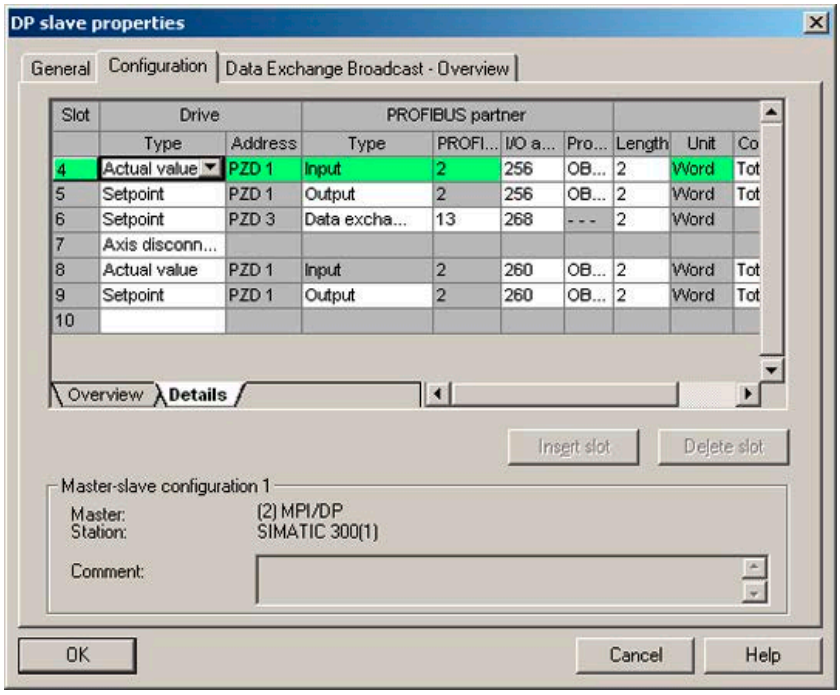



Figure 10-26 Details after the creation of the direct data exchange link

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 HWConfig and is simply an extension of an existing telegram. Telegrams can be extended in STARTER (e.g. p0922 = 999).

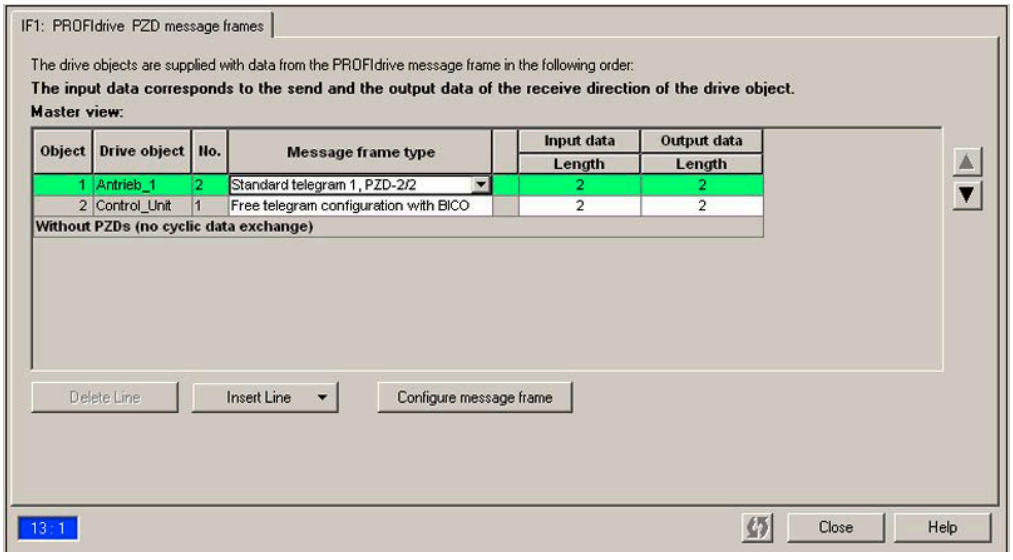



Figure 10-27 Configuring the direct data exchange links in STARTER

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 components of the drive objects, here DC_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.
3. Then set the telegram component in the telegram selection to the standard telegram for drive objects (in the example: Standard telegram 1), which results in a split display of the telegram types (standard telegram + telegram extension). The telegram extension represents the telegram portion of direct data exchange.

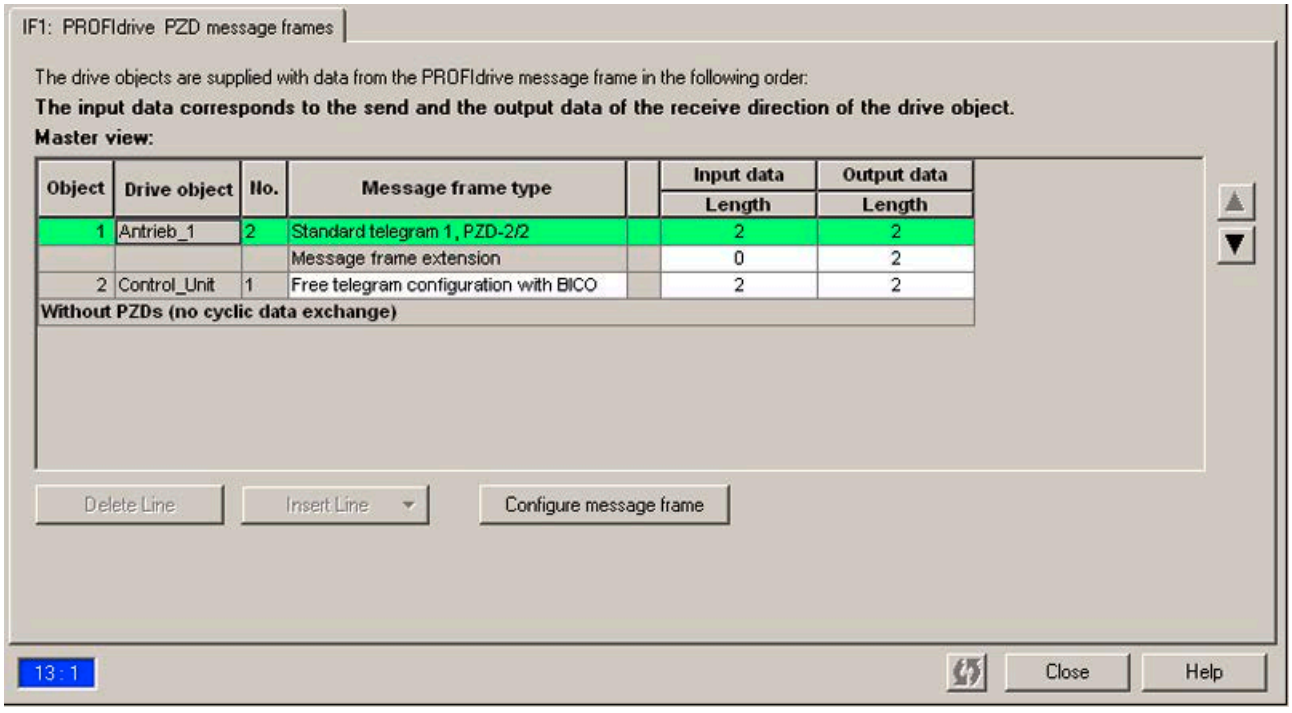



Figure 10-28 Display of the telegram extension

By selecting the item "Communication → PROFIBUS" for the drive object "DC_CTRL" in the project navigator, you obtain the structure of the PROFIBUS telegram in the receive and send directions.
The telegram extension from PZD3 onwards is the component for direct data exchange.

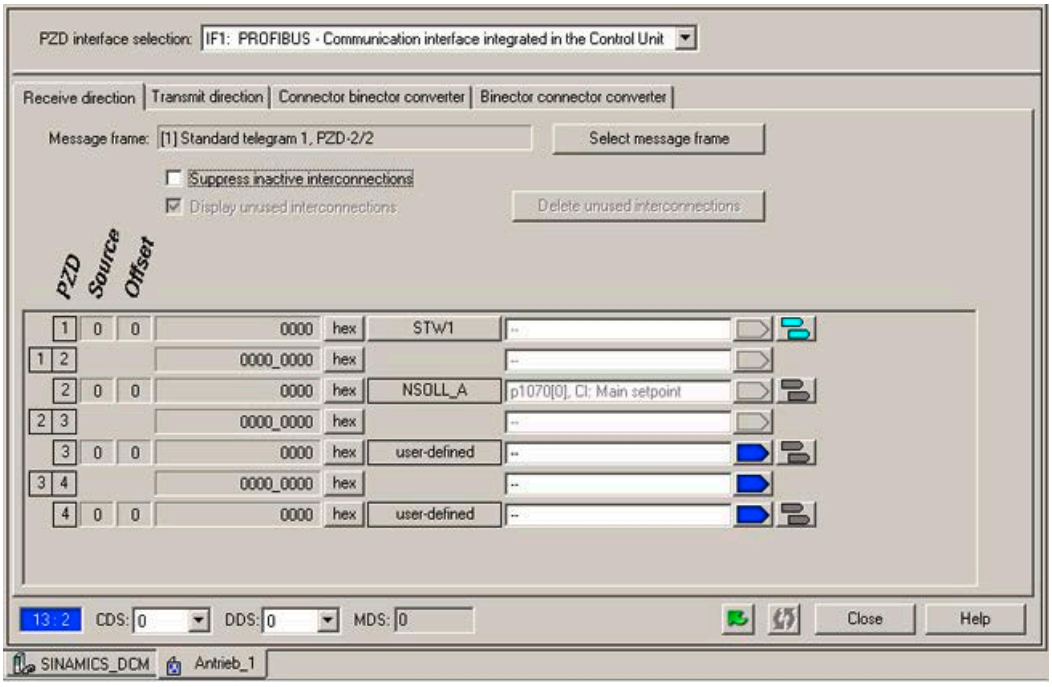



Figure 10-29 Configuring the PROFIBUS direct data exchange in STARTER

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.

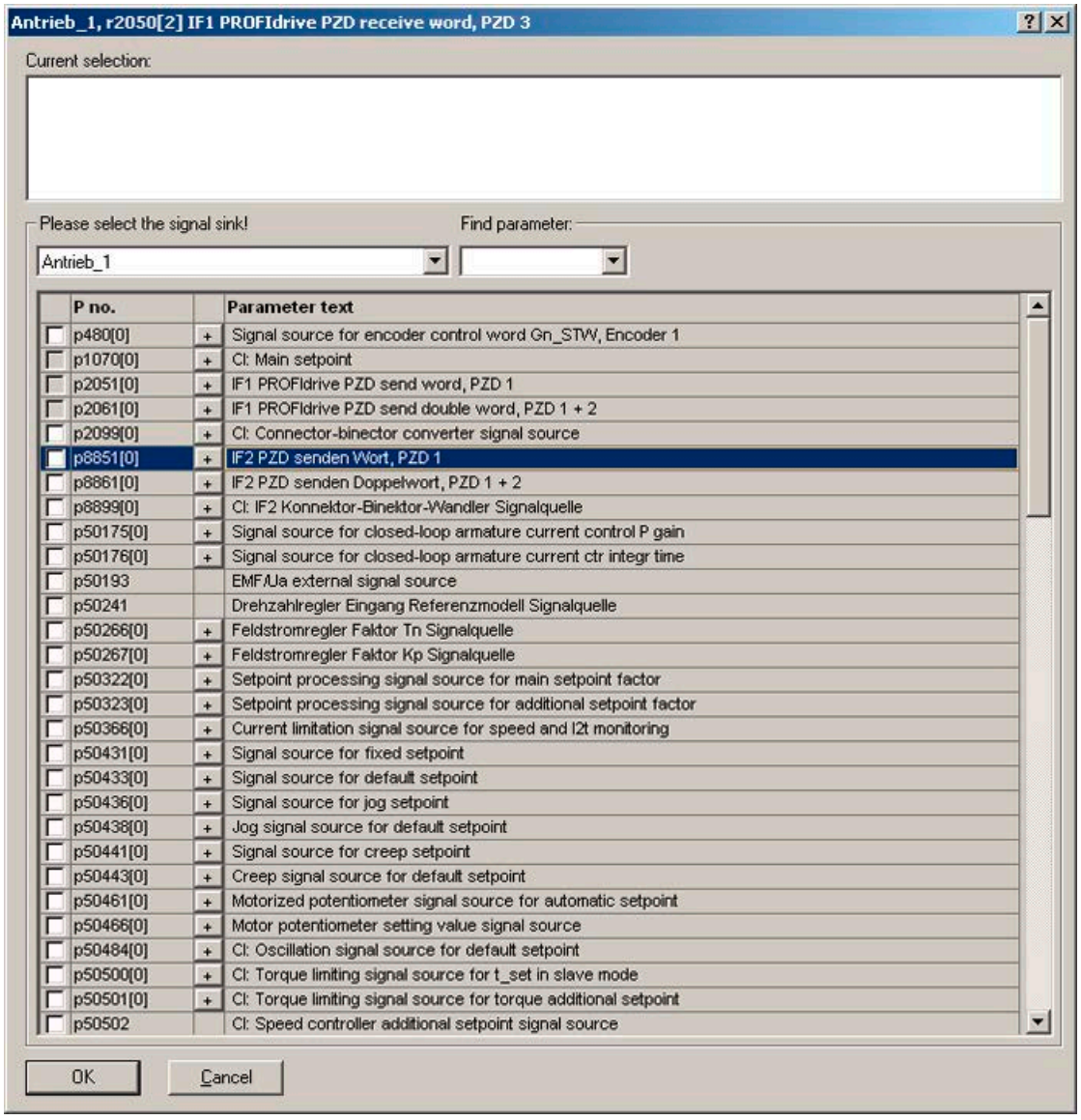



Figure 10-30 Linking the PZDs for direct data exchange with external signals

### 10.4.4.4 GSD during operation

#### Generic station description file

In special generic station description files (GSD), the properties of a PROFIBUS slave are uniquely and fully described to use PROFIBUS direct data exchange for SINAMICS.

The GSD files can be found:

- On the Internet. For the link, see "Preface (Page 3)"
- On the memory card in the directory \\SIEMENS\SINAMICS\DATA\CFG\
  - Universal module
  - Axis separator
  - Standard telegram1, PZD-2/2
  - Standard telegram20, PZD-2/6
  - SIEMENS telegram 220, PZD-10/10
  - SIEMENS telegram 352, PZD-6/6
  - Free telegram, PZD-4/4
  - Free telegram, PZD-8/8
  - Free telegram, PZD-16/16
  - Free telegram, PZD-32/32
  - Free telegram, PZD-64/64
  - Slave-to-slave, PZD-1
  - Slave-to-slave, PZD-2
  - Slave-to-slave, PZD-4
  - Slave-to-slave, PZD-8

The SINAMICS S DXB GSD file contains among other things standard telegrams, free telegrams and slave-to-slave telegrams for configuring direct data exchange. The user must take these telegram parts and an axis separator after each drive object to compose a telegram for the drive unit.

Processing a GSD file in HW Config is covered in the SIMATIC documentation. Suppliers of PROFIBUS components 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 slaves facilitates diagnostics and provides an overview of the nodes on the PROFIBUS.

The information for each slave is stored in the Control Unit parameter r0964[0...6] device identification.

### 10.4.4.5 Diagnostics of the PROFIBUS slave-to-slave 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 DCM List Manual.

## 10.4.5 Messages via diagnostics channels

Messages can be displayed not only via the well-known commissioning tools (STARTER, SCOUT). After the activation of a diagnostic function, the messages are also transferred to the higher-level controller via the standardized diagnostic channels. The messages are evaluated there or forwarded for convenient display to the corresponding 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.).

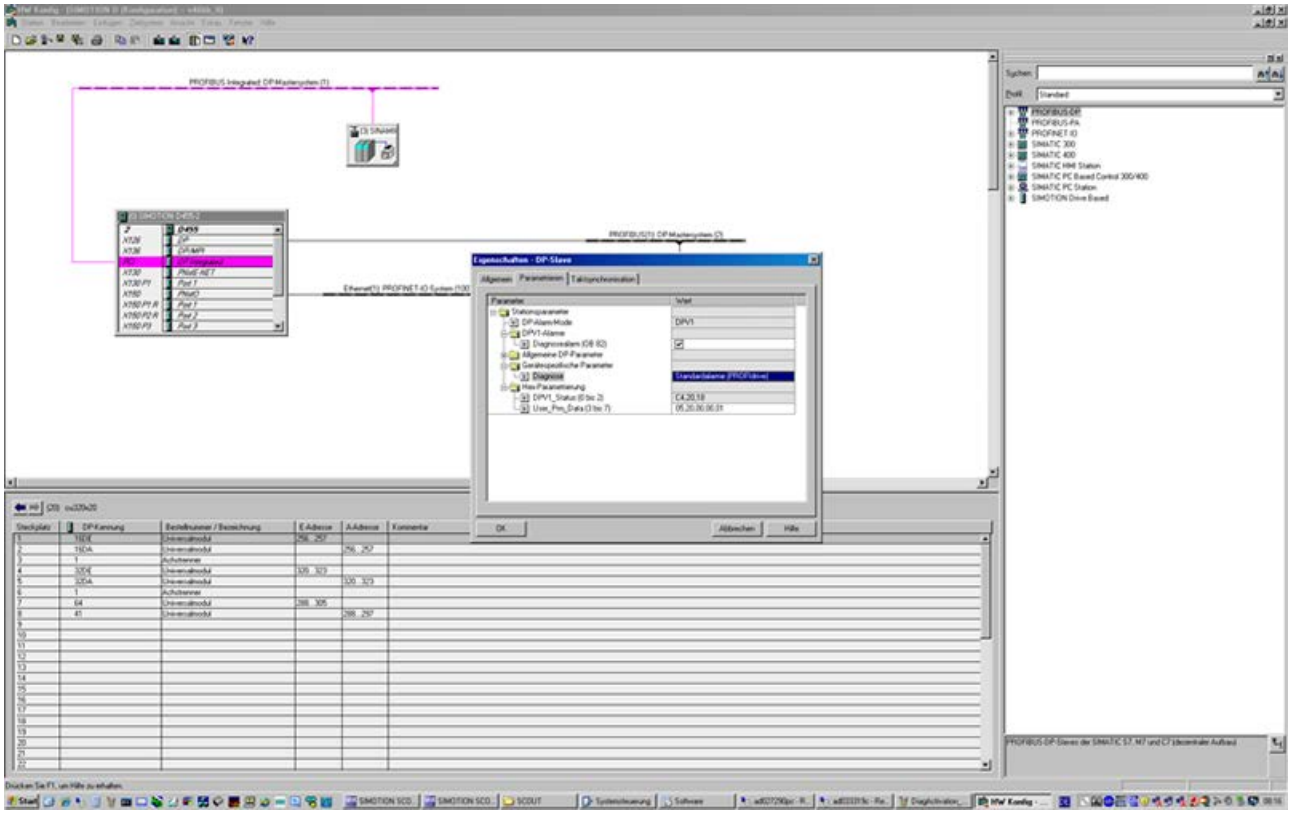


Figure 10-31 Activation of PROFIBUS

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:

**Line faulted**

A line supply fault has occurred (phase failure, voltage level, etc.). Check the line supply and fuses. Check the supply voltage. Check the wiring.

**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.

**Ground fault / inter-phase short-circuit detected**

A ground fault / inter-phase short-circuit was detected in the power cables or in the motor windings. Check the power cables (connection). Check the motor.

**Motor overload**

The motor was operated outside the permissible limits (temperature, current, torque…). Check the load cycles and set limits. Check the ambient temperature / motor cooling.

**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.

**Actual position/speed value error**

An illegal signal state was detected while evaluating the encoder signals (track signals, zero marks, absolute values, etc.). Check the encoder / state of the encoder signals. Observe the maximum permissible frequencies.

**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.

**Application / function faulted**

The application / technological function has exceeded a (set) limit (position, velocity, torque, etc.). Identify and check the relevant limit. Check the setpoint specification of the higher-level controller.

**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.

# 10.5 Communication via PROFINET IO

## 10.5.1 Activating online mode: 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 DCM is supported starting only from STARTER Version 4.1.5)
- CBE20

### STARTER via PROFINET IO (example)

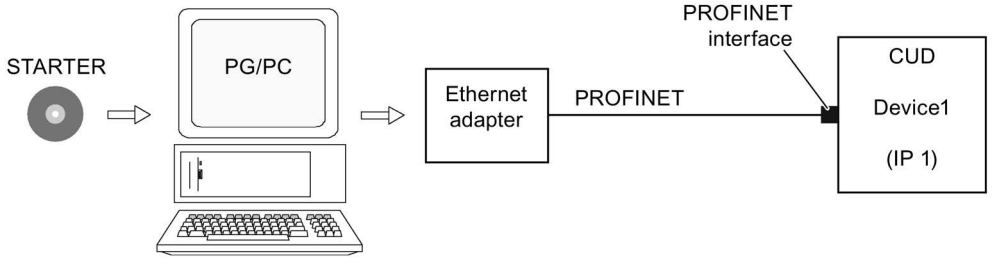



Figure 10-32 STARTER via PROFINET (example)

### Procedure for activating online mode 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 Windows 7

**Note**

The following procedure is based on the Windows 7 operating system. Under other operating systems (such as Windows XP), 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 to the Control Unit to 169.254.11.1 and the subnet mask to 255.255.0.0.

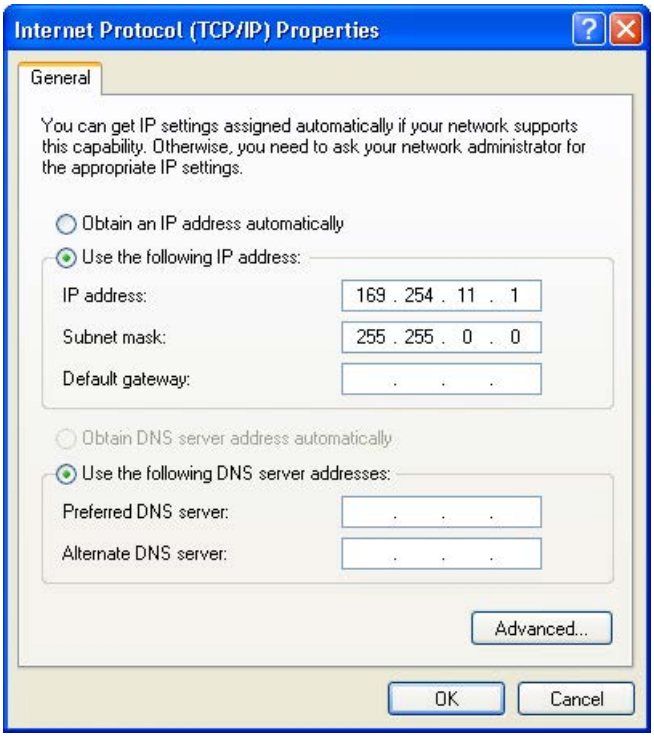



Figure 10-33 Example: IPv4 address of the PG/PC

8. Click "OK" and close the 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").

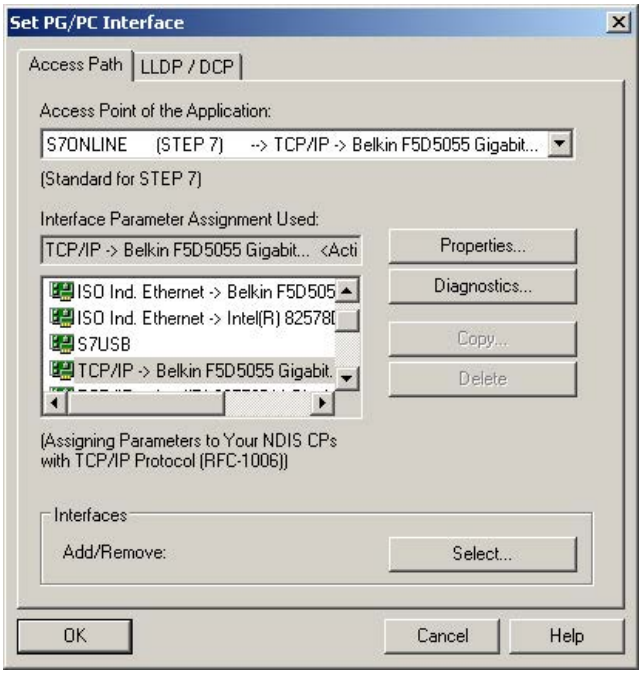



Figure 10-34 Setting the PG/PC interface

If the desired interface does not yet exist in the selection list, you can create it.

3. Click the "Select" button.

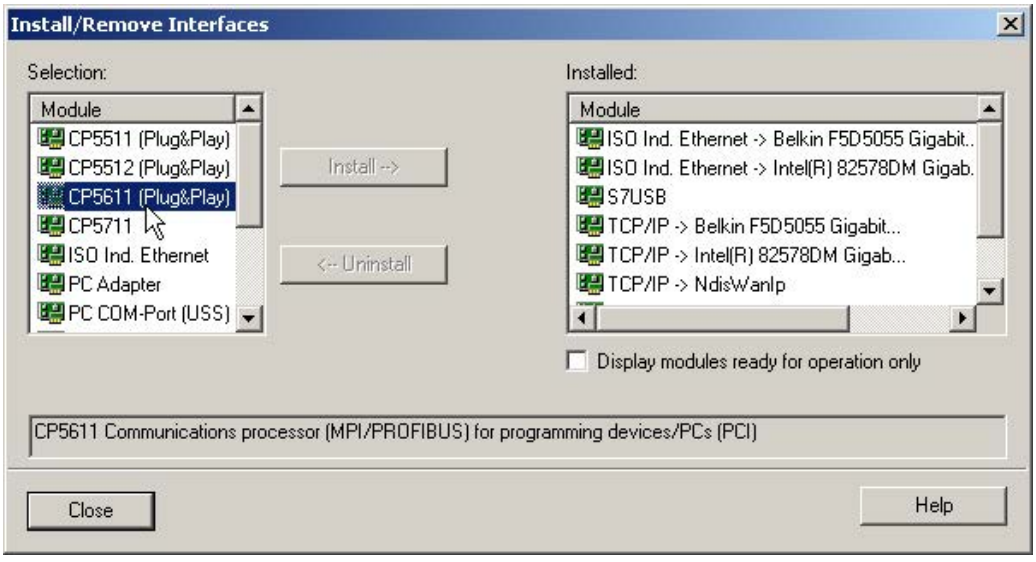



Figure 10-35 Installing the interface

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".

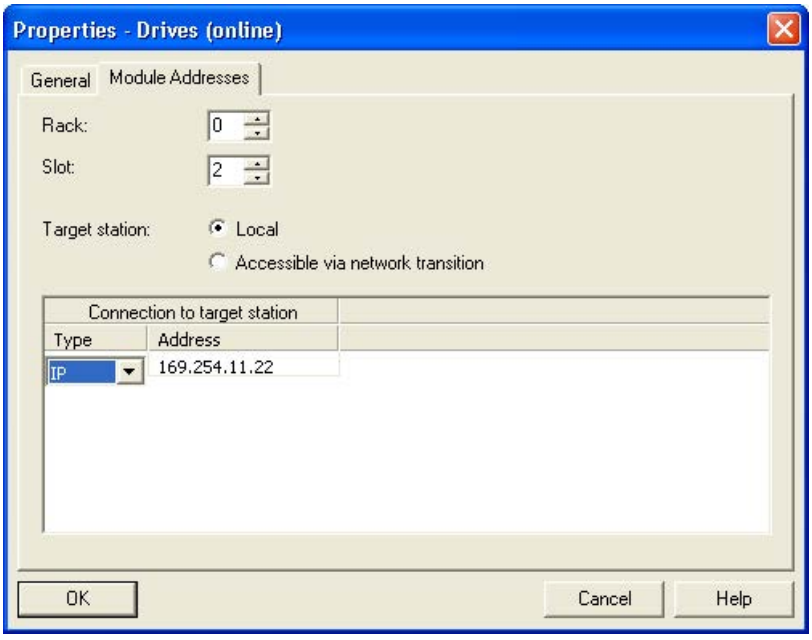



Figure 10-36 Setting online access

## 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 10-37 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 non-volatile on the memory card of the Control Unit.

## 10.5.2 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 observes TCP/IP and IT standards.

Deterministic signal processing in real time 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 systems:

- 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 "slave 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 assembled from 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 DCM 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**
  Version V4.1, May 2006
  PROFIBUS User Organization e. V.
  Haid-und-Neu-Straße 7, D-76131 Karlsruhe, Germany
  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 406)".

### 10.5.2.1 Real-time (RT) and isochronous real-time (IRT) communication

#### Real-time communication

When communication takes place via TCP/IP, the resultant transmission times may be too long and non-deterministic to meet 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 planned data transfer.

Minimum cycle times of 500 µs and a jitter accuracy of less than 1 µs can be achieved with this transmission method.

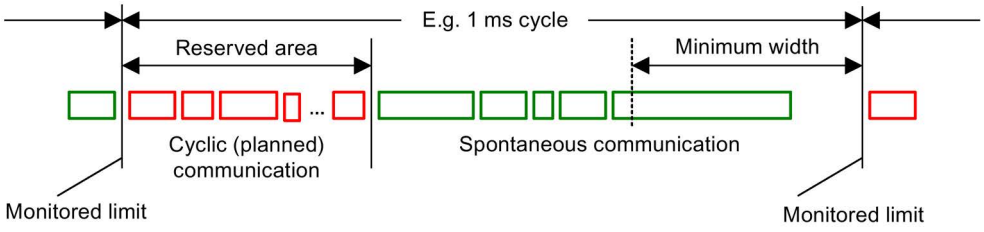



Figure 10-38 Bandwidth distribution/reservation, PROFINET IO

### 10.5.2.2 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 parameterization. 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. The function is called "Edit Ethernet node" here.

**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 module exchange without an IO supervisor when a fault occurs in a PROFINET device.

## 10.5.2.3 Data transmission

### 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. HW Config), 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_DC)
- Terminal Module 15 (TM15)
- Terminal Module 31 (TM31)
- Terminal Module 150 (TM150)
- DC drive control (DC_CTRL)

**Note**

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

The structure of the telegram 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_DC, DC_CTRL
- Configuration with DC_CTRL, TM31, TM31
- etc.

#### 10.5.2.4 Communication channels for PROFINET

### Control Unit with CBE20 Communication Board Ethernet

A Communication Board can be optionally inserted in the Control Unit CUD:

- The CBE20 Communication Board is a PROFINET switch with four PROFINET ports.

### Overview of important parameters

(see the SINAMICS DCM List Manual)

- p8829 CBE20 remote controller number
- p8940[0...239] CBE20 name of station
- p8941[0...3] CBE20 IP address of station
- p8942[0...3] CBE20 default gateway of station
- p8943[0...3] CBE20 subnet mask of station
- p8944 CBE20 DHCP mode
- p8945 CBE20 interface configuration
- r8950[0...239] CBE20 name of active station
- r8951[0...3] CBE20 IP address of active station
- r8952[0...3] CBE20 default gateway of active station
- r8953[0...3] CBE20 subnet mask of active station
- r8954 CBE20 DHCP mode active
- r8955[0...5] CBE20 MAC address of station
- r8959 CBE20 DAP ID

## 10.5.3 Drive control with PROFINET

### PROFINET interfaces

The CBE20 Communication Board Ethernet can be inserted in the option slot of a CUD. The Communication Board Ethernet CBE20 is a PROFINET switch with four ports.

**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 467)".

### References

- The integration of a SINAMICS Control Unit in a PROFINET IO system is described in detail in System Manual "SIMOTION SCOUT Communication" "Communication with SIMOTION (https://support.industry.siemens.com/cs/de/en/view/109749943)".
- 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.
- For a description of the CBE20 Communication Board Ethernet and how you can use this in the drive, see Chapter "Additional system components (Page 157)".

### Telegrams

PROFIdrive telegrams are available for implementing cyclic communication via PROFINET IO (see Chapter "Communication according to PROFIdrive", cyclic communication).

### DCP flashing

This function checks the correct assignment to a module and its interfaces.

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 activated on 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 is closed, the LED will go out automatically. The function is available as of STEP 7 V5.3 SP1 via Ethernet.

### STEP 7 routing with CBE20 Communication Board Ethernet

The CBE20 does not support STEP 7 routing between PROFIBUS and PROFINET IO.

## Connecting the PC to the STARTER commissioning tool

You can go online with STARTER in a number of ways, which are illustrated below:

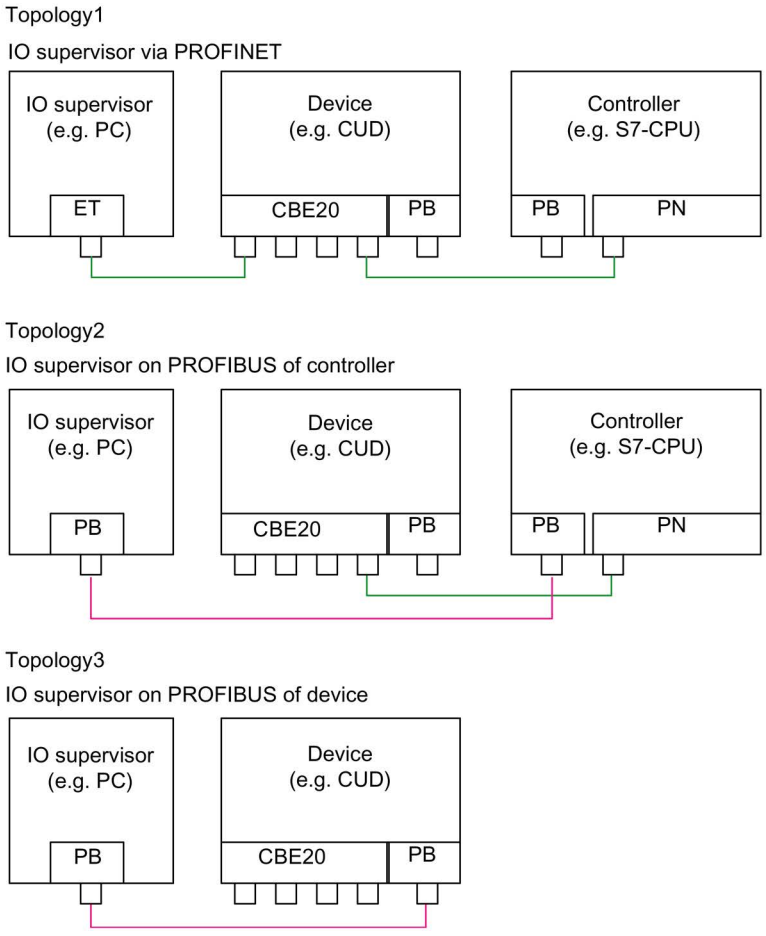



Figure 10-39 Connecting the IO supervisor

**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.

#### 10.5.3.1 Media redundancy

To increase the availability of PROFINET, you can create a ring topology for redundancy purposes. 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 two 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.

If a short-term interruption is not permitted, data transfer must be set to IRT High Performance. The uninterruptible MRRT is automatically set.

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.

### 10.5.4 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"
- IRT "high performance"

  Only option IRT "high performance" is supported.

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"

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"

**Note**

**Only option IRT "high performance" is supported.**

The IRT "high performance" real-time class is supported by the drives of the SINAMICS S110 and S120 series and is described here for reasons of completeness.

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 schedule.

#### Modules

The following S110/S120 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

## Comparison between RT and IRT

Table 10- 36 Comparison between RT and IRT

| RT class | RT | IRT "high flexibility" | IRT "high performance" |
|---|---|---|---|
| Transmission 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 performance" option must not be selected for SINAMICS DCM, otherwise an error message is issued.

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.

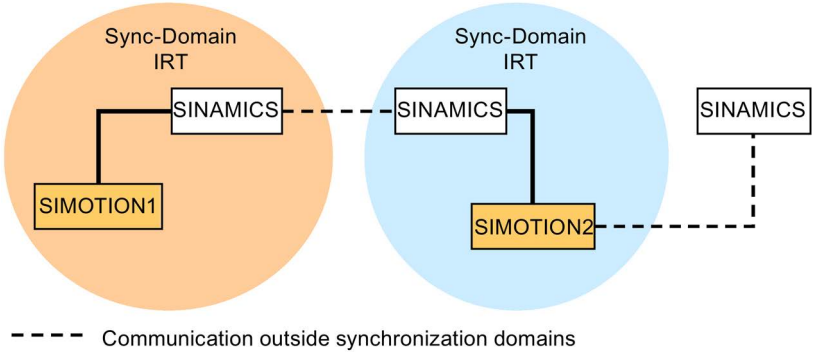



Figure 10-40 RT communication across the limits of synchronization domains

## 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 10- 37 Settable send cycles and update cycles

| Send cycle | | Reduction ratio between update and send cycles | |
|---|---|---|---|
| | | RT<br>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 RT 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 "I/O 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 "uneven" range can be set only if a synchronization domain does not include any IO devices with RT class "RT". Likewise, only the reduction ratios from the "uneven" range can be set for a send cycle setting from the "uneven" range.

4) Isochronous operation is not compatible with IRT "high flexibility".

5) Uneven 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.

## 10.5.5 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 26)" for ordering data of the memory card.

Alternatively, the GSDML file can be requested from the Customer Support.

Table 10- 38 Submodules depending on the particular drive object

| Module | Subslot 1<br>MAP | Subslot 2<br>PROFIsafe | Subslot 3<br>PZD telegram | Subslot 4<br>PZD extension | Max. number of PZD |
|---|---|---|---|---|---|
| D_CTRL | MAP | - | Telegrams: 1...352<br>free PZD-16/16, 32/32 | PZD-2/2, -2/4, -2/6 | 64/64 |
| Encoder | MAP | Reserved | Telegrams: 81, 82, 83<br>free PZD-4/4 | PZD-2/2, -2/4, -2/6 | 4/12 |
| TM31, TM15, DI_DO | MAP | Reserved | Telegrams: no<br>free PZD-4/4 | Reserved | 5/5 |
| TM150 | MAP | Reserved | Telegrams: no<br>free PZD-4/4 | Reserved | 7/7 |
| Control Unit | MAP | Reserved | Telegrams: 390<br>free PZD-4/4 | Reserved | 20/25 |
| TM15/TM17 | Not supported. | | | | |

The telegrams in subslots 2, 3 and 4 can be freely configured, i.e. they can also remain empty.

## 10.5.6 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 10- 39 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 identified uniquely.

### Overview of important parameters (see SINAMICS DCM List Manual)

- p8835 CBE20 firmware selection
- r8858[0...39] COMM BOARD read diagnostics channel
- r8859[0...7] COMM BOARD identification data

## 10.5.7 Messages via diagnostics channels

Messages can be displayed not only via the well-known commissioning tools (STARTER, SCOUT). After the activation of a diagnostic function, the messages are also transferred to the higher-level controller via the standardized diagnostic channels. The messages are evaluated there or forwarded for convenient display to the corresponding 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.).

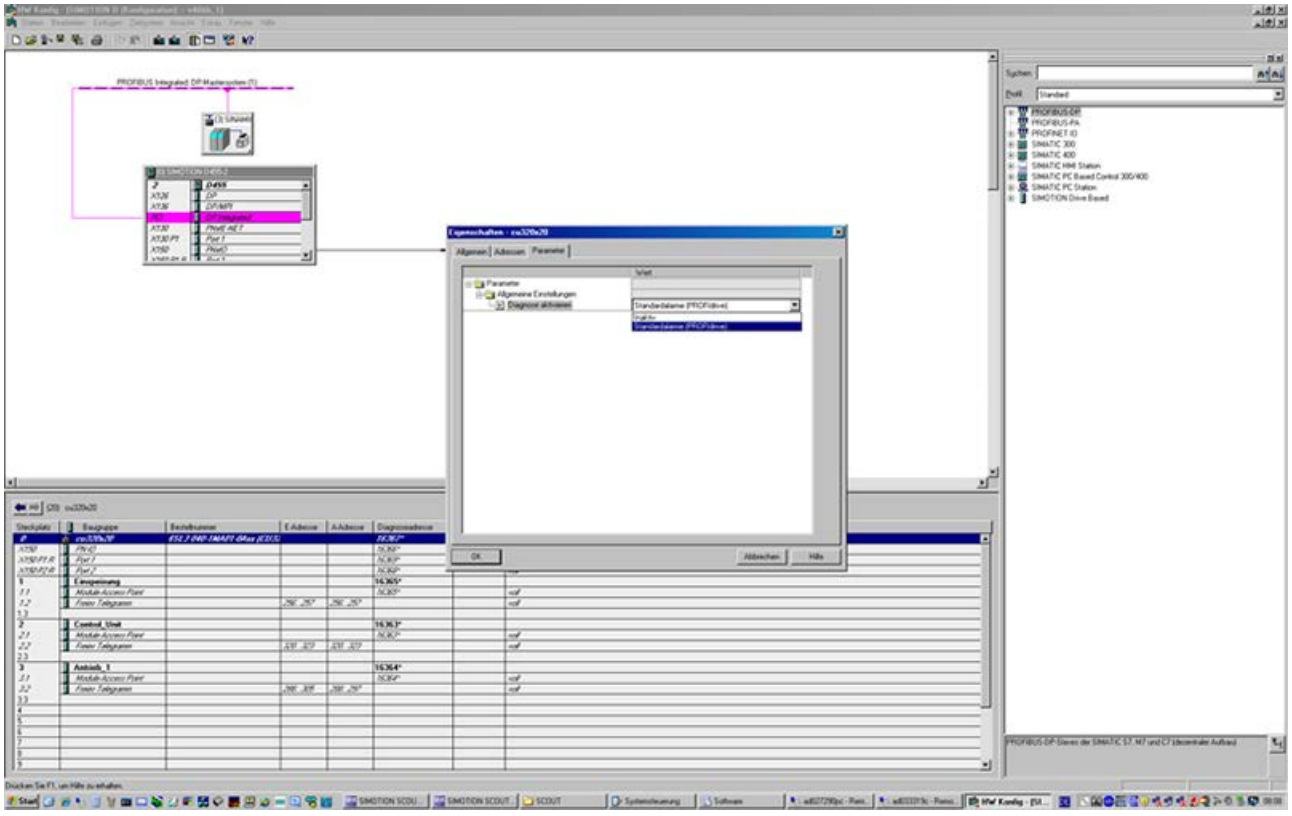


Figure 10-41 Activation of PROFINET

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/software fault**

A hardware or software malfunction was detected. Carry out a POWER ON for the relevant component. If it occurs again, contact the hotline.

**Line supply fault**

A line supply fault has occurred (phase failure, voltage level, etc.). Check the line supply and fuses. Check the supply voltage. Check the wiring.

**Supply voltage fault**

An electronic power supply fault (48 V, 24 V, 5 V, etc.) was detected. Check the wiring. Check the voltage level.

**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).

**Overtemperature of an electronic component**

The temperature in the component has exceeded the highest permissible limit. Check the ambient temperature / control cabinet ventilation.

**Ground fault / inter-phase short-circuit detected**

A ground fault / inter-phase short-circuit was detected in the power cables or in the motor windings. Check the power cables (connection). Check the motor.

**Motor overload**

The motor was operated outside the permissible limits (temperature, current, torque, etc.). Check the load cycles and set limits. Check the ambient temperature / motor cooling.

**Communication to the higher-level 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.

**Actual position/speed value incorrect or not available**

An illegal signal state was detected while evaluating the encoder signals (track signals, zero marks, absolute values, etc.). Check the encoder / state of the encoder signals. Observe the maximum permissible frequencies.

**Internal (DRIVE-CLiQ) 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 measured value / signal state outside of 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.

**Application / technological function disrupted**

The application / technological function has exceeded a (set) limit (position, velocity, torque, etc.). Identify and check the relevant limit. Check the setpoint specification of the higher-level controller.

**Error in the parameterization/configuration/commissioning procedure**

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.

**Auxiliary unit faulted**

The monitoring of an auxiliary unit (incoming transformer, cooling unit, etc.) has detected an illegal state. Determine the exact cause of the error and check the relevant device.

## 10.5.8 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 10- 40 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.<br>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:<br>• YYYY-MM-DD<br>• YYYY-MM-DD hh:mm<br>– YYYY: Year<br>– MM: Month 01...12<br>– DD: Day 01...31<br>– hh: Hours 00...23<br>– mm: Minutes 00...59<br>The separators between the individual specifications, i.e. hyphen '-', blank ' ' and colon ':', must be entered. |
| I&M 3: DESCRIPTOR | Visible string | 54 | Space 0x20…0x20 | p8808[0...53] | Text with any comments or notes. |

| I&M parameter designation | Format | Size/ octets | Initialization | SINAMICS parameters | Meaning |
|---|---|---|---|---|---|
| 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:<br>• The first four octets (0...3) contain the content of parameter r9781 index 0: "SI change monitoring checksum (Control Unit)".<br>• The second four octets (4...7) contain the content of parameter r9782 index 0: "SI change monitoring time stamp (Control Unit)".<br>• 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 SINAMICS DCM 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

# 10.6 Communication via SINAMICS Link

## 10.6.1 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. All of the participating Control Units must be equipped with a CBE20 in order that SINAMICS Link functions. 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/slave function for infeed units
- Links between SINAMICS DC MASTER and SINAMICS S120

### Requirements

The following preconditions must be fulfilled to operate SINAMICS Link:

- One CBE20 must be inserted for each drive object.
- The following applies for the CUD:
  - an Advanced CUD must be inserted.
  - the memory card (the device firmware) must be inserted.

### 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 1000 µs or 2000 µs.

After changing parameter p8811, p8812, p8835 or p8836, carry out a POWER ON to transfer the settings.

## 10.6.2 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.

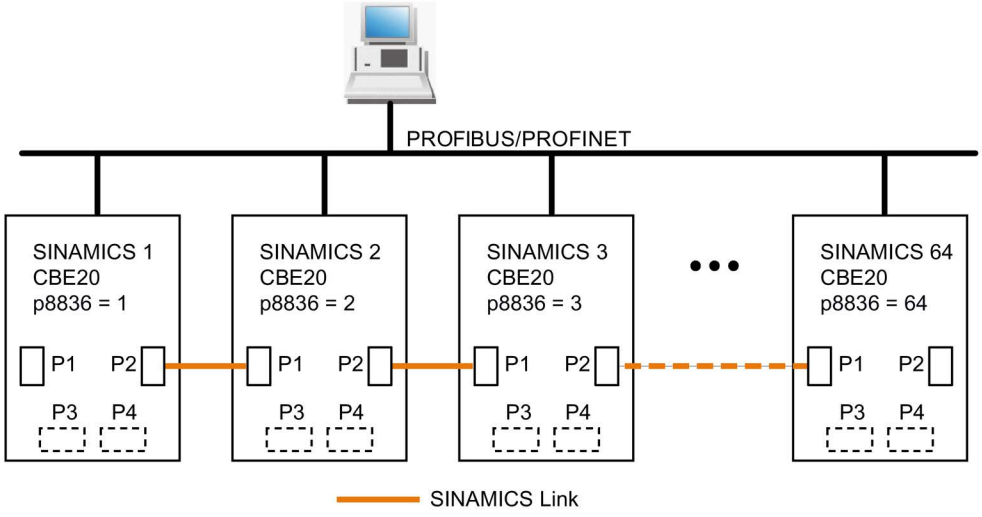



Figure 10-42 Maximum topology

### 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.
- In the "SINAMICS Link" mode, ports 3 and 4 of the CBE20 can only be used to connect to the STARTER commissioning tool or Startdrive.

### Corresponding parameters for IF1 or IF2

Use different parameters for configuring, depending on which interface SINAMICS Link is assigned:

Table 10- 41 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 |

## 10.6.3 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 10-41 Corresponding parameters (Page 483)".

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 10- 42 Compile send data of drive 1 (DO2)

| p2051[x] Index | p2061[x] Index | Contents | 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 10- 43 Compile send data of drive 2 (DO3)

| p2051[x] Index | p2061[x] Index | Contents | 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 10- 44 Compile send data of Control Unit 1 (DO1)

| p2051[x] Index | p2061[x] Index | Contents | 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 10- 45 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 | Contents |
| | | | | 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.

## 10.6.4 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.

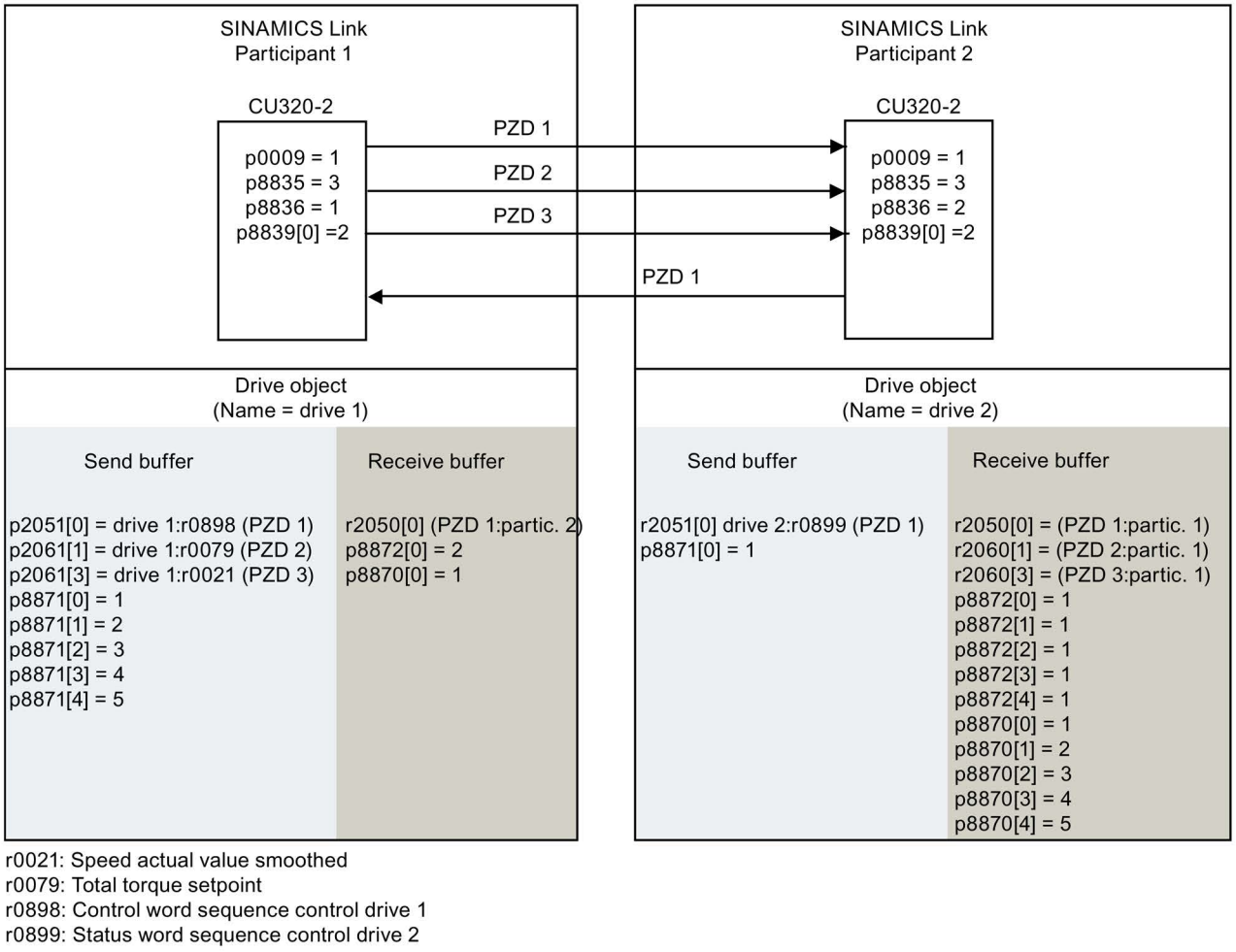



Figure 10-43 SINAMICS Link: Configuration example

## 10.6.5 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.

## 10.6.6 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.

## 10.6.7 Function diagrams and parameters

### Function diagrams (see the SINAMICS DCM List Manual)

- 2197 Control Unit communication – SINAMICS Link overview (r0108.31 = 1, p8835 = 3)
- 2198 Control Unit communication – SINAMICS Link configuration (r0108.31 = 1, p8835 = 3)
- 2199 Control Unit communication – SINAMICS Link receive data (r0108.31 = 1, p8835 = 3)
- 2200 Control Unit communication – SINAMICS Link send data (r0108.31 = 1, p8835 = 3)

### Overview of important parameters (see SINAMICS DCM 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

# 10.7 EtherNet/IP

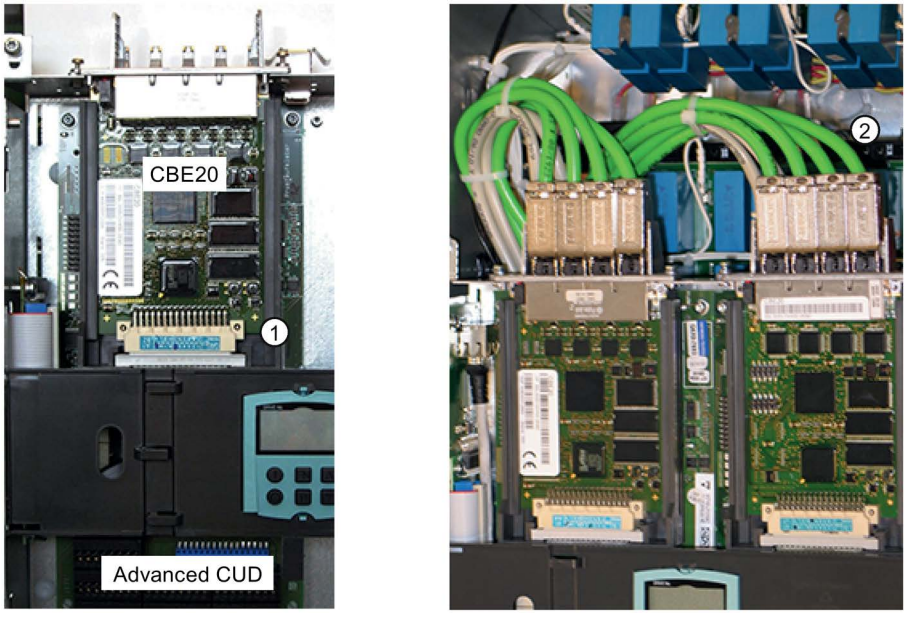
SINAMICS DCM supports the communication with the fieldbus EtherNet Industrial Protocol (EtherNet/IP or also EIP). EtherNet/IP is an open standard based on Ethernet, which is predominantly used in the automation industry. EtherNet/IP is supported by the Open DeviceNet Vendor Association (ODVA).

