SINAMICS DCM Manual

SIEMENS

Siemens Sinamics DCM is a range of converters created for work with variable-speed DC motors. The drives of the DC Master series combine the experience of the previous generation of SIMOREG DC frequency inverters with the modern functions of the SINAMICS family.

Main characteristics of DCM drive system are:

➢Suitability to control DC motors with power from 6 to 30.000 kW.

➢A high degree of integration in any industrial automation systems .

➢Expandability due to the modular concept.

➢Availability of a variety of ready-made function blocks for programming (DCC).

➢The power supply of the control board from a separate module 24VDC.

➢It is possible to supply drives with a current up to 125A from a single-phase network.

➢Simple setup and start-up procedure using the AOP30 operator panel (BOP20).

➢Rated power supply voltage of the power unit from 400 to 830 V.

➢Short and easy start-up due to the fully electronic parameterization of all components.

To find out stock ability and delivery time to your region, please contact our manager.

info@eltra-trade.com

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SINAMICS

SINAMICS DCM DC Converter

Operating Instructions

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**
>
> with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

> **CAUTION**
>
> without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that an unintended result or situation can occur if the relevant information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

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

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Preface

Note

Information on connecting the unit

The inside front cover of the SINAMICS DC MASTER Operating Instructions contains a summary of the key information required for connecting the unit.

Product name

The SINAMICS DCM documentation uses the following product names:

- SINAMICS DCM
- SINAMICS DC MASTER

Device software version

When these operating instructions went to print, SINAMICS DCM units were being supplied from the factory with the software release specified on Page 3.

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

- **Older software versions:**
  It is possible that not all of the functions described here may be available.

- **Newer software versions:**
  It is possible that the SINAMICS DCM 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 software release is displayed using r50060[6].

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

Downloading the latest software version
(http://support.automation.siemens.com/WW/view/en/38157755/133100)

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.

SINAMICS DCM DVD documentation

Includes
All the manuals listed above, in all of the available languages
Function diagrams in VISIO® format
Application notes
Spare parts list

Manuals and application notes on the Internet

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

Manuals (http://support.automation.siemens.com/WW/view/en/38157755/133300)

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 - (http://support.automation.siemens.com/WW/view/en/16604318)

Technical Support

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

German (www.siemens.de/automation/support-request)
English (www.siemens.com/automation/support-request)

Central hotlines for SINAMICS DCM technical support

European and African time zone	Phone: +49 (0)911 895 7222 Fax: +49 (0)911 895 7223 email (mailto:support.automation@siemens.com)	8:00 to 17:00 CET
America time zone	**24-hour hotline: +1 800 333 7421**	
	Phone: +1 423 262 2960 Fax: +1 423 262 2200 email (mailto:support.america.automation@siemens.com)	8:00 to 17:00 Eastern Standard Time
Asia/Australia time zone	Phone: +86 1064 757575 Fax: +86 1064 747474 email (mailto:support.asia.automation@siemens.com)	7:30 to 17:30 Beijing local time

Spare parts

You can find information on spare parts

- in Catalog D23

- on the SINAMICS DCM documentation DVD
  (to reorder please quote order number 6RX1800-0AD64)

- Using the electronic spare parts catalog Spares On Web, after entering the serial number and order number of your SINAMICS DCM in the Internet (registration required).
  Spares On Web (http://workplace.automation.siemens.de/sparesonweb)

Table of contents

9

Information

1

1.1 Warning information

Note

In the interests of clarity, these Operating Instructions do not contain full details of all information for all product types and cannot take into account every possible aspect of installation, operation, or maintenance.

If you require further information, or particular problems arise which these Operating Instructions do not cover in enough detail, please contact your local Siemens office.

We also draw your attention to the fact that the contents of these Operating Instructions are not part of and do not modify any prior or existing agreement, commitment, or legal relationship. Any obligations on the part of Siemens arise from the respective contract of sale, which also contains the solely valid warranty conditions in full. Any statements contained in these Operating Instructions neither expand nor restrict the scope of these contractual warranty conditions.

⚠ WARNING
This unit is subject to hazardous voltage levels and contains dangerous rotating machine parts (fans). Failure to comply with these Operating Instructions can lead to death, serious physical injury, and material damage.
Even after all of the supply voltages have been switched-off, a hazardous voltage is available for 1 min.
Only qualified personnel who are familiar with all the safety instructions provided in these Operating Instructions, as well as the assembly, operating, and maintenance instructions, should carry out work on this unit.

⚠ WARNING
There is electrical separation according to the requirements for protection against electric shock according to EN61800-5-1 at all customer connections with input/output voltages in the range up to 60 V DC (DVC A).
This is the reason that only components whose inputs/output voltages lie in this range and which also have electrical separation can be connected at these connections.

> ## ⚠ DANGER
>
> When this unit is operated, it is inevitable that certain components will be subject to dangerous electrical voltage levels. Touching these components may lead to serious physical injury or even death. The following precautions should be taken in order to reduce the risk to life and limb:
>
> 1. Only qualified personnel who are familiar with this unit and the information supplied with it should be charged with work on the unit involving installation, operation, troubleshooting and fault correction, or repair.
> 2. The unit must be installed in accordance with safety regulations (e.g. EN, DIN, or VDE) as well as all other applicable national or local regulations. Grounding, conductor dimensioning, and the relevant short-circuit protection work must be carried out correctly in order to ensure operational safety.
> 3. The unit must be operated with all covers supplied.
>   The fixing screws for the front cover of the SINAMICS DCM must be tight.
>   When required, additional covers should be provided in the control cabinet.
> 4. Before carrying out visual inspections and maintenance work, ensure that the unit is disconnected from the supply voltage and disabled. Before they are shut down, both the converter unit and the motor are subject to dangerous voltage levels; these may be present even when the converter unit's line contactor is open.
> 5. If measurements need to be taken while the power supply is switched on, do not under any circumstances touch the electrical connection points. Remove all jewelry from wrists and fingers. Make sure that the measuring and test equipment is in good condition and is safe to operate.
> 6. When working on a unit that is switched on and on an insulated surface, make sure that no grounding has been put in place.
> 7. Follow these Operating Instructions faithfully and observe all information concerning hazards, warnings, or areas where caution is required.
> 8. This list is not exhaustive and as such cannot outline all the measures required in order to operate the unit safely. Should you require further information or encounter specific problems which have not been handled in enough detail for the purposes of the buyer, please contact your local Siemens office.

> ### CAUTION
>
> Operating the unit in the immediate vicinity (< 1.5 m) of mobile telephones with a transmitter power of > 1 W may lead to incorrect operation of the unit.

> ## ⚠ WARNING
>
> The OFF switch on the AOP30 operator panel does not have an EMERGENCY OFF function.
>
> In order to avoid dangerous incorrect operator actions, the EMERGENCY OFF pushbutton must be installed in a plant or system at an adequate distance from the AOP30.

1.2   ESD-sensitive components

> ⚠️ **CAUTION**
>
> The electronic boards contain electrostatic sensitive devices. These can be easily destroyed if not handled properly. If you have to work with electronic modules, please note:
>
> • You should only touch electronic modules if absolutely necessary.
>
> • If you do have to touch modules, your body must be electrically discharged first.
>
> • Boards must not come into contact with highly insulating materials (such as plastic parts, insulated desktops, articles of clothing manufactured from man-made fibers).
>
> • Modules must only be set down on conductive surfaces.
>
> • Boards and components should only be stored and transported in conductive packaging (such as metalized plastic boxes or metal containers).
>
> • If the packaging material is not conductive, the modules must be wrapped with a conductive packaging material (such as conductive foam rubber or household aluminum foil).

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

Seated   Standing   Seated/standing

a   conductive floor
b   ESD Table
c   ESD footwear
"d" ESD smock
e   ESD wrist strap
f   cubicle ground connection

1.2 ESD-sensitive components
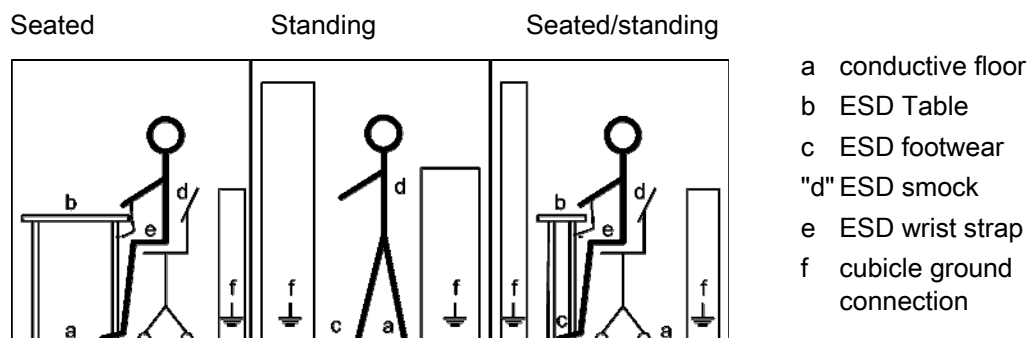
Type spectrum, ordering information

| 400 A - 600 A | 850 A | 1200 A | 1500 A - 3000 A | 60 A - 280 A | 15 A, 30 A | Control Module |

Figure 2-1　　Type series

2.1   Unit order numbers

2Q units				
Armature supply voltage	Rated DC current	Rated DC voltage	Type designation	Order number MLFB
3-ph. 400 V AC	60 A	485 V	D485/60 Mre-GeE6S22	6RA8025-6DS22-0AA0
	90 A	485 V	D485/90 Mre-GeE6S22	6RA8028-6DS22-0AA0
	125 A	485 V	D485/125 Mre-GeE6S22	6RA8031-6DS22-0AA0
	210 A	485 V	D485/210 Mre-GeEF6S22	6RA8075-6DS22-0AA0
	280 A	485 V	D485/280 Mre-GeEF6S22	6RA8078-6DS22-0AA0
	400 A	485 V	D485/400 Mre-GeEF6S22	6RA8081-6DS22-0AA0
	600 A	485 V	D485/600 Mre-GeEF6S22	6RA8085-6DS22-0AA0
	850 A	485 V	D485/850 Mre-GeEF6S22	6RA8087-6DS22-0AA0
	1200 A	485 V	D485/1200 Mre-GeEF6S22	6RA8091-6DS22-0AA0
	1600 A	485 V	D485/1600 Mre-GeEF4S22	6RA8093-4DS22-0AA0
	2000 A	485 V	D485/2000 Mre-GeEF4S22	6RA8095-4DS22-0AA0
	3000 A	485 V	D485/3000 Mre-GeEF4S22	6RA8098-4DS22-0AA0
3-ph. 480 V AC	60 A	550 V	D575/60 Mre-GeE6S22	6RA8025-6FS22-0AA0
	90 A	550 V	D575/90 Mre-GeE6S22	6RA8028-6FS22-0AA0
	125 A	550 V	D575/125 Mre-GeE6S22	6RA8031-6FS22-0AA0
	210 A	550 V	D575/210 Mre-GeEF6S22	6RA8075-6FS22-0AA0
	280 A	550 V	D575/280 Mre-GeEF6S22	6RA8078-6FS22-0AA0
	450 A	550 V	D575/450 Mre-GeEF6S22	6RA8082-6FS22-0AA0
	600 A	550 V	D575/600 Mre-GeEF6S22	6RA8085-6FS22-0AA0
	850 A	550 V	D575/850 Mre-GeEF6S22	6RA8087-6FS22-0AA0
	1200 A	550 V	D575/1200 Mre-GeEF6S22	6RA8091-6FS22-0AA0
3-ph. 575 V AC	60 A	690 V	D690/60 Mre-GeE6S22	6RA8025-6GS22-0AA0
	125 A	690 V	D690/125 Mre-GeE6S22	6RA8031-6GS22-0AA0
	210 A	690 V	D690/210 Mre-GeEF6S22	6RA8075-6GS22-0AA0
	400 A	690 V	D690/400 Mre-GeEF6S22	6RA8081-6GS22-0AA0
	600 A	690 V	D690/600 Mre-GeEF6S22	6RA8085-6GS22-0AA0
	800 A	690 V	D690/800 Mre-GeEF6S22	6RA8087-6GS22-0AA0
	1100 A	690 V	D690/1100 Mre-GeEF6S22	6RA8090-6GS22-0AA0
	1600 A	690 V	D690/1600 Mre-GeEF4S22	6RA8093-4GS22-0AA0
	2000 A	690 V	D690/2000 Mre-GeEF4S22	6RA8095-4GS22-0AA0
	2200 A	690 V	D690/2200 Mre-GeEF4S22	6RA8096-4GS22-0AA0
	2800 A	690 V	D690/2800 Mre-GeEF4S22	6RA8097-4GS22-0AA0
3-ph. 690 V AC	720 A	830 V	D830/720 Mre-GeEF6S22	6RA8086-6KS22-0AA0
	1000 A	830 V	D830/1000 Mre-GeEF6S22	6RA8090-6KS22-0AA0
	1500 A	830 V	D830/1500 Mre-GeEF4S22	6RA8093-4KS22-0AA0
	2000 A	830 V	D830/2000 Mre-GeEF4S22	6RA8095-4KS22-0AA0
	2600 A	830 V	D830/2600 Mre-GeEF4S22	6RA8097-4KS22-0AA0
3-ph. 830 V AC	950 A	1000 V	D1000/950 Mre-GeEF6S22	6RA8088-6LS22-0AA0
	1500 A	1000 V	D1000/1500 Mre-GeEF4S22	6RA8093-4LS22-0AA0
	1900 A	1000 V	D1000/1900 Mre-GeEF4S22	6RA8095-4LS22-0AA0
3-ph. 950 V AC	2200 A	1140 V	D1140/2200 Mre-GeEF4S22	6RA8096-4MS22-0AA0
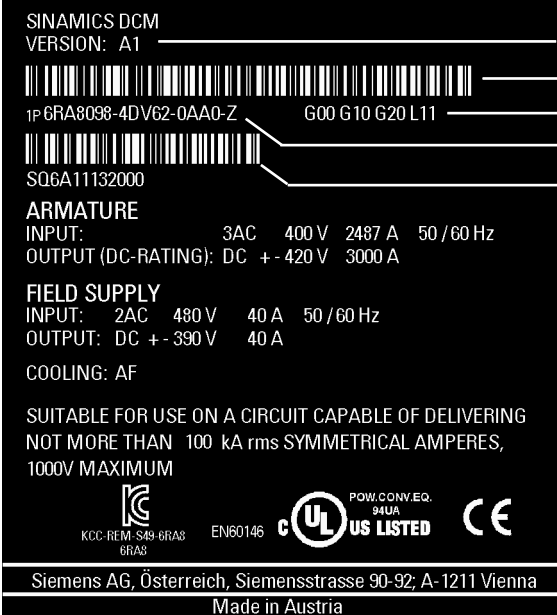
4Q units				
Armature supply voltage	Rated DC current	Rated DC voltage	Type designation	Order number MLFB
3-ph. 400 V AC	15 A	420 V	D420/15 Mreq-GeG6V62	6RA8013-6DV62-0AA0
	30 A	420 V	D420/30 Mreq-GeG6V62	6RA8018-6DV62-0AA0
	60 A	420 V	D420/60 Mreq-GeG6V62	6RA8025-6DV62-0AA0
	90 A	420 V	D420/90 Mreq-GeG6V62	6RA8028-6DV62-0AA0
	125 A	420 V	D420/125 Mreq-GeG6V62	6RA8031-6DV62-0AA0
	210 A	420 V	D420/210 Mreq-GeGF6V62	6RA8075-6DV62-0AA0
	280 A	420 V	D420/280 Mreq-GeGF6V62	6RA8078-6DV62-0AA0
	400 A	420 V	D420/400 Mreq-GeGF6V62	6RA8081-6DV62-0AA0
	600 A	420 V	D420/600 Mreq-GeGF6V62	6RA8085-6DV62-0AA0
	850 A	420 V	D420/850 Mreq-GeGF6V62	6RA8087-6DV62-0AA0
	1200 A	420 V	D420/1200 Mreq-GeGF6V62	6RA8091-6DV62-0AA0
	1600 A	420 V	D420/1600 Mreq-GeGF4V62	6RA8093-4DV62-0AA0
	2000 A	420 V	D420/2000 Mreq-GeGF4V62	6RA8095-4DV62-0AA0
	3000 A	420 V	D420/3000 Mreq-GeGF4V62	6RA8098-4DV62-0AA0
3-ph. 480 V AC	15 A	500 V	D500/15 Mreq-GeG6V62	6RA8013-6FV62-0AA0
	30 A	500 V	D500/30 Mreq-GeG6V62	6RA8018-6FV62-0AA0
	60 A	500 V	D500/60 Mreq-GeG6V62	6RA8025-6FV62-0AA0
	90 A	500 V	D500/90 Mreq-GeG6V62	6RA8028-6FV62-0AA0
	125 A	500 V	D500/125 Mreq-GeG6V62	6RA8031-6FV62-0AA0
	210 A	500 V	D500/210 Mreq-GeGF6V62	6RA8075-6FV62-0AA0
	280 A	500 V	D500/280 Mreq-GeGF6V62	6RA8078-6FV62-0AA0
	450 A	500 V	D500/450 Mreq-GeGF6V62	6RA8082-6FV62-0AA0
	600 A	500 V	D500/600 Mreq-GeGF6V62	6RA8085-6FV62-0AA0
	850 A	500 V	D500/850 Mreq-GeGF6V6	6RA8087-6FV62-0AA0
	1200 A	500 V	D500/1200 Mreq-GeGF6V62	6RA8091-6FV62-0AA0
3-ph. 575 V AC	60 A	600 V	D600/60 Mreq-GeG6V62	6RA8025-6GV62-0AA0
	125 A	600 V	D600/125 Mreq-GeG6V62	6RA8031-6GV62-0AA0
	210 A	600 V	D600/210 Mreq GeGF6V62	6RA8075-6GV62-0AA0
	400 A	600 V	D600/400 Mreq-GeGF6V62	6RA8081-6GV62-0AA0
	600 A	600 V	D600/600 Mreq-GeGF6V62	6RA8085-6GV62-0AA0
	850 A	600 V	D600/850 Mreq-GeGF6V62	6RA8087-6GV62-0AA0
	1100 A	600 V	D600/1100 Mreq-GeGF6V62	6RA8090-6GV62-0AA0
	1600 A	600 V	D600/1600 Mreq-GeGF4V62	6RA8093-4GV62-0AA0
	2000 A	600 V	D600/2000 Mreq-GeGF4V62	6RA8095-4GV62-0AA0
	2200 A	600 V	D600/2200 Mreq-GeGF4V62	6RA8096-4GV62-0AA0
	2800 A	600 V	D600/2800 Mreq-GeGF4V62	6RA8097-4GV62-0AA0
3-ph. 690 V AC	760 A	725 V	D725/760 Mreq-GeGF6V62	6RA8086-6KV62-0AA0
	1000 A	725 V	D725/1000 Mreq-GeGF6V62	6RA8090-6KV62-0AA0
	1500 A	725 V	D725/1500 Mreq-GeGF4V62	6RA8093-4KV62-0AA0
	2000 A	725 V	D725/2000 Mreq-GeGF4V62	6RA8095-4KV62-0AA0
	2600 A	725 V	D725/2600 Mreq-GeGF4V62	6RA8097-4KV62-0AA0
3-ph. 830 V AC	950 A	875 V	D875/950 Mreq-GeGF6V62	6RA8088-6LV62-0AA0
	1500 A	875 V	D875/1500 Mreq-GeGF4V62	6RA8093-4LV62-0AA0
	1900 A	875 V	D875/1900 Mreq-GeGF4V62	6RA8095-4LV62-0AA0
3-ph. 950 V AC	2200 A	1000 V	D1000/2200 MreqGeGF4V62	6RA8096-4MV62-0AA0

21

2.2 Key for unit order numbers

6	R	A					–							–	0	A	A	0	–	
①		②		③				④	⑤	⑥	⑦	⑧				⑨				⑩

① 6RA definition in accordance with general MLFB guidelines

② Unit version

23: SIMOREG compact unit, 4th generation analog 24: SIMOREG compact unit, 4th generation digital	70: SIMOREG DC MASTER 80: SINAMICS DCM

③ Rated DC currents and cooling

Natural air cooling, ambient temperature +45 °C

00: - 01: ≥3.6....<4.1 02: ≥4.1....<4.65 03: ≥4.65<5.25 04: ≥5.25..<6.0 05: ≥6.0....<6.8 06: ≥6.8....<7.75 07: ≥7.75<8.8 08: ≥8.8....<10.0 09: -	10: ≥10.0...<11.5 11: ≥11.5...<13.0 12: ≥13.0...<14.5 13: ≥14.5...<16.5 14: ≥16.5...<19.0 15: ≥19.0...<21.5 16: ≥21.5...<24.5 17: ≥24.5...<28.0 18: ≥28.0...<31.5 19: -	20: ≥31.5...<36.0 21: ≥36.0...<41.0 22: ≥41.0...<46.5 23: ≥46.5...<52.5 24: ≥52.5...<60.0 25: ≥60.0...<68.0 26: ≥68.0...<77.5 27: ≥77.5...<88.0 28: ≥88.0...<100 29: -	30: ≥100...<115 31: ≥115...<130 32: ≥130...<145 33: ≥145...<165 34: ≥165...<190 35: ≥190...<215 36: ≥215...<245 37: ≥245...<280 38: ≥280...<315 39: -	40: - 41: - 42: - 43: - 44: - 45: - 46: - 47: - 48: - 49: -

Forced ventilation: Ambient air temperature: +35 °C. With 6RA70 and 6RA80 +40 °C.

50: - 51: - 52: - 53: - 54: - 55: - 56: - 57: - 58: - 59: -	60: ≥31.5...<36.0 61: ≥36.0...<41.0 62: ≥41.0...<46.5 63: ≥46.5...<52.5 64: ≥52.5...<60.0 65: ≥60.0...<68.0 66: ≥68.0...<77.5 67: ≥77.5...<88.0 68: ≥88.0...<100 69: -	70: ≥100...<115 71: ≥115...<130 72: ≥130...<145 73: ≥145...<165 74: ≥165...<190 75: ≥190...<215 76: ≥215...<245 77: ≥245...<280 78: ≥280...<315 79: -	80: ≥315...<360 81: ≥360...<410 82: ≥410...<465 83: ≥465...<525 84: ≥525...<600 85: ≥600...<680 86: ≥680...<775 87: ≥775...<880 88: ≥880...<1000 89: -	90: ≥1000...<1150 91: ≥1150...<1300 92: ≥1300...<1450 93: ≥1450...<1650 94: ≥1650...<1900 95: ≥1900...<2150 96: ≥2150...<2400 97: ≥2400...<2850 98: ≥2850...<3250 99: -

④ Thyristor type of construction and fuse construction		**⑤ Rated supply voltage**	
0: Control Units without power unit 1: USA Power 2: USA Base 3: Disc-type thyristors, made in China 4: Disc-type thyristors with fuse construction 5: Thyristor modules, made in China 6: Thyristor modules 7: Rated DC current in acc. with ③ × 100 8: I IS		A: - B: 230 V C: - D: 400 V E: - F: 440 V - 480 V	G: 500 V - 575 V H: 660 V K: 690 V - 750 V L: 830 V M: 950 V

⑥ Converter circuit		**⑦ Closed-loop control**	
A: - B: - C: - D: B2HZ (1Q) ... K: (B2) A (B2) C (4Q) ...	S: B6C (2Q) T: - U: - V: (B6) A (B6) C (4Q)	0: No closed-loop control 1: 2Q, analog 2: 2Q, digital	6: 4Q digital 7: 4Q analog
		⑧ Field closed-loop control	
		0: No field 1: Field without closed-loop control	2: Field with closed-loop control
		⑨ Innovation	
		⑩ Z: With option	

2.3 Rating plates, packaging label

Rating plate on front cover
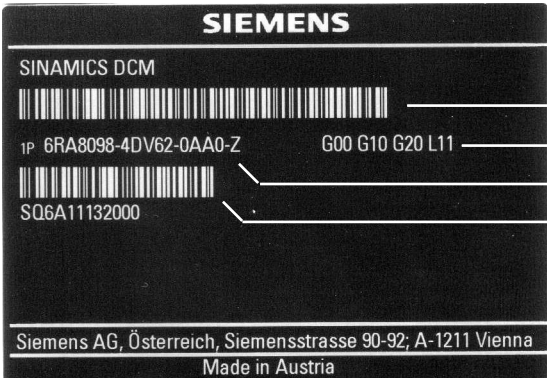
① Bar code for order number (MLFB)

② For options: "Z" after order number

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

④ Serial number bar code (order-specific)

⑤ Product version

Rating plate in unit

① For options: "Z" after order number

② Order codes for options (according to ordering information for options)

Figure 2-2   Packaging label

2.4 Ordering information for options and accessories

Ordering information for options with order codes

6 R A 8 0 ☐ ☐ ☐ – ☐ ☐ ☐ ☐ ☐ – 0 A A 0 – Z

☐ ☐ ☐ + ☐ ☐ ☐ + ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐ ☐

Order number of SINAMICS DCM 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-hand 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
Memory Card, left	S01
Memory card, right (possible with options G10 and G11)	S02
Note: Standard equipment = Standard CUD left	

Table 2- 2   Options field

Option	Order codes
2Q field power unit (not possible for 15 A and 30 A units)	L11
No field power unit (not possible for 15 A and 30 A units)	L10
Field power unit with 85 A rated current (possible for units with rated armature DC current of ≥1500 A, in standard version and with option L11)	L85

Table 2- 3   Fan options

Option	Order codes
Unit without fan (possible for units with a rated armature DC current ≥1500 A) Note: The air flow specified in the technical data must be maintained (fan air flow in m³/h).	L20
Fan for 1-phase connection (possible for units with rated armature DC current 400 A to 1200 A)	L21

Table 2- 4   Additional options

Option	Order codes
Armature infeed with extra-low voltage 10 V to 50 V (possible for units with rated supply voltage ≤575 V	L04
Electronics power supply for connection to 24 V DC	L05
Sensor for the air intake temperature	L15 [2]
Coated modules	M08 [1]
Nickel-plated copper bars (for units with aluminum bars as standard, use of nickel-plated copper bars)	M10
Control for switching over the power unit topology for devices connected in parallel and series This option is described in the application document "12-pulse applications".	S50
[1] Coated modules increase the degree of ruggedness with respect to climatic effects: Relative / absolute humidity 5 % to 95 % / 1 to 29 g/m^3 for ambient temperature or cooling medium temperature ≤30 °C ≤ 60 % with the occurrence of SO_2 and H_2S and/or for ambient temperature or cooling medium temperature 30 °C to 40 °C Oil mist, salt mist, formation of ice, condensation, dropping, spray, splashing and jet-water not permissible. [2] possible from software release 1.3 HF1 and higher	

Ordering information for accessories

Table 2- 5   Order numbers for documentation

Item	Order number
Set of manuals, German	6RX1800-0GD00
SINAMICS DCM DC Converter Operating Instructions, German	6RX1800-0AD00
SINAMICS DCM List Manual, German	6RX1800-0ED00
Free Function Blocks manual, German	6RX1800-0FD00
Set of manuals, English	6RX1800-0GD76
SINAMICS DCM DC Converter Operating Instructions, English	6RX1800-0AD76
SINAMICS DCM List Manual, English	6RX1800-0ED76
Free Function Blocks manual, English	6RX1800-0FD76
Set of manuals, French (includes the Free Function Blocks manual in English)	6RX1800-0GD77
SINAMICS DCM DC Converter Operating Instructions, French	6RX1800-0AD77
SINAMICS DCM List Manual, French	6RX1800-0ED77
Set of manuals, Italian (includes the Free Function Blocks manual in English)	6RX1800-0GD72
SINAMICS DCM DC Converter Operating Instructions, Italian	6RX1800-0AD72
SINAMICS DCM List Manual, Italian	6RX1800-0ED72

Item	Order number
Set of manuals, Russian (includes the Free Function Blocks manual in English)	6RX1800-0GD56
SINAMICS DCM DC Converter Operating Instructions, Russian	6RX1800-0AD56
SINAMICS DCM List Manual, Russian	6RX1800-0ED56
Set of manuals, Spanish (includes the Free Function Blocks manual in English)	6RX1800-0GD78
SINAMICS DCM DC Converter Operating Instructions, Spanish	6RX1800-0AD78
SINAMICS DCM List Manual, Spanish	6RX1800-0ED78
Set of manuals, Chinese (includes the Free Function Blocks Manual in English)	6RX1800-0GD27
SINAMICS DCM DC Converter Operating Instructions, Chinese	6RX1800-0AD27
SINAMICS DCM List Manual, Chinese	6RX1800-0ED27
All documentation in all of the above languages, on DVD	6RX1800-0AD64

Table 2- 6   Order numbers for accessories

Item	Order number
Standard CUD retrofit kit Combination of the spare parts, Standard CUD and connector board	6RY1803-0AA00 + 6RY1803-0GA00
Standard CUD coated retrofit kit Combination of the spare parts, Standard CUD coated and connector board coated	6RY1803-0AA20 + 6RY1803-0GA20
Advanced CUD retrofit kit Combination of the spare parts, Advanced CUD and connector board	6RY1803-0AA05 + 6RY1803-0GA00
Advanced CUD coated retrofit kit Combination of the spare parts, Advanced CUD coated and connector board coated	6RY1803-0AA25 + 6RY1803-0GA20
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	6SL3055-0AA00-3AA1
Sensor Module Cabinet-Mounted SMC30	6SL3055-0AA00-5CA2
Mounting kit to increase the degree of protection to IP20 for 15 A to 30 A units	6RX1800-0MA00 [3]
Mounting kit to increase the degree of protection to IP20 for 60 A to 280 A units	6RX1800-0MA01 [3]
Mounting kit to increase the degree of protection to IP20 for 400 A to 600 A units	6RX1800-0MA02 [3]
Mounting kit to increase the degree of protection to IP20 for 720 A to 850 A units	6RX1800-0MA03 [3]
SICROWBAR overvoltage protection	Depending on unit type [1]
SIMOREG DC-MASTER Converter Commutation Protector	Depending on unit type [1]
Firing Unit Trigger-Board	6RY1803-0CP00
Fuses	Depending on unit type [4]
Reactors	Depending on unit type [2]
RFI suppression filter	Depending on unit type [2]

27

Item	Order number
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.	
[2] Refer to the section titled "Connecting" as well as the catalogs and reference sources specified in this section.	
[3] The installation instructions are provided on the SINAMICS DCM Documentation DVD under "Accessories"	
[4] see Chapter "Fuses" as well as the catalogs and reference sources specified in this chapter.	

Table 2- 7   Order numbers for the Advanced Operator Panel AOP30

Item	Order number
Advanced Operator Panel AOP30	6SL3055-0AA00-4CA4
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. When ordering the RS485 cable with option, the suffix "-Z" must be attached to the Order No. followed by the order code for the required option. Ordering example for a 35 m long cable: Order 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

2.5 Accessories

2.5.1 SIMOREG DC-MASTER Converter Commutation Protector (CCP)

As supplement to the series of SINAMICS DCM converters, we offer the SIMOREG DC-MASTER Converter Commutation Protector (SIMOREG CCP).

Area of application

The SIMOREG DC-MASTER Converter Commutation Protector (SIMOREG CCP) is used to protect the semiconductor fuses of a line-commutated converter when operating in the inverter mode.

When an inverter commutation fault occurs, a high current flows in the regenerative feedback direction via the line supply or a cross-current in the converter. SIMOREG CCP limits the current to a non-hazardous value so that the thyristors and the associated super-fast fuses are protected. This therefore eliminates the complex replacement of fuses that takes a considerable amount of time. Although it cannot prevent inverter commutation faults, it can protect its effects.

Compatibility

The SIMOREG CCP is compatible to line-commutated SIMOREG DC-MASTER converters (6RA70 series) and SINAMICS DCM. It can be used for converters connected in parallel.

Using the SIMOREG CCP

The SIMOREG CCP is operated (parameter assignment, fault signals) is realized via the SINAMICS DCM. The SINAMICS DCM must have a software release of 1.2 or higher.

For a parallel connection of SINAMICS DCM units, a SIMOREG CCP must be used for each SINAMICS DCM. In this particular application, each of the SINAMICS DCM must be equipped with a Firing Unit Trigger-Board. The input for the "fast pulse inhibit interface" is implemented there.

For ordering data, see also the section titled "Ordering information for options and accessories".

The operating instructions for the SIMOREG CCP are included on the DVD "SINAMICS DCM documentation". These operating instructions also include

- help to select the suitable SIMOREG CCP
- the instructions to install the Firing Unit Trigger-Board in the SINAMICS DCM
- the instructions to operate the SINAMICS DCM with the SIMOREG CCP

CAUTION
The parallel interface (X165, X166) at the SINAMICS DCM is not compatible to the parallel interface (X165) at the SIMOREG CCP. It is not permissible that both connectors are connected.

For more detailed information as well as support when selecting a suitable SIMOREG CCP for your application, please contact your local Siemens office.

2.5.2 Mounting kit to increase the degree of protection to IP20

Degree of protection IP20 acc. to EN 60529

The degree of protection indicates protection against touching and penetration of solid objects and/or water.

Units in the SINAMICS DCM range are delivered with degree of protection IP00 and therefore offer no protection against touching or penetration. The mounting kit for units with a rated DC current up to 850 A increases the degree of protection to IP20.

Degree of protection IP20 offer protection against touching with the finger and penetration of solid objects greater than 12.5 mm dia, but no protection against water.

For ordering data, see also the section titled "Ordering information for options and accessories".

The installation instructions are provided on the SINAMICS DCM Documentation DVD (as of 12/2010 edition) under "Accessories"

Description 3

Area of application

The SINAMICS DC MASTER converter units have been specifically designed to supply the armature and field of variable-speed DC motors.

Alternative applications (e.g. supplying the field of a synchronous generator) are also possible.

Design

SINAMICS DC MASTER converter units are compact units containing both the power unit for the armature supply and the power unit for the field supply, as well as the control electronics and possible additional modules.

In the case of units with a 15 A to 1200 A rated DC current, the power units for the armature and field include electrically insulated thyristor modules, meaning that the heat sink is at ground potential. In units with a higher rated DC current, the power unit for the armature circuit includes disc-type thyristors and heat sinks (thyristor modules) at voltage potential.

The units have degree of protection IP00.

The connecting terminals are accessible from the front. The fan supply is fed in from the top; depending on the unit type, the field supply is either fed in from the top or the bottom.

All SINAMICS DC MASTER units are equipped with a Basic Operator Panel BOP20 in the front plate.

The BOP20 can be used

- To make all the settings that are required for commissioning

- To display all relevant measured values

- To display faults and alarms and acknowledge faults

- To switch the drive on and off

Versions

The armature supply is available in the following versions:

- 2-quadrant units:
  The armature is supplied via a fully-controlled three-phase bridge (B6C).

- 4-quadrant units:
  The armature is supplied via two fully-controlled three-phase bridges connected in a circulating-current-free inverse-parallel configuration ((B6)A(B6)C).

The field supply is available in the following versions:

- 1-phase, single-pair controllable two-pulse bridge circuit (B2HZ)

- 1-phase, fully-controlled two-pulse bridge circuit (B2C) (option)

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 or Advanced) (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

  – Supports commissioning by means of a commissioning wizard

  – Supports the display of measured values via a graphical operation screen

  – Displays a user-friendly parameter list, including text

  – Features several editors for user-friendly setting and changing of parameters

  – Displays lists of faults and alarms that have occurred, as well as infotext concerning the individual faults and alarms

  – Enables "local" drive control (ON/OFF, setpoint setting, jog mode, direction reversal)

  – Features 3 LEDs for displaying the drive state

- **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 participate in **ProfiNet** network as 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)

  – SMC30 (incremental encoder evaluation for actual speed value acquisition)

An SMC30 and up to 3 TMx modules can be connected to each CUD.

- **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. In addition to logic operations, however, drive systems require mathematical operations and latching elements.
  These functions are available in the form of the "free function blocks" function module. There is a range of elementary function blocks that are freely available for use:

  - 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 for one of the interconnected elementary function blocks to generate a graphical depiction of an existing function diagram 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 onto the CUD in the left-hand slot, but also to an optional second CUD in the right-hand slot.
  The closed-loop drive control is computed on the CUD in the left-hand slot. which means that it only provides a small amount of computing capacity for a DCC function 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.

Technical data

<div style="text-align: right; font-size: 2em; font-weight: bold;">4</div>

Note

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

4.1 Load types

For maximum efficiency when adapting the SINAMICS DC MASTER to the load profile for the driven machine, you can use the load cycle to carry out dimensioning.

Parameter p50067 is used to make the setting on the SINAMICS DC MASTER.

Table 4- 1 Load classes

Load class	Load for converter	Load cycle
DC I (p50067 = 1)	$I_{DC\,I}$ continuous (I_{dN})	$I_{DC\,I}$; 100 %; t
DC II (p50067 = 2)	$I_{DC\,II}$ for 15 mins and $1.5 \times I_{DC\,II}$ for 60 s	$I_{DC\,II}$; 15 min; 100 %; 150 %; t
DC III (p50067 = 3)	$I_{DC\,III}$ for 15 mins and $1.5 \times I_{DC\,III}$ for 120 s	$I_{DC\,III}$; 15 min; 100 %; 150 %; t
DC IV (p50067 = 4)	$I_{DC\,IV}$ for 15 mins and $2 \times I_{DC\,IV}$ for 10 s	$I_{DC\,IV}$; 15 min; 100 %; 200 %; t
US rating (p50067 = 5)	I_{US} for 15 mins and $1.5 \times I_{US}$ for 60 s	I_{US}; 15 min; 100 %; 150 %; t

---

NOTICE

- If a value > 1 is set at p50067, you need to make sure that the "Dynamic overload capability of the power unit" is enabled. This requires a value > 0 to be set at p50075.

- The SINAMICS DC MASTER does not monitor whether the load class set using p50067 is being adhered to. If the power unit permits it, longer overload periods can be used than correspond to the load class.
  The actual permissible overload duration for the particular power unit is always greater than the overload duration corresponding to the particular load class. and the SINAMICS DC MASTER does monitor whether the overload duration that is actually permitted for the power unit is being adhered to. For details on the power unit's dynamic overload capability, refer to Chapter 10.

- The 100 % I_{DCx} shown above DO NOT generally correspond to the rated unit current, but are reduced corresponding to the subsequent table.

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Duty cycles for 2Q applications

Table 4- 2   Duty cycles

SINAMICS DCM	Duty cycles									
	Tu	DC I continuous	DC II		DC III		DC IV		US rating Tu = 45 °C	
			15 min 100 %	60 s 150%	15 min 100 %	120 s 150%	15 min 100 %	10 s 200 %	15 min 100 %	60 s 150%
6RA80..	°C	A	A	A	A	A	A	A	A	A
400 V, 2Q										
.25-6DS22	45	60	51.4	77.1	50.2	75.3	46.4	92.8	51.4	77.1
.28-6DS22	45	90	74.4	111	72.8	109	65.4	130	74.4	111
.31-6DS22	45	125	106	159	103	155	96.3	192	106	159
.75-6DS22	40	210	164	247	161	242	136	273	157	236
.78-6DS22	40	280	226	340	219	328	201	402	215	323
.81-6DS22	40	400	290	435	282	423	244	488	278	417
.85-6DS22	40	600	462	693	446	669	413	826	443	665
.87-6DS22	40	850	652	978	622	933	609	1219	619	929
.91-6DS22	40	1200	884	1326	857	1286	768	1537	842	1263
.93-4DS22	40	1600	1255	1883	1213	1819	1139	2279	1190	1785
.95-4DS22	40	2000	1477	2216	1435	2152	1326	2653	1404	2106
.98-4DS22	40	3000	2288	3432	2189	3283	2164	4328	2178	3267
480 V, 2Q										
.25-6FS22	45	60	51.4	77.1	50.2	75.3	46.4	92.8	51.4	77.1
.28-6FS22	45	90	74.4	111	72.8	109	65.4	130	74.4	111
.31-6FS22	45	125	106	159	103	155	96.3	192	106	159
.75-6FS22	40	210	164	247	161	242	136	273	157	236
.78-6FS22	40	280	226	340	219	328	201	402	215	323
.82-6FS22	40	450	320	480	311	466	274	548	306	460
.85-6FS22	40	600	462	693	446	669	413	826	443	665
.87-6FS22	40	850	652	978	622	933	609	1219	619	929
.91-6FS22	40	1200	884	1326	857	1286	768	1537	842	1263
575 V, 2Q										
.25-6GS22	45	60	51.4	77.1	50.2	75.3	46.4	92.8	51.4	77.1
.31-6GS22	45	125	106	159	103	155	96.3	192	106	159
.75-6GS22	40	210	164	247	161	242	136	273	157	236
.81-6GS22	40	400	290	435	282	423	244	488	278	417
.85-6GS22	40	600	462	693	446	669	413	826	443	665
.87-6GS22	40	800	607	911	581	872	559	1118	578	867
.90-6GS22	40	1100	804	1207	782	1173	689	1379	766	1150
.93-4GS22	40	1600	1255	1883	1213	1819	1139	2279	1190	1785
.95-4GS22	40	2000	1663	2494	1591	2386	1568	3136	1569	2354
.96-4GS22	40	2200	1779	2669	1699	2549	1697	3394	1678	2517
.97-4GS22	40	2800	2136	3204	2044	3066	2022	4044	2024	3036

690 V, 2Q										
.86-6KS22	40	720	553	829	527	791	515	1031	525	788
.90-6KS22	40	1000	737	1105	715	1072	639	1279	702	1053
.93-4KS22	40	1500	1171	1757	1140	1710	1036	2073	1116	1674
.95-4KS22	40	2000	1589	2383	1522	2283	1505	3011	1503	2255
.97-4KS22	40	2600	1992	2989	1906	2859	1887	3774	1876	2815
830 V, 2Q										
.88-6LS22	40	950	700	1051	679	1019	607	1215	667	1001
.93-4LS22	40	1500	1171	1757	1140	1710	1036	2073	1116	1674
.95-4LS22	40	1900	1485	2228	1421	2132	1396	2793	1414	2121
950 V, 2Q										
.96-4MS22	40	2200	1674	2511	1603	2404	1570	3141	1588	2382

Duty cycles for 4Q applications

Table 4- 3　　Duty cycles

SINAMICS DCM	Duty cycles									
	Tu	DC I continuous	DC II		DC III		DC IV		US rating Tu = 45 °C	
			15 min 100 %	60 s 150%	15 min 100 %	120 s 150%	15 min 100 %	10 s 200 %	15 min 100 %	60 s 150%
6RA80..	°C	A	A	A	A	A	A	A	A	A
400 V, 4Q										
.13-6DV62	45	15	13.9	20.8	13.5	20.2	12.6	25.2	13.9	20.8
.18-6DV62	45	30	24.9	37.3	24.2	36.3	22.4	44.8	24.9	37.3
.25-6DV62	45	60	53.1	79.6	51.8	77.7	47.2	94.4	53.1	79.6
.28-6DV62	45	90	78.2	117	76.0	114	72.2	144	78.2	117
.31-6DV62	45	125	106	159	103	155	95.4	190	106	159
.75-6DV62	40	210	164	247	161	242	136	273	157	236
.78-6DV62	40	280	226	340	219	328	201	402	215	323
.81-6DV62	40	400	300	450	292	438	247	494	285	428
.85-6DV62	40	600	470	706	453	680.	410	820	450	675
.87-6DV62	40	850	658	987	634	951	579	1159	626	939
.91-6DV62	40	1200	884	1326	857	1286	768	1537	842	1263
.93-4DV62	40	1600	1255	1883	1213	1819	1139	2279	1190	1785
.95-4DV62	40	2000	1477	2216	1435	2152	1326	2653	1404	2106
.98-4DV62	40	3000	2288	3432	2189	3283	2164	4328	2178	3267

480 V, 4Q										
.13-6FV62	45	15	13.9	20.8	13.5	20.2	12.6	25.2	13.9	20.8
.18-6FV62	45	30	24.9	37.3	24.2	36.3	22.4	44.8	24.9	37.3
.25-6FV62	45	60	53.1	79.6	51.8	77.7	47.2	94.4	53.1	79.6
.28-6FV62	45	90	78.2	117	76	114	72.2	144	78.2	117
.31-6FV62	45	125	106	159	103	155	95.4	190	106	159
.75-6FV62	40	210	164	247	161	242	136	273	157	236
.78-6FV62	40	280	226	340	219	328	201	402	215	323
.82-6FV62	40	450	320	480	311	466	274	548	306	460
.85-6FV62	40	600	470	706	453	680	410	820	450	675
.87-6FV62	40	850	658	987	634	951	579	1159	626	939
.91-6FV62	40	1200	884	1326	857	1286	768	1537	842	1263
575 V, 4Q										
.25-6GV62	45	60	53.1	79.6	51.8	77.7	47.2	94.4	53.1	79.6
.31-6GV62	45	125	106	159	103	155	95.4	190	106	159
.75-6GV62	40	210	164	247	161	242	136	273	157	236
.81-6GV62	40	400	300	450	292	438	247	494	285	428
.85-6GV62	40	600	470	706	453	680	410	820	450	675
.87-6GV62	40	850	658	987	634	951	579	1159	626	939
.90-6GV62	40	1100	804	1207	782	1173	689	1379	766	1150
.93-4GV62	40	1600	1255	1883	1213	1819	1139	2279	1190	1785
.95-4GV62	40	2000	1663	2494	1591	2386	1568	3136	1569	2354
.96-4GV62	40	2200	1779	2669	1699	2549	1697	3394	1678	2517
.97-4GV62	40	2800	2136	3204	2044	3066	2022	4044	2024	3036
690 V, 4Q										
.86-6KV62	40	760	598	898	575	863	532	1065	569	853
.90-6KV62	40	1000	737	1105	715	1072	639	1279	702	1053
.93-4KV62	40	1500	1171	1757	1140	1710	1036	2073	1116	1674
.95-4KV62	40	2000	1589	2383	1522	2283	1505	3011	1503	2255
.97-4KV62	40	2600	1992	2989	1906	2859	1887	3774	1876	2815
830 V, 4Q										
.88-6LV62	40	950	700	1051	679	1019	607	1215	667	1001
.93-4LV62	40	1500	1171	1757	1140	1710	1036	2073	1116	1674
.95-4LV62	40	1900	1485	2228	1421	2132	1396	2793	1414	2121
950 V, 4Q										
.96-4MV62	40	2200	1674	2511	1603	2404	1570	3141	1588	2382

4.2 Environmental requirements

Environmental classes according to EN 60721-3

Table 4- 4   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 • 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	-
Transportation	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

Table 4- 5   Ambient temperature Tu

Use	Tu [°C]	Comment
Storage	-40 ... +70	Only applies when product is in its original packing
Transportation	-40 ... +70	Only applies when product is in its original packing
Operation	0 ... +45	for units with a rated DC current ≤125 A (self-ventilated units), at rated DC current
	0 ... +40	for units with a rated DC current ≥210 A (force ventilated units), at rated DC current
	0 ... +55	With derating; see the section titled "Derating" after the unit data

Installation altitude above sea level

≤ 1,000 m   With rated DC current

> 1,000 m   With derating; see the section titled "Derating" after the unit data

4.3 Unit data

For dimension drawings, please refer to Chapter 5.