For communication with EtherNet/IP, a CBE20 Communication Board Ethernet is required. By setting p8835 = 4, you can choose the communication profile EtherNet/IP. After POWER ON, the profile becomes active.

## 10.7.1 Connection of SINAMICS DCM with EtherNet/IP to Ethernet networks

The SINAMICS DC MASTER version with option G20/G21 (CBE20 Communication Board Ethernet left/right) is required for the connection to EtherNet/IP. See Chapter "Ordering information for options and accessories (Page 26)" for ordering data.

For additional information on the CBE20 Communication Board Ethernet see Chapter "Additional system components (Page 157)".




Picture left: Communication Board Ethernet CBE20 inserted in the option module slot ① of an Advanced CUD

Picture right: Maximum configuration with two CBE20. Four Ethernet cables ② for each CBE20.

Figure 10-44 CBE20

## 10.7.2 Configuration of SINAMICS DCM for EtherNet/IP

### 10.7.2.1 Setting the IP address and activating the EtherNet/IP protocol

**Requirements**

- Version with option G00/G10 (Advanced CUD)
- CBE20

The IP configuration is performed via STARTER or through direct parameter input via the BOP or AOP30.

Table 10- 46 Settable parameters on the drive object CU

| Parameter | | Note |
|---|---|---|
| p8941 | IP address | Setting is mandatory |
| p8943 | Subnet screen | Setting is mandatory |
| p8942 | Default gateway | - |
| p8940 | Name of station | In contrast to PROFINET, setting is not mandatory. |
| p8945 = 2 | Save and activate IP configuration | Setting must be made when the parameters are entered directly. |

In addition to direct input, the IP address can also be obtained via DHCP.

#### Configuration of EtherNet/IP on the drive unit

1. For setting the IP address directly via parameters, see the previous table.
2. Activation of EtherNet/IP
   - Set access level 3 (p0003 = 3) in the drive object CU (BOP object 1) via STARTER, BOP or AOP30.
   - Activate the device configuration on the CU by setting p0009 = 1.
   - Activate EtherNet/IP by setting p8835=4 on the CU.
   - Complete the device configuration on the CU by setting p0009 = 0.
   - Save the parameters (copy RAM to ROM).
   - Switch the device off and on again (POWER ON).
   - After power-up, the SINAMICS DC MASTER is visible as Ethernet/IP slave in the network.

### 10.7.2.2 Communication with the SINAMICS DCM

The Ethernet/IP communication with the SINAMICS DCM is possible with two CIP types:

- IMPLICIT: For cyclic I/O data (setpoints, actual values, control and status words)
- EXPLICIT: For acyclic message requests ("explicit messaging")

The following CIP / messaging classes are available for the SINAMICS DCM:

| Class code (hex) | Class code | Object name |
|---|---|---|
| 0x01 | 1 | Identity object |
| 0x04 | 4 | Assembly object |
| 0x06 | 6 | Connection Manager object |
| 0x32C* | 7 | Drive object |
| 0x401 - 0x43E | 1025 - 1086 | Parameter object (reading/writing a single parameter value) |

#### "Implicit messaging" – Cyclic communication as I/O slave

The cyclic communication is represented by Class 4 and the assembly object structure.

As standard, the SINAMICS DCM as I/O slave exchanges cyclic process data (PZDs) with a PLC or another control system.

Process data is the cyclic information such as control and status words as well as actual values and setpoints.

The following I/O assembly settings are to be made (from PLC perspective).
4 ms is supported as the minimum value for RPI (Requested Packet Interval).

| | |
|---|---|
| Assembly 101 – receive data: | Length depends on the user settings |
| Assembly 102 – send data: | Length depends on the user settings |
| Assembly 103 – configuration data: | Length 0 bytes |

16-bit integer is used as the data type.

The data length is the sum of the number of words transferred from each drive object.

Example 1:

| DO | Number of words to be sent | Number of words to be received |
|---|---|---|
| DC_CTRL (drive) | 10 | 10 |
| CU | 2 | 2 |
| Sum = length | 12 words = 24 bytes | 12 words = 24 bytes |

Example 2:

| DO | Number of words to be sent | Number of words to be received |
|---|---|---|
| DC_CTRL (drive) | 10 | 5 |
| CU | 0 | 0 |
| TM31 | 1 | 1 |
| Sum = length | 11 words = 22 bytes | 6 words = 12 bytes |

In contrast to PROFIBUS and PROFINET communication, only connected PZDs in the drive can be used in the assembly.

In example 1, all ten words of the drive and the two words of the CU must have an active BICO connection. This means that all data received from the PLC must be connected to a parameter, which correspondingly also applies to the data sent to the PLC. All words must therefore be supplied with status or actual values.

The assembly for Ethernet/IP is automatically made up of the sum of the interconnected parameters r2067 for IF1 r8867 for IF2 of the respective drive object.

Corresponding to example 1, the total length for the send data would be:
DC_CTRL r2067[1] = 10 + CU r2067[1] = 2 ≥ 12 words = 24 bytes

**Note**

For a firmware release < 1.5, the assembly must be manually created by setting p8842 = 1 on the CU.

If the change is to be permanent, copy RAM to ROM.

The sequence of the drive objects depends on the communication settings in the drive which can be accessed via the "communication item" of the associated drive in the project tree of the STARTER software.

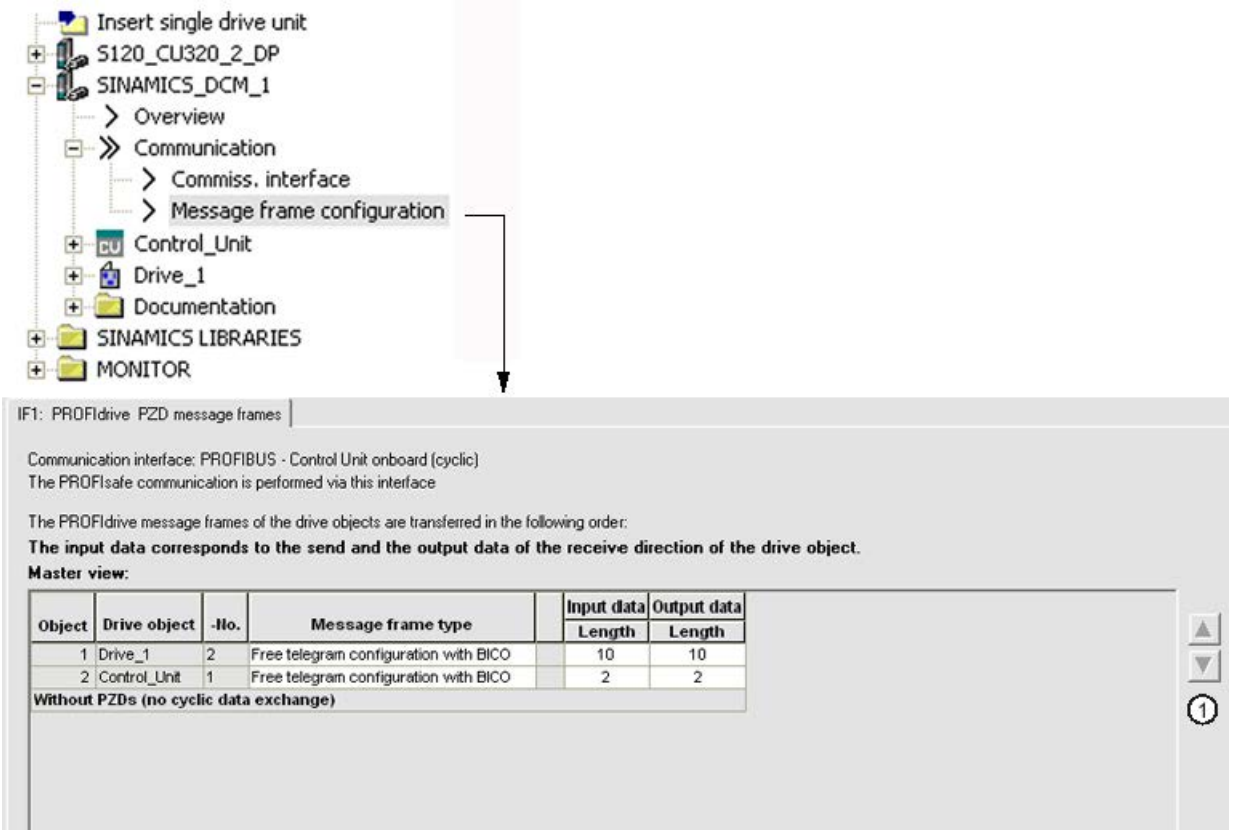



Figure 10-45 Changing the DO sequence

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 drive.

## "Explicit messaging" – Acyclic or event-driven communication

Acyclic or event-driven information can also be read from the drive or written to the drive, e.g. read-out of the fault buffer when an error occurs.

"Explicit messaging" must be used in order to be able to use this information in the classes described in the following.

## Class 1 Identity object

| Identity Object | Class 01h |
|---|---|

| Supported Services: | |
|---|---|
| Class | Get Attribute All |
| | Get Attribute Single |
| | |
| Instance | Get Attribute All |
| | Get Attribute Single |
| | Reset |

| Class Attribute | | | | | |
|---|---|---|---|---|---|
| # | Attributename | Service | Description | Datatype | Value |
| 1 | Revision | Get | | UINT16 | |
| 2 | Max Instance | Get | | UINT16 | |
| 3 | Num of Instances | Get | | UINT16 | |

| Instance Attribute | | | | | | | |
|---|---|---|---|---|---|---|---|
| # | Attributename | Service | Description | Datatype | Value | Device Type | Value |
| 1 | Vendor ID | Get | Device Vendor | UINT16 | 145 | AC Drive | 02h |
| 2 | Device Type | Get | General product type | UINT16 | Profil | Siemens AC D | 12h |
| | | | | | ODVA AC/DC Drive | | |
| | | | | | Siemens Driv | PROFIdrive Device Type | |
| | | | | | | start with versioning from 10 and increment +10 for major change in EDS and +1 for minor change | |
| 3 | Product Code | Get | DVC_TYPE | UINT16 | r964[1] | Name | Definition |
| 4 | Revision | Get | Object Revision | UINT16 | revision shou | Owned | True: The device or an object has an owner |
| 5 | Status | Get | Sumary Status of Drive | UINT16 | Bits | res | reserved |
| | | | | | 0 | Configured | True: Any parameters was changed |
| | | | | | 1 | res | reserved |
| | | | | | 2 | res | reserved |
| | | | | | 3 | Minor Fault recoverable | True: a fault accurse and can be reseted |
| | | | | | 4-7 | Minor Fault unrecoverable | True: a fault accurse and cannot be reseted |
| | | | | | 8 | Major Fault recoverable | True: a fault accurse and can be reseted by power cycle |
| | | | | | 9 | Major Fault unrecoverable | True: a fault accurse and cannot be reseted by power cycle |
| | | | | | 10 | res | |
| | | | | | 11 | Serial Number mapping | |
| | | | | | 12-15 | | |
| 6 | Serial number | Get | Serial Number | UINT32 | r8820 [32..47] | | |
| 7 | Product Name | Get | Name of product (max.32) | Short String | SINAMICS S | | |
| | | | | | SINAMICS G120 | | |
| | | | | | SINAMICS V.. (not supported) | | |

Figure 10-46 General drive information

## Class 32C Drive object

| Drive Siemens Object | Class 32Ch |
|---|---|

| Supported Sevices: | |
|---|---|
| Class | Get Attribute All<br>Get Attribute Single |
| Instance | Get Attribute Single<br>Set Attribute Single |

| Class Attribute | | | | | |
|---|---|---|---|---|---|
| # | Attributename | Service | Description | Datatype | Value |
| 1 | Revision | Get | | UINT16 | |
| 2 | Max Instance | Get | Max slot num | UINT16 | |
| 3 | Num of Instances | Get | Max slot ID | UINT16 | |

| Instance Attribute | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| # | Attributename | Service | Description | Datatype | Parameter Reference | Units | Scaling | Min | Max |
| 2 | Commisioning state | Set/Get | Commisioning state | | P10 | -- | -- | 0 | 10000 |
| 3-18 | STW1 | Get | Bitwise access:<br>Attr.3~STW1.0<br>Attr.18~STW1.15 | | STW1 | -- | -- | 0 | 1 |
| 19 | Main Setpoint | Get | Main Setpoint | | HSW | % | 100 | -200 | 200 |
| 20-35 | ZSW1 | Get | Bitwise access:<br>Attr.20~ZSW1.0<br>Attr.35~ZSW1.15 | | ZSW1 | -- | -- | 0 | 1 |
| 36 | Actual Frequency | Get | Actual Frequency | | HIW | % | 100 | -200 | 200 |
| 37 | Ramp Up Time | Set/Get | Ramp Up Time | | P1120[0] | sec | 100 | 0 | 650 |
| 38 | Ramp Down Time | Set/Get | Ramp Down Time | | P1121[0] | sec | 100 | 0 | 650 |
| 39 | Current Limit | Set/Get | Current Limit | | P0640[0] | % | 10 | 10 | 400 |
| 40 | Frequency MAX Limit | Set/Get | Frequency MAX Limit | | P1082[0] | Hz | 100 | 1 | 649.99 |
| 41 | Frequency MIN Limit | Set/Get | Frequency MIN Limit | | P1080[0] | Hz | 100 | 0 | 649.99 |
| 42 | OFF3 Ramp Down Time | Set/Get | OFF3 Ramp Down Time | | P1135[0] | sec | 100 | 0 | 650 |
| 43 | PID Enable | Set/Get | PID Enable | | P2200[0] | -- | -- | Enable | No |
| 44 | PID Filter Time Constant | Set/Get | PID Filter Time Constant | | P2265 | sec | 100 | 0 | 60 |
| 45 | PID D Gain | Set/Get | PID D Gain | | P2274 | sec | 1000 | 0 | 60 |
| 46 | PID P Gain | Set/Get | PID P Gain | | P2280 | -- | 1000 | 0 | 65 |
| 47 | PID I Gain | Set/Get | PID I Gain | | P2285 | sec | 1000 | 0 | 60 |
| 48 | PID Up Limit | Set/Get | PID Up Limit | | P2291 | % | 100 | -200 | 200 |
| 49 | PID Down Limit | Set/Get | PID Down Limit | | P2292 | % | 100 | -200 | 200 |
| 50 | Speed Setpoint | Get | Speed Setpoint | | r0020 | Hz | 10 | -3250 | 3250 |
| 51 | Output Frequency | Get | Output Frequency | | r0024 | Hz | 10 | -3250 | 3250 |
| 52 | Output Voltage | Get | Output Voltage | | r0025 | Vac | 10 | -3250 | 3250 |
| 53 | DC Link Voltage | Get | DC Link Voltage | | r0026[0] | Vac | 10 | -3250 | 3250 |
| 54 | Actual Current | Get | Actual Current | | r0027 | A | 100 | 0 | 655.35 |
| 55 | Actual Torque | Get | Actual Torque | | r0031 | Nm | 10 | -3250 | 3250 |
| 56 | Output Power | Get | Output Power | | r0032 | kW/Hp | 100 | -325 | 325 |
| 57 | Motor Temperature | Get | Motor Temperature | | r0035[0] | °C | 100 | 0 | 200 |
| 58 | Power Unit Temperature | Get | Power Unit Temperature | | r0037[0] | °C | 100 | 0 | 200 |
| 59 | Energy kWh | Get | Energy kWh | | r0039 | kWh | 1 | 0 | 65535 |
| 60 | CDS Eff (Local Mode) | Get | CDS Eff (Local Mode) | | r0050 | -- | 1 | 0 | 2 |
| 61 | Status Word 2 | Get | Status Word 2 | | r0053 | -- | Bit Mask | 0 | FFFF |
| 62 | Control Word 1 | Get | Control Word 1 | | r0054 | -- | Bit Mask | 0 | FFFF |
| 63 | Motor Speed (Encoder) | Get | Motor Speed (Encoder) | | r0061 | rpm | 10 | -650 | 650 |
| 64 | Digital Inputs | Get | Digital Inputs | | r0722 | -- | Bit Mask | 0 | FFFF |
| 65 | Digital Outputs | Get | Digital Outputs | | r0747 | -- | Bit Mask | 0 | FFFF |
| 66 | Analog Input 1 | Get | Analog Input 1 | | r0752[0] | V/mA | 1000 | -20 | 20 |
| 67 | Analog Input 2 | Get | Analog Input 2 | | r0752[1] | V/mA | 1000 | -20 | 20 |
| 68 | Analog Output 1 | Get | Analog Output 1 | | r0774[0] | V/mA | 1000 | -20 | 20 |
| 69 | Analog Output 2 | Get | Analog Output 2 | | r0774[1] | V/mA | 1000 | -20 | 20 |
| 70 | Fault Code 1 | Get | Fault Code 1 | | r0947[0] | -- | 1 | 0 | 65535 |
| 71 | Fault Code 2 | Get | Fault Code 2 | | r0947[1] | -- | 1 | 0 | 65535 |
| 72 | Fault Code 3 | Get | Fault Code 3 | | r0947[2] | -- | 1 | 0 | 65535 |
| 73 | Fault Code 4 | Get | Fault Code 4 | | r0947[3] | -- | 1 | 0 | 65535 |
| 74 | Fault Code 5 | Get | Fault Code 5 | | r0947[4] | -- | 1 | 0 | 65535 |
| 75 | Fault Code 6 | Get | Fault Code 6 | | r0947[5] | -- | 1 | 0 | 65535 |
| 76 | Fault Code 7 | Get | Fault Code 7 | | r0947[6] | -- | 1 | 0 | 65535 |
| 77 | Fault Code 8 | Get | Fault Code 8 | | r0947[7] | -- | 1 | 0 | 65535 |
| 78 | Pulse Frequency | Get | Pulse Frequency | | r1801 | kHz | 100 | 0 | 16 |
| 79 | Alarm Code 1 | Get | Alarm Code 1 | | r2110[0] | -- | 1 | 0 | 65535 |
| 80 | Alarm Code 2 | Get | Alarm Code 2 | | r2110[1] | -- | 1 | 0 | 65535 |
| 81 | Alarm Code 3 | Get | Alarm Code 3 | | r2110[2] | -- | 1 | 0 | 65535 |
| 82 | Alarm Code 4 | Get | Alarm Code 4 | | r2110[3] | -- | 1 | 0 | 65535 |
| 83 | PID Setpoint Output | Get | PID Setpoint Output | | r2260 | % | 100 | -100 | 100 |
| 84 | PID Feedback | Get | PID Feedback | | r2266 | % | 100 | -100 | 100 |

Figure 10-47 32C drive object

As shown in the previous table, certain drive parameters can be read and written. Note that this function was originally created for SINAMICS AC drives. It can therefore only access parameters that are available on the SINAMICS DCM.

The function described in Chapter "Class 0x401 - 0x43E Writing and reading of parameters (Page 500)" is preferred instead of Class 0x32C for reading and writing parameter data.

## Class 0x401 - 0x43E Writing and reading of parameters

With this class, it is possible to read and write an arbitrary parameter of the respective drive object (DO).

| | |
|---|---|
| Class value | Selects the DO. 0x4xx xx = object number |
| Instance | Represents the parameter number,<br>e.g. p50100 ⇒ instance = 50100 |
| Attribute | Represents the index to be read or written,<br>e.g. index 0 ⇒ attribute = 0 |

The appropriate object number must be taken from the "Message frame configuration" shown in Figure 10-45 Changing the DO sequence (Page 497).

Generally, the following applies:

- Object number 1 = CU of the DCM ⇒ Class 401
- Object number 2 = drive unit of the DCM ⇒ Class 402

The data type of the parameter is specified by the drive and can be found in the SINAMICS DCM List Manual (Chapter "List of parameters").

**Note**

All bytes defined by the data type must be assigned, even if they are not used.

Examples

- INT/UINT 16 must be assigned to 4 bytes.
- Floating point 32, INT/UINT 32 must be assigned to 8 bytes.

## 10.7.3 Examples of the use of a Rockwell PLC

### 10.7.3.1 Configuration of a Rockwell PLC for the communication with SINAMICS DCM

**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 DCM.

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.

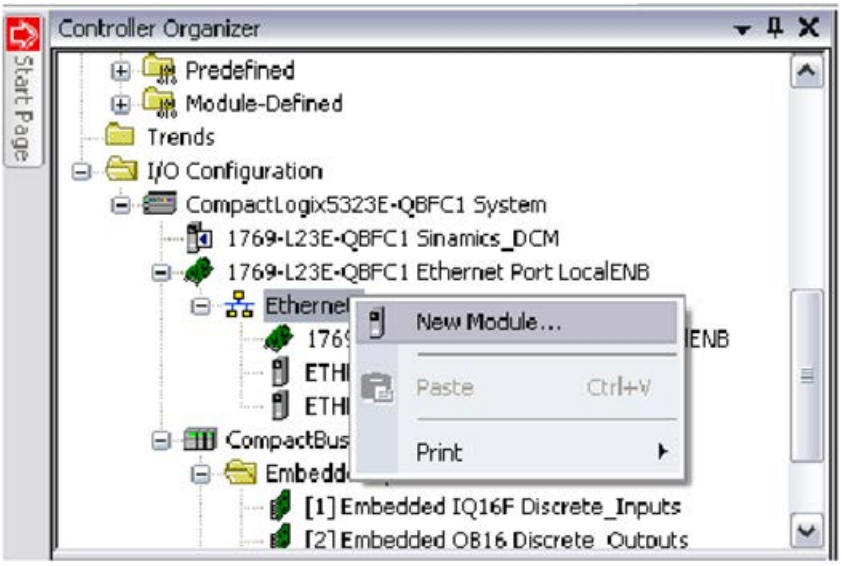



Figure 10-48 Selection of the module (1)

The "Generic Ethernet Module" is selected at Communication:

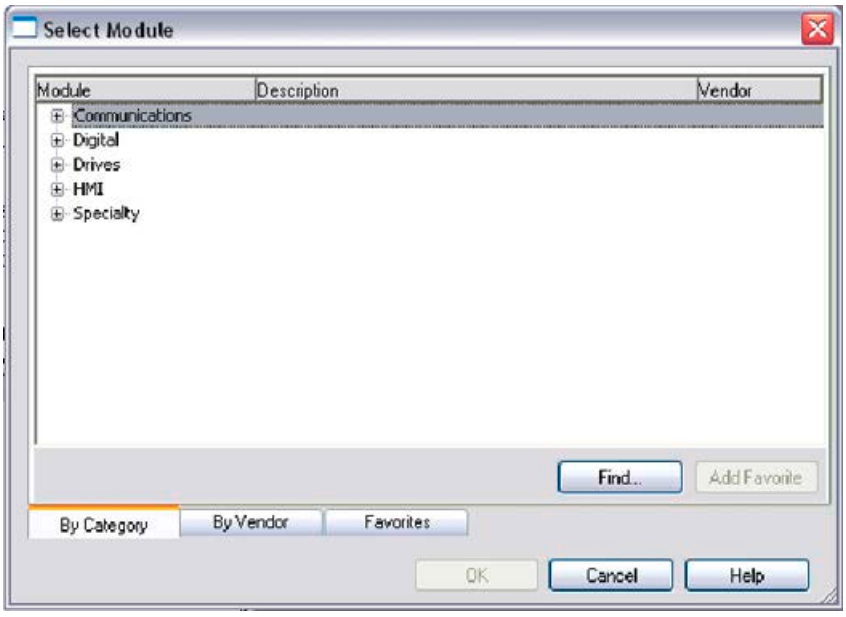



Figure 10-49 Selection of the module (2)

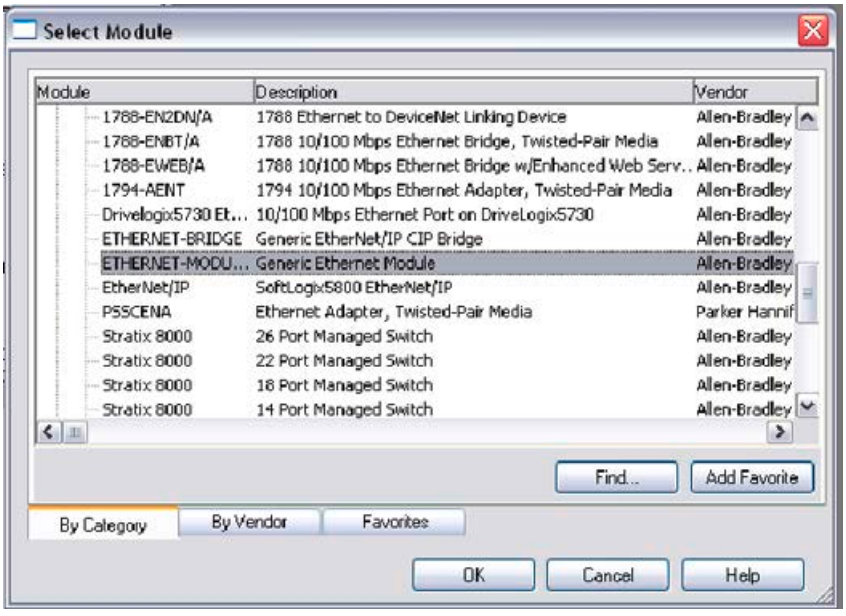



Figure 10-50 Selection of the module (3)

- After the module has been inserted by clicking OK, a new Ethernet/IP slave appears in the structure tree.
  A window is opened as follows by double-clicking with the left-hand mouse key or > right-hand mouse key > Properties.

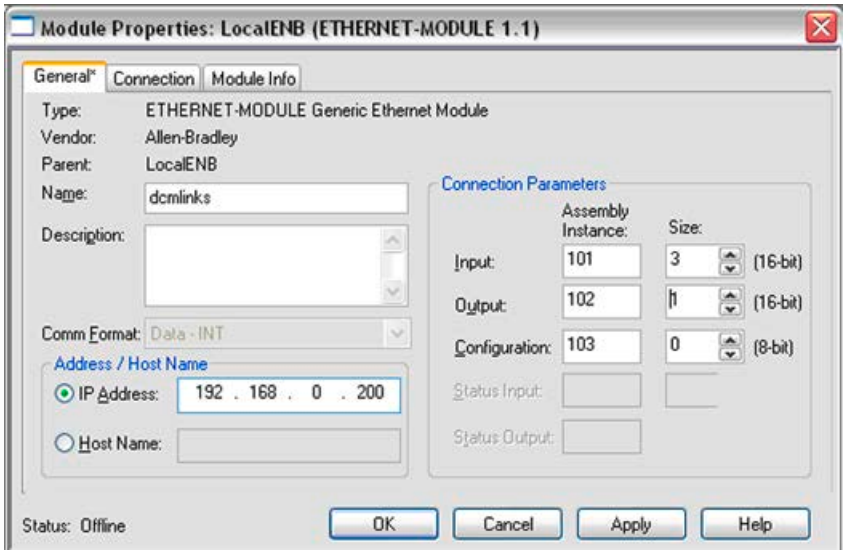



Figure 10-51 Properties

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 slave (Page 495)".

After the configuration has been activated, the drive data can be accessed via the input and output data fields (see following diagram).

For a better program documentation, it is recommended that aliases be defined for each input and output signal.

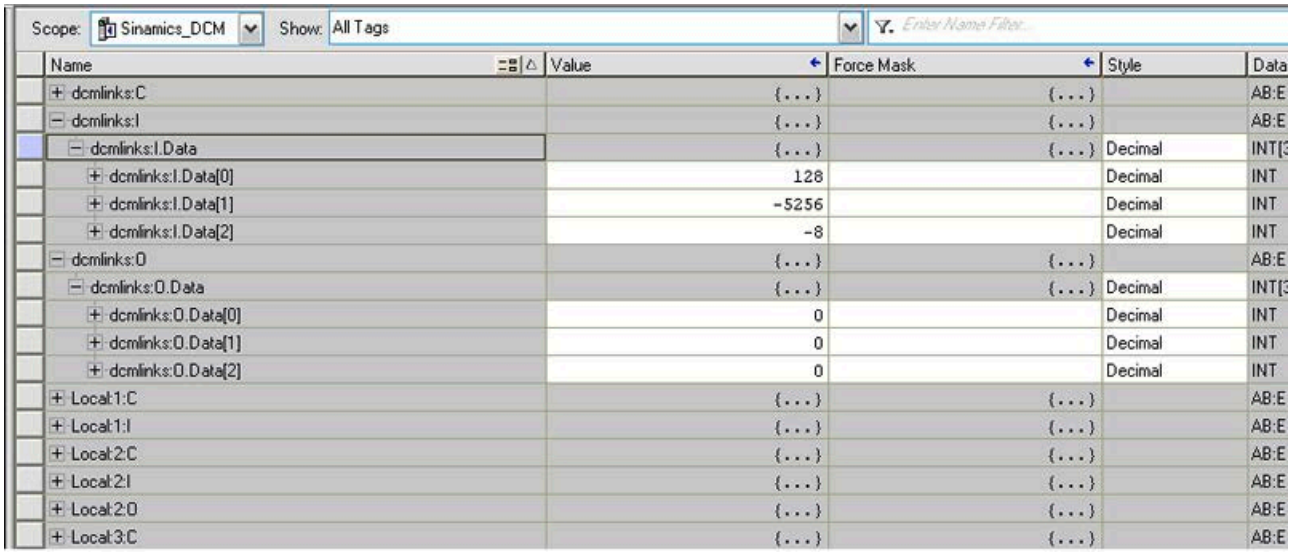



Figure 10-52 Input data and output data

Now configure the drive in order to use Ethernet/IP.

### 10.7.3.2 Writing and reading parameters with Class 4xx

As described in Chapter "Class 0x401 - 0x43E Writing and reading of parameters (Page 500)", individual drive parameters can be read and written.

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).

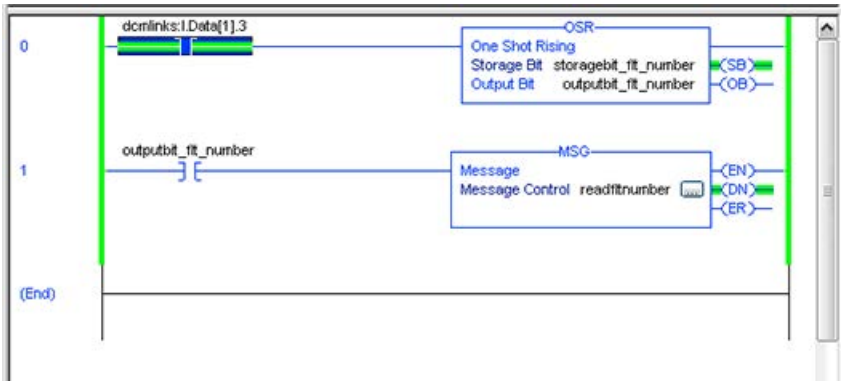



Figure 10-53 Inserting MSG

The configuration dialog shown in the following figure opens:

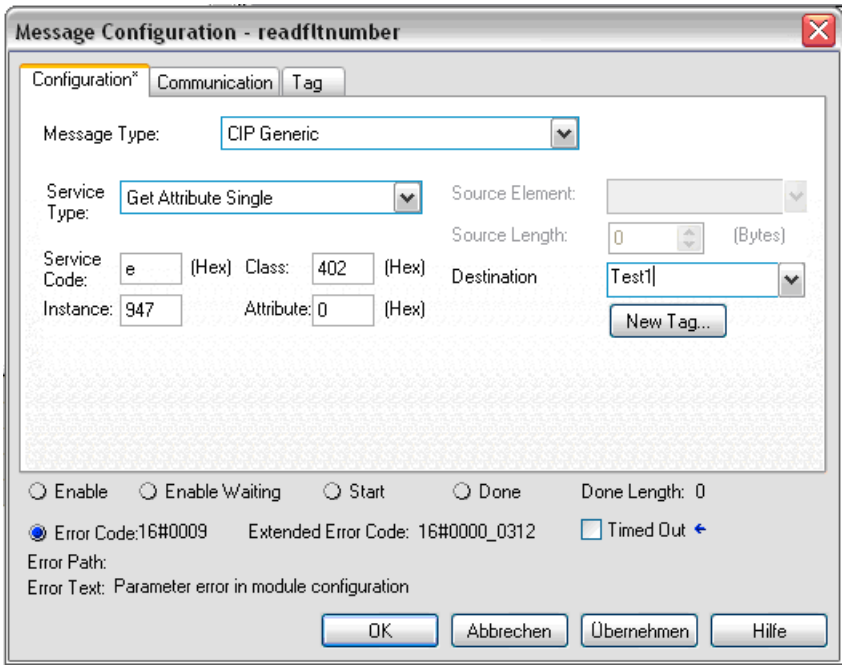



Figure 10-54 Configuration dialog

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 number (as standard 02 for drive ⇒ 402)
- Instance: Parameter number
- Attribute: Index number
- 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 slave to which the message is to be sent must be specified.

This is done on the "Communication" tab:

Figure 10-55 Communication

"Path": Defines the Ethernet/IP module, in this example "dcmlinks".

The previous example reads the active error number from parameter r947 index 0 on drive object number 2 (drive).

# 10.8 Communication via MODBUS TCP

## 10.8.1 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 DCM.

### Modbus functionality

Process data and parameters are accessed via the Modbus register.

- Process data: 40100 - 40119
  A maximum of 10 process data (PZD) can be exchanged.
- Drive data: 40300 - 40522
- All parameters via DS47: 40601 - 40722

Modbus TCP always provides a basic Ethernet functionality, which corresponds to the functionality of Ethernet interface X127:

- Commissioning access for STARTER/Startdrive 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 uses the Ethernet/PROFINET interface:

**X1400**:

For Modbus TCP with a CUD via a CBE20.

The following applies for the CUD:

- An advanced CUD must be inserted.
- The memory card (with the device firmware) must be inserted.

### 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]). A DC_CTRL drive object must be in this parameter.

- 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 | Significance |
|---|---|---|
| Green | Continuous light | Connections and setpoints are OK. |
| Green | Flashing light | Connection is OK, but no setpoints (dependent on timeout). |
| Red | Flashing light 2 Hz | No connection or setpoint timeout. |

## 10.8.2 Configuring Modbus TCP via interface X1400

### Activating Modbus TCP via X1400 (CBE20)

1. For drive object DO1, set p8835 = 5 (Modbus TCP).
2. Set the IP address for the CBE20 using p8941.
3. Set the standard gateway for the CBE20 using p8942.
4. Set the subnet mask for the CBE20 using p8943.
5. Set the DHCP mode for the CBE20 using p8944.
6. Select the setting "Activate and save configuration" as interface configuration using p8945 = 2.
7. 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").
8. Save the settings in the STARTER commissioning tool and carry out a POWER ON.

### Modbus settings with interface X1400

Using the following parameters, set the communication for Modbus TCP with a X1400 interface:

| Parameters | 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. |
| r2054 | Status display for the internal communication interface. |
| p8840 | Setting the monitoring time to monitor the received process data via the COMM BOARD.<br>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. |
| r8854 | Status display for COMM BOARD. |

## 10.8.3 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 10- 47 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 | Control word (see SINAMICS DCM List Manual, function block diagram 2442) | R/W | - | 1 | - | Process data 1 |
| 40101 | Main setpoint | R/W | - | 1 | - | Process data 2 |
| 40102 | STW 3 | R/W | - | 1 | - | Process data 3 |
| 40103 | STW 4 | R/W | - | 1 | - | Process data 4 |
| 40104 | PZD 5 | R/W | - | 1 | - | Process data 5 |
| 40105 | PZD 6 | R/W | - | 1 | - | Process data 6 |
| 40106 | PZD 7 | R/W | - | 1 | - | Process data 7 |
| 40107 | PZD 8 | R/W | - | 1 | - | Process data 8 |
| 40108 | PZD 9 | R/W | - | 1 | - | Process data 9 |
| 40109 | PZD 10 | R/W | - | 1 | - | Process data 10 |
| **Status data** | | | | | | |
| 40110 | Control word (see SINAMICS DCM List Manual, function block diagram 2452) | R | - | 1 | - | Process data 1 |
| 40111 | Main actual value | R | - | 1 | - | Process data 2 |
| 40112 | ZSW 3 | R | - | 1 | - | Process data 3 |
| 40113 | ZSW 4 | R | - | 1 | - | Process data 4 |
| 40114 | PZD 5 | R | - | 1 | - | Process data 5 |
| 40115 | PZD 6 | R | - | 1 | - | Process data 6 |
| 40116 | PZD 7 | R | - | 1 | - | Process data 7 |
| 40117 | PZD 8 | R | - | 1 | - | Process data 8 |
| 40118 | PZD 9 | R | - | 1 | - | Process data 9 |
| 40119 | PZD 10 | R | - | 1 | - | Process data 10 |

Table 10- 48 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 data** | | | | | | |
| 40322 | Ramp-up time | R/W | s | 100 | 10.00 … 655.35 | p50303 |
| 40323 | Ramp-down time | R/W | s | 100 | 10,00 … 655.35 | p50304 |
| 40324 | Reference speed | R/W | RPM | 1 | 6 … 65535 | p2000 |

| Register | Description | Ac-cess | Unit | Scaling | ON/OFF text or Value range | Data / parameter |
|---|---|---|---|---|---|---|
| **Drive diagnostics** | | | | | | |
| 40340 | Speed setpoint | R | RPM | 1 | -32768 … 32767 | r0020 |
| 40341 | Actual speed value | R | RPM | 1 | -32768 … 32767 | r0021 |
| 40345 | Actual current value | R | A | 100 | 0 … 655.35 | r0027 |
| 40347 | Actual active power | R | kW | 100 | 0 … 655.35 | r0032 |
| 40349 | Control priority | R | - | 1 | MANUAL \| AUTO | r0807 |
| **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 | - |
| **Technology controller**[1)] | | | | | | |
| 40500 | Technology controller enable | R/W | - | 1 | 0 … 1 | p2200, r2349.0 |
| **Adapt technology controller**[1)] | | | | | | |
| 40510 | Time constant for actual-value filters of the technology controller | R/W | - | 100 | 0.00 … 60.0 | p2265 |
| 40511 | Scaling factor for actual value of the technology controller | R/W | % | 100 | 0.00 … 500.00 | p2269 |
| 40512 | Proportional amplification of the technology controller | R/W | - | 1000 | 0.000 … 65.535 | p2280 |
| 40513 | Integral time of the technology controller | R/W | s | 1 | 0 … 60 | p2285 |
| 40514 | Time constant D-component of the technology controller | R/W | - | 1 | 0 … 60 | p2274 |
| 40515 | Max. limit of technology controller | R/W | % | 100 | -200.0 … 200.0 | p2291 |
| 40516 | Min. limit technology controller | R/W | % | 100 | -200.0 … 200.0 | p2292 |
| **PID diagnostics** | | | | | | |
| 40521 | Actual value of technology controller after filter | R | % | 100 | -100.0 … 100.0 | r2266 |
| 40522 | Output signal technology controller | R | % | 100 | -100.0 … 100.0 | r2294 |

1) The technology controller parameters can only be accessed if, in the STARTER project, also the "Technology controller" function module is activated.

Table 10- 49 Assignment of the Modbus register for general parameter access using DS47

| Register | Description | Ac-cess | Unit | Scaling | ON/OFF text or Value range | Data / parameter |
|---|---|---|---|---|---|---|
| 40601 | DS47 Control | R/W | - | - | - | - |
| 40602 | DS47 header | R/W | - | - | - | - |
| 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

## 10.8.4 Read and write 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 inverter
- 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 10-56 Individual components, including the Modbus Application Header (MBAP) and function code

## 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 10- 50 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 10- 51 Device response to the read request, example

| Value | Byte | Description |
|---|---|---|
| MBAP header | | |
| 03 h | 7 | |
| 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 10- 52 Invalid read request

| Read request | Inverter response |
|---|---|
| Invalid register address | Exception code 02 (invalid data address) |
| Read a write-only register | Telegram in which all values are set to 0. |
| Read a reserved register | |
| Controller addresses more than 125 registers | Exception code 03 (invalid data value) |
| The start address and the number of registers of an address are located outside of a defined register block | Exception code 02 (invalid data address) |

### 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 10- 53 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 10- 54 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 10- 55 Invalid write request

| Write request | Inverter 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.

## 10.8.5 Communication via data set 47

Via 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.

### 10.8.5.1 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 inverter 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.

### 10.8.5.2 Examples: Read parameter

Table 10- 56 Write parameter request: Reading parameter value of r0002 from device number 17

| 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 (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 |
| 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 10- 57 Start parameter request: Reading parameter value of r0002 from device number 17

| 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 10- 58 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 10- 59 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 2F h(47), response length 0 (fault) |
| 0004 h | 13,14 | 40603: Error code: 0004 Response Not Ready (response has still not been issued) |

### 10.8.5.3 Examples: Write parameter

Table 10- 60 Write parameter request: Writing the parameter value of p1121 from device number 17

| 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: C1 (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 |
| 0461 h | 23,24 | 40606: Parameter number = 1121 |
| 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 10- 61 Start parameter request: Writing the parameter value of p1121 from device number 17

| 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 10- 62 Response for successful write 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 (request was executed) |
| 2F04 h | 11,12 | 40602: Function code 2F h (47), response length 4 bytes |
| 8002 h | 13,14 | 40603: Request reference mirrored = 80 h,<br>response identifier = 2 (change parameter) |
| 0101 h | 15,16 | 40604: DO-ID = 1, number of parameters = 1 |

Table 10- 63 Response for unsuccessful write operation – Write 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: DS47 Control = 1 (request is processed) |
| 2F00 h | 11,12 | 40602: Function 2F h(47), response length 0 (fault) |
| 0004 h | 13,14 | 40603: Error code: 0004 Response Not Ready (response has still not been issued) |

## 10.8.6 Communication sequence

### 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 10- 64 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 … 40522).

**Fieldbus interface:**

In parameter p2040 you define the time for cyclic data exchange for process data.

Setting range 0 - 2000 s.

The time depends on the amount of data to be transferred and the control.

"Setpoint timeout" (F01910) is issued by the Modbus if p2040 is set to a value > 0 ms and no process data is requested within this time period.

**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.

## 10.8.7 Messages and parameters

### Faults and alarms (see DCM List Manual)

- F01910 Fieldbus: Setpoint timeout
- 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 SINAMICS DCM List Manual)

- p0978[0...n] List of drive objects
- p2030 Fieldbus interface protocol selection
- p2040 Fieldbus interface monitoring time:
- 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
- r2054 PROFIBUS status
- 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
- r8854 COMM BOARD state
- 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

# 10.9 Serial interface with USS protocol

## Specification

Developed by Siemens, the USS® protocol is a proprietary fieldbus which was already being used in a variety of applications before PROFIBUS was established.

The USS® protocol is described in the following document:
USS® Protocol Specification: Order number E20125-D0001-S302-A1

## Properties

The USS® protocol can only be used as a fieldbus **instead** of PROFIBUS; USS and PROFIBUS cannot run at the same time.

The USS® protocol enables one or more SINAMICS DCMs to be connected to a master station. It is a point-to-point coupling or a bus-type coupling. A maximum of 31 nodes can be connected in the bus configuration (1 master and a maximum of 30 slaves). The bus terminator must be activated on both bus nodes at each end of the bus line.

The USS® protocol enables access to all relevant process data, diagnostic information, and parameters for the SINAMICS DCM.

The USS® protocol is purely a master-slave protocol in which a SINAMICS DCM can only ever be a slave. In this case, a SINAMICS DCM only sends a telegram to the master if it has received a telegram from it. Therefore, SINAMICS DCMs cannot use the USS® protocol to exchange data with one another directly.

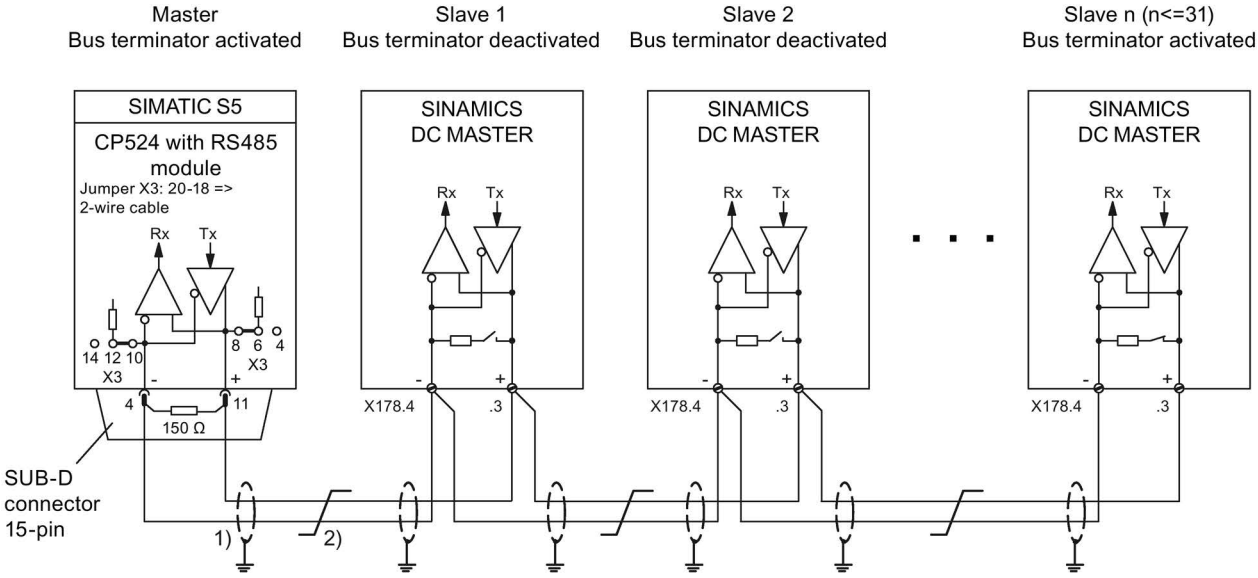
## Connecting

Terminal X178, X179

## Function diagrams

The function diagrams for the fieldbus interface are relevant:
See FP2410, FP2420, FP2440, FP2442, FP2450, FP2452, FP2460, FP2470, FP2472, FP2481, and FP2483.

### Wiring example for a USS bus




1) The shields for the interface cables must be connected directly on the devices (using a clamp, for example) to device or cabinet ground, with a low level of impedance.

2) Twisted cable, e.g. LIYCY 2×0.5 mm$^2$; with longer cables, an equipotential bonding cable should be used to ensure that the difference in ground potentials between the link partners remains below 7 V.

Figure 10-57 USS bus

# 10.10 Switch on, switch off, enable

## 10.10.1 Switch on/Switch off (ON/OFF1) – Control word bit 0

The "Switch on/Shutdown" (ON/OFF1) function is controlled using the "ON/OFF1 switch-on command" (= ANDing the signal from terminal X177.12 with the signal selected using p0840).

The following operating modes are possible here:

p50445 = 0: The "ON/OFF1 switch-on command" takes the form of ANDing the signal from terminal X177.12 with the signal selected using p0840 (level-controlled, 0 = shutdown, 1 = switch on).

p50445 = 1: Edge triggering of "ON/OFF1 switch-on command":
The switch-on command is saved when a 0 → 1 transition takes place (see function diagram 3130 in the SINAMICS DCM List Manual). The binector selected using p50444 must be in the log. "1" state at this point. The memory is reset when this binector enters the log. "0" state.

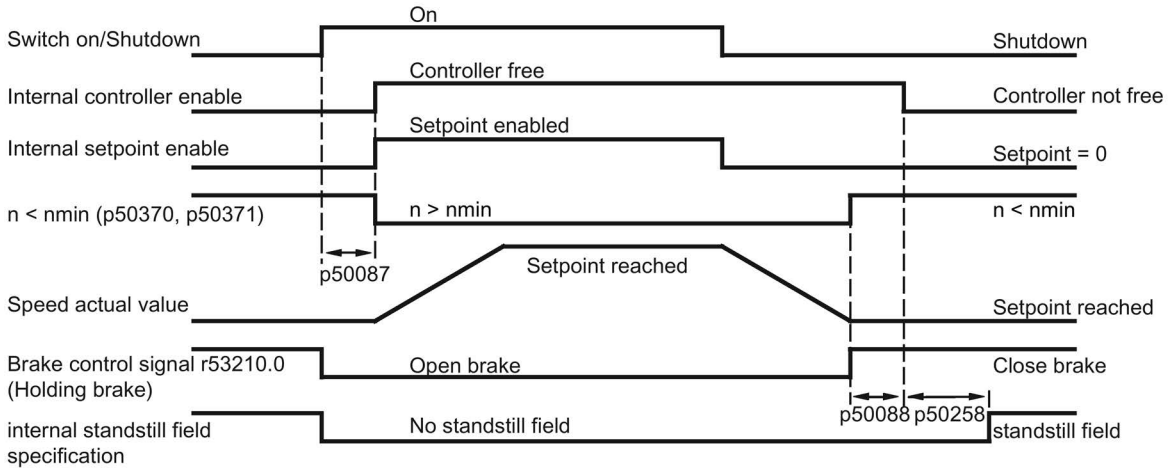
**Sequence of events for switching on the drive:**

1. Apply the "Switch on" command (e.g. using the "Switch on/Shutdown" terminal).
2. The system exits operating state o7.
3. The "Line contactor closed" relay (terminal XR1-109 and -110) picks up.
4. The field-current reduction function stops
5. if "Operation enable" is applied:
   - With positive brake-release time (p50087):
     The "Release holding or operational brake" signal (r53210.0 = 0) is output and p50087 is awaited in operating state o1.0.
   - With negative brake-opening time (p50087 negative):
     Go immediately to step 6; brake is still closed (r53210.0 = 1)
6. The ramp-function generator, n controller, and I controller are enabled.
7. Once a negative brake-release time (p50087) has elapsed, the "Release holding or operational brake" (r53210.0 = 0) signal is output.

**Procedure for shutting down the drive:**

1. Apply the "Switch on" command (e.g. using the "Switch on/Shutdown" terminal).
2. Deceleration along the ramp-function generator ramp
3. Wait until n < nmin (p50370, p50371).
4. The "Close holding or operational brake" (r53210.0 = 1) signal is output.
5. The brake-closing time (p50088) is awaited.
6. The ramp-function generator and n controller are disabled.
7. Reduction in armature current
8. The armature firing pulses are disabled.
9. The "Line contactor closed" relay (terminal XR1-109 and XR1-110) drops out.
10. Operating state o7.0 or higher is reached.
11. The wait time for field-current reduction (p50258) elapses.
12. The field is reduced to a parameterizable value (p50257).

**"Switch on/Shutdown" overview**




p50087 Brake-release time (positive in this case)

p50088 Brake-closing time

p50258 Wait time for automatic field-current reduction

Figure 10-58 Switch on/Shutdown

- An internal interlock becomes active once n < nmin (r50370, r50371) for the first time. This stops the drive from attempting to decelerate again if the motor is rotated by external influences; the n < nmin message then disappears.
- Whether level triggering or edge triggering is selected has an overarching effect on "Switch on", "Switch off", and "Creep".

**Note**

The "Creep' function is described in the "Creep (Page 532)" chapter.

- Selecting edge triggering causes "Switch on" and "Creep" to replace one another, i.e.:
  - A "Switch on" edge at terminal X177.12 cancels a "Creep" function that had previously been triggered.
  - A "Creep" edge at a binector selected using p50440 cancels a "Switch on" function that had previously been triggered.
- With edge triggering, an automatic restart following a brief interruption in the electronic power supply voltage is not possible.
- To ensure that "Shutdown" functions even when rewiring is carried out, current or torque lower limits are specified, or additional setpoints are supplied, certain functions are disabled automatically when "Shutdown" is applied.
  - All torque limits are disabled during braking to n < nmin.
  - Of the current limits, only the system current limit (p50171 and p50172), speed-dependent current limit, and current limit resulting from $I^2t$ monitoring of the power unit are enabled.

## 10.10.2 OFF2 (disconnection) – Control word bit 1

The OFF2 signal is LOW active (log. "0" state = disconnection).

**Procedure for applying disconnection:**

1. The ramp-function generator, n controller, and Ia controller are disabled.
2. Reduction in armature current
3. The firing pulses are disabled.
4. "Close operational brake" is output (r53210.0 = 1, where p50080 = 2).
5. Operating state o10.0 or higher is reached.
6. The field current is maintained at a fixed point (i.e. there is **no** increase in the field current, even on exiting the field-weakening range).
7. The "Line contactor closed" relay (terminal XR1-109 and XR1-110) drops out.
8. The drive coasts down (or is decelerated by the operational brake).
9. The parameterizable wait time (p50258) elapses.
10. The field is reduced to a parameterizable value (p50257).
11. Once n < nmin (p50370, p50371), the "Close holding brake" signal is output (r53210.0 = 1, where p50080 = 1).

## 10.10.3 OFF3 (quick stop) – Control word bit 2

The OFF3 signal is LOW active (log. "0" state = quick stop).

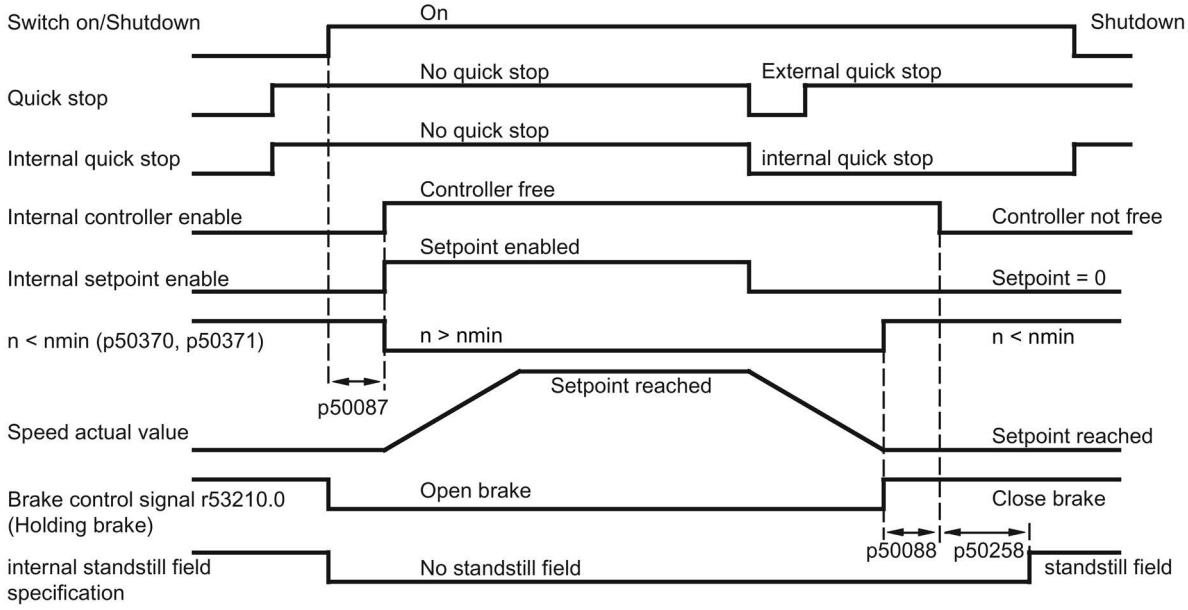
**Procedure for applying "Quick stop":**

1. The ramp-function generator is disabled.
2. A speed setpoint of zero is applied.
3. Deceleration along the down ramp acc. to p50296, p50297, p50298
4. Wait until n < nmin (p50370, p50371).
5. "Close operational or holding brake" (r53210.0 = 1) is output.
6. Wait for brake-closing time (p50088)
7. The ramp-function generator and speed controller are disabled.
8. Reduction in armature current
9. The armature firing pulses are disabled.
10. The "Line contactor closed" relay (terminal XR1-109 and XR1-110) drops out.
11. Operating state o9.0 or higher is reached.
12. The wait time for field-current reduction (p50258) elapses.
13. The field is reduced to a parameterizable value (p50257).

**Procedure for withdrawing "Quick stop":**

1. Remove "Quick stop" command.
2. Apply the "Shutdown" command (e.g. using the "Switch on/Shutdown" terminal).
3. The system exits operating state o8.

**Quick stop overview**




p50087 Brake-release time (positive in this case)

p50088 Brake-closing time

p50258 Wait time for automatic field-current reduction

Figure 10-59 OFF3 (quick stop)

- The "Quick stop" command only needs to be present as a short pulse (> 10 ms). It is then saved internally. It is only possible to reset the memory by applying the "Shutdown" command.
- The SINAMICS DC MASTER links all "Quick stop" commands in such a way that the "Quick stop" function is only disabled once all commands are in the "No quick stop" state.
- An internal interlock becomes active once n < nmin (r50370, r50371) for the first time. This stops the drive from attempting to decelerate again if the motor is rotated by external influences; the n < nmin message then disappears.
- To ensure that "fast stopping" functions even when rewiring is carried out, current or torque lower limits are specified, or additional setpoints are supplied, certain functions are disabled automatically when "fast stopping" is applied.
  - All torque limits are disabled while braking to n < nmin.
  - Of the current limits, only the system current limit (p50171 and p50172), speed-dependent current limit, and current limit resulting from $I^2t$ monitoring of the power unit are enabled.

### 10.10.4 Operation enable (enable) - control word bit 3

The enable signal is HIGH active (log. "1" state = enable).

Control word bit 3 and terminal X177.13 (enable) are logically ANDed. See also function diagram 2580.

**Procedure for applying operation enable (if a switch-on command is present):**

1. With positive brake-release time (p50087):
   The "Release holding or operational brake" signal (r53210.0 = 0) is output and p50087 is awaited in operating state o1.0.
   With negative brake-opening time (p50087 negative):
   Go immediately to step 2; brake is still closed (r53210.0 = 1)
2. The ramp-function generator, n controller, and I controller are enabled.
3. Operating state o0 is reached.
4. Once a negative brake-release time (p50087) has elapsed, the "Release holding or operational brake" (r53210.0 = 0) signal is output.

**Procedure for withdrawing operation enable:**

1. The ramp-function generator, n controller, and I controller are disabled.
2. Reduction in armature current
3. The armature firing pulses are disabled.
4. The "Close operational brake" signal is output (r53210.0 = 1, where p50080 = 2).
5. Operating state o1.0 or higher is reached.
6. The drive coasts down (or is decelerated by the operational brake).
7. Once n < nmin (p50370, p50371), the "Close holding brake" signal is output (r53210.0 = 1, where p50080 = 1).

## 10.11 Safety shutdown (E-STOP)

**Note**

The E-STOP function is not an EMERGENCY STOP function in the sense of EN 60204-1.

The E-STOP function forces the "line contactor closed" relay to drop out, activating the relay contact (terminals XR1-109 and -110) for the main contactor control within approximately 15 ms, independent of the semiconductor components and Control Unit (CUD) functions. If the CUD is operating correctly, applying I = 0 via the controller serves to disconnect the line contactor from the power supply. The drive coasts down once E-STOP has been applied.

The E-STOP function is triggered when the switch between terminals XS1-105 and XS1-106 is opened.

The E-STOP function causes the drive to enter the "Switching on inhibited" operating state. This must be acknowledged by activating the "Shutdown" function, e.g. by opening terminal X177.12.

Procedure for applying E-STOP:

1. The ramp-function generator, n controller, and I controller are disabled.
2. Reduction in armature current
3. a) p51616 = 0: E-STOP acts like OFF2 (firing pulses are disabled as soon as I = 0).
   b) p51616 = 1: E-STOP immediately stops firing pulses from being output (without waiting for I = 0).
4. The "Close operational brake" signal is output (r53210.0 = 1, where p50080 = 2).
5. Operating state o10.0 or higher is reached.
6. The field current is maintained at a fixed point (i.e. there is **no** increase in the field current, even on exiting the field-weakening range).
7. The "Line contactor closed" relay (terminal XR1-109 and XR1-110) drops out.
8. The drive coasts down (or is decelerated by the operational brake).
9. The wait time (to be set at p50258) elapses.
10. The field is reduced to a parameterizable value (p50257).
11. Once n < nmin (p50370, p50371), the "Close holding brake" signal is output (r53210.0 = 1, where p50080 = 1).

**Note**
15 ms after E-STOP has been applied (even if point 7 in this procedure has not yet been reached), the "Line contactor closed" relay (terminal XR1-109 and XR1-110) will always drop out; this is triggered by the hardware.

# 10.12 Setpoint channel

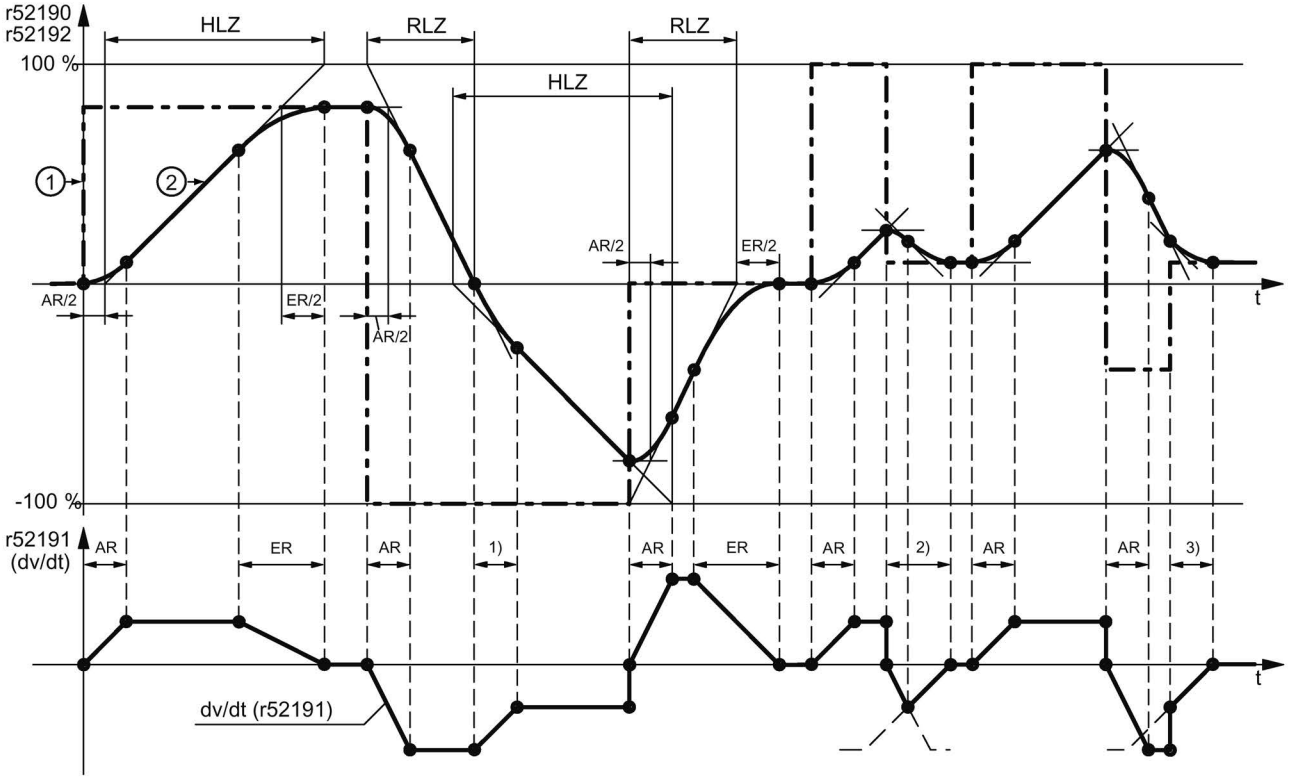
## 10.12.1 Ramp-function generator

Table 10- 65 Definitions

| | |
|---|---|
| Ramp-up | Acceleration from lower positive to higher positive speeds (e.g. 10% to 90%) or from lower negative to higher negative speeds (e.g. -10% to -90%) |
| Return flow | Deceleration from higher positive to lower positive speeds (e.g. 90% to 10%) or from higher negative to lower negative speeds (e.g. -90% to -10%) |
| Transition from negative to positive speeds | E.g. from -10% to +50%:<br>From -10% to 0 = ramp-down and<br>From 0 to +50% = ramp-up, and vice versa |

| | |
|---|---|
| Ramp-up time | The amount of time the ramp-function generator requires, when initial rounding and final rounding = 0 and an input variable jump from 0 to 100% or 0 to -100% is performed, for passing through the 100% range at the ramp-function generator output. For smaller jumps at the input, the rise at the output is performed at the same rate. |
| Ramp-down time | The amount of time that the ramp-function generator requires, when initial rounding and final rounding = 0 and an input variable jump from 100% to 0 or -100% to 0 is performed, for passing through the 100% range at the ramp-function generator output. For smaller jumps at the input, the rise at the output is performed at the same rate. |

## Ramp-function generator mode of operation




① = Ramp-function generator setpoint ② = Ramp-function generator output

HLZ = Rampup time RLZ = Ramp-down time

AR = Initial rounding ER = Final rounding

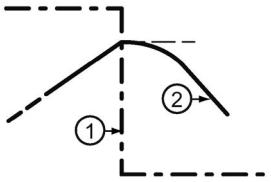
1) Transition from ramp-down incline to ramp-up incline

2) Initial rounding makes the transition to final rounding even before the maximum ramp-down incline is reached.

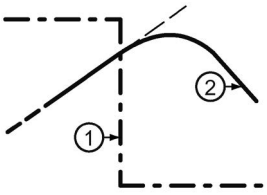
3) Only the last part of final rounding is performed here due to the ramp-function generator setpoint jump.

Figure 10-60 Ramp-function generator mode of operation

## Operating modes for ramp-function generator rounding




**p50295 = 0:**
When a setpoint reversal occurs during ramp-up (or ramp-down), the ramp-up (or ramp-down) process is interrupted and initial rounding for the ramp-down (or ramp-up) process starts immediately. This does not mean any additional increase (or decrease) in the setpoint, But rather a bend in the signal at the ramp-function generator output (i.e. a jump in the acceleration).




**p50295 = 1:**
when a setpoint reversal occurs during ramp-up or ramp-down, the ramp-up/ramp-down process slowly crosses over into ramping-down/ramping-up. This results in an additional increase (or decrease) in the setpoint, as well as a bend in the signal at the ramp-function generator output (i.e. there is no jump in the acceleration).

## Control signals

Table 10- 66 Control signals for the ramp-function generator operating mode

| | |
|---|---|
| **Ramp-function generator enable**<br>Control word bit 4, p01140[c] | 0 = Ramp-function generator disabled; ramp-function generator output set to 0 |
| | 1 = Ramp-function generator enabled |
| **Ramp-function generator start**<br>Control word bit 5, p01141[c] | 1 = Setpoint is switched into the ramp-function generator input |
| | 0 = Ramp-function generator is stopped at the current value (ramp-function generator output is switched in as ramp-function generator input) |
| **Setpoint enable**<br>Control word bit 6, p01142[c] | 1 = Setpoint enabled at ramp-function generator input |
| | 0 = Switchover to ramp-function generator setting 1 performed and 0 applied to the input (ramp-function generator output travels to 0) |
| **Set ramp-function generator** (p50640[c]) | 1 = The ramp-function generator output is set to the setting value (selection via p50639). |
| **Ramp-function integrator operation** (p50302) | See below and description of p50302 in the parameter list found in the SINAMICS DCM List Manual. |
| **Enable switchover of the ramp-function integrator** (p50646) | See below. |
| **Ramp-function generator settings 2 and 3** | See below. |
| **Ramp-function generator tracking ON** (p50317) | See below and description of p50317 in the parameter list found in the SINAMICS DCM List Manual. |
| **Set ramp-function generator on switching off** (p50318) | See description of p50318 in the parameter list found in the SINAMICS DCM List Manual. |
| **Bypass ramp function generator** | 1 = The ramp-function generator operates with ramp-up time and ramp-down time = 0.<br>The function is then controlled via the binector selected using p50641. It is also possible to select the option of bypassing the ramp-function generator in operating modes JOG, CREEP, and APPLY FIXED SETPOINT. |

### Ramp-function generator settings 1, 2, and 3

Selection via the binectors selected using p50637 and p50638.

The ramp-function generator settings that are entered via the binectors selected using p50637 and p50638 have priority over the ramp-function generator setting entered by the ramp-function integrator.

| Binector state selected via parameters | | Ramp-function generator setting | Active ramp-up time | Active ramp-down time | Active initial rounding | Active final rounding |
|---|---|---|---|---|---|---|
| p50637 | p50638 | | | | | |
| 0 | 0 | 1 | p50303 | p50304 | p50305 | p50306 |
| 1 | 0 | 2 | p50307 | p50308 | p50309 | p50310 |
| 0 | 1 | 3 | p50311 | p50312 | p50313 | p50314 |
| 1 | 1 | Not permitted; fault F60041 (setting not unique) triggered | | | | |

### Ramp-function integrator

The ramp-function integrator is activated by setting p50302 to 1, 2, or 3. Once an "ON" command ("Switch on", "Jog", "Creep") has been applied, ramp-function generator setting 1 (p50303 to p50306) is used until the ramp-function generator output reaches the required setpoint for the first time.

Following this, the process is controlled by the "Enable switchover of ramp-function integrator" signal (binector selected using p50646):

- Enable switchover of ramp-function integrator = 1:
  If the ramp-function generator output reaches the required setpoint for the first time after the "ON" command has been applied, the system automatically switches over to the ramp-function generator setting selected according to p50302.
- Enable switchover of ramp-function integrator = 0:
  Once the ramp-function generator output has reached the setpoint, ramp-function generator setting 1 (p50303 to p50306) remains active until "Enable switchover of ramp-function integrator" is switched to 1. The system then switches over to the ramp-function generator setting selected according to p50302.

If the "Enable switchover of ramp-function integrator" signal is withdrawn (→ 0), the system switches back to ramp-function generator setting 1 and, when the signal is applied again (→ 1), remains at this setting until the ramp-function generator output has reached the setpoint again. Following this, the system switches back over to the ramp-function generator setting selected according to p50302.

When the "Switch off" command is applied, the drive is switched off via ramp-function generator setting 1.

**Note**

Activating "Ramp-function generator setting 2" (p50307 to p50310; selection via p50637) or "Ramp-function generator setting 3" (p50311 to p50314; selection via p50638) has priority over the ramp-function generator setting requested by the "Ramp-function integrator" function.

## Ramp-function-generator tracking

The ramp-function generator output (r52190) is limited to the following values when ramp-function generator tracking is active:

**(-Mlimitx 1.25 / Kp + nact) < HLG output < (+Mlimit x 1.25 / Kp + nact)**

When p50170 = 1 (closed-loop torque control), the following applies:

**(-IA.limit x ΦMotor x 1.25 / Kp + nact) < HLG output < (+IA.limit x ΦMotor x 1.25 / Kp + nact)**

When p50170 = 0 (closed-loop current control), the following applies:

**(-IA.limit x 1.25 / Kp + nact) < HLG output < (+IA.limit x 1.25 / Kp + nact)**

| | |
|---|---|
| Φmotor | Scaled motor flux (1 at rated excitation current) |
| nact | Actual speed value (r52167) |
| +Mlimit | Smallest positive torque limit (r52143) |
| -Mlimit | Smallest negative torque limit (r52144) |
| +IA.limit | Smallest positive current limit (r52131) |
| -IA.limit | Smallest negative current limit (r52132) |
| Kp | Active speed controller gain |

If, however, the value added to nact would be less than 1%, then +1% or is –1% is added.

The "Ramp-function generator tracking" function prevents the ramp-function generator value from straying too far from the actual speed value if the torque or current limit has been reached.

**Note**

When ramp-function generator tracking is active, the filtering time of the speed setpoint p50228 should be low (ideally = 0).

## Limiting after ramp-function generator

This limiting stage can be used by freely selecting the input signal, independently from the ramp-function generator.

A distinguishing feature of this type of limiting is that lower limiting can also be set to positive values and upper limiting to negative values (see p50300 and p50301). In this case, a limit set using this method acts as a lower limit (lower limiting value) for the output signal of the ramp-function generator, with the sign inverted.

Example:
p50632.01 ... 04 = 1 (= 100.00%)
p50300 = 100.00 (%)
p50301 = 10.00 (%)
p50633.01-04 = 9 (= -100.00%)
results in the value range of r52170 being limited to between +10.00% and +100.00%.

### Acceleration signal dv/dt (r52191)

This signal specifies the change in ramp-function generator output r52190 during the time set in p50542.

### Braking distance (r52047, r52048)

This signal specifies the distance that the drive would travel if, e.g. it would be stopped using an OFF1 command.

This braking distance is calculated under the assumption that at the ramp-function generator input, a speed setpoint of 0 would be input and the speed actual value would go down to 0 with the set ramp-down time and the set rounding-off.
The calculation of the braking distance is only then correct if the ramp-down time and rounding elements do not change during the braking process.
The braking distance is output in the same unit as the encoder position actual value r0482. This means that one encoder revolution corresponds to a value of p0400×2^p0418

The braking distance is available in two different data formats:

- r52047 has the Unsigned32 data type
- r52048 has the FloatingPoint32 data type

## 10.12.2 Jog

See also function diagram 3125 in the SINAMICS DCM Parameter Manual

The JOG function can be applied via the binectors selected using p50435 index .00 to .07, and via control word bit 8 and bit 9 (r0898.8 & r0898.9) (see function diagram for logic operation).

The "Jog" function can only be executed if "Switch off" and "Operation enable" have been applied.

The "Jog" function is applied by one or more of the sources referred to (binectors, control word bits) entering the log. "1" state. During this, each source is assigned a setpoint (to be selected using p50436).

If two or more sources apply the "Jog" function at the same time, then 0 is applied as the jog setpoint.

For each source (binector, control word bit) with which the "Jog" function can be applied, p50437 may be used to determine whether the ramp-function generator is bypassed (binector r53170.11). In this case, the ramp-function generator operates with ramp-up time = 0 and ramp-down time = 0.

#### Procedure for applying jog:

If "Jog" is applied, the system is switched on and the jog setpoint applied via the ramp-function generator. For this procedure, refer to the section titled "Switch on/Switch off (ON/OFF1)".

#### Procedure for withdrawing jog:

Once the "Jog" function has been withdrawn, the procedure begins in the same way as the "Switch off" function, as outlined in the section titled "Switch on/Switch off (ON/OFF1)". Once n < nmin, the controller is disabled and, following a parameterizable time (p50085)

of 0 to 60 s, the line contactor is opened (operating state o7.0 or higher). While the wait time that can be parameterized using p50085 (max. 60.0 s.) is running, the drive remains in operating state o1.3.

## 10.12.3 Creep

See also function diagram 3130 in the SINAMICS DCM Parameter Manual.

The "Creep" function can be activated in operating state o7 and the "Operation" state while "Operation enable" applies.

"Creep" is applied by means of one or more of the binectors selected using p50440 entering the log. "1" state. During this, each binector is assigned a setpoint (to be selected using p50441). If "Creep" is applied by several binectors, their corresponding setpoints are added together.

For each source (binector) with which the "Creep" function can be applied, p50442 may be used to determine whether the ramp-function generator is bypassed (binector r53170.12). In this case, the ramp-function generator operates with ramp-up time = 0 and ramp-down time = 0.

**Level/Edge**

p50445 = 0: Level-controlled
Binector selected using p50440= 0: No creep
Binector selected using p50440= 1: Creep

p50445 = 1: Edge-triggered
The application of the "Creep" function is saved when the binector makes the 0 → 1 transition. The binector selected using p50444 must be in the log. "1" state at this point. The memory is reset when this binector enters the log. "0" state.

**Procedure for applying creep:**

If "Creep" is applied in operating state o7, the system is switched on and the creep setpoint is applied via the ramp-function generator.

If "Creep" is applied in the "Operation" state, the drive uses the ramp-function generator to travel from the operating speed to the creep setpoint.

**Procedure for withdrawing creep:**

- For "Creep" when the "Switch on" command is not present:

  If all binectors that apply the "Creep" function enter the log. "0" state, the controller is disabled and the line contactor is opened (operating state o7.0 or higher) after n < nmin.

- For "Creep" from the "Operation" state:

  If all binectors that apply the "Creep" function enter the log. "0" state, and the conditions for the "Operation" state are still present, the drive uses the ramp-function generator to travel from the set creep speed to the operating speed.

See also the section titled "Switch on/Switch off (ON/OFF1)" for information on edge triggering, automatic restart, and the effect of current and torque limits when decelerating.

## 10.12.4 Fixed setpoint

See also function diagram 3115 in the SINAMICS DCM Parameter Manual.

The "Fixed setpoint" function can be applied via the binectors selected using p50430 index .00 to .07, and via p50680 and p50681 (see function diagram for logic operation).

"Fixed setpoint" is applied by one of more of the sources referred to (binectors) entering the log. "1" state. During this, each source is assigned a setpoint (to be selected using p50431). If "Fixed setpoint" is applied by several sources at the same time, their corresponding setpoints are added together (limited to ±200%).

For each source with which "Fixed setpoint" can be applied, p50432 may be used to determine whether the ramp-function generator is bypassed. In this case, the ramp-function generator operates with ramp-up time = 0 and ramp-down time = 0.

**Response when "Fixed setpoint" is applied:**

The fixed setpoint is switched in instead of the r52211 setpoint.

**Withdrawal of "Fixed setpoint":**

If all possible sources for switching in the fixed setpoint are in the log. "0" state again, r52211 is switched through as a setpoint.

# 10.13 Encoder evaluation

## General information

The SINAMICS DC MASTER can evaluate speed/position encoders.

Two encoders can be evaluated simultaneously. Encoder 1 is connected to connector X177 on the CUD. Encoder 2 is connected to an encoder module SMC10 or an encoder module SMC30, which is connected via DRIVE-CLiQ with the CUD.

Encoder 1 is often referred to as the motor encoder as it is normally attached directly to the motor.
Encoder 2 is often referred to as the load encoder as it is normally attached directly to the load.

Table 10- 67 Supported encoder types

| Setting for p0400 | Encoder type | Encoder 1 p0400[0] | Encoder 2 p0400[1] |
|---|---|---|---|
| 0 | No encoder | ✓ | ✓ |
| 1001 | Resolver 1 speed | x | ✓ |
| 1002 | Resolver 2 speed | x | ✓ |
| 1003 | Resolver 3 speed | x | ✓ |
| 1004 | Resolver 4 speed | x | ✓ |
| 3001 | 1024 HTL A/B R | ✓ | ✓ |
| 3002 | 1024 TTL A/B R | ✓ | ✓ |
| 3003 | 2048 HTL A/B R | ✓ | ✓ |
| 3005 | 1024 HTL A/B | ✓ | ✓ |
| 3006 | 1024 TTL A/B | ✓ | ✓ |
| 3007 | 2048 HTL A/B | ✓ | ✓ |
| 3008 | 2048 TTL A/B | ✓ | ✓ |
| 3009 | 1024 HTL A/B unipolar | ✓ | ✓ |
| 3011 | 2048 HTL A/B unipolar | ✓ | ✓ |
| 3020 | 2048 TTL A/B R, with sense | x | ✓ |
| 3081 | SSI, singleturn, 24 V | x | ✓ |
| 3082 | SSI, multiturn 4096, 24 V | x | ✓ |
| 3088 | 1024, HTL, A/B, SSI, singleturn | x | ✓ |
| 3090 | 4096, HTL, A/B, SSI, singleturn | x | ✓ |
| 9999 | User defined | ✓ | ✓ |
| 20000 | Encoder from OEM list | x | ✓ |
| ✓ = Encoder type is supported<br>x = Encoder type is not supported, setting not permitted | | | |

The encoder evaluation determines the current actual speed value and the actual position value for both encoders. (See function diagrams 4704, 4710 and 4711 in the SINAMICS DCM List Manual.)

Furthermore, for both encoders the encoder control word and the encoder status word according to PROFIdrive are available. (See function diagrams 4720, 4730 and 4735 in the SINAMICS DCM List Manual.)

PROFIdrive V4.1 is the PROFIBUS profile for drive technology with a wide range of applications in production and process automation systems.

**Note**

PROFIdrive 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

## 10.13.1 Actual speed values

The calculation of the actual speed value can be seen in the following function diagrams:

- FP4710 (for encoder 1)
- FP4711 (for encoder 2)

The actual speed values of the encoders are always available as freely interconnected BICO outputs.

- r0061[0]: Actual speed value for encoder 1
- r0061[1] = r3370: Actual speed value for encoder 2

If you want to use an actual speed value from the encoder as an actual-value input for the speed controller, you need to set the actual speed value selection p50083 to 1 (for encoder 1) or to 5 (for encoder 2). See FP6810.

The maximum speed (i.e. the 100% speed) is set via p2000 in both cases.

### Actual position values

| | |
|---|---|
| G1_XIST1 | Encoder 1 actual position value 1 |
| G1_XIST2 | Encoder 1 actual position value 2 |
| Gn_XIST2 | Fault code |
| G2_XIST1 | Encoder 2 actual position value 1 |
| G2_XIST2) | Encoder 2 actual position value 2 |

For description, refer to Chapter "Control and status words for encoders (Page 392)".

## 10.13.2 Control and status words for encoders

### 10.13.2.1 Control and status words for encoders

An encoder interface is defined in the PROFIBUS Profile for drive technology (PROFIdrive V4.1). This interface defines a control and status word for encoders.
They are available in the following parameters:

- r0480[0] = G1_STW encoder 1 control word
- r0480[1] = G2_STW encoder 2 control word
- r0481[0] = G1_ZSW encoder 1 status word
- r0481[1] = G2_ZSW encoder 2 status word

The bit assignments of the control and status words for the encoders can be seen in the following function diagrams:

- FP4720 (control word for encoders 1 and 2)
- FP4730 (status word for encoders 1 and 2)

For description, refer to Chapter "Control and status words for encoders (Page 392)".

# 10.14 Speed controller

The speed controller is a PI controller with the following additional properties:

**Start pulse**

When starting the speed controller (i.e. when the controller is enabled) the I component can start with a selectable value. This is necessary for suspended/hanging loads in order to prevent the load from briefly sagging.

**Adaptation**

P gain and integral action time can be changed as a function of any signal (e.g. from the actual speed value).

**Droop**

Droop (which can be switched in) can be implemented by feeding back the I component to the input. As a consequence, the controller does not precisely control to the setpoint, but permits a continuous setpoint-actual value deviation.
This is required, for example, if two drives are mechanically coupled with one another (e.g. for a production machine where drives are coupled through the material web being processed). In this case, the droop prevents that the two drives start to operate against one another, although both operate with closed-loop speed control. In the case that a mechanical connection is interrupted (e.g. if the material web breaks), then the speed of the drive operating with droop only slightly changes.

**Lead/lag element element**

The lead/lag element is used to improve the stability of the speed control. If required, it can be inserted in the actual speed value channel.

Remark: The functions shown in function diagram 6810 have the following execution sequence:

- Generation of the speed setpoint (r52174)
- Selection of the actual speed value (r52167)
- PT1 element (r52179)
- Bandstop filter 1 (r52177)
- Bandstop filter 2 (r52178)
- DT1 element (r52169)
- Lead/lag element (r52156)
- Generation of the setpoint/actual-value difference (r52165)

**Reference model**

The reference model represents the P-controlled speed control loop and creates an appropriately processed speed setpoint for the I-component. This means that the I-component largely plays no role for setpoint changes, with the consequent improved, overshoot-free response.

The reference model contains a PT2 element and a dead time element to emulate the controlled system. See function charts 6810 and 6815.
Further, it is possible to feed in an external reference model (e.g. generated using DDC function diagrams).

The reference model is set using the following parameters:

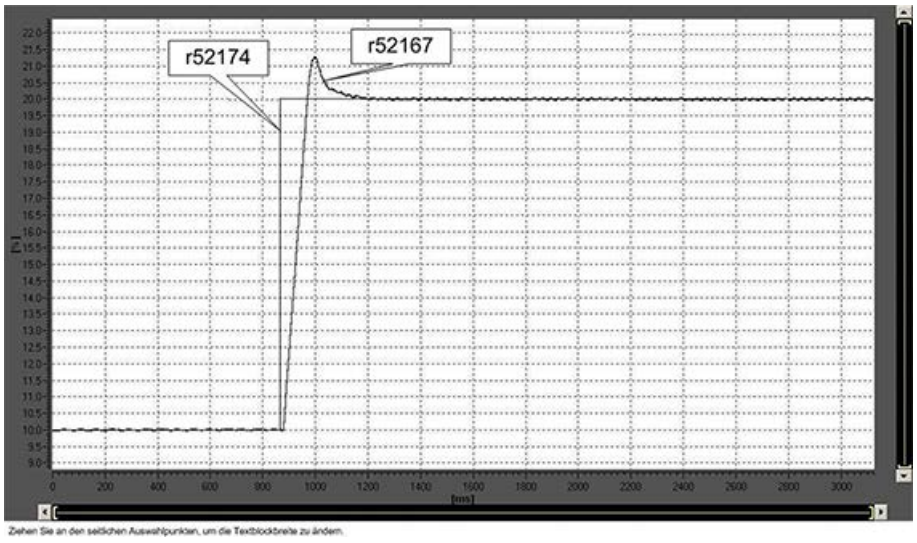
p50237 natural frequency
p50238 damping
p50239 deadtime
p50240 activation

The reference model is correctly set when the characteristics of the reference model output (r52154) and the actual speed value (r52167) are virtually identical when the I-component of the speed controller (p50224 = 0) is disabled.

### Example

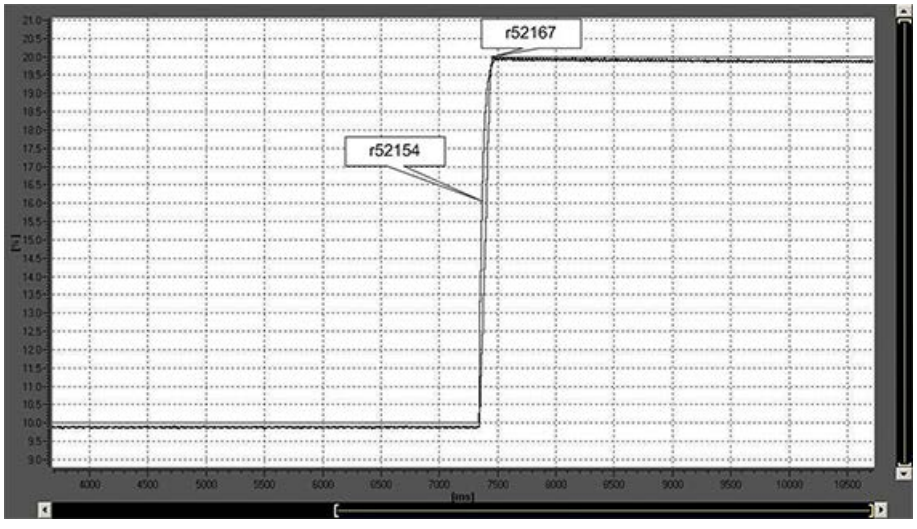
The following diagram shows the step response of the speed controller after carrying out the optimization run, if the reference model is not activated.

r52174 Speed setpoint
r52167 Actual speed value



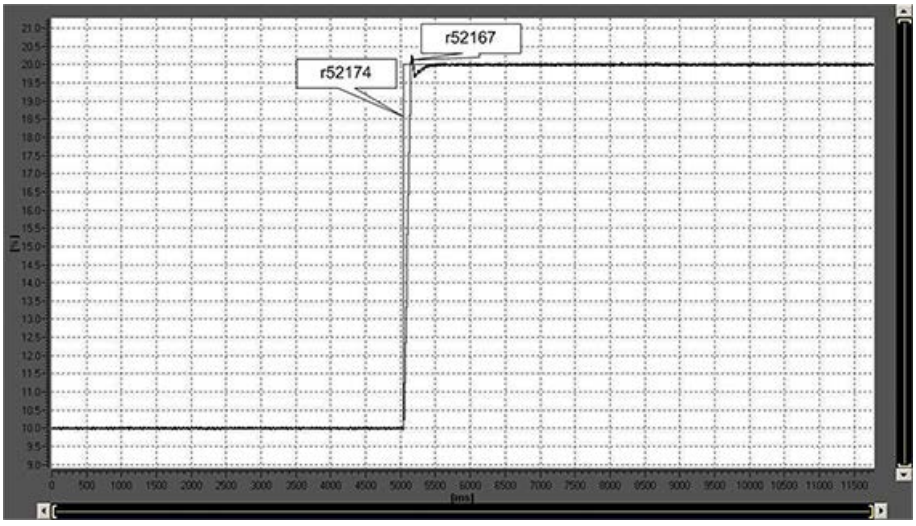

The following diagram shows the setting of the reference model.

r52154 Reference model output
r52167 Actual speed value



The following diagram shows the step response of the speed controller if the same controller parameters are set as shown previously, however, with the reference model activated.

r52174 Speed setpoint
r52167 Actual speed value




**Note**

See Chapter "Commissioning", Section "Manual optimization" for the procedure to manually optimize the speed controller.

**Use of the speed controller for other applications**

If the SINAMICS DCM is not used for the speed control of a motor, but rather for the voltage control of a capacitor load, it may be advantageous to support the speed controller working as a voltage controller with a load connection. The "Load connection" function block is available for this purpose. This function block is shown in function diagram 6851. It provides an additional current setpoint that is preferably fed in at p50601[3] (see function diagram 6840).

# 10.15 Adaptation of the armature and field current controller

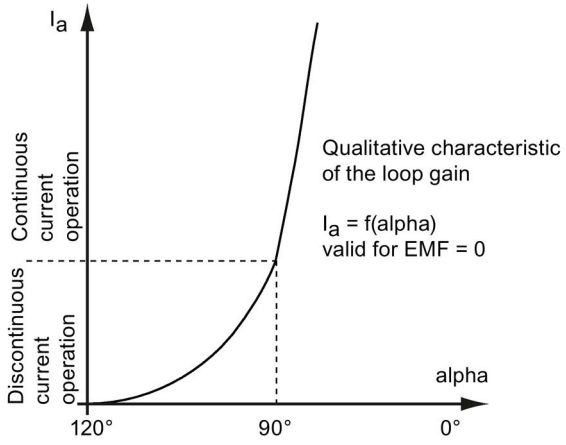
The current controller (armature current controller and field current controller) of the SINAMICS DCM operate with a controlled system that is very non-linear.

### Types of non-linearity

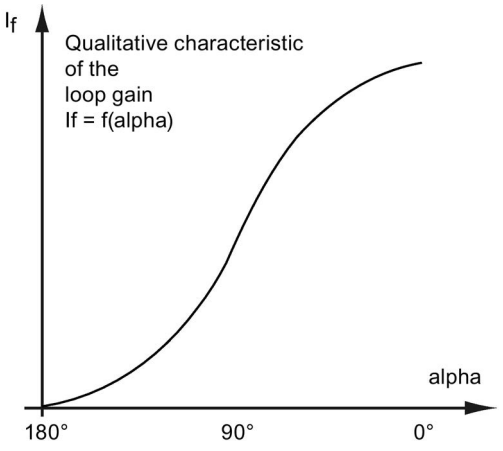
There are 2 types of non-linearity:

### 1. Non-linearity of the gating unit

In the armature circuit, there is a significant difference in the controlled system gain (= line-commutated thyristor converter in the B6 bridge connection) between discontinuous and continuous current.

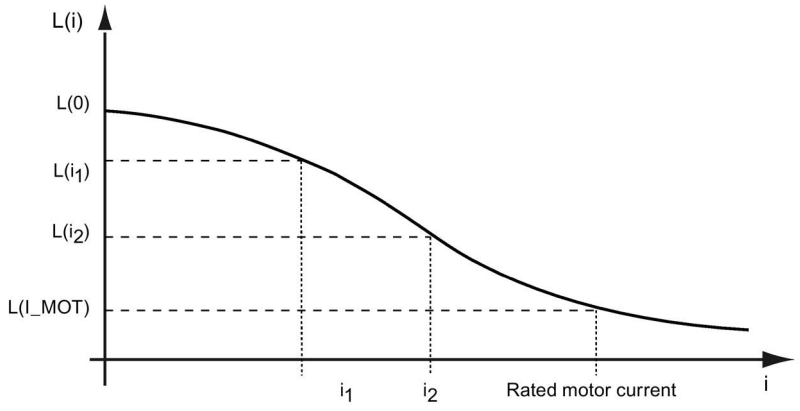



In the field circuit, the system is essentially always in the discontinuous current range, but the control characteristic of the B2Z or B2 bridge manifests a significant degree of non-linearity.



**2. Non-linearity of the load inductance** (= armature circuit or field circuit of the motor):

At higher currents, both the armature winding as well as the field winding – or also when there is a smoothing reactor available in the armature circuit, can go into the magnetic saturation range; as a consequence, they can have a significantly lower inductance than at low currents.
The inductance as a function of the current is modelled according to the following diagram:




Inductance at a very low current:
L(0) = p50111 (La) or p50116 (Lf)
Inductance at the rated motor current:
L(I_Mot) = p50111×p51591 (La×$\lambda_a$) or p50116×p51597 (Lf×$\lambda_f$)

**Effect of the adaptation**

The SINAMICS DCM converter provides the option of adapting the gain of the armature current controller or the field current controller to the existing non-linearities:

**Compensating gating unit non-linearities:**
The controller gain is normally set so that in the range of the largest controlled system gain (i.e. where the armature is in the discontinuous current range or for the field, with a firing angle of 90°) the required control behavior is obtained. For other currents, the current controller becomes appropriately slower. When the current controller adaptation is activated, the current controller gain is increased inversely proportional to the controlled system gain. As a consequence, the controller behavior is approximately the same at any current.

**Compensating non-linear inductances**
The controller gain is normally set so that at a high current, the required control behavior is obtained. At low currents, the current controller becomes appropriately slower. When the current controller adaptation is activated, the current controller gain is increased proportionally to the inductance. As a consequence, the controller behavior is approximately the same at any current.

### Activating the controller adaptation

The current controller adaptation is not activated in the factory setting.
Reason:
When the adaptation is set, this means that the control behavior must be precisely checked at various currents. In many applications, the improved control behavior that can be thus achieved isn't necessary anyway. This is why in these cases it doesn't make any sense to "invest" this time when commissioning the system.

### Setting the armature current controller adaptation

With the armature current controller, it is possible to calculate the adaptation using p50570 from the actual value or from the setpoint of the armature current. The adaptation to non-linear inductances can be activated using p50571, the discontinuous-continuous current adaptation can be activated using p50572. The adaptation factor can be limited using p50573. In order to be able to incorporate the adaptation at the armature current controller, connector output r52350 must be interconnected to connector input p50175 (Kp adaptation). With this intervention, the armature current controller gain is increased or decreased depending on the armature current actual value and/or setpoint (this is selected using p50570). The calculations of the adaptations are now created to change the gain.

### Setting the field current controller adaptation

For the field current controller, it is possible to calculate the adaptation from the actual value or from the setpoint of the field current using p50575. The adaptation to non-linear inductances can be activated using p50576; the adaptation to the non-linearity of the gating unit, can be activated using p50577. The adaptation factor can be limited using p50578. In order to be able to incorporate the adaptation at the field current controller, connector output r52355 must be interconnected to connector input p50267 (Kp adaptation). With this intervention, the field current controller gain is increased or decreased depending on the field current actual value and/or setpoint (this is selected using p50570). The calculations of the adaptations are now created to change the gain.

The corresponding function diagrams show additional details regarding how to activate the gain adaptation and the various setting options:

| | |
|---|---|
| FP 6853 | Calculating the adaptation factor for the armature current controller gain |
| FP 6855 | Intervention to adapt the armature current controller gain<br>(p50175 = r52350 establishes the intervention) |
| FP 6908 | Calculating the adaptation factor for the armature current controller gain intervention to adapt the armature current controller gain<br>(p50267 = r52355 establishes the intervention) |

# 10.16 Technology controller

## Features

Simple control functions can be implemented with the technology controller, e.g.:

- Level control
- Temperature control
- Dancer position control
- Pressure control
- Flow control
- Simple closed-loop controls without higher-level controller
- Tension control

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched into the control deviation or actual value channel.

## Description

The technology controller is designed as a PID controller, whereby the differentiator can be switched to the control deviation channel or the actual value channel (factory setting). The P, I, and D components can be set separately. A value of 0 deactivates the corresponding component. Setpoints can be specified via two connector inputs. The setpoints can be scaled via parameters (p2255 and p2256). A ramp-function generator in the setpoint channel can be used to set the setpoint ramp-up/ramp-down time via parameters p2257 and p2258. The setpoint and actual value channel each have a smoothing element. The smoothing time can be set via parameters p2261 and p2265.

Pre-control can be integrated via a connector input.

The output can be scaled via parameter p2295 and the control direction reversed. It can be limited via parameters p2291 and p2292 and interconnected as required via a connector output (r2294).

The actual value can be fed in, for example, via an analog input.

If a PID controller has to be used for control reasons, the D component is switched to the setpoint/actual value difference (p2263 = 1) unlike in the factory setting. This is always necessary when the D component is to be effective, even if the reference variable changes. The D component can only be activated when p2274 > 0.

## Commissioning with STARTER

The "technology controller" function module can be activated via the commissioning wizard or the drive configuration (configure DDS).

You can check the actual configuration in parameter r0108.16.

## Application example: Level control

The objective here is to maintain a constant level in the container.

This is carried out by means of a variable-speed pump in conjunction with a sensor for measuring the level.

The level is determined via an analog input and sent to the technology controller. The level setpoint is defined in a fixed setpoint. The resulting controlled variable is used as the setpoint for the speed controller.

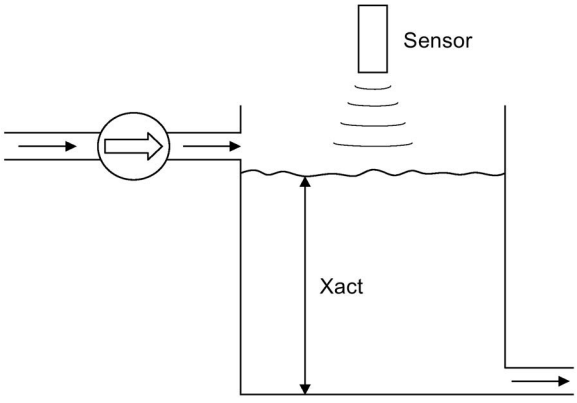



Figure 10-61 Level control: Application

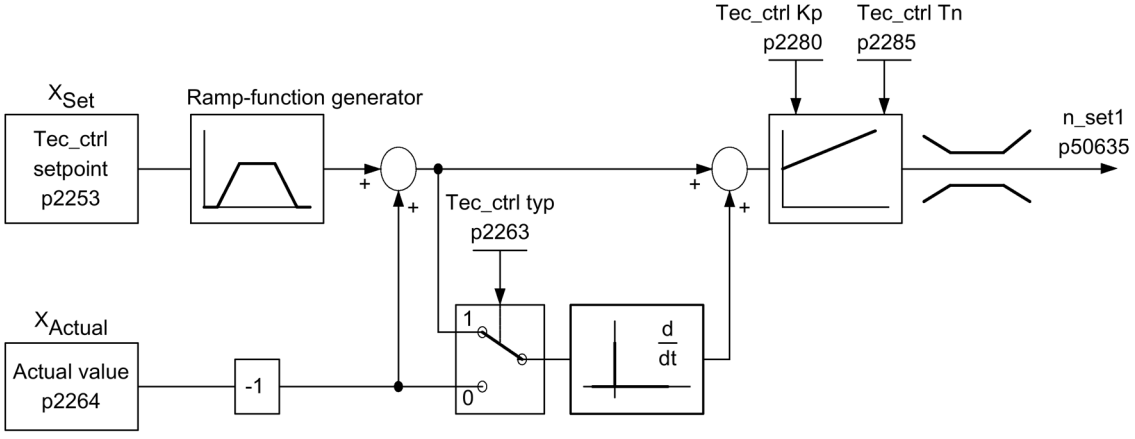



Figure 10-62 Level control: Controller structure

Table 10- 68 Important parameters for the level control

| Parameter | Designation | Example |
|---|---|---|
| p50625 | n_set after the ramp-function generator | p50625= r2294 Tec_ctrl outp_sig |
| p2200 | BI: Technology controller enable | p2200 = 1 Technology controller enabled |
| p2253 | CI: Technology controller setpoint 1 | p2253 = r52401 fixed value |
| p2263 | Technology controller type | p2263 = 1 D component in fault signal |
| p2264 | CI: Technology controller actual value ($X_{ACTUAL}$) | p2264 = r52015 analog input AI1 of the CUD |
| p2280 | Technology controller p-gain | p2280 Determine by optimization |
| p2285 | Technology controller integral action time | p2285 Determine by optimization |

## Function diagrams (see the SINAMICS DCM List Manual)

- 7958 Closed-loop control (r0108.16 = 1)

## Overview of important parameters (see the SINAMICS DCM List Manual)

- p2200 BI: Technology controller enable
- p2253[0...n] CI: Technology controller setpoint 1
- p2254[0...n] CI: Technology controller setpoint 2
- p2255 Technology controller setpoint 1 scaling
- p2256 Technology controller setpoint 2 scaling
- p2257 Technology controller ramp-up time
- p2258 Technology controller ramp-down time
- p2261 Technology controller setpoint filter time constant
- p2263 Technology controller type
- p2264[0...n] CI: Technology controller actual value
- p2265 Technology controller actual value filter time constant
- p2280 Technology controller proportional gain
- p2285 Technology controller integral action time
- p2289[0...n] CI: Technology controller pre-control signal
- p2295 Technology controller output scaling

## 10.17 Switch-on command for holding or operational brake

See also the SINAMICS DCM List Manual, function diagram 2750.

The signal for controlling the brake is available at binector r53210[0]:

r53210[0] = 1 ⇒ close brake
r53210[0] = 0 ⇒ open brake

This binector must be wired to a digital output in order to activate a brake; see function diagrams 2055, 2060, and 2065 in the SINAMICS DCM List Manual.

The following parameters affect the function of the brake-control signal:

| | |
|---|---|
| p50080 = 0 | No brake |
| p50080 = 1 | The brake is a holding brake:<br>The "Close brake" command is only applied when n < nmin (p50370, p50371). |
| p50080 = 2 | The brake is an operational brake:<br>The "Close brake" command is applied even if the motor is running. |
| p50087 | Brake-release time:<br>A positive value prevents the motor from working against a brake that is currently being released.<br>A negative value causes the motor to work against a brake that is still closed in order to prevent a short-term torque-free state. |
| p50088 | Brake-closing time:<br>Causes the motor to keep applying torque while the brake is closing |
| p50319 | Delay time for ramp-function generator enable:<br>Following a controller enable, the setpoint 0 is applied during the time set here. This time should be set so that the brake has actually been released once it has elapsed. This is mainly necessary when p50087 is set to a negative value. |

The figures below illustrate the brake-control timing interval when a level change occurs at the "Switch on/Shutdown" (terminal X177.12) and "Operation enable" (terminal X177.13) inputs.

Where brake control is concerned, the "Jog", "Creep", or "Quick stop" input commands act in the same way as "Switch on/Switch off", and the "Disconnection" or "E-STOP" input commands act in the same way as when the "Operation enable" command is withdrawn.

The "Close brake" command is output during the optimization run for precontrol and current controller (p50051 = 23, 24 and 25).