Explanation of footnotes following tables

3-ph. 400 V AC, 2Q units

6RA8025-6DS22	*6RA8028-6DS22*	*6RA8031-6DS22*	*6RA8075-6DS22*
6RA8078-6DS22	*6RA8081-6DS22*	*6RA8085-6DS22*	*6RA8087-6DS22*
6RA8091-6DS22			
6RA8093-4DS22	*6RA8095-4DS22*	*6RA8098-4DS22*	

Table 4- 6   Technical data for 3-ph. 400 V AC, 2Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 400 V AC (+15% / -20%); for unit 6RA8098-4DS22: +10 % / -20 %
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	485
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 7   Technical data for 3-ph. 400 V AC, 60 to 210 A, 2Q units

Order number 6RA80 ..		..25-6DS22	..28-6DS22	..31-6DS22	..75-6DS22
Rated DC current	A	60	90	125	210
Rated armature input current 2)	A	49.8	74.7	104	174
Rated power	kW	29.1	43.7	60.6	102
Power loss at rated DC current (approx.)	W	250	356	409	689
Rated field supply voltage 1)	V	2-ph. 400 V AC (+15 % / – 20 %)			
Rated field DC voltage 1)	V	325	325	325	325

Order number 6RA80 ..		..25-6DS22	..28-6DS22	..31-6DS22	..75-6DS22
Rated field DC current	A	10	10	10	15
Type of cooling		Self-ventilated	Self-ventilated	Self-ventilated	Forced ventilation
Rated fan supply voltage	V	-	-	-	Fan with internal power supply
Fan air flow	m³/h	-	-	-	300
Fan noise level	dBA	-	-	-	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	11	14	14	14
Rated DC voltage for single-phase operation	V	320	320	320	-
Rated DC current for single-phase operation	A	42.0	63.0	87.5	-

Table 4- 8   Technical data for 3-ph. 400 V AC, 280 to 850 A, 2Q units

Order number 6RA80 ..			..78-6DS22	..81-6DS22	..85-6DS22	..87-6DS22
Rated DC current		A	280	400	600	850
Rated armature input current 2)		A	232	332	498	706
Rated power		kW	136	194	291	412
Power loss at rated DC current (approx.)		W	812	1375	1844	2467
Rated field supply voltage 1)		V	2-ph. 400 V AC (+15 % / – 20 %)			
Rated field DC voltage 1)		V	325	325	325	325
Rated field DC current		A	15	25	25	30
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	Fan with internal power supply	3-ph. 400 V AC (±15 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz		
				With option L21: 1-ph. 230 V AC (±10 %)		
Rated fan current	50 Hz 60 Hz	A	-	0.23 8) 0.26 8)	0.23 8) 0.26 8)	0.23 8) 0.26 8)
Rated fan current with option L21	50 Hz 60 Hz	A	-	0.51 8) 0.72 8)	0.51 8) 0.72 8)	0.51 8) 0.72 8)
Fan air flow		m³/h	300	600	600	600
Fan noise level	50 Hz 60 Hz	dBA	70.3 70.3	70.3 74.4	70.3 74.4	70.3 74.4
Dimensions (HxWxD)		mm	385x268x252	625x268x275	625x268x275	700x268x311
Weight (approx.)		kg	15	26	28	38

Table 4- 9   Technical data for 3-ph. 400 V AC, 1200 A, 2Q units

Order number 6RA80 ..			..91-6DS22
Rated DC current		A	1200
Rated armature input current 2)		A	995
Rated power		kW	582
Power loss at rated DC current (approx.)		W	4107
Rated field supply voltage 1)		V	2-ph. 480 V AC (+10 % / − 20 %)
Rated field DC voltage 1)		V	390
Rated field DC current		A	40
Type of cooling			Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10%) 50 Hz 3-ph. 460 V AC (±10%) 60 Hz with option L21: 1-ph. 230 V AC (±10 %)
Rated fan current	50 Hz 60 Hz	A	0.3 9) 0.38 9)
Rated fan current with option L21	50 Hz 60 Hz	A	0.81 9) 1.14 9)
Fan air flow		m³/h	1000
Fan noise level	50 Hz 60 Hz	dBA	70.4 74.2
Dimensions (HxWxD)		mm	785x268x435
Weight (approx.)		kg	78

Table 4- 10   Technical data for 3-ph. 400 V AC, 1600 A to 3000 A, 2Q units

Order number 6RA80 ..			..93-4DS22	..95-4DS22	..98-4DS22
Rated DC current		A	1600	2000	3000
Rated armature input current 2)		A	1328	1660	2490
Rated power		kW	776	970	1455
Power loss at rated DC current (approx.)		W	5678	6781	10640
Rated field supply voltage 1)		V	2-ph. 480 V AC (+10 % / − 20 %)		
Rated field DC voltage 1)		V	390	390	390
Rated field DC current		A	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz		
Rated fan current	50 Hz 60 Hz	A	0.95 9) 1.25 9)	0.95 9) 1.25 9)	0.95 9) 1.25 9)

44

Order number 6RA80 ..			..93-4DS22	..95-4DS22	..98-4DS22
Fan air flow		m³/h	2400	2400	2400
Fan noise level	50 Hz	dBA	80.8	80.8	80.8
	60 Hz		83.2	83.2	83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	135	135	165

3-ph. 480 V AC, 2Q units

6RA8025-6FS22   *6RA8028-6FS22*   *6RA8031-6FS22*

6RA8075-6FS22   *6RA8078-6FS22*

6RA8082-6FS22   *6RA8085-6FS22*   *6RA8087-6FS22*   *6RA8091-6FS22*

Table 4- 11   Technical data for 3-ph. 480 V AC, 2Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 480 V AC (+10 % / -20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / -20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	575
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 12   Technical data for 3-ph. 480 V AC, 60 A to 125 A, 2Q units

Order number 6RA80 ..		..25-6FS22	..28-6FS22	..31-6FS22
Rated DC current	A	60	90	125
Rated armature input current 2)	A	49.8	74.7	104
Rated power	kW	34.5	51.8	71.9
Power loss at rated DC current (approx.)	W	299	378	431
Rated field DC current	A	10	10	10
Type of cooling		Self-ventilated	Self-ventilated	Self-ventilated
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	11	14	14
Rated DC voltage for single-phase operation	V	385	385	385
Rated DC current for single-phase operation	A	42.0	63.0	87.5

Table 4- 13   Technical data for 3-ph. 480 V AC, 210 A to 280 A, 2Q units

Order number 6RA80 ..		..75-6FS22	..78-6FS22
Rated DC current	A	210	280
Rated armature input current 2)	A	174	232
Rated power	kW	121	161
Power loss at rated DC current (approx.)	W	720	811
Rated field DC current	A	15	15
Type of cooling		Forced ventilation	Forced ventilation
Rated fan supply voltage	V	Fan with internal power supply	Fan with internal power supply
Fan air flow	m³/h	300	300
Fan noise level	dBA	70.3	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252
Weight (approx.)	kg	14	15

Table 4- 14   Technical data for 3-ph. 480 V AC, 450 A to 1200 A, 2Q units

Order number 6RA80 ..			..82-6FS22	..85-6FS22	..87-6FS22	..91-6FS22
Rated DC current		A	450	600	850	1200
Rated armature input current 2)		A	374	498	706	996
Rated power		kW	259	345	489	690
Power loss at rated DC current (approx.)		W	1583	1909	2597	4237
Rated field DC current		A	25	25	30	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage	50 Hz	V	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±10 %)
	60 Hz	V	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)
		V	With option L21: 1-ph. 230 V AC (±10 %)			
Rated fan current	50 Hz 60 Hz	A	0.23 0.26	0.23 0.26	0.23 0.26	0.30 0.38
Rated fan current with option L21	50 Hz 60 Hz	A	0.51 0.72	0.51 0.72	0.51 0.72	0.81 1.14
Fan air flow		m³/h	600	600	600	1000
Fan noise level	50 Hz 60 Hz	dBA	70.3 74.4	70.3 74.4	70.3 74.4	70.4 74.2
Dimensions (HxWxD)		mm	625x268x275	625x268x275	700x268x311	785x268x435
Weight (approx.)		kg	28	28	38	78

3-ph. 575 V AC, 2Q units

6RA8025-6GS22	*6RA8031-6GS22*	*6RA8075-6GS22*	
6RA8081-6GS22	*6RA8085-6GS22*	*6RA8087-6GS22*	*6RA8090-6GS22*
6RA8093-4GS22	*6RA8095-4GS22*	*6RA8096-4GS22*	*6RA8097-4GS22*

Table 4- 15   Technical data for 3-ph. 575 V AC, 2Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 575 V AC (+10 % / – 20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	690

Common data

Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 16   Technical data for 3-ph. 575 V AC, 60 A to 210 A, 2Q units

Order number 6RA80 ..		..25-6GS22	..31-6GS22	..75-6GS22
Rated DC current	A	60	125	210
Rated armature input current 2)	A	49.8	104	174
Rated power	kW	41.4	86.3	145
Power loss at rated DC current (approx.)	W	274	463	742
Rated field DC current	A	10	10	15
Type of cooling		Self-ventilated	Self-ventilated	Forced ventilation
Rated fan supply voltage	V	-	-	Fan with internal power supply
Fan air flow	m³/h	-	-	300
Fan noise level	dBA	-	-	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	11	14	14
Rated DC voltage for single-phase operation	V	460	460	-
Rated DC current for single-phase operation	A	42.0	87.5	-

Table 4- 17   Technical data for 3-ph. 575 V AC, 400 A to 1100 A, 2Q units

Order number 6RA80 ..			..81-6GS22	..85-6GS22	..87-6GS22	..90-6GS22
Rated DC current		A	400	600	800	1100
Rated armature input current 2)		A	332	498	664	913
Rated power		kW	276	414	552	759
Power loss at rated DC current (approx.)		W	1598	2002	2686	4022
Rated field DC current		A	25	25	30	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage	50 Hz	V	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±10 %)
	60 Hz	V	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)
			With option L21: 1-ph. 230 V AC (±10 %)			
Rated fan current	50 Hz 60 Hz	A	0.23 8) 0.26	0.23 8) 0.26	0.23 8) 0.26	0.30 9) 0.38
Rated fan current with option L21	50 Hz 60 Hz	A	0.51 0.72	0.51 0.72	0.51 0.72	0.81 1.14
Fan air flow		m³/h	600	600	600	1000
Fan noise level	50 Hz 60 Hz	dBA	70.3 74.4	70.3 74.4	70.3 74.4	70.4 74.2
Dimensions (HxWxD)		mm	625x268x275	625x268x275	700x268x311	785x268x435
Weight (approx.)		kg	26	28	38	78

Table 4- 18   Technical data for 3-ph. 575 V AC, 1600 A to 2800 A, 2Q units

Order number 6RA80 ..			..93-4GS22	..95-4GS22	..96-4GS22	..97-4GS22
Rated DC current		A	1600	2000	2200	2800
Rated armature input current 2)		A	1328	1660	1826	2324
Rated power		kW	1104	1380	1518	1932
Power loss at rated DC current (approx.)		W	6036	7073	7391	10530
Rated field DC current		A	40	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz			
Rated fan current	50 Hz 60 Hz	A	0.95 9) 1.25	0.95 9) 1.25	0.95 9) 1.25	0.95 9) 1.25
Fan air flow		m³/h	2400	2400	2400	2400
Fan noise level	50 Hz 60 Hz	dBA	80.3 83.2	80.3 83.2	80.3 83.2	80.3 83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	135	135	165	165

3-ph. 690 V AC, 2Q units

6RA8086-6KS22   *6RA8090-6KS22*

6RA8093-4KS22   *6RA8095-4KS22*   *6RA8097-4KS22*

Table 4- 19   Technical data for 3-ph. 690 V AC, 2Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 690 V AC (+10 % / – 20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (–25 %) to 480 V AC (+10 %); In=1 A or 1-ph. 190 (–25 %) to 240 V AC (+10 %); In=2 A (–35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	830
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 20   Technical data for 3-ph. 690 V AC, 720 A to 1000 A, 2Q units

Order number 6RA80 ..		**..86-6KS22**	**..90-6KS22**
Rated DC current	A	720	1000
Rated armature input current 2)	A	598	830
Rated power	kW	598	830
Power loss at rated DC current (approx.)	W	2767	3963
Rated field DC current	A	30	40
Type of cooling		Forced ventilation	Forced ventilation
Rated fan supply voltage	V	3-ph. 400 AC (±15%) 50 Hz 3-ph. 460 AC (±10%) 60 Hz	3-ph. 400 AC (±10%) 50 Hz 3-ph. 460 AC (±10%) 60 Hz
		With option L21: 1-ph. 230 V AC (±10 %)	With option L21: 1-ph. 230 V AC (±10 %)

Order number 6RA80 ..			..86-6KS22	..90-6KS22
Rated fan current	50 Hz	A	0.23 8)	0.30 9)
	60 Hz		0.26	0.38
Rated fan current with option L21	50 Hz	A	0.51	0.81
	60 Hz		0.72	1.14
Fan air flow		m³/h	600	1000
Fan noise level	50 Hz	dBA	70.3	70.4
	60 Hz		74.4	74.2
Dimensions (HxWxD)		mm	700x268x311	785x268x435
Weight (approx.)		kg	38	78

Table 4- 21   Technical data for 3-ph. 690 V AC, 1500 A to 2600 A, 2Q units

Order number 6RA80 ..			..93-4KS22	..95-4KS22	..97-4KS22
Rated DC current		A	1500	2000	2600
Rated armature input current 2)		A	1245	1660	2158
Rated power		kW	1245	1660	2158
Power loss at rated DC current (approx.)		W	6675	8158	10300
Rated field DC current		A	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz		
Rated fan current	50 Hz	A	0.95 9)	0.95 9)	0.95 9)
	60 Hz		1.25	1.25	1.25
Fan air flow		m³/h	2400	2400	2400
Fan noise level	50 Hz	dBA	80.8	80.8	80.8
	60 Hz		83.2	83.2	83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	135	135	165

3-ph. 830 V AC, 2Q units

6RA8088-6LS22   *6RA8093-4LS22*   *6RA8095-4LS22*

Table 4- 22   Technical data for 3-ph. 830 V AC, 2Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 830 V AC (+10 % / – 20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	1000
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 23   Technical data for 3-ph. 830 V AC, 900 A to 1900 A, 2Q units

Order number 6RA80 ..		..88-6LS22	..93-4LS22	..95-4LS22
Rated DC current	A	950	1500	1900
Rated armature input current 2)	A	789	1245	1577
Rated power	kW	950	1500	1900
Power loss at rated DC current (approx.)	W	4221	7122	8669
Rated field DC current	A	40	40	40
Type of cooling		Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage	50 Hz 60 Hz	V	3-ph. 400 V AC (±10 %) 3-ph. 460 V AC (±10 %)	3-ph. 400 V AC (±10 %) 3-ph. 460 V AC (±10 %)
			With option L21: 1-ph. 230 V AC (±10 %)	-

Order number 6RA80 ..			..88-6LS22	..93-4LS22	..95-4LS22
Rated fan current	50 Hz	A	0.30 9)	0.95 9)	0.95 9)
	60 Hz		0.38	1.25	1.25
Rated fan current with option L21	50 Hz	A	0.81	-	-
	60 Hz		1.14		
Fan air flow		m³/h	1000	2400	2400
Fan noise level	50 Hz	dBA	70.4	80.8	80.8
	60 Hz		74.2	83.2	83.2
Dimensions (HxWxD)		mm	785x268x435	883x453x505	883x453x505
Weight (approx.)		kg	78	135	135

3-ph. 400 V AC, 4Q units

6RA8013-6DV62	6RA8018-6DV62	6RA8025-6DV62	6RA8028-6DV62
6RA8031-6DV62	6RA8075-6DV62	6RA8078-6DV62	
6RA8081-6DV62	6RA8085-6DV62	6RA8087-6DV62	
6RA8091-6DV62			
6RA8093-4DV62	6RA8095-4DV62	6RA8098-4DV62	

Table 4- 24   Technical data for 3-ph. 400 V AC, 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 400 V AC (+15% / -20%); 6RA8098-4DV62 units: +10 % / -20 %
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	420
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 25   Technical data for 3-ph. 400 V AC, 15 A to 90 A, 4Q units

Order number 6RA80 ..		..13-6DV62	..18-6DV62	..25-6DV62	..28-6DV62
Rated DC current	A	15	30	60	90
Rated armature input current 2)	A	12.5	24.9	49.8	74.7
Rated power	kW	6.3	12.6	25.2	37.8
Power loss at rated DC current (approx.)	W	131	180	250	321
Rated field supply voltage 1)	V	2-ph. 400 V AC (+15 % / – 20 %)			
Rated field DC voltage 1)	V	325	325	325	325
Rated field DC current	A	3	5	10	10
Type of cooling		Self-ventilated	Self-ventilated	Self-ventilated	Self-ventilated
Dimensions (HxWxD)	mm	385x268x221	385x268x221	385x268x252	385x268x252
Weight (approx.)	kg	11	11	11	14
Rated DC voltage for single-phase operation	V	280	280	280	280
Rated DC current for single-phase operation	A	10.5	21.0	42.0	63.0

Table 4- 26   Technical data for 3-ph. 400 V AC, 125 A to 280 A, 4Q units

Order number 6RA80 ..		..31-6DV62	..75-6DV62	..78-6DV62
Rated DC current	A	125	210	280
Rated armature input current 2)	A	104	174	232
Rated power	kW	52.5	88.2	118
Power loss at rated DC current (approx.)	W	409	689	812
Rated field supply voltage 1)	V	2-ph. 400 V AC (+15 % / – 20 %)		
Rated field DC voltage 1)	V	325	325	325
Rated field DC current	A	10	15	15
Type of cooling		Self-ventilated	Forced ventilation	Forced ventilation
Rated fan supply voltage	V	-	Fan with internal power supply	Fan with internal power supply
Fan air flow	m³/h	-	300	300
Fan noise level	dBA	-	70.3	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	14	15	15

Order number 6RA80 ..		..31-6DV62	..75-6DV62	..78-6DV62
Rated DC voltage for single-phase operation	V	280	-	-
Rated DC current for single-phase operation	A	87.5	-	-

Table 4- 27   Technical data for 3-ph. 400 V AC, 400 A to 850 A, 4Q units

Order number 6RA80 ..			..81-6DV62	..85-6DV62	..87-6DV62
Rated DC current		A	400	600	850
Rated armature input current 2)		A	332	498	706
Rated power		kW	168	252	357
Power loss at rated DC current (approx.)		W	1375	1844	2467
Rated field supply voltage 1)		V	2-ph. 400 V AC (+15 % / – 20 %)		
Rated field DC voltage 1)		V	325	325	325
Rated field DC current		A	25	25	30
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±15 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz With option L21: 1-ph. 230 V AC (±10 %)		
Rated fan current	50 Hz 60 Hz	A	0.23 8) 0.26	0.23 8) 0.26	0.23 8) 0.26
Rated fan current with option L21	50 Hz 60 Hz	A	0.51 0.72	0.51 0.72	0.51 0.72
Fan air flow		m^3/h	600	600	600
Fan noise level	50 Hz 60 Hz	dBA	70.3 74.4	70.3 74.4	70.3 74.4
Dimensions (HxWxD)		mm	625x268x275	625x268x275	700x268x311
Weight (approx.)		kg	26	31	42

Table 4- 28   Technical data for 3-ph. 400 V AC, 1200 A, 4Q units

Order number 6RA80 ..		..91-6DV62
Rated DC current	A	1200
Rated armature input current 2)	A	996
Rated power	kW	504
Power loss at rated DC current (approx.)	W	4107
Rated field supply voltage 1)	V	2-ph. 480 AC (+10 % / – 20 %)

55

Order number 6RA80 ..			..91-6DV62
Rated field DC voltage 1)		V	390
Rated field DC current		A	40
Type of cooling			Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10%) 50 Hz 3-ph. 460 V AC (±10%) 60 Hz with option L21: 1-ph. 230 V AC (±10 %)
Rated fan current	50 Hz 60 Hz	A	0.30 9) 0.38 9)
Rated fan current with option L21	50 Hz 60 Hz	A	0.81 1.14
Fan air flow		m³/h	1000
Fan noise level	50 Hz 60 Hz	dBA	70.4 74.2
Dimensions (HxWxD)		mm	785x268x435
Weight (approx.)		kg	78

Table 4- 29   Technical data for 3-ph. 400 V AC, 1600 A to 3000 A, 4Q units

Order number 6RA80 ..			..93-4DV62	..95-4DV62	..98-4DV62
Rated DC current		A	1600	2000	3000
Rated armature input current 2)		A	1328	1660	2490
Rated power		kW	672	840	1260
Power loss at rated DC current (approx.)		W	5678	6781	10640
Rated field supply voltage 1)		V	2-ph. 480 V AC (+10 % / – 20 %)		
Rated field DC voltage 1)		V	390	390	390
Rated field DC current		A	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz		
Rated fan current	50 Hz 60 Hz	A	0.95 9) 1.25 9)	0.95 9) 1.25 9)	0.95 9) 1.25 9)
Fan air flow		m³/h	2400	2400	2400
Fan noise level	50 Hz 60 Hz	dBA	80.8 83.2	80.8 83.2	80.8 83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	155	155	185

3-ph. 480 V AC, 4Q units

6RA8013-6FV62	*6RA8018-6FV62*	*6RA8025-6FV62*	*6RA8028-6FV62*
6RA8031-6FV62	*6RA8075-6FV62*	*6RA8078-6FV62*	
6RA8082-6FV62	*6RA8085-6FV62*	*6RA8087-6FV62*	*6RA8091-6FV62*

Table 4- 30   Technical data for 3-ph. 480 V AC, 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 480 V AC (+10 % / -20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	500
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 31   Technical data for 3-ph. 480 V AC, 15 A to 90 A, 4Q units

Order number 6RA80 ..		**..13-6FV62**	**..18-6FV62**	**..25-6FV62**	**..28-6FV62**
Rated DC current	A	15	30	60	90
Rated armature input current 2)	A	12.5	24.9	49.8	74.7
Rated power	kW	6.3	15	30	45
Power loss at rated DC current (approx.)	W	131	190	299	343
Rated field DC current	A	3	5	10	10
Type of cooling		Self-ventilated	Self-ventilated	Self-ventilated	Self-ventilated
Dimensions (HxWxD)	mm	385x268x221	385x268x221	385x268x252	385x268x252
Weight (approx.)	kg	11	11	11	14

Order number 6RA80 ..		..13-6FV62	..18-6FV62	..25-6FV62	..28-6FV62
Rated DC voltage for single-phase operation	V	335	335	335	335
Rated DC current for single-phase operation	A	10.5	21.0	42.0	63.0

Table 4- 32   Technical data for 3-ph. 480 V AC, 125 A to 280 A, 4Q units

Order number 6RA80 ..		..31-6FV62	..75-6FV62	..78-6FV62
Rated DC current	A	125	210	280
Rated armature input current 2)	A	104	174	232
Rated power	kW	62.5	105	140
Power loss at rated DC current (approx.)	W	431	720	811
Rated field DC current	A	10	15	15
Type of cooling		Self-ventilated	Forced ventilation	Forced ventilation
Rated fan supply voltage	V	-	Fan with internal power supply	Fan with internal power supply
Fan air flow	m³/h	-	300	300
Fan noise level	dBA	-	70.3	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	14	15	15
Rated DC voltage for single-phase operation	V	335	-	-
Rated DC current for single-phase operation	A	87.5	-	-

Table 4- 33   Technical data for 3-ph. 480 V AC, 450 A to 1200 A, 4Q units

Order number 6RA80 ..		..82-6FV62	..85-6FV62	..87-6FV62	..91-6FV62
Rated DC current	A	450	600	850	1200
Rated armature input current 2)	A	374	498	706	996
Rated power	kW	225	300	425	600
Power loss at rated DC current (approx.)	W	1583	1909	2597	4237
Rated field DC current	A	25	25	30	40
Type of cooling		Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation

Order number 6RA80 ..			..82-6FV62	..85-6FV62	..87-6FV62	..91-6FV62
Rated fan supply voltage	50 Hz	V	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±10 %)
	60 Hz	V	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)
		V	With option L21: 1-ph. 230 V AC (±10 %)			
Rated fan current	50 Hz	A	0.23	0.23	0.23	0.30
	60 Hz		0.26	0.26	0.26	0.38
Rated fan current with option L21	50 Hz	A	0.51	0.51	0.51	0.81
	60 Hz		0.72	0.72	0.72	1.14
Fan air flow		m³/h	600	600	600	1000
Fan noise level	50 Hz	dBA	70.3	70.3	70.3	70.4
	60 Hz		74.4	74.4	74.4	74.2
Dimensions (HxWxD)		mm	625x268x275	625x268x275	700x268x311	785x268x435
Weight (approx.)		kg	31	31	42	78

3-ph. 575 V AC, 4Q units

6RA8025-6GV62	*6RA8031-6GV62*	*6RA8075-6GV62*
6RA8081-6GV62	*6RA8085-6GV62*	*6RA8087-6GV62*	*6RA8090-6GV62*
6RA8093-4GV62	*6RA8095-4GV62*	*6RA8096-4GV62*	*6RA8097-4GV62*

Table 4- 34   Technical data for 3-ph. 575 V AC, 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 575 V AC (+10 % / -20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	600
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)

Common data

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

Table 4- 35   Technical data for 3-ph. 575 V AC, 60 A to 210 A, 4Q units

Order number 6RA80 ..		..25-6GV62	..31-6GV62	..75-6GV62
Rated DC current	A	60	125	210
Rated armature input current 2)	A	49.8	104	174
Rated power	kW	35	75	126
Power loss at rated DC current (approx.)	W	274	463	742
Rated field DC current	A	10	10	15
Type of cooling		Self-ventilated	Self-ventilated	Forced ventilation
Rated fan supply voltage	V	-	-	Fan with internal power supply
Fan air flow	m³/h	-	-	300
Fan noise level	dBA	-	-	70.3
Dimensions (HxWxD)	mm	385x268x252	385x268x252	385x268x252
Weight (approx.)	kg	11	14	15
Rated DC voltage for single-phase operation	V	400	400	-
Rated DC current for single-phase operation	A	42.0	87.5	-

Table 4- 36   Technical data for 3-ph. 575 V AC, 400 A to 1100 A, 4Q units

Order number 6RA80 ..			..81-6GV62	..85-6GV62	..87-6GV62	..90-6GV62
Rated DC current	A		400	600	850	1100
Rated armature input current 2)	A		332	498	706	913
Rated power	kW		240	360	510	660
Power loss at rated DC current (approx.)	W		1598	2002	2826	4022
Rated field DC current	A		25	25	30	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage	50 Hz	V	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±15 %)	3-ph. 400 V AC (±10 %)
	60 Hz	V	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)	3-ph. 460 V AC (±10 %)
		V	With option L21: 1-ph. 230 V AC (±10 %)			

Order number 6RA80 ..			..81-6GV62	..85-6GV62	..87-6GV62	..90-6GV62
Rated fan current	50 Hz	A	0.23 8)	0.23 8)	0.23 8)	0.30 9)
	60 Hz		0.26	0.26	0.26	0.38
Rated fan current with option L21	50 Hz	A	0.51	0.51	0.51	0.81
	60 Hz		0.72	0.72	0.72	1.14
Fan air flow		m³/h	600	600	600	1000
Fan noise level	50 Hz	dBA	70.3	70.3	70.3	70.4
	60 Hz		74.4	74.4	74.4	74.2
Dimensions (HxWxD)		mm	625x268x275	625x268x275	700x268x311	785x268x435
Weight (approx.)		kg	26	31	42	78

Table 4- 37   Technical data for 3-ph. 575 V AC, 1600 A to 2800 A, 4Q units

Order number 6RA80 ..			..93-4GV62	..95-4GV62	..96-4GV62	..97-4GV62
Rated DC current		A	1600	2000	2200	2800
Rated armature input current 2)		A	1328	1660	1826	2324
Rated power		kW	960	1200	1320	1680
Power loss at rated DC current (approx.)		W	6036	7073	7391	10530
Rated field DC current		A	40	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz			
Rated fan current	50 Hz	A	0.95 9)	0.95 9)	0.95 9)	0.95 9)
	60 Hz		1.25	1.25	1.25	1.25
Fan air flow		m³/h	2400	2400	2400	2400
Fan noise level	50 Hz	dBA	80.3	80.3	80.3	80.3
	60 Hz		83.2	83.2	83.2	83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	155	155	185	185

3-ph. 690 V AC, 4Q units

6RA8086-6KV62	*6RA8090-6KV62*	
6RA8093-4KV62	*6RA8095-4KV62*	*6RA8097-4KV62*

Table 4- 38   Technical data for 3-ph. 690 V AC, 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 690 V AC (+10 % / -20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	725
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 39   Technical data for 3-ph. 690 V AC, 760 A to 1000 A, 4Q units

Order number 6RA80 ..		**..86-6KV62**	**..90-6KV62**
Rated DC current	A	760	1000
Rated armature input current 2)	A	631	830
Rated power	kW	551	725
Power loss at rated DC current (approx.)	W	2897	3963
Rated field DC current	A	30	40
Type of cooling		Forced ventilation	Forced ventilation
Rated fan supply voltage	V	3-ph. 400 V AC (±15 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz
		With option L21: 1-ph. 230 V AC (±10 %)	With option L21: 1-ph. 230 V AC (±10 %)

Order number 6RA80 ..			..86-6KV62	..90-6KV62
Rated fan current	50 Hz 60 Hz	A	0.23 8) 0.26	0.30 9) 0.38
Rated fan current with option L21	50 Hz 60 Hz	A	0.51 0.72	0.81 1.14
Fan air flow		m³/h	600	1000
Fan noise level	50 Hz 60 Hz	dBA	70.3 74.4	70.4 74.2
Dimensions (HxWxD)		mm	700x268x311	785x268x435
Weight (approx.)		kg	42	78

Table 4- 40   Technical data for 3-ph. 690 V AC, 1500 A to 2600 A, 4Q units

Order number 6RA80 ..			..93-4KV62	..95-4KV62	..97-4KV62
Rated DC current		A	1500	2000	2600
Rated armature input current 2)		A	1245	1660	2158
Rated power		kW	1088	1450	1885
Power loss at rated DC current (approx.)		W	6675	8158	10300
Rated field DC current		A	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz		
Rated fan current	50 Hz 60 Hz	A	0.95 9) 1.25	0.95 9) 1.25	0.95 9) 1.25
Fan air flow		m³/h	2400	2400	2400
Fan noise level	50 Hz 60 Hz	dBA	80.8 83.2	80.8 83.2	80.8 83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505	883x453x505
Weight (approx.)		kg	155	155	185

3-ph. 830 V AC, 4Q units

6RA8088-6LV62   *6RA8093-4LV62*   *6RA8095-4LV62*

Table 4- 41   Technical data for 3-ph. 830 V AC, 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 830 V AC (+10 % / -20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / -20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated DC voltage 1)	V	875
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 42   Technical data for 3-ph. 830 V AC, 950 A to 1900 A, 4Q units

Order number 6RA80 ..			..88-6LV62	..93-4LV62	..95-4LV62
Rated DC current		A	950	1500	1900
Rated armature input current 2)		A	789	1245	1577
Rated power		kW	831	1313	1663
Power loss at rated DC current (approx.)		W	4221	7122	8669
Rated field DC current		A	40	40	40
Type of cooling			Forced ventilation	Forced ventilation	Forced ventilation
Rated fan supply voltage	50 Hz 60 Hz	V	3-ph. 400 V AC (±10 %) 3-ph. 460 V AC (±10 %)	3-ph. 400 V AC (±10 %) 3-ph. 460 V AC (±10 %)	
			With option L21: 1-ph. 230 V AC (±10 %)	-	

Order number 6RA80 ..			..88-6LV62	..93-4LV62	..95-4LV62
Rated fan current	50 Hz	A	0.30 9)	0.95 9)	0.95 9)
	60 Hz		0.38	1.25	1.25
Rated fan current with option L21	50 Hz	A	0.81	-	-
	60 Hz		1.14		
Fan air flow		m³/h	1000	2400	2400
Fan noise level	50 Hz	dBA	70.4	80.8	80.8
	60 Hz		74.2	83.2	83.2
Dimensions (HxWxD)		mm	785x268x435	883x453x505	883x453x505
Weight (approx.)		kg	78	155	155

3-ph. 950 V AC, 2Q and 4Q units

6RA8096-4MS22   *6RA8096-4MV62*

Table 4- 43   Technical data for 3-ph. 950 V AC, 2Q and 4Q units

Common data		
Rated armature supply voltage 1)	V	3-ph. 950 V AC (+15 % / – 20 %)
Rated field supply voltage 1)	V	2-ph. 480 V AC (+10 % / – 20 %)
Electronics power supply, rated supply voltage	V	2-ph. 380 (– 25 %) to 480 V AC (+10 %); In = 1 A or 1-ph. 190 (– 25 %) to 240 V AC (+10 %); In = 2 A (– 35 % for 1 min.)
		With option L05: 18 to 30 V DC; In = 5 A
Rated field DC voltage 1)	V	390
Rated frequency	Hz	45 to 65 10)
Overload possibility 6)		Max. 1.8x rated DC current
Closed-loop control constancy		Δn = 0.006% of rated motor speed during operation with incremental encoder **and** digital setpoint
		Δn = 0.1% of rated motor speed during operation with analog tachometer **or** analog setpoint 5)
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

Table 4- 44   Technical data for 3-ph. 950 V AC, 2200 A, 2Q and 4Q units

Order number 6RA80 ..		..96-4MS22	..96-4MV62
Rated DC current	A	2200	2200
Rated DC voltage 1)	V	1140	1000

Order number 6RA80 ..			..96-4MS22	..96-4MV62
Rated armature input current 2)		A	1826	1826
Rated power		kW	2508	2200
Power loss at rated DC current (approx.)		W	11340	11340
Rated field DC current		A	40	40
Type of cooling			Forced ventilation	Forced ventilation
Rated fan supply voltage		V	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz	3-ph. 400 V AC (±10 %) 50 Hz 3-ph. 460 V AC (±10 %) 60 Hz
Rated fan current	50 Hz 60 Hz	A	0.95 9) 1.25	0.95 9) 1.25
Fan air flow		m³/h	2400	2400
Fan noise level	50 Hz 60 Hz	dBA	80.8 83.2	80.8 83.2
Dimensions (HxWxD)		mm	883x453x505	883x453x505
Weight (approx.)		kg	165	185

Footnotes:

1)   The supply voltage for the armature/field can lie below the rated armature/field voltage (set in p50078):
Permissible input voltage:
≥50 V for devices with rated voltage 400 V, 480 V and 575 V
≥100 V for units with rated voltage 690 V, 830 V and 950 V
The output voltage is reduced accordingly.
The specified output DC voltage can be ensured for an undervoltage up to 95 % of the line voltage (rated supply voltage of the armature/field).
Note:
Option L04 is available for armature infeed with extra-low voltage (ordering data for options, see Chapter 2)

2)   Values apply to rated DC output current

5)   Conditions:
The closed-loop control (closed-loop PI control) constancy is related to the rated motor speed and applies when the SINAMICS DC MASTER is at the operating temperature. This is subject to the following preconditions:

- Temperature changes of ±10 °K
Changes to the line voltage of +10% / – 5% of the rated input voltage

- Temperature coefficient of tachometer generator with temperature compensation: 0.15‰ every 10 °K (with analog tachometer generator only)

- Constant setpoint (14-bit resolution)

6)   For dynamic overload capability, see also Chapter 10

8) 9)   see also Chapter "Installation notes for design according to UL 508C"

10)   The option of operating in an extended frequency range can be provided on request.

4.4 Derating

Depending on the ambient temperature and the installation altitude, a derating is required for the maximum permissible load of the SINAMICS DC MASTER.

The derating factor can be taken from the following tables and should be set at p50077. Intermediate values can be obtained through linear interpolation.

NOTICE
Units with option L15 and use of the SINAMICS DCM in a SINAMICS DCM Cabinet drive cabinet with option L99
In these cases, p50077 should be set according to Chapter "Sensor for the ambient and/or air intake temperature (Page 444)".

Table 4- 45   Derating factor for units up to 125 A (with natural air cooling, cooling type AN)

Installation altitude above sea level	Ambient or coolant temperature					
	30 °C	35 °C	40 °C	45 °C	50 °C	55 °C
1000 m	1.00	1.00	1.00	1.00	0.94	0.88
2000 m	1.00	1.00	0.94	0.88	0.82	x
3000 m	0.96	0.90	0.84	x	x	x
4000 m	0.86	0.80	x	x	x	x
5000 m	0.78	x	x	x	x	x
x ... SINAMICS DCM operation not possible						

Table 4- 46   Derating factor for units from 210 A (with forced air cooling, cooling type AF)

Installation altitude above sea level	Ambient or coolant temperature					
	30 °C	35 °C	40 °C	45 °C	50 °C	55 °C
1000 m	1.00	1.00	1.00	0.95	0.90	x
2000 m	0.98	0.93	0.88	0.83	0.78	x
3000 m	0.88	0.83	0.78	x	x	x
4000 m	0.78	0.73	x	x	x	x
5000 m	0.70	x	x	x	x	x
x ... SINAMICS DCM operation not possible						

Voltage derating as a function of installation altitude:

The series of SINAMICS DCM units fulfill overvoltage category III according to EN 61800-5-1 for line supply circuits with respect to the environment (other line supply circuits, housing, electronics).

For electronics and field supplies with voltages of 2-ph. 480 V AC (line-to-line; maximum 300 V AC to ground), operation is permitted up to 4500 m above sea level. A maximum of 2-ph. 400 V AC (line-to-line; maximum 230 V AC to ground) is permitted up to 5000 m.

All units, with 400 V up to 575 V as well as also with 690 V to 950 V rated armature supply voltage, can be operated up to a maximum of 4000 m above sea level without voltage derating.

For units with rated armature supply voltages of 690 V to 950 V, up to 4500 m a maximum 930 V AC and up to 5000 m, a maximum 880 V AC is permissible as armature supply voltage.

For units with rated armature supply voltages of 400 V to 575 V, up to 4500 m a maximum 550 V AC and up to 5000 m, a maximum 500 V AC is permissible as armature supply voltage.

If the specified voltages with respect to ground are exceeded or the installation altitude is exceeded, then a reduction of the overvoltage category to II must be applied. As a consequence, operation up to 6000 m without derating is permissible.

The overvoltage category of the line supply can be reduced to II using an appropriate surge arrester, filter or isolation transformer. If this is not realized, then there is no longer safe electrical separation of the electronics (interface connections on the CUD) with respect to the line supply.

According to EN61800-5-1, operation of units without "safe electrical separation" is only permissible if it can be absolutely excluded that persons are in danger by being able to directly touch or indirectly touch parts, i.e. in operation, none of the CUD interfaces can be touched. A digital connection can be realized using an optical isolation.

Transportation, unpacking, installation

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5

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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 vibrations and severe shocks during transportation, e.g. when lowering the unit 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

<table>
<tr><td>

⚠ **CAUTION**

Failure to lift the unit properly can lead to physical injury or material damage.

The unit should only be lifted with suitable equipment (work gloves should be used) and by appropriately qualified personnel.

In order to prevent the enclosure from becoming deformed when lifting units with a rated DC current above 720 A, no horizontal forces may be exerted on the lifting eyes.

The user assumes responsibility for installing the converter unit, motor, transformer, and other units in accordance with safety regulations (e.g. EN, DIN, VDE) and all other relevant national or local regulations affecting conductor dimensioning, protection, grounding, disconnectors, overcurrent protection, and so on.

The unit must be installed in accordance with safety regulations (e.g. EN, DIN, or VDE) as well as all other applicable national or local regulations. Grounding, conductor dimensioning, and the relevant short-circuit protection work must be carried out correctly in order to ensure operational safety.

</td></tr>
</table>

Options for lifting units with a 1500 to 3000 A rated DC current

Figure 5-1   Options for lifting units with 1500 - 3000 A currents

UL 508 C-compliant cabinet installation for a SINAMICS DC MASTER

- If this unit is to be installed in a cabinet, the cabinet must be sufficiently ventilated and of "type 1" in accordance with standard UL 508 C.