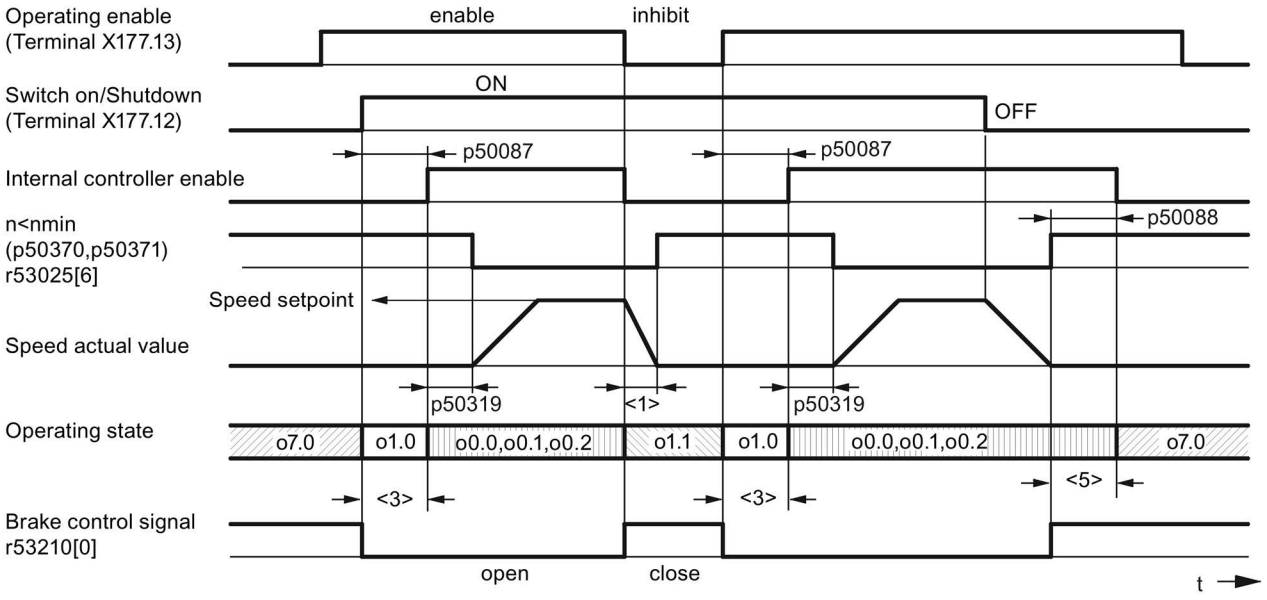
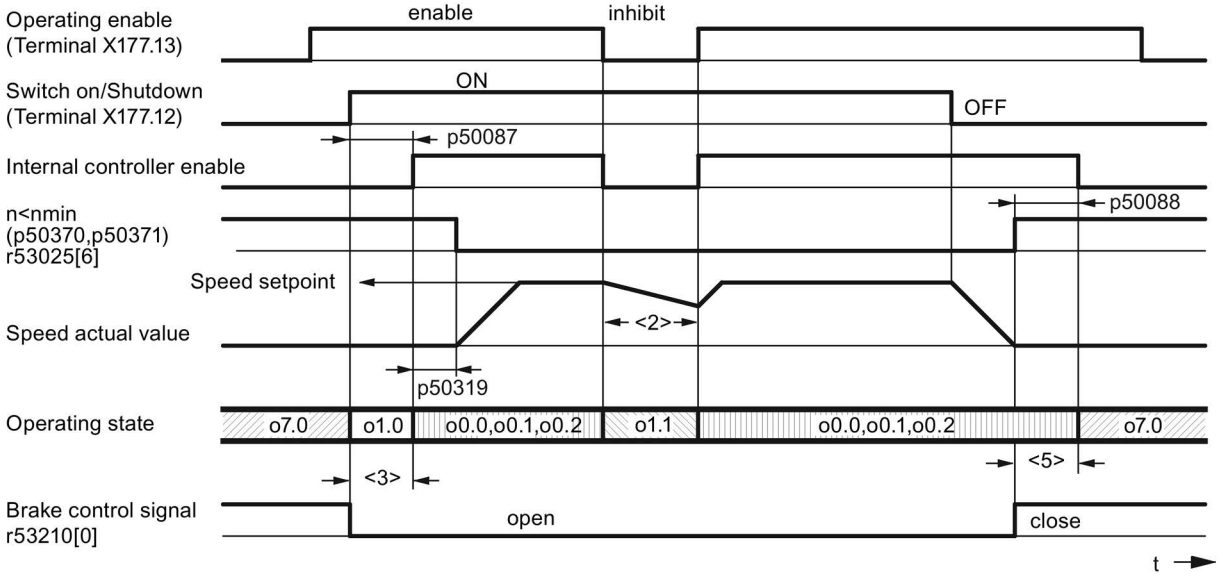



Figure 10-63 Operational brake (p50080 = 2), brake opening time (p50087) positive




Footnotes for the two figures above

<1> Mechanical deceleration of drive by means of operational brake

<2> Drive coasting down; "Close holding brake" first applied when n < nmin

<3> Time for brake to be released before motor applies torque (p50087 positive)

<5> Time for brake to be closed, during which motor continues to apply torque (p50088)

Figure 10-64 Holding brake (p50080 = 1), brake opening time (p50087) positive

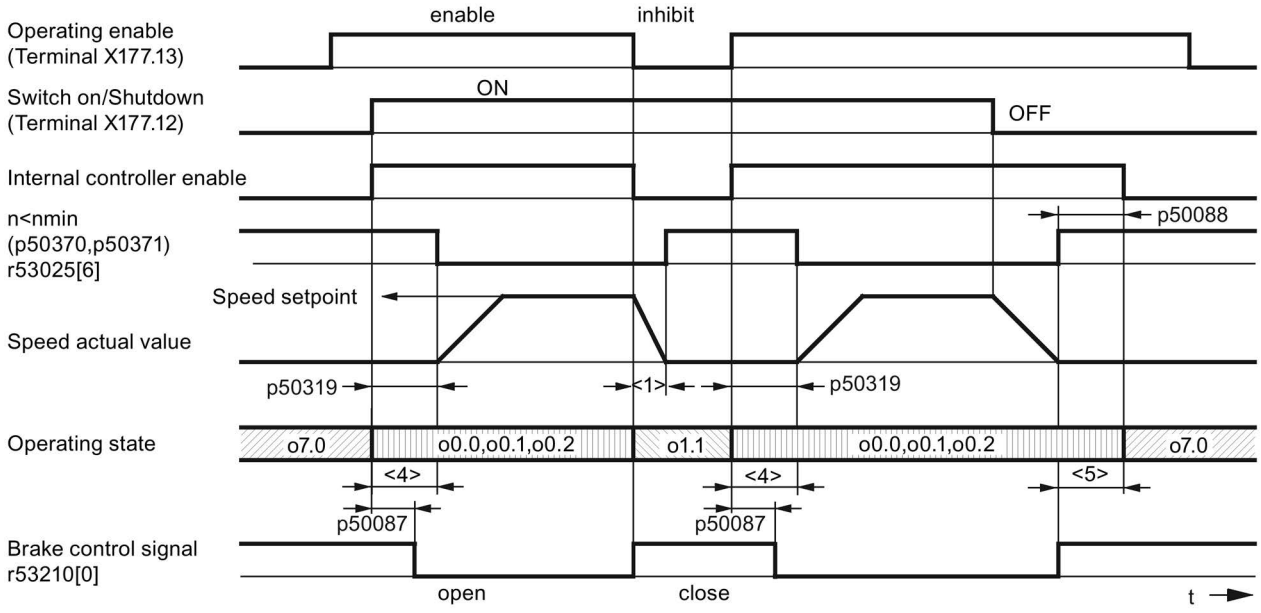
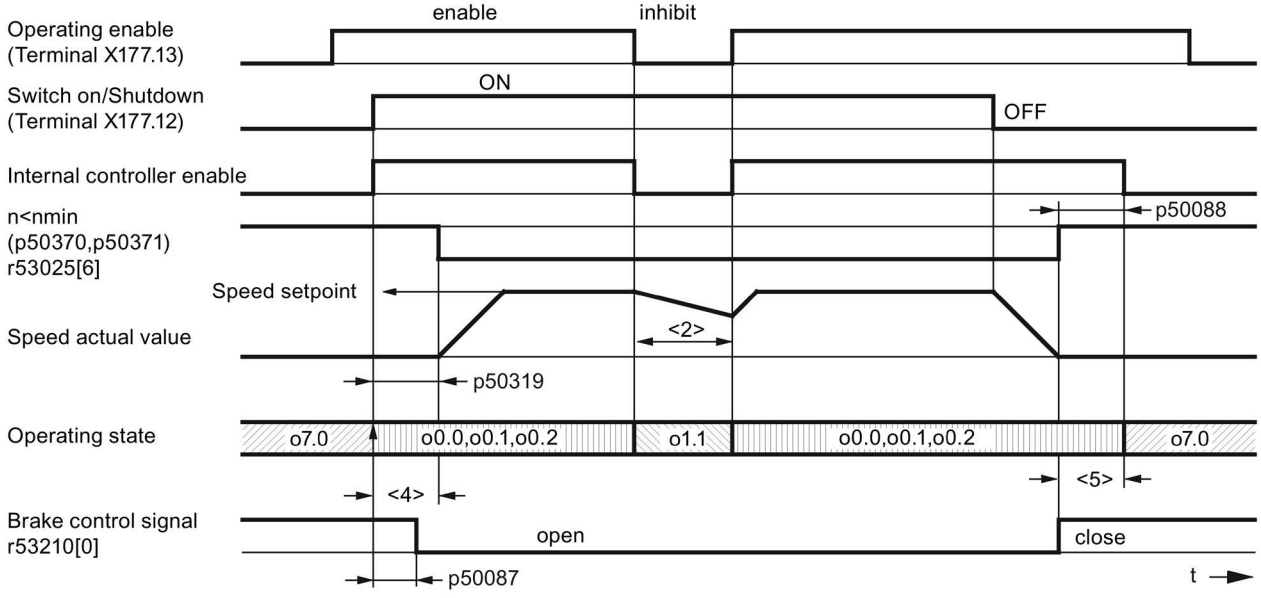



Figure 10-65 Operational brake (p50080 = 2), brake opening time (p50087) negative




Footnotes for the two figures above

<1> Mechanical deceleration of drive by means of operational brake

<2> Drive coasting down; "Close holding brake" first applied when n < nmin

<4> Here, motor works against the brake, which is still closed (p50087 negative)

<5> Time for brake to be closed, during which motor continues to apply torque (p50088)

Figure 10-66 Holding brake (p50080 = 1), brake opening time (p50087) negative

## 10.18 Switching on auxiliary circuits

This function serves as a switch on command for auxiliaries (e.g. motor fans).

The "Switch on auxiliary circuits" signal is available at binector r53210.2:

r53210[2] = 0 ⇒ auxiliaries OFF
r53210[2] = 1 ⇒ auxiliaries ON

This binector must be wired to a digital output in order to activate the auxiliary circuit; See SINAMICS DCM List Manual, function diagrams 2055, 2060 and 2065.

The "Switch on auxiliaries" goes to 1 at the same time as the "Switch on" command. Following this, the system remains in operating state o6.0 for a parameterizable time (p50093); only once this has elapsed is the line contactor closed.

When the "Switch off" command is applied, the firing pulses are disabled and the line contactor drops out after n < nmin. After a parameterizable time (p50094), the "Switch on auxiliaries" signal goes to 0 If, however, the "Switch on" command is issued again before this time elapses, operating state o6.0 is not retained; instead, the line contactor is immediately closed.

## 10.19 Operating hours counter, unit fan

A fan for the power unit can be controlled via r53135[0]. The isolated relay output terminal 120/121 is available to control the fan.

### Operating hours counter

Every unit fan has an operating hours counter. The counter states are displayed at parameter r50960[0..4].

| | |
|---|---|
| r50960[0..3] | Operating hours counter for the fans connected at the internal unit connectors XV1 to XV4 |
| r50960[4] | For SINAMICS DCM Control Modules, operating hours counter for the fan controlled via r53135[0]. |

The operating hours counter is incremented, if

- SINAMICS DCM switches-on the corresponding fan AND
- it actually rotates
  i.e. the speed is higher than 5% of the response threshold of the fan monitoring (this does not apply to r50960[4])

The operating hours counters for unit fans that are not available are not incremented.

### Monitoring the fan lifetime

The planned lifetime for each fan is set at p50961[0...4]; the factory setting is 30000 hours.

Alarm A60165 is output 500 hours before the planned lifetime is reached. It is recommended that the corresponding fan is replaced at the next opportunity when the system is not operational (scheduled downtime).

If the lifetime for a fan is set to zero (p50961[0...4] = 0.0 hours), then the fan lifetime monitoring for this fan is disabled.

The corresponding operating hours counter is reset to 0 by setting parameter p50962[0..4] to 1. This should be done each time that a fan is replaced!

See also the SINAMICS DCM List Manual, function diagram 8045.

## 10.20 Thermal overload protection for the DC motor ($I^2t$ monitoring of the motor)

$I^2t$ monitoring protects the motor against impermissible loads.

**NOTICE**

**No full motor protection**

$I^2t$ monitoring only provides an approximate representation of the motor's thermal image.

In the factory setting, when switching off the drive, the calculated temperature is saved in a non-volatile fashion; when the drive is switched on again, the saved value is taken into account when continuing to calculate the temperature.
This response can be adapted using p50140.

When p50114 = 0, $I^2t$ monitoring is disabled.

**Note**

- Please observe the manufacturer's specifications if you are using other motor types.
- If you are using DC motors 1G.5/1H.5 as per Catalog DA12, p50113 must be set to 1.00.

## Adaptation

Table 10- 69 Parameter settings for $I^2t$ monitoring

| Parameter | | Data |
|---|---|---|
| p50114 | Thermal time constant | Time constant [s] with which $I^2t$ monitoring is to operate |
| p50100 | Rated armature current | Determination of permissible continuous current for motor:<br>Permissible continuous current = p50100 × p50113 |
| p50113 | Continuous-current factor | |
| p50140 | Motor $I^2t$ monitoring, response when starting | Sets the response when starting for the motor $I^2t$ monitoring:<br>2: Start $I^2t$ at zero<br>12: Start $I^2t$ with the saved value (factory setting) |

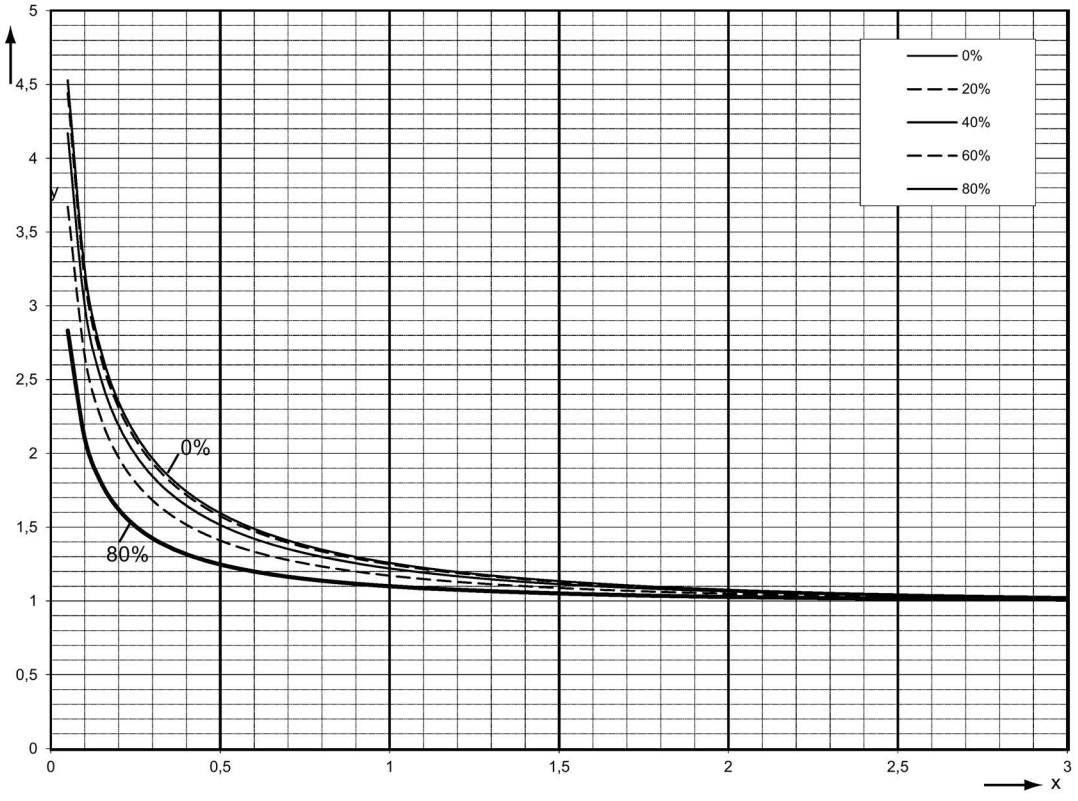
## Advance-alarm characteristic/Shutdown characteristic

If, for example, the motor load is continuously at approximately 125% of the permissible continuous current for the motor, alarm A60037 responds after a time constant (p50114) has elapsed. If there is no reduction in the load, the drive is shut down when the shutdown characteristic is reached, and error message F60137 is displayed.
Advance-alarm/shutdown times for other loads may be taken from the diagram below.

### Alarm and fault initiation from the motor I²t monitoring

The diagrams below show the time after which an alarm or fault is triggered when a new, constant load is suddenly switched in following an extended period of preloading (> 5×T_th).

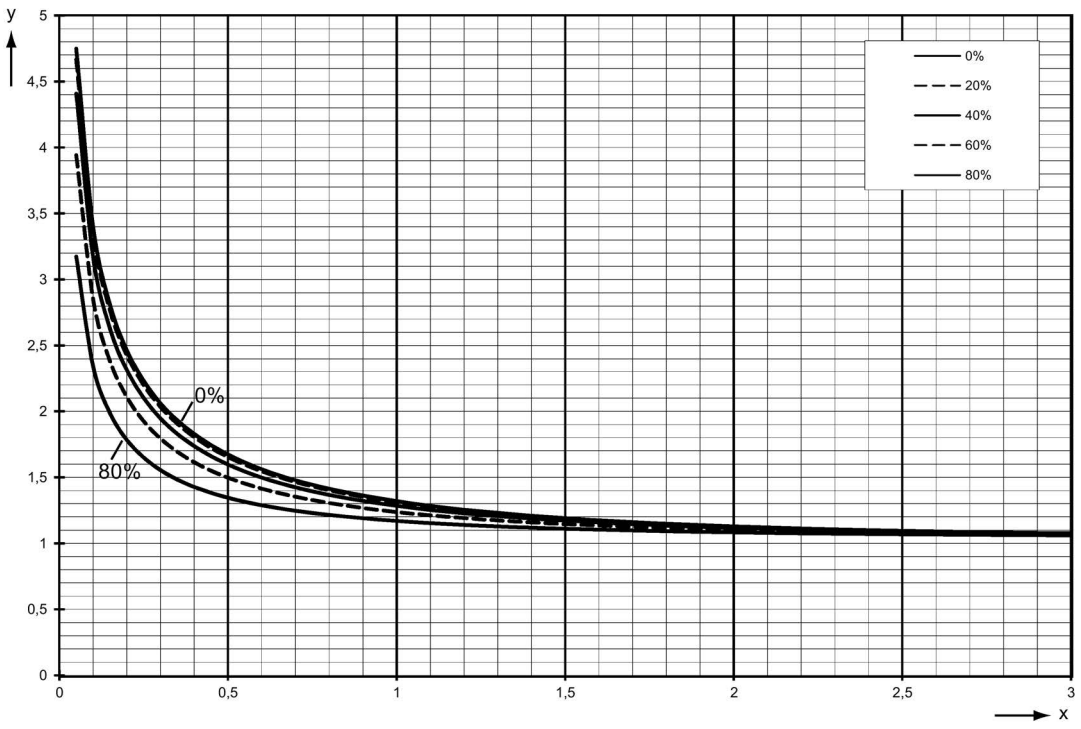
T_th = p50114 (motor thermal time constant)




y ... Load current/permissible continuous current (p50100 × p50113)

x ... time/thermal time constant of motor

Figure 10-67 I²t monitoring of the motor: Alarm triggering




y ... Load current/permissible continuous current (p50100 × p50113)

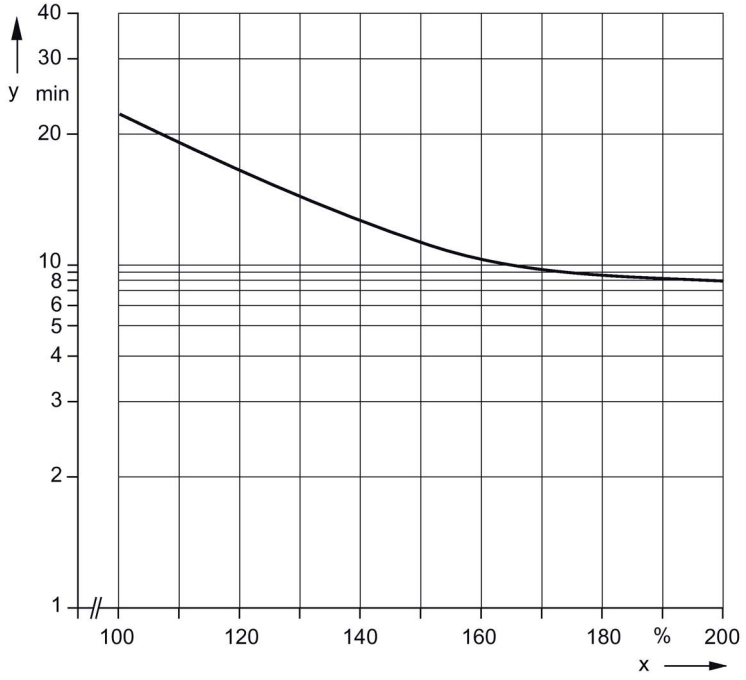
x ... time/thermal time constant of motor

Figure 10-68 $I^2t$ monitoring of the motor: Fault triggering

## Determining the thermal equivalent time constant (p50114)

It should be noted that the thermal equivalent time constant depends on the maximum overcurrent.

Thermal equivalent time constant of DC motors 1G . 5/1H . 5 according to Catalog DA12 T (configuring notes for Catalog DA 12):




y ... $T_{therm}$, thermal equivalent time constant [min] (p50114)

x ... $I/I_N$ [%]
I = Maximum overcurrent at which the motor is operated
$I_N$ = Rated armature current for the motor (p50100)

Figure 10-69 Thermal equivalent time constant

## 10.21 Measuring the motor temperature

SINAMICS DCM provides the possibility of evaluating a temperature sensor integrated in the motor (see the SINAMICS DCM Parameter Manual, function diagram 8030).

**⚠WARNING**

**Electric shock in the event of voltage flashovers at the temperature sensor**

Voltage flashovers in the signal electronics can occur in motors without safe electrical separation of the temperature sensors.

- Use temperature sensors that comply with the specifications relating to safe electrical separation.

The following measuring sensors can be evaluated.

- **KTY84**
  approx. 350 Ω up to approx. 2600 Ω at -40 °C to +300 °C
  positive temperature coefficient, almost a linear characteristic

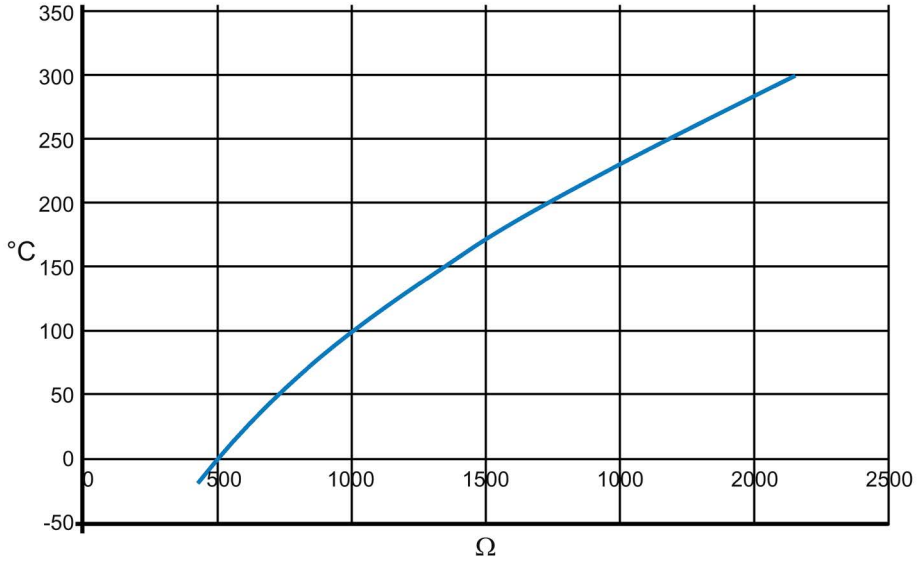



Figure 10-70 Characteristic KTY84

- **PTC thermistor** acc. to DIN 44081 / 44082
  600 Ω, 1200 Ω, 1330 Ω or 2660 Ω response temperature
  positive temperature coefficient, the resistance changes suddenly at the response temperature
  Note:
  It is not possible to determine the actual temperature, it is only possible to identify as to whether the response temperature has been exceeded or not.
- **PT100**
  approx. 80 Ω up to approx. 280 Ω at -40 °C to +500 °C
  positive temperature coefficient, almost a linear characteristic

- **PT1000**
  approx. 840 Ω up to approx. 2980 Ω at -40 °C to +550 °C
  positive temperature coefficient, almost a linear characteristic
- **NTC thermistor** K227/S1/1.8 kΩ/KER
  approx. 200 Ω at 190 °C to 1.8 kΩ at 100 °C

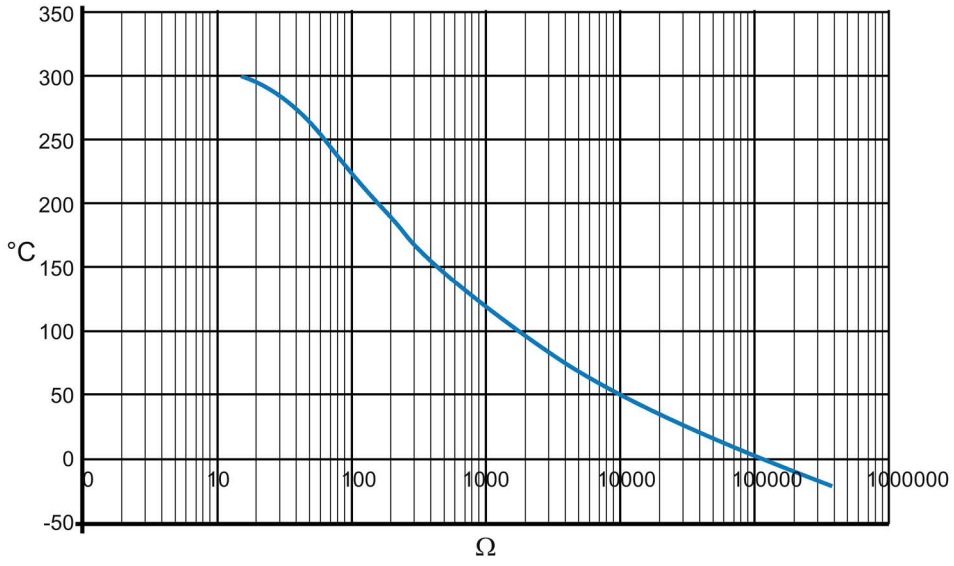



Figure 10-71 Characteristic K227

## 10.22 Speed-dependent current limitation

Speed-dependent current limitation protects the DC motor's commutator and brushes at high speeds.

The settings required for this (p50104 to p50107) must be taken from the motor rating plate.

Additionally, the maximum operating speed of the motor (p50108) must be entered; this must match the actual maximum operating speed.

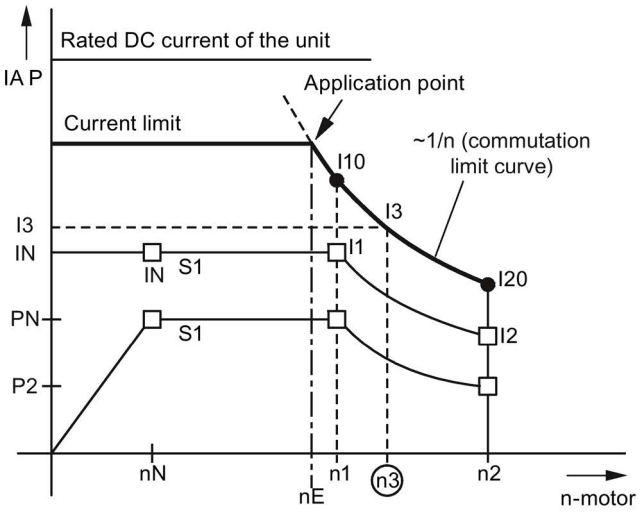
The actual maximum operating speed is determined as follows:

- Using p2000 in cases where the actual speed value comes from an incremental encoder
- Using p50741 in cases where the actual speed value comes from an analog tachometer
- Using p50115 in the case of operation without a tachometer

Aside from this, speed-dependent current limitation must be activated by setting p50109 to 1.

| NOTICE |
| --- |
| **Excessive stress on the commutator and brushes due to incorrect setting** |
| Making an incorrect setting for speed-dependent current limitation can lead to excessive stress on the commutator and brushes, which in turn results in a significantly reduced service life for the brushes. |

**Setting speed-dependent current limitation for motors with a bend in the commutation characteristic**




□ = Motor rating plate
● = Permissible limit values
nE = Start of the speed-dependent current limiting
(n3) = Maximum operating speed
I10 = 1.4 × I1
I20 = 1.2 × I2

The current limitation curve is determined using n1, I10, n2, and I20.

Parameter:

p50104 = n1
p50105 = I1 (unit calculates I10 from this)
p50106 = n2
p50107 = I2 (unit calculates I20 from this)
p50108 = n3 (defines the speed scaling)
p50109 = 0 ... speed-dependent current limitation switched off
= 1 ... speed-dependent current limitation switched on

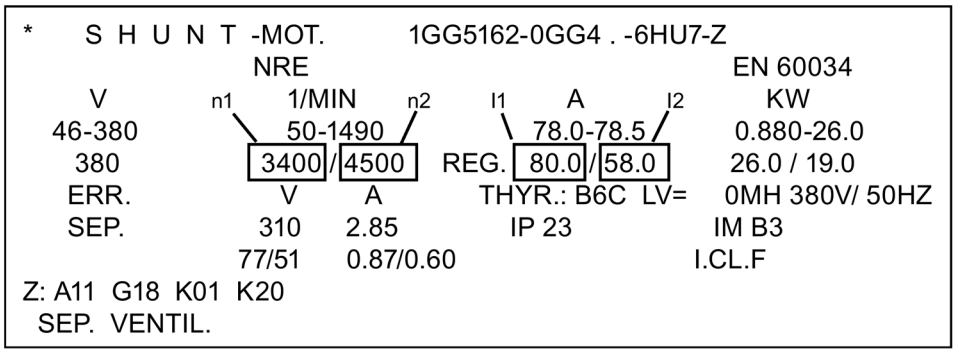
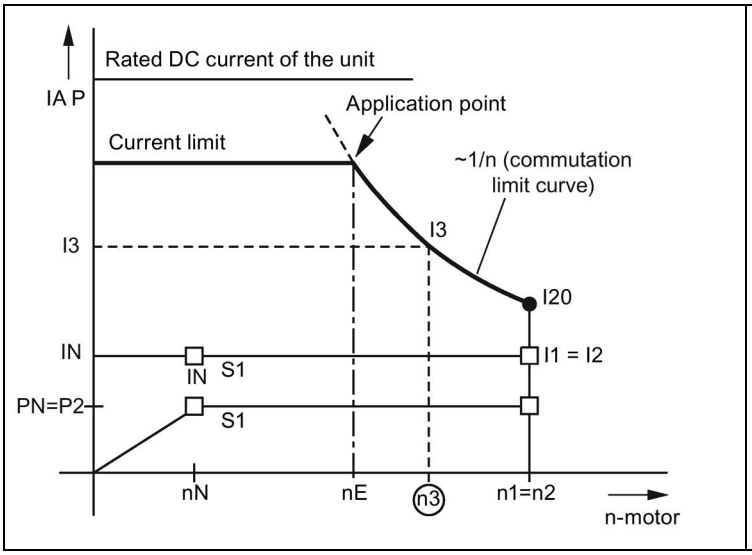



Figure 10-72 Example of a motor rating plate

**Setting speed-dependent current limitation for motors without a bend in the commutation characteristic**




□ = Motor rating plate
● = Permissible limit values
nE = Start of the speed-dependent current limiting
(n3) = Maximum operating speed
I20 = 1.2 × I2

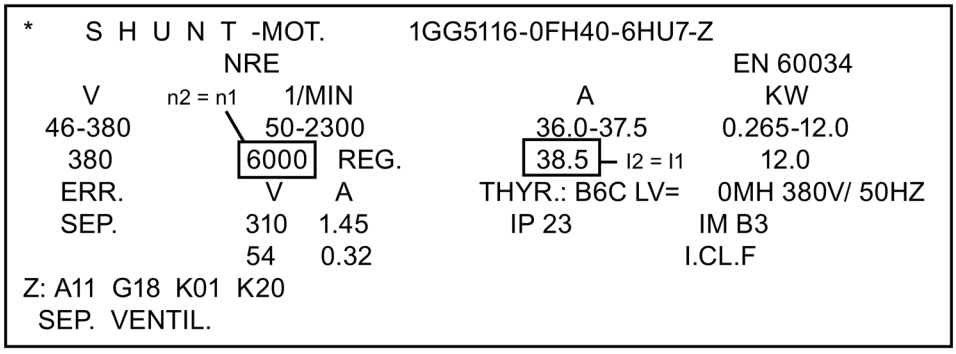



Figure 10-73 Example of a motor rating plate

# 10.23 Thyristor blocking voltage calculation

The SINAMICS DCM converter offers the possibility of continually determining the voltage available at each individual thyristor of the armature converter. The voltage is used to identify which armature thyristors are presently conducting and which are presently blocked.

This information is available via BICOs (see function diagram 6950).

This information is used for the following functions as input variable:

- Inverter commutation fault detection and initiation of the CCP
  The thyristor that is relinquishing the current must assume the blocking voltage, otherwise, commutation was unsuccessful.
- Torque direction changeover (sequential logic module)
  Before a thyristor of the new torque direction is triggered, all thyristors associated with the old torque direction must be blocked. The condition is evaluated in addition to the Ia=0 message.

The voltage at the armature thyristors is determined from the following measured values:

- Two phase-to-phase line supply voltages (UV, VW)
- Voltage at a thyristor (for 4Q: Anti-parallel thyristor pair) (X13/X26)
- DC voltage (Va)

## Selecting the thyristor blocking voltage calculation using p50166

This parameter is only evaluated once during power up, i.e. a change only takes effect after a restart or power up with saved parameters (p0976 = 11).

The thyristor blocking voltage calculation is only really required in just a few applications and requires approx. 5% processor utilization; this is the reason that it is deactivated in the factory setting.

p50166 = 0 Thyristor blocking voltage monitoring not active (factory setting)
= 1 Thyristor blocking voltage monitoring active

Activation is recommended if a motor is not connected to the armature converter, but rather a very large inductance.

**Note**

The thyristor blocking voltage calculation function is available as product version 5 of the "Voltage measurement" module. You can find this information on the bar code label of the module.

**Note**

The thyristor blocking voltage calculation only functions for the armature voltage measurement via the "Voltage measurement" module.
If the thyristor blocking voltage calculation is activated with p50166 = 1 when the hardware version of the power interface is not suitable, fault message F60058 with fault value r0949[0] = 6 appears after the next power-up with the saved parameters.

## 10.24 Automatic restart

"Automatic restart" means:
When brief interruptions in the network (such as voltage dips) occur, the SINAMICS DC MASTER does not enter the "FAULT" operating state immediately, but instead blocks the armature firing pulses before automatically re-enabling them once the network returns to normal.

"Brief" refers to a time that is: shorter than the time set at p50086 (= hot restart time)

During the brief pulse inhibit period that is initiated when faults occur in the network, the SINAMICS DC MASTER waits in operating state o4.0 (for power system faults in the armature circuit) or o5.1 (for power system faults in the field circuit).

If the network does not return to normal during the hot restart time, the relevant fault is triggered as soon as it elapses.

The following faults relate to the "Automatic restart" function:

| | |
|---|---|
| F60004 | Armature circuit phase failure (1U1, 1V1, 1W1) |
| F60005 | Field circuit phase failure (3U1, 3W1) |
| F60006 | Undervoltage (armature current or field current) |
| F60007 | Overvoltage (armature current or field current) |
| F60008 | Line frequency too low (armature current or field current) |
| F60009 | Line frequency too high (armature current or field current) |

**Note**

There is no automatic restart when the electronics power supply fails.

## 10.25 Operation on a single-phase line supply

SINAMICS DCM converters can also be operated on single-phase line supplies.

Fields of application for this operating mode include:

- Replacement of older single-phase converters employing analog technology
- Plants and systems where there is no 3-phase line supply
- Presenting and demonstrating SINAMICS DCM in seminar hotels and demonstration rooms where generally there is no three-phase line supply

**Note**

For single-phase operation, dynamic overload of the devices is not possible. The $I^2t$ monitoring must be deactivated (p50075=0). If the $I^2t$ monitoring is activated, for single-phase operation, fault 60058 is output with fault value 4.

## Connection

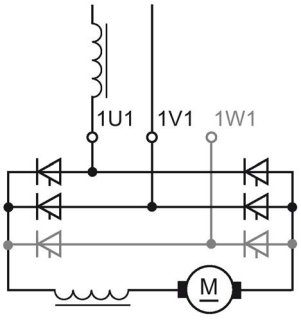



Figure 10-74 Connection to a single-phase line supply

The converter is connected to the line supply (one phase and the neutral conductor, e.g. 230 V or two phase conductors of a three-phase line supply, e.g. 400 V) via terminals 1U1 and 1V1. Connection 1W1 remains free.

It is mandatory that a single-phase line reactor or a transformer with 4% $u_k$ is provided, which only supplies the DC converter involved.

Commutating reactor and transformer should be selected according to the rated motor current of the armature circuit.

In this B2 circuit, the line current is equal to the DC current in the armature circuit. All of the other line-side drive components should be dimensioned according to this. Further, due to the higher current ripple when compared to six-pulse operation, a smoothing reactor must be provided in the DC circuit. Please contact the motor manufacturer when dimensioning the smoothing reactor.

## Parameterization

Selecting operation on a single-phase line supply with **p51799 = 1**

The high current ripple in this mode causes ripple in the actual speed. For smooth speed control, it is recommended to set the actual speed smoothing to approx. 10 ms (p50200 = 10 ms)

## Derating

When selecting operation on a single-phase line supply, the rated DC current (r50072[1]) is automatically reduced to 67% of the value for 3-phase operation. The reason for this is the uneven distribution of the current in the thyristors in the power unit of the drive converter.

As a consequence, the rated output voltage is also reduced. See also Chapter "Technical data (Page 37)".

# 10.26 Connecting units in parallel and in series

## Topology overview

Several SINAMICS DCM converters can be arranged in various topologies. The following topologies are supported:

- **6-pulse parallel connection**
  This topology is used in order to realize converter power ratings that are above the highest available SINAMICS DCM rating.
- **12-pulse parallel connection**
  This topology is especially used at higher power ratings to achieve lower line harmonics. In addition, by using this circuit, a lower DC current ripple is obtained when compared to a 6-pulse connection. One or several 6-pulse converters can be connected in parallel to each of the two 12-pulse converters connected in parallel.
- **6-pulse series connection**
  This topology is used to achieve a higher no-load DC voltage.
  The following versions are available:
  - Both converters are operated with the same firing angle.
  - Sequence control (one of the two converters is always at a control limit, the other converter controls the armature current)
  - Series connection of a controlled converter with an uncontrolled converter (thyristor bridge B6 + diode rectifier)

  One or several converters can be connected in parallel to each of the converters connected in series to increase the power rating.
- **12-pulse series connection**
  The topology corresponds to a 6-pulse series connection. In addition, a lower DC current ripple is obtained when compared to a 6-pulse connection. One or several converters can be connected in parallel to each of the converters connected in series to increase the power rating.

**Note**

- All of the topologies listed here are only permissible in the restricted line frequency range from 20 Hz to 65 Hz.
- For all of the topologies listed here, only power units with the same rated DC current, the same commutating reactors, and the same wiring/busbars may be used!
- For all of the topologies listed here, only units with the same firmware version may be used.

**Note**

More information about design is given in the associated application notes (see link "Preface (Page 3)").

## Communication

**Note**

Before activating the parallel interface (i.e. before setting p51800 > 0), a unique station address must be set at p51806 on all SINAMICS DCMs. Otherwise, the parallel interface will not work property.

Remedy in this case: Switch the electronics power supply off and then on.

- In the particular topology, communication between all converters is established via the parallel interface. The CUDs of all converters should be connected with one another.
- The parallel interface allows a maximum of 16 nodes to communicate.
- The devices are connected using 8-core shielded patch cables, type UTP CAT5 according to ANSI/EIA/TIA 568, such as those that are used to network PCs. A standard 5 m long cable can be directly purchased from Siemens (article number: 6RY1707-0AA08). (n-1) cables are required to connect n devices. The bus termination must be activated at the units connected at the start of the bus and at the end of the bus (p51805 = 1).

  **Note**

  A patch cable according to TIA568A (European) or TIA568B (American) can be used. However, both cable ends must be wired according to the same standard (patch cable = 1:1). A crossover cable is **not** suitable.

- The parallel interface also enables any BICOs (that can be parameterized by the user) to be exchanged between nodes. See function block diagrams 9352 and 9355. Exchanging data in this way is not required for closed-loop control of the firing pulses or for generating them, and is available for the user for any purpose.
  **Remark**: For a 12-pulse series connection, it is not permissible that the parallel interface is used to transfer BICOs, i.e. p51801 = 0 must be set. Failure to comply with this remark can result in sporadic current peaks.
- For additional details on how devices are connected in parallel, please refer to function diagrams 9350, 9352, and 9355.

## Controller

- For all of the topologies, a SINAMICS DCM is used as the master converter. The other converters are called slave converters.
- The control commands – switch-on/stop, operating enable, quick stop, etc. are fed to the master converter for all topologies.
  At the slave converters, terminals 12 and 13 must be permanently connected to terminal 9. If, in spite of this, a control command is entered at a slave converter, then it has the following consequences:

  | | |
  |---|---|
  | OFF1 | Has no effect, as long as n<nmin has not been reached, then the current is reduced to zero at the slave and the slave goes into operating state o7.0 or o7.1 |
  | OFF2 | The current is reduced to zero at the slave, then the slave goes into operating state o10.1 or o10.2 |
  | OFF3 | No effect, as long as n<nmin has not been reached, then the current is reduced to zero at the slave and the slave goes into operating state o9.1 or 9.2 |
  | E-STOP | The current is reduced to zero at the slave, then the slave goes into operating state o10.3 |
  | Operating enable | The current is reduced to zero at the slave, then the slave goes into operating state o1.1 or o1. |

  As long as the master does not receive a switch-on command, the slaves stay in operating state o10.0 (wait for switch-on from the master).

  If the master receives a switch-on command, then it automatically transfers this to the slaves. Then, all devices carry out their switch-on sequence, i.e. they attempt to go into operating state o0. However, the master waits in operating state o1.7 until all slaves have reached operating state o0 (exception: n+m operation for a 6-pulse parallel connection)

  If a slave leaves operating state o0, then the master outputs fault message F60044 (exception: n+m operation for a 6-pulse parallel connection)
- The speed setpoint and the actual speed value should be entered at the master converter.
- The optimization runs should be started at the master converter. The slave converters must be connected and ready for operation at this point.

## Miscellaneous

**Note**

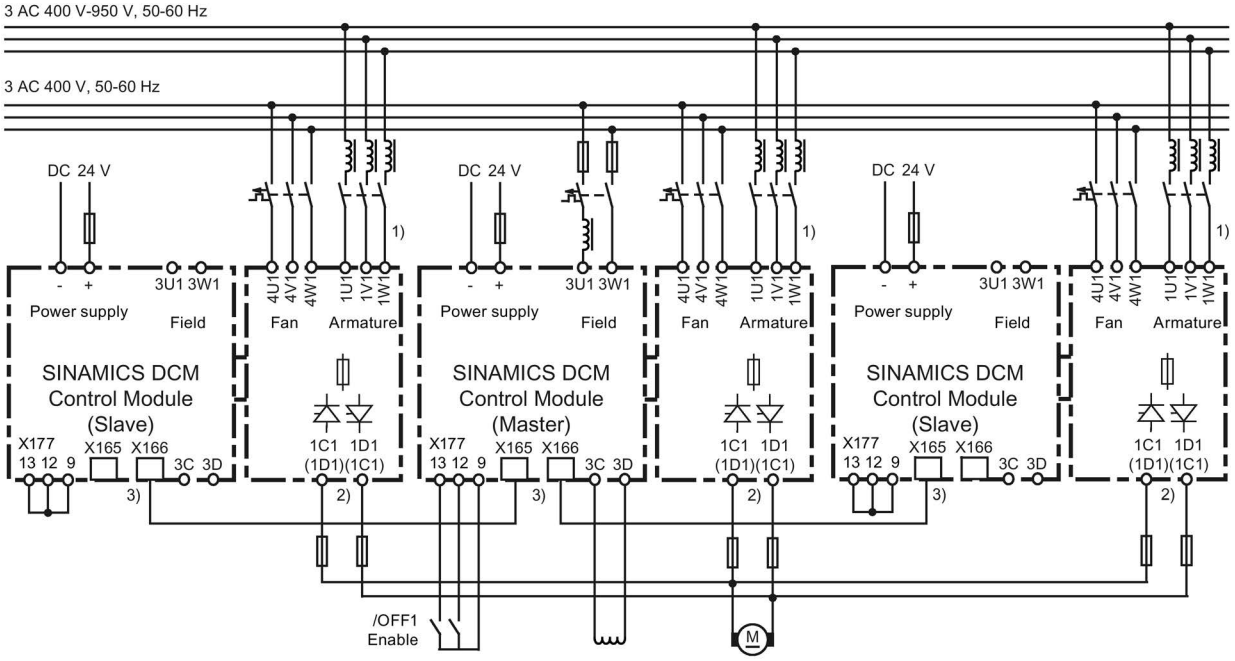
For a slave converter the $i^2t$ monitoring of the motor should be deactivated (p50114 = 0), because for a non-symmetrical current, this would then respond at the slave.

## 10.26.1 6-pulse parallel connection

### Topology

#### Basic topology

The topology of a 6-pulse parallel connection, comprising a master converter and two slave converters is shown in the following diagram.




1) The same phase sequence is required between 1U1/1V1/1W1.

2) The same phase sequence is required between 1C1/1D1.

3) The devices are connected using (8-pin) shielded patch cables of type UTP CAT5 in acc. with ANSI/EIA/TIA 568, such as those that are used in PC network technology.
A standard, 5 m cable can be obtained directly from Siemens (article number: 6RY1707-0AA08).
(n-1) cables are required for connecting n devices in parallel.
The bus terminator must be activated for each device positioned at the start or end of the bus (p51805 = 1).

Figure 10-75 Parallel connection

- Up to six devices can be connected in parallel.
- When connecting several devices in parallel, the master device should be positioned centrally due to the signal runtimes. Maximum cable length of the parallel-connection interface cable between master and slave devices at each bus end: 15 m.
- Separate line reactors of the same type are required for each power unit for current splitting purposes. The difference in reactor tolerances determines the current splitting. For operation without derating (current reduction), a tolerance of 5% or less is recommended.

### Extended topology

The topology of a 6-pulse parallel connection, comprising a master converter, one substitute master, two slave converters, as well as an independent converter is shown in the following diagram.

The converters SINAMICS DCM 1, DCM 2, DCM 3 and DCM 4 are operated in the n+m operating mode. The SINAMICS DCM 5 converter is, regarding its power unit, independent of the others. It only exchanges BICOs with them via the parallel interface.

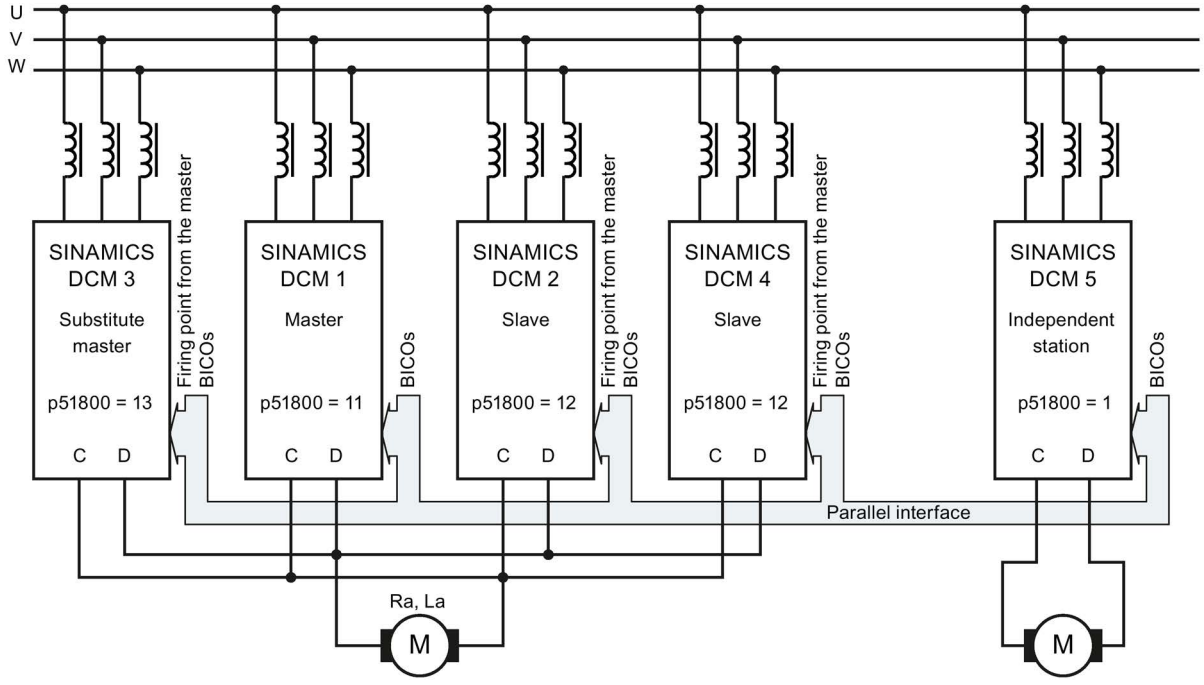



Figure 10-76 6-pulse parallel connection, extended topology

## Operating modes of the 6-pulse parallel connection

There are two operating modes:

- Standard mode
- n+m operation (also known as redundancy mode or redundant operation)

## Standard mode

A SINAMICS DCM is defined as the master. This device carries out the closed-loop speed control, the closed-loop armature-current control, the line synchronization tasks and determines the firing points. The firing points and the thyristor pair to be fired are transferred to the slave devices; all the slaves then fire the thyristor pairs at these points.

## n+m mode

n+m converters are connected in parallel. When up to m converters fail (e.g. a fuse ruptures in the power unit, a fault message occurs), operation is maintained without any interruption.

For n+m operation, a SINAMICS DCM is defined as master. Additional SINAMICS DCM are defined as substitute masters. As with the standard mode, the device defined as the master carries out the closed-loop speed control, the closed-loop armature current control, the line synchronization tasks and determines the firing points.

If a slave fails (due to a fuse blowing in the power unit or a fault being output, for example), operation continues with the remaining converters. The SINAMICS DCMs that are still in proper working order continue to operate uninterrupted.

If a master fails (due to a fuse blowing in the power unit or a fault being output, for example) a substitute master automatically becomes the master and the remaining devices continue to operate uninterrupted. If several SINAMICS DCMs are parameterized as substitute masters, the substitute master with the lowest bus address (p51806) that is ready for operation takes over.
Parameter r53311.0 indicates whether the SINAMICS DCM is currently operating as master (see FP9350).

During configuration, it is important to note that the power produced by n devices alone (rather than n+m devices) must also be sufficient for the application in question.

When operating the SINAMICS DCM together with a SIMOREG DC-MASTER Converter Commutation Protector (CCP), n+m operation must be deactivated.

**Optimization runs:**
n+m operation must be deactivated before starting the optimization runs. P51803 must be set = 0 at the master and at the substitute master units.
Otherwise, during the optimization runs, monitoring functions can inadvertently respond (e.g. for p51803 = 2, fault message F60105 with fault value 1 can be output).