- To install a unit, the minimum dimensions of the cabinet must be 2,200 mm x 600 mm x 600 mm (H x W x D).

Cabinet installation for units with a 1500 to 3000 A rated DC current
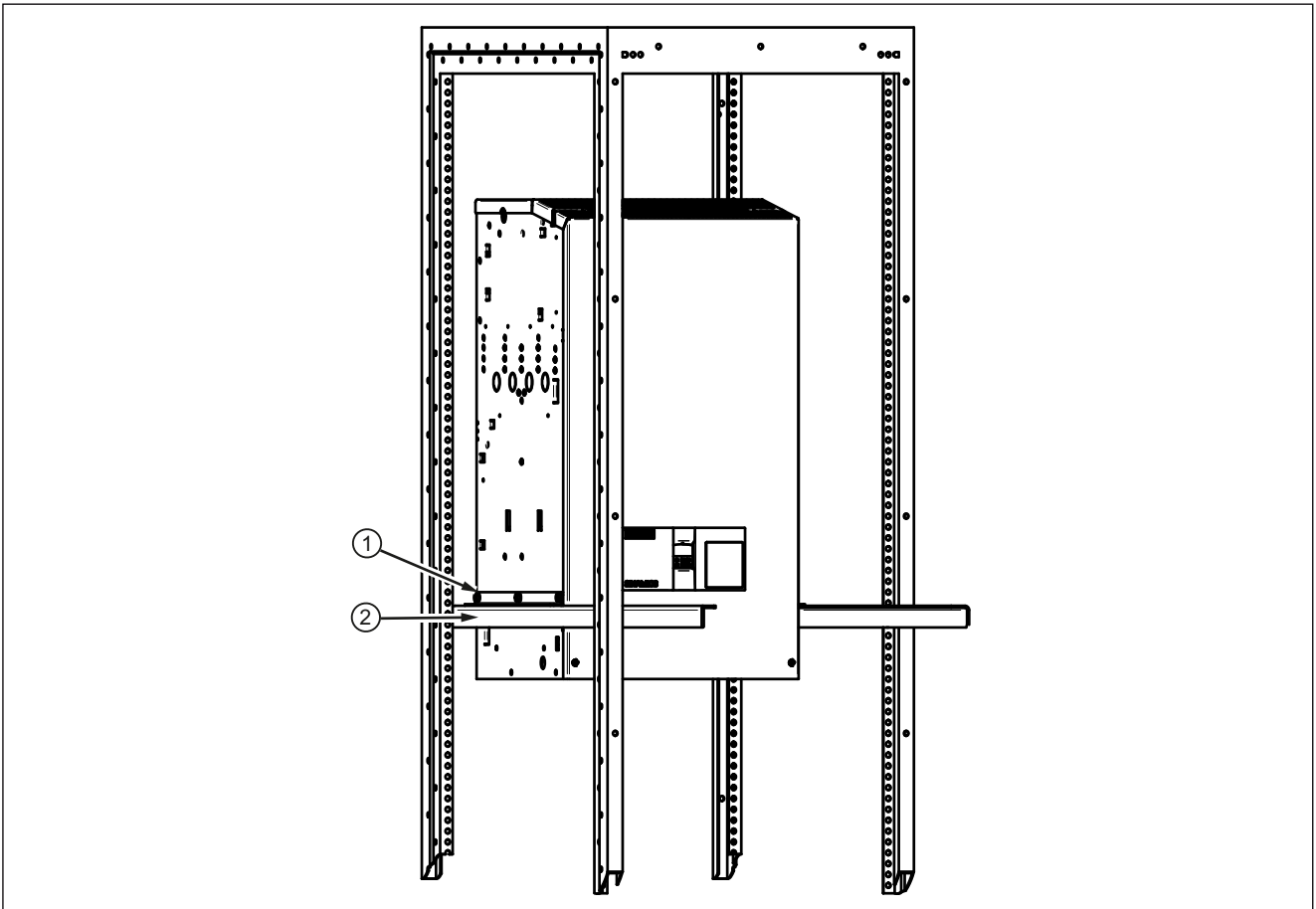
- The scope of delivery for these units includes 2 brackets ① that can be attached to the SINAMICS DC MASTER using 3 M8 hexagon bolts (also supplied) to facilitate installation.
- In this way, the unit can be pushed onto 2 additional brackets ② (not supplied) in the control cabinet.
- The units then have to be fixed to the rear cabinet wall using 4 attachments.
- Removing brackets ① and ②

Figure 5-2   Cabinet installation

⚠ WARNING

To ensure that cooling air can flow in and out uninhibited, there must be a clearance of 100 m both above and below the unit.

Otherwise, the unit will run the risk of overheating.

5.2.1 Dimension drawings

All dimensions in mm
tolerance of the outer dimensions, +2 mm,
tolerance of the distances of the busbar holes for customer connections, ±1.5 mm

15 to 30 A, 4Q units
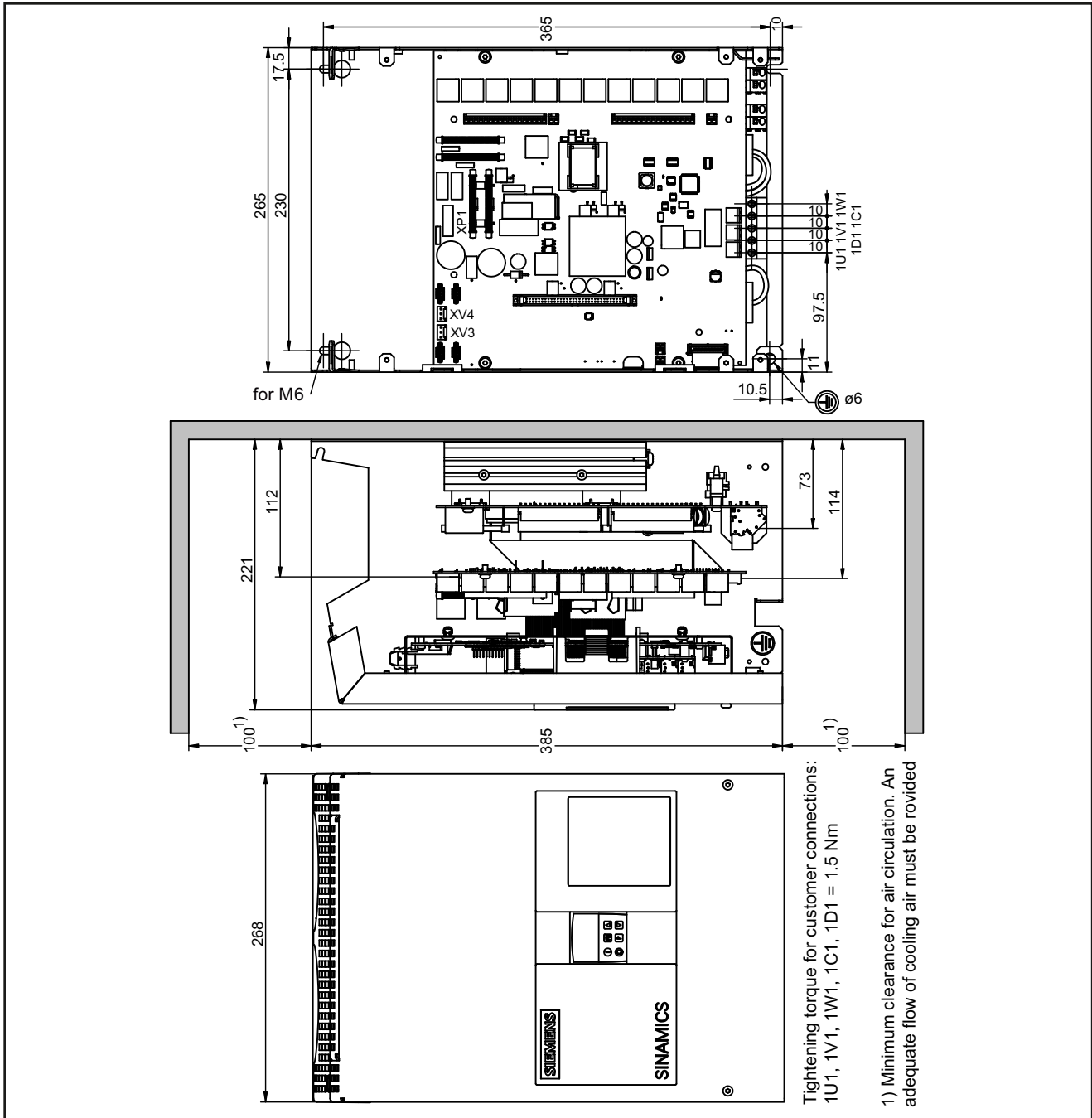
Figure 5-3   Dimension drawing, 15 A to 30 A, 4Q

60 to 280 A, 2Q units
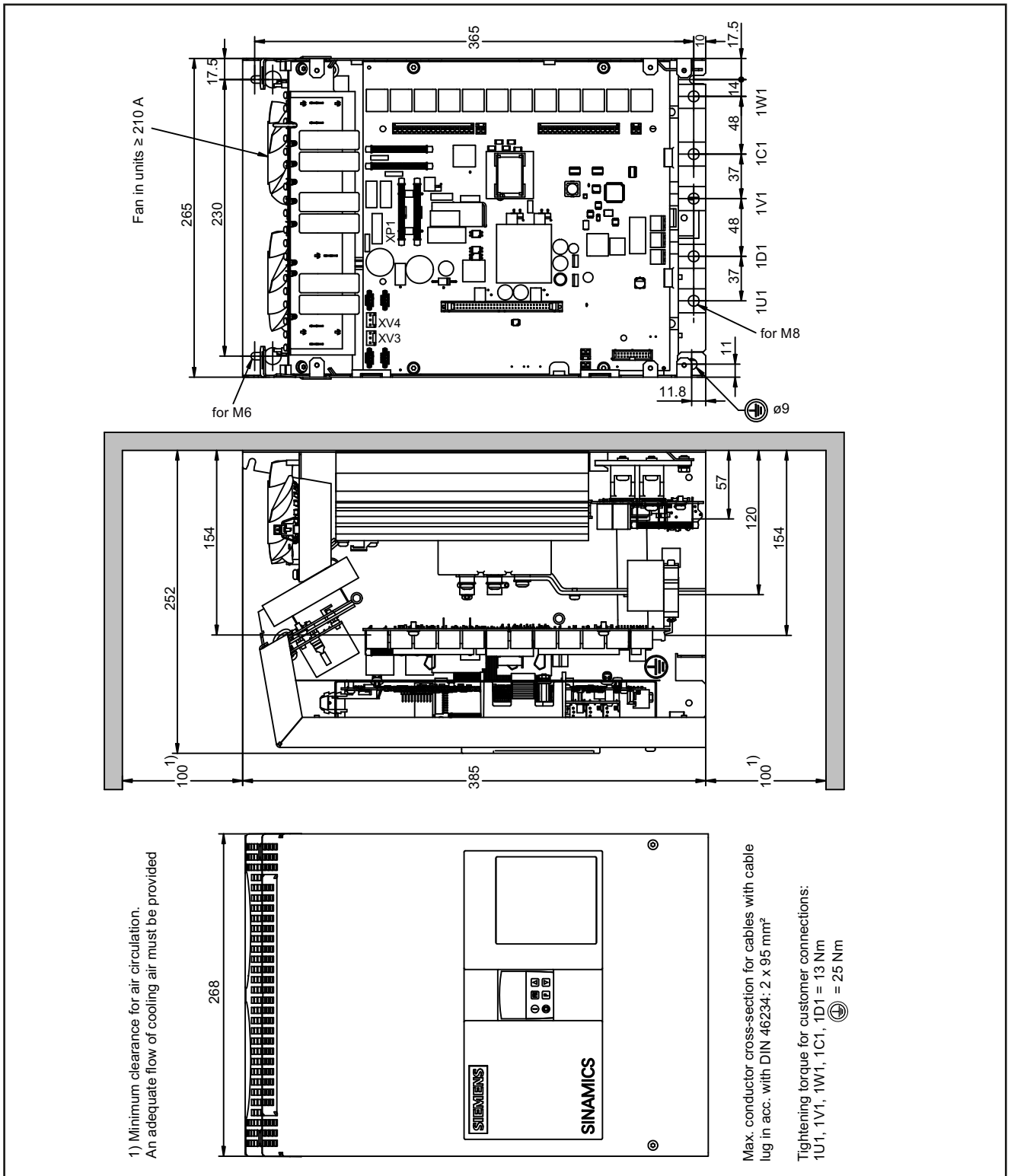
Figure 5-4   Dimension drawing, 60 A to 280 A, 2Q
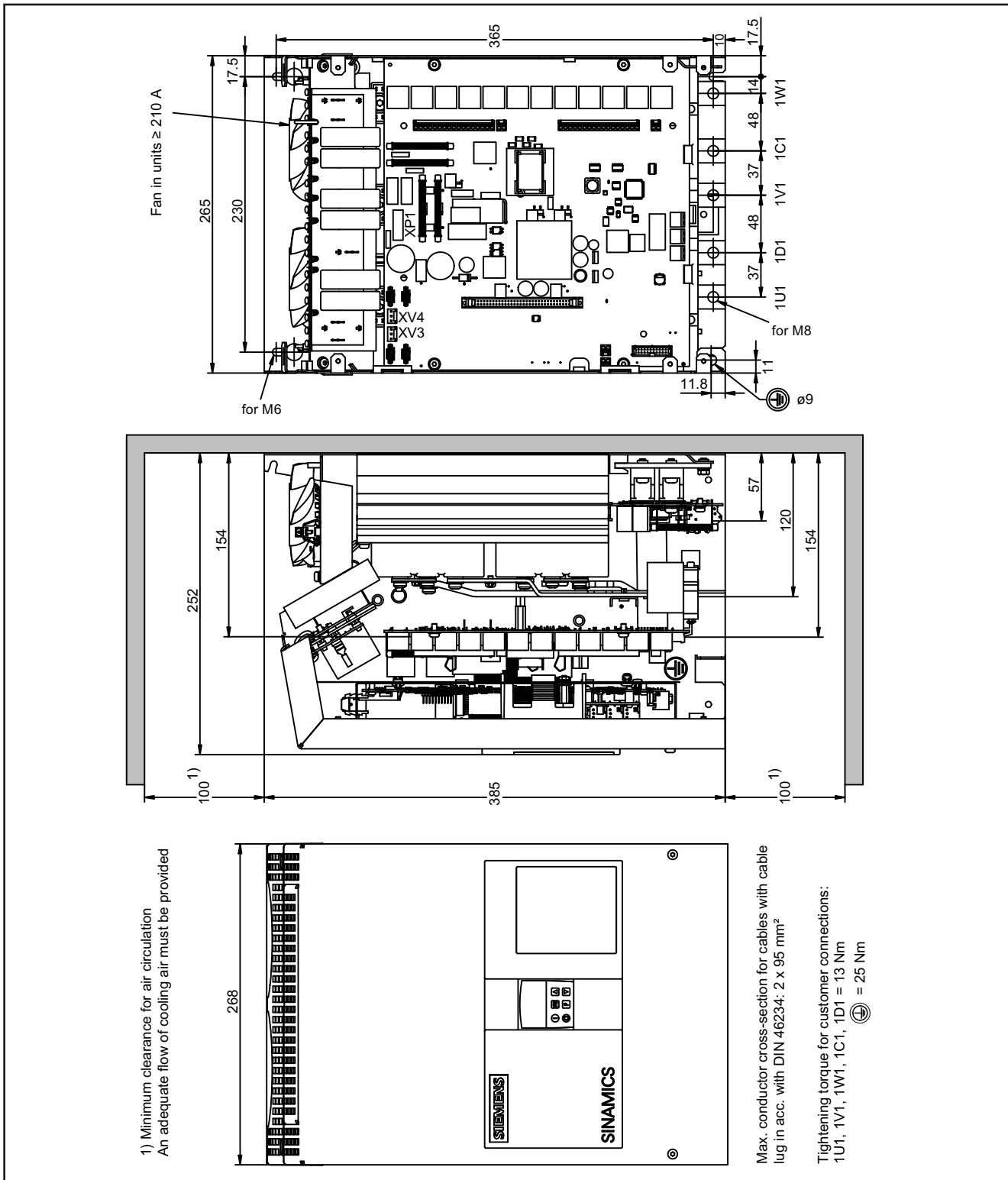
60 to 280 A, 4Q units

Figure 5-5   Dimension drawing 60 A to 280 A, 4Q

400 to 600 A, 2Q units
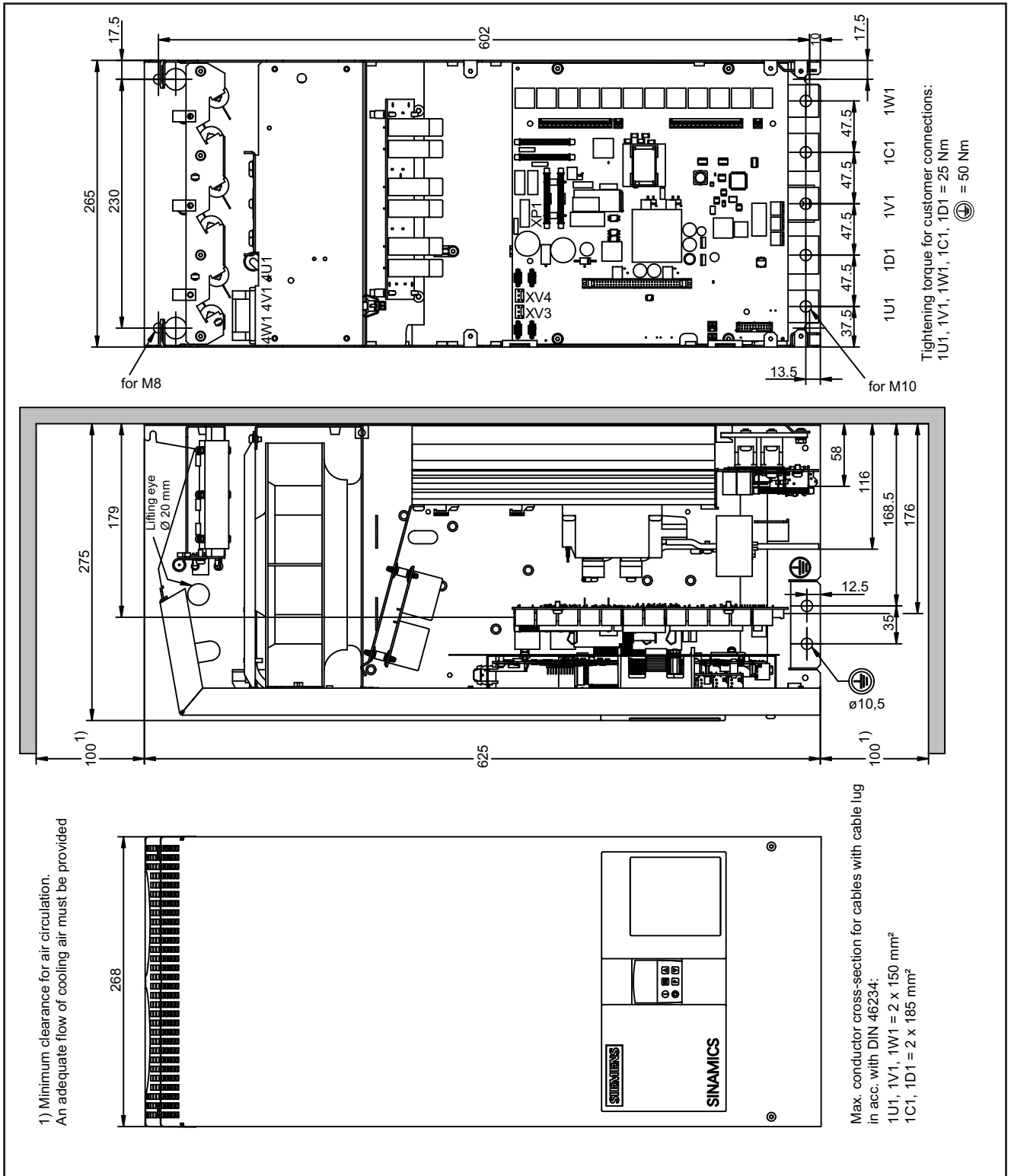
Figure 5-6   Dimension drawing: 400 to 600 A, 2Q
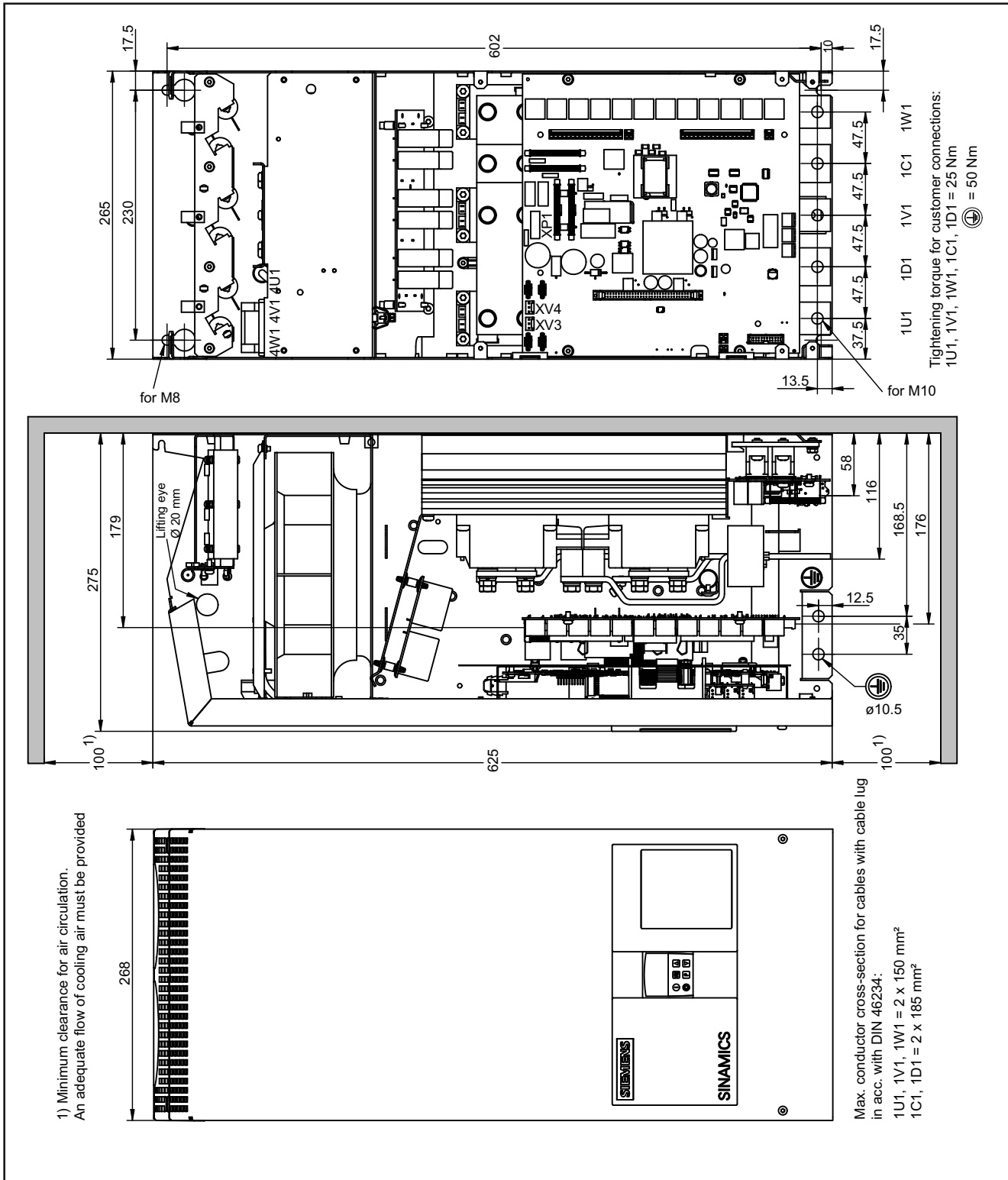
400 to 600 A, 4Q units

Figure 5-7   Dimension drawing, 400 A to 600 A, 4Q

720 to 850 A, 2Q units

The protective conductor connection must under all circumstances be distributed across both connecting lugs

for M8

for M12

4U1
4V1
4W1

XV4
XV3

1W1
1C1
1V1
1D1
1U1

17.5
677
10
17.5

265
230

30
30
30
30
30
31.5
74.5
117.5
160.5
203.5

23 19.7

Lifting eye Ø 20 mm

311
216.5

57.5
142
212
56
15
38
ø13

1)
100

700

100 1)

1) Minimum clearance for air circulation.
An adequate flow of cooling air must be provided

268

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Tightening torque for customer connections:

1U1, 1V1, 1W1, 1C1, 1D1 = 44 Nm

⏚ = 50 Nm

Max. conductor cross-section for cables with cable lug
in acc. with DIN 46234: 4 x 150 mm²

Figure 5-8   Dimension drawing: 720 to 850 A, 2Q
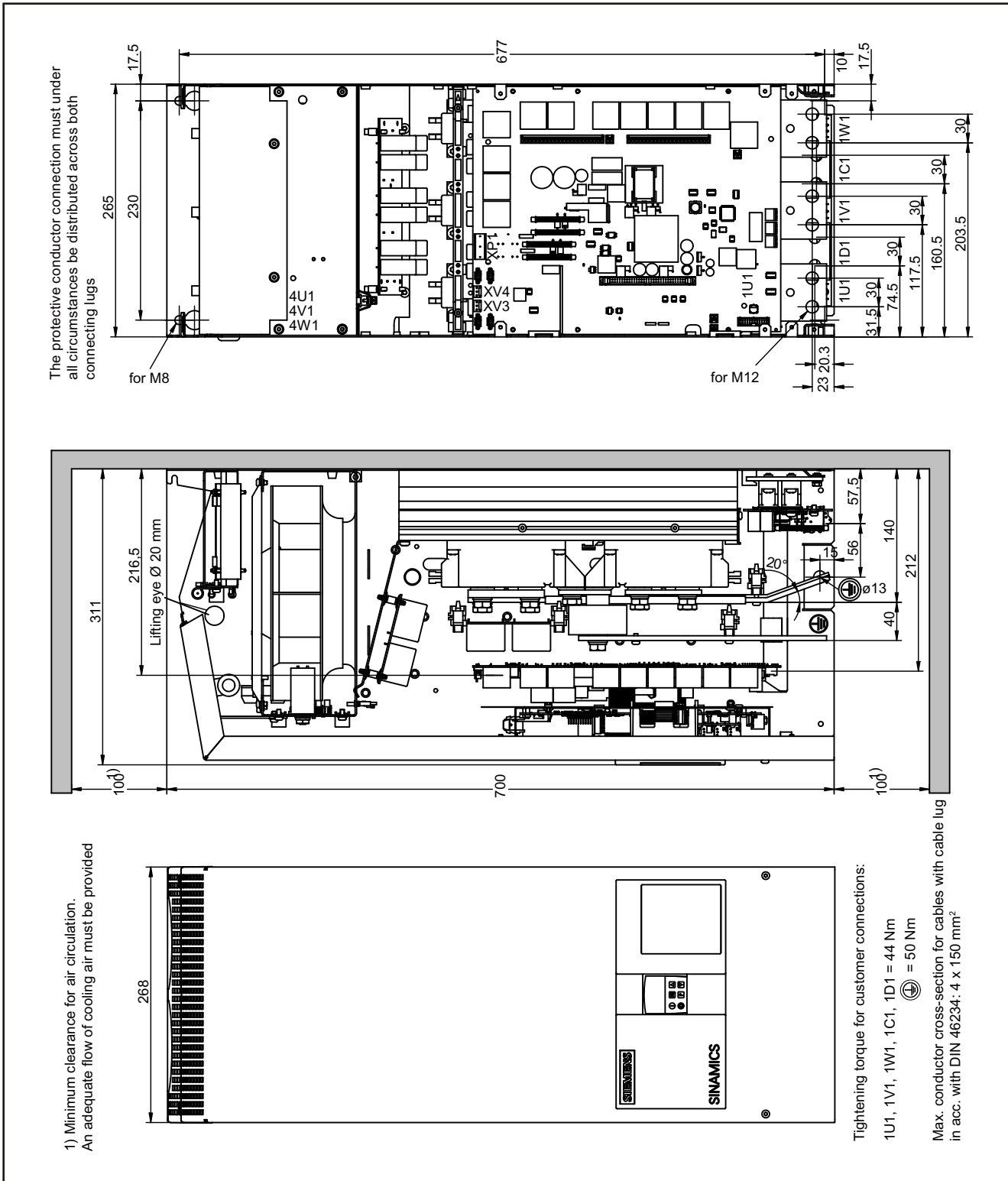
760 to 850 A, 4Q units

Figure 5-9   Dimension drawing: 760 to 850 A, 4Q

900 to 1200 A units
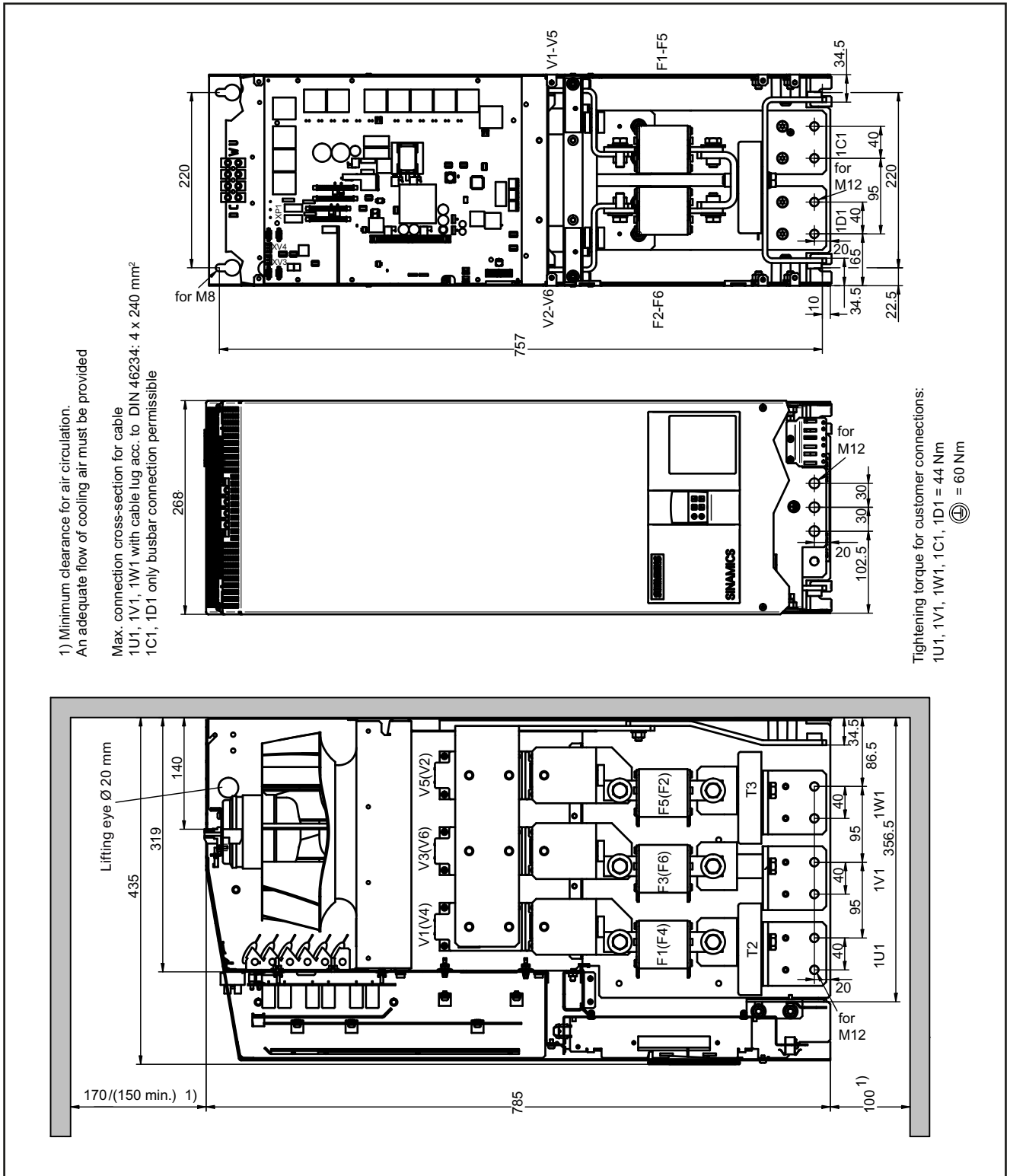
Figure 5-10   Dimension drawing: 900 to 1200 A
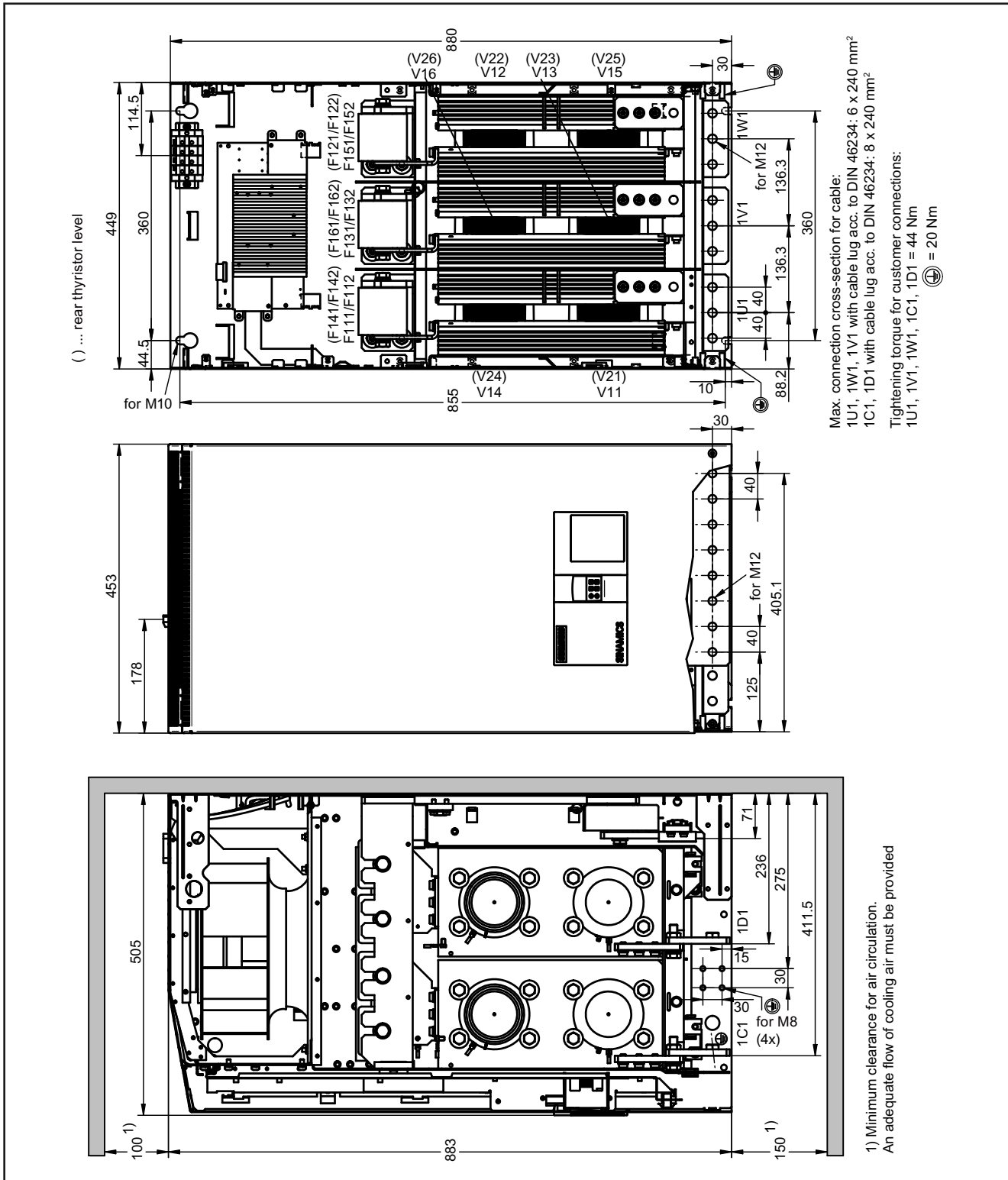
1500 to 3000 A units

Figure 5-11   Dimension drawing: 1500 to 3000 A

5.2.2 Installing options and accessories

5.2.2.1 AOP30 operator panel

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

5.2.2.2 Installing a second CUD

CAUTION
Please observe the information provided on "Electrostatic sensitive devices (ESD)" in Chapter 1.
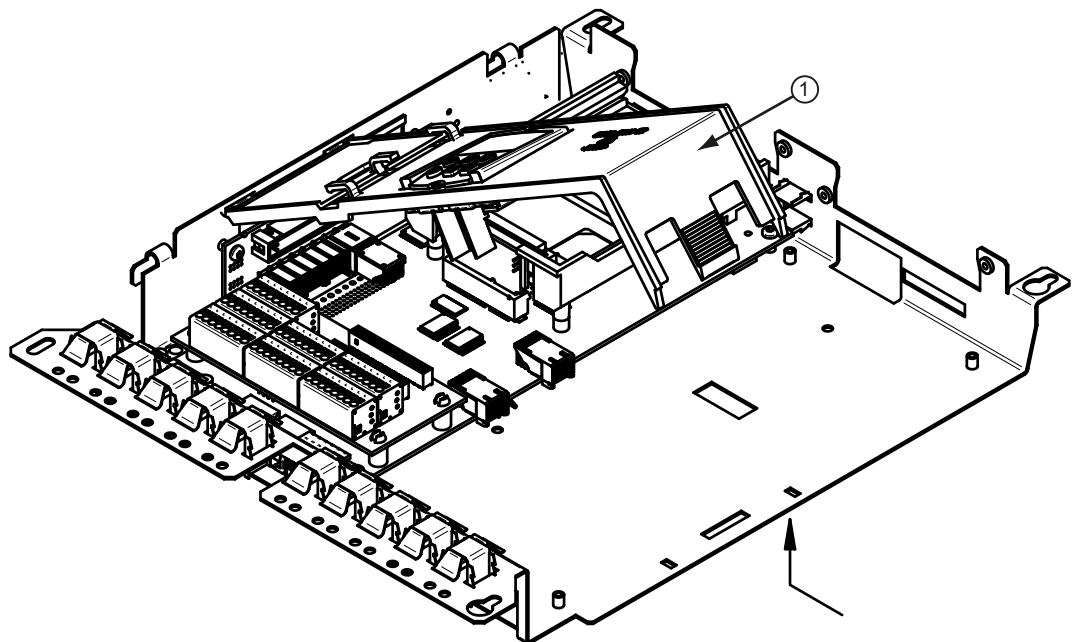
- Unlock and tilt up the BOP support ①.

Figure 5-12   Installing a second CUD (1)
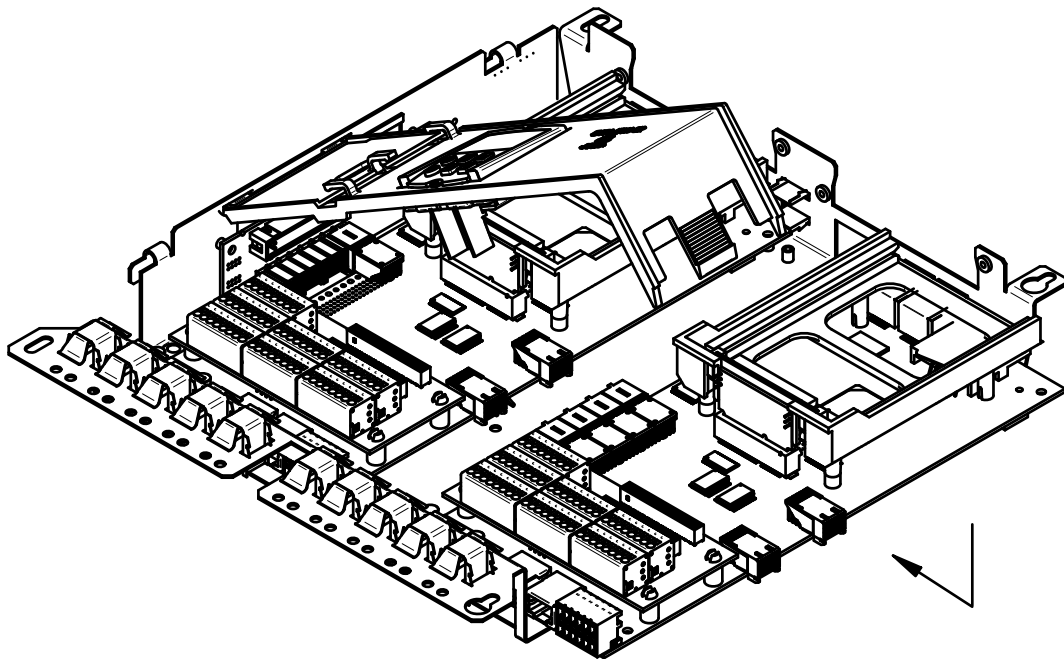
- Mount the CUD and push it into the connectors for the left-hand CUD.
- Secure the CUD using 4 screws (screw and washer assembly, M3×6), tightening torque 1 Nm

Figure 5-13   Installing a second CUD (2)
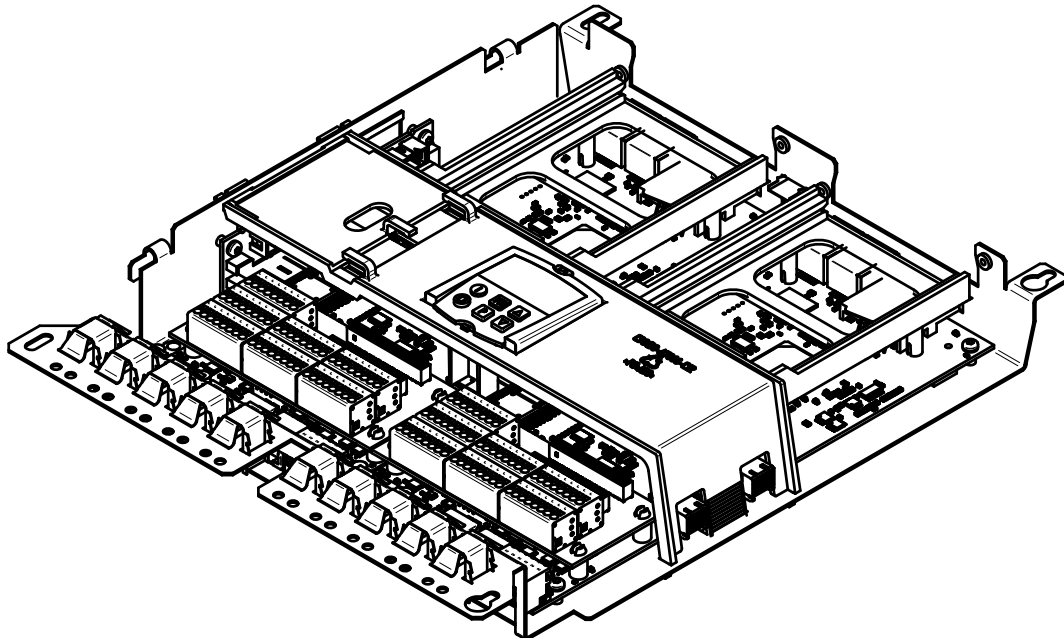
- Lock the BOP support again.

CAUTION: Do not clamp the BOP cable

Figure 5-14   Installing a second CUD (3)

Connecting

6

Note

Information on connecting the unit

The inside front cover of the SINAMICS DC MASTER Operating Instructions contains a summary of the key information required for connecting the unit.

> ⚠️ **WARNING**
>
> The units are operated with high voltages.
>
> All connection work must be carried out while the cabinet is de-energized.
>
> Only qualified personnel who are familiar with all the safety instructions in these Operating Instructions, as well as the assembly, installation, operating, and maintenance instructions, should carry out work on these units.
>
> Failure to observe this warning information can result in death, serious physical injury, or extensive material damage.
>
> Connecting the unit incorrectly can lead to it being damaged or destroyed.
>
> The units 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.
>
> The TSE capacitors may continue to carry dangerous voltage levels following disconnection. For this reason, the unit should not be opened until an appropriate period of time has elapsed.
>
> When handling the unit while it is open, remember that live parts are exposed. The unit 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).

> ⚠ **WARNING**
>
> The operator is responsible for ensuring that the motor, SINAMICS DC MASTER, and other units are installed and connected in accordance with recognized engineering practice in the country of installation and in compliance with applicable regional regulations. Special attention should be paid to cable dimensioning, fuses, grounding, shutdown, disconnection, and overcurrent protection.
>
> The units listed here contain dangerous rotating machine parts (fans) and control rotating mechanical parts (drives). Failure to follow these Operating Instructions may result in death, serious physical injury, or extensive material damage.
>
> Perfect, safe, and reliable operation of the units is conditional upon them having been transported, stored, mounted, and installed correctly, as well as carefully operated and serviced.
>
> To operate the SINAMICS DC MASTER, both front cover fixing screws must be tight.

> **CAUTION**
>
> 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 units, 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.

The contents of these installation instructions neither form part of nor modify any prior or existing contract, agreement, or legal relationship. The contract of sale in each case outlines all the obligations of the I DT LD Variable-Speed Drives Division of SIEMENS AG. The warranty conditions specified in the contract between the parties are the only warranty conditions accepted by the I DT LD Variable-Speed Drives Division. Any statements contained in these installation instructions neither create new warranty conditions nor modify the existing warranty conditions.

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 units used should not cause interference to one another.

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

Interference emissions and interference immunity

EMC is dependent upon two properties demonstrated by the units involved in the system: interference emissions and interference immunity. Electrical units may be sources of interference (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 unit may even be a source of interference and potentially susceptible equipment at the same time: For example, the power unit of a converter unit should be viewed as a source of interference and the control unit as potentially susceptible equipment.

Product standard EN 61800-3

The EMC requirements for "Variable-speed drive systems" are described in the product standard EN 61800-3. 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 limits depending on the installation site 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.
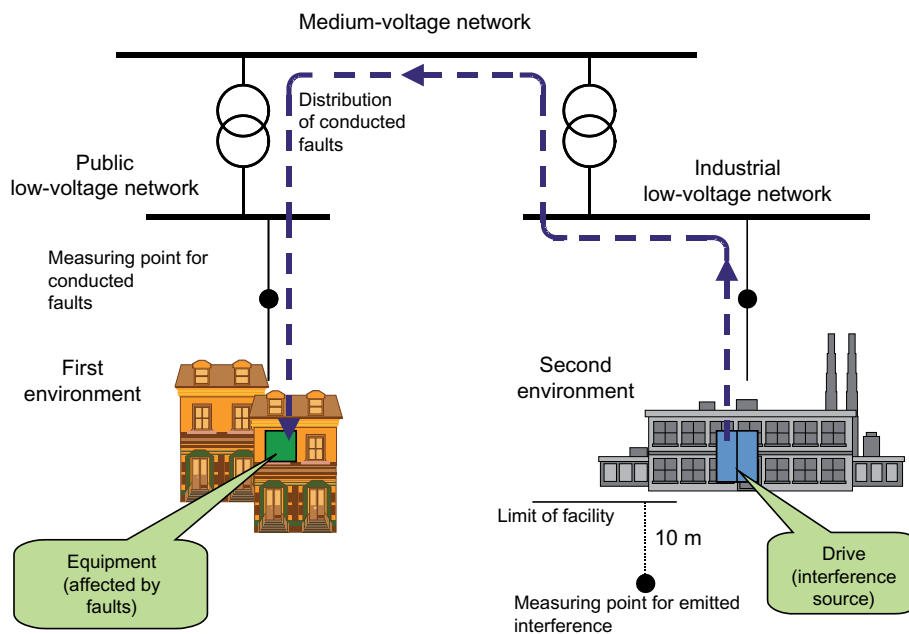
Figure 6-1   Definition of the first and second environments

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 < 1,000 V for unlimited use in the first environment

Category C2:   Stationary drive systems for rated voltages < 1,000 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 < 1,000 V for exclusive use in the second environment

Category C4:   Drive systems for rated voltages ≥ 1,000 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 units 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 units 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.

EN 55011

Some situations require compliance with EN 55011, which defines limit values for interference emissions in industrial and residential environments. The values that are measured are conducted interference at the line supply connection as interference voltage, and electromagnetically radiated interference as radio interference, under standardized conditions.

The standard defines limit values "A1" and "B1" which, for interference voltage, apply to the 150 kHz - 30 MHz range and, for radio interference, the 30 MHz - 2 GHz range. Since SINAMICS DC MASTER converter units are used in industrial applications, they are subject to the limit value "A1"; in order to achieve this value, the SINAMICS DC MASTER units must be provided with external RFI suppression filters and line reactors.

SINAMICS DC MASTER: Industrial applications

Industrial applications demand that units 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 converter units 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 unit, 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" 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 an RFI suppression filter, the interference emission level demonstrated by SINAMICS DC MASTER converter units will exceed limit value "A1" as prescribed by 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 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 units 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 units 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 units, meaning that - economically speaking - increasing interference immunity is generally a more favorable option for industrial applications than reducing the interference emission level. To adhere to limit value class A1 (defined by EN 55011), for example, the interference emission level on a 150 - 500 kHz line supply connection may not exceed 79 dB(μV), while on a 500 kHz - 30 MHz line supply connection it must not exceed 73 dB (μV) (9 mV and 4.5 mV respectively).

In industrial applications, EMC between units 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 unit 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 are 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 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 shields at one end prevents low-frequency, capacitive interference injections (e.g. 50 Hz humming). 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 and 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 power supply 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

The cabinet configuration image below is intended to help the user become familiar with EMC-critical parts. This example does not claim to show all possible cabinet components or configuration options.

Later figures show details that are not made immediately clear by the overview image and which may also have an effect on the cabinet's resistance/interference emission levels, as well as shield connection techniques.

Arrangement of RFI suppression filters and line reactors

Another section shows how the RFI suppression filters and line reactors are arranged in a SINAMICS DC MASTER. The order in which the reactors and filters are installed must be adhered to. The filter cables on the line side and modular side must be physically separated. For information on selecting fuses for semiconductor protection, please refer to the section titled "Fuses".
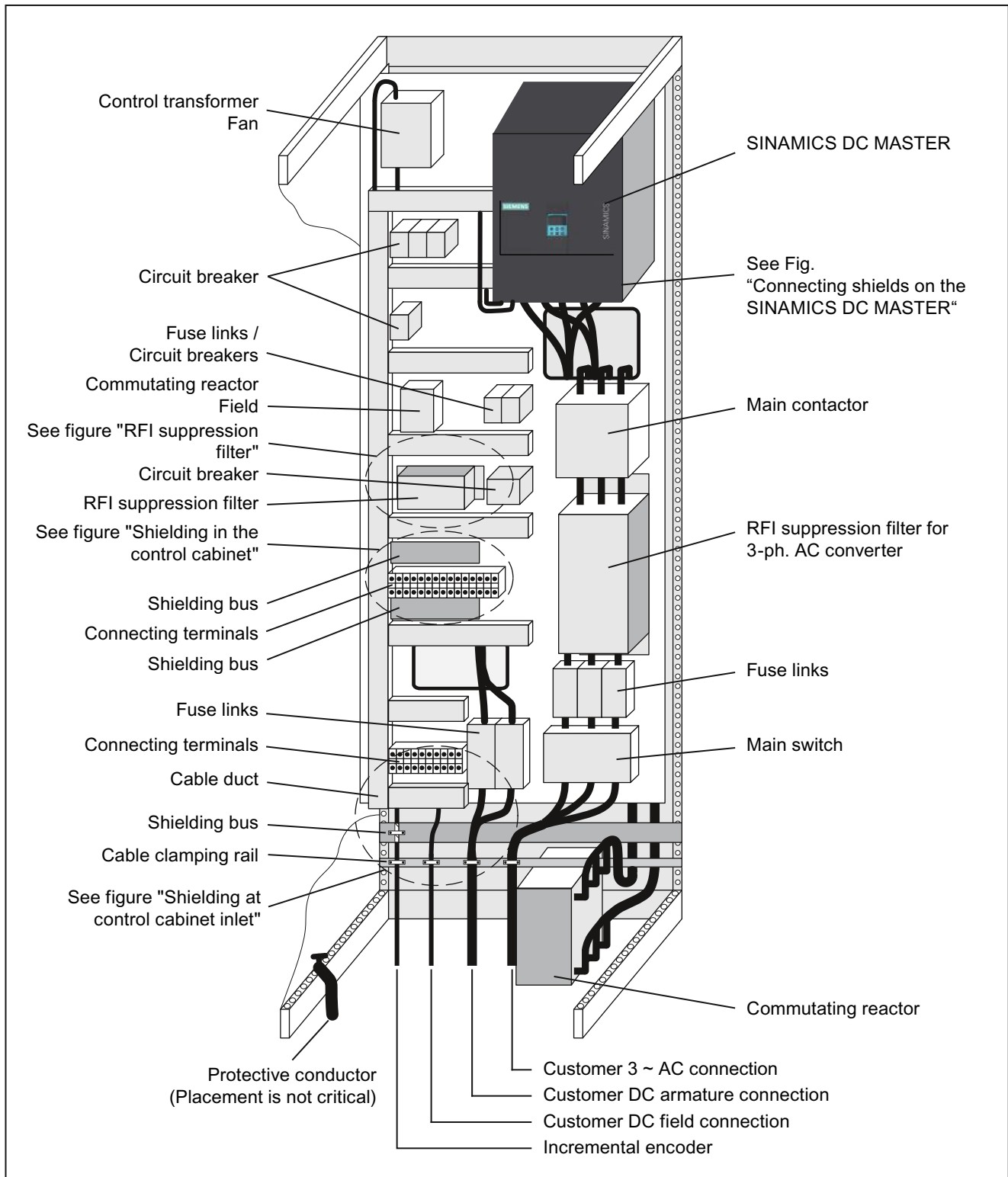
Figure 6-3   Example of a cabinet configuration with a SINAMICS DC MASTER of up to 850 A
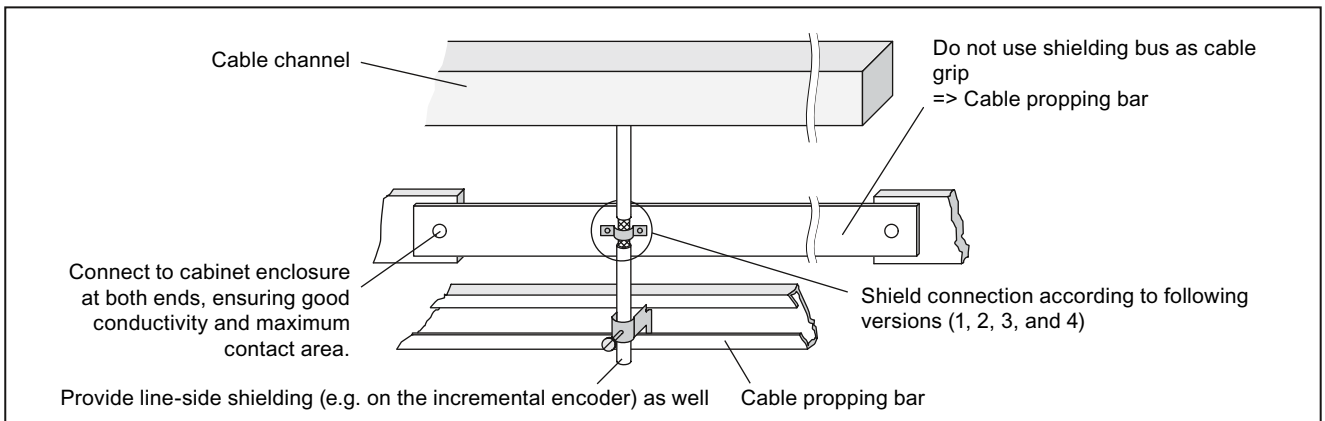
Figure 6-4   Shielding at control cabinet inlet
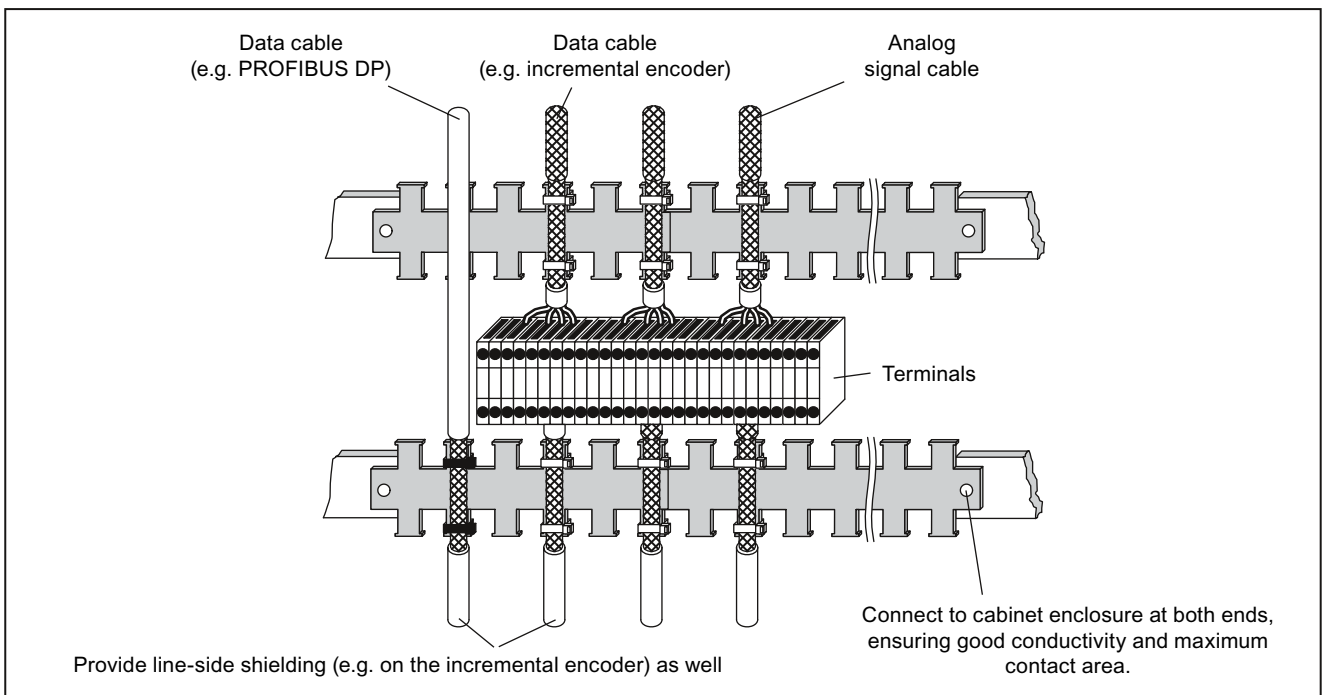
Figure 6-5   Shielding in control cabinet

Connecting shields on the SINAMICS DC MASTER
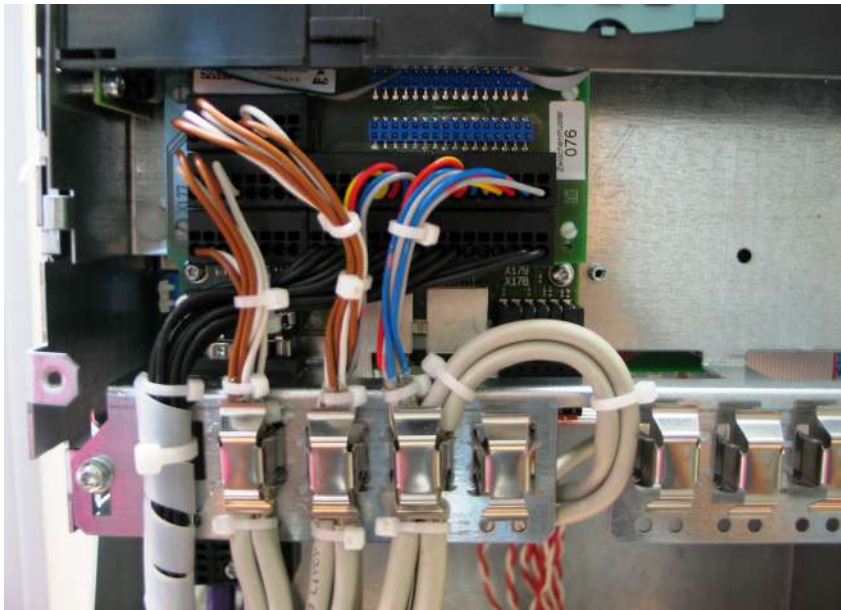
Figure 6-6   Connecting shields

Note

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

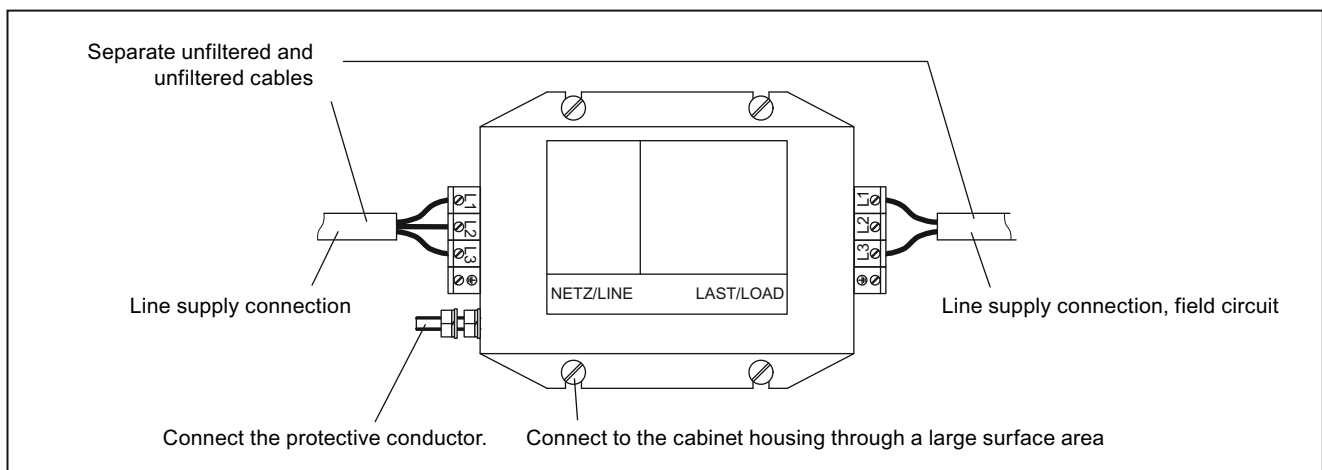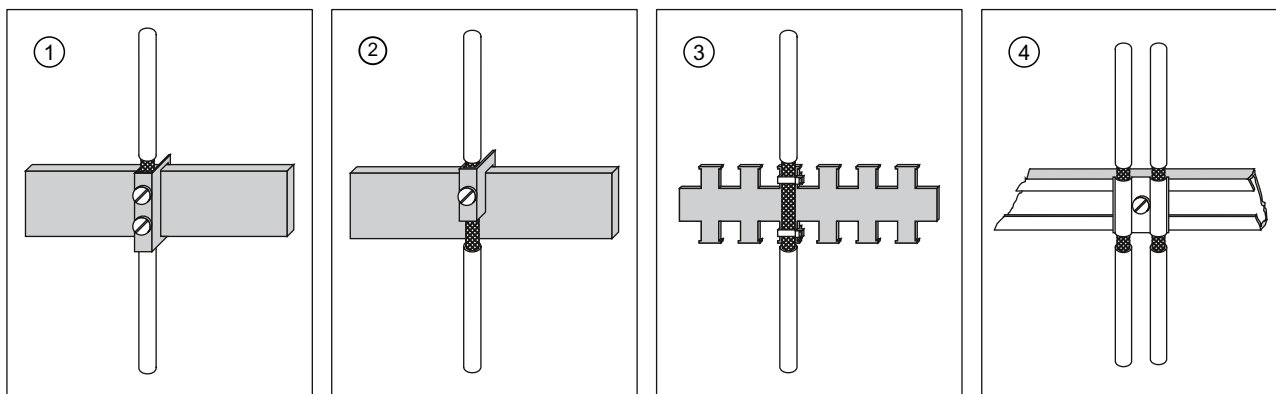**Radio interference suppression filters for the field circuit**

Separate unfiltered and unfiltered cables

Line supply connection

NETZ/LINE   LAST/LOAD

Line supply connection, field circuit

Connect the protective conductor.   Connect to the cabinet housing through a large surface area

Figure 6-7   RFI suppression filter

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   Metallic tube or cable tie on bare metallic comb-type/toothed bar

④   Clamp with metallic backing plate on cable support rail

Figure 6-8   Shield connection

6.1.3 Arranging components for converter units

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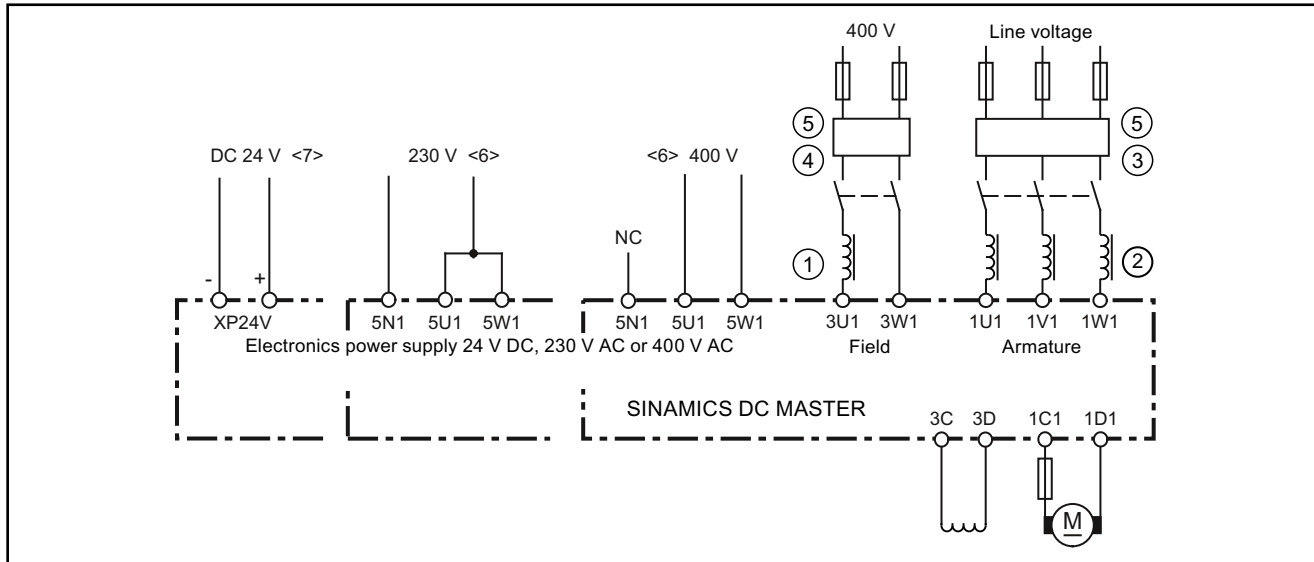
①   The line reactor in the field circuit is dimensioned for the rated current of the motor field.

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 radio interference suppression filter is dimensioned for the rated motor field current.

⑤   If the supply voltages for the armature circuit and field circuit are the same, the voltage for the field can also be
         taken after the radio interference suppression filter for the armature circuit.

<6>   Units with Power Interface C98043-A7105/A7106

<7>   Units with Power Interface C98043-A7107/A7108 (option L05)

Figure 6-9   Arrangement of reactors and RFI suppression filters

CAUTION
Whenever RFI suppression filters are used, line reactors are required between the filter and unit input for the purpose of decoupling the TSE circuit and providing protection for the X capacitors.
The components must be wired in the following order: Line supply – radio interference suppression filter – commutating reactor – SINAMICS DCM.
An incorrect arrangement can destroy a thyristor (short-circuit) and rupture a fuse.

Catalog LV60 is used for selecting line reactors and RFI suppression filters from Siemens..

The table below can be used for selecting the RFI suppression filters from EPCOS.

6.1.4 Suggested RFI suppression filter

Table 6- 1 List of recommended EPCOS RFI suppression filters

Rated current RFI suppression filter (A)	RFI suppression filter Order number	Terminal cross-section (mm²) Holes for M. .	Weight (kg)	Dimensions H x W x D (mm)
8	B84143-G8-R11*	4 mm^2	1.3	80 x 230 x 50
20	B84143-G20-R11*	4 mm^2	1.3	80 x 230 x 50
36	B84143-G36-R11*	6 mm^2	2.8	150 x 280 x 60
50	B84143-G50-R11*	16 mm^2	3.3	150 x 60 x 330
66	B84143-G66-R11*	25 mm^2	4.4	150 x 330 x 80
90	B84143-G90-R11*	25 mm^2	4.9	150 x 330 x 80
120	B84143-G120-R11*	50 mm^2	7.5	200 x 380 x 90
150	B84143-G150-R11*	50 mm^2	8.0	200 x 380 x 90
220	B84143-G220-R11*	95 mm^2	11.5	220 x 430 x 110
150	B84143-B150-S**	M10	13	140 x 310 x 170
180	B84143-B180-S**	M10	13	140 x 310 x 170
250	B84143-B250-S**	M10	15	115 x 360 x 190
320	B84143-B320-S**	M10	21	115 x 360 x 260
400	B84143-B400-S**	M10	21	115 x 360 x 260
600	B84143-B600-S**	M10	22	115 x 410 x 260
1000	B84143-B1000-S**	M12	28	165 x 420 x 300
1600	B84143-B1600-S**	2 x M12	34	165 x 550 x 300
2500	B84143-B2500-S**	4 x M12	105	200 x 810 x 385
*) The number indicating the design is to be used in place of *: 0 = 480 V, 2 = 530 V				
**) The number indicating the design is to be used in place of **: 20 = 500 V, 21 = 760 V, 24 = 690 V				
*) The RFI 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 unit are installed on a single metal plate.				

In the case of converter units with a 3-phase connection, the minimum rated current of the filter is the same as the unit's input current or output DC current, as specified on the unit 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 line current is the same as the input current (see Field Input) or field DC current.

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 two-pulse bridge circuit configuration. Below is an example of the harmonics that can be found in a typical system configuration for two firing angles ($\alpha = 20°$ and $\alpha = 60°$).

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 example specifies formulae 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 to 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 unit terminal and the armature inductance L_a of the motor, calculated using the formulae below, match the actual values found in the system. If the values do not match, a separate calculation procedure will need to be carried out for the harmonics.

a) $\alpha = 20°$
Fundamental factor g = 0.962

b) $\alpha = 60°$
Fundamental factor g = 0.953

v	I_v/I_1	v	I_v/I_1	v	I_v/I_1	v	I_v/I_1
5	0.235	29	0.018	5	0.283	29	0.026
7	0.100	31	0.016	7	0.050	31	0.019
11	0.083	35	0.011	11	0.089	35	0.020
13	0.056	37	0.010	13	0.038	37	0.016
17	0.046	41	0.006	17	0.050	41	0.016
19	0.035	43	0.006	19	0.029	43	0.013
23	0.028	47	0.003	23	0.034	47	0.013
25	0.024	49	0.003	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 above)

The harmonics currents calculated on the basis of the tables above **only** apply to

I.) Short-circuit power SK at the converter unit terminal

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

where

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

and

U_{v0} is the no-load voltage at the converter unit terminal in V,
I_d is the DC current of the operating point under investigation in A,
f_N is the line frequency in Hz,
L_D is the inductance of the line reactor used in H,
X_D is the line reactor impedance,
X_N is the network impedance, and
X_K is the impedance at the unit terminals

II.) Armature inductance La

$L_a = 0.0488 \times U_{v0} / (f_N \times I_d)$ (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 formulae above, a separate calculation procedure will need to be carried out.

Example:

Let us take 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)

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

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 (where $I_1 = g \times 0.817 \times I_d$ for firing angles α = 20° and α = 60°) that can be taken from the tables **only** apply for the values S_K and L_a calculated using this method. If the actual values deviate from these, a separate calculation procedure will need to be carried out.

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 v	B2C [2] Iv / I	B6C [2] Iv / I	Harmonic order v	B2C [2] Iv / I	B6C [2] 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 into the unit

Cable routing example
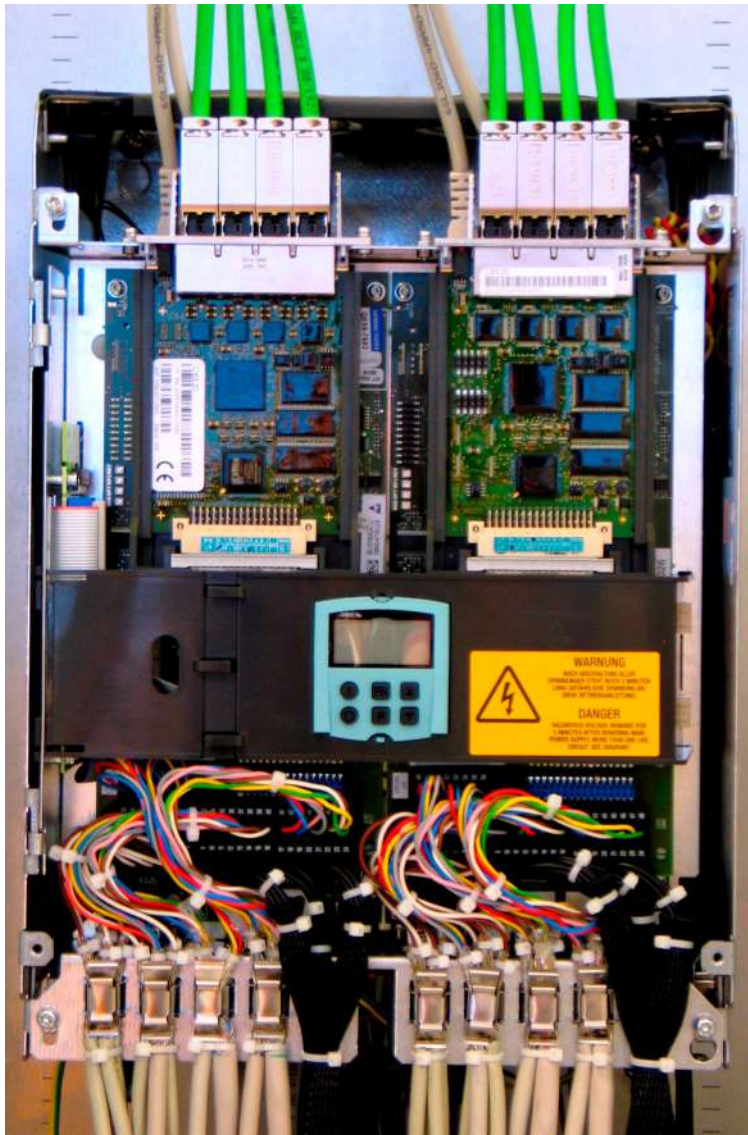
Figure 6-10   Example for cable routing when fully expanded

Note

For units with a rated DC current ≤280 A, the PROFINET cable must be routed into the unit
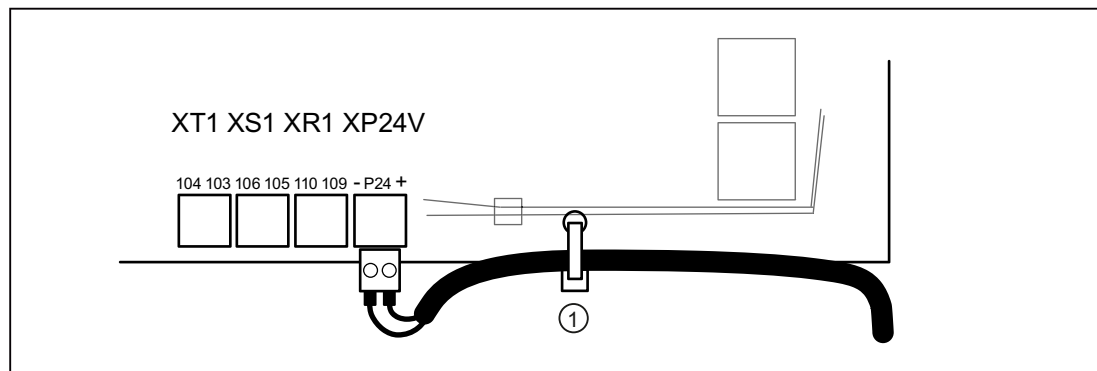from the top (PROFINET is only available with Communication Board(s) CBE20).
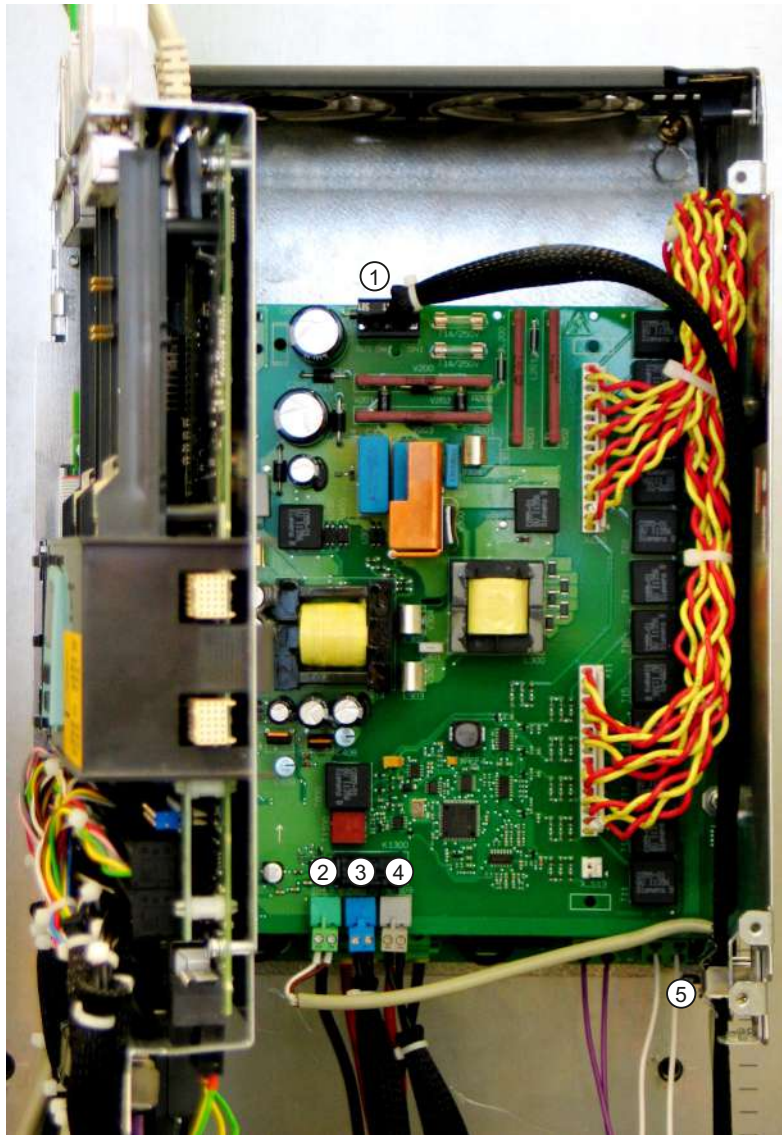
①   Connection for the electronics power supply (XP1). Mechanically attach the cable using one of the shield clamps ⑤ at the side of the enclosure. 2 holes on the printed-circuit board to attach the cable using cable ties.

②   Connection for the analog tachometer (XT1) Connect the shield to one of the shield clamps ⑤ on the side of the enclosure.

③   Connection for E-STOP (XS1). Route the cable into the unit from the bottom.

④   Connection for the floating relay output for the line contactor (XR1). Route the cable into the unit from the bottom.

Figure 6-11   Cable routing, power interface

Option L05: Connecting the electronics power supply

Units with Power Interface C98043-A7107/A7108

①   Use a cable tie to attach the cable to the circuit board (Power Interface)

Figure 6-12   Option L05, electronics power supply

Connection for the PROFIBUS cable

 (not visible in the photographs above):

- Route the PROFIBUS cable into the unit from the bottom

- Screw the PROFIBUS bus connector to connector X126 at the CUD using the two screws

- It is not necessary to have a shield support in the unit, it is recommended that the shield is connected in the cabinet.

Routing PROFINET cables

Note: PROFINET is only available with Communication Board(s) CBE20
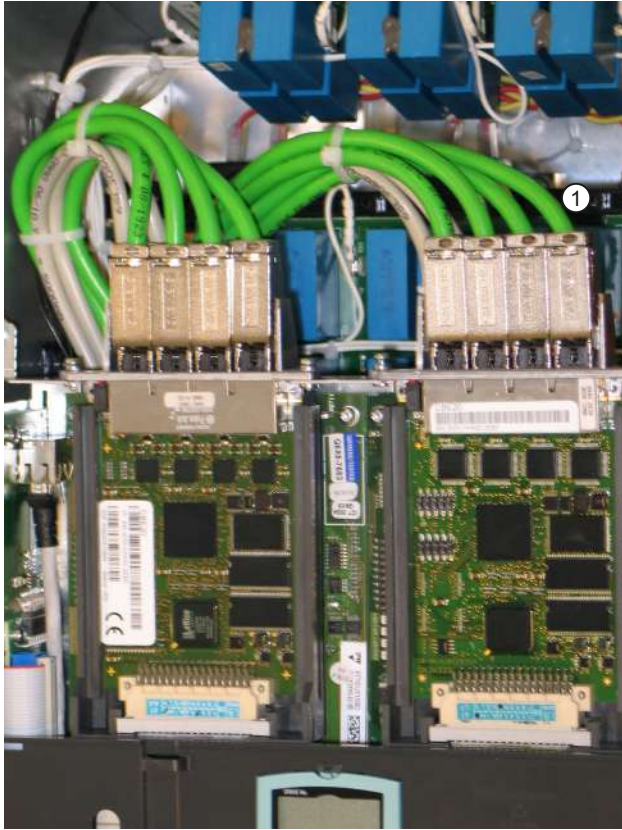
① PROFINET cable (4 connections on each CBE20)

Figure 6-13 Routing PROFINET cables in units >280 A

Note

Cables, which are not mechanically retained in the unit, must be externally retained

6.3 Block diagram with connection suggestion
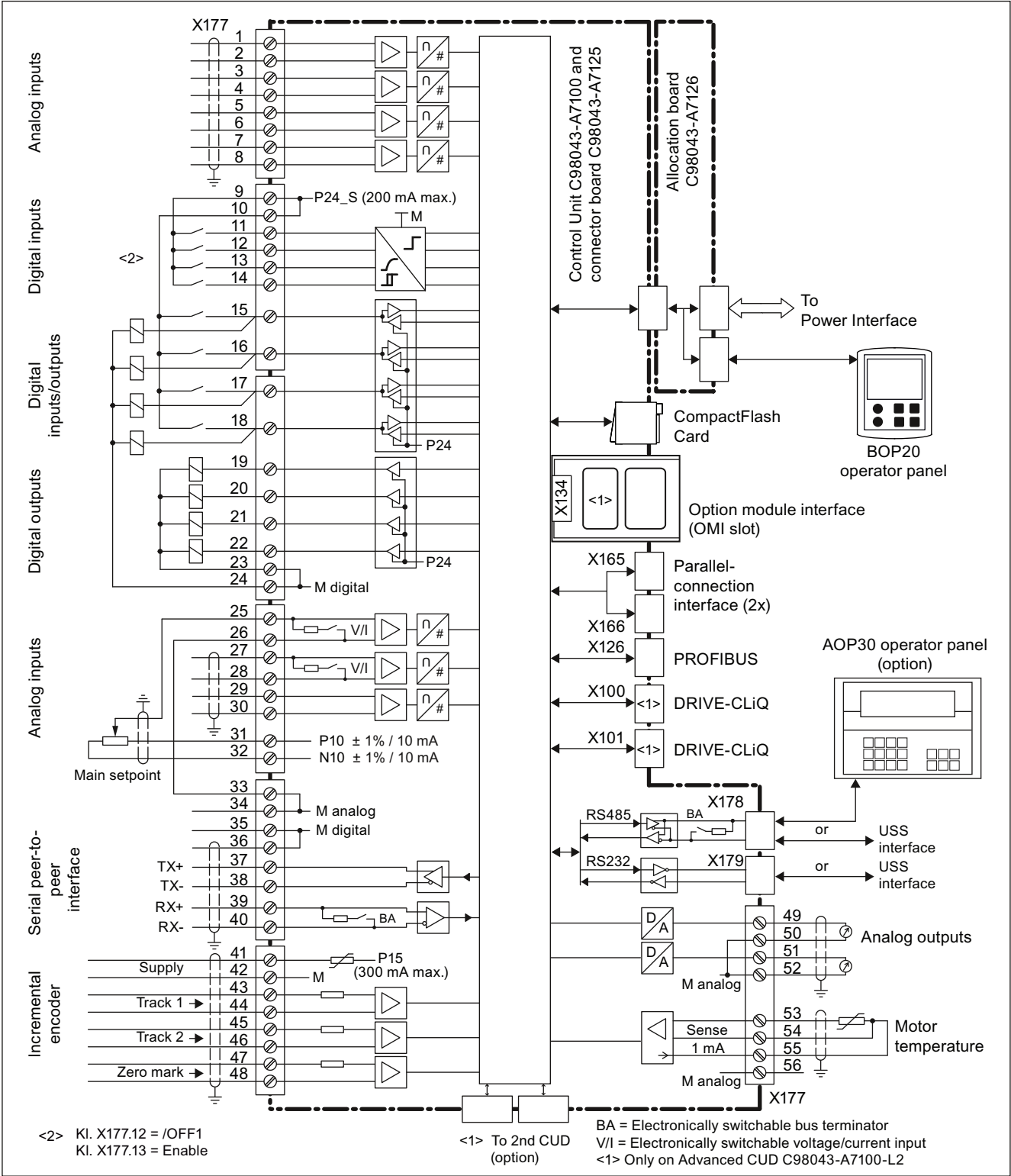
Figure 6-14   Open-loop/closed-loop control section block diagram

Connecting the electronics power supply
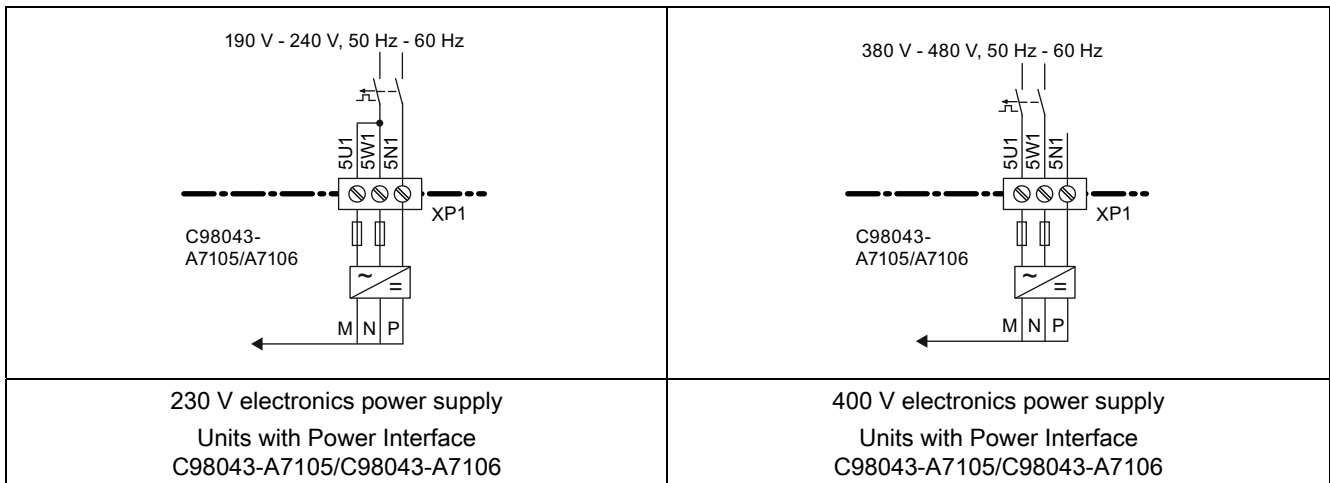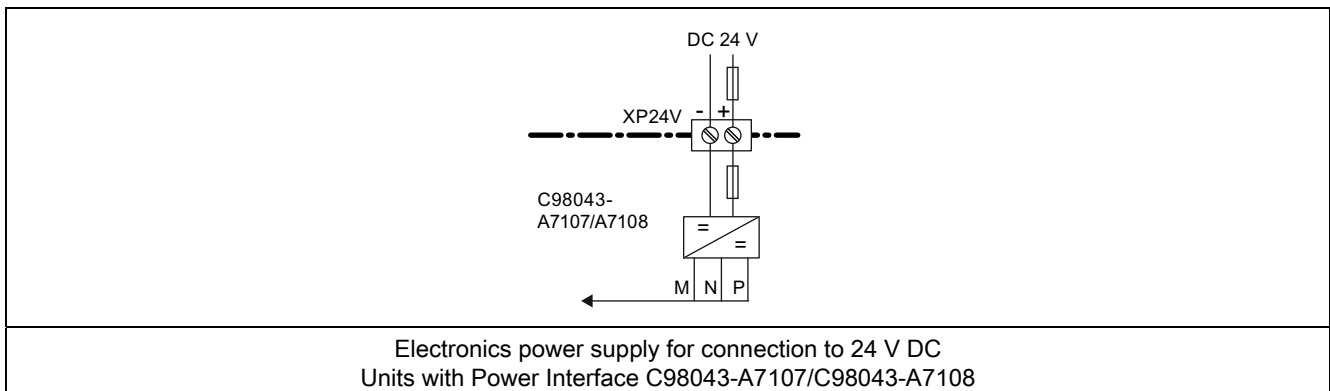
230 V electronics power supply	400 V electronics power supply
Units with Power Interface	Units with Power Interface
C98043-A7105/C98043-A7106	C98043-A7105/C98043-A7106

With option L05

Electronics power supply for connection to 24 V DC
Units with Power Interface C98043-A7107/C98043-A7108

NOTICE
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 the "Description of functions" chapter, "Description of the LEDs on the CUD" section)
• The BOP20 flashes
Interrupting the power supply while saving can lead to the loss of the current device parameter assignments. Also refer to the "Operation" chapter, "Memory Card functions" section.