**Versions of the n+m operating mode:**

1. **n+m mode only in the armature circuit**

   In this operating mode, when the master fails, only the armature firing pulses and the upstream closed-loop control (setpoint channel, speed control, armature-current control) are transferred to the substitute master; however, not the field firing pulses and the upstream control (EMF control, field current control).

   The main application for the operating mode is to supply large inductances (e.g. field windings of synchronous generators) with the SINAMICS DCM armature converter.

   **Activation:**
   At the master and substitute master devices, set p51803=1.

2. **n+m mode in the armature circuit and in the field circuit**

   In this operating mode, when the master fails the following values are forwarded to the substitute master:

   – the armature firing pulses and the upstream control (setpoint channel, speed control, armature current control)

   – the field firing pulses and the upstream control (EMF control, field current control)

   **Activation:**
   On the master and substitute master devices, set p51803 = 2.

   **Connection:**
   Outputs 3C and 3D (field DC voltage output) of the master and all substitute masters must be connected to the motor field winding in parallel.

**Remarks on n+n mode:**

- When commissioning, after carrying out the optimization (by starting optimization runs, for example), all parameters set by the optimization runs must be transferred to all substitute masters according to Chapter "Table 10-71 6-pulse parallel connection n+m operation (Page 570)".
- Since the field supplies are connected in parallel, part of the overall motor-field current flows through the freewheeling arm of the respective field power units with disabled field firing pulses. For detecting the total motor field current (displayed at parameter r50035), in the actual master, the free-wheeling current detected by the "partner" device is therefore automatically added.
  Therefore, for this operating mode, there must be an intact parallel connection as well as an intact electronic power supply of the master and the substitute master – these are prerequisites.
  If this operating mode is also to be used after the electronic power supply of the master or the substitute master fails, then the total motor field actual current value must be externally sensed. The value must be supplied to the master and substitute master using p50612.
- Generally speaking, the master function is only transferred from the active master to the substitute master via telegram and an intact parallel interface. Even if the master's electronic power supply fails, the master still has enough time to transmit a telegram for the purpose of transferring the master function.
- As soon as the parallel connection is interrupted (by disconnecting the parallel connecting cable), it can no longer be guaranteed that the master/slave assignment will be correct. The electronic power supply must be switched off and back on again at all devices!

**Note**

The control commands – switch-on/stop, operating enable, quick stop, etc. – must also be entered at all of the substitute master devices.

The speed setpoint and the actual speed value must be entered at all substitute master devices.

If the thermal overload protection of the DC motor ($I^2t$ motor monitoring) is used, as explained in Chapter "Thermal overload protection for the DC motor ($I^2t$ monitoring of the motor) (Page 550)", the following should be observed:
After a device fails, the calculated motor temperature of this device deviates from the devices still operational. In this particular case, thermal overload protection as described in Chapter "Thermal overload protection for the DC motor ($I^2t$ monitoring of the motor) (Page 550)" no longer applies.

## Parameter assignment

Table 10- 70 6-pulse parallel connection, standard mode

| Parameter | | Master | Slave or parallel units |
|---|---|---|---|
| p51799 | Operating principle | 0 | The same as at the master |
| p51800 | Position in the topology | 11 (Master) | 12 (Slave) |
| p51801 | Number of send data | Any | Any |
| p51802 | Minimum number of nodes | Number of SINAMICS DCM units in this topology | Number of SINAMICS DCM units in this topology |
| p51803 | n+m mode | 0 | 0 |
| p51804[..] | Transmit data | Any | Any |
| p51805 | Bus terminator | 0 or 1 [1)] | 0 or 1 [1)] |
| p51806 | Station address | Unique address | Unique address |
| p51807 | Telegram failure time | 0.1 s | 0.1 s |
| p50082 | Field operating mode | ≠ 0 | 0 (no field) |
| p50076[..] | Reduction in rated unit DC current | - | The same as at the master |
| p50078[..] | Rated value for supply voltage | - | The same as at the master |
| p50100 | Rated motor current | Rated motor current/number of SINAMICS DCM | The same as at the master |
| p50110 | Armature resistance Ra [2)] | Actual armature resistance × number of SINAMICS DCM | The same as at the master |
| p50111 | Armature inductance La [2)] | Actual armature inductance × number of SINAMICS DCM | The same as at the master |
| p50114 | Motor thermal time constant | Motor thermal time constant in s | The same as at the master |
| p50140 | Motor $I^2t$ monitoring, response when starting | Application-specific | The same as at the master |
| p51591 | La reduction factor [2)] | - | The same as at the master |
| p50357 | Threshold for interrupted tachometer | Application-specific | 100% (tachometer interruption monitoring not active) |

1) = 1 at the two outermost units (= at the physical ends of the bus line)
= 0 on all of the other units

2) The optimization run for current controller and precontrol (p50051 = 23 or 25) sets the correct values for these parameters.

Table 10- 71 6-pulse parallel connection n+m operation

| Parameter | | Master | Substitute master | Slave |
|---|---|---|---|---|
| p51799 | Operating principle | 0 | The same as at the master | The same as at the master |
| p51800 | Position in the topology | 11 (Master) | 13 (Substitute master) | 12 (Slave) |
| p51801 | Number of send data | Any | Any | Any |
| p51802 | Minimum number of nodes | n | The same as at the master | The same as at the master |
| p51812 | Total number of nodes | n+m | The same as at the master | The same as at the master |
| p51803 | n+m mode | 1 (only armature)<br>2 (armature + field) | The same as at the master | 0 |
| p51804[..] | Transmit data | Any | Any | Any |
| p51805 | Bus terminator | 0 or 1 [1)] | 0 or 1 [1)] | 0 or 1 [1)] |
| p51806 | Station address | Unique address | Unique address | Unique address |
| p51807 | Telegram failure time | 0.1 s | 0.1 s | 0.1 s |
| p50082 | Field operating mode | ≠ 0 | 0 (if only armature)<br>≠ 0 (if armature + field) | 0 (no field) |
| p50076[..] | Reduction in rated unit DC current | - | The same as at the master | The same as at the master |
| p50078[..] | Rated value for supply voltage | - | The same as at the master | The same as at the master |
| p50100 | Rated motor current | Rated motor current/ number of SINAMICS DCM | The same as at the master | The same as at the master |
| p50110 | Armature resistance Ra [2)] | Actual armature resistance × number of SINAMICS DCM | The same as at the master | The same as at the master |
| p50111 | Armature inductance La [2)] | Actual armature inductance × number of SINAMICS DCM | The same as at the master | The same as at the master |
| p50114 | Motor thermal time constant | Motor thermal time constant in s | The same as at the master | The same as at the master |
| p50140 | Motor $I^2t$ monitoring, response when starting | Application-specific | The same as at the master | The same as at the master |
| p50115 to p50139 | Field characteristic | - | The same as at the master<br>(only if n+ m operation for armature + field) | The same as at the master |
| p51591 | La reduction factor [2)] | - | The same as at the master | The same as at the master |
| p50357 | Threshold for interrupted tachometer | application-specific | The same as at the master | 100% (tachometer interruption monitoring not active) |

1) = 1 at the two outermost units (= at the physical ends of the bus line)
= 0 on all of the other units

2) The optimization run for current controller and precontrol (p50051 = 23 or 25) sets the correct values for these parameters.

## 10.26.2 12-pulse parallel connection

**Note**

**12-pulse applications**

The circuit diagrams in this chapter are block diagrams.

You can find detailed information on interconnecting, dimensioning and parameterizing in the application document "12-pulse applications".

Support is also available through our Technical Support organization (for contact address, see "Preface (Page 3)").

### Topology

The following diagram shows the topology of a 12-pulse parallel connection.

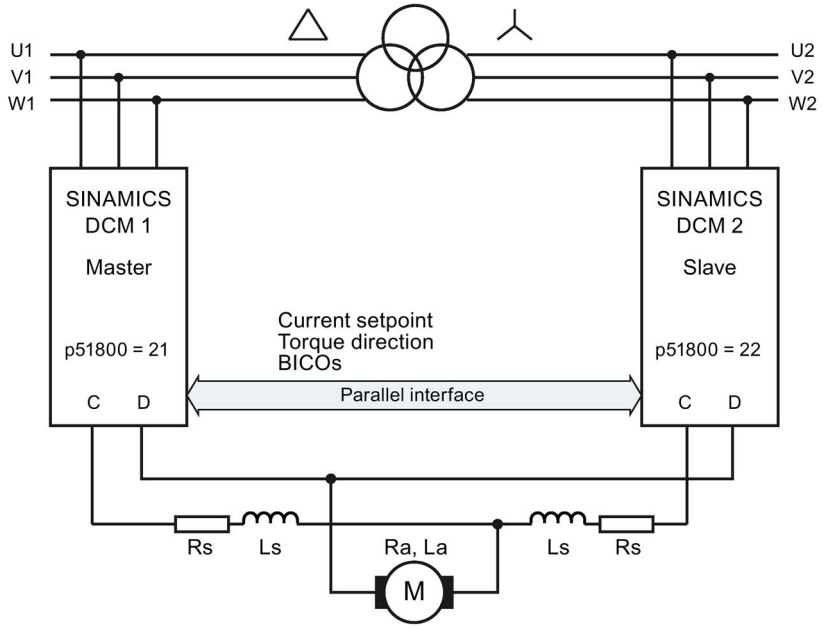



Figure 10-77 12-pulse parallel connection (1), block diagram

The following diagram shows the topology of a 12-pulse parallel connection, where an additional 6-pulse converter is connected in parallel to each of the two 12-pulse converters connected in parallel.

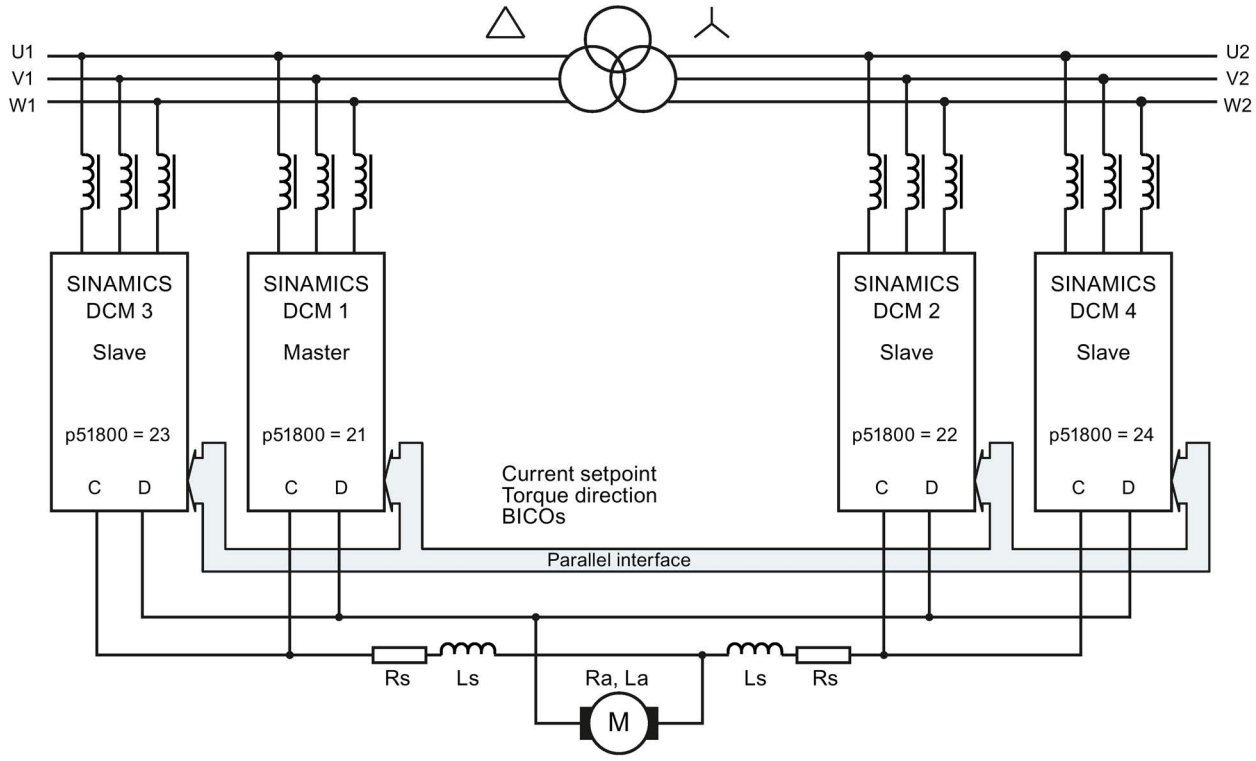



Figure 10-78 12-pulse parallel connection (2), block diagram

**Note**

If additional converters are connected in parallel to the master converter, then exactly the same number of converters must also be connected in parallel with the slave converter.

## 10.26.3 6-pulse series connection

### Topology

The following diagram shows the topology of a 6-pulse series connection of two SINAMICS DCM.

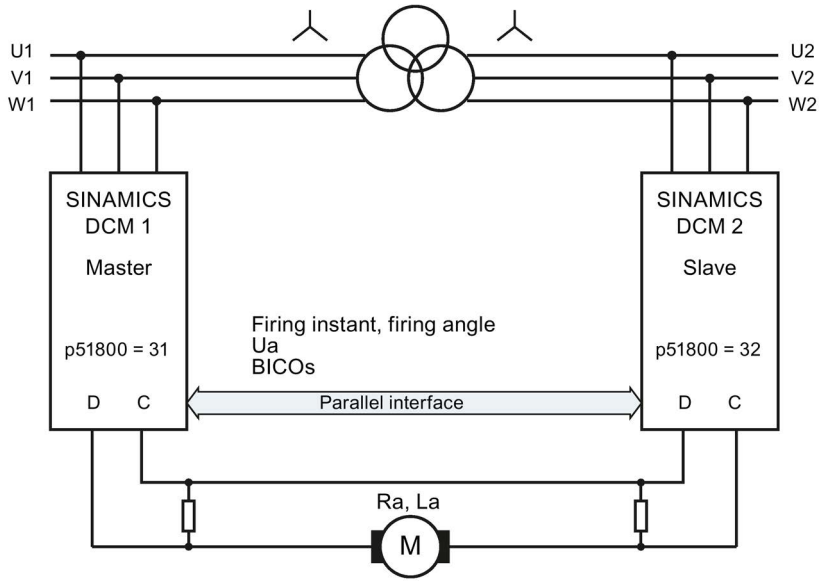



Figure 10-79 6-pulse series connection (1)

The following diagram shows the topology of a 6-pulse series connection, where additional converters are connected in parallel to each of the two 6-pulse converters connected in series.

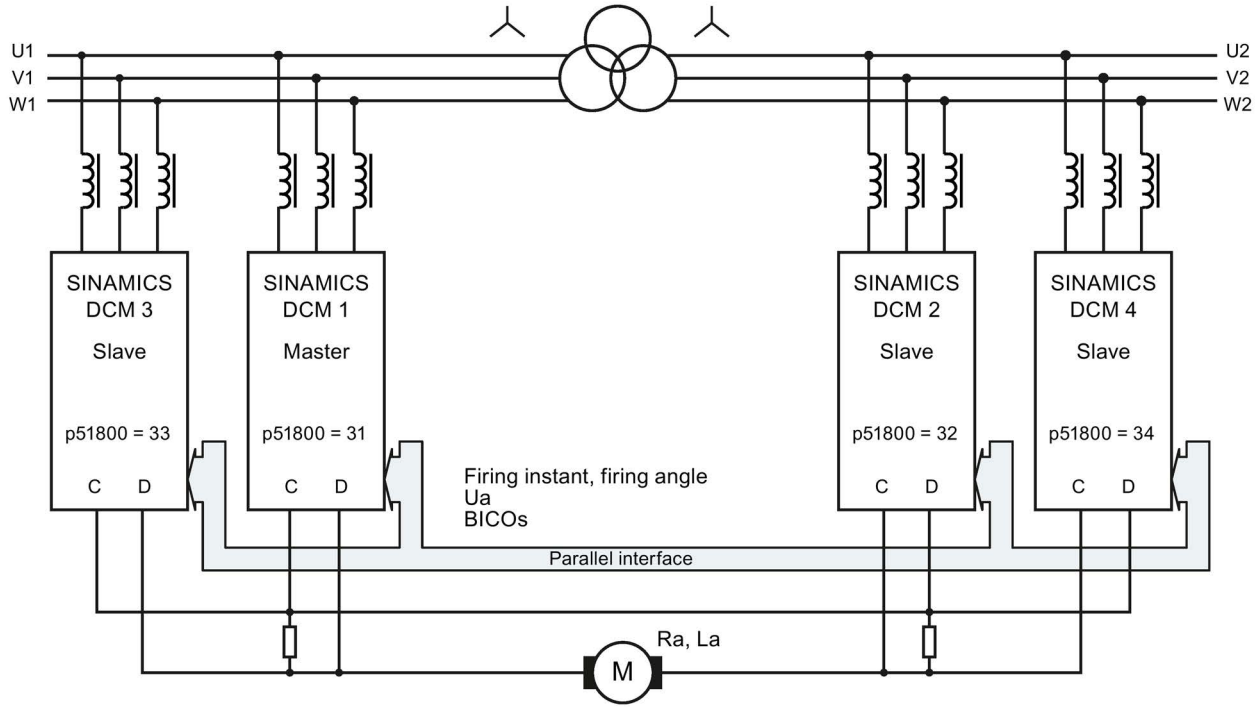



Figure 10-80 6-pulse series connection (2)

The instructions for dimensioning the balancing resistors can be found in an FAQ (for the link, see the Preface).

## Operating modes

There are 2 operating modes:

- **Operation with the same firing pulses (p51799 = 0 or p51799 = 31):**
  Both partial converters are fired at precisely the same point. The master calculates the firing point and this is transferred to the slave via the parallel interface. Synchronization to the line supply is exclusively performed by the master. The slave must be connected to the line supply with the same phase sequence as the master.
- **Operation with sequence control (p51799 = 32):**
  Both partial converters synchronize to the line supply and generate their own firing points. The firing angle for the master and the firing angle for the slave are calculated by the master and the firing angle and the torque direction for the slave are transferred to the slave via the parallel interface. The firing angle for the master and slave are generated so that the reactive power load of the line supply is as low as possible. This is the case if one of the two partial converters is at a control limit and the other carries-out the closed-loop control. This type of closed-loop control is only possible for continuous current. Operation with the same firing points is automatically selected in the discontinuous (pulsating) current range.

**Note**

The phase sequence at the master and the slave must be the same.

## Parameter assignment

The following parameters should be specifically set for operation with this converter topology:

Table 10- 72 Parameter assignment, 6-pulse series connection

| Parameter | | Master | Slave or parallel units |
|---|---|---|---|
| p51799 | Operating principle | 0, 31 or 32 | The same as at the master |
| p51800 | Position in the topology | 31 (Master) | 32 (slave)<br>33 (parallel to the master)<br>34 (parallel to the slave) |
| p51801 | Number of send data | Any | Any |
| p51802 | Minimum number of nodes | Number of SINAMICS DCM units in this topology | Number of SINAMICS DCM units in this topology |
| p51803 | n+m mode | 0 | 0 |
| p51804[..] | Transmit data | Any | Any |
| p51805 | Bus terminator | 0 or 1 [1)] | 0 or 1 [1)] |
| p51806 | Station address | Unique address | Unique address |
| p51807 | Telegram failure time | 0.1 s | 0.1 s |
| p50082 | Field operating mode | ≠ 0 | 0 (no field) |
| p50076[..] | Reduction in rated unit DC current | - | The same as at the master |
| p50078[..] | Rated value for supply voltage | - | The same as at the master |
| p50100 | Rated motor current | - | The same as at the master |
| p50110 | Armature resistance Ra [2)] | - | The same as at the master |
| p50111 | Armature inductance La [2)] | - | The same as at the master |
| p50114 | Motor thermal time constant | Motor thermal time constant in s | The same as at the master |
| p50140 | Motor $I^2t$ monitoring, response when starting | Application-specific | The same as at the master |
| p51591 | La reduction factor [2)] | - | The same as at the master |

1) = 1 at the two outermost units (= at the physical ends of the bus line)
= 0 on all of the other units

2) The optimization run for current controller and precontrol (p50051 = 23 or 25) sets the correct values for these parameters.

## 10.26.4 6-pulse series connection: controlled converter + uncontrolled converter

### Topology

The following diagram shows the topology of a 6-pulse series connection of a SINAMICS DCM 2-quadrant unit and a diode rectifier (thyristor bridge B6 + diode rectifier).

**Note**

The AC input voltage of the controlled converter should be between 10% and 15% higher than that of the uncontrolled converter, so that the current can be reliably reduced down to 0.

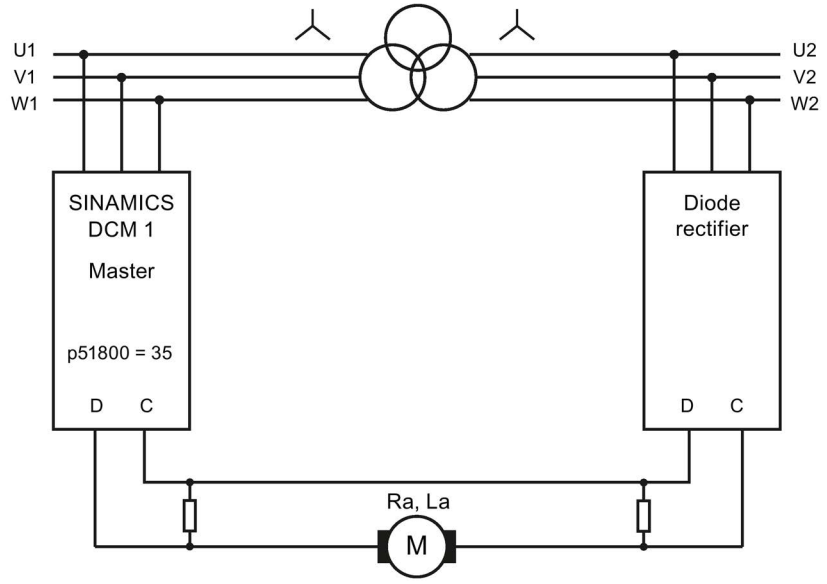



Figure 10-81 6-pulse series connection: controlled + uncontrolled rectifier

The instructions for dimensioning the balancing resistors can be found in an FAQ (for the link, see the Preface).

## Parameter assignment

The following parameters should be specifically set for operation with this converter topology:

Table 10- 73 Parameter assignment, 6-pulse series connection

| Parameter | | Master | Units connected in parallel with the master |
|---|---|---|---|
| p51798 | Voltage at an uncontrolled rectifier | Actual voltage as a percentage of the voltage at the master (standard: 85%) | The same as at the master |
| p51799 | Operating principle | 0 | 0 |
| p51800 | Position in the topology | 35 (Master for diode rectifier) | 33 |
| p51802 | Minimum number of nodes | Number of SINAMICS DCM units in this topology | Number of SINAMICS DCM units in this topology |
| p51807 | Telegram failure time | 0.0 s<br>0.1 s if units connected in parallel are available | 0.1 s |
| p50082 | Field operating mode | ≠ 0 | 0 (no field) |
| p50076[..] | Reduction in rated unit DC current | - | The same as at the master |
| p50078[..] | Rated value for supply voltage | - | The same as at the master |
| p50100 | Rated motor current | Rated motor current/number of SINAMICS DCM | The same as at the master |
| p50110 | Armature resistance Ra [2)] | Actual armature resistance × number of SINAMICS DCM | The same as at the master |
| p50111 | Armature inductance La [2)] | Actual armature inductance × number of SINAMICS DCM | The same as at the master |
| p51591 | La reduction factor [2)] | - | The same as at the master |

[2)] The optimization run for current controller and precontrol (p50051 = 23 or 25) sets the correct values for these parameters.

## 10.26.5 12-pulse series connection

**Note**

**12-pulse applications**

The circuit diagrams in this chapter are block diagrams.

You can find detailed information on interconnecting, dimensioning and parameterizing in the application document "12-pulse applications".

Support is also available through our Technical Support organization (for contact address, see "Preface (Page 3)").

### Topology

The following diagram shows the topology of a 12-pulse series connection of two SINAMICS DCM.

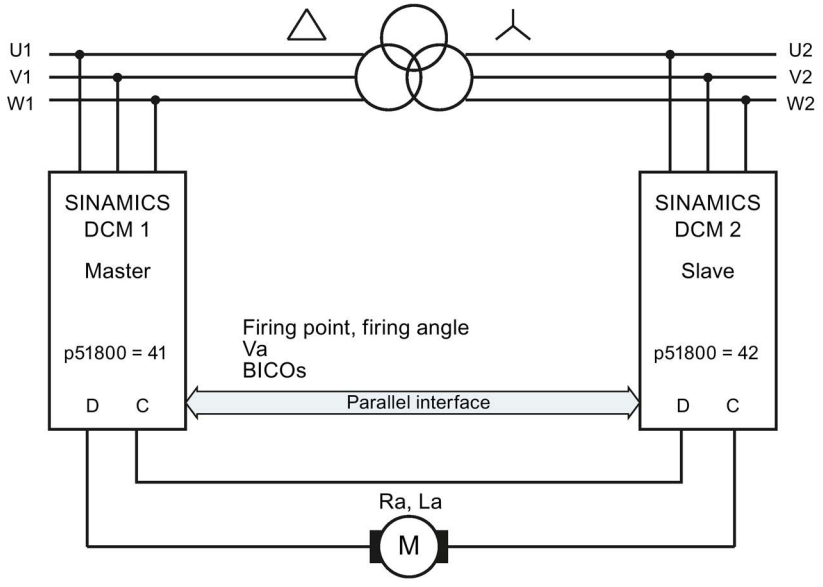



Figure 10-82 12-pulse series connection (1), block diagram

The following diagram shows the topology of a 12-pulse series connection, where additional converters are connected in parallel to each of the two 12-pulse converters connected in series.

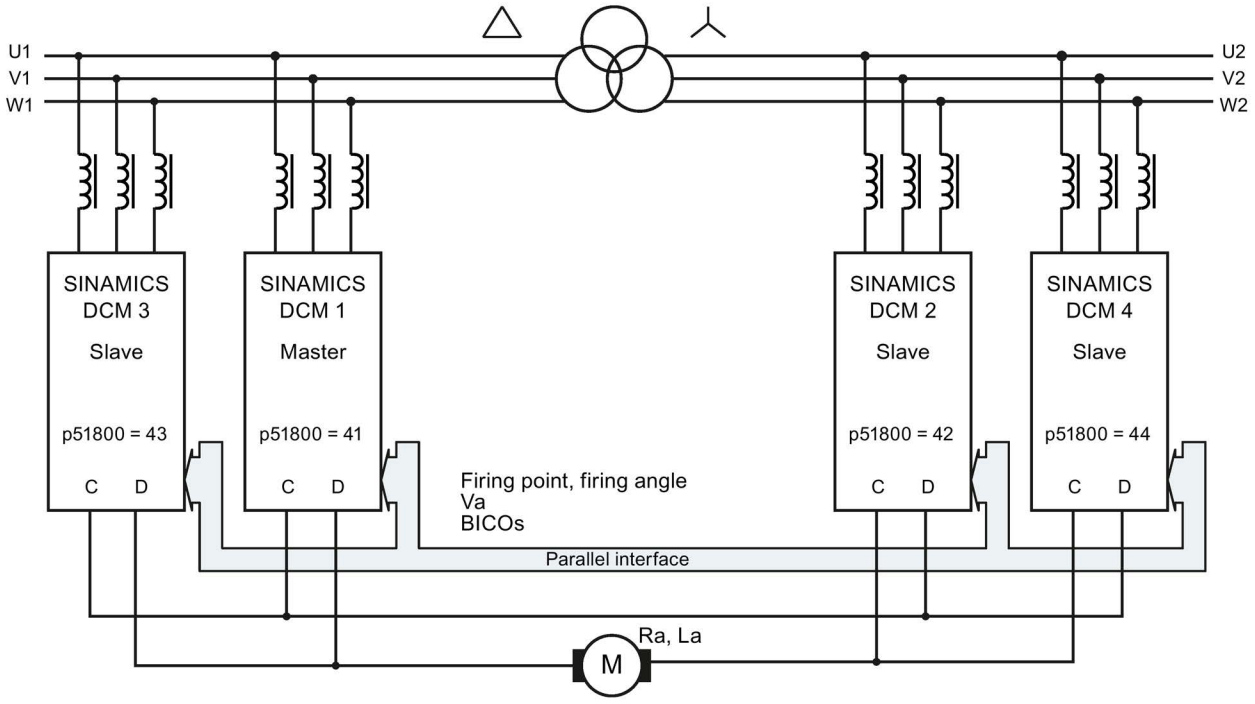



Figure 10-83 12-pulse series connection (2), block diagram

## Operating modes

There are two operating modes:

- **Operation with the same firing times (p51799 = 41):**
  Both partial converters are fired at precisely the same instant. The master calculates the firing point and this is transferred to the slave via the parallel interface. Synchronization to the line supply is exclusively performed by the master. The slave must be connected to the line supply with the same phase sequence as the master.
- **Operation with sequence control (p51799 = 42):**
  Both partial converters synchronize to the line supply and generate their own firing points. The firing angle for the master and the firing angle for the slave are calculated by the master and the firing angle and the torque direction for the slave are transferred to the slave via the parallel interface. The firing angle for the master and slave are generated so that the reactive power load of the line supply is as low as possible. This is the case if one of the two partial converters is at a control limit and the other carries-out the closed-loop control. This type of closed-loop control is only possible for continuous current. Operation with the same firing points is automatically selected in the discontinuous (pulsating) current range.

### Remark

The current ripple is significantly higher when the two partial converters operate with sequence control than when they operate with the same firing times. In this case, the current ripple approximately corresponds to that for 6-pulse operation. Especially in older motors, under certain circumstances this ripple can cause problems (for example, during commutation).

Therefore, a conscious decision must be made:

- Low ripple, but no reduction of the reactive power:
  → Operation with the same firing times (p51799 = 41)
- Low reactive power, but no reduction of the ripple:
  → Operation with sequence control (p51799 = 42)

**Note**

**Connecting the slave converter to the 12-pulse transformer**

The power unit of the slave converter must be connected to the 12-pulse transformer so that its phases lag the phases of the line supply at the master by 30°. The phase sequence must be the same.

## 10.26.6 12-pulse series connection: controlled converter + uncontrolled converter

**Note**

**12-pulse applications**

The circuit diagrams in this chapter are block diagrams.

You can find detailed information on interconnecting, dimensioning and parameterizing in the application document "12-pulse applications".

Support is also available through our Technical Support organization (for contact address, see "Preface (Page 3)").

### Topology

The following diagram shows the topology of a 12-pulse series connection of a SINAMICS DCM 2-quadrant unit and a diode rectifier (thyristor bridge B6 + diode rectifier).

**Note**

The AC input voltage of the controlled converter should be between 10% and 15% higher than that of the uncontrolled converter, so that the current can be reliably reduced down to 0.

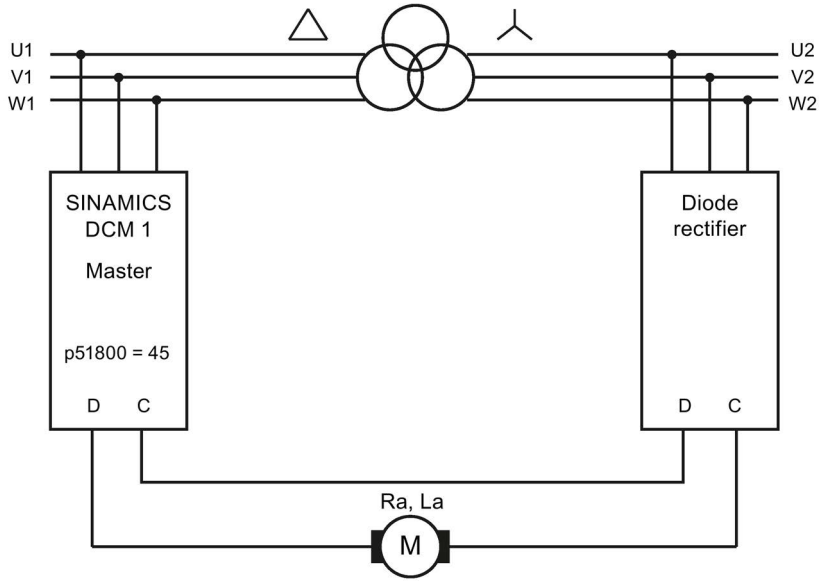



Figure 10-84 12-pulse series connection: Controlled + uncontrolled rectifier, block diagram

## 10.26.7 Switchover of the power unit topology – Option S50

Ordering information for option S50, see Chapter "Ordering information (Page 25)".

**Note**

SINAMICS DCM can only be retrofitted with option S50 in the manufacturers factory.

**Note**

You can find detailed information on interconnecting, dimensioning and parameterizing in the application document "12-pulse applications". Support is also available through our Technical Support organization (for contact address, see "Preface (Page 3)").

In certain applications, it is necessary to switch between a 12-pulse parallel connection and a 12-pulse series connection during operation using a control command.

External contactors must be used to switch over the power unit topology. Option S50 provides the required firmware functionality.

### Requirements for using this functionality

- All SINAMICS DCMs involved must be equipped with option S50.
- It is not permissible that the "n+m" mode is used.
- The function of the "parallel switching master" must remain on the same SINAMICS DCM in both power unit topologies.

# 10.27 Field reversal

See also the SINAMICS DCM List Manual, function diagram 6920.

When using a two-quadrant unit (with only one armature current flow direction) by reversing the current in the excitation winding of the DC motor (field reversal) operation in additional quadrants of the speed-torque characteristic is possible (direction of rotation reversal and braking).

Two contactors are required in the field circuit to reverse the field voltage.
The functions "Direction of rotation reversal using field reversal" and "Braking using field reversal" control connector outputs r53195[0] (close field contactor 1) and r53195[1] (close field contactor 2), which are then used to control the two field contactors.

A protection circuit is required in the field circuit.

| | | |
|---|---|---|
| r53195[0] | = 0 | No contactor control |
| | = 1 | Control for a contactor to switch-in the positive field direction |
| r53195[1] | = 0 | No contactor control |
| | = 1 | Control for a contactor to switch-in the negative field direction |

## 10.27.1 Direction of rotation reversal using field reversal

The function "Direction of rotation reversal using field reversal" is controlled using the signal source (binector) selected at binector input p50580 and this has a switch-type function.
It defines the field direction and therefore also the direction of rotation for a positive speed setpoint.

| | |
|---|---|
| Binector = 0 | A positive field direction is selected.<br>"Close field contactor 1" (r53195.0) = 1, "Close field contactor 2" (r53195.1) = 0 |
| Binector = 1 | A negative field direction is selected.<br>"Close field contactor 1" (r53195.0) = 0, "Close field contactor 2" (r53195.1) = 1 |

Changing the logical level of the binector controlling the function "Direction of rotation reversal using field reversal " brakes the drive and accelerates it in the opposite direction of rotation.

Field reversal is completely executed. Level changes at the connector input have no effect while the field is being reversed.

**Note**

Only positive speed setpoints make sense.

### Control sequence when specifying "Direction of rotation using field reversal"

1. Drive rotates in direction of rotation 1 or 2 (or is at a standstill)
2. Specify "Direction of rotation reversal using field reversal" by changing the logical state of the binector selected using p50580
3. Field reversal is executed
   Precondition: No braking was initiated using the button function "Braking using field reversal"
   - Wait until armature current $I_A$ = 0 , then armature pulse inhibit (the drive then remains in operating state ≥ o1.4)
   - Inhibit field firing pulses (r52268=0 also initiates this)
   - Wait until $I_{field}$ (r52265) < $I_{field\ min}$ (p50394)
   - Wait time according to p50092[00] (0.0 to 10.0 s, factory setting 3.0 s)
   - Open current field contactor (r53195.0 = 0 or r53195.1 = 0)
   - Wait time according to p50092[01] (0.0 to 10.0 s, factory setting 0.2 s)
   - Control new field contactor (r53195.0 = 1 or r53195.1 = 1)
   - Reverse the speed actual value (with the exception, for p50083 = 3 ... EMF as speed actual value)
   - Wait time according to p50092[02] (0.0 to 10.0 s, factory setting 0.1 s)
   - Enable field firing pulses
   - Wait until $I_{field}$ (r52265) > $I_{field\ set}$ (r52268)*p50398
   - Wait time according to p50092[03] (0.0 to 10.0 s, factory setting 3.0 s)
   - Enable armature firing pulses (operating state o1.4 can be exited)
4. Drive brakes and then rotates in direction of rotation 1 or 2 (or is at a standstill)

**Note**

In the case of an internal speed actual value reversal as a result of field reversal, p50083 is supplied with inverted signal values (exception: p50083 = 3, see the SINAMICS DCM List Manual, function diagram 6810).

When using the ramp-function generator it is recommended to parameterize p50228 = 0 (no speed controller setpoint filtering). If this is not done, then initial braking can occur at the current limit as a result of the speed actual value reversal and setting the ramp-function generator output to the (reversed) speed actual value or to the value according to p50639 in operating state o1.4.

## 10.27.2 Braking using field reversal

The function "Braking using field reversal" is controlled using the signal source (binector) set at binector input p50581 and this has a button-type function.

Binector = 1 (for ≥30 ms) in operating state ≤o5 (line contactor closed) causes the drive to brake to $n < n_{min}$.
After this, the original field direction is selected.
The motor can accelerate in the original direction of rotation after the braking command has been withdrawn (binector = 0) and acknowledged using "Stop" and "Switch-on".

### Control sequence when specifying "Braking using field reversal"

1. Drive rotates with direction of rotation 1 or 2
2. Specify "Braking using field reversal" using log. 1 (for ≥30 ms) selected at binector using p50581
3. Field reversal is executed.
   Preconditions: Line contactor is closed (for operating state ≤o5) and the drive is not already braking.
   Braking is identified by the negative internal actual speed (whereby, this is obtained in the negative field direction by reversing the real actual speed):
   - Wait until armature current $I_A = 0$ , then armature pulse inhibit (the drive then remains in operating state ≥ o1.4)
   - Inhibit field firing pulses (r52268 = 0 also initiates this)
   - Wait until $I_{field}$ (r52265) < $I_{field\ min}$ (p50394)
   - Wait time according to p50092[00] (0.0 to 10.0 s, factory setting 3.0 s)
   - Open current field contactor (r53195.0 = 0 or r53195.1 = 0)
   - Wait time according to p50092[01] (0.0 to 10.0 s, factory setting 0.2 s)
   - Control new field contactor (r53195.1 = 1 or r53195.1 = 1)
   - Reverse the speed actual value (with the exception, for p50083 = 3 ... EMF as speed actual value)
   - Wait time according to p50092[02] (0.0 to 10.0 s, factory setting 0.1 s)
   - Enable field firing pulses
   - Wait until $I_{field}$ (r52265) > $I_{field\ set}$ (r52268) × p50398
   - Wait time according to p50092[03] (0.0 to 10.0 s, factory setting 3.0 s)
   - Enable armature firing pulses (operating state o1.4 can be exited)
4. Sequence when braking the drive:
   - $n_{set} = 0$ internally entered at the ramp-function generator input, the drive brakes
   - Wait until $n < n_{min}$ (p50370)
   - Wait until armature current $I_A = 0$ , then armature pulse inhibit (drive goes into operating state o7.2)
   - Wait until the braking command has been withdrawn by logical 0, on the binector selected with p50581
     (as long as level = 1 is present, the drive is kept in operating state o7.2)

5. Sequence to change over to the original field direction
   Precondition: The present field direction does not match the field direction requested using the function "Direction of rotation reversal using field reversal"
   - Wait until armature current $I_A$ = 0 , then armature pulse inhibit (the drive then remains in operating state ≥ o1.4)
   - Inhibit field firing pulses (r52268=0 also initiates this)
   - Wait until $I_{field}$ (r52265) < $I_{field\ min}$ (p50394)
   - Wait time according to p50092[00] (0.0 to 10.0 s, factory setting 3.0 s)
   - Open current field contactor (r53195.0 = 0 or r53195.1 = 0)
   - Wait time according to p50092[01] (0.0 to 10.0 s, factory setting 0.2 s)
   - Control new field contactor (r53195.0 = 1 or r53195.1 = 1)
   - Reverse the speed actual value (with the exception, for p50083 = 3 ... EMF as speed actual value)
   - Wait time according to p50092[02] (0.0 to 10.0 s, factory setting 0.1 s)
   - Enable field firing pulses
   - Wait until $I_{field}$ (r52265) > $I_{field\ set}$ (r52268×p50398)
   - Wait time according to p50092[04] (0.0 to 10.0 s, factory setting 3.0 s)
   - Armature firing pulses are again possible
6. The drive is in operating state o7.2
   Acceleration is possible in the original direction of rotation when acknowledging using an external "Stop" and "Switch-on"

Please also read the note at the end of the chapter "Direction of rotation reversal using field reversal"

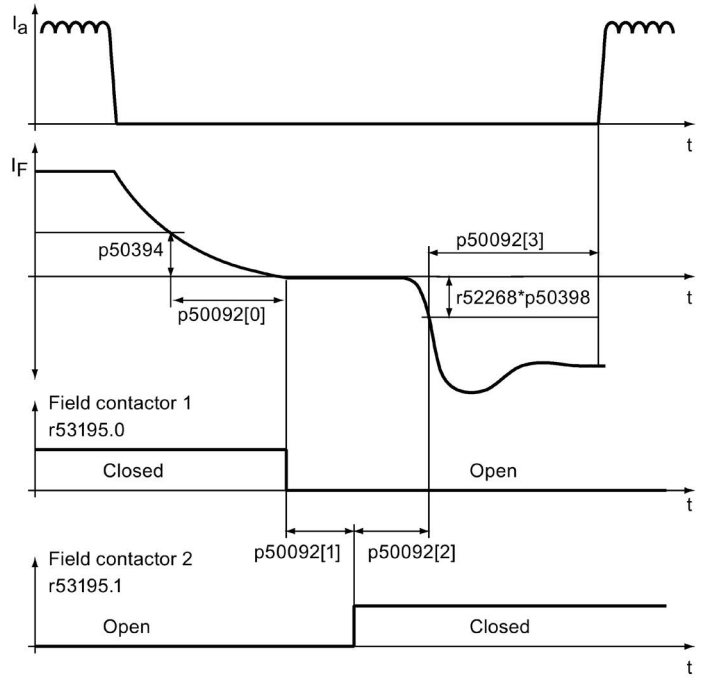



Figure 10-85 Wait times for field reversal (parameter p50092)

# 10.28 Serial interface with peer-to-peer protocol

## General information

The peer-to-peer interface enables BICO interconnections across several SINAMICS DCMs, As well as allowing the peer-to-peer interface to establish signal connections between converters in the SINAMICS DC MASTER range (order number = 6RA80...) and converters in other ranges, such as SIMOREG DC-MASTER (order number = 6RA70...) and SIMOREG K (order number = 6RA24...).

## Properties

A "peer-to-peer connection" refers to "a connection between partners with equal status". Unlike the classic master-slave bus systems (such as PROFIBUS or USS), peer-to-peer connections enable the same converter to act as both a master (setpoint source) and a slave (setpoint recipient).

Signals can be transferred via the peer-to-peer connection from one converter to another in fully digital format.

- Velocity setpoints for creating a setpoint cascade, e.g. in paper making machines, film manufacturing machines, and wire drawing machines, as well as fiber stretching plants
- Torque setpoints for load distribution control systems on drives that are coupled either mechanically or by means of the material, e.g. horizontal-shaft drives on a printing machine or S-roll drives
- Acceleration setpoints (dv/dt) for acceleration precontrol in multi-motor drives
- Control commands

The peer-to-peer interface uses the RS485 interface at connector X177 (terminals 37, 38, 39, and 40).

## Function diagrams

Function diagram FP9300 shows the settings and BICO interconnection options for the "peer-to-peer connection".

## Diagnostics

Parameter r50799 contains information about the distribution of error-free telegrams and telegrams with errors over time, as well as the type of any communications errors that occur.

## Topologies

The peer-to-peer interface supports two topologies:

- Point-to-point connection (see the series connection example further down)
  - 4-wire connection between two converters
  - Data transmission in both directions
- Bus connection (see the bus connection example further down)
  - 2-wire connection between multiple converters
  - Data transmission in one direction only
  - The active sender is selected by means of the "Send enable" signal selected using p50817. The send enable may only be at the "High" level for one converter in each case. Converters whose send enable is at the "Low" level switch their sender to high resistance.

## Parameterization

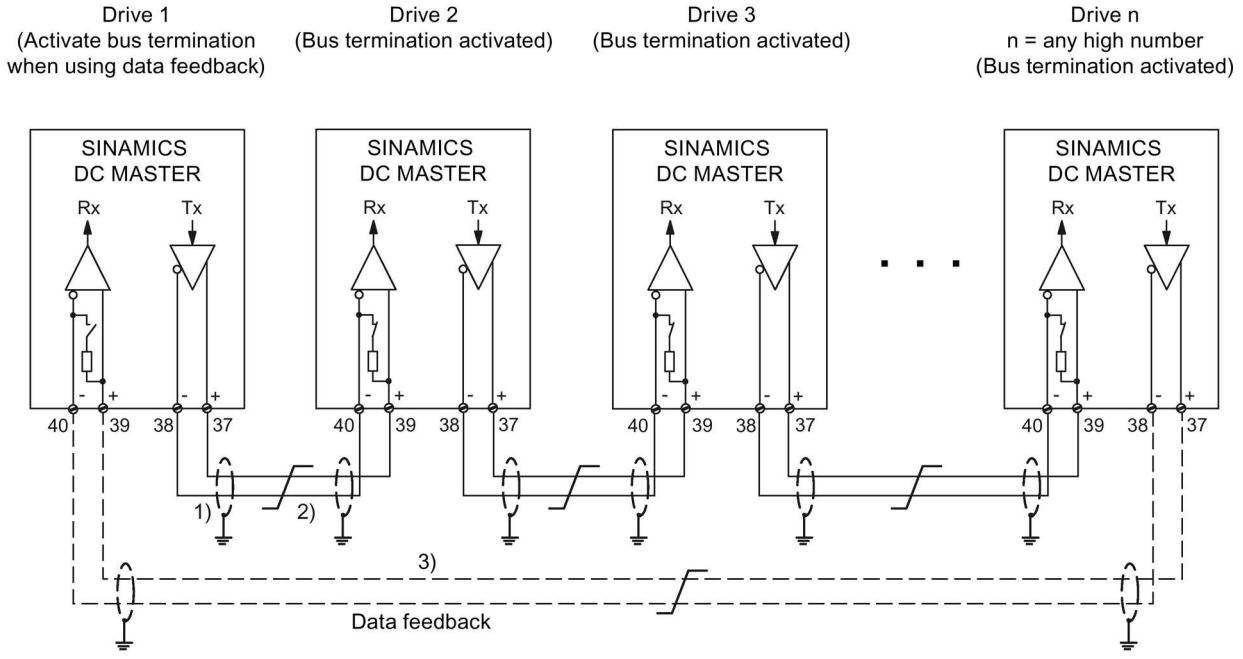
Table 10- 74 Parameterizing the peer-to-peer interface

| Function | Parameter |
|---|---|
| Peer-to-peer protocol selection | p50790 = 5 |
| PZD number | p50791 = 1 to 5 words |
| Baud rate | p50793 = 1 to 13, corresponding to between 300 and 187,500 baud |
| Bus terminator | p50795 = 0: Bus terminator OFF<br>p50795 = 1: Bus terminator ON |
| Error statistics | r50799[1]: Displays receive errors on the peer-to-peer interface |

## 10.28.1 Examples of peer-to-peer connections

### Series connection

Each drive receives its own individual setpoint from the previous drive (classic setpoint cascade).

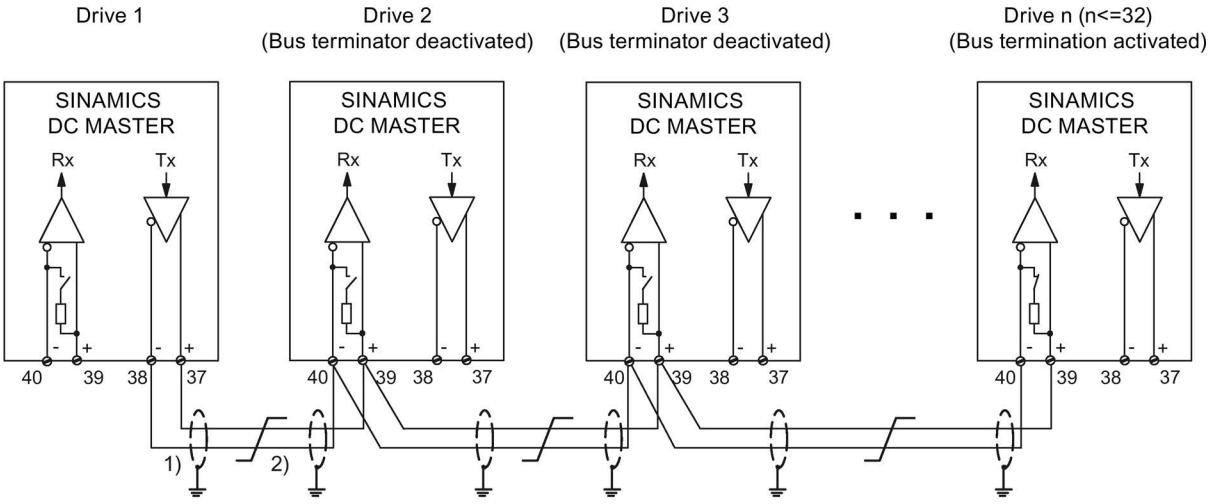



1) The shields for the interface cables must be connected directly on the devices (using a clamp, for example) to device or cabinet ground, with a low level of impedance.
2) Twisted cable, e.g. LIYCY 2×0.5 $mm^2$; with longer cables, an equipotential bonding cable should be used to ensure that the difference in ground potentials between the link partners remains below 7 V.
3) Optional data feedback, which drive 1 can use to monitor the functionality of the entire peer chain.

Figure 10-86 "Series connection" peer connection type

## Parallel connection

Up to 31 drives receive the same setpoints from drive 1.



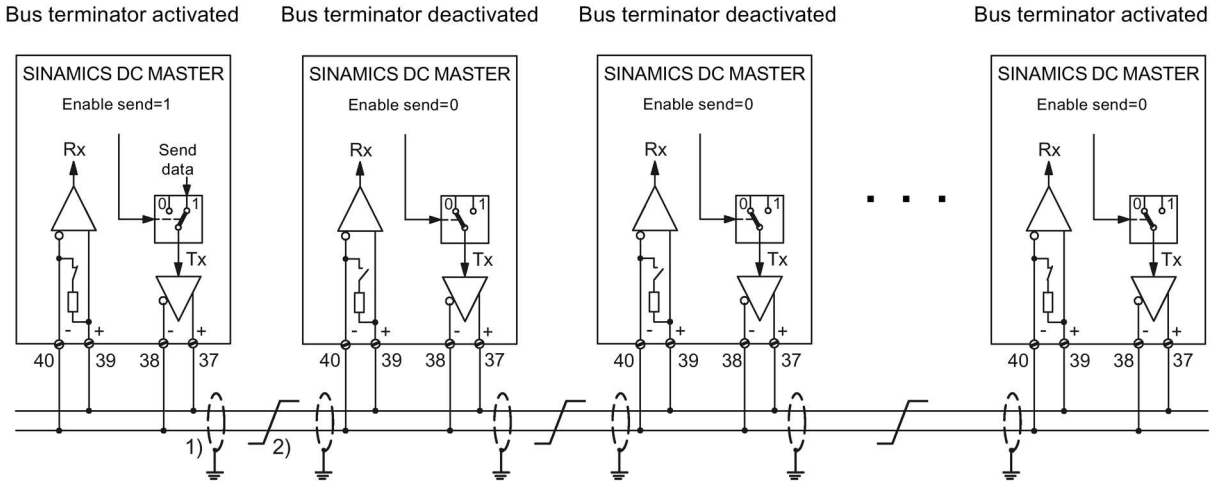

1) The shields for the interface cables must be connected directly on the devices (using a clamp, for example) to device or cabinet ground, with a low level of impedance.

2) Twisted cable, e.g. LIYCY 2×0.5 $mm^2$; with longer cables, an equipotential bonding cable should be used to ensure that the difference in ground potentials between the link partners remains below 7 V.

Figure 10-87 "Parallel connection" peer connection type

### Bus connection

Up to 31 drives receive the same setpoints from a drive. The drive that sends the setpoints must be selected by setting "Enable send" to 1. For all other drives, "Enable send" must be set to 0.