15 to 30 A units
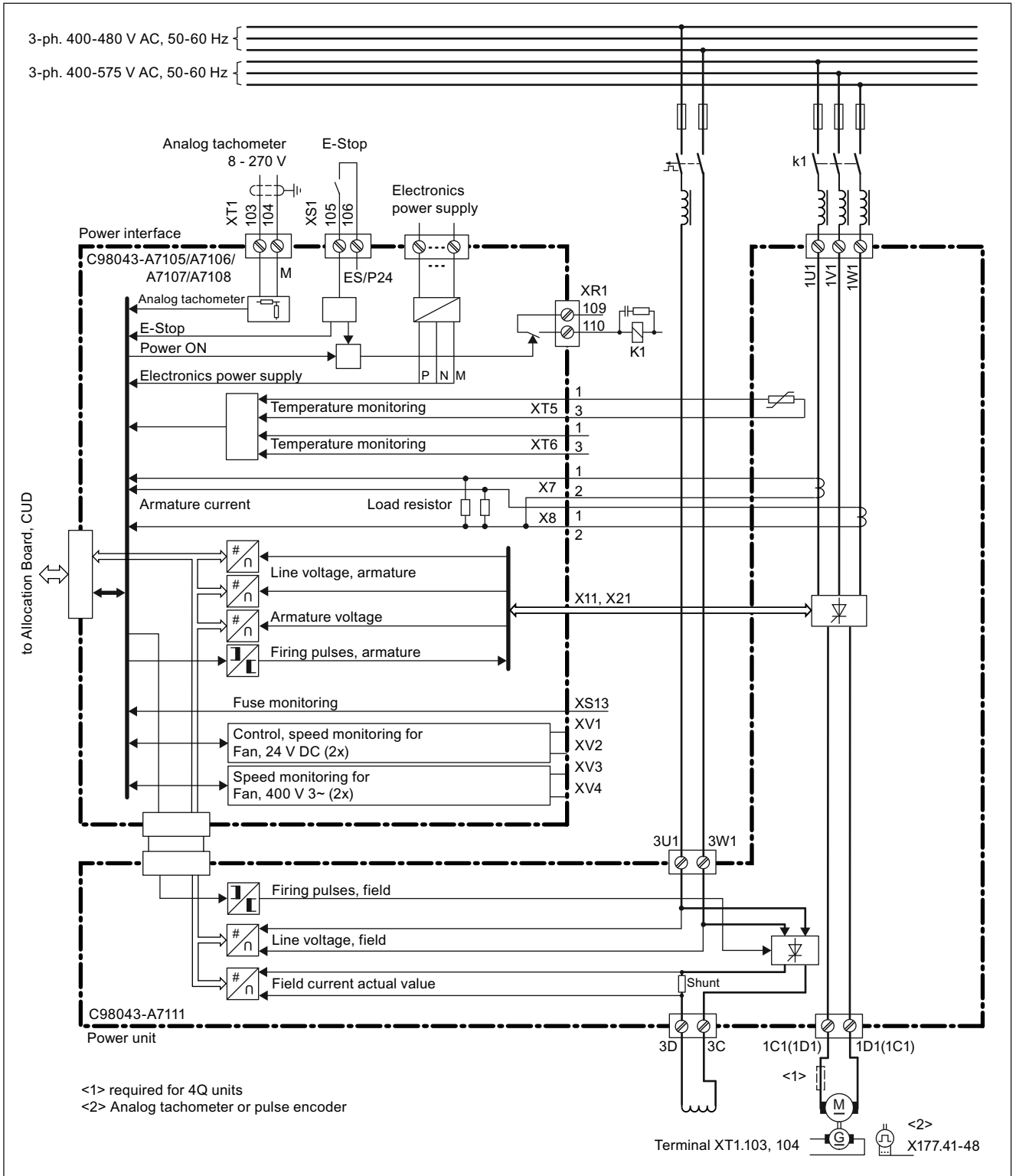
Figure 6-15   Block diagram for 15 to 30 A units

60 to 125 A units
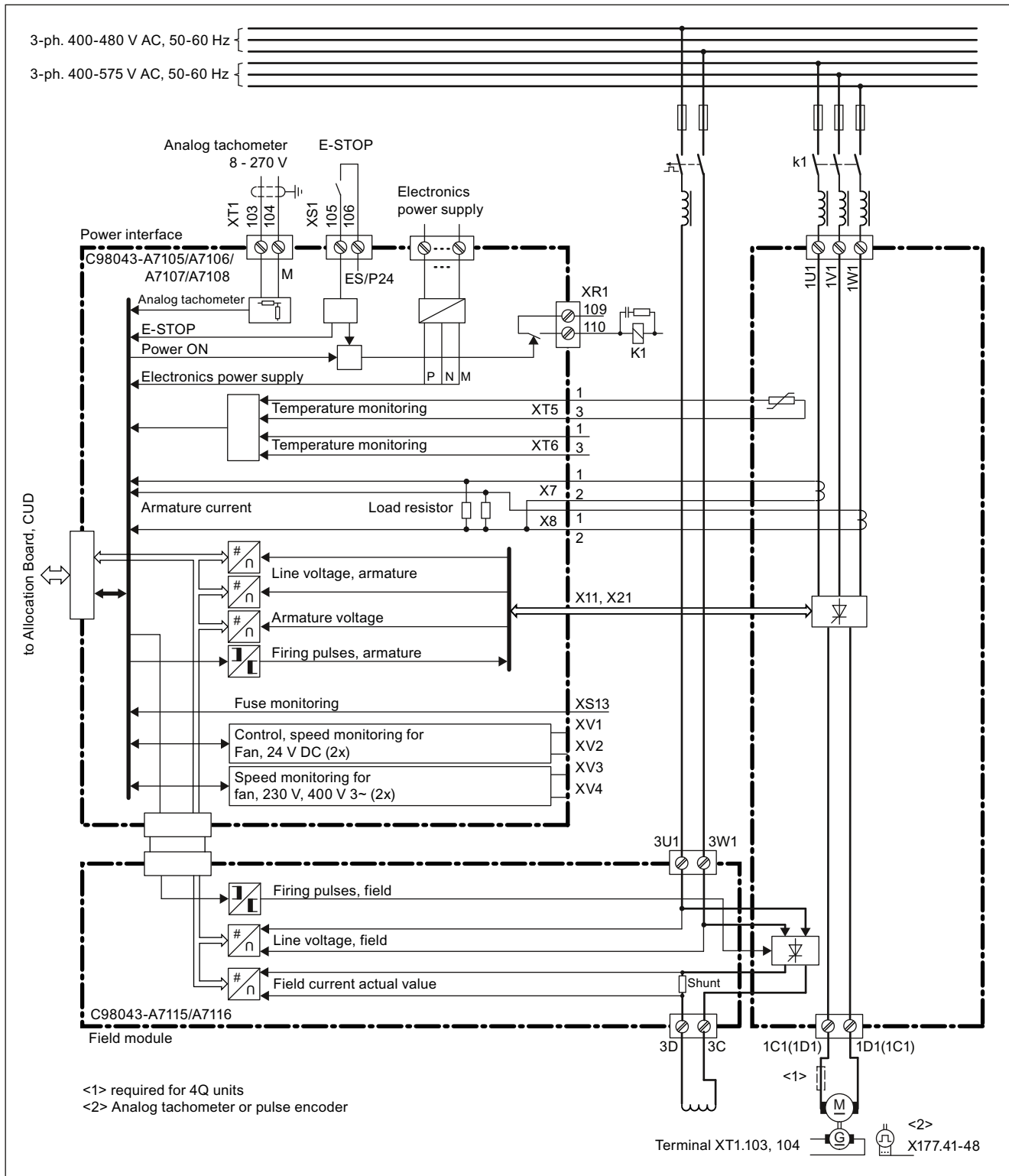
Figure 6-16   Block diagram for 60 to 125 A units
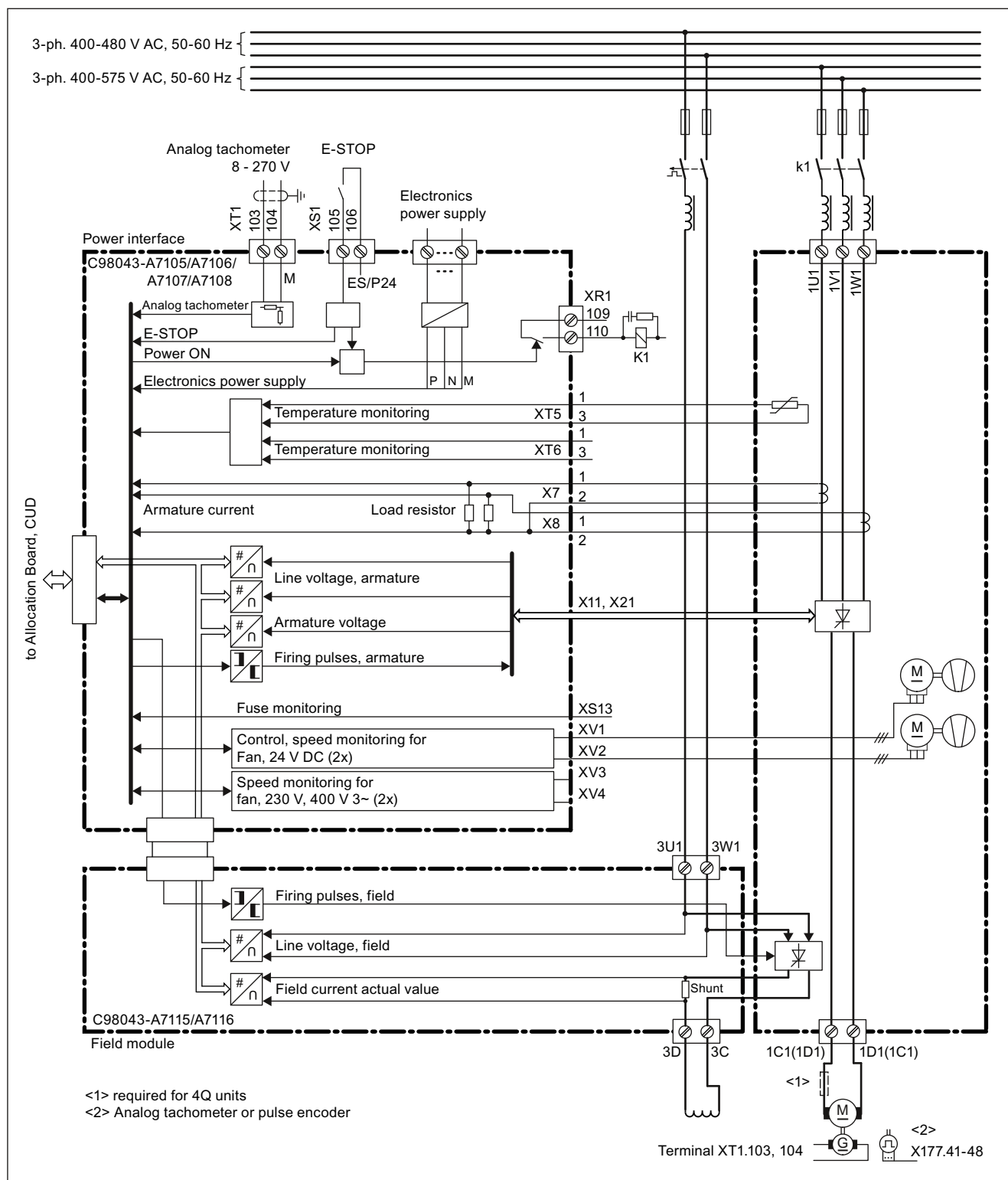
210 to 280 A units

Figure 6-17   Block diagram for 210 to 280 A units

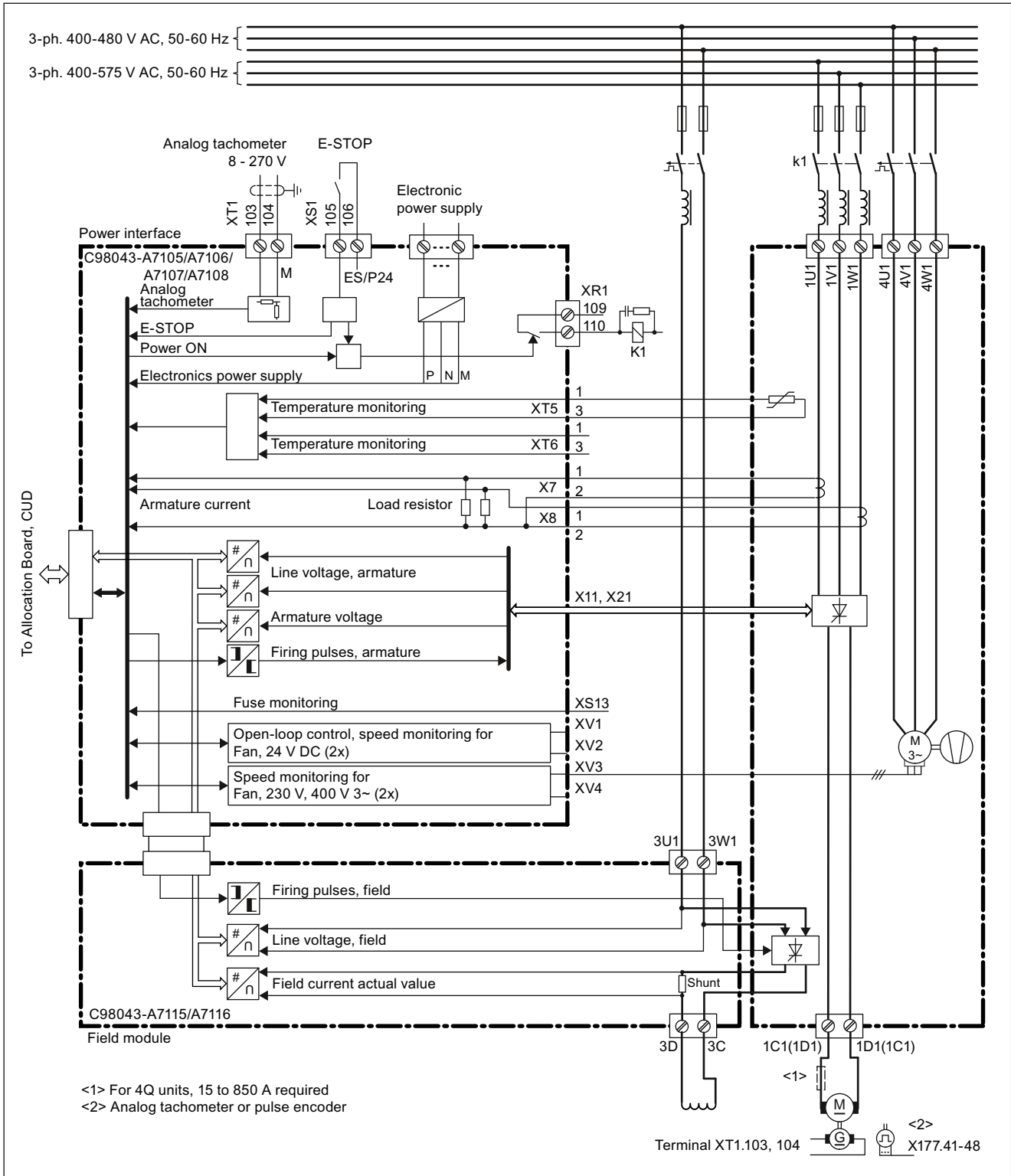## 400 to 3000 A units, three-phase fan connection

Figure 6-18   Block diagram for 400 to 3000 A units, 3-phase fan connection

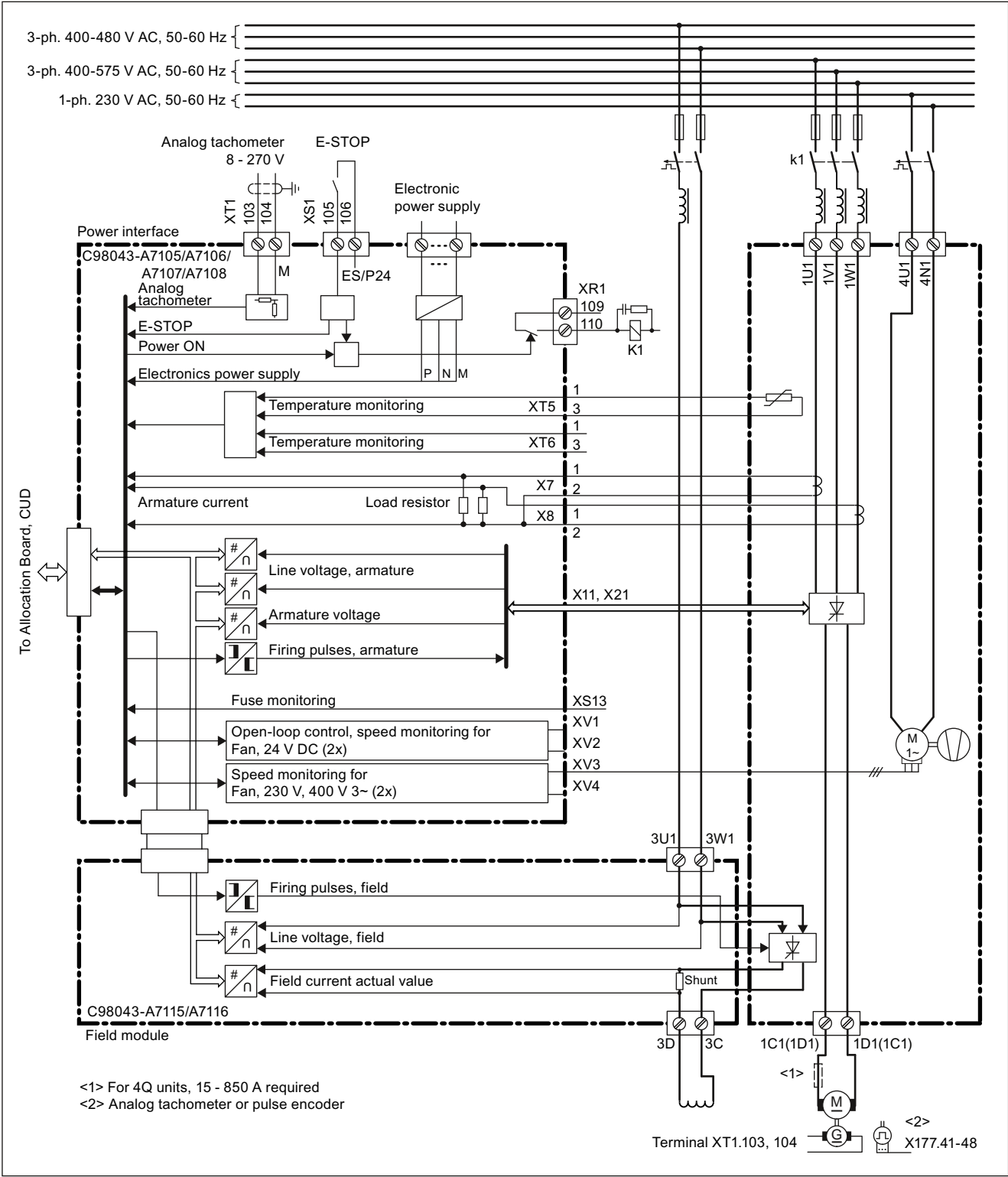## 400 to 1200 A units, with option L21, 1-phase fan connection

Figure 6-19   Block diagram for 400 to 1200 A units, 1-phase fan connection

6.4   Power connections

Explanations for the connection diagrams

G   Gate cables ⇒ yellow

K   Cathode cables ⇒ red

a   Copper/aluminum busbar

b   Copper/aluminum busbar

c   Raychem 44A0311-20-9

Firing cables (G, K):

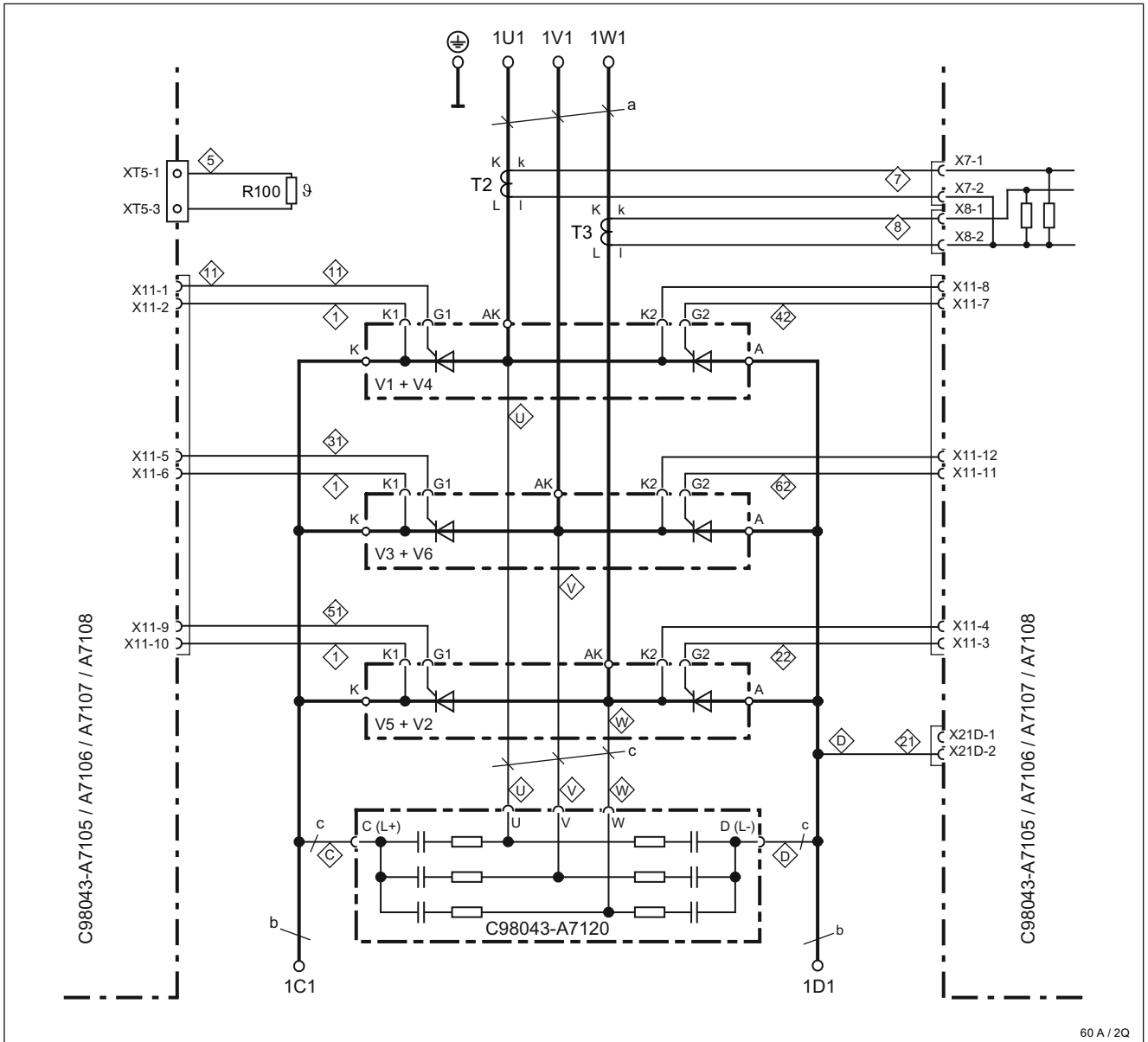In units with a rated armature supply voltage of < 690 V:
Betatherm 145, 0.5 mm^2, UL

In units with a rated armature supply voltage of ≥ 690 V:
Radox 125, 0.75 mm^2

◇   Cable ends are marked with their specified designation.

60 A/2Q units

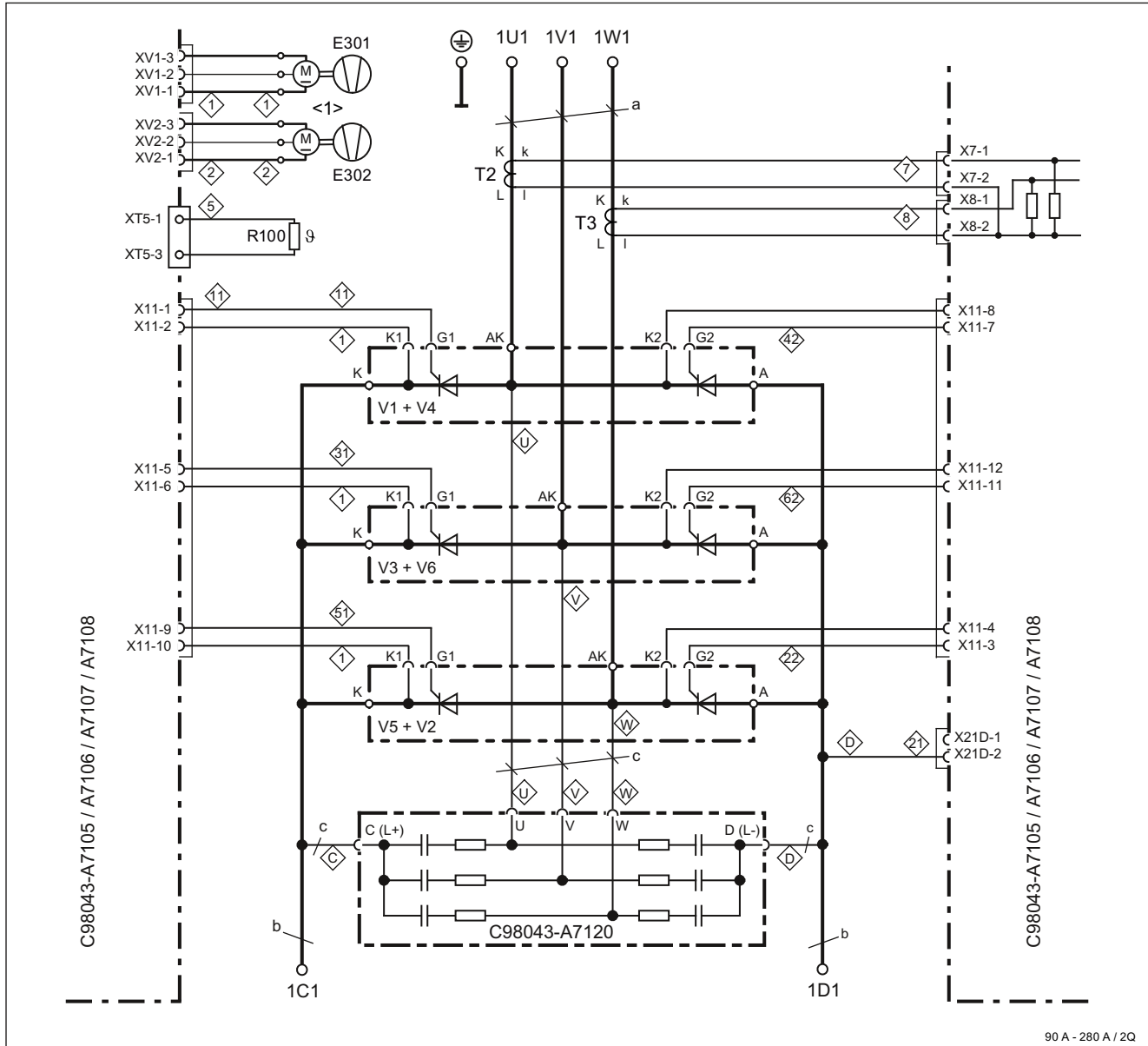*6RA8025-6DS22-0AA0, 6RA8025-6FS22-0AA0, 6RA8025-6GS22-0AA0*

a = 20 x 3 mm, b = 20 x 5 mm

Figure 6-20   Power connections for 60 A/2Q units

90 to 280 A/2Q units

6RA8028-6DS22-0AA0, 6RA8028-6FS22-0AA0, 6RA8031-6DS22-0AA0,
6RA8031-6FS22-0AA0, 6RA8031-6GS22-0AA0, 6RA8075-6DS22-0AA0,
6RA8075-6FS22-0AA0, 6RA8075-6GS22-0AA0, 6RA8078-6DS22-0AA0,
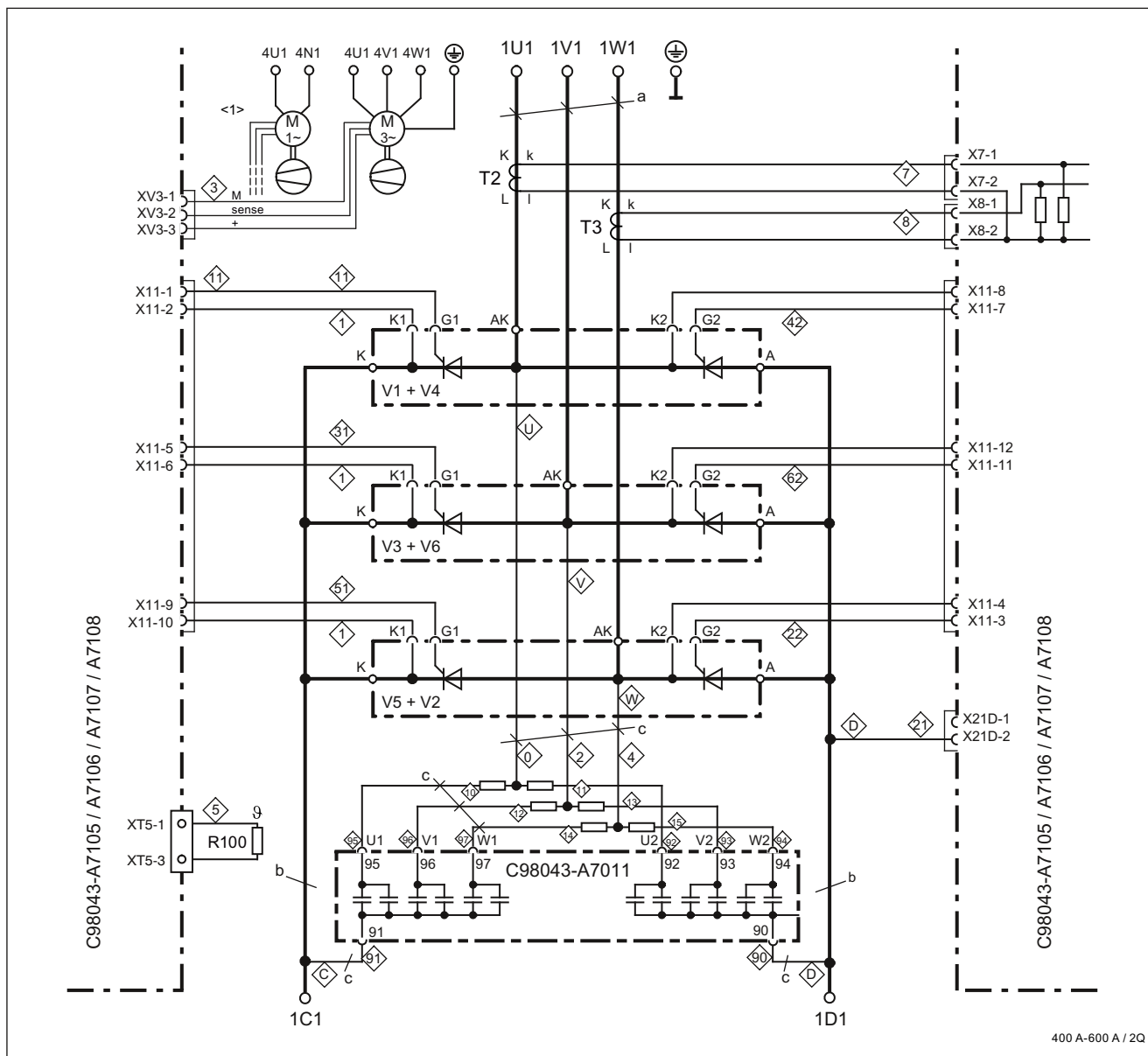6RA8078-6FS22-0AA0,

<1> Fan configuration for units of 210 A and above

a = 20 x 3 mm, b = 20 x 5 mm

Figure 6-21   Power connections for 90 to 280 A/2Q units

400 to 600 A/2Q units

6RA8081-6DS22-0AA0, 6RA8081-6GS22-0AA0, 6RA8082-6FS22-0AA0,
6RA8085-6DS22-0AA0, 6RA8085-6FS22-0AA0, 6RA8085-6GS22-0AA0
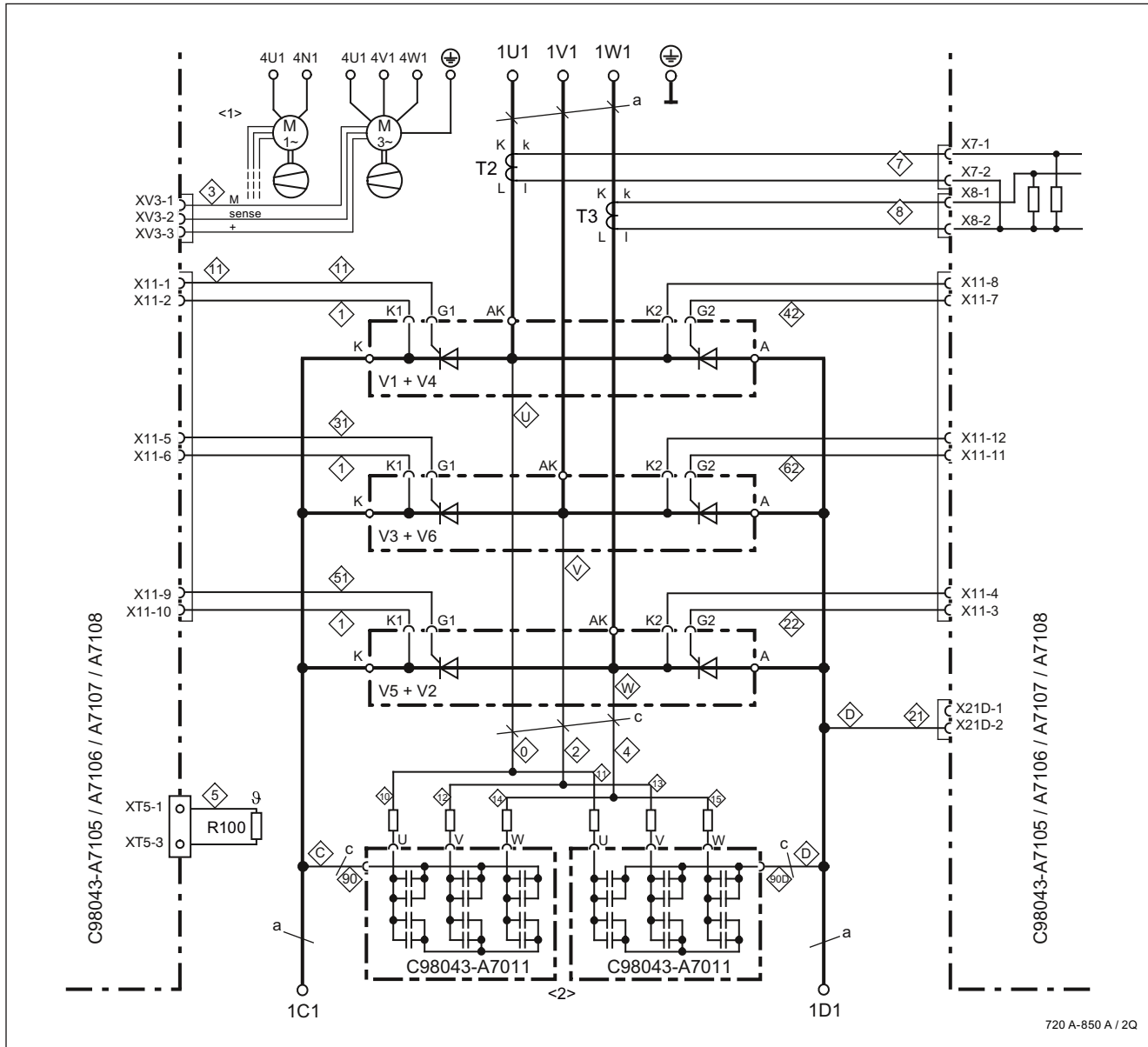

<1>   Fan with single-phase connection for units with option L21

a = 30 x 5 mm, b = 35 x 5 mm

Figure 6-22   Power connections for 400 to 600 A/2Q units

720 to 850 A/2Q units

6RA8086-6KS22-0AA0, 6RA8087-6DS22-0AA0, 6RA8087-6FS22-0AA0, 6RA8087-6GS22-0AA0

a = 60 x 5 mm

<1> Fan with single-phase connection for units with option L21
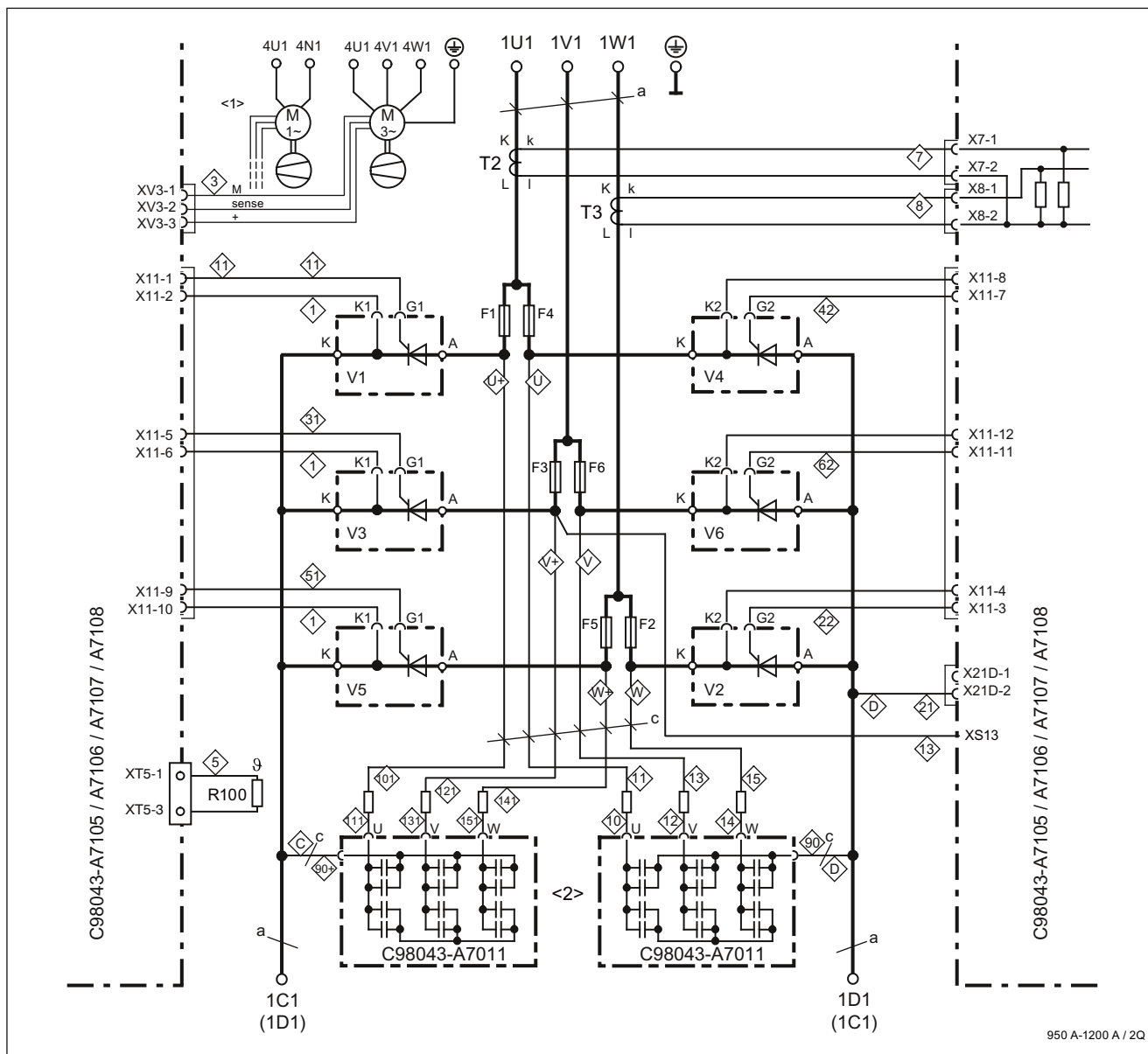
<2> Connections for module C98043-A7011:

720 A units:	U = 91	V = 99	W = 98	C, D = 90
800 A to 850 A units:	U = 92	V = 93	W = 94	C, D = 90

Figure 6-23   Power connections for 720 to 850 A/2Q units

900 to 1200 A/2Q units

6RA8088-6KS22-0AA0, 6RA8088-6LS22-0AA0, 6RA8090-6GS22-0AA0,
6RA8091-6DS22-0AA0, 6RA8091-6FS22-0AA0

a = 80 x 6 mm

<1> Fan with single-phase connection for units with option L21

<2> Connections for module C98043-A7011:

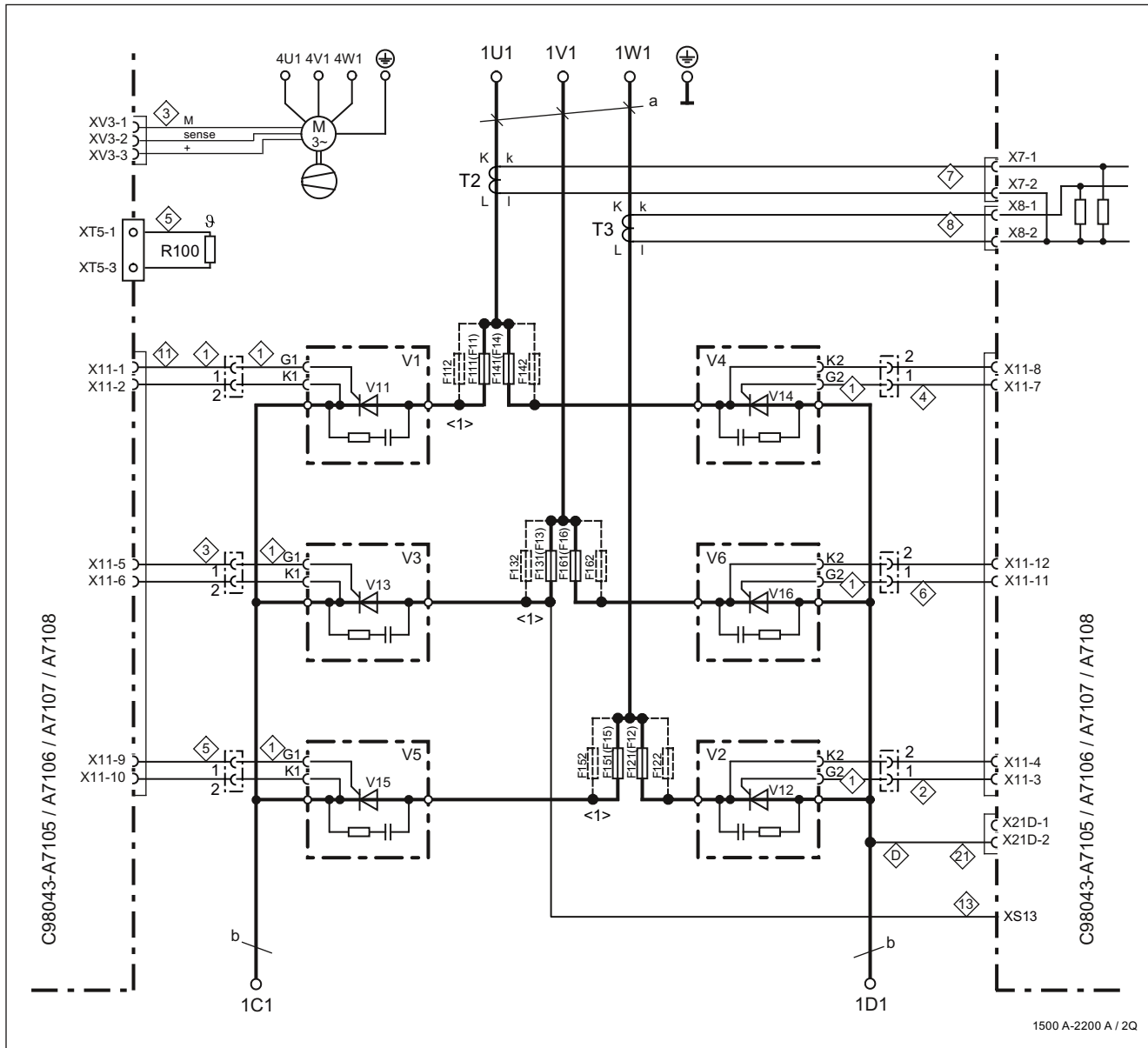|				
< 1100 A units:	U = 91	V = 99	W = 98	C, D = 90
≥ 1100 A units:	U = 92	V = 93	W = 94	C, D = 90

Figure 6-24   Power connections for 900 to 1200 A/2Q units

1,500 to 2,000 A and 575 V/2,200 A/2Q units

6RA8093-4DS22-0AA0, 6RA8093-4G S22-0AA0, 6RA8093-4KS22-0AA0,
6RA8093-4LS22-0AA0, 6RA8095-4DS22-0AA0, 6RA8095-4GS22-0AA0,
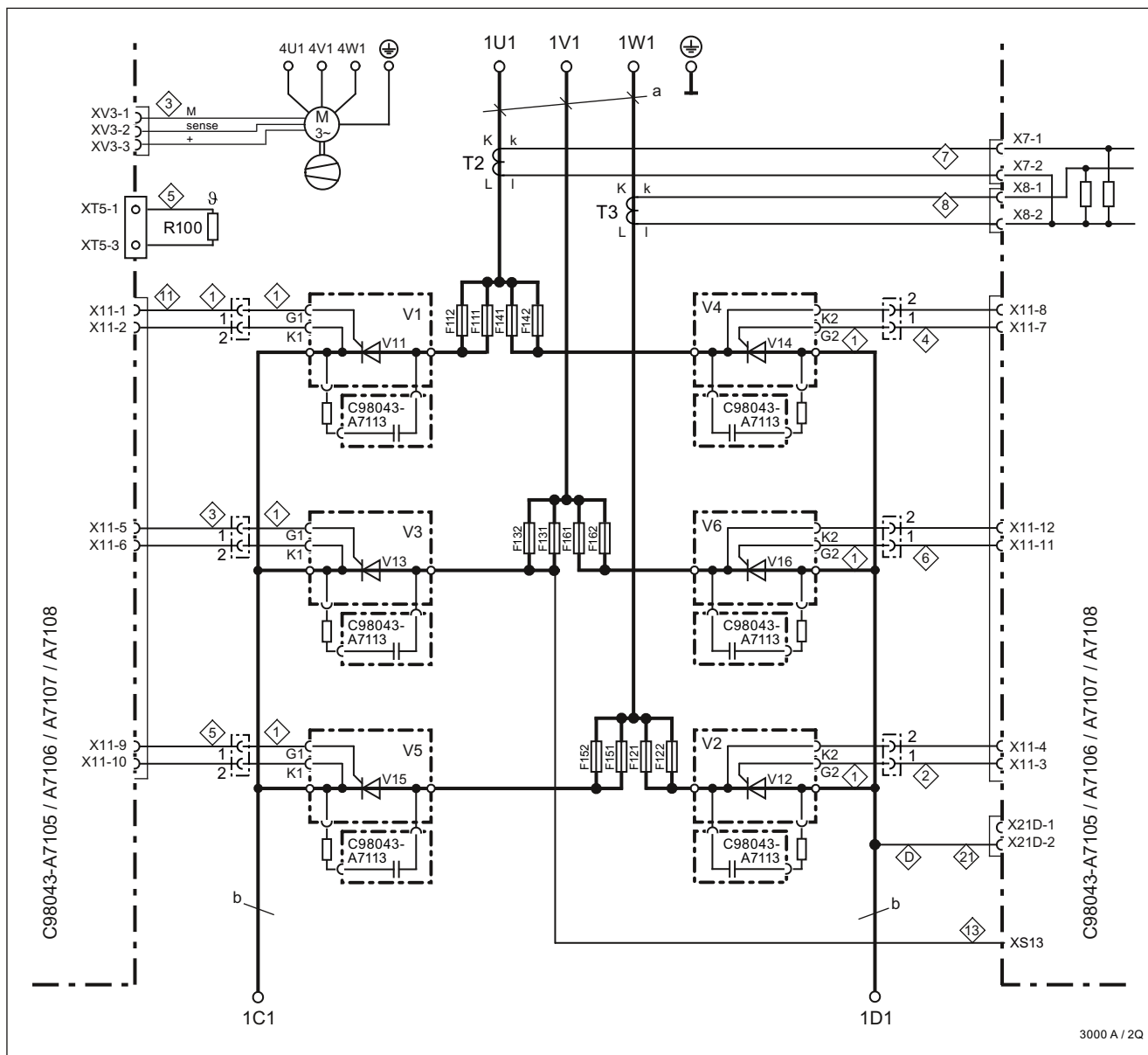*6RA8095-4KS22-0AA0, 6RA8095-4LS22-0AA0, 6RA8096-4GS22-0AA0*

<1>   For number of fuses, refer to the chapter "Fuses"

a = 120 x 10 mm, b = cross-section 60 x 10 mm / width 323 mm

Figure 6-25   Power connections for 1,500 to 2,000 A and 575 V/2,200 A/2Q units

400 V/3,000 A, 575 V/2,800 A, 690 V/2,600 A, 950 V/2,200 A/2Q units

6RA8096-4MS22-0AA0, 6RA8097-4G S22-0AA0, 6RA8097-4KS22-0AA0, 6RA8098-4DS22-0AA0

a = 120 x 10 mm, b = cross-section 60 x 10 mm / width 323 mm

Figure 6-26   Power connections for 2,200 to 3,000 A/2Q units

15 to 30 A/4Q units

6RA8013-6DV62-0AA0, 6RA8013-6FV62-0AA0, 6RA8018-6DV62-0AA0, 6RA8018-6FV62-0AA0
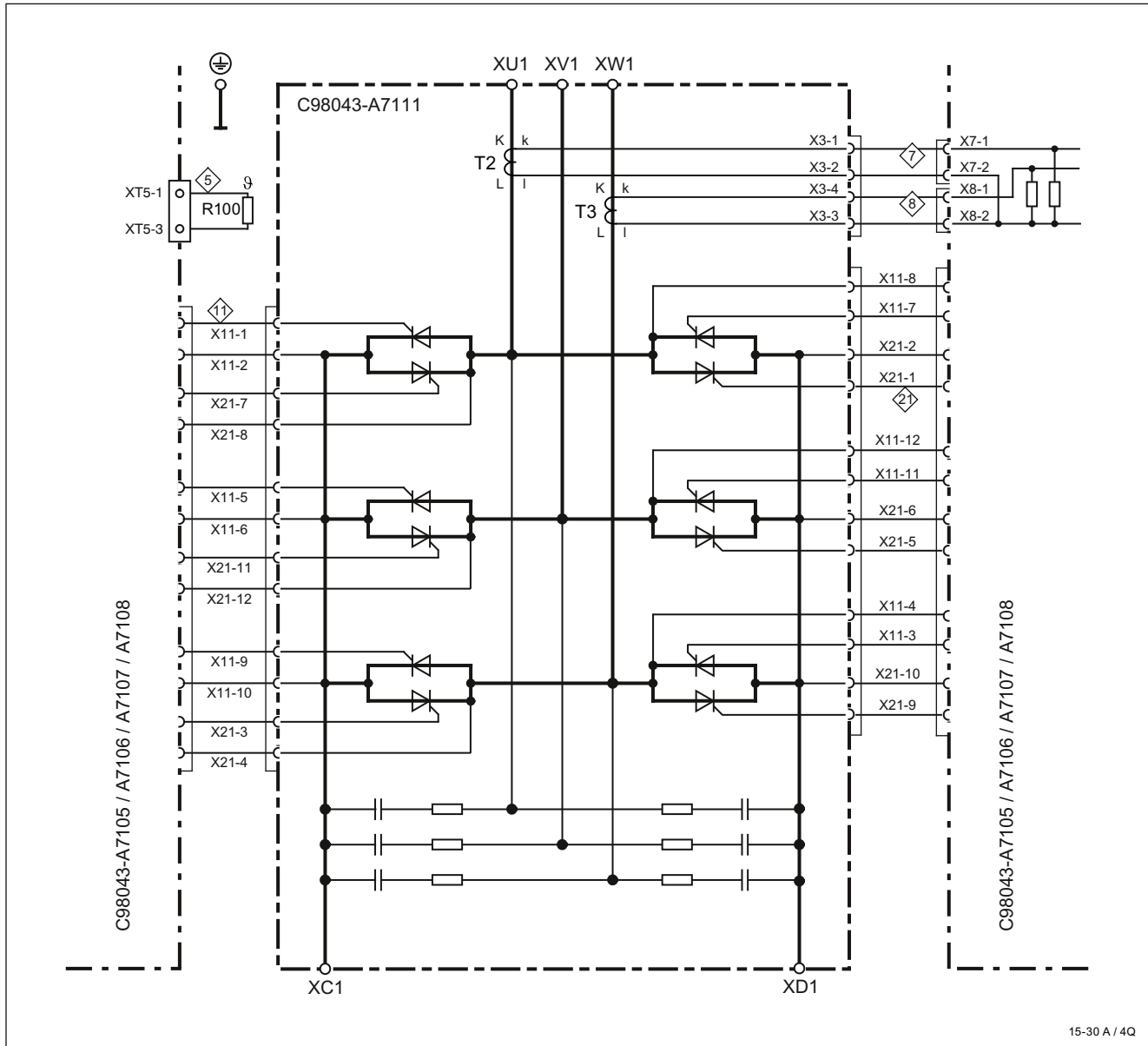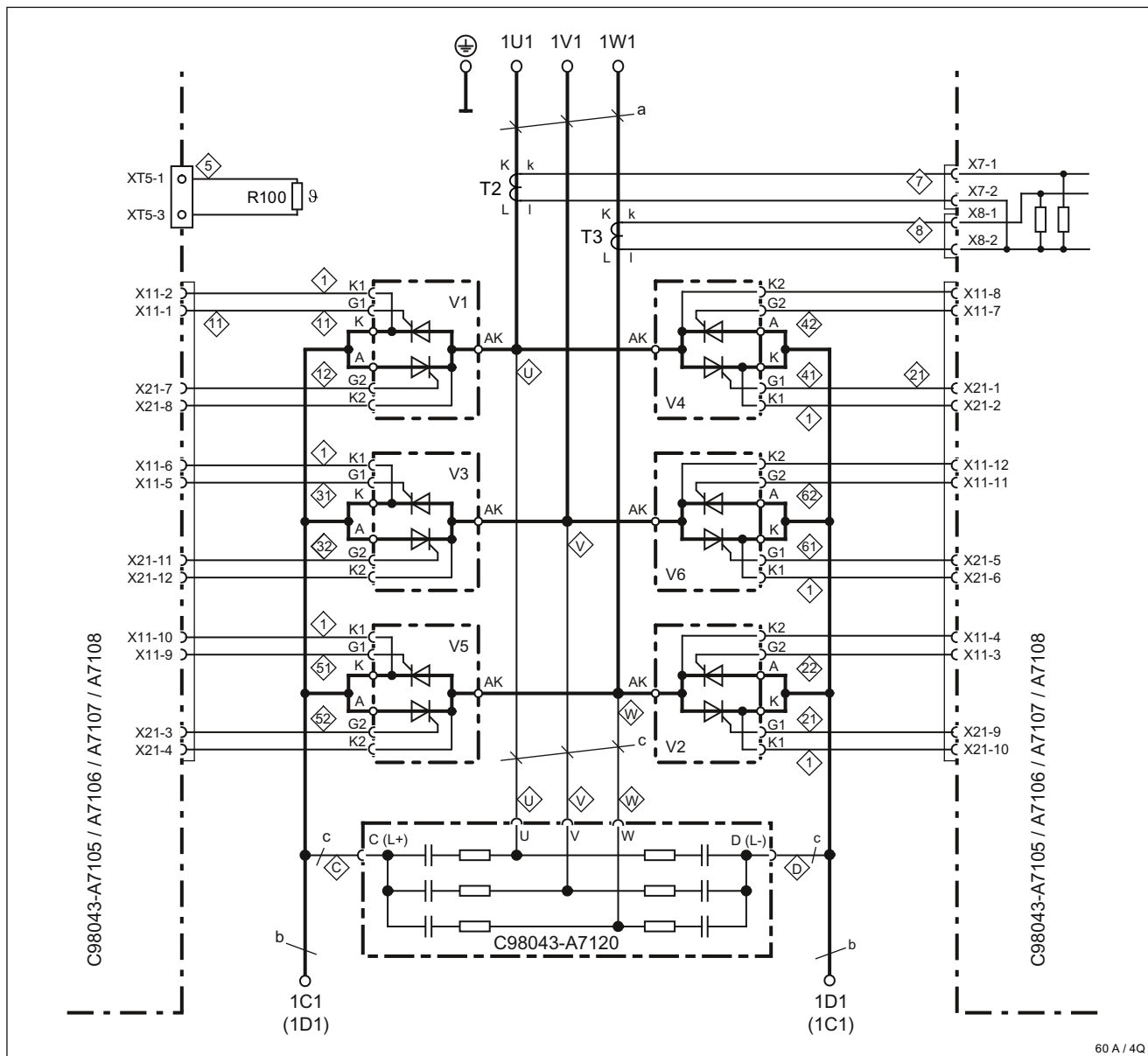

Figure 6-27   Power connections for 15 to 30 A/4Q units

60 A/4Q units

6RA8025-6DV62-0AA0, 6RA8025-6FV62-0AA0, 6RA8025-6GV62-0AA0

a = 20 x 3 mm, b = 20 x 5 mm

Figure 6-28   Power connections for 60 A/4Q units

90 to 280 A/4Q units

6RA8028-6DV62-0AA0, 6RA8028-6FV62-0AA0, 6RA8031-6DV62-0AA0,
6RA8031-6FV62-0AA0, 6RA8031-6GV62-0AA0, 6RA8075-6DV62-0AA0,
6RA8075-6FV62-0AA0, 6RA8075-6GV62-0AA0, 6RA8078-6DV62-0AA0,
6RA8078-6FV62-0AA0,
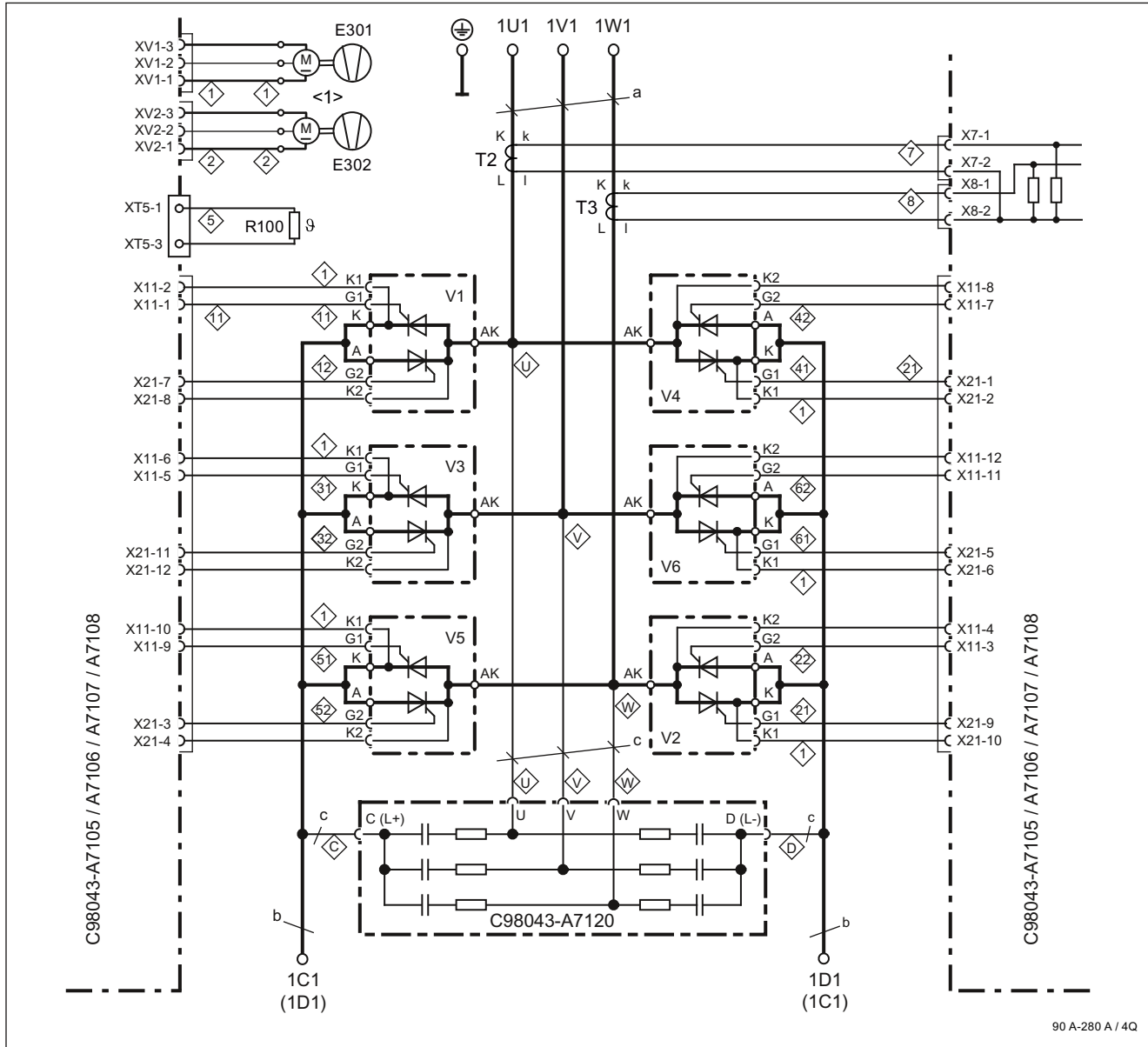
<1>   Fan configuration for units of 210 A and above

a = 20 x 3 mm, b = 20 x 5 mm

Figure 6-29   Power connections for 90 to 280 A/4Q units

400 to 600 A/4Q units

6RA8081-6DV62-0AA0, 6RA8081-6GV62-0AA0, 6RA8082-6FV62-0AA0,
6RA8085-6DV62-0AA0, 6RA8085-6FV62-0AA0, 6RA8085-6GV62-0AA0

400 A-600 A / 4Q
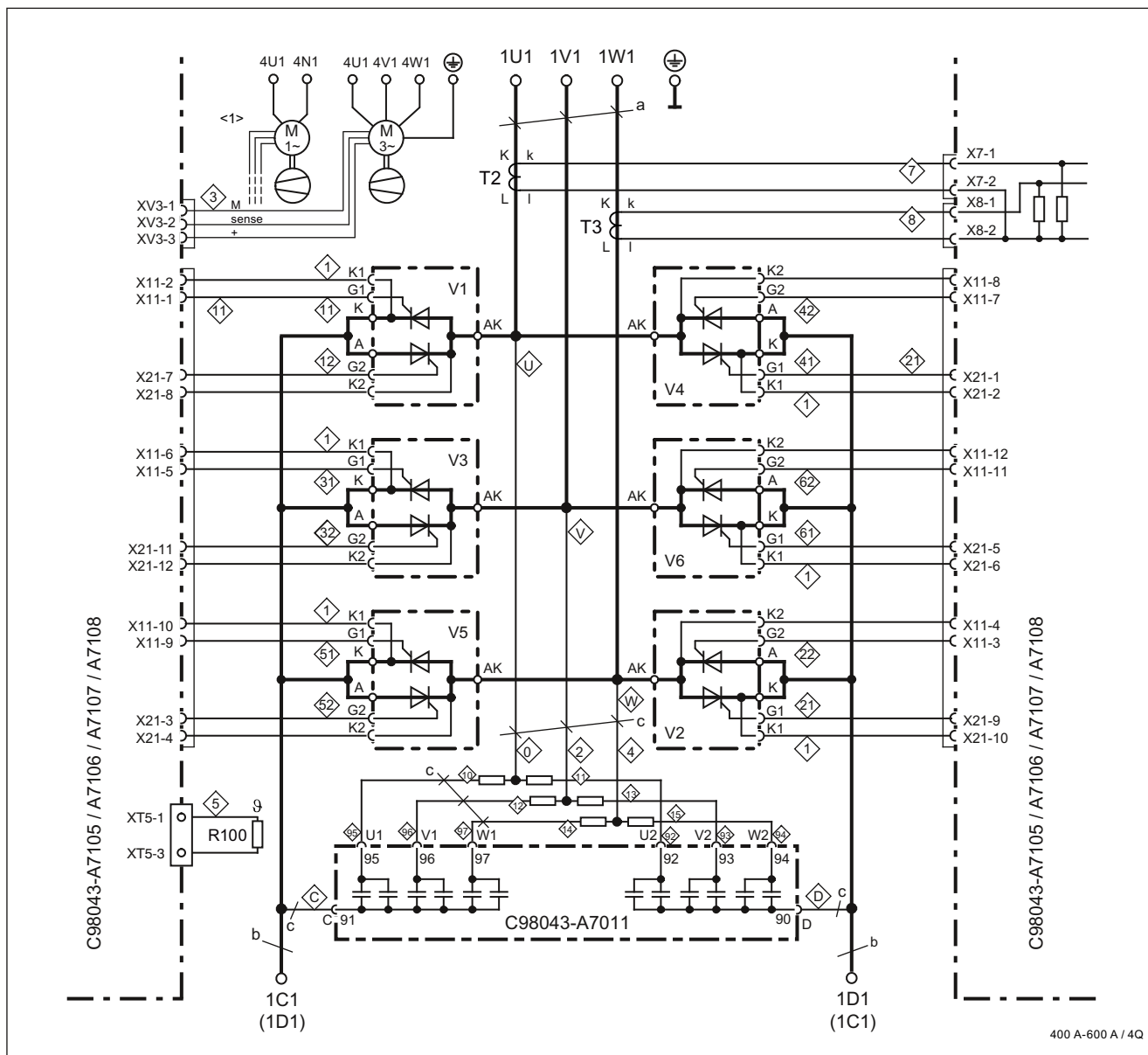
<1> Fan with single-phase connection for units with option L21

a = 30 x 5 mm, b = 35 x 5 mm

Figure 6-30   Power connections for 400 to 600 A/4Q units

760 to 850 A/4Q units

6RA8086-6KV62-0AA0, 6RA8087-6DV62-0AA0, 6RA8087-6FV62-0AA0,
6RA8087-6GV62-0AA0,
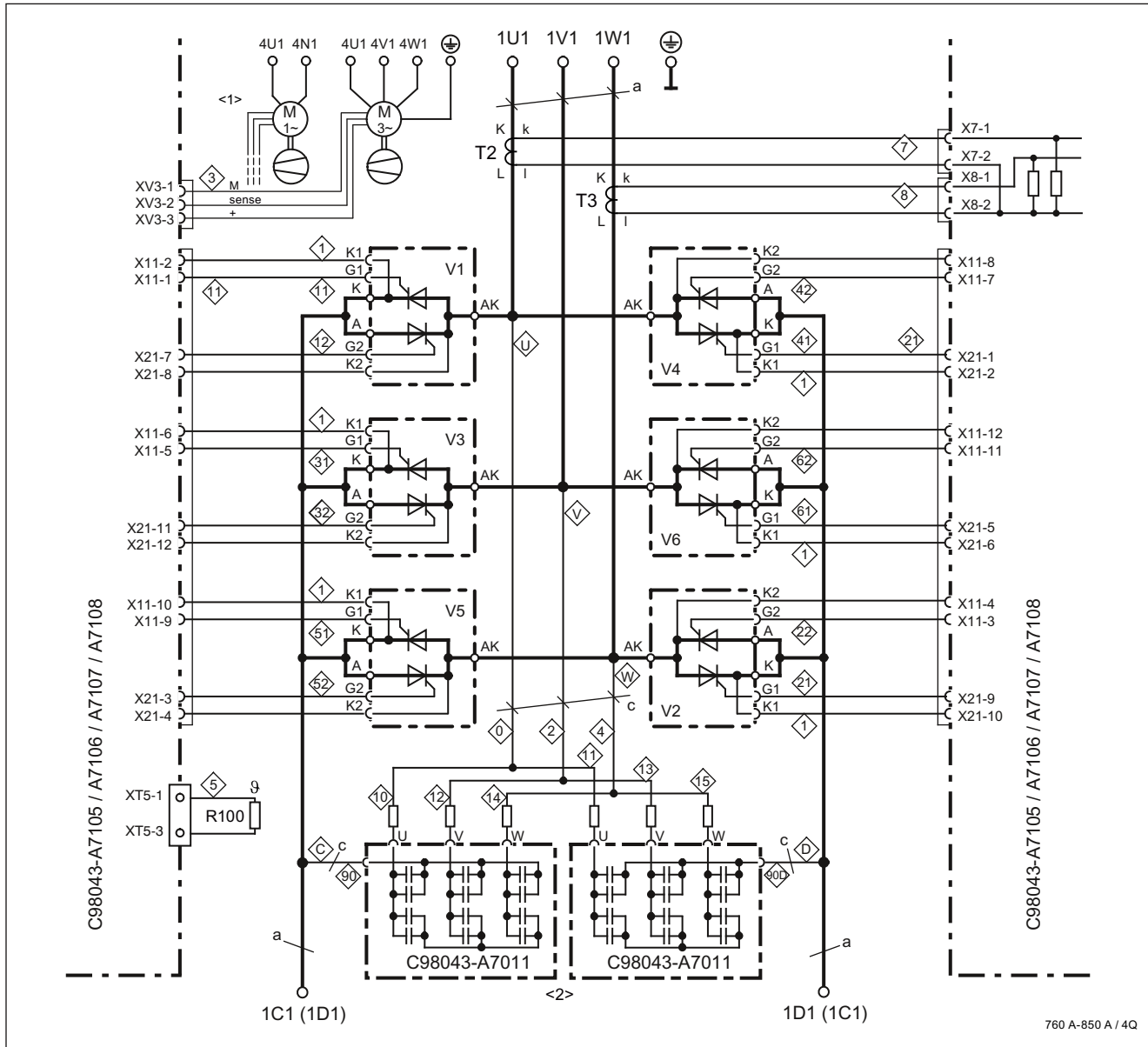
a = 60 x 5 mm

<1> Fan with single-phase connection for units with option L21

<2> Connections for module C98043-A7011:

760 A units:	U = 91	V = 99	W = 98	C, D = 90
850 A units:	U = 92	V = 93	W = 94	C, D = 90

Figure 6-31   Power connections for 760 to 850 A/4Q units

900 to 1200 A/4Q units

6RA8088-6LV62-0AA0, 6RA8090-6G   V62-0AA0, 6RA8090-6KV62-0AA0,
6RA8091-6DV62-0AA0, 6RA8091-6FV62-0AA0

a = 80 x 6 mm

<1> Fan with single-phase connection for units with option L21

<2> Connections for module C98043-A7011:

< 1100 A units:	U = 91	V = 99	W = 98	C, D = 90
≥ 1100 A units:	U = 92	V = 93	W = 94	C, D = 90

Figure 6-32   Power connections for 900 to 1200 A/4Q units

1,500 to 2,000 A and 575 V/2,200 A/4Q units

6RA8093-4DV62-0AA0, 6RA8093-4G V62-0AA0, 6RA8093-4KV62-0AA0,
6RA8093-4LV62-0AA0, 6RA8095-4DV62-0AA0, 6RA8095-4GV62-0AA0,
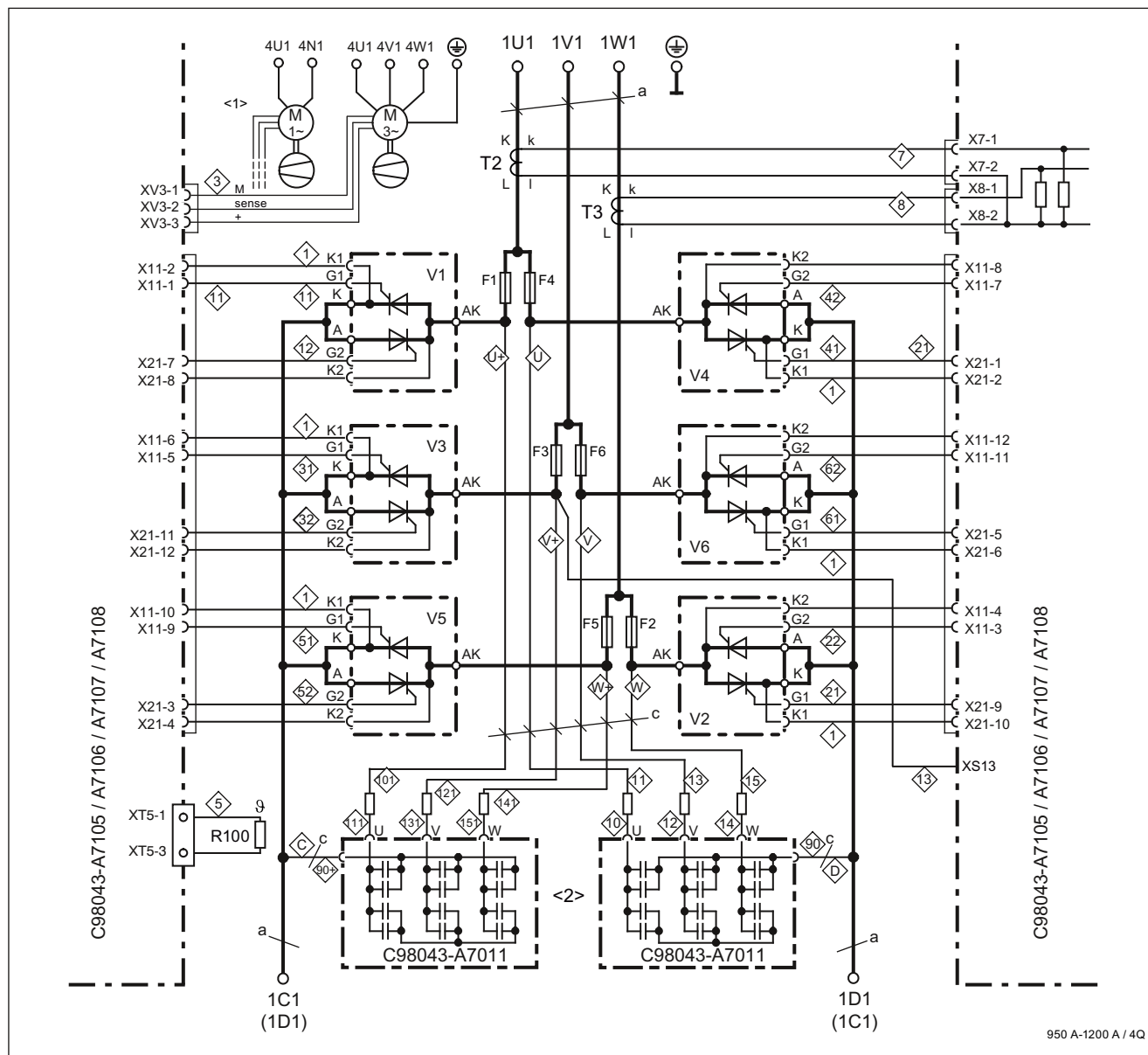*6RA8095-4KV62-0AA0, 6RA8095-4LV62-0AA0, 6RA8096-4GV62-0AA0*
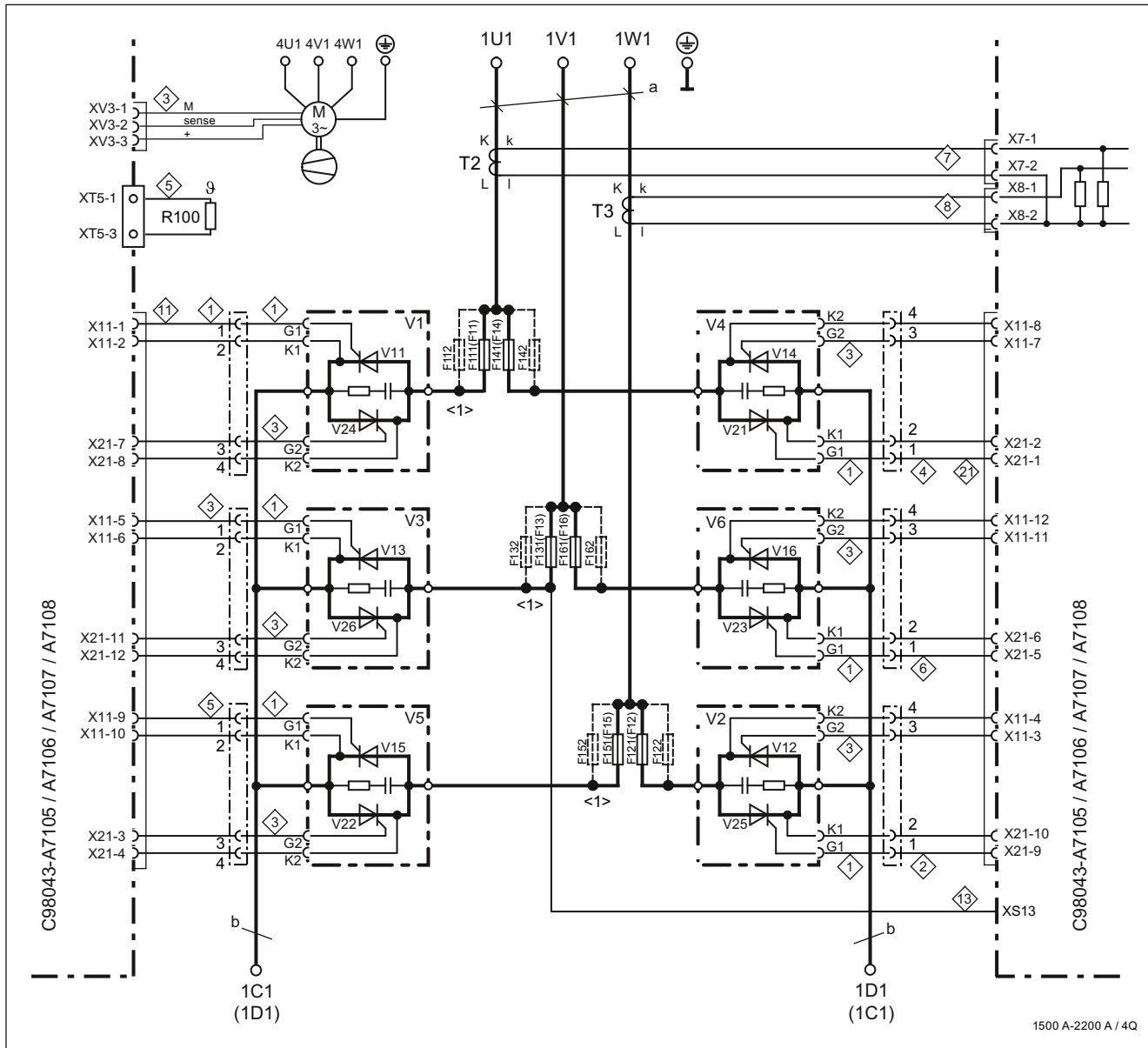
<1>   For number of fuses, refer to the chapter "Fuses"

a = 120 x 10 mm, b = cross-section 60 x 10 mm / width 323 mm

Figure 6-33   Power connections for 1,500 to 2,000 A and 575 V/2,200 A/4Q units

400 V/3,000 A, 575 V/2,800 A, 690 V/2,600 A, 950 V/2,200 A/4Q

6RA8096-4MV62-0AA0, 6RA8097-4G   V62-0AA0, 6RA8097-4KV62-0AA0,
6RA8098-4DV62-0AA0
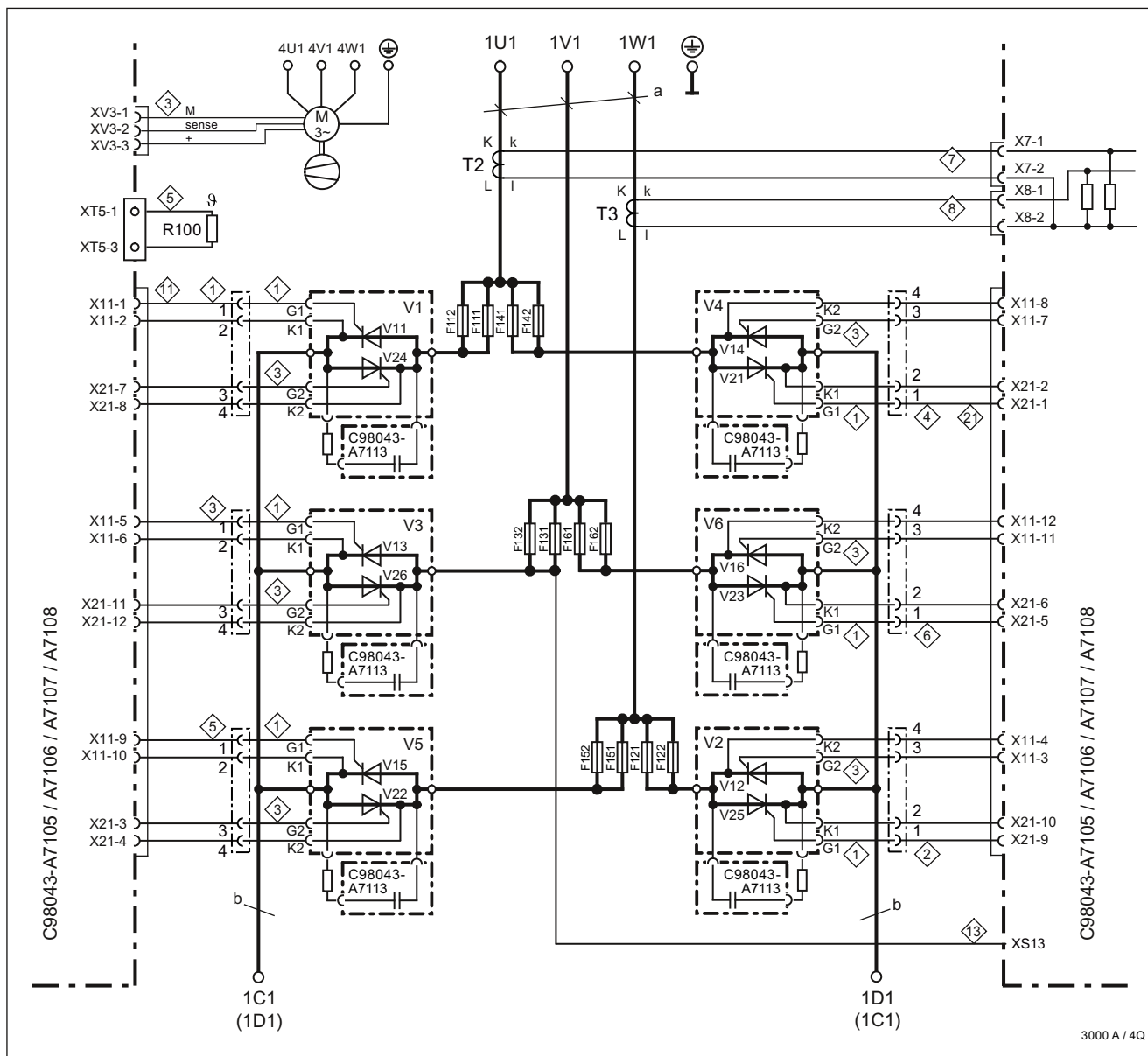
a = 120 x 10 mm, b = cross-section 60 x 10 mm / width 323 mm

Figure 6-34   Power connections for 2,200 to 3,000 A/4Q units

Arrangement of thyristor modules

Note:
The drawings only show how the thyristor modules are arranged and the positions of the connections. They do not take into account the frame sizes of the modules.

2Q units

60 A, 400 V/90 A, 125 A, 210 A, 480 V/90 A, 125 A, 575 V/125 A, 210 A

480 V/210 A 575 V/400 A

480 V/280 A, 575 V/280 A, 400 V/400 A

480 V/450 A, 400 - 575 V/600 A

720 - 850 A

900 A - 1200 A

① Rear level ② Front level
1,500 to 3,000 A

4Q units

60 A, 400 V / 90 A, 125 A, 210 A
480 V / 90 A, 125 A, 575 V / 125 A, 210 A

480 V / 210 A
575 V / 400 A

280 A, 400 V/400 A

450 - 850 A

900 A - 1200 A

131
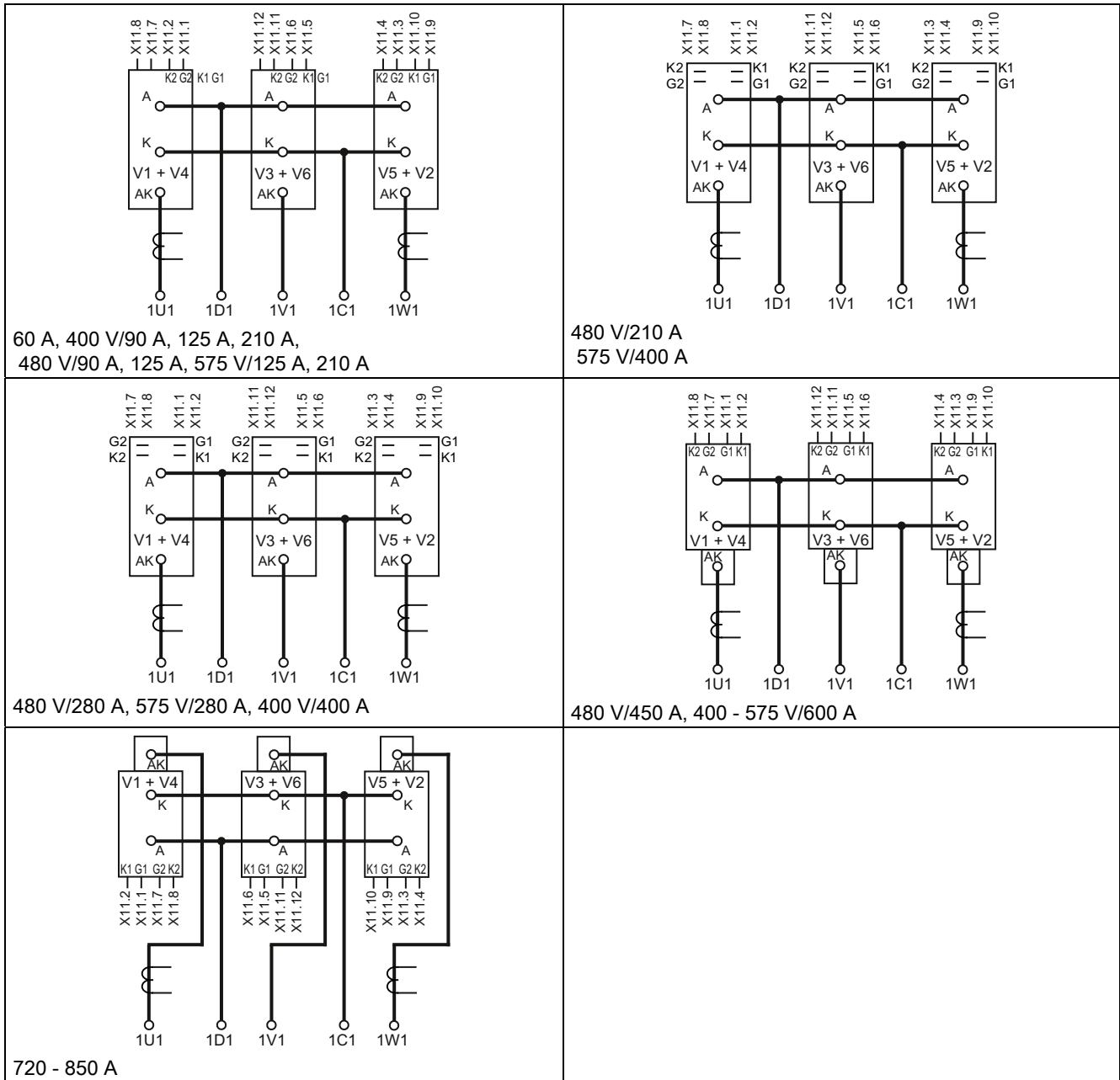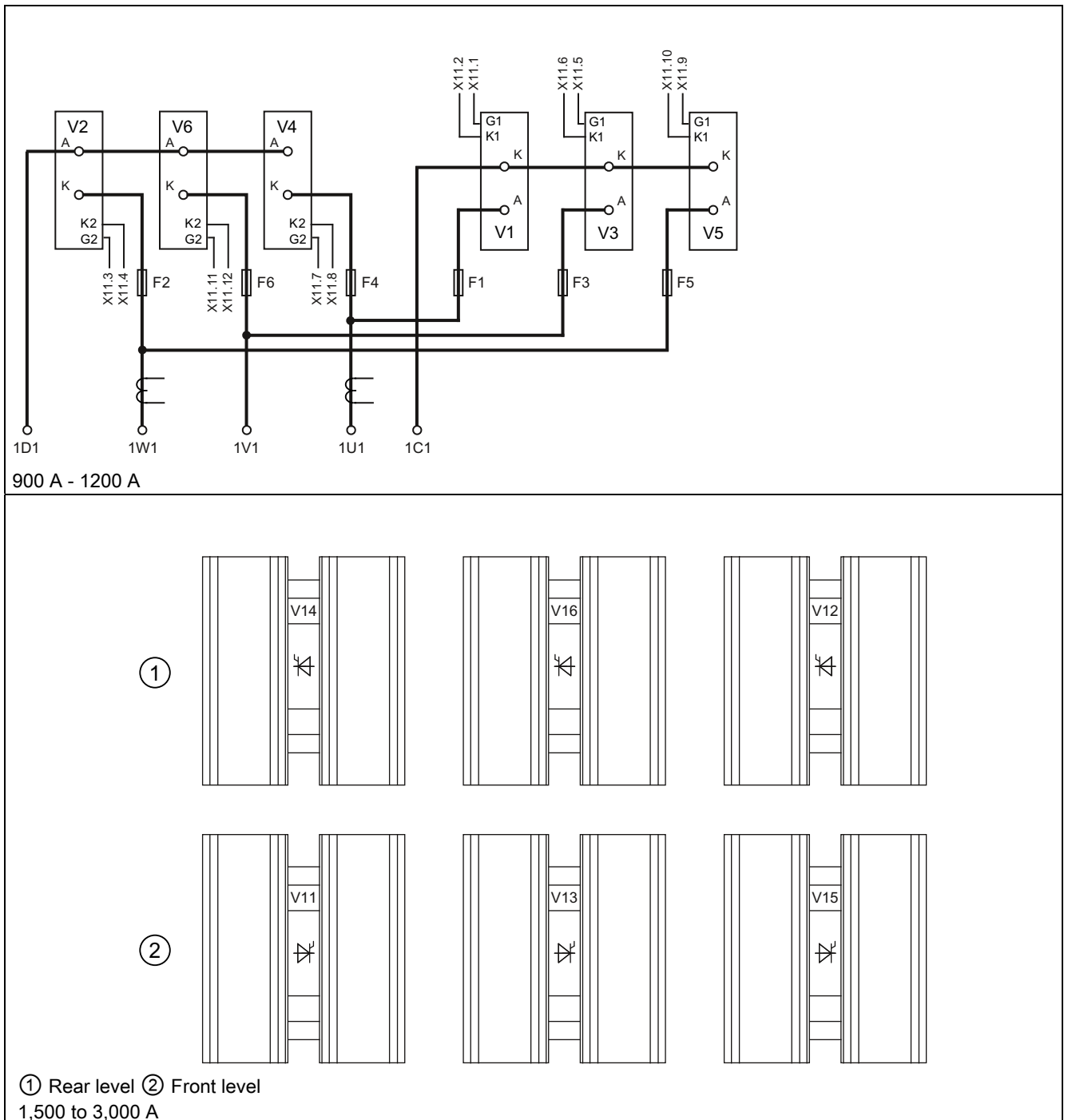
① Rear level ② Front level
1,500 to 3,000 A units
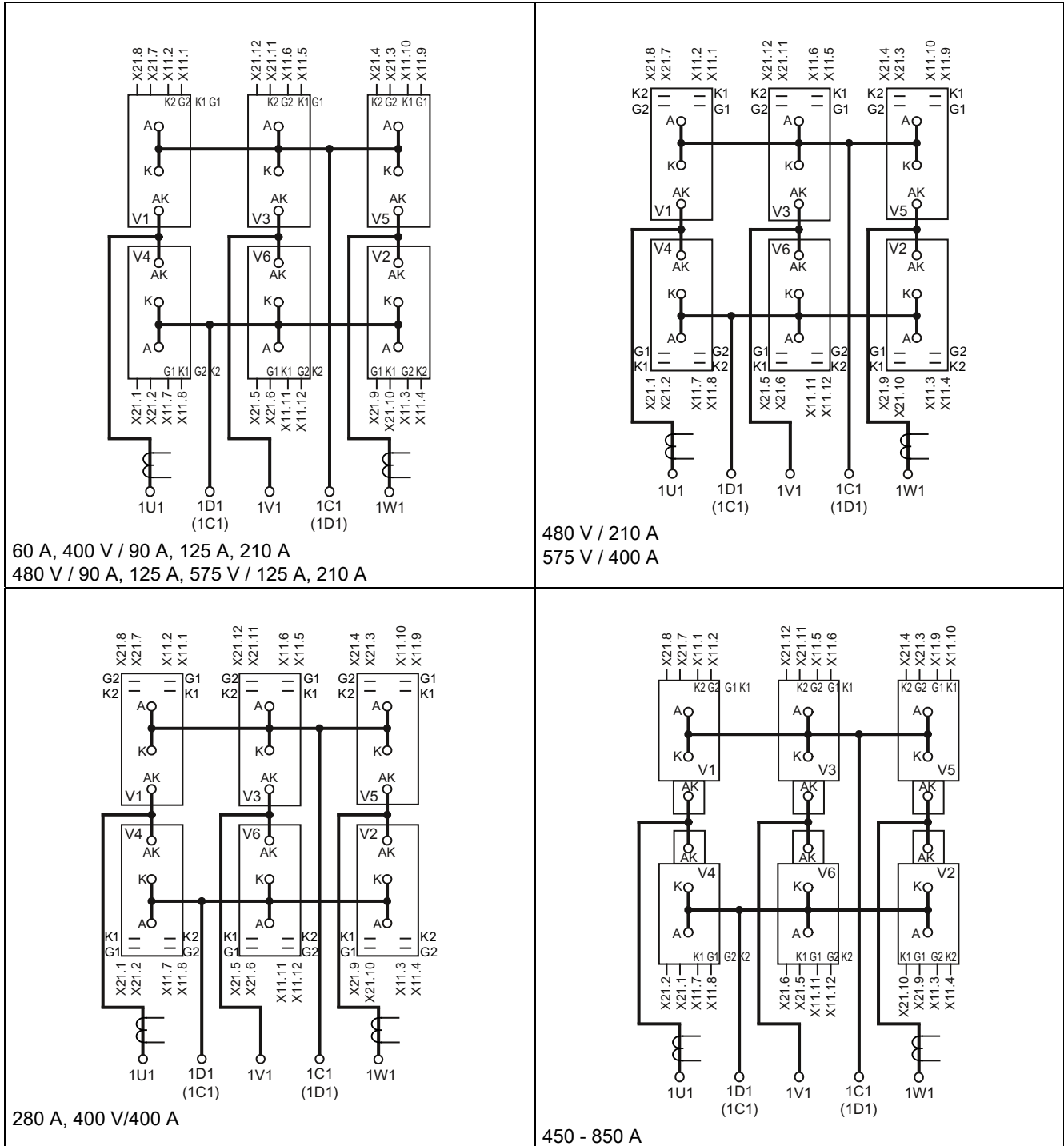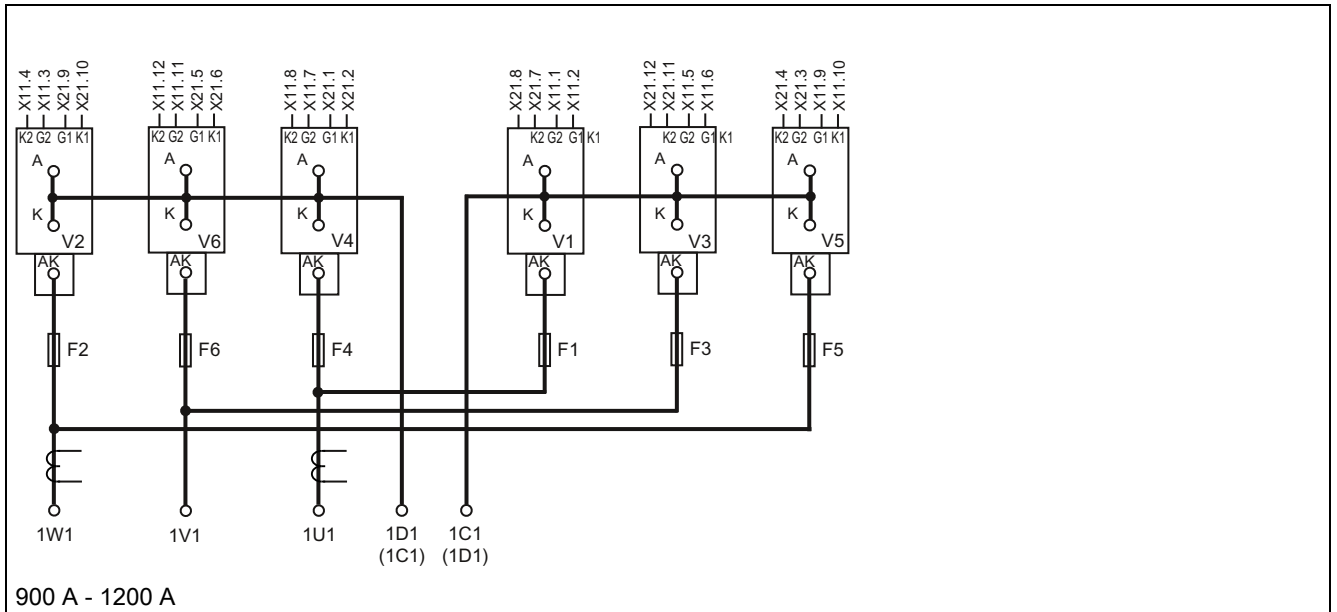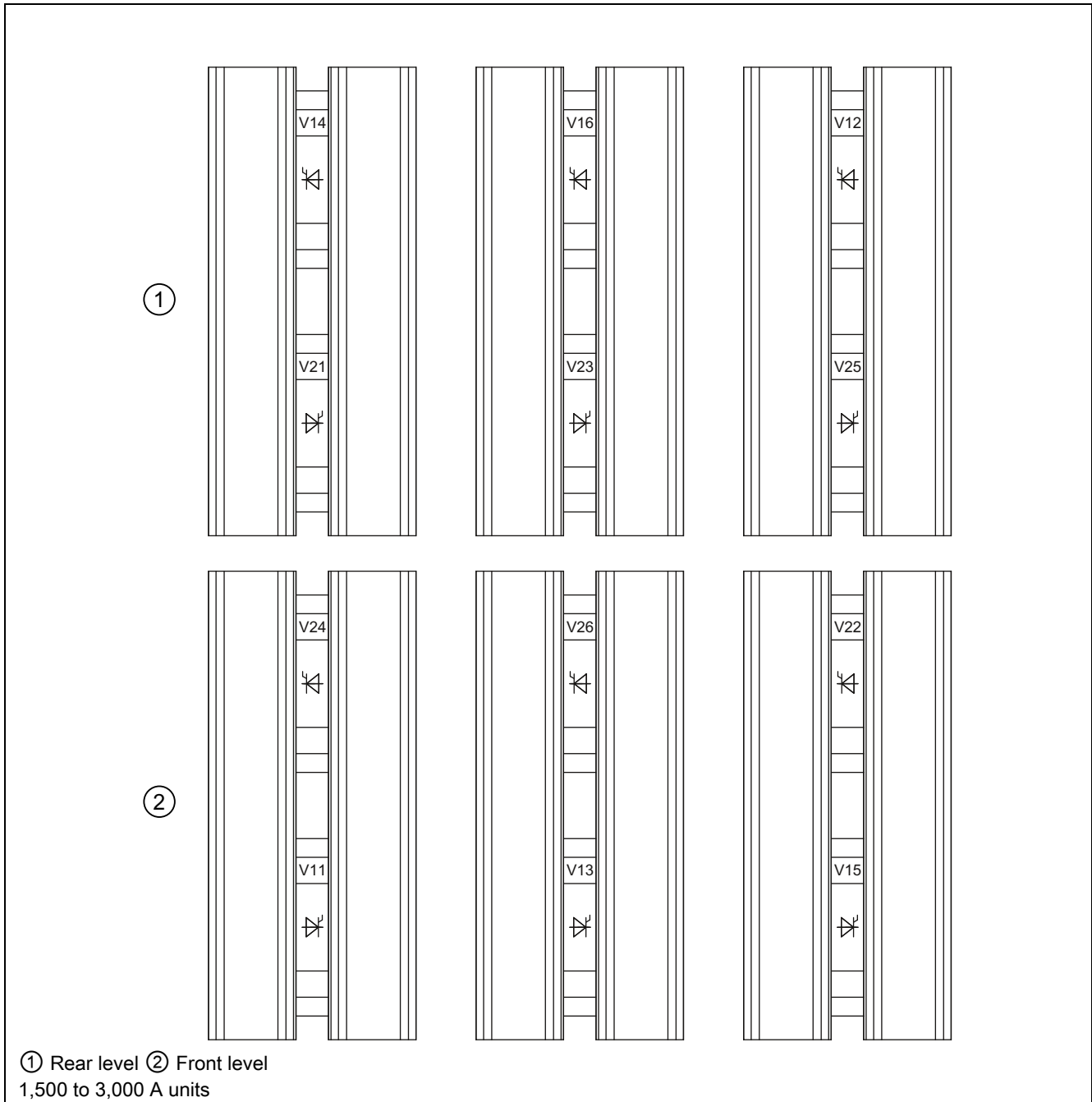
6.5   Field supply

15 to 30 A units
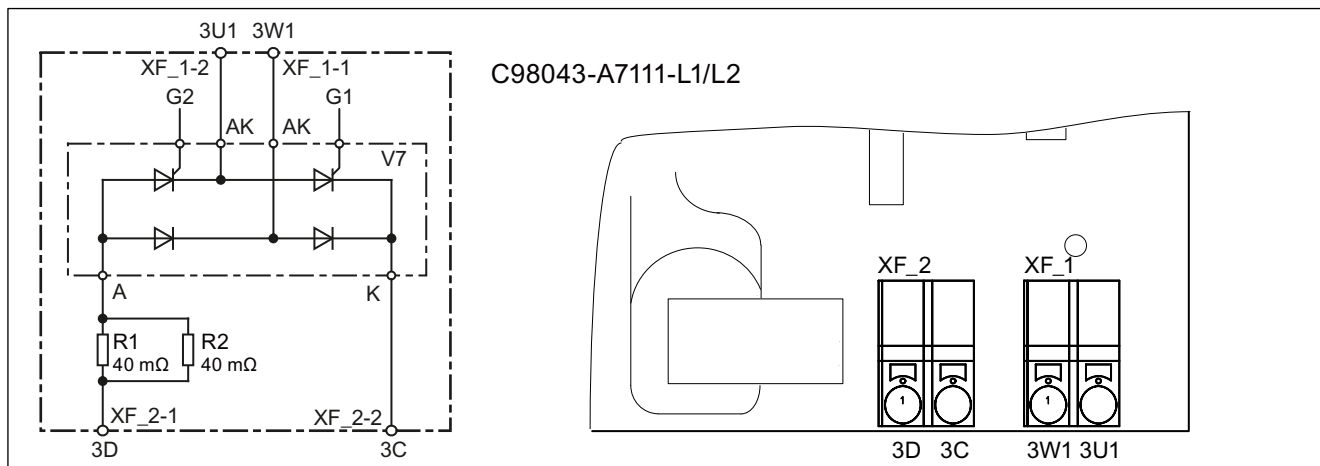
Figure 6-35   15 - 30 A units, 1Q field

Table 6- 2   R1, R2 equipment

Rated DC current, armature	Rated DC current, field	Module	R1	R2
15 A	3 A	C98043-A7111-L1	x	-
30 A	5 A	C98043-A7111-L2	x	x

60 to 850 A units
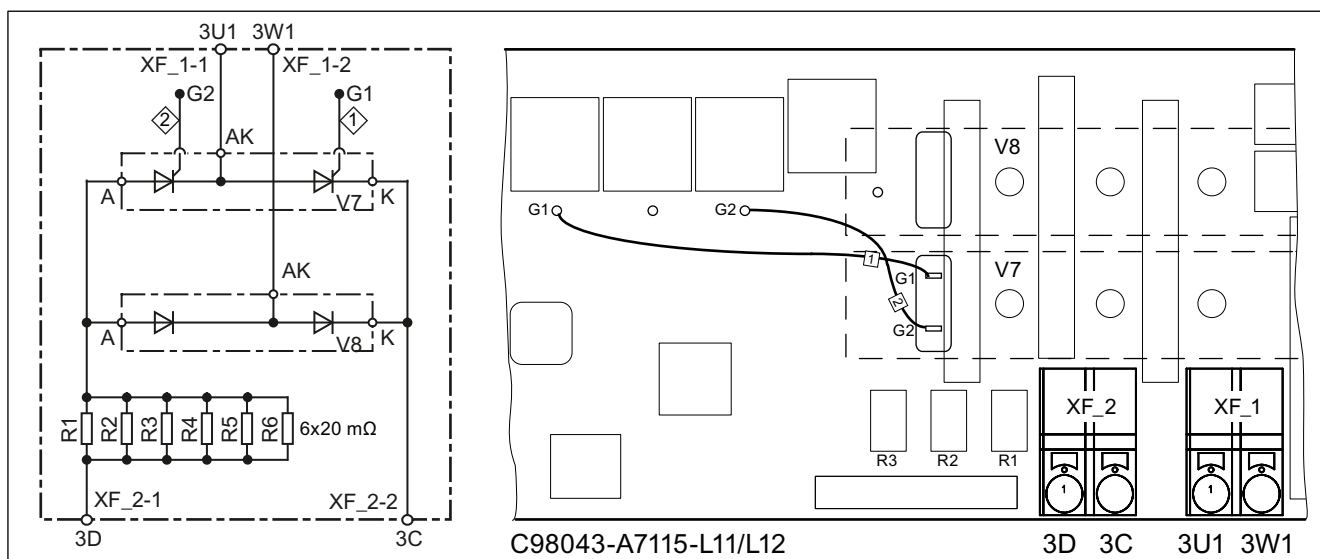
Figure 6-36   60 - 850 A units, 1Q field
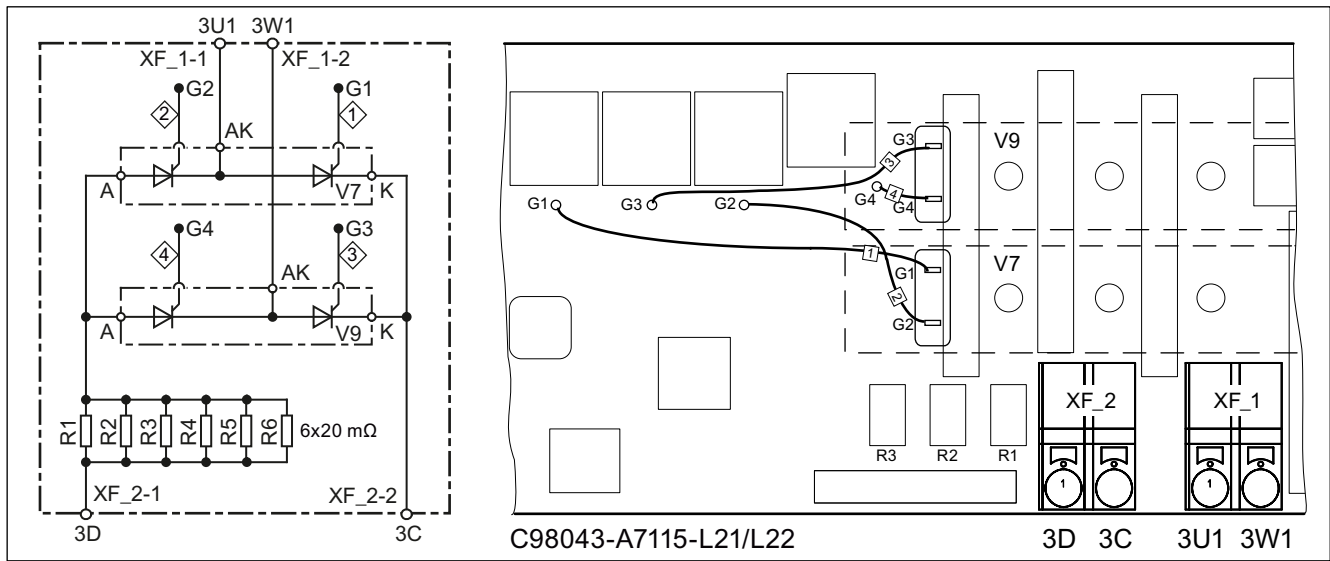
Figure 6-37   60 - 850 A units, 2Q field (option)

Gate cables: Betatherm 145 0.5 mm², UL

Table 6- 3   R1 to R6 equipment

Rated armature DC current	Rated field DC current	Module C98043-...	R1	R2	R3	R4	R5	R6
60 to 125 A	10 A	A7115-L11/L21	x	x	-	-	-	-
210 to 280 A	15 A	A7115-L12/L22	x	x	x	x	x	x
400 to 600 A	25 A	A7115-L12/L22	x	x	x	x	x	x
720 to 850 A	30 A	A7115-L12/L22	x	x	x	x	x	x

900 to 3,000 A units
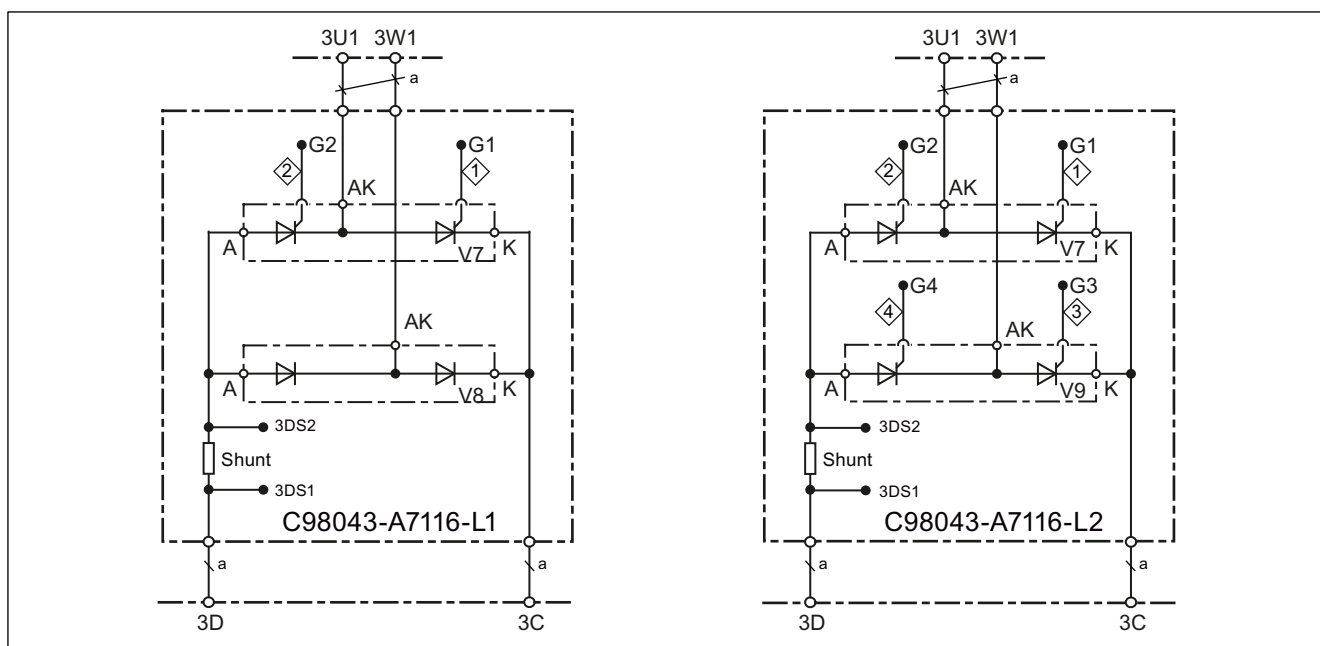
C98043-A7116-L1 = 1Q field

C98043-A7116-L2 = 2Q field (option)

Gate cables: Betatherm 145 0.5 mm^2, UL

Rated field DC current = 40 A:

Shunt = 2 mΩ; a = Betatherm 145 6 mm^2, UL

Rated field DC current = 85 A (option):

 Shunt = 1 mΩ; a = Betatherm 145 10 mm^2, UL

Figure 6-38   900 - 3,000 A units, 1Q/2Q field

6.6 Line reactors

Line reactors are obtained from Catalog LV60.

The line impedance, with line reactors factored in, should be between 4 and 10% of the short-circuit voltage.

Line inductances always need to be provided in the infeed in order to limit voltage dips and ensure that the SINAMICS DCM functions correctly. In the most straightforward situations this can be done by using a 4% line reactor.

The only situations in which a line reactor is not required are when the converter is supplied as the only load by means of a separate transformer winding (converter transformer adapted to the power level).

Where several converters are used on a transformer winding, line reactors must be used upstream of every converter.

6.7 Fuses

For technical data, project engineering data, and dimension drawings for Siemens fuses, please refer to Chapter 4 of the BETA Catalog.

In order to ensure UL-compliant protection of units, it is essential that you use UL-listed or UL-recognized fuses.

6.7.1 Fuses for the exciter circuit

Table 6- 4 Suggested fuses for the exciter circuit

Rated DC current for converter unit	Max. excitation current	Siemens fuse		Bussmann fuse FWP 700V ЯU	
A	A	Order number	A	Order number	A
15	3	5SD420	16	FWP-5B	5
30	5	5SD420	16	FWP-5B	5
60-125	10	5SD420	16	FWP-15B	15
210-280	15	5SD440	25	FWP-20B	20
400-600	25	5SD440	25	FWP-30B	30
710-850	30	5SD480	30	FWP-35B	35
900-3000	40	3NE1802-0 1)	40	FWP-50B	50
1500-3000 with option L85	85	3NE8021-1 1)	100	FWP-100B	100
1) UL-recognized					

6.7.2 Fuses for the armature circuit

2Q units: 400 V, 575 V, 690 V, 830 V, and 950 V

Table 6- 5 Phase fuses

Unit		3x Siemens ЯU phase fuses	
Order number	I/U [A/V]	Order number	I/U [A/V]
6RA8025-6DS22	60 / 400	3NE1817-0	50 / 690
6RA8025-6GS22	60 / 575	3NE1817-0	50 / 690
6RA8028-6DS22	90 / 400	3NE1820-0	80 / 690
6RA8031-6DS22	125 / 400	3NE1021-0	100 / 690
6RA8031-6GS22	125 / 575	3NE1021-0	100 / 690
6RA8075-6DS22	210 / 400	3NE3227	250 / 1000
6RA8075-6GS22	210 / 575	3NE3227	250 / 1000
6RA8078-6DS22	280 / 400	3NE3231	350 / 1000
6RA8081-6DS22	400 / 400	3NE3233	450 / 1000
6RA8081-6GS22	400 / 575	3NE3233	450 / 1000
6RA8085-6DS22	600 / 400	3NE3336	630 / 1000
6RA8085-6GS22	600 / 575	3NE3336	630 / 1000
6RA8087-6DS22	850 / 400	3NE3338-8	800 / 800
6RA8087-6GS22	800 / 575	3NE3338-8	800 / 800
6RA8086-6KS22	720 / 690	3NE3337-8	710 / 900

Table 6- 6   Arm fuses

Unit		Siemens ЯU arm fuses		
Order number	I/U [A/V]	Quantity	Order number	I/U [A/V]
6RA8091-6DS22	1200 / 400	6	3NE3338-8	800 / 800
6RA8090-6GS22	1100 / 575	6	3NE3338-8	800 / 800
6RA8090-6KS22	1000 / 690	6	3NE3337-8	710 / 900
6RA8088-6LS22	950 / 830	6	3NE3337-8	710 / 900
6RA8093-4DS22	1600 / 400	6	6RY1702-0BA02	1000 / 660
6RA8093-4GS22	1600 / 575	6	6RY1702-0BA02	1000 / 660
6RA8093-4KS22	1500 / 690	6	6RY1702-0BA03	1000 / 1000
6RA8093-4LS22	1500 / 830	6	6RY1702-0BA03	1000 / 1000
6RA8095-4DS22	2000 / 400	6	6RY1702-0BA01	1250 / 660
6RA8095-4GS22	2000 / 575	6	6RY1702-0BA01	1250 / 660
6RA8095-4KS22	2000 / 690	12	6RY1702-0BA04	630 / 1000
6RA8095-4LS22	1900 / 830	12	6RY1702-0BA04	630 / 1000
6RA8096-4GS22	2200 / 575	6	6RY1702-0BA05	1500 / 660
6RA8096-4MS22	2200 / 950	12	3NC3438-6	800 / 1100
6RA8097-4KS22	2600 / 690	12	3NC3341-6	1000 / 1000
6RA8097-4GS22	2800 / 575	12	3NC3341-6	1000 / 1000
6RA8098-4DS22	3000 / 400	12	3NC3341-6	1000 / 1000
The arm fuses are included in the unit. No external semiconductor fuses are required.				

2Q units: 480 V

Table 6- 7   Phase fuses

Unit		3x Siemens ЯU phase fuses		3x Bussmann ЯU phase fuses		3x Bussmann ЯU phase fuses	
Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]
6RA8025-6FS22	60 / 480	3NE1817-0	50 / 690	170M1565	63 / 660	FWH-60B	60 / 500
6RA8028-6FS22	90 / 480	3NE1820-0	80 / 690	170M1567	100 / 660	FWH-100B	100 / 500
6RA8031-6FS22	125 / 480	3NE1021-0	100 / 690	170M1568	125 / 660	FWH-125B	125 / 500
6RA8075-6FS22	210 / 480	3NE3227	250 / 1000	170M3166	250 / 660	FWH-225A	225 / 500
6RA8078-6FS22	280 / 480	3NE3231	350 / 1000	170M3167	315 / 660	FWH-275A	275 / 500
6RA8082-6FS22	450 / 480	3NE3233	450 / 1000	170M3170	450 / 660	FWH-450A	450 / 500
6RA8085-6FS22	600 / 480	3NE3336	630 / 1000	170M4167	700 / 660	FWH-600A	600 / 500
6RA8087-6FS22	850 / 480	3NE3338-8	800 / 800	170M5165	900 / 660	FWH-800A	800 / 500
FWH-... and FWP-... fuses are mechanically incompatible with 3NE... and 170M... fuses.							

Table 6- 8   Arm fuses

Unit		Siemens ЯU arm fuses		
Order number	I/U [A/V]	Quantity	Order number	I/U [A/V]
6RA8091-6FS22	1200 / 480	6	3NE3338-8	800 / 800
The arm fuses are included in the unit. No external semiconductor fuses are required.				

4Q units: 400 V, 575 V, 690 V, 830 V, and 950 V

Table 6- 9   Phase fuses, DC fuse

Unit		3x Siemens ЯU phase fuses		1x Siemens ЯU DC fuse	
Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]
6RA8013-6DV62	15 / 400	3NE1814-0	20 / 690	3NE1814-0	20 / 690
6RA8018-6DV62	30 / 400	3NE8003-1	35 / 690	3NE4102	40 / 1000
6RA8025-6DV62	60 / 400	3NE1817-0	50 / 690	3NE4120	80 / 1000
6RA8025-6GV62	60 / 575	3NE1817-0	50 / 690	3NE4120	80 / 1000
6RA8028-6DV62	90 / 400	3NE1820-0	80 / 690	3NE4122	125 / 1000
6RA8031-6DV62	125 / 400	3NE1021-0	100 / 690	3NE4124	160 / 1000
6RA8031-6GV62	125 / 575	3NE1021-0	100 / 690	3NE4124	160 / 1000
6RA8075-6DV62	210 / 400	3NE3227	250 / 1000	3NE3227	250 / 1000
6RA8075-6GV62	210 / 575	3NE3227	250 / 1000	3NE3227	250 / 1000
6RA8078-6DV62	280 / 400	3NE3231	350 / 1000	3NE3231	350 / 1000
6RA8081-6DV62	400 / 400	3NE3233	450 / 1000	3NE3233	450 / 1000
6RA8081-6GV62	400 / 575	3NE3233	450 / 1000	3NE3233	450 / 1000
6RA8085-6DV62	600 / 400	3NE3336	630 / 1000	3NE3336	630 / 1000
6RA8085-6GV62	600 / 575	3NE3336	630 / 1000	3NE3336	630 / 1000
6RA8087-6DV62	850 / 400	3NE3338-8	800 / 800	3NE3334-0B 1)	500 / 1000
6RA8087-6GV62	850 / 575	3NE3338-8	800 / 800	3NE3334-0B 1)	500 / 1000
6RA8086-6KV62	760 / 690	3NE3337-8	710 / 900	3NE3334-0B 1)	500 / 1000
1) Two fuses connected in parallel					

Table 6- 10   Arm fuses

Unit		Siemens ЯU arm fuses		
Order number	I/U [A/V]	Quantity	Order number	I/U [A/V]
6RA8091-6DV62	1200 / 400	6	3NE3338-8	800 / 800
6RA8090-6GV62	1100 / 575	6	3NE3338-8	800 / 800
6RA8090-6KV62	1000 / 690	6	3NE3337-8	710 / 900
6RA8088-6LV62	950 / 830	6	3NE3337-8	710 / 900
6RA8093-4DV62	1600 / 400	6	6RY1702-0BA02	1000 / 660
6RA8093-4GV62	1600 / 575	6	6RY1702-0BA02	1000 / 660
6RA8093-4KV62	1500 / 690	6	6RY1702-0BA03	1000 / 1000
6RA8093-4LV62	1500 / 830	6	6RY1702-0BA03	1000 / 1000
6RA8095-4DV62	2000 / 400	6	6RY1702-0BA01	1250 / 660
6RA8095-4GV62	2000 / 575	6	6RY1702-0BA01	1250 / 660
6RA8095-4KV62	2000 / 690	12	6RY1702-0BA04	630 / 1000
6RA8095-4LV62	1900 / 830	12	6RY1702-0BA04	630 / 1000
6RA8096-4GV62	2200 / 575	6	6RY1702-0BA05	1500 / 660
6RA8096-4MV62	2200 / 950	12	3NC3438-6	800 / 1100
6RA8097-4KV62	2600 / 690	12	3NC3341-6	1000 / 1000
6RA8097-4GV62	2800 / 575	12	3NC3341-6	1000 / 1000
6RA8098-4DV62	3000 / 400	12	3NC3341-6	1000 / 1000
The arm fuses are included in the unit. No external semiconductor fuses are required.				

4Q units: 480 V

Table 6- 11   Phase fuses

Unit		3x Siemens ЯU phase fuses		3x Bussmann ЯU phase fuses		3x Bussmann ЯU phase fuses	
Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]
6RA8013-6FV62	15 / 480	3NE1814-0	20 / 690	170M1562	32 / 660	FWH-35B	35 / 500
6RA8018-6FV62	30 / 480	3NE1815-0	25 / 690	170M1562	32 / 660	FWH-35B	35 / 500
6RA8025-6FV62	60 / 480	3NE1817-0	50 / 690	170M1565	63 / 660	FWH-60B	60 / 500
6RA8028-6FV62	90 / 480	3NE1820-0	80 / 690	170M1567	100 / 660	FWH-100B	100 / 500
6RA8031-6FV62	125 / 480	3NE1021-0	100 / 690	170M1568	125 / 660	FWH-125B	125 / 500
6RA8075-6FV62	210 / 480	3NE3227	250 / 1000	170M3166	250 / 660	FWH-225A	225 / 500
6RA8078-6FV62	280 / 480	3NE3231	350 / 1000	170M3167	315 / 660	FWH-275A	275 / 500
6RA8082-6FV62	450 / 480	3NE3233	450 / 1000	170M3170	450 / 660	FWH-450A	450 / 500
6RA8085-6FV62	600 / 480	3NE3336	630 / 1000	170M4167	700 / 660	FWH-600A	600 / 500
6RA8087-6FV62	850 / 480	3NE3338-8	800 / 800	170M5165	900 / 660	FWH-800A	800 / 500

Table 6- 12   DC fuse

Unit		1x Siemens ЯU DC fuse		1x Bussmann ЯU DC fuse	
Order number	I/U [A/V]	Order number	I/U [A/V]	Order number	I/U [A/V]
6RA8013-6FV62	15 / 480	3NE1814-0	20 / 690	FWP-35B	35 / 660
6RA8018-6FV62	30 / 480	3NE4102	40 / 1000	FWP-35B	35 / 660
6RA8025-6FV62	60 / 480	3NE4120	80 / 1000	FWP-70B	70 / 660
6RA8028-6FV62	90 / 480	3NE4122	125 / 1000	FWP-125A	125 / 660
6RA8031-6FV62	125 / 480	3NE4124	160 / 1000	FWP-150A	150 / 660
6RA8075-6FV62	210 / 480	3NE3227	250 / 1000	FWP-250A	250 / 660
6RA8078-6FV62	280 / 480	3NE3231	350 / 1000	FWP-350A	350 / 660
6RA8082-6FV62	450 / 480	3NE3334-0B	500 / 1000	FWP-500A	500 / 660
6RA8085-6FV62	600 / 480	3NE3336	630 / 1000	FWP-700A	700 / 660
6RA8087-6FV62	850 / 480	3NE3334-0B 1)	500 / 1000	FWP-1000A	1000 / 660
1) Two fuses connected in parallel					
FWH-... and FWP-... fuses are mechanically incompatible with 3NE... and 170M... fuses.					

Table 6- 13   Arm fuses

Unit		Siemens ЯU arm fuses		
Order number	I/U [A/V]	Quantity	Order number	I/U [A/V]
6RA8091-6FV62	1200 / 480	6	3NE3338-8	800 / 800
The arm fuses are included in the unit. No external semiconductor fuses are required.				

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6.7.3 Fuses in the Power Interface

Only UL-listed or UL-recognized fuses may be used in UL-listed units.