1) The shields for the interface cables must be connected directly on the devices (using a clamp, for example) to device or cabinet ground, with a low level of impedance.

2) Twisted cable, e.g. LIYCY 2×0.5 $mm^2$; with longer cables, an equipotential bonding cable should be used to ensure that the difference in ground potentials between the link partners remains below 7 V.

Figure 10-88 "Bus connection" peer connection type

## 10.29 Expanding the SINAMICS DCM to include a second CUD

### General information

As an option, the SINAMICS DC MASTER can be equipped with a second CUD by inserting it in the right-hand slot. This option is only available in conjunction with option G00 (Advanced CUD in left-hand slot). See also Chapter "Ordering information for options and accessories".

For the installation of the second CUD, see Chapter "Installing a second CUD (Page 52)" and "Replacing the CUD (Page 656)".

| NOTICE |
| --- |
| **Installation or removal only in a no-voltage state.**<br>Installing or removing a module is only permitted when the SINAMICS DC MASTER is in the voltage-free state. |

## Properties

The right-hand CUD is used for system-specific extension of the SINAMICS DC MASTER functions.

It enables the following function extensions:

- Doubling the number of hardware inputs and outputs for applications requiring more analog inputs, analog outputs, digital inputs, or digital outputs
- Additional computing capacity for free function blocks and, above all, for application-specific function diagrams generated using DCC

**Connection between the left-hand and right-hand CUD:**

This involves using the parallel-connection interface.
16 BICO connections can be established in each direction. Function diagrams FP9350, FP9352, and FP9355 show the settings and BICO interconnection options for the parallel-connection interface.

The hardware connection for the two CUDs is established inside the unit; there is no need for an external connection using connector X165 or X166. It is also possible to use the parallel-connection interface for controlling a power unit-side configuration in which several SINAMICS DC MASTER units are connected in parallel.

## Parameter assignment

The parameters for the right-hand CUD are assigned using the AOP30 or the STARTER commissioning tool. The Basic Operator Panel BOP20 cannot be used for this purpose.

- Assigning parameters for the right-hand CUD using the AOP30:
  The AOP30 must be connected to connector X178 (RS485 interface) or X179 (RS232 interface) on the right-hand CUD.
- Assigning parameters for the right-hand CUD using STARTER:
  STARTER views the right-hand CUD as a separate PROFIBUS node. Either the unique bus address must be set using the AOP30, or STARTER must first be connected as the sole bus node in order to set the unique bus address.

The second CUD must be parameterized as an "independent node" for the parallel-connection interface, meaning that it participates in BICO exchange between multiple CUDs.

Table 10- 75 Assigning parameters in cases where several SINAMICS DC MASTER units are not connected in parallel at the power unit side

| Left-hand CUD | | Right-hand CUD | |
|---|---|---|---|
| p51800 = 1 | Independent node | p51800 = 1 | Independent node |
| p51801 | Number of words to be sent | p51801 | Number of words to be sent |
| p51802 = 2 | Minimum number of stations | p51802 = 2 | Minimum number of stations |
| p51803 = 0 | "n+m mode" not active | p51803 = 0 | "n+m mode" not active |
| p51804[..] | Establish required BICO connections | p51804[..] | Establish required BICO connections |
| p51805 = 1 | Bus terminator | p51805 = 1 | Bus terminator |
| p51806 = | Unique station address | p51806 = | Unique station address |

Table 10- 76 Assigning parameters in cases where several SINAMICS DC MASTER units are connected in parallel at the power unit side

| Left-hand CUD | | Right-hand CUD | |
|---|---|---|---|
| p51800 | Required as with parallel connection of power units | p51800 = 1 | Independent node |
| p51801 | Number of words to be sent | p51801 | Number of words to be sent |
| p51802 | Required as with parallel connection of power units | p51802 | Required as with parallel connection of power units |
| p51803 | Required as with parallel connection of power units | p51803 = 0 | "n+m mode" not active |
| p51804[..] | Establish required BICO connections | p51804[..] | Establish required BICO connections |
| p51805 | Required as with parallel connection of power units | p51805 = 0 | No bus terminator |
| p51806 = | Unique station address | p51806 = | Unique station address |

Normally, on the CUD on the right-hand slot the closed-loop drive control (setpoint processing, ramp-function generator, closed-loop speed control, armature-current control, closed-loop EMF control, closed-loop field-current control) is not required.

For that reason it makes sense to deactivate the closed-loop drive control (with p50899[0..6] = 0, see also function diagram 1721) in order to gain more CPU time for free function blocks and, especially, for application-specific function diagrams created with DCC.

## 10.30 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 26)" for ordering data.

The dimensions needed in the control cabinet are approx. 230 mm x 45 mm.

Figure 10-89 Terminal Module Cabinet

The CUD is equipped with a "Cabinet Board".

During installation, connectors X1 and X2 on the Cabinet 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.

For terminal assignment, see Chapter "Connector assignment (terminals, Faston mounting tabs, ribbon cables) (Page 126)".

## 10.31 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**

Errors and alarms are stamped with this system runtime.

If a connected AOP30 is parameterized as the time-of-day master (see Chapter "Assigning parameters to make AOP30 time-of-day master (Page 370)"), faults and alarms are provided with a real-time stamp.

### 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 49 days.

## 10.32 Diagnostics

### 10.32.1 Diagnostic memory

To provide support for troubleshooting and remedying problems, the SINAMICS DC MASTER records various types of data in a diagnostics file. Siemens specialists can use the contents of this file to glean more in-depth information about the cause of inexplicable faults or other problems such as blown fuses or defective thyristors.

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.

With parallel or series connection, the diagnostics files of **all** devices must always be read out and sent to the Siemens experts.

Proceed as follows to read out the diagnostics file:

1. Insert the memory card in the drive.
2. Set p50832 = 1:
   this copies the diagnostics file to the CompactFlash Card. A process which takes approximately 2 minutes. Copying is complete when p50832 takes on the value 0 again.
3. The diagnostics file is called **DiagStor.spd**, is approx. 600 KB in size, and 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 FP8052.

## 10.32.2 Trend recorder function

The SINAMICS DC MASTER enables data from 4 channels to be recorded over an extended period, with a large memory depth. A file on the CompactFlash Card takes on the role of a long-term storage facility. The signals to be recorded are updated periodically and written cyclically to the file.

The file contains a line-by-line account of the operating hour and values for the 4 channels, in the form of an ASCII string, and can be evaluated and visualized using standard PC tools (such as Notepad or Excel).

Recording must be started manually (by setting p51705 = 0/1/2). With a recording period of 1 second, the file grows by approximately 100 kB per hour.

When starting via p51705 = 1, recording is automatically stopped after the number of entries set in p51706 – and p51705 is set to 0.

When starting via p51705 = 2, the oldest entries are overwritten after the number of entries set in p51706. Recording must be stopped manually (with p51705 = 0).

The file is called **Track.csv** and can be found in the **\USER\SINAMICS\DATA\LOG** directory on the CompactFlash Card.

For more details on the trend recorder function, please refer to function diagram FP8050.

## 10.32.3 Thyristor diagnostics

The SINAMICS Control Module can perform a self-test of the external power unit. As a consequence, defective thyristors and other faults can be detected in the power unit.

**Note 1**

The thyristor diagnostics cannot be used when external power units are connected in series.

**Note 2**

In parallel connections of SINAMICS DCMs (6-pulse or 12-pulse), the thyristor diagnostics must only be selected on the master. The thyristor diagnostics are then performed first on the master and then automatically in succession on all slaves. If a faulty thyristor is detected on an external power unit, the appropriate fault message is issued on the assigned Control Module and not on the master on which the thyristor diagnostics was started.

**Note 3**

If a thyristor is fused, in 6-pulse parallel connection it is not possible to identify in which of the parallel power units the defective thyristor is located. The corresponding fault message occurs on the master.

## Selecting thyristor diagnostics

Thyristor diagnostics are performed during the switch-on procedure. Parameter p50830 can be used to select for which switch-on procedures thyristor diagnostics is performed.

p50830 = 0 never
= 1 at the first ON after switching-on the electronics
= 2 at each ON
= 3 at the next ON (p50830 is then reset to 0)

## Thyristor diagnostics sequence

At each switch-on procedure, starting from operating state o7 the drive goes into state o0. During thyristor diagnostics, it remains in operating state o3 (see parameter r50000). Thyristor diagnostics takes approx. 30 s.

Thyristor diagnostics comprises two parts:

1. **Checking the thyristor for its blocking capability**

   All thyristors are individually fired and it is not permissible for current to flow. If it does, this indicates that a thyristor is fused or it triggers with forward breakover or a ground fault has occurred, i.e. terminal 1C or 1D is connected to ground.

| NOTICE |
| --- |
| **Ground leakage circuit breaker**<br>In IT systems (i.e. in systems with an ungrounded neutral point of the supply transformer), the thyristor diagnostics cannot detect a single-pole ground fault.<br>For these types of line supply, it is recommended that a ground fault monitor is used. |

| ⚠WARNING |
| --- |
| **Electric shock or electric arc during operation with ground fault**<br>The type and location of the fault cannot be established just from a ground fault error message. In the event of continued operation, serious aftereffects all the way to electric arcs are possible. This can result in death, serious injury or material damage.<br>• If a ground fault occurs during operation, the system must be switched off immediately. Then identify and eliminate the source of the ground fault.<br>• The plant operating company is responsible for the consequences for further operation after a ground fault has been detected. Carry out a risk analysis. |

2. **Checking that the thyristors can be triggered**

   All of the thyristors are triggered in pairs and in this case, a current must flow (as a minimum, 5% of r50072[1]). Otherwise, a thyristor cannot be triggered. This can also be caused by a fault in the firing pulse generation.

| NOTICE |
| --- |
| **Possible rotation of the motor shaft.**<br>The low current that flows during this test can cause the motor shaft to briefly rotate for motors that are very easy to move and are not loaded, as in this operating state, the full field is already present. |

Faults that are detected result in fault message F60061. The fault value provides information as to which thyristor was detected to be defective and what the possible cause of the fault could be.

## 10.32.4 Description of the LEDs on the CUD

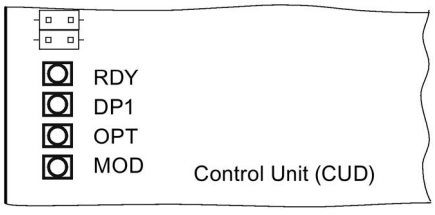



Figure 10-90 Layout of the LEDs

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.
- At the end of a successful ramp-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 can only be seen when the front cover of the SINAMICS DC MASTER is opened.

## CUD - Response of LEDs during a firmware update

Table 10- 77 Firmware update

| LED | | | | Meaning |
|---|---|---|---|---|
| RDY | DP1 | OPT | MOD | |
| Red | Off | Off | Off | Firmware update in progress. |
| Red 2 Hz | Red | Off | Off | Firmware on the memory card is incomplete or defective. |
| | | | | The firmware update failed. The CRC of the programmed firmware is incorrect. |
| Red 0.5 Hz | Red 0.5 Hz | Off | Off | The firmware has been successfully completed. The electronic power supply must be switched off and back on again. |
| Red 2 Hz | Red 2 Hz | Off | Off | The firmware on the memory card does not belong to SINAMICS DCM. |
| | | | | The firmware version and hardware version of the CUD are not compatible. For information on the hardware/firmware compatibility, see Chapter "Upgrading the device firmware (Page 651)". |
| 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 10- 78 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 10- 79 CUD – Description of the LEDs after ramp-up

| LED | Color | State | Description, cause | Remedy |
|---|---|---|---|---|
| RDY (READY) | - | Off | Electronic 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<br>**Notice!**<br>The electronic power supply for the SINAMICS DC MASTER must not be switched off during this write process.<br>Switching off the electronic power supply can lead to the loss of the parameter assignments. Also refer to Chapter "Operation", Section "Memory card functions". | - |
| | Red | 2 Hz flashing light | General errors | Check parameterization/ configuration |
| | Orange | 0.5 Hz flashing light | Updating the firmware of the connected 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]).<br>**Note:**<br>Both options depend on the LED state when component detection is activated via p0124[0] = 1. | - |
| DP1<br>PROFIdrive cyclic operation | - | Off | Cyclic communication has not (yet) taken place.<br>**Note:**<br>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)<br>Full cyclic communication is not yet taking place.<br>Possible cause:<br>The controller is not transferring any setpoints. | - |
| | Red | Continuous light | USS: No activity on bus | |
| | | 0.5 Hz flashing light | USS: Activity on bus; no PZD received | |
| | | | Bus fault (no dataEx)(config fault) | - |
| | | 2 Hz flashing light | Bus fault (no more dataEx) | - |
| | | | Bus fault (search baud rate) | |

| LED | Color | State | Description, cause | Remedy |
|---|---|---|---|---|
| | | | No link established | - |
| OPT<br>(OPTION) | - | Off | Electronic power supply is missing or outside permissible tolerance range,<br>Component not ready for operation,<br>Option Board not installed,<br>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.<br>Option board not ready (e.g. after switching on) | Remedy and acknowledge fault |
| RDY and DP1 | Red | 2 Hz flashing light | Bus fault – Communication has been interrupted | Correct fault |
| RDY and OPT | Orange | 0.5 Hz flashing light | The firmware of the connected CBE20 Communication Board Ethernet is being updated | - |
| MOD | - | Off | Reserved | - |

## 10.32.5 Diagnostics via STARTER

The diagnostic functions support commissioning and service personnel during commissioning, troubleshooting, diagnostics and service activities.

### Requirement

- Online operation of the STARTER commissioning tool.

### Diagnostic functions

The following diagnostic functions are available in the STARTER commissioning tool:

- Specification of signals with the ramp-function generator
- Signal recording with the trace function
- Analysis of the control response with the measuring function

### 10.32.5.1 Function generator

The function generator is part of the STARTER commissioning tool.

The function generator can be used, for example, to perform the following tasks:

- Measuring and optimizing control loops.
- Comparing the dynamic response of coupled drives.
- Specifying a simple traversing profile without a traversing program.

The function generator can be used to generate various waveforms.

In the "Connector output" operating mode (r4818), the output signal can be injected into the control loop via the BICO interconnection.

#### Properties

- The following freely parameterizable waveforms can be set:
  - Square-wave
  - Staircase
  - Triangular
  - Sinusoidal
  - PRBS (pseudo random binary signal, white noise)
- An offset is possible for each signal. The power-up to the offset can be parameterized. The signal generation starts after the power-up to the offset.
- Limitation of the output signal to the minimum and maximum value can be set.

#### Further waveforms

Additional waveforms can be generated.

Example:

The "triangular" waveform can be parameterized with "Upper limit" to produce a triangle with no peak.

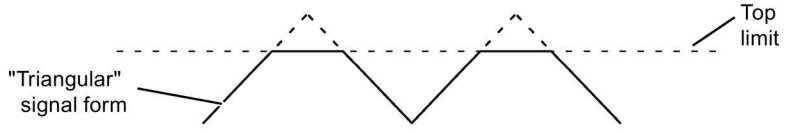



Figure 10-91 "Triangular" without peak waveform

## Parameterizing and operating the function generator

You operate and parameterize the function generator via STARTER.

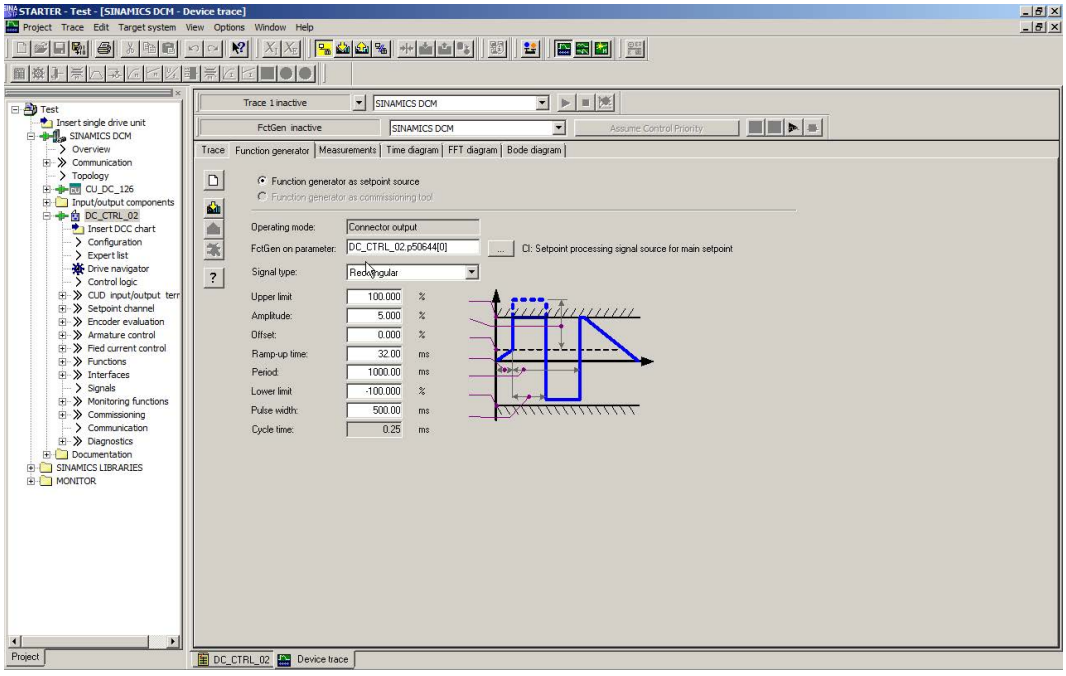



Figure 10-92 Function generator

**Note**

Please refer to the online help for more information about parameterization and operation.

**Note**

The "Function generator as commissioning tool" button must not be selected!

If this button is still selected, then the message "Error occurred while parameterizing" is output on STARTER when "Loading the parameterization to the drive" as well as alarm A02007 on the SINAMICS DCM (Function generator: Drive not SERVO/VECTOR).

## Starting/stopping the function generator

**⚠WARNING**

**Hazardous axis movement**

With the corresponding ramp-function generator parameter settings (e.g. offset), the motor can "drift" and travel to its end stop.

The motion of the drive is not monitored with the function generator activated.

- Observe the general safety instructions.

**Starting the function generator:**

1. Load the function generator.
   - Click the symbol.

     or

   - In the project navigator, double-click "Drives" > "Drive_xy" > "Commissioning" > "Function generator".
2. Select "Function generator as setpoint source".
3. Select the BICO input.
4. Set the waveform, for example, "Square-wave".
5. Click the "Assume control priority!" button.
6. For "Sign of life monitoring", click the "Accept" button (the control priority button then changes to yellow).
7. Click the "Drive on" symbol.
8. Start the function generator by clicking the triangle next to the red zero ("Start FctGen" button).
9. Read the "Caution" note and confirm with "Yes".
   The drive starts and runs through the set trace function.
   Trace recordings are now possible.

**Stopping the function generator:**

1. Click the "Stop FctGen" button.

   or

2. Click the "Drive off" icon to stop the drive.

## Parameterization

The "Function generator" parameterization screen is selected with the symbol in the toolbar of the STARTER commissioning tool.

### 10.32.5.2 Trace function

## Single trace

You can use the trace function to record measured values over a defined period, depending on trigger conditions. Alternatively, the measured values can also be recorded using immediate recording.

In the STARTER commissioning tool you can parameterize the trace function by using the "Trace" parameterizing screen form.

### Calling the "Trace" parameterizing screen form

In the STARTER commissioning tool, click the symbol (device trace-function generator).

The "Trace" parameterizing screen form is then displayed.

Example:

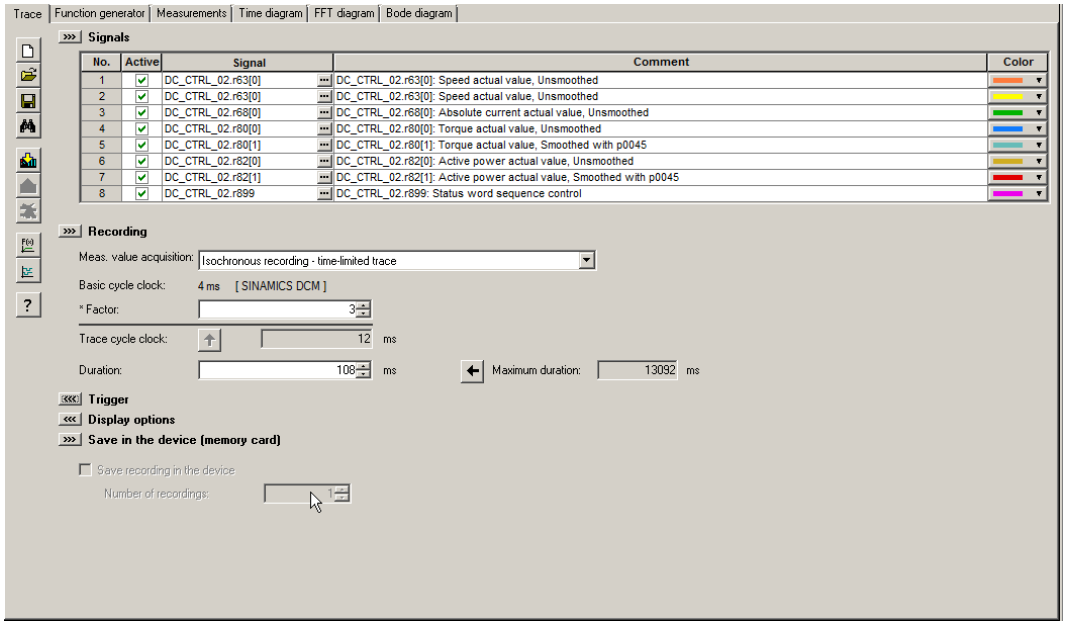



Figure 10-93 Trace function

### Parameterizing and operating the trace function

**Note**

Detailed information on how to parameterize and operate the trace function is available in the STARTER online help in Chapter "Trace, measuring functions and automatic controller setting".

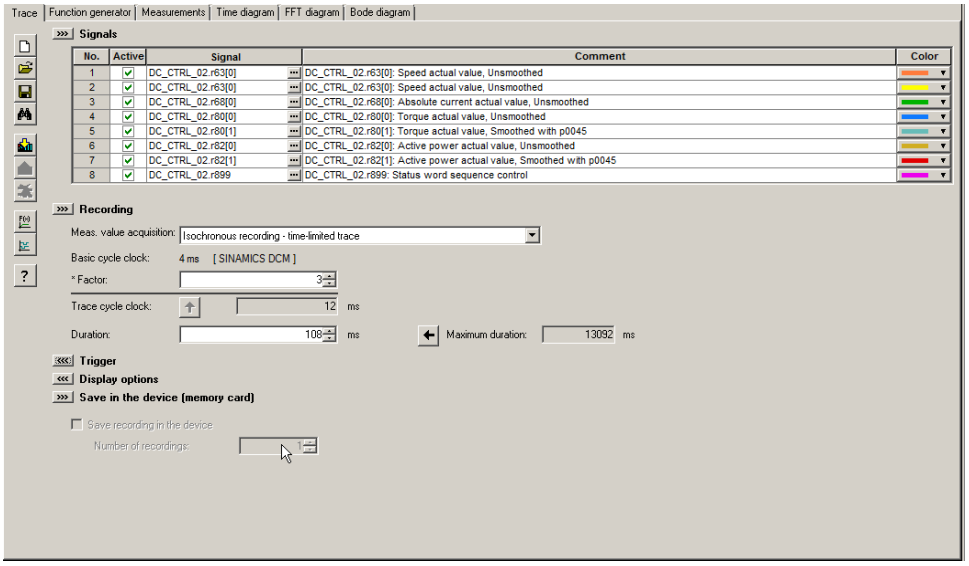



Figure 10-94 Trace function

The device cycle time display flashes 3 times at around 1 Hz when the time slice is changed from < 4 ms to ≥ 4 ms (see description at "Properties"). The display also flashes in the inverse direction from ≥ 4 ms to < 4 ms.

### Properties

- Two independent traces
- Up to eight recording channels for each trace
  When more than four channels per single trace are used, the trace's device clock cycle is switched automatically from 0.250 ms to 4 ms. As a consequence, the performance of the SINAMICS DCM is not influenced too strongly by the trace function.
- Single trace:
  Device clock cycles of the SINAMICS DCM trace
  Up to four channels: 0.250 ms
  ≥ five channels: 4 ms
  The specified trace cycles can be increased.
- Endless trace:
  The parameter data is written to the memory until this is full.
  Further parameter data is then lost.
  A ring buffer can be selected in order to avoid this. When the ring buffer is activated, then the STARTER commissioning tool automatically starts again from the beginning to write to the trace memory after the last trace parameter was saved.
  Device cycle of the SINAMICS DCM trace for an endless trace:
  Up to four channels: 2 ms
  ≥ five channels: 4 ms
- Triggering
  - Without triggering (recording immediately after start)
  - Triggering on signal with edge or on level
- STARTER commissioning tool
  - Automatic or adjustable scaling of the display axes
  - Signal measurement via cursor
- Adjustable trace cycle: Integer multiples of the basic sampling time

## Multiple trace

A multiple trace consists of single, completed, consecutive traces. Using multiple tracing on a card, it is possible to cyclically record (a specific number) traces with the same trace configuration (number of channels, sample depth, recording cycle,..), and to save these traces persistently on the drive memory card.

The "Endless trace", "Single trace" and "Multiple trace" functions cannot be used simultaneously. With a correspondingly incorrect configuration, alarm "A02097" is output. However, a multiple trace with a cycle of 1 is nothing more than a single trace with saved measurement results.

| NOTICE |
| --- |
| **Shorter service life of memory cards as a result of multiple traces.**<br>The service life of the cards can be shortened by the multiple traces because the memory media is subject to wear as a result of the write access operations from a technical point of view. |

**Note**

The performance of the complete system can be negatively influenced by a continuous multiple trace.

### Requirement

A multiple trace is only possible if the memory card is plugged in and not blocked. In this case, alarm "A02098 MTrace: Cannot be saved" is output with alarm value "1".

### Activating a multiple trace

**Note**

The multiple trace can be activated or set separately for each trace recorder.

1. In STARTER, click the symbol (device trace-function generator).

   The "Trace" parameterizing screen form is then displayed.

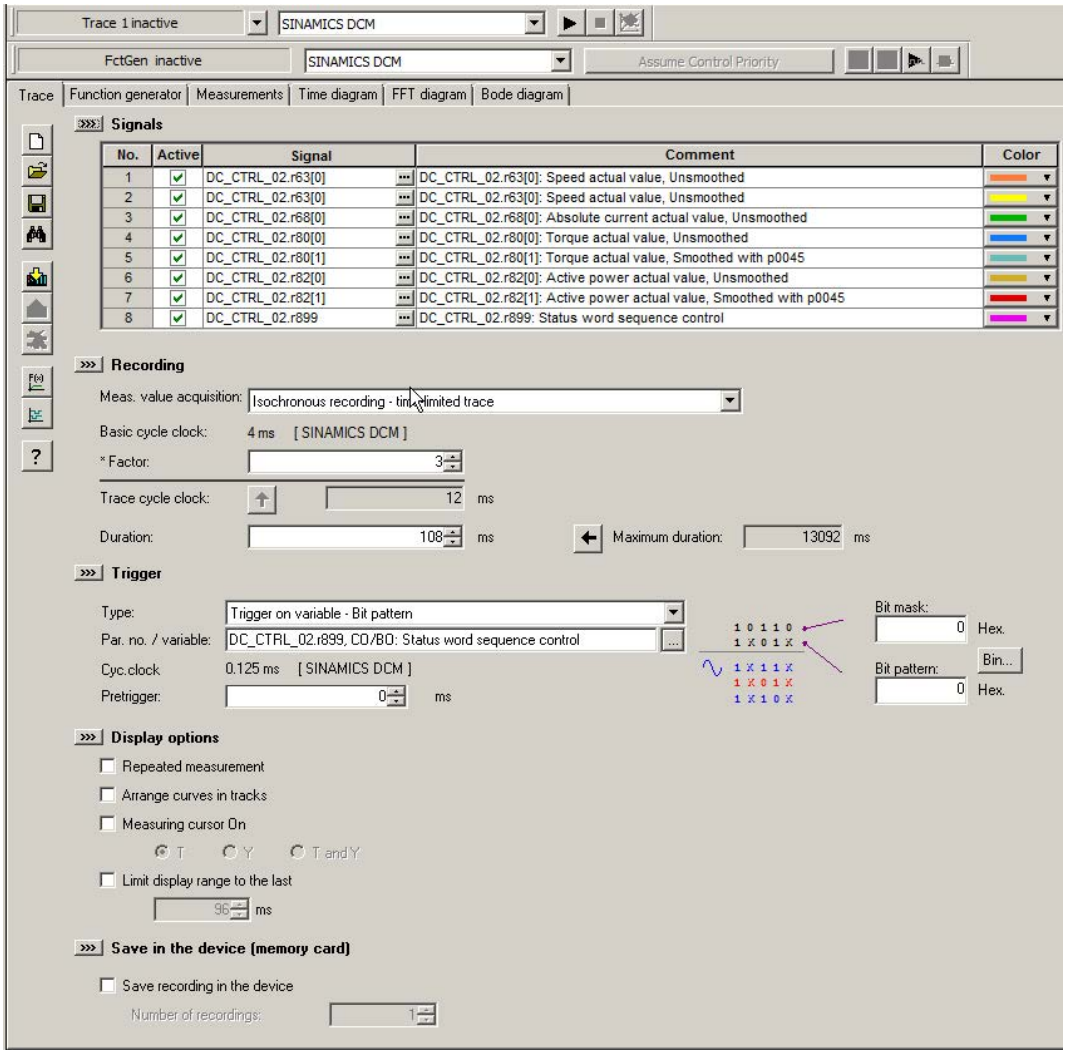



Figure 10-95 Multiple trace in STARTER

2. Activate the "Save recording in the device" checkbox.
3. Enter the number of cycles in the "Number of recordings" field.

**Note**

Detailed information on how to parameterize and operate the trace function is available in the STARTER online help in Chapter "Trace, measuring functions and automatic controller setting".

4. Make the required trace settings and save the settings.

### Sequence of a multiple trace

1. A multiple trace is started just like a conventional single trace using the STARTER "Trace" screen form.
2. The multiple trace component saves the measurement result after the trigger condition has occurred and the trace data has been completely recorded.
3. The single trace that has actually been completed is now automatically restarted from the multiple trace component. In this case, the same trace configuration (trigger condition, recording cycle, etc. ) is used as before. The trace buffer of the previous single trace is emptied in the process.

### Trace status

The status of the multiple trace is displayed in the screen form (red frame):

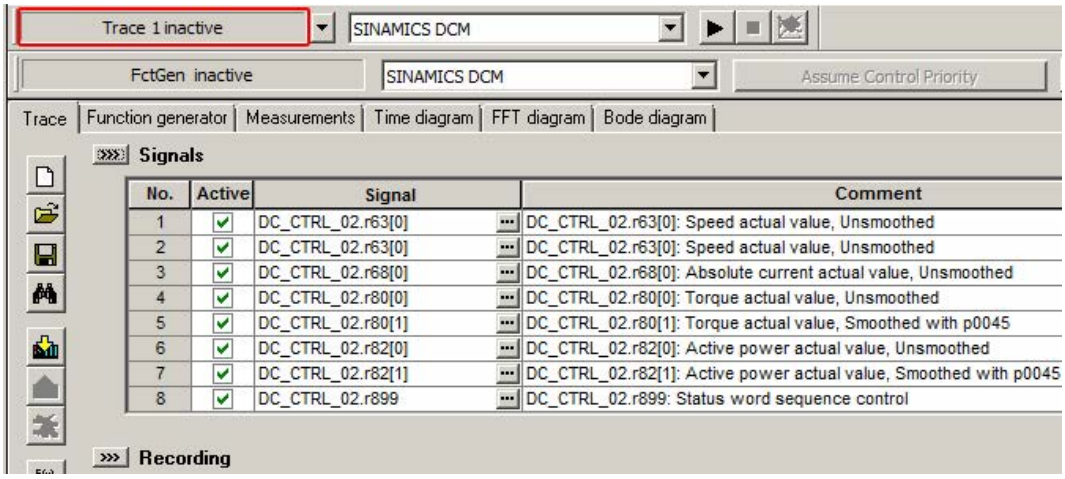



Figure 10-96 Trace status in STARTER

## Startup trace

A startup trace basically consists of a conventional single trace with all of its configuration options (number of channels, sampling depth, recording cycle, etc.). With the appropriate configuration, a startup trace is automatically active after a drive restarts.

### Configuring the startup trace

1. In STARTER, click the symbol (device trace-function generator).

   The "Trace" parameterizing screen form is then displayed.

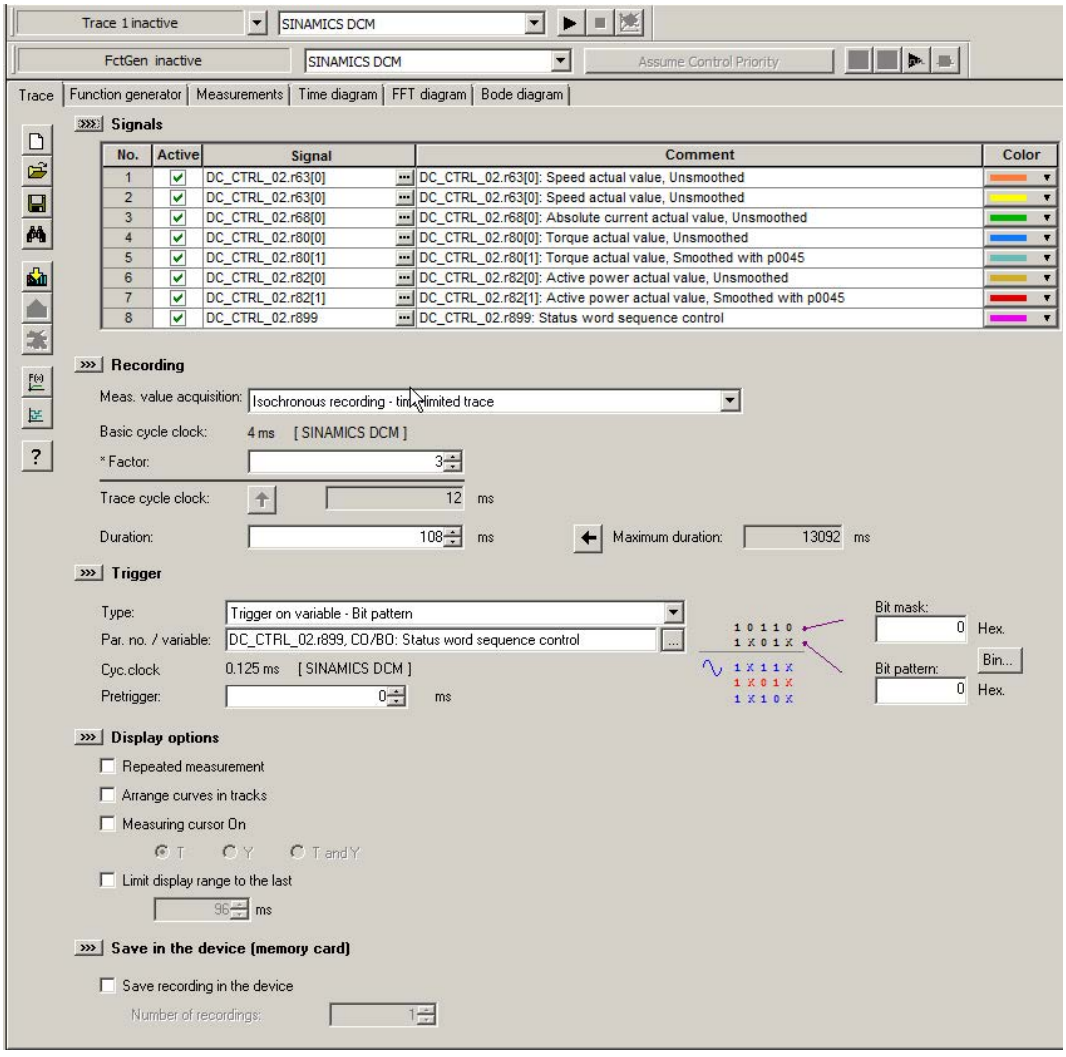



Figure 10-97 Startup trace in STARTER

2. Activate the "Save recording in the device" checkbox.
3. Enter a number ≥ 1 in the "Number of recordings" field.

**Note**

Detailed information on how to parameterize and operate the trace function is available in the STARTER online help in Chapter "Trace, measuring functions and automatic controller setting".

4. Make the required trace settings and save the settings.

5. Start the trace.

   This is followed by the prompt whether the parameterization in the device should be saved.

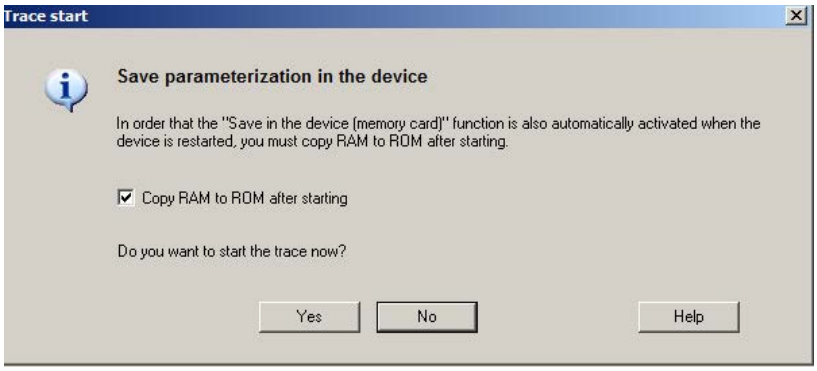



Figure 10-98 Trace save prompt in STARTER

6. Activate the "Copy RAM to ROM after starting" option.
7. Click "Yes" to start the trace.

   After the restart (POWER ON) of the SINAMICS DCM, the trace is started automatically (without a user action). After satisfying the trigger condition, the measurement is saved on the memory card in the USER\SINAMICS\DATA\LOG directory as ACX file. The trace is then restarted automatically. As many files are created as set at "Number of recordings". The oldest file is overwritten.

   In order to view the measurements later with STARTER, the memory card must be removed from the SINAMICS DCM and inserted into the PC. The files can then be opened with the STARTER trace.

### Overview of important alarms and faults (see SINAMICS DCM List Manual)

- A02097 MTrace: Multiple trace cannot be activated
- A02098 MTrace: Cannot be saved

## 10.32.6 Faults and alarms

### 10.32.6.1 General information

### Description

The errors 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 the section titled "Faults and alarms" in the SINAMICS DCM 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
  - The alarms are automatically reset once the cause has been remedied.
    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 PROFIBUS 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 drive cannot resume operation until all active faults have been acknowledged.

### 10.32.6.2 Buffer for faults and alarms

**Note**

A fault buffer and alarm buffer are provided for each drive. The drive and device-specific messages are entered in these buffers.

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 unit 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:

| | | Fault code | Fault value | Fault time "received" | Fault time "rectified" | Fault Drive object triggering | Component number Fault | Diagnostic attribute Fault |
|---|---|---|---|---|---|---|---|---|
| Current fault | Fault 1 | r0945[0] | r0949[0] [I32] r2133[0][Float] | r0948[0] [ms] r2130[0][d] | r2109[0] [ms] r2136[0][d] | r3115[0] | r3120[0] | r3122[0] |
| | Fault 2 | r0945[1] | r0949[1] [I32] r2133[1][Float] | r0948[1] [ms] r2130[1][d] | r2109[1] [ms] r2136[1][d] | r3115[1] | r3120[1] | r3122[1] |
| | Fault 8 | r0945[7] | r0949[7] [I32] r2133[7][Float] | r0948[7] [ms] r2130[7][d] | r2109[7] [ms] r2136[7][d] | r3115[7]<1> | r3120[7]<1> | r3122[7]<1> |
| 1st acknowledged fault | Fault 1 | r0945[8] | r0949[8] [I32] r2133[8][Float] | r0948[8] [ms] r2130[8][d] | r2109[8] [ms] r2136[8][d] | r3115[8] | r3120[8] | r3122[8] |
| | Fault 2 | r0945[9] | r0949[9] [I32] r2133[9][Float] | r0948[9] [ms] r2130[9][d] | r2109[9] [ms] r2136[9][d] | r3115[9] | r3120[9] | r3122[9] |
| | Fault 8 | r0945[15] | r0949[15] [I32] r2133[15][Float] | r0948[15] [ms] r2130[15][d] | r2109[15] [ms] r2136[15][d] | r3115[15] | r3120[15] | r3122[15] |
| 7th acknowledged fault [oldest] | Fault 1 | r0945[56] | r0949[56] [I32] r2133[56][Float] | r0948[56] [ms] r2130[56][d] | r2109[56] [ms] r2136[56][d] | r3115[56] | r3120[56] | r3122[56] |
| | Fault 2 | r0945[57] | r0949[57] [I32] r2133[57][Float] | r0948[57] [ms] r2130[57][d] | r2109[57] [ms] r2136[57][d] | r3115[57] | r3120[57] | r3122[57] |
| | Fault 8 | r0945[63] | r0949[63] [I32] r2133[63][Float] | r0948[63] [ms] r2130[63][d] | r2109[63] [ms] r2136[63][d] | r3115[63] | r3120[63] | r3122[63] |

<1> This fault is overwritten when “newer” faults occur

Figure 10-99 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 8 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.

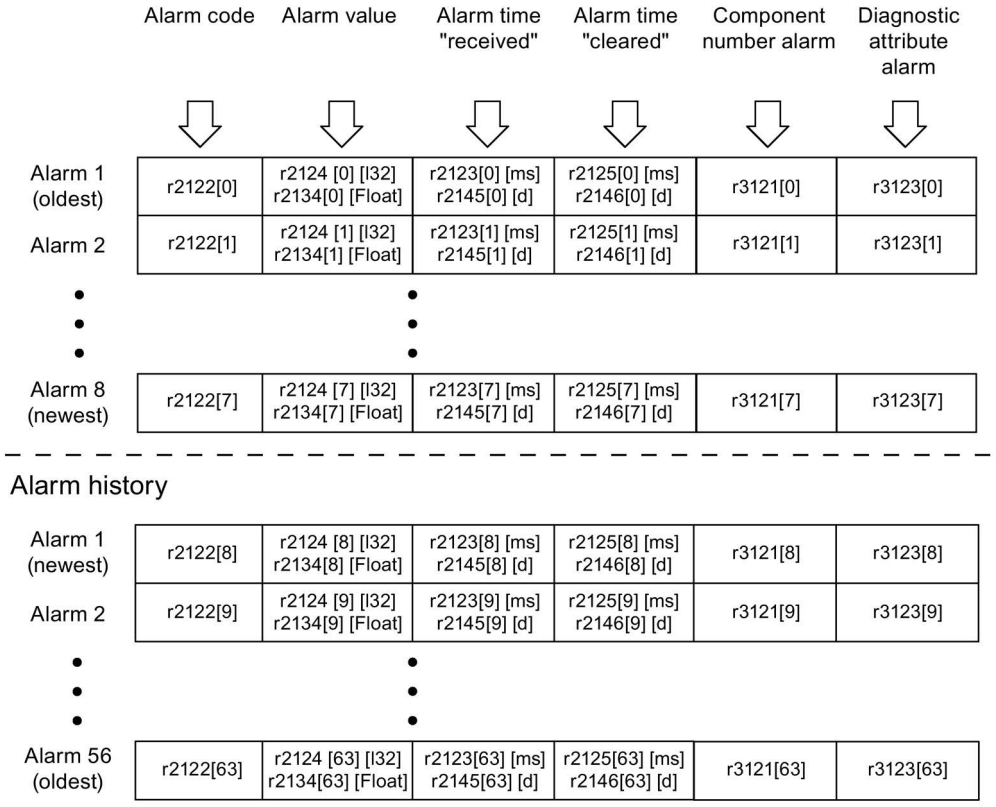



Figure 10-100 Structure of alarm buffer

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 8 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

### 10.32.6.3 Configuring messages

The properties of the faults and alarms in the drive system are permanently defined.

The following configuration settings can be made for some of the messages within a permanently defined framework for the drive system:

**Change message type (example)**

| Select message | Set message type | |
|---|---|---|
| p2118[5] = 1001 | p2119[5] | = 1: Fault (F) |
| | | = 2: Alarm (A) |
| | | = 3: No message (N) |

**Change fault response (example)**

| Select message | Set fault response | |
|---|---|---|
| p2100[3] = 1002 | p2101[3] | = 0: None |
| | | = 1: OFF1 |
| | | = 2: OFF2 |
| | | = 3: OFF3 |

**Change acknowledgment (example)**

| Select message | Set acknowledgment | |
|---|---|---|
| p2126[4] = 1003 | 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

**Delay of the fault response**

The fault response can be delayed by a parameterized time for all faults.
p51780 delay time (0.000 s .. .. 60.000 s), factory setting = 0.000 s
See also function diagram 2651.
The two CO/BOs r2139.3 (Fault active) and r3114.10 (Fault present) can be used by a higher-level controller in order to detect the time when a fault occurs (Fault present) and the time when a fault takes effect (Fault active).

## 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.

Once an external fault 1 to 3 has been triggered on the Control Unit drive object, 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 drive message has been generated. The cause of an external fault and warning should, therefore, be remedied outside the drive unit.

### 10.32.6.4 Parameters and function diagrams for faults and alarms

#### Function diagrams (see the SINAMICS DCM List Manual)

- 1710 Overview diagram – Monitoring functions, faults, alarms
- 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 (refer to the SINAMICS DCM 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

### 10.32.6.5 Forwarding faults and alarms

#### Forwarding faults and alarms of the CU

When faults or alarms are triggered on the drive object of the CU, 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, but are also forwarded to all other drive objects. The fault reaction affects the drive object of the CU and all other drive objects. This behavior also applies to the faults set in a DCC chart on the CU with the aid of DCB STM.

A fault that was set on the drive object of the CU must be acknowledged on all drive objects to which this fault was forwarded. In this way, the fault is then automatically acknowledged on the drive object of the CU. Alternatively, all faults of all drive objects can also be acknowledged on the CU.

If a set alarm is reset on the drive object of the CU, 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 from CU, TM31, TM15, TM17, and TM15DIDO drive objects are forwarded to DC_CTRL-type 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 with the aid of DCB STM.

## 10.32.7 Simulation mode

#### Description

Electrical systems are to be subjected to extensive testing (correctness of wiring, etc.) prior to mounting and before each commissioning. In the case of converter systems, in which in DCM Control Module and a thyristor power unit (possibly re-used from an old system) are installed, this check is to be performed very carefully due to the complexity of the wiring.

The DCM Control Module offers simulation mode for support.

Simulation mode enables firing pulses to be transferred to specific individual thyristors only without the line voltage being present for the power unit.

### Sequence of simulation mode

1. Selection of an individual thyristor with p51840.

   This results in the activation of simulation mode. However, this only happens in operating states ≥ o7.0. This means that during simulation mode the line contactor is opened and the power unit is not under voltage load.
   In all other operating states, p51840 is ineffective.

   If simulation mode is active, every 20 ms it outputs two firing pulses with intervals of 3.33 ms to the selected thyristor. The length setting of the pulse packet with p50079 (short pulse/long pulse) is considered here.

   While simulation mode is active, the DCM switches to operating state o8.1. As such, an ON command is ineffective during simulation mode.

2. Measurement of the firing current on the gate connection of the selected thyristor using current probe and oscilloscope.
3. End simulation mode with p51840 = 0.

By successively testing all thyristors, the following checks are possible:

- Correctness of wiring on firing pulse cables
- Correctness of set firing pulse chopping (see p51826)
- Correctness of firing current of the thyristors

### Remarks on simulation mode

- Remark 1:
  Simulation mode is in principle also possible for a DCM DC Converter. However, there is no need for this there, as the corresponding tests have already been performed at the manufacturer's factory. Furthermore, the firing pulse cables are not accessible without impermissible intervention (opening cable ties).
- Remark 2:
  The thyristor diagnostics described in Chapter "Thyristor diagnostics (Page 595)" are not suitable for checking the electrical system following mounting. In the case of thyristor diagnostics, the line voltage must be present at the power unit. The wiring of the firing pulse cables is assumed to be correct.
  Thyristor diagnostics are intended to support troubleshooting in the case of unexplained fault messages or blown fuses which suggest the presence of defective thyristors (F60004, F60010, F60057, F60300, etc.).

## 10.33 CPU time load with SINAMICS DCM

The CPU time load of the SINAMICS DCM can be read out at r9976[1]. Principally, the following rules apply:

1. The cyclic DC closed-loop control of the SINAMICS DCM generates a base load of approx. 70% (can be read on r9976[1]).
2. The use of peripherals (AOP30, Starter, TM15, TM31, TM150, SMC10, SCM30, 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. The CPU time load must not exceed a utilization of 100% at r9976[1].

**⚠WARNING**

**Exceeding the CPU time load**

At a CPU time load of >100% on r9976[1], the correct functioning of the drive is no longer ensured.

- 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 DCM.

Table 10- 80 Additional CPU time load as a result of optional components

| Component | Additional CPU time load |
|---|---|
| AOP30 via PPI | +4% |
| 1 TM31 | +4% |
| 2 TM31 | +5% |
| 3 TM31 | +6% |
| 1 TM15 | +1% |
| 2 TM15 | +1.5% |
| 3 TM15 | +2% |
| 1 TM150 | +1% |
| 2 TM150 | +1.5% |
| 3 TM150 | +2% |
| 1 SMC10, SMC30 | +2% |
| 1 CBE20 | +1% |
| Internal encoder (p50083 = 2) | +2% |
| Parallel interface | +4% |
| Peer-to-peer | +4% |

| Component | Additional CPU time load |
|---|---|
| Calculating the thyristor blocking voltage | +4.5% |
| Is supported by the CCP | +3.5% |
| Memory card inserted | +1% |
| Technology controller | +1.5% |
| Free function blocks | Depending on the number of free function blocks being used and their runtime groups, see Chapter "Free function blocks (Page 625)" |
| DCC | Depending on the number of DCC blocks being used and their runtime groups, see Chapter "Drive Control Chart (DCC) (Page 627)" |

**Note**

The additional CPU time load listed above for TM15, TM31 and TM150 apply for a sampling time of 4 ms (p4099 = 4000). Setting faster sampling rates in the TM modules increases the CPU time load in the SINAMICS DCM 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.

## 10.33.1 Maximum configuration

The following configuration can be operated as the maximum on one CUD.

Table 10- 81 Maximum configuration with SINAMICS DCM

| Number | Component | Note |
|---|---|---|
| 3 | TM15, TM31, TM150 | Connection of any combination of TM15, TM31 and TM150 modules on DRIVE-CLiQ. The connection of other TM modules (TM17, TM41,..) and of more than 3 TM modules is not permissible.<br>Sampling in 4 ms cycle (p4099=4000). Faster sampling increases the CPU time load, and precludes operation of this maximum configuration |
| 1 | SMC10, SMC30 | The connection of others (SMC20,..) and of more than 1 external encoder module is not permissible. |
| 1 | CBE20 | The connection of other OMI modules (CBE10) is not permissible. |
| 1 | Pulse encoder evaluation | p0400 > 0 |
| 1 | AOP30 | |
| 1 | STARTER | Online |
| 1 | Parallel interface | Active |
| 1 | Peer-to-peer | Active |

**Note**

The capacity of the SINAMICS DCM can be expanded by equipping the SINAMICS DCM with a 2nd CUD (right-hand mounting slot). See Chapter "Expanding the SINAMICS DCM to include a second CUD (Page 590)".

## 10.33.2 Computation examples

**Example 1:**

Project A is a single drive in a control cabinet. An AOP30 is located in the control cabinet door. The motor has a pulse encoder, which is connected through the pulse encoder input X177.41-48

| | |
|---|---|
| Base load | 70% |
| AOP30 | +4% |
| Internal encoder | +2% |
| **Calculated CPU time load =** | **76%** |

Approx. 24% remain free for use by the free function blocks and/or DCC blocks.

**Example 2:**

Project B is a single drive connected to an S7 via PROFINET. 3 TM31 modules are used for terminal expansion. The sampling rates of the TM modules (p4099) are set to 4000 ms. In addition, a configured DCC application in the drive is running, which comprises 50 blocks and runs in the 6 ms time slice.

| | |
|---|---|
| Base load | 70% |
| CBE20 | +1% |
| 3 × TM31 with p4099[1,2,3] = 500 | +6% |
| DCC application: 50 blocks @ 1 ms | +5% |
| **Calculated CPU time load =** | **82%** |

The CUD is 82% utilized.

**Note**

The available CPU time can be expanded by equipping the SINAMICS DCM with a 2nd CUD (right-hand mounting slot). See Chapter "Expanding the SINAMICS DCM to include a second CUD (Page 590)".

# 10.34 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 DCM.

## General remarks

- Exact information on the scope of the blocks, about parameter assignment and about commissioning the free function blocks is available in the "SINAMICS" Free function blocks" manual. This chapter describes the special features of the free function blocks with SINAMICS DCM.
- 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 significantly higher CPU time load. If that does not suffice, the application can be implemented with the DCC technology option. See Chapter "Drive Control Chart (DCC) (Page 627)".
- In the SINAMICS DCM, simultaneous use of the free function blocks and the DCC technology option are feasible.
- With the SINAMICS DCM, 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 displayed in STARTER and on the AOP30.

  **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..percent 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 through free function blocks with the SINAMICS DCM

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 10- 82 CPU time load through free function blocks with the SINAMICS DCM

| 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 on r9976. Please refer to the Chapter "CPU time load with SINAMICS DCM (Page 621)" for more information about the CPU load on the SINAMICS DCM.
- 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.
  - The time slice that can be selected with p20000 = 9003 is that time slice, in which the setpoint channel (function diagrams 3105 to 3155) is calculated. One of the free function blocks assigned to this time slice is immediately calculated before the functions of the setpoint channel.

# 10.35 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 DC MASTER.

The following steps are required to implement an executable DCC control with the SINAMICS DCM:

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 diagram on the PC and load it into 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 DCM.
- 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.

## 10.35.1 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 DCM 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 DCM 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 DCM 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).

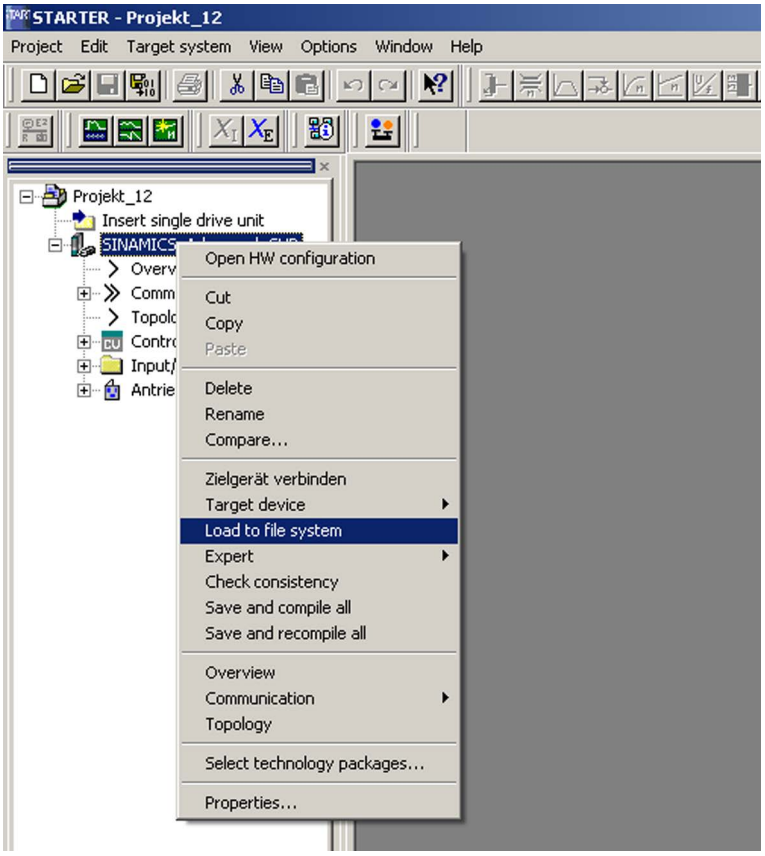



Figure 10-101 Loading into the file system

- **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 S01 or S02 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 device off/on (POWER OFF / POWER ON). After the new power-up, the DCC is ready.
- Repeat **steps 5 and 6** on additional SINAMICS DCM drives.

**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.

## 10.35.2 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 DCM and the required computation times are listed in Appendix B.

Table 10- 83 CPU time load DCC blocks left-hand CUD

| 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 a left-hand CUD without additional options. These options increase the basic load of the CUD and reduce the available CPU time for the DCC blocks. Please refer to the "CPU time load with the SINAMICS DCM" chapter for more information about the CPU load.

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. Please refer to the "CPU time load with SINAMICS DCM (Page 621)" chapter for more information about the CPU load on the SINAMICS DCM.
- 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.

## 10.35.3 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 DCM, as compared with the maximum possible configurations documented in the "Maximum configuration" chapter, depending on the size of the diagram, one must omit optional components. The number of blocks and the @parameters are decisive.

For one CUD without additional options, the following rules apply.

Table 10- 84 Maximum number of DCC blocks and @parameters

| Drive object | Number of DCC blocks and @parameters |
|---|---|
| CU_DC | 800 |
| DC_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_DC or 600 DCC blocks and @parameters on the DO DC_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 DC_CTRL, due to the large number of drive parameters, fewer DCC blocks can be computed than on the DO CU_DC.

In addition, the memory is loaded by optional components as follows:

Table 10- 85 Additional memory load through optional components

| Component | Additional memory load (expressed in DCC blocks) |
|---|---|
| AOP30 | - 200 blocks |
| TM31 | - 150 blocks |
| TM15 | - 150 blocks |
| TM150 | - 150 blocks |
| SMC10, SMC30 | - 25 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.

**Sample calculation:**

The SINAMICS DM is equipped with one AOP30 and two TM31 modules. The DCC diagram is to be computed on the DO DC_CTRL.

→ 600 – 200 – 2×150 = 100 DCC blocks can be computed on the DO DC_CTRL.

**Notes:**

- If there is insufficient memory on the CUD for the configuration of the desired DCC diagram, the scope of the blocks needs to be reduced or the SINAMICS DCM needs to be equipped with a 2nd CUD inserted in the right-hand slot.
- The computation rules stated previously also apply to the CUD on the right-hand slot.
- In most cases, the CPU time load of the CUD becomes the limiting factor when designing the DCC application and not the memory load.

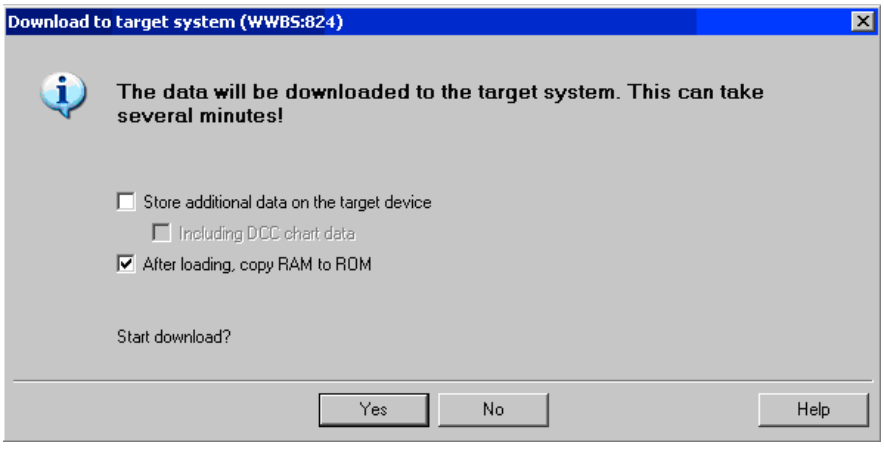
## 10.35.4 Backing up the DCC diagrams

A DCC project comprises two parts.

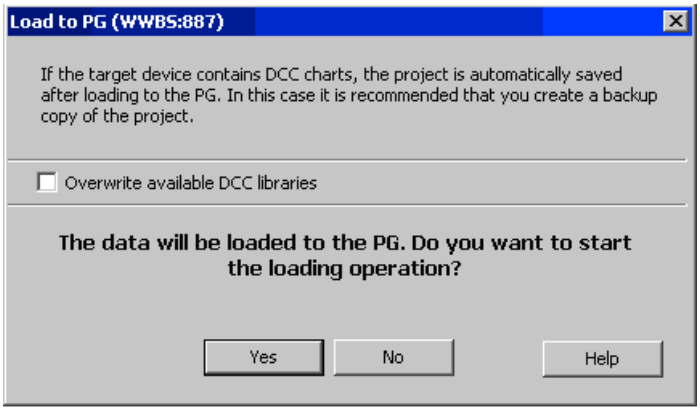
1. Information about the type, time slices and interconnection of the DCB blocks
2. Information about the layout and graphics in the DCC charts

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.

## 10.36 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. |

### 10.36.1 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".

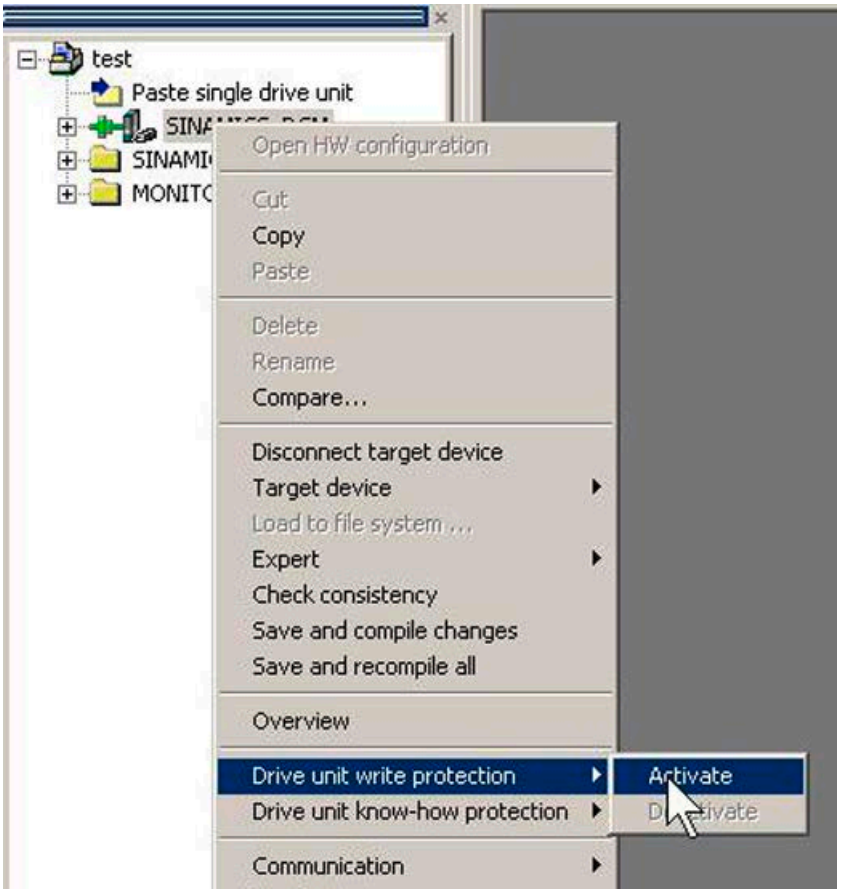



Figure 10-102 Activating write protection

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 carry out the "RAM to ROM" data save operation.

**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 DCM 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.

## 10.36.2 Know-how protection

The "Know-how protection" function prevents, for example, confidential company know-how 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.

### Characteristics when know-how protection is activated

- Except for a small number of system parameters and the parameters specified in an exception list, all other parameters are locked. In the expert list, the value of these parameters cannot be read or changed.
- In the expert list of STARTER, the text "Know-how protected" is displayed for the locked parameters instead of the parameter values.
- Know-how protected parameters of the expert list can be hidden in the "Online value of the Control Unit" drop-down list via the entry "Without know-how protection".
- The values of display parameters remain visible.
- The contents of screen forms are not displayed when know-how protection is active.
- Know-how protection can be combined with copy protection.

### Functions locked using know-how protection

The following listed functions are inhibited when know-how protection is active:

- Download
- Trace function
- Function generator
- Deleting the alarm history
- Creating acceptance documentation

### Functions that can only be partly executed with know-how protection

The following listed functions can only be partly executed when know-how protection is active:

- Displaying the topology (actual topology only)
- Upload (restricted scope; see Chapter "OEM exception list (Page 638)")

### Functions that can be executed for know-how protection

The following listed functions can still be executed despite of the fact that know-how protection is activated:

- Restoring factory settings
- Acknowledging alarms
- Displaying alarms and warnings
- Displaying the alarm history
- Reading out the diagnostic buffer
- Switching over to the control panel (fetch the master control, all the buttons and setting parameters)
- Displaying created acceptance documentation

## 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 DCM List Manual in Chapter "Parameters for write protection and know-how protection", Section "Parameters with KHP_WRITE_NO_LOCK".

## 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 DCM List Manual in Chapter "Parameters for write protection and know-how protection", in Section "Parameters with KHP_ACTIVE_READ".

**Note**

**Password check for know-how protection**

Please note that if the Windows language settings are changed, 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.

### 10.36.2.1 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 639)").
- 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.

### 10.36.2.2 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.

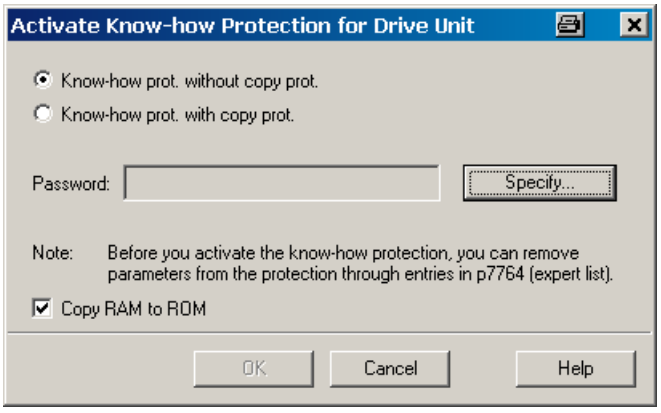



Figure 10-103 Activating

   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.

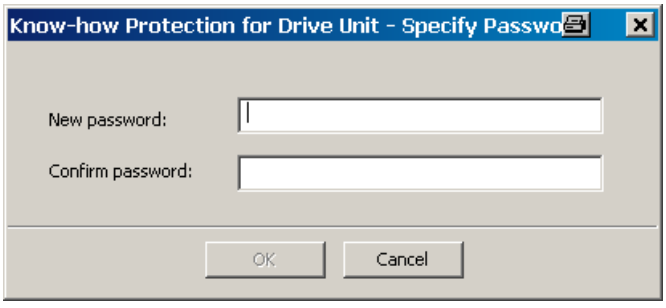



Figure 10-104 Setting the password

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.

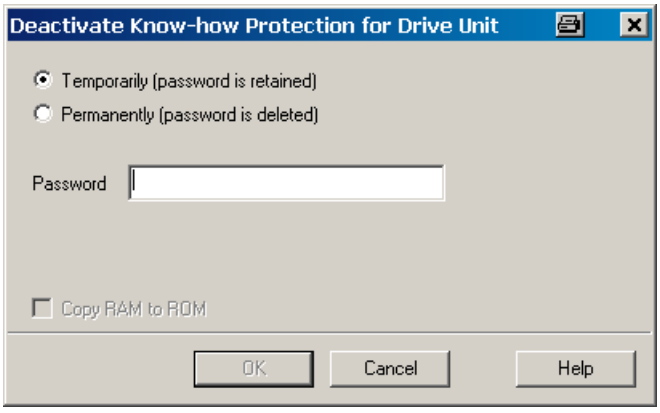



Figure 10-105 Deactivating

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, you must perform a manual "RAM to ROM" data backup later if the know-how protection remains deactivated after switching off and on.
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.

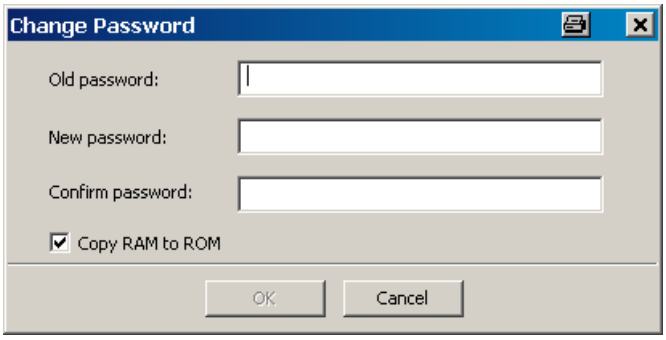



Figure 10-106 Changing the password

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.

## 10.36.2.3 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 642)").
   - 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.

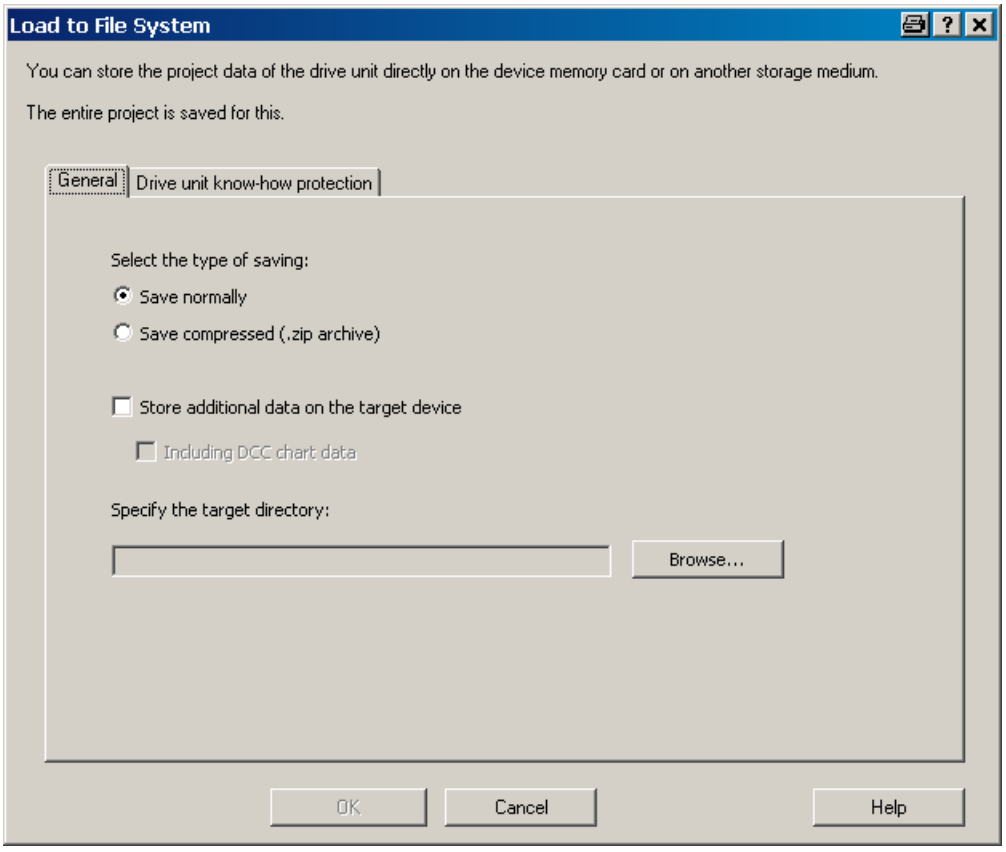



Figure 10-107 Load to file system (default setting)

## 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.

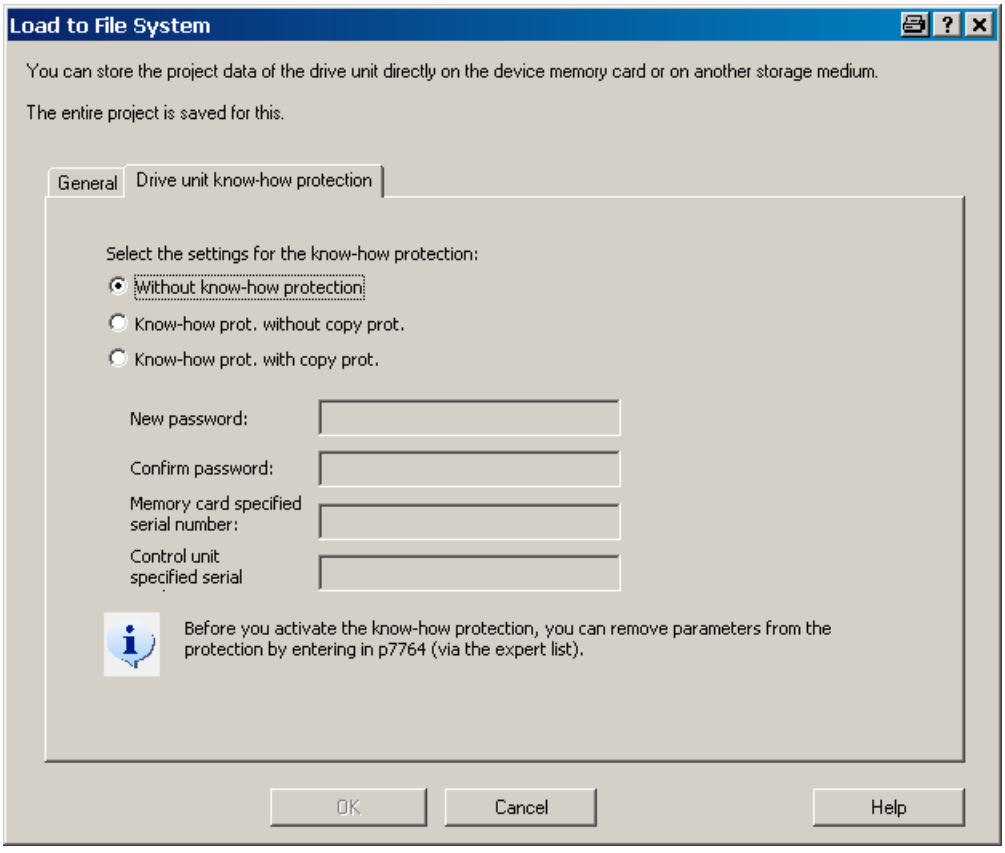



Figure 10-108 Load to file system know-how protection

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, activate the "Know-how protection without copy protection" or "Know-how protection with copy protection" option.

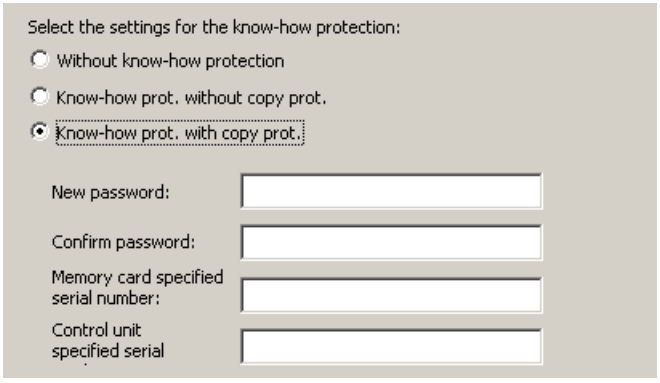



Figure 10-109 Activating load to file system know-how protection

   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.

## 10.36.3 Overview of important parameters

### Overview of important parameters (see SINAMICS DCM 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

# Maintenance 11

**⚠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.
- When assessing the risk, take into account remaining risks.

The SINAMICS DCM Control Module must be provided with extensive protection measures against contamination in order to prevent voltage flashovers and, therefore, destruction. Dust and foreign bodies must be thoroughly removed at given intervals depending on the level of soiling and certainly at least once every 12 months. The unit 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 the SINAMICS DCM Control Modules are maintained.

# 11.1 Upgrading the device firmware

This chapter describes how you can upgrade a drive – including STARTER project – from one firmware version to a higher firmware version (e.g. V1.1 to V1.2).

## Basic information

The following steps are necessary:

- Upgrading the device firmware
  - Step 1: Backup the configuration
  - Step 2: Firmware update of the drive (incl. I/O)
  - Step 3: Update the STARTER project
  - Step 4: Load into the target system, RAM to ROM
- Upgrade the DCC technology option (optional)
  - Step 5: Update the DCC technology option (DCBLIB) and the DCC charts
  - Step 6: Load into the target system, RAM to ROM

**Note**

A memory card is required for the firmware update (see Chapter "Ordering information for options and accessories (Page 26)").

When updating the firmware, always proceed as follows:

1. Firmware update of the drive
   - Insert the memory, then switch the electronic power supply OFF and ON again. The device firmware is now installed.
   - Switch the electronic power supply OFF and ON again. The device firmware just installed now powers up.
     If neither a CBE20 nor DRIVE-CLiQ components are available, the drive is ready for operation.
     However, if a CBE20 or DRIVE-CLiQ components or both are available, the firmware of these components is updated during the power-up of the device firmware. At the end of the power-up of the device firmware, the DRIVE-CLiQ components indicate that a restart is required through flashing red LEDs. Alarm A1006 also appears. Switch the electronic power supply OFF and ON again a third time.
   - If only a CBE20 is connected, there is no indication after the second OFF and ON that the CBE20 also requires a restart so that the CBE20 firmware installed in the previous step is also started. However, a third OFF and ON of the electronic power supply is also required in this case.
2. Update the STARTER project
3. Load the converted STARTER project to the drive (load to the target device)

Do not proceed as follows:

1. Firmware update of the drive
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 drive 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.

### 11.1.1 Upgrading the device firmware

**Note**

**Hardware/firmware compatibility**

The hardware version of the Control Unit (CUD) must be taken into account when updating the device firmware. See the table below.

The hardware version can be read from the label on the right-hand side of the CUD.

| CUD (print on label) | Executable firmware versions |
|---|---|
| C98043-A7100-**L1**-...<br>C98043-A7100-**L2**-...<br>C98043-A7100-**L100**-...<br>C98043-A7100-**L200**-... | 1.1, 1.2, 1.3 |
| C98043-A7100-**L3**-...<br>C98043-A7100-**L4**-...<br>C98043-A7100-**L103**-...<br>C98043-A7100-**L204**-... | All versions |
| A5E... | All versions |

#### Step 1: Backup the configuration

The drive parameter assignment is not lost while updating the firmware. Nevertheless, before starting the firmware update, back up the drive configuration:

- Backup the parameter assignment on a memory card (see Chapter "Functions of the memory card") and/or
- Backup the parameter assignment in a STARTER project (see Chapter "Commissioning with the STARTER commissioning tool (Page 253)")

### Step 2: Firmware update of the drive

**Notes:**

Only those memory cards that Siemens has prepared for these systems are accepted.
If the memory card is formatted, then this must always be realized with the FAT16 setting.
Download the current firmware version: See preface

**Procedure:**

1. Unzip the *.zip file to an empty memory card
2. Insert the card in the drive, which has been switched-off, and switch the device on again. A firmware update is being performed. The update has been completed if the RDY-LED and the DP1-LED flash at 0.5 Hz (the update takes about 12 min).
3. Carry out a POWER OFF. Remove the memory card from the drive.

| NOTICE |
| --- |
| **Removing the memory card before POWER ON**<br>If the memory card is not removed from the drive before the POWER ON, the parameterization in the drive is copied to the memory card during power-up, or a parameterization already on the card copied to the drive.<br>For a detailed description of this function, see Chapter "Memory card functions (Page 327)", 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 drive, the following mechanism described in Chapter "Memory card functions (Page 327)", Section "Copying parameter data sets from non-volatile memory to the memory card" takes effect.

   – The connected TM modules and/or SMC10 or SMC30 carry out a firmware update when powered up for the first time.
   After the firmware update of these components, it is necessary to carry out a POWER OFF / POWER ON for these components. The memory card no longer needs to be inserted for this step.

   – An optionally connected AOP30 indicates that new AOP firmware is available. Confirm the prompt after the update with "OK".

**Note**

As a result of the device firmware update, DCC charts in the device are not automatically upgraded to the new DCC version. This is also not absolutely necessary. See also Step 5 (next chapter).

**Note**

The electronic power supply must not be interrupted during the firmware update, otherwise the update will need to be restarted.

**Note**

To safely remove the memory card, see Chapter "Memory card functions (Page 327)".

### Step 3: Update the STARTER project

Install the SSP that matches the new firmware version (e.g. SSP SINAMICS DCP V1.2).

SSPs for different versions of the same drive 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. V1.2 to V1.1).

### Step 4: Load into the target system, RAM to ROM

Load the project into the drive (load into the target system) and permanently save the parameter assignment (carry out RAM to ROM).

## 11.1.2 Upgrading the DCC technology option

### Step 5: Update the DCC technology option (DCBLIB) and the DCC charts

It is not absolutely necessary to upgrade the DCC library. Only upgrade the DCC library if you wish to use functions that the old DCC library does not support.

It is only possible to upgrade the DCC library via the associated STARTER project. While upgrading, it is not permissible that there is a DCC chart in the drive.

After you have upgraded the unit firmware according to the previous chapter, update the DCC technology option as follows:

- Establish a connection to the drive using STARTER.
- Delete the parameter assignment and DCC charts in the drive, by setting p0976 to 200. After deleting, the parameterization including the DCC charts only exist in STARTER.
- After the system was reset via p0967 = 200, re-establish a connection to the drive via STARTER.
- Import the new DCC library (see Chapter "Drive Control Chart (DCC) (Page 627)").

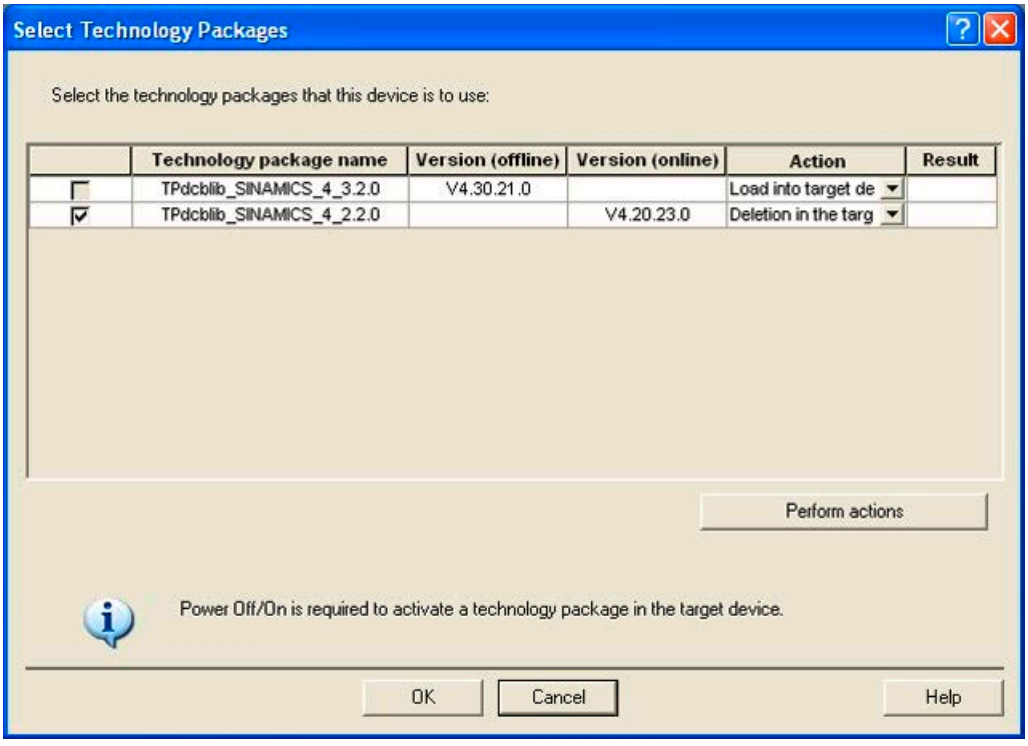



Figure 11-1 Selecting technology packages

- Carry out a POWER OFF / POWER ON to activate the new DCC library.

- Convert the existing DCC Charts.
  - Open the DCC editor by double clicking on the DCC chart.
  - In the DCC editor, in the menu, selection "Options" → "Block types…".
  - Answer the question "Do you wish to update the block types in the DCC editor" with "OK".

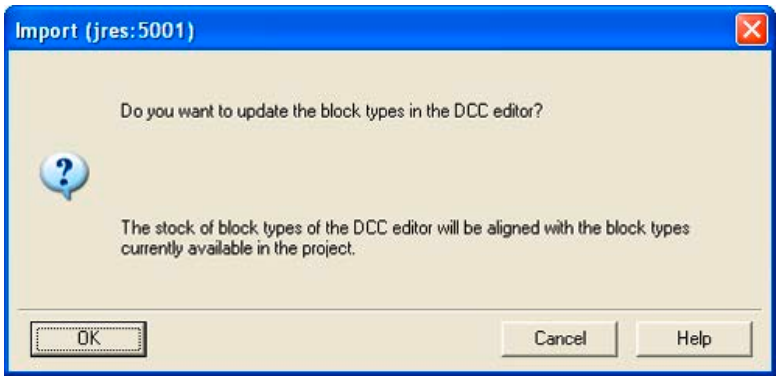



Figure 11-2 Importing the DCC library (1)

  - Shift the DCC library, which appears in the left-hand window, to the right with ">>".

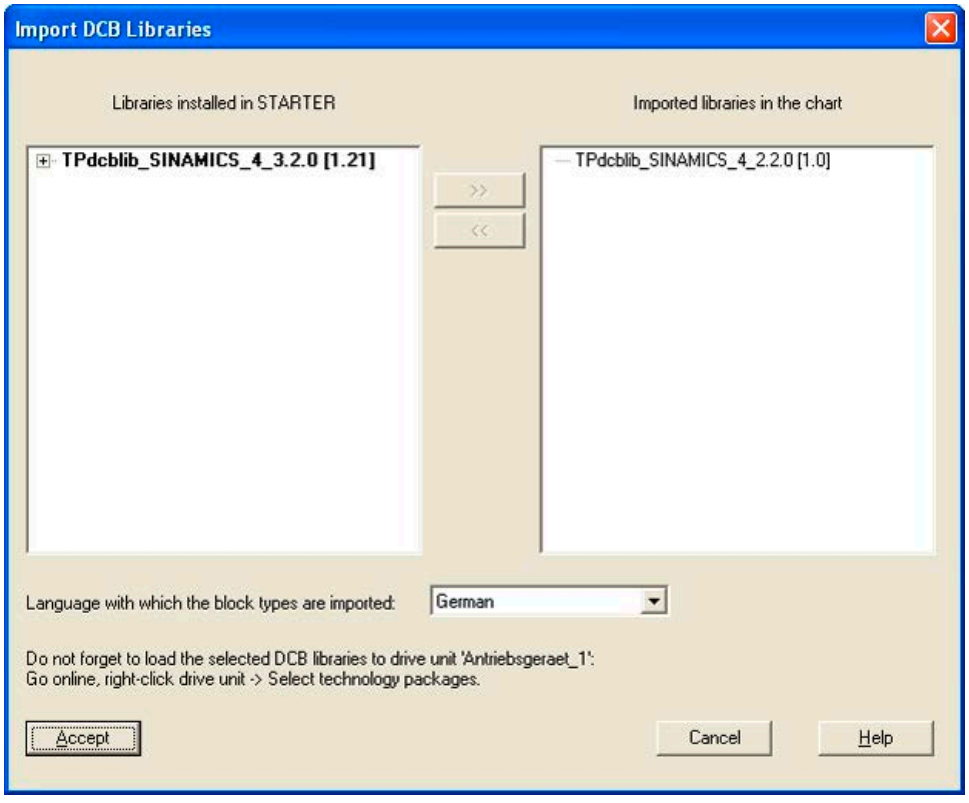



Figure 11-3 Importing the DCC library (2)

  - Select "Accept".
  - The chart is compiled into the new version.
  - Perform these steps for all DCC charts which are in the drive.

### Step 6: Load into the target system, RAM to ROM

Load the project into the drive (load into the target system) to upgrade the charts in the drive to the new version and permanently save the parameter assignment (carry out RAM to ROM).

## 11.2 Replacing the CUD

**Note**

The information regarding electrostatic sensitive devices must be carefully observed. See Chapter "ESD-sensitive components (Page 22)".

**Note**

**Use the supplied protective cover**

The module is equipped on both sides with highly sensitive components that can be damaged if installed incorrectly.

It is therefore essential that you use the supplied mounting aid (protective cover) when installing or removing the CUD.

**Required tools**

Torx screwdrivers TX10 (CUD) and TX20/TX30 (front cover).

## Removing the existing CUD

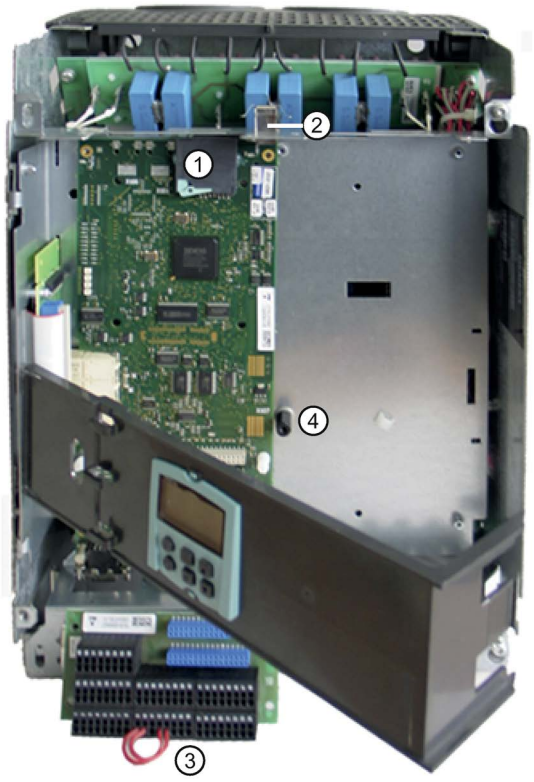



Figure 11-4 CUD replacement 1

1. Remove the memory card ①.
2. Remove the shield clamp ②.
3. Remove the Connector Board ③. The connection wires remain in the terminals.
4. If a CBE20 is present: Unplug the PROFINET cable.
5. Disconnect all plug-in connections on the CUD.
6. Remove the support element ④ (only present in standard CUD).
7. Loosen the fixing screws of the CUD.
8. Insert the supplied mounting aid.
9. Withdraw the CUD carefully.

After removing the screws and before pulling out the CUD, the module must be raised slightly and the supplied mounting aid (protective cover) inserted between the CUD and the assembly bolts in order to prevent any damage to the CUD to be replaced.

There are sensitive components on the rear of the CUD that may be torn off or damaged by coming into contact with the assembly bolts when pulling the CUD out without the mounting aid.

## Installing the CUD

Figure 11-5 CUD replacement 2

- Insert the protective cover ⑤ so that the mounting sockets below it are covered.
- Hold the new CUD at an angle of 10° to 15° at the connector and parallel to the side wall ⑥.
- Press the CUD onto the terminal strip ⑦.
- Pull out the mounting aid ⑧.
- Screw the CUD tight and attach all the components again that were removed from the old CUD. Reconnect the connections.

## Replacement/installation of a CUD in the right slot

A CUD is installed in the right slot in the same way as in the left slot.

For simple handling, it is recommended that you swing out the electronics plate slightly.

Make sure that the mounting sockets are covered by the mounting aid.

# 11.3 Replacing the back-up battery in the AOP30 operator panel

Table 11- 1 Technical specifications of the backup battery

| | |
|---|---|
| Type | CR2032 3 V lithium battery |
| Manufacturer | Maxell, Sony, Panasonic |
| Nominal capacity | 220 mAh |
| Self-discharge at 20 °C | 1%/year |
| Service life (in backup mode) | > 1 year at 70 °C; >1.5 years at 20 °C |
| Service life (during operation) | > 2 years |

## Replacement

1. Disconnect the SINAMICS DCM from the power supply.
2. Open the cabinet.
3. Disconnect the 24 V DC power supply and communications line on the operator panel.
4. Open the cover of the battery compartment.
5. Remove the old battery.
6. Insert the new battery.
7. Close the cover of the battery compartment.
8. Reconnect the 24 V DC power supply and communications line.
9. Close the cabinet.

**Note**

The battery must be replaced within one minute to ensure that no AOP settings are lost.

Figure 11-6 Replacing the backup battery for the cabinet operator panel

**Note**

The battery must be disposed of in accordance with the manufacturer guidelines and applicable country-specific laws and directives.

# Applications

# 12

## 12.1 Using SINAMICS DCM in shipbuilding

When using SINAMICS DCM in shipbuilding, the following points must be observed:

- Radio interference suppression filters must be used in the armature circuit and in the field circuit (see Chapter "Connecting (Page 55)")
- For EMC-compliant installation, see Chapter "Connecting (Page 55)".
- Use coated modules (option M08), see Chapter "Ordering information for options and accessories (Page 26)".

## 12.2 Connecting an incremental encoder

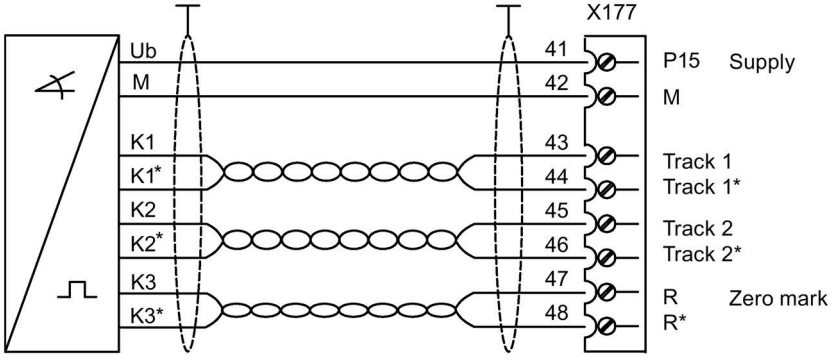
**Note**

Because the physical transmission media is more robust, the bipolar connection should always be used. The unipolar connection should only be used if the encoder type does not output push-pull signals.

**Note**

The technical data of the incremental encoder inputs (X177.41 to 48) and further information on how to connect an incremental encoder are given in Chapter "Connecting (Page 55)".

### HTL encoder, bipolar, with zero signal




Improved protection against induced interference is achieved by twisting the signal lines in pairs.

Figure 12-1 Bipolar incremental encoder

### HTL encoder, bipolar, with zero signal

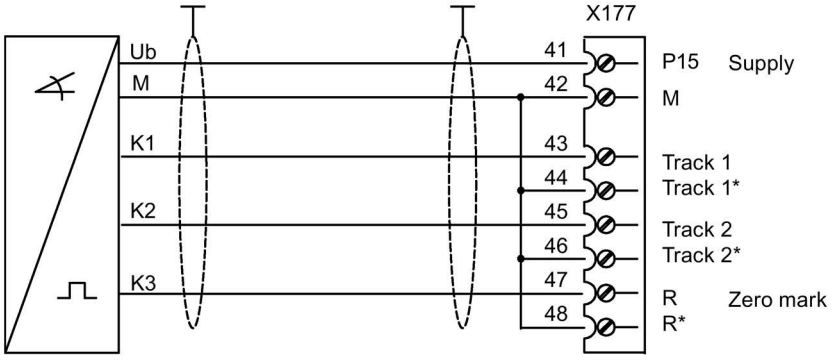



Figure 12-2 Unipolar incremental encoder

## 12.3 Use of the SINAMICS DCM in galvanizing and dip-painting plants

2Q devices are used when using the SINAMICS DCM in galvanizing, dip-painting or similar plants.

2Q devices have a thyristor bridge in B6 circuit. In this power unit topology, the output voltage of the SINAMICS DCM is partly negative for firing angles between 60° and 120°. In order to ensure that no negative voltages are present at the load, i.e. at the galvanizing and paint tanks, an external freewheeling diode is usually installed on the DC side for these applications. This is not part of the SINAMICS DCM, but rather is installed in the control cabinet.

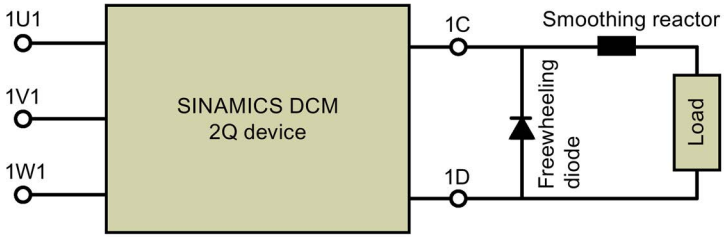



Figure 12-3 SINAMICS DCM, 2Q device with external freewheeling diode

Make sure that in this case, the current actual value sensing in the converter only measures part of the load current, i.e. the current through the converter, **not** the freewheeling current.

This means that the SINAMICS DCM cannot control the load current.

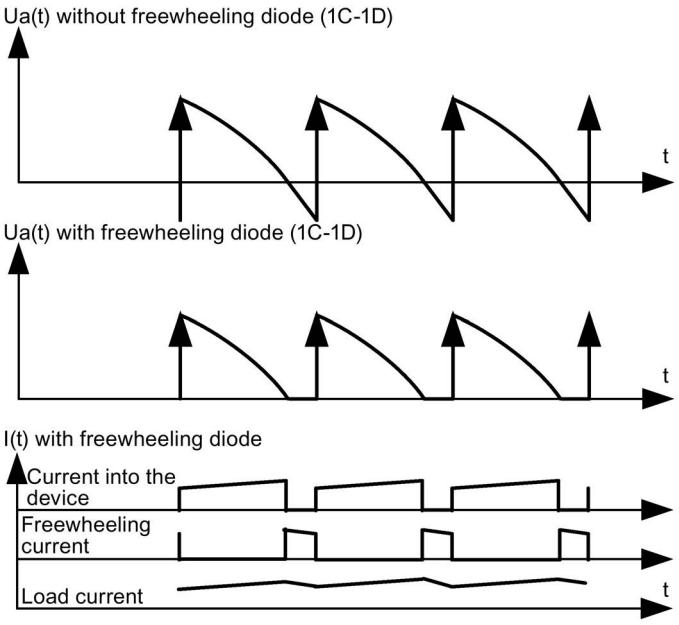



Figure 12-4 Voltage and current curves

In order to be able to control the load current, it is recommended that an external actual current sensing circuit be used for these applications. Whereby, the entire load current (including the freewheeling current) is measured via an external shunt. The shunt voltage must be increased via an external shunt converter and then led to the SINAMICS DCM via an analog input. See function diagram 6850, column 2.

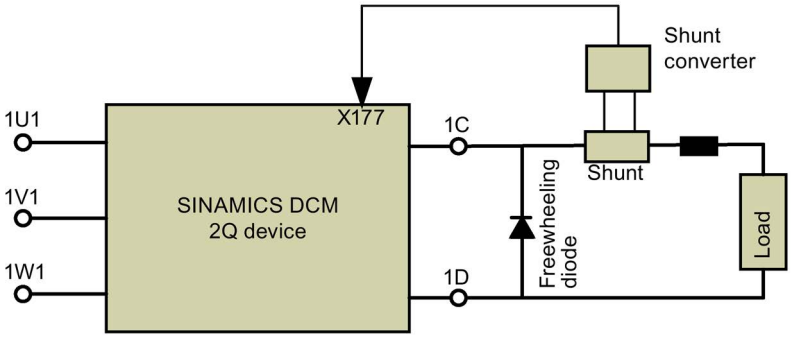



Figure 12-5 SINAMICS DCM with external current actual value sensing

### Parameter

| | |
|---|---|
| p51852 | Selection of external current actual value sensing |
| p51853 | Scaling of external current actual value sensing |

## 12.4 Using SINAMICS DCM as thyristor controller in heating applications

Under certain preconditions, the SINAMICS DCM can be used as three-phase AC power controller for heating applications.
This means that in some cases SIVOLT A three-phase AC power controllers can be replaced by SINAMICS DCM converters.

You can download an application document from the Internet: Manuals (https://support.industry.siemens.com/cs/ww/en/ps/13298/man)

# Functional safety 13

## 13.1 Functional safety: Deactivated – Activated

### STO circuit deactivated

Jumper in terminal X200/1:2 (STO to P24): STO circuit is deactivated.

Here, the STO input is deactivated and the STO is therefore deselected. Converter operation is possible independent of the signal states at the STO input.

- The converter is supplied in this state. The terminals 105 and 106 are jumpered in the delivery state (no Emergency Stop).
- Applications where STO is not used.

### STO circuit activated

Jumper in terminal X200 must be removed: STO circuit is activated.

Safety relay can be connected.

## 13.2 General technical specifications of the DCM (6RA80)

Table 13- 1 SINAMICS DCM

| Functional safety | |
|---|---|
| $MTTF_D$ according to ISO 13849-1 | 500 years |
| Diagnostics coverage (DC) according to ISO 13849-1/IEC 61508 | 99% |
| Maximum operating altitude above MSL | 4000 m [1)] |
| T1 value for proof test interval or service duration according to ISO 13849-1/IEC 61508 | 20 years |
| Response time when activating STO | Maximum 250 ms |

1) For installation altitude > 2000 m, select a suitable safety relay and coupling relay (contactor relay).

Table 13- 2 Application

| **Functional safety** | |
|---|---|
| Safety integrity level (SIL) according to IEC 61508 | SIL 3<br>Depending on the application and diagnostic test interval |
| Performance Level (PL) according to EN ISO 13849-1 | PL e<br>Depending on the application and diagnostic test interval |
| Category according to EN ISO 13849-1 | Cat. 4<br>Depending on the application and diagnostic test interval |
| $PFH_D$ with high demand rate according to IEC 61508 | 70 x $10^{-9}$ /h<br>Depending on the application and diagnostic test interval |
| Maximum installation altitude above sea level [1)] | 2000 m |

1) For installation altitude > 2000 m, select a suitable safety relay.

The general environmental conditions and technical data can be found in the SINAMICS DCM DC converters / SINAMICS DCM Control Modules.

## 13.3 Standards

| | |
|---|---|
| EN ISO 13849-1:2016 | Safety of Machinery; Safety-Related Parts of Control Systems – Part 1: General principles for design |
| EN ISO 13849-2:2013 | Safety of Machinery; Safety-Related Parts of Control Systems – Part 2: Validation |
| EN 61800-5-2:2017 | Adjustable-speed electrical power drive systems – Part 5-2: Safety requirements – Functional safety |
| EN 62061:2015 | Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| EN 61508-2:2016 | Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements placed on safety-related electrical/electronic/programmable electronic systems |
| EN 61511-1:2017 | Functional safety – Safety instrumented systems for the process industry sector – Part 1: General, terminology, requirements relating to systems, software and hardware |

# 13.4 Fundamental safety technology principles

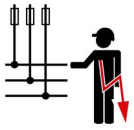
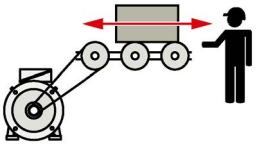
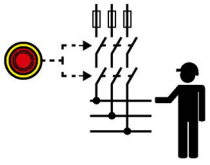
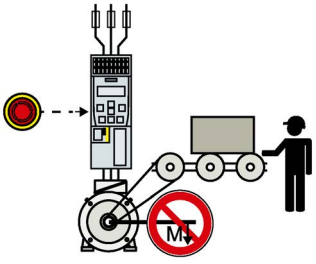
## 13.4.1 Standard stop functions

### 13.4.1.1 Emergency Off and Emergency Stop

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

The STO function is suitable for achieving an Emergency Stop but not an Emergency Off.

You can review the details about the definitions in EN 60204-1.

| Risk: | Risk of electric shock:<br>  | Risk of unexpected motion:<br>  |
|---|---|---|
| Measure to minimize risk: | **Safe switch off**<br>Switching off the electric power supply for the installation, either completely or partially. | **Safely stop and safely prevent restarting**<br>Stopping or preventing the dangerous movement |
| Command: | **Emergency Off** | **Emergency Stop** |
| Solution: | Switch off the power supply:<br>  | Select STO:<br>  <br>It is permissible that you switch off the inverter power supply as well. However, switching off the voltage is not required as a risk-reduction measure: |

## 13.4.2 Standard safety functions according to EN 61800-5-2

### 13.4.2.1 Safe Torque Off (STO)

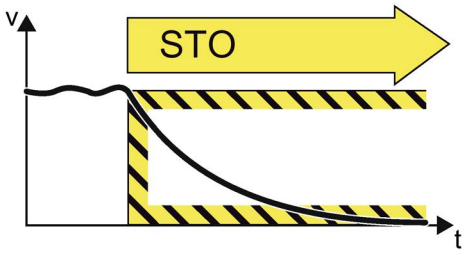



Figure 13-1 Safe Torque Off (STO)

Safe Torque Off is a safety subfunction that immediately ensures that torque or force-generating energy is not fed to the motor. This function corresponds to stop Category 0 according to EN 60204-1.

The Safe Torque Off (STO) function is used to safely disconnect the torque-generating energy feed to the motor; this is achieved in the power unit by preventing (through two channels), alternating voltage to be output to the motor.

The switch-on inhibit, which prevents automatic restart after deactivating STO, must be implemented by the upstream external monitoring and control system (e.g. 3SK1), according to the requirements of EN 60204-1, Chapter 9.2.5.

#### Typical applications

Applications include all machines and systems with moving axes (e.g. conveyor technology, fans). STO allows personnel to safely work with a protective door open; a classic emergency stop with electromechanical disconnection is not required. The inverter remains connected to the line and can be fully diagnosed.

### 13.4.2.2 Safe Stop 1 (SS1-t, time controlled)

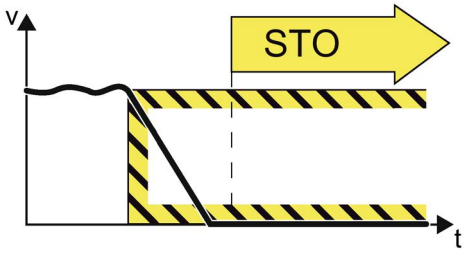



Figure 13-2 Safe Stop 1 (SS1-t, time controlled)

Safe Stop 1 (time controlled) causes the motor to be braked (this function is integrated in the drive) – and after a specified time interval, the Safe Torque Off function is initiated. This function corresponds to Stop Category 1 according to EN 60204-1.

The Safe Stop 1 function (SS1-t) function means that the motor is stopped and then the torque-generating energy is shut down (STO). When SS1-t is activated, the inverter brakes the motor along a braking ramp. This happens via the braking function integrated in the drive along the OFF3 ramp.

SS1-t corresponds to the SS1-t function according to EN 61800-5-2.

#### Typical applications

SS1-t can be used wherever the load torque cannot stop the motor in a sufficiently short time as a result of friction – or where there is a safety risk if the drive coasts down (STO).

### 13.4.3 Safety functions of the SINAMICS DC MASTER

#### Technical fundamentals and data

The SINAMICS DCM is equipped from function version 04 with a safety-related switch-off signal path for STO. An additional license is not required for this function.

In connection with an external safety relay (e.g. 3SK1) and with a redundant switch-off signal path via armature line contactor, a Safe Torque Off (STO) or Safe Stop 1 (SS1) safety function SIL 3/PL e Cat. 4-capable application is achieved according to EN 62061 or ISO 13849-1.

The STO safety function comprises three safety element functions:

1. **Detect**

   Performed externally, e.g. by emergency stop button or other sensors

2. **Evaluate**

   Performed externally, e.g. by a 3SK1 safety relay

   – Evaluation and diagnostics of the input / sensor circuits
   – Logical interconnection of input signals as well as diagnostics and parameterization
   – Controlling the switch-off signal paths
   – Diagnostics of the switch-off signal paths via their feedback circuits

3. **React**

   Performed by two separate channels with different technologies:

   – Switch-off signal path channel 1 through the armature line contactor
   – Switch-off signal path channel 2 through the STO switch-off signal path of the DCM

   The structure from the two switch-off signal paths incl. their diagnostic paths fulfill a SIL 3 or PL e Cat. 3 / 4-capable STO shutdown.

## 13.5 Application examples

**Note**

**Response time of the STO function**

The STO safety function in the DC master is designed for a 250 ms response time.

The external redundant switch-off signal path via the contactor/circuit breaker must also be designed for a 250 ms response time.

In six application examples (see the following figures), the safety functions STO and SS1 are shown for applications with a safety relay and a contact block (line contactor and circuit breaker) to safely shut down the armature circuit (first channel):

- STO application with line contactor
- STO application with circuit breaker
- SS1 application with line contactor
- SS1 application with circuit breaker
- SS1 application with line contactor and F-PLC
- SS1 application with circuit breaker and F-PLC

### Description of the applications

The SINAMICS DCM is activated and evaluated in all four application examples each with a 2-channel EMERGENCY STOP trigger mechanism (e.g. EMERGENCY STOP button, safety door switch, etc.) via an additional **3SK1121 safety relay** (green block).

- STO application:

  3SK1121-2AB40 safety relay

- SS1 application:

  Safety relay 3SK1121-2CB42 (with the option to set a delay time for quick stop)

Via the corresponding terminals of the safety relay, the **STO input** and the **feedback circuit RM1 / RM2** of **SINAMICS** DCM (red block, SAFETY circuit, second channel) are wired via the contacts of the contact blocks (blue block, line contactor or circuit breaker, first channel).

- For applications with line contactor, the feedback circuit is routed via **contacts A1 and A2** of the **line contactor KA1**.
- For applications with circuit breaker, the feedback circuit is routed via the undervoltage coil **U<** of the **circuit breaker 3WL**.

In addition, **E-STOP** (terminals 106, 109, 110) and the 24V input **P24** (terminal X177.9) of the Power Interface are guided in **SINAMICS DCM** via the safety relay.

In the case of SS1 applications, the **quick stop function OFF 3** (undelayed contact block, terminal X177.15 DI/DO 4) of **SINAMICS DCM** is guided via the safety relay.

**Note**

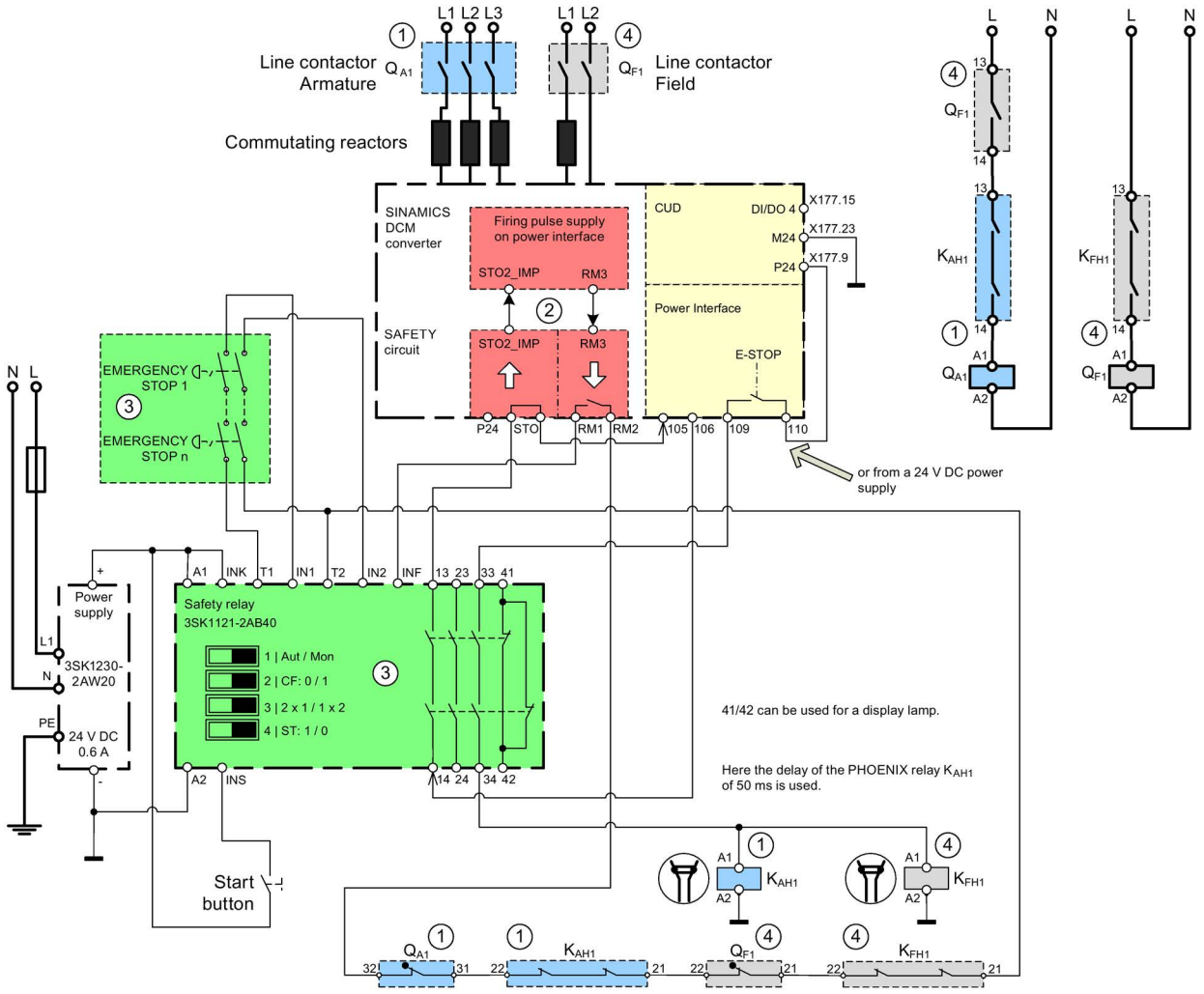
In the case of SS1 applications, the OFF 3 ramp of the SINAMICS DCM and the setting of the delay time on the safety relay, must be manually set to the process and adjusted and coordinated with one another when commissioning the system.

## Principle

Legend for **SINAMICS** DCM applications:

| | |
|---|---|
| $Q_{A[n]}$ | Armature contactor |
| $Q_{F[n]}$ | Field contactor |
| $K_{AH[n]}$ | Safety-related interface relay to control the armature contactor |
| $K_{FH1}$ | Safety-related interface relay to control the field contactor |
| DI/DO 4 | Programmable digital input 4, X177.15 (to select OFF3 = fast stop) |
| $K_{FH1}$ $K_{AH1}$ $K_{AH[n]}$ | Phoenix Contact, PSR-SPP-24DC/FSP/1X1/1X2 - 2981981 |
| STO | Activation/deactivation STO on SINAMICS DCM |
| RM1 / RM 2, 106, 109, 110 | Connection for feedback circuits and safety relay on SINAMICS DCM |
| P24 | 24 V supply via X177.9 |
| M24 | 24 V ground via X177.23 |
| PE | Protective conductor connection |
| L, N | Maximum supply voltage, 250 $V_{AC}$ |
| U< | Undervoltage release 3WL circuit breaker |
| | Positively-driven contacts = combination of NO and NC contacts is designed so that they can never be simultaneously closed |
| | Mirror contact = auxiliary NC contact that cannot be closed simultaneously with a main NO contact. |
| | Switch position = black |

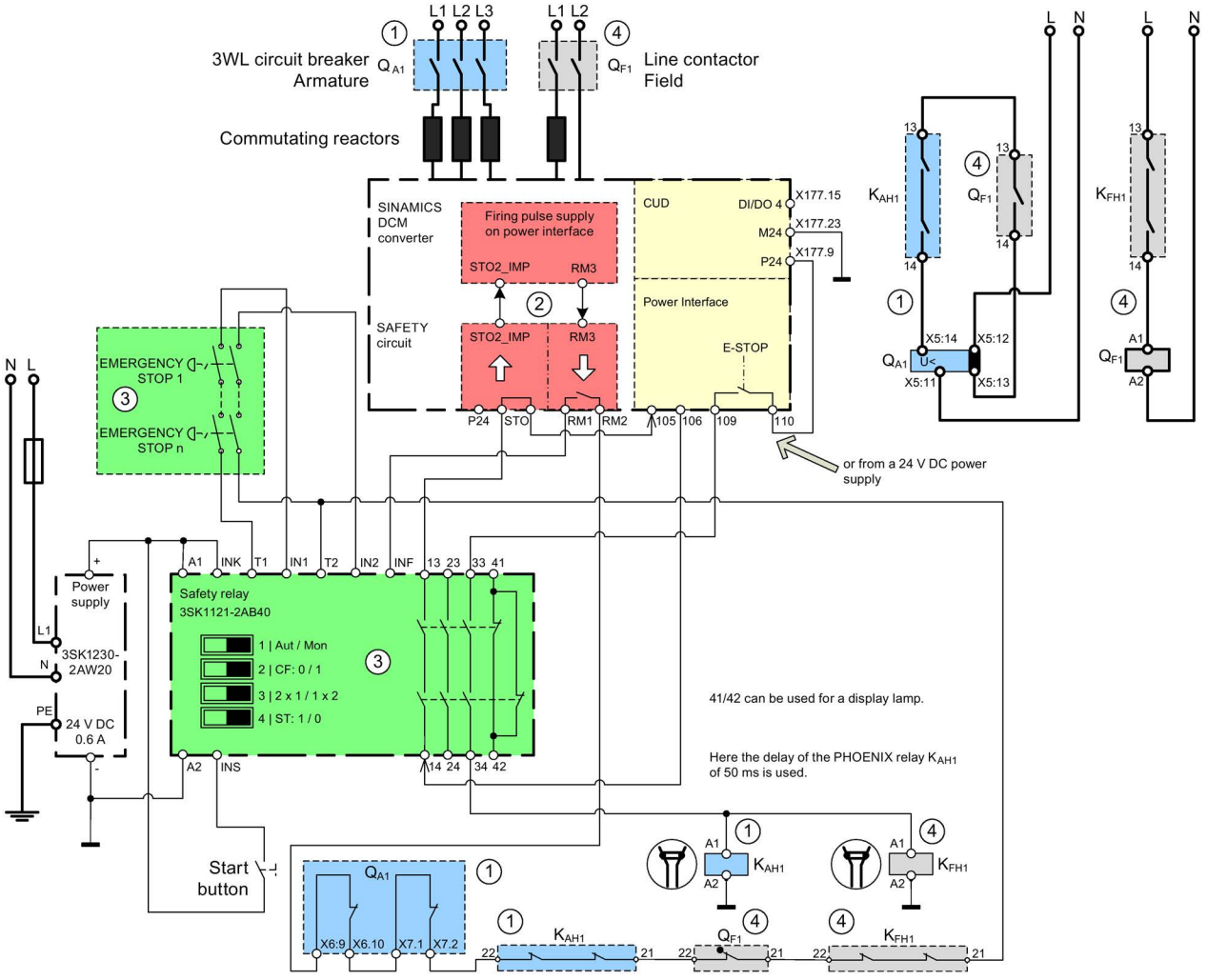
## STO application with line contactor




① First channel (blue): Line contactor armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (green)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-3 STO application with line contactor

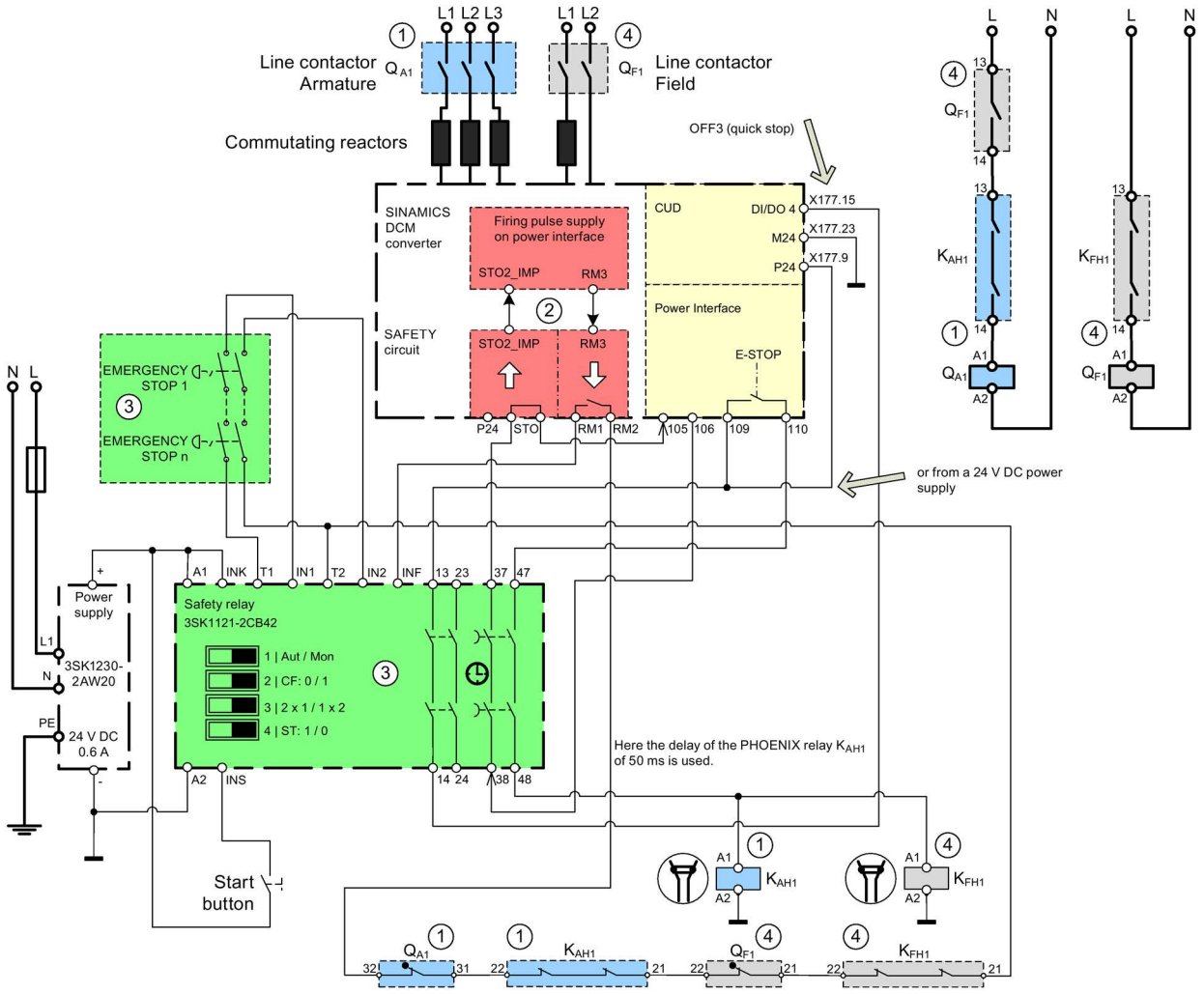
## STO application with circuit breaker




① First channel (blue): Circuit breaker (3WL) armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (green)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-4 STO application with circuit breaker

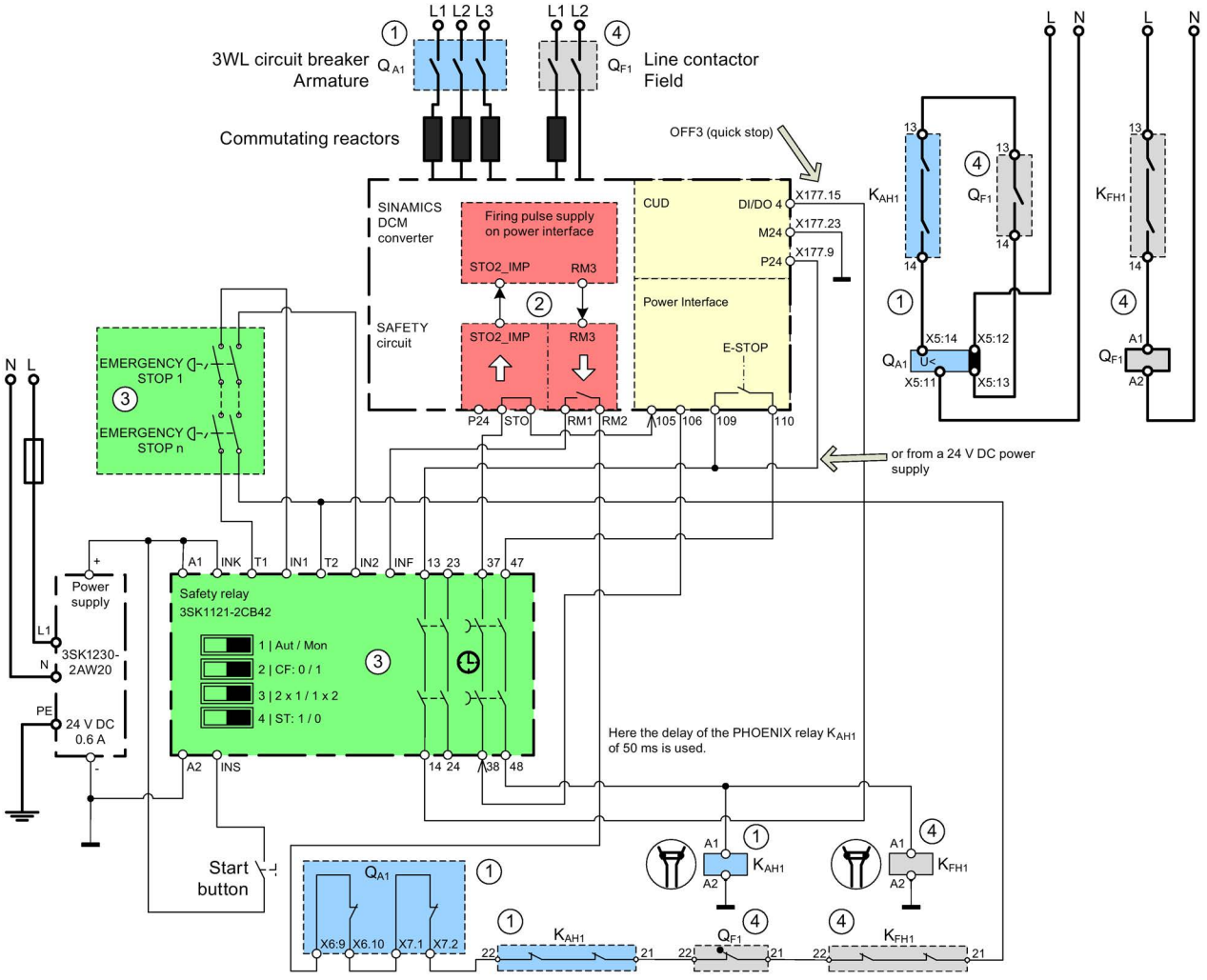
## SS1 application with line contactor




① First channel (blue): Line contactor armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (green)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-5 SS1 application with line contactor

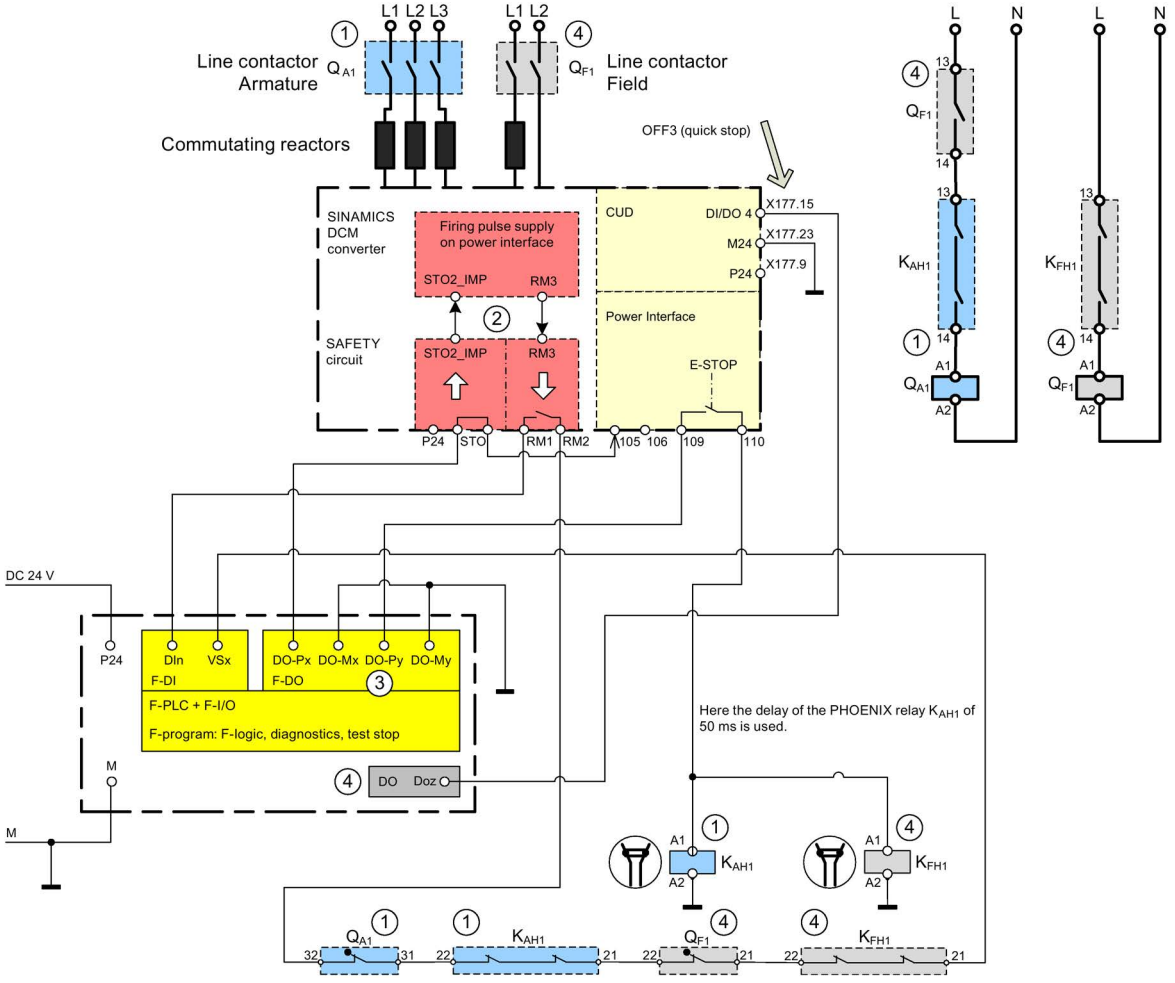
## SS1 application with circuit breaker




① First channel (blue): Circuit breaker (3WL) armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (green)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-6 SS1 application with circuit breaker

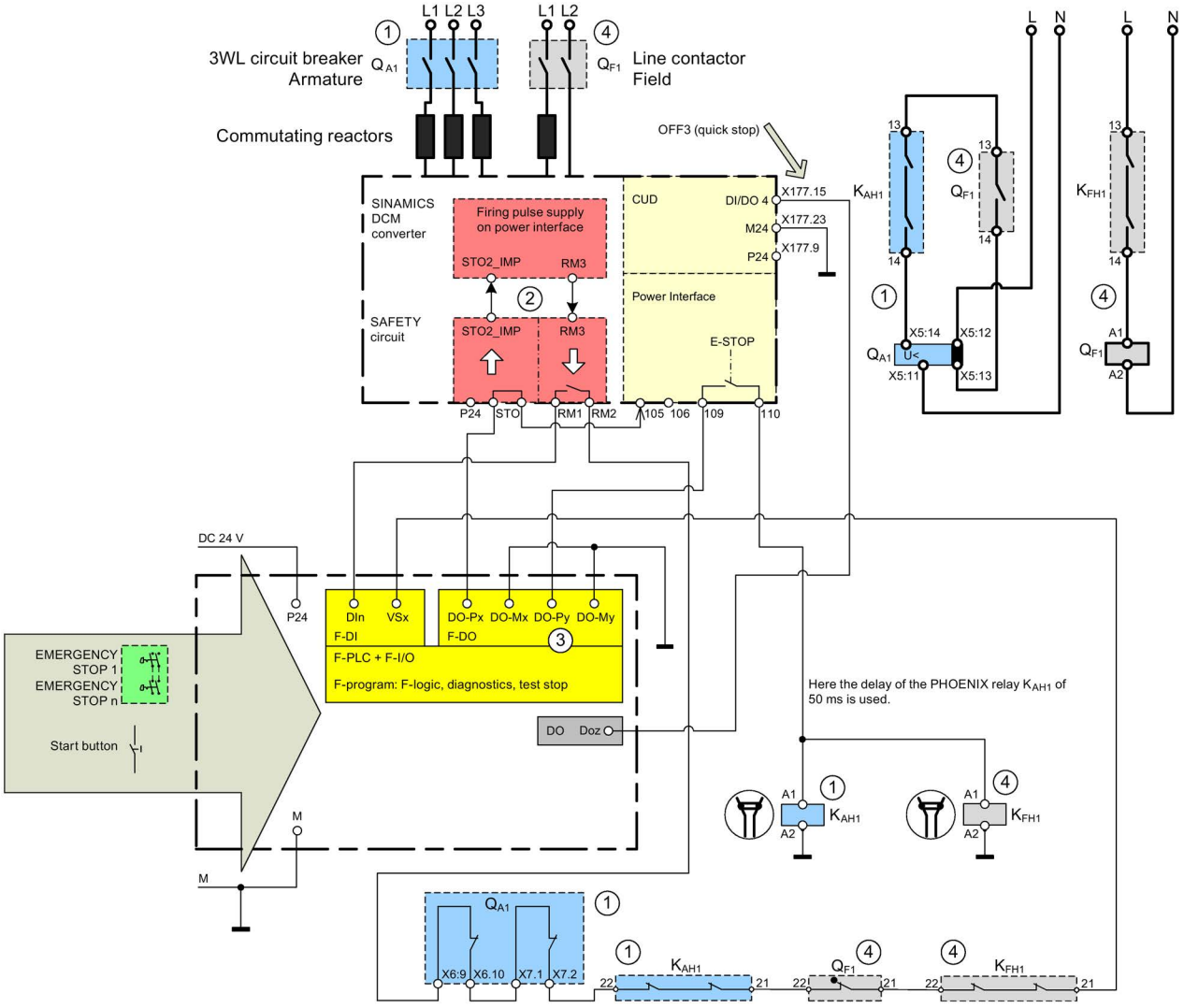
## SS1 application with line contactor and F-PLC




① First channel (blue): Line contactor armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (yellow)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-7 SS1 application with line contactor and F-PLC

## SS1 application with circuit breaker and F-PLC




① First channel (blue): Circuit breaker (3WL) armature + armature auxiliary contactor
② Second channel (red): Firing pulse circuit, SAFETY circuit
③ Safety components (yellow)
④ Contact blocks for field excitation (gray): Line contactor field + field auxiliary contactor (also as the field contactor is usually controlled as well)

Figure 13-8 SS1 application with circuit breaker and F-PLC

## 13.6 Validating/checking the safety functions

Carefully check/test the safety functions after commissioning the system for the first time, after carrying out any repairs and after each change to the machine/system, in particular the feedback circuits.

These tests must be performed by qualified personnel who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner.

| NOTICE |
| --- |
| **Components in the external feedback circuits**<br>In external feedback circuits of the DCM, no additional components and / or functions may be installed which are not part of the safety functions. |

## 13.7 Diagnostics test

In order to ensure that the function of the switch-off signal paths comply with the requirements laid down in the applicable standards, regulations and guidelines, these must be tested at regular intervals (diagnostics test interval, "Diagnostic test" in accordance with IEC 61800-5-2). As a consequence, faults are detected in an acceptable time. The intervals depend on the safety function and the desired/required SIL / PL, Cat.

The user must ensure that this test of the switch-off signal paths (test stop: activating and deactivating an STO) is performed at regular intervals.

The external safety relay (e.g. 3SK11…), can, based on the feedback signals of the SINAMICS DCM DC converter, detect possible faults/errors in the switch-off signal paths, and trigger an STO in both channels. An error is thus detected and the system can be repaired.

## 13.8 Relationship between the test stop interval and SIL or PL and Cat.

The hardware, the hardware structure and, where applicable, the software (when using parameterizable or programmable external safety components), must correspond to the required SIL / PL and Cat.

Also see the application examples in the previous sections of this document.

Test intervals required:

- SIL 2/PL d, Cat. 3: Test stop at least once per year
- SIL 3 / PL e, Cat. 3: As a minimum, a test stop every 3 months
- SIL 3 / PL e, Cat. 4: Test stop at least once per day

# 13.9 Circuit breakers and power contactors

| **6RA8013_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 15 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480 | - | - | - |
| Contactor armature circuit | - | Main contactor designed for AC1, 40 A | Siemens | 3RT2023-2AL20 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8018_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 30 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480 | - | - | - |
| Contactor armature circuit | - | Main contactor designed for AC1, 40 A | Siemens | 3RT2023-2AL20 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8025_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 60 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor designed for AC1, 50 A | Siemens | 3RT1035-3AL20 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8028_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 90 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480 | - | - | - |
| Contactor armature circuit | - | Main contactor designed for AC1, 100 A | Siemens | 3RT1044-3AL20 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8031_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 125 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor designed for AC1, 120 A | Siemens | 3RT1446-1AL20 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8075_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 210 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 275 A | Siemens | 3RT1456-6AP36 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8078_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 280 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 275 A | Siemens | 3RT1456-6AP36 |
| Contactor field circuit | - | Field contactor designed for AC1 | Siemens | 3RT2015-2AP01 |

| **6RA8081_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 400 | - | - | - |
| Rated supply voltage armature [V] | 400<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 400 A | Siemens | 3RT1466-6AP36 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8082_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 450 | - | - | - |
| Rated supply voltage armature [V] | 480 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 400 A | Siemens | 3RT1466-6AP36 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8085_XXXXX_0AA0** | Value | Designation | Manufacturer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 600 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 690 A | Siemens | 3RT1476-6AP36 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8086_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 720<br>760 | - | - | - |
| Rated supply voltage armature [V] | 690 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 800 A | ABB | AF750-30-22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8087_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 800<br>850 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480<br>575 | - | - | - |
| Contactor armature circuit | - | Main contactor AC1, 800 A | ABB | AF750-30-22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8088_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 950 | - | - | - |
| Rated supply voltage armature [V] | 830 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 1000 A 1000 V with LI trigger ETU15B | Siemens | 3WL1210-4BB33-4AS2-Z<br>Z=A05+C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| **6RA8090_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 1000<br>1100 | - | - | - |
| Rated supply voltage armature [V] | 575<br>690 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 1000 A 690 V with LI trigger ETU15B | Siemens | 3WL1210-3BB33-4AS2-Z<br>Z=C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| 6RA8091_XXXXX_0AA0 | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 1200 | - | - | - |
| Rated supply voltage armature [V] | 400<br>480 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 1000 A 690 V with LI trigger ETU15B | Siemens | 3WL1210-3BB33-4AS2-Z Z=C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT2023-2AL20<br>3RT2023-2AL24 |

| 6RA8093_XXXXX_0AA0 | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 1500 | - | - | - |
| Rated supply voltage armature [V] | 690<br>830 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 1250 A 690 V with LI trigger ETU15B<br>3WL1 circuit breaker 1250 A 1000 V with LI trigger ETU15B | Siemens<br>Siemens | 3WL1212-3BB33-4AS2-Z Z=C22<br>3WL1212-4BB33-4AS2-Z Z=A05+C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

| 6RA8093_XXXXX_0AA0 | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 1600 | - | - | - |
| Rated supply voltage armature [V] | 400<br>575 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 1600 A 690 V with LI trigger ETU15B | Siemens | 3WL1216-3BB33-4AS2-Z Z=C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

| 6RA8095_XXXXX_0AA0 | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 2000 | - | - | - |
| Rated supply voltage armature [V] | 400<br>575<br>690<br>830 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 2000 A 690 V with LI trigger ETU15B<br>3WL1 circuit breaker 2000 A 1000 V with LI trigger ETU15B | Siemens<br>Siemens | 3WL1220-3BB33-4AS2-Z Z=C22<br>3WL1220-4BB33-4AS2-Z Z=A05+C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

| **6RA8096_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 2200 | - | - | - |
| Rated supply voltage armature [V] | 575<br>690<br>950 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 2000 A 690 V with LI trigger ETU15B<br>3WL1 circuit breaker 2000 A 1000 V with LI trigger ETU15B | Siemens<br>Siemens | 3WL1220-3BB33-4AS2-Z Z=C22<br>3WL1220-4BB33-4AS2-Z Z=A05+C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

| **6RA8097_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 2600<br>2800 | - | - | - |
| Rated supply voltage armature [V] | 575<br>690 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 2500 A 690 V with LI trigger ETU15B | Siemens | 3WL1225-3BB33-4AS2-Z Z=C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

| **6RA8098_XXXXX_0AA0** | Value | Designation | Manufac-turer | Article number |
|---|---|---|---|---|
| Rated DC current [A] (DC) | 3000 | - | - | - |
| Rated supply voltage armature [V] | 400 | - | - | - |
| 3WL circuit breaker armature circuit | - | 3WL1 circuit breaker 2500 A 690 V with LI trigger ETU15B | Siemens | 3WL1225-3BB33-4AS2-Z Z=C22 |
| Contactor field circuit | - | Field contactor designed for AC1<br>Field contactor designed for AC1 | Siemens<br>Siemens | 3RT1034-3AL20<br>3RT1044-3AL20 |

# 13.10 Recommended safety relays

| Number | Devices | Manufacturer, order number | Details |
|---|---|---|---|
| 1 | EMERGENCY STOP button | Siemens 3SB3000-1HA20 | EMERGENCY STOP mushroom pushbutton, positive latching, rotate to release |
| | | Siemens 3SB3403-0D | Contact block with 2 contacts, 2NO, spring-loaded connection, for front panel mounting |
| | | Siemens 3SB3921-0AX | Protective collar for EMERGENCY STOP mushroom pushbutton, with block, yellow |
| 1 | Power supply for 3SK1 | Siemens 3SK1230-2AW20 | Power supply for 3SK1 (https://mall.industry.siemens.com/mall/en/Catalog/Product/3SK1230-2AW20) SIRIUS safety relay - power supply for 3SK1 advanced series Us = 115 - 230 V AC/DC spring-loaded connection |
| 1 | Safety relay Basic device advanced | Siemens 3SK1121-2CB41 3SK1121-2CB42 3SK1121-2CB44 | Safety relay basic unit Advanced (for SS1) (https://mall.industry.siemens.com/mall/en/Catalog/Product/3SK1121-2CB42) SIRIUS safety relay, basic device advanced, with time delay 0.5-30 s, 4 relay enable circuits (2 NO contacts without delay, 2 NO contacts, with delay) Us = 24 V DC, spring-loaded connection |
| 2 | Coupling relay for SIL3 | Phoenix Contact PSR-SPP-24DC/FSP/1X1/1X2 - 2981981 | Coupling relay for SIL3 (https://www.phoenixcontact.com/en/produkte/2981981) Coupling relay for SIL 3 high and low demand applications, coupled with digital output signals to the I/O, 1 enable current path, 1 feedback signal current path, 1 digital signaling output, safe-state-off applications, test pulse filter, PSR-TBUS connection, pluggable spring-loaded terminal |
| 1 | Safety relay basic device advanced | Siemens 3SK1121-2AB40 | Safety relay basic unit Advanced (for STO) (https://mall.industry.siemens.com/mall/en/Catalog/Product/3SK1121-2AB40) SIRIUS safety relay basic device advanced range, relay enable circuits, 3 NO contact + relay signaling circuit, 1 NC contact Us = 24 V DC, spring-loaded connection |

# Appendix A

A

## A.1 Certifications and standards

### Certifications

**Development, production, sales:**

| | | |
|---|---|---|
| ISO 9001:2008 | Quality management | |
| ISO 14001:2004 | Environmental management | |

**Devices:**

| | | |
|---|---|---|
| EAC | | |
| Germanischer Lloyd | Shipbuilding [1] | 11787-10HH |
| Lloyd's Register | Shipbuilding [1] | No. 06/20053 |
| American Bureau of Shipping | Shipbuilding [1] | 06-HG196692-1-PDA |
| Det Norske Veritas | Shipbuilding [1] | No. E-10357 (DC converter)<br>No. E-10358 (Control Module) |

**Communication:**

PROFIBUS slave (DP-V0, DP-V1, PROFIdrive 3.1.2)

PROFINET IO devices (V 2.2.4, PROFIdrive 4.1)

[1] In order to maintain the limit values decisive for certification for marine applications, the requirements as listed in Section Using SINAMICS DCM in shipbuilding (Page 661) must be observed.

## Korean Certification (KC)

| Type of Equipment | User's Guide |
|---|---|
| A급 기기<br>(업무용 방송통신기자재) | 이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다. |
| Class A Equipment<br>(Industrial Broadcasting & Communication Equipment) | This equipment is **Industrial (Class A) electromagnetic wave suitability equipment** and seller or user should take notice of it, and this equipment is to be used in the places except for home. |

The EMC limit values to be complied with for Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3, category C2 or limit value class A1 according to EN 55011.

With suitable additional measures, the limit values according to category C2 or according to limit value class A1 are maintained.

To do this, an additional radio interference suppression filter (EMC filter) must be used and the converters must be installed in the control cabinet in compliance with EMC rules.

The appropriate radio interference suppression filters (for the field and armature circuits) for the SINAMICS DC MASTER are listed in Catalog D23.1.

Additional notes are provided there as well as technical data and constraints regarding the use of radio interference suppression filters:

- The use in grounded line supplies
- The mandatory use of a commutating reactor

Detailed information about the basics of EMC and EMC-compliant design of drives can be found in the Chapter "Connecting (Page 55)".

## Basic standards

| | |
|---|---|
| EN 50178 | Electronic equipment for use in power installations |
| EN 50274 | Low-voltage switchgear and controlgear assemblies: Protection against electric shock – Protection against unintentional direct contact with hazardous live parts |
| EN 60146-1-1 | Semiconductor converters; General requirements and line-commutated converters; specification of basic requirements |
| EN 61800-1 | Adjustable speed electrical power drive systems – General requirements - Rating specifications for low voltage adjustable speed DC power drive systems |
| EN 61800-3 | Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods |
| EN 61800-5-1 | Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal, and energy |
| EN 60204-1 | Safety of machinery – Electrical equipment of machines – Part 1: General requirements |
| UBC 97 | Uniform Building Code |

## Reference standards

| | |
|---|---|
| SN 29500-1 | Component failure rates: Anticipated values, general |
| SN 36350-1 | Environmentally compatible products, Part 1: Product design guidelines |
| SN 27095 | Inspection and testing of switchgear and control equipment for marine engineering |
| ISO 3740 | Determination of sound power levels of noise sources: Guidelines for the use of basic standards |

## Country-specific standards

| | |
|---|---|
| NEMA | National Electrical Manufacturers Association |

# 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 |
| AR | Wiedereinschaltautomatik | Automatic Restart |
| ASC | Ankerkurzschluss | Armature short-circuit |
| ASCII | Amerikanische Code-Norm für den Informationsaustausch | American Standard Code for Information Interchange |
| ASM | Asynchronmotor | Induction motor |
| **B** | | |
| BERO | Firmenname für einen Näherungsschalter | Trade name for a type of proximity switch |
| 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 | Control Area Network |
| CBC | Kommunikationsbaugruppe CAN | Communication Board CAN |
| CD | Compact Disc | Compact Disc |
| 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 |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| COB ID | CAN Object-Identification | CAN Object-Identification |
| COM | Mittelkontakt eines Wechselkontaktes | Common contact of a changeover relay |
| CP | Kommunikationsprozessor | Communication Processor |
| CPU | Zentrale Recheneinheit | Central Processing Unit |
| CRC | Checksummenprüfung | Cyclic Redundancy Check |
| CSM | Control Supply Module | Control Supply Module |
| CU | Control Unit | Control Unit |
| **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 |
| DPRAM | Speicher mit beidseitigem Zugriff | Dual-Port Random Access Memory |
| DRAM | Dynamischer Speicher | Dynamic Random Access Memory |
| 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 |
| ECD | Ersatzschaltbild | Equivalent Circuit Diagram |
| EDS | Geberdatensatz | Encoder Data Set |
| ELP | Erdschlussüberwachung | Earth Leakage Protection |
| EMC | Elektromagnetische Verträglichkeit | Electromagnetic Compatibility |
| EMF | Elektromagnetische Kraft | Electromagnetic Force |
| EN | Europäische Norm | European standard |
| EnDat | Geber-Schnittstelle | Encoder Data Interface |
| EP | Impulsfreigabe | Enable Pulses |
| EPOS | Einfachpositionierer | Basic positioner |
| ES | Engineering System | Engineering System |
| ESD | Elektrostatisch gefährdete Baugruppen | Electrostatic Sensitive Devices |
| ESR | Erweitertes Stillsetzen und Rückziehen | Extended Stop and Retract |
| **F** | | |
| F... | Störung | Fault |
| FAQ | Häufig gestellte Fragen | Frequently Asked Questions |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| FBL | Freie Funktionsblöcke | Free Blocks |
| FCC | Function Control Chart | Function Control Chart |
| FCC | Flussstromregelung | Flux Current Control |
| F-DI | Fehlersicherer Digitaleingang | Fail-safe Digital Input |
| F-DO | Fehlersicherer Digitalausgang | Fail-safe 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 |
| 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-Slaves | Device master file: describes the features of a PROFIBUS slave |
| GSV | Gate Supply Voltage | Gate Supply Voltage |
| GUID | Globally Unique Identifier | Globally Unique Identifier |
| **H** | | |
| HF | Hochfrequenz | High Frequency |
| HFD | Hochfrequenzdrossel | High frequency reactor |
| HMI | Mensch-Maschine-Schnittstelle | Human Machine Interface |
| HTL | Logik mit hoher Störschwelle | High-Threshold Logic |
| HW | Hardware | Hardware |
| **I** | | |
| i. V. | Under development: This property 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 | Interpolator cycle | Interpolator clock |
| IT | Non-grounded three-phase line supply | Insulated three-phase supply network |
| IVP | Interner Spannungsschutz | Internal Voltage Protection |
| **J** | | |
| JOG | Tippen | Jogging |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| **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 | Mass | 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 |
| MSB | Höchstwertiges Bit | Most Significant Bit |
| MSC | Motorstromrichter | Motor power converter |
| MSCY_C1 | Zyklische Kommunikation zwischen Master (Klasse 1) und Slave | Master Slave Cycle Class 1 |
| MT | Messtaster | Measuring input |
| **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 |
| NO | Schließer | Normally Open (contact) |
| NSR | Netzstromrichter | Line power converter |
| **O** | | |
| OA | Open Architecture | Open Architecture |
| OC | Betriebsbedingung | Operating condition |
| OEM | Original Equipment Manufacturer | Original Equipment Manufacturer |
| OLP | Busstecker für Lichtleiter | Optical Link Plug |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| 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 device |
| PI | Proportional Integral | Proportional Integral |
| PID | Proportional Integral Differential | Proportional Integral Differential |
| PLC | Speicherprogrammierbare Steuerung (SPS) | Programmable Logical Controller |
| 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 |
| PTC | Positiver Temperaturkoeffizient | Positive Temperature Coefficient |
| PTP | Punkt zu Punkt | Point-To-Point |
| PWM | Pulsweitenmodulation | Pulse Width Modulation |
| PZD | PROFIBUS Prozessdaten | PROFIBUS process data |
| **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 |
| RFG | Hochlaufgeber | Ramp-Function Generator |
| RJ45 | Norm. Beschreibt eine 8-polige Steckverbindung mit Twisted-Pair Ethernet. | Standard. Describes an 8-pole plug connector with twisted pair Ethernet. |
| RKA | Rückkühlanlage | Cooling unit |
| 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 |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| **S** | | |
| S1 | Dauerbetrieb | Continuous operation |
| S3 | Aussetzbetrieb | Intermittent 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 |
| SIL | Sicherheitsintegritätsgrad | Safety Integrity Level |
| 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 |
| 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 |
| SVA | Raumzeigerapproximation | Space vector approximation |
| **T** | | |
| TB | Terminal Board | Terminal Board |
| TIA | Totally Integrated Automation | Totally Integrated Automation |
| TM | Terminal Module | Terminal Module |
| TN | Drehstromversorgungsnetz geerdet | Grounded three-phase line supply |
| Tn | Nachstellzeit | Integral time |
| TPDO | Transmit Process Data Object | Transmit Process Data Object |
| TT | Drehstromversorgungsnetz geerdet | Grounded three-phase line supply |

| Abbreviation | Meaning, German | Meaning, English |
|---|---|---|
| TTL | Transistor-Transistor-Logik | Transistor-Transistor Logic |
| Tv | Vorhaltezeit | Derivative-action time |
| **U** | | |
| UL | Underwriters Laboratories Inc. | Underwriters Laboratories Inc. |
| UPS | Unterbrechungsfreie Stromversorgung | Uninterruptible Power Supply |
| **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** | | |
| WZM | Werkzeugmaschine | Machine tool |
| **X** | | |
| XML | Erweiterbare Auszeichnungssprache (Standardsprache für Web-Publishing und Dokumentenmanagement) | Extensible Markup Language |
| **Z** | | |
| ZK | Zwischenkreis | DC link |
| ZSW | PROFIBUS Zustandswort | PROFIBUS status word |

## Abbreviations, DC-specific terms

| Abbreviation | Meaning |
|---|---|
| 2Q | 2 quadrant |
| 4Q | 4 quadrant |
| CU_DC | Control Unit DC |
| DC_CTRL | DC drive control |
| FR | Final rounding |
| Ia | Actual armature current value |
| IAlimit | Current limit |
| If | Actual field current value |
| ILG | Current at critical conduction |
| In | Rated current |
| IR | Initial rounding |
| Kp | P gain |
| La | Armature circuit inductance |
| Mact | Actual torque value |
| Mlimit | Torque limit |
| n | Speed |
| nact | Actual speed value |
| nmin | Minimum speed |
| NN | Normal zero |
| nsetp | Speed setpoint |
| Ra | Armature circuit resistance |
| RDT | Ramp-down time |
| RUT | Rampup time |
| SICROWBAR | Overvoltage protection |
| Tn | Integral time |
| TSE | Snubber |
| Tu | Ambient temperature |
| Ua | Armature voltage |
| Uf | Field voltage |
| ULine | Line voltage |
| USS | Universal serial interface |

# A.3 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.

| | | | |
|---|---|---|---|
| Front parts: | PC + ABS | Bayblend | Bayer |
| Plastic parts in the device: | PC | Lexan 915-R | |
| Insulation materials: | PC (FR) fl | Makrolon or Lexan | |
| Rating plate: | Polyester film | | |

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 DCM Control Module).

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 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 printed circuit boards may be used in recycling processes involving energy recovery. The proportion of components containing hazardous substances is low.

# A.4 Servicing

### Repairs

If you wish to have a part or unit repaired, please get in touch with your regional contact for repairs.

### Service calls

Qualified personnel can perform repair work on your devices and offer services that ensure their availability. This work can be carried out with charges that are scaled according to the amount of time and work involved, or at a flat rate as part of a contract. Services whose charges depend on the amount of time and work involved are performed within the normal working hours for the region and with an appropriate response time.

You can get in touch with your regional contact if you wish to have any services carried out.

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### Note

We would be grateful if you could specify the following device data when you have any queries:

- Device article number and serial number
- Firmware version
- Hardware version of the electronics module CUD (printed on the component side)
- Hardware version and firmware version of additional modules (if used)

---

# Appendix B

B

## B.1 Runtimes of the DCC blocks for SINAMICS DCM

The typical runtimes of the DCC blocks (in µs) are listed in the following table.

Table B- 1 DCC blocks on the SINAMICS DCM

| 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 | Inverter | 6 | |
| SUB | Subtractor | 6 | |
| SUB_D | Subtractor (double integer type) | 6 | |
| SUB_I | Subtractor (integer type) | 5 | |
| 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 | |

| Designation | Function | Typ. runtime | Group |
|---|---|---|---|
| RGE | Ramp-function generator | 12 | |
| RGJ | Ramp-function generator with jerk limiting | 78 | |
| 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 | |

| Designation | Function | Typ. runtime | Group |
|---|---|---|---|
| US_D | UNSIGNED-SHORT-INTEGER to DOUBLE INTEGER converter | 6 | |
| US_I | UNSIGNED-SHORT-INTEGER to INTEGER converter | 5 | |
| 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 | |
| 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 | |

| Designation | Function | Typ. runtime | Group |
|---|---|---|---|
| NOP8_I | Dummy blocks (INTEGER type) | 8 | |
| NOR | Block (BOOL type) | 7 | |
| NOT | Inverter (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 | |
| 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 | |

| Designation | Function | Typ. runtime | Group |
|---|---|---|---|
| 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 | |
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## B.2 BOP20 status display during power-up

During power-up, the status of the power-up is briefly displayed on the BOP20.

Table B- 2 Display of the power-up on the BOP20

| Displayed value | Meaning |
|---|---|
| 0 | Operation |
| 10 | Ready |
| 20 | Wait for power-up |
| 25 | Wait for automatic firmware update of DRIVE-CLiQ components |
| 31 | Commissioning software download active |
| 33 | Remove/acknowledge topology error |
| 34 | End commissioning mode |
| 35 | Perform the first commissioning |
| 70 | Initialization |
| 80 | Reset active |
| 99 | Internal software error |

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

In the following exceptional cases, power-up is interrupted with display value 33. In this state, the unit can be parameterized using BOP20, AOP30 and 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. Ramp-up is continued.
- A memory card with a parameter data set, which comes from a SINAMICS DCM with a different article number is inserted in the drive
  - Accept the parameter data set by setting p9906 = 3. Ramp-up is continued.
- A memory card with a parameter data set from another CUD type is inserted in the drive (e.g. a parameter data set from the right-hand CUD was loaded into a left-hand CUD, a parameter data set of a standard CUD was loaded into an advanced CUD)
  - Accept the parameter data set by setting p9906 = 3. Ramp-up is continued.

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## Further information

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