Table 6- 14   Power Interface C98043-A7105 and C98043-A7106: Fuses F200 and F201

Manufacturer	Type	Data	Dimensions	Order designation	UL
Littlefuse	239	1 A/250 V, time-lag	5 x 20 mm	239 001, MXP	✓
Schurter	FST	1 A/250 V, time-lag	5 x 20 mm	0034.3117	✓

With option L05

(Units with Power Interface C98043-A7107/A7108, F200 fuse):

T 6.3 A / 250 V 5×20 mm (Slow-Acting Fuse)
e.g. Wickmann 193, Littlefuse 217P Series

6.8 Arrangement of terminals and connectors

Module C98043-A7100 - Control Unit (CUD)

C98043-A7100-L1 = Standard CUD
C98043-A7100-L2 = Advanced CUD
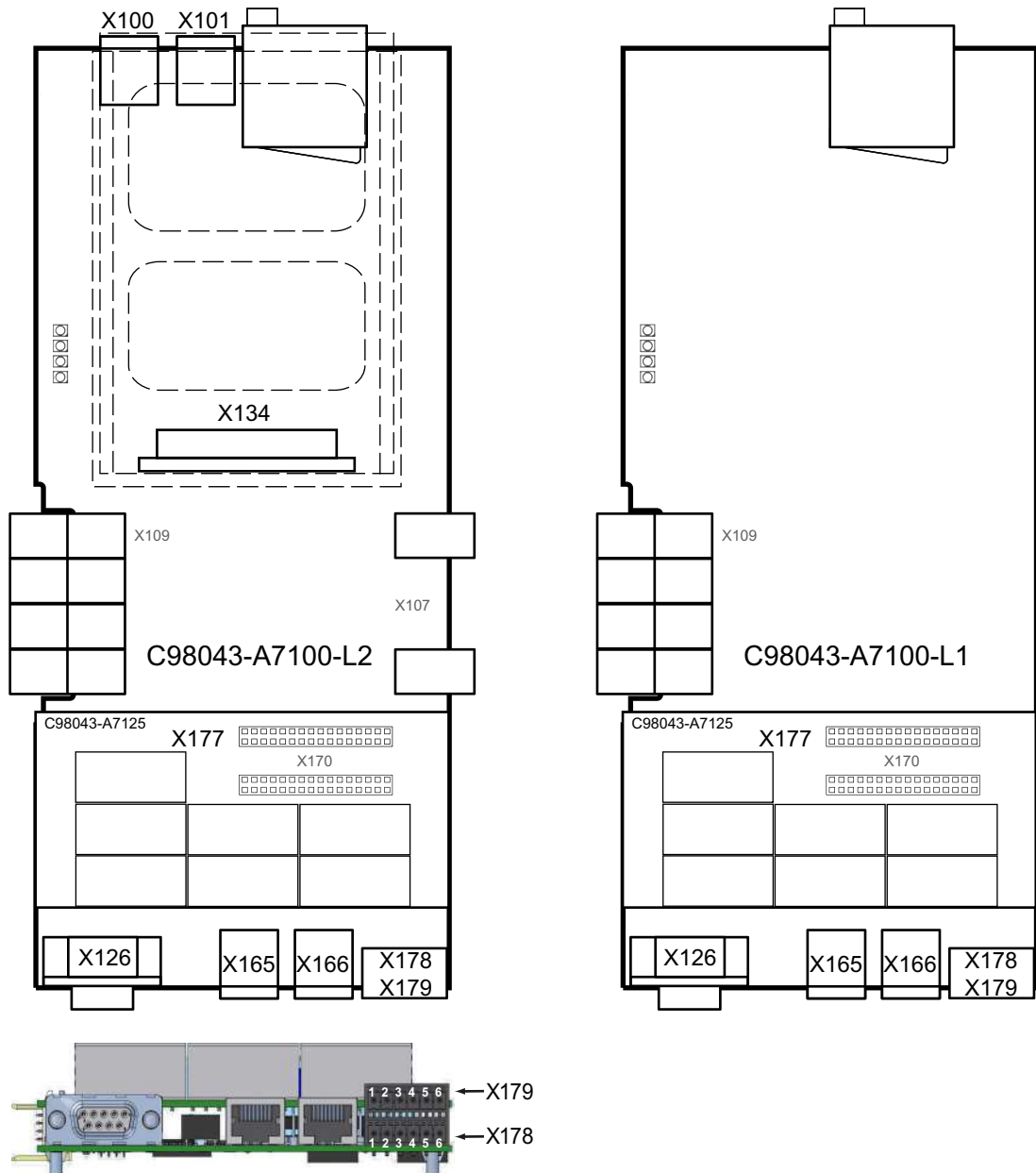(shown with connector board C98043-A7125 installed)

Figure 6-39   A7100 terminal/connector arrangement

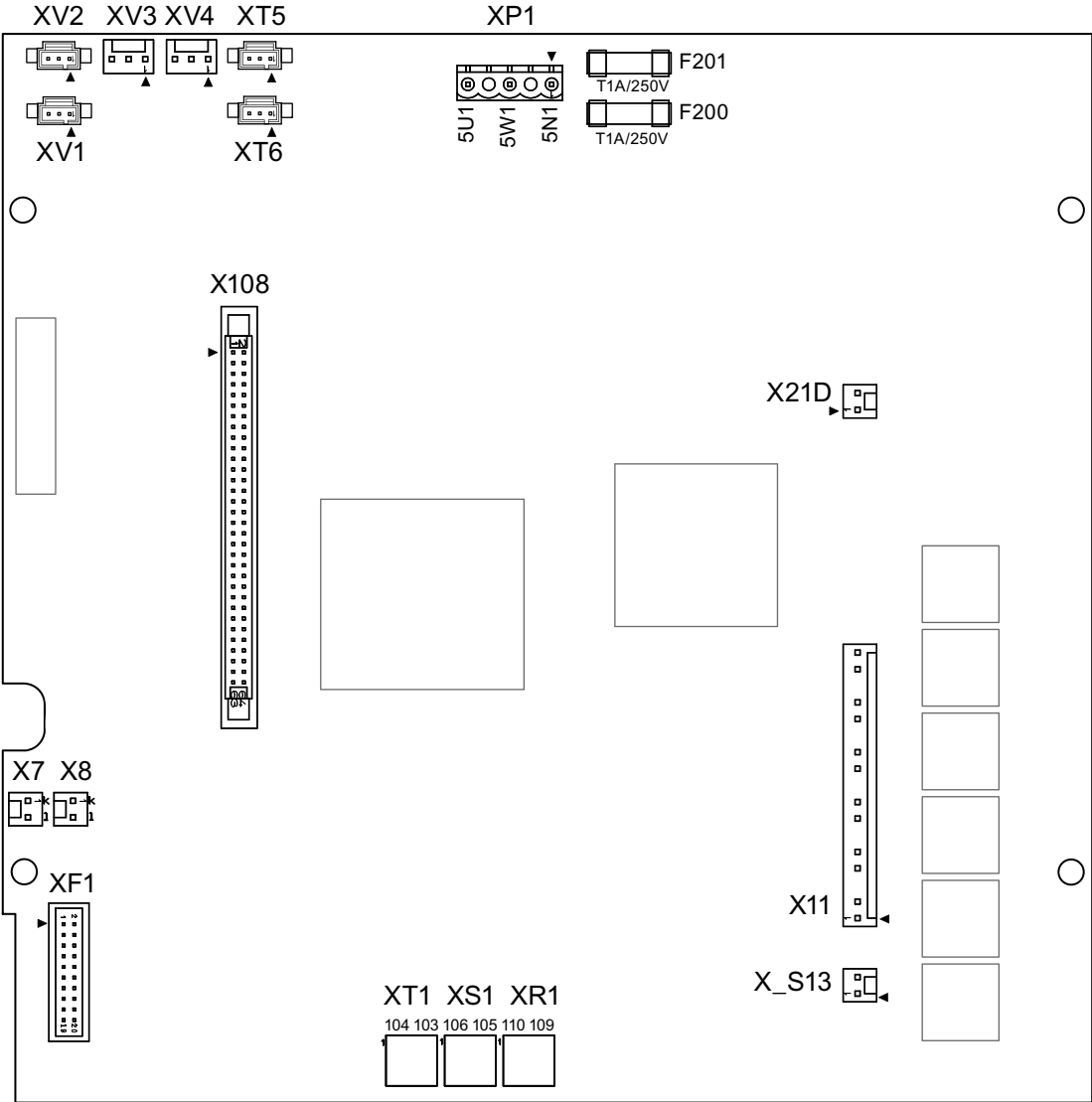**Module C98043-A7105 - Power Interface for 2Q units, 400 - 600 V**

Figure 6-40   A7105, 2Q terminal/connector arrangement

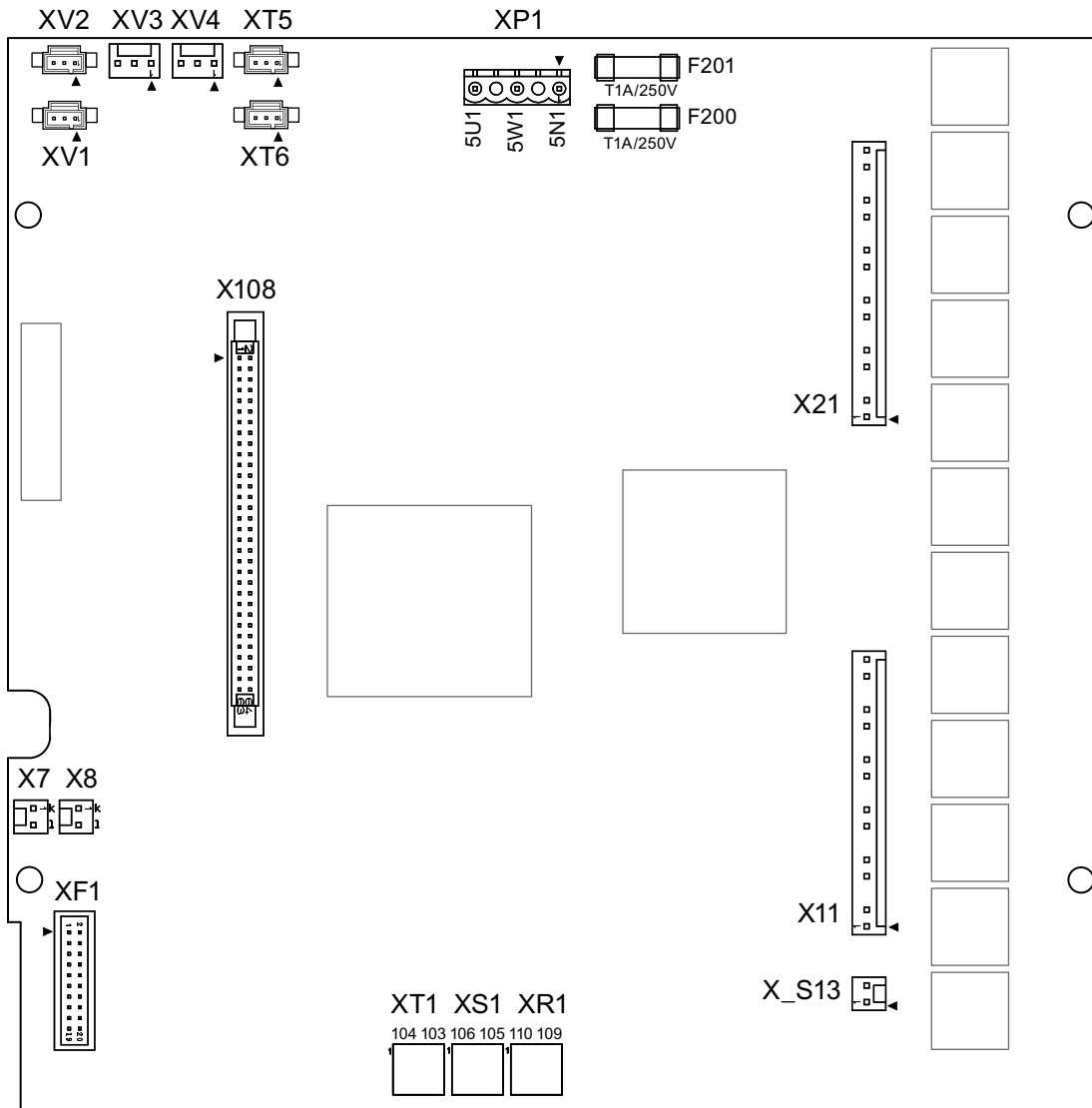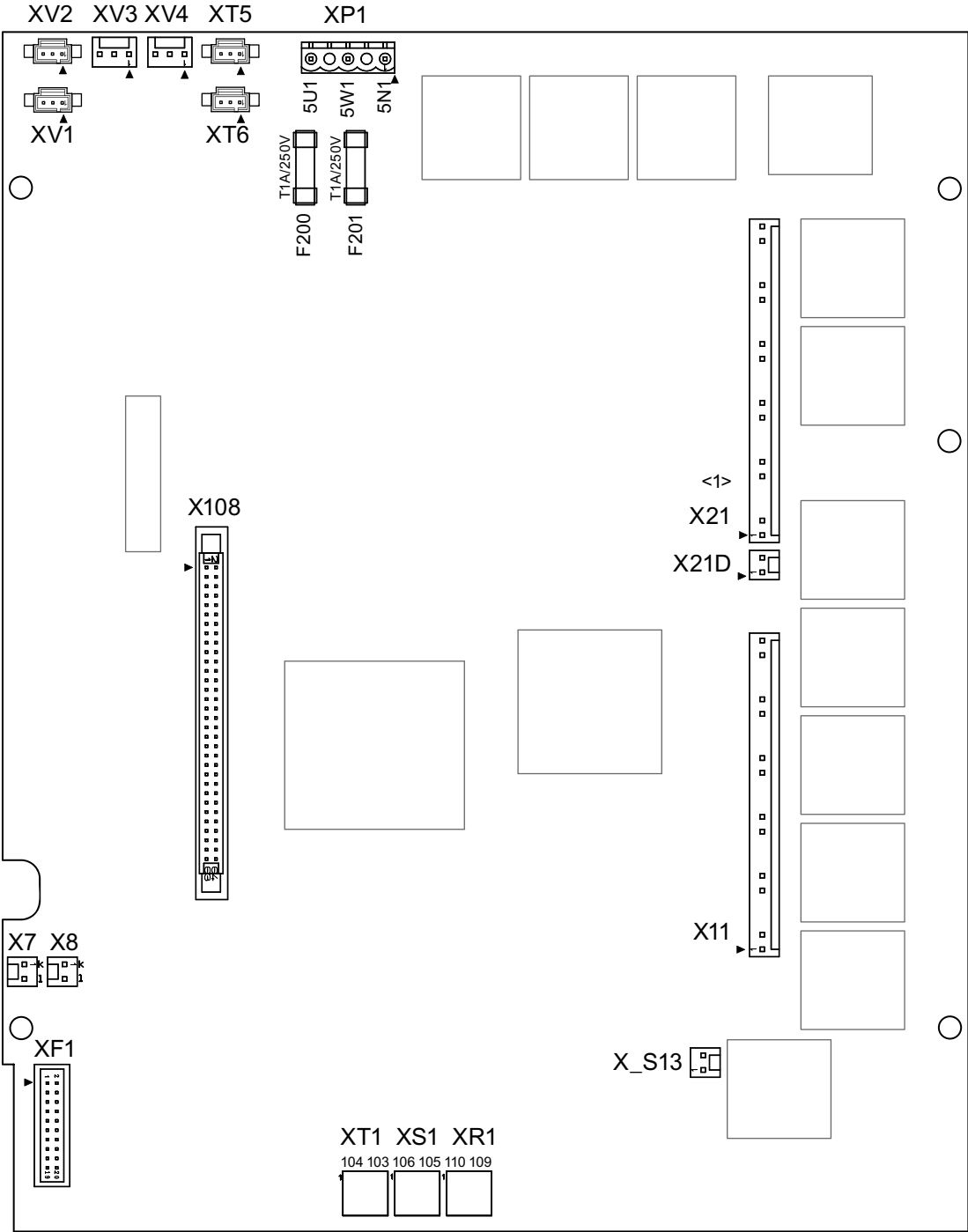**Module C98043-A7105 - Power Interface for 4Q units, 400 - 600 V**

Figure 6-41   A7105, 4Q terminal/connector arrangement

Module C98043-A7106 - Power Interface 690 - 950 V

<1> Connector X21 not fitted on 2Q units
Connector X21D not fitted on 4Q units

Figure 6-42   A7106 terminal/connector arrangement

Module C98043-A7107 - Power Interface for 2Q units 400 V - 600 V for option L05 (Electronic power supply for connection to DC 24 V)
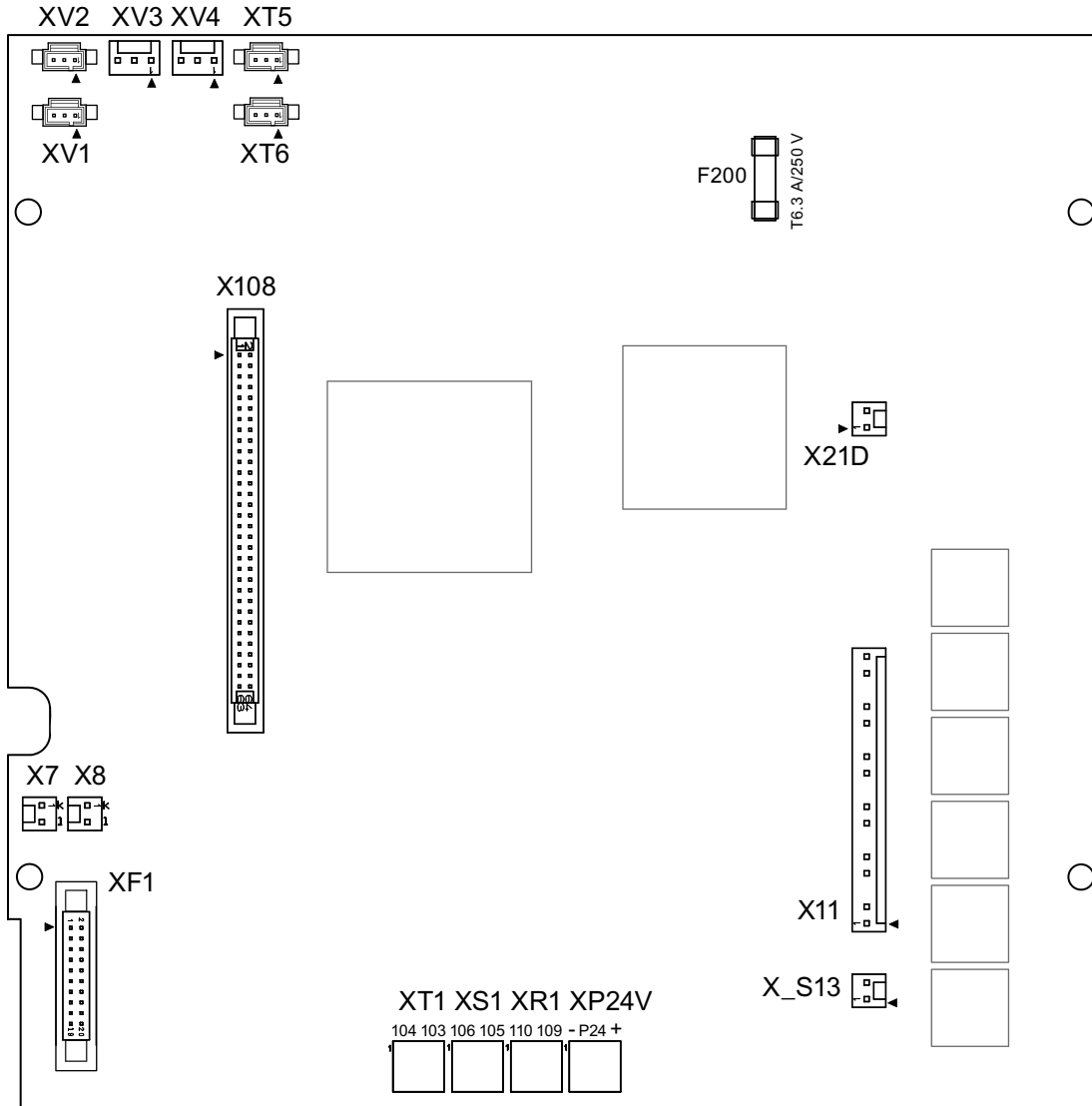

Figure 6-43   A7107, 2Q terminal/connector arrangement

**Module C98043-A7107 - Power Interface for 4Q units 400 V - 600 V
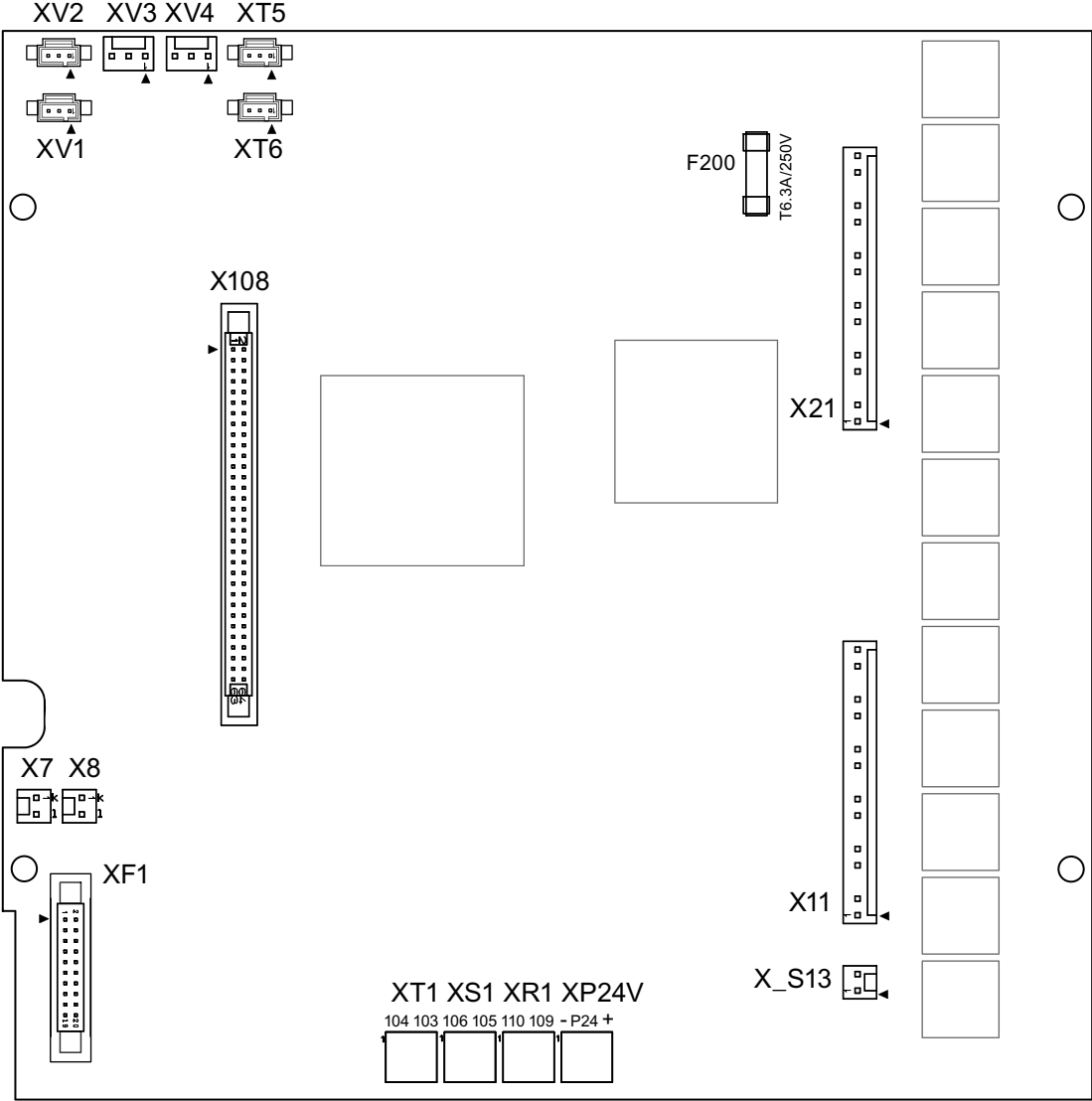for option L05 (Electronic power supply for connection to DC 24 V)**

Figure 6-44   A7107, 4Q terminal/connector arrangement

Module C98043-A7108 - Power Interface 690 V - 950 V
for option L05 (Electronic power supply for connection to DC 24 V)

XV2 XV3 XV4 XT5

XV1 XT6

T6.3 A/250 V

F200

X108

<1>

X21

X21D

X11

X7 X8

XF1

X_S13

XT1 XS1 XR1 XP24V

104 103 106 105 110 109 - P24 +
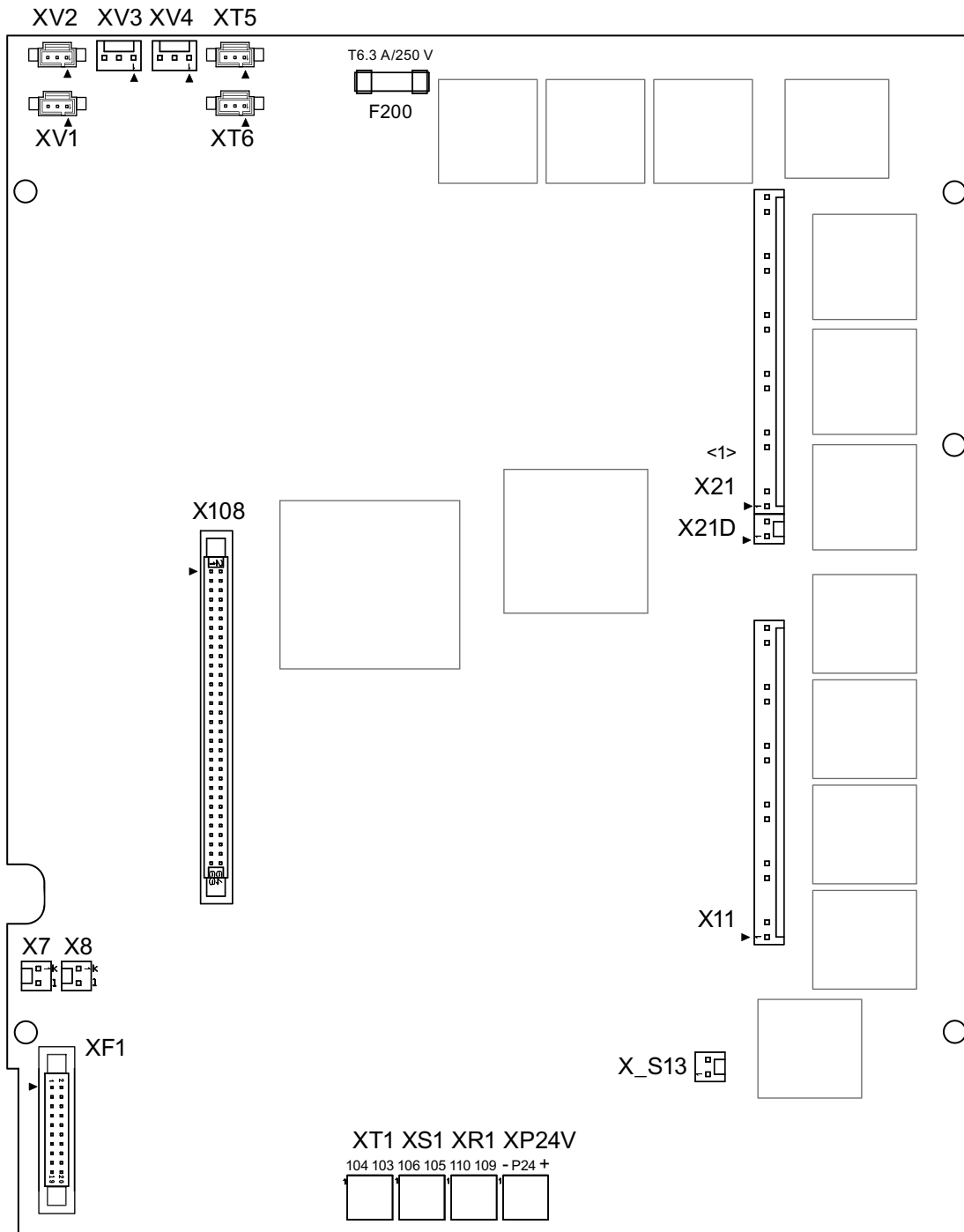
<1>   Connector X21 not fitted on 2Q units
        Connector X21D not fitted on 4Q units

Figure 6-45   A7108 terminal/connector arrangement

Module C98043-A7111 - 15/30 A power unit

Figure 6-46   A7111 terminal/connector arrangement

Module C98043-A7115 - 10 to 30 A field module
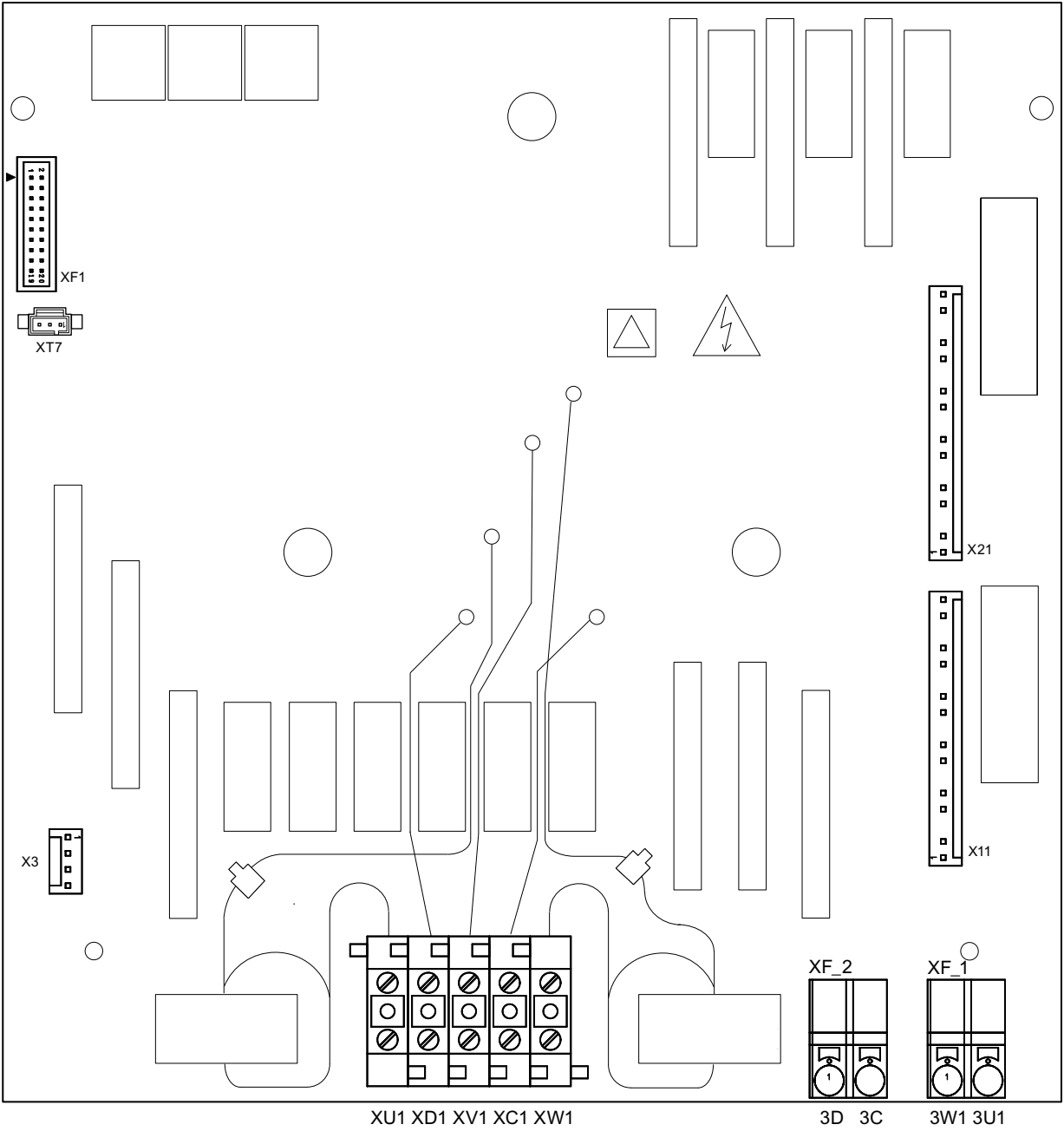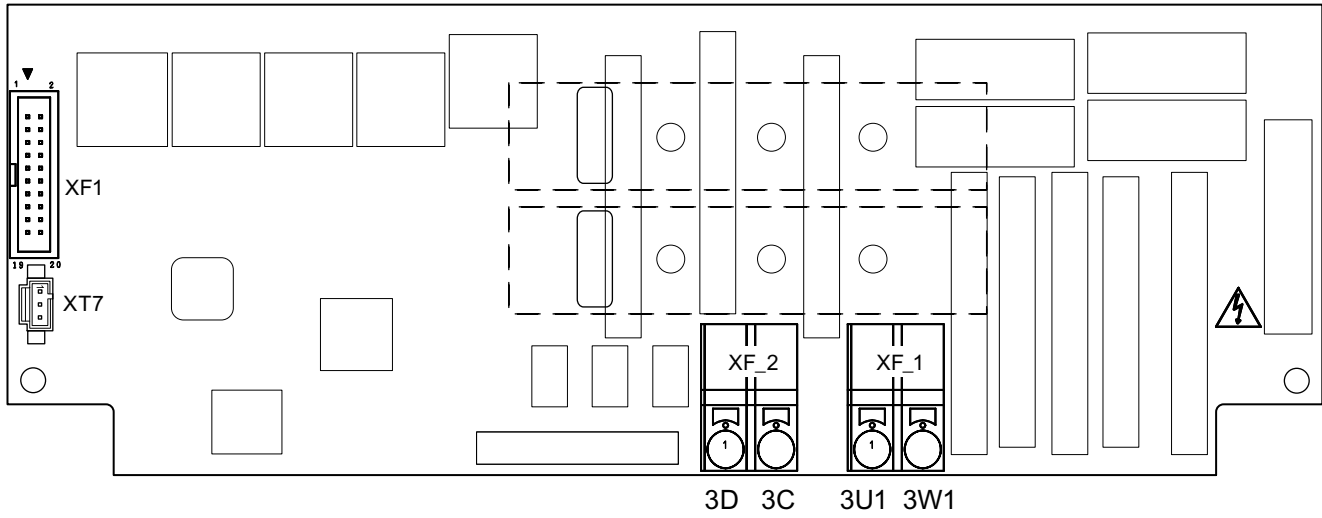

Figure 6-47   A7115 terminal/connector arrangement
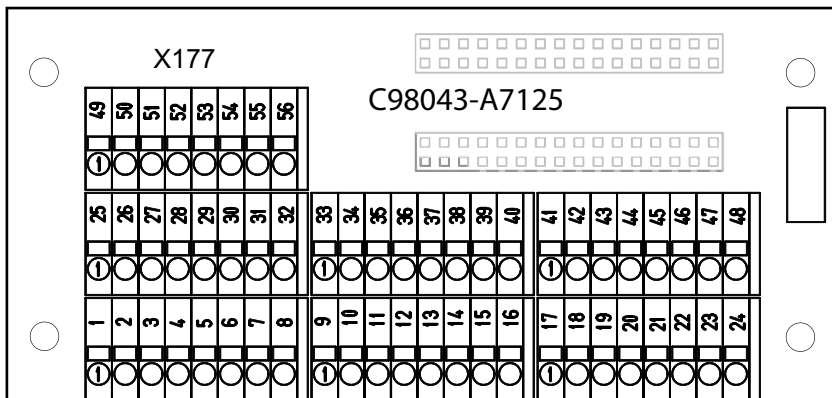
Module C98043-A7125 - connector board

Figure 6-48   A7125 terminal/connector arrangement

6.9 Assignment of terminals and connectors

⚠ WARNING
Connecting the unit incorrectly can lead to damage or destruction.   Power cables and busbars must be mechanically fastened in place outside of the unit.

CAUTION
The information regarding the connection capability of the terminals in the tables below is based on values from the terminal data sheets. The connecting cables must be dimensioned for the currents that will flow.

Overview

Table 6- 15   Terminals and connectors overview

1U1, 1V1, 1W1, 1C1, 1D1	Power unit
3U1, 3W1, 3C, 3D	Exciter circuit
4U1, 4V1, 4W1, 4N1	Fan
5U1, 5W1, 5N1	Units with Power Interface C98043-A7105/A7106: Electronics power supply
XP24V	Units with Power Interface C98043-A7107/A7108 (option L05) Electronics power supply
X100, X101	DRIVE-CLiQ
X126	PROFIBUS
X165, X166	Parallel interface
X177	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
XR1	Relay output for line contactor (up to 240 V)
XS1	Safety shutdown E-STOP
XT1	Analog tachometer

6.9.1   Power unit

Table 6- 16   Connection system for the power connections 1U1, 1V1, 1W1, 1C1, 1D1

Units	permissible connection type	
	Connections 1U1, 1V1, 1W1	**Connections 1C1, 1D1**
60 A - 850 A	Cable, busbars	Cable, busbars
900 A - 1200 A	Cable, busbars	Busbars
1500 A - 2000 A	Cable, busbars	Cable, busbars
2200 A - 3000 A	Busbars	Busbars
Handling the contact surfaces of busbar connections: All contact surfaces must be clean and may not be damaged. • Busbars manufactured out of Cu, Al, Al-Mg-Si: The contact surfaces should be bare metal (e.g. use a file brush, abrasive stone). Use separate brushes for Cu and Al, mark appropriately Immediately apply acid-free Vaseline (for example, Shell 8422) to aluminum busbars. Apply the appropriate grease to the contact points of the Al busbars approx. 10 mm beyond the contact surface. Do not apply grease to copper busbars. • Nickel-plated copper busbars: Wipe the contact surfaces with a clean, dry cloth If the nickel-plated surfaces are slightly oxidized, then remove these oxide layers before bolting. It is not permissible to use a steel brushes or similar.		
Note: The clearances required between the power connections (12.7 mm / 1/2 ") must not be fallen below. Otherwise, insulating elements must be inserted.		

Table 6- 17   Terminal type, power connections for 15 A and 30 A units

Type	KDS 10 PC board terminal
Connection capacity	Rigid/flexible/conductor sizes (mm²/mm²/AWG): 0.5-16 / 0.5-10 / 20-6 Flexible with end sleeve with/without plastic sleeve: 0.5-10/0.5-10 mm²
Stripped length	12 mm
Tightening torque	1.2 - 1.5 Nm

Table 6- 18   Terminal type, power connections for units of 60 A and above

Units	Data
60 - 210 A	1U1, 1V1, 1W1: 3x20 mm aluminum busbar, through hole for M8 1C1, 1D1: 5x20 mm aluminum busbar, through hole for M8
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1, 1C1, 1D1: 2×95 mm²
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 13 Nm Tightening torque for protective conductor: 25 Nm
280 A	1U1, 1V1, 1W1: 3x20 mm copper busbar, through hole for M8 1C1, 1D1: 5x20 mm copper busbar, through hole for M8
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1, 1C1, 1D1: 2×95 mm²
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 13 Nm Tightening torque for protective conductor: 25 Nm

Units	Data
400 - 450 A	1U1, 1V1, 1W1: 5x30 mm aluminum busbar, through hole for M10 1C1, 1D1: 5x35 mm aluminum busbar, through hole for M10
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1: 2×150 mm^2 1C1, 1D1: 2×185 mm^2
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 25 Nm Tightening torque for protective conductor: 50 Nm
600 A	1U1, 1V1, 1W1: 5x30 mm copper busbar, through hole for M10 1C1, 1D1: 5x35 mm copper busbar, through hole for M10
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1: 2×150 mm^2 1C1, 1D1: 2×185 mm^2
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 25 Nm Tightening torque for protective conductor: 50 Nm
720 - 850 A	1U1, 1V1, 1W1, 1C1, 1D1: 5x60 mm copper busbar, through hole for M12
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1, 1C1, 1D1: 4×150 mm^2
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 44 Nm Tightening torque for protective conductor: 50 Nm
900 A - 1200 A	1U1, 1V1, 1W1, 1C1, 1D1: 6x80 mm copper busbar, through hole for M12
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1, 1C1, 1D1: 4×150 mm^2
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 44 Nm Tightening torque for protective conductor: 60 Nm
1500 A - 2000 A	1U1, 1V1, 1W1: 10x120 mm aluminum busbar, through hole for M12 1C1, 1D1: Aluminum busbar, cross-section 60 x 10 mm / 323 mm wide, through hole for M12
	Max. conductor cross-section for cables with cable lug in acc. with DIN 46234: 1U1, 1V1, 1W1: 4×240 mm^2 1C1, 1D1: 8×240 mm^2
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 44 Nm Tightening torque for protective conductor: 60 Nm
2200 A - 3000 A	1U1, 1V1, 1W1: 10x120 mm copper busbar, through hole for M12 1C1, 1D1: Copper busbar, cross-section 60 x 10 mm / 323 mm wide, through hole for M12
	Tightening torque for 1U1, 1V1, 1W1, 1C1, 1D1: 44 Nm Tightening torque for protective conductor: 60 Nm
See the dimension drawings in Chapter 5 for how the protective conductor can be connected. 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 housing. Before connecting the protective conductor, this must be removed from the connection points.	

The units are designed for a permanent line supply connection in accordance with EN 61800-5-1.

The conductor cross-sections (also for the protective conductor) must be determined in accordance with the applicable regulations that apply in each case – e.g. EN 60204-1.

Table 6- 19   Assignment of power connections

Terminal	Function	Technical specifications
1U1 1V1 1W1	Armature power input	See technical data, Chapter 4
⏚	Protective conductor PE	
1C1 (1D1) 1D1 (1C1)	Armature circuit for motor connection	

6.9.2   Exciter circuit

Table 6- 20   Terminal type, connections for the exciter circuit

Units with power unit C98043-A7111 (15 A and 30 A units) and units with field module C98043-A7115 (the terminals are located on the module):	
Type	ZFKDS 4-10 PC board terminal
Connection capacity	Rigid/flexible/conductor sizes (mm^2/mm^2/AWG): 0.2-6 / 0.2-4 / 24-10 Flexible with end sleeve without/with plastic sleeve: 0.25-4/0.25-4 mm^2
Stripped length	10 mm
Units with field module C98043-A7116 with rated armature DC current = 900 - 1,200 A:	
Type	20E/4DS terminal strip
Connection capacity	Rigid/flexible (mm^2/mm^2): 6-16 / 6-10
Stripped length	8 mm
Units with field module C98043-A7116 with rated armature DC current = 1,500 - 3,000 A:	
Type	UK16N terminal block
Connection capacity	Rigid/conductor sizes (mm^2/AWG): 2.5-25 / 14-4 Flexible/conductor sizes (mm^2/AWG): 4-16 / 12-6
Stripped length	11 mm
Tightening torque	1.5 - 1.8 Nm
Units with option L85 (with rated field DC current = 85 A):	
Type	UK35 terminal block
Connection capacity	Rigid/flexible/conductor sizes (mm2/mm2/AWG): 0.75-50 / 0.75-35 / 18-0/1 Flexible with end sleeve without/with plastic sleeve: 0.75-35/0.75-35 mm^2
Stripped length	16 mm
Tightening torque	3.2 - 3.7 Nm

Table 6- 21   Assignment of connections for the exciter circuit

Terminal	Function	Technical data
XF1: 3U1, 3W1	Line supply connection	2-ph. 400 V AC (– 20 %), 2-ph. 480 V AC (+10 %)
XF2-1: 3D XF2-2: 3C	Field winding connection	325 V / 373 V rated DC voltage with 2-ph. 400 V / 480 V AC line supply connection

6.9.3 Electronics power supply

Table 6- 22   Terminal type, electronics power supply

Type	MSTB 2.5/CIF plug-in terminal
Connection capacity	Rigid/flexible/conductor sizes (mm²/mm²/AWG): 0.2-2.5 / 0.2-2.5 / 24-12 Flexible with end sleeve without/with plastic sleeve: 0.25-2.5/0.25-2.5 mm²
	Multi-conductor connection (2 conductors of the same type and with same cross-section): Rigid/flexible: 0.2-1 / 0.2-1.5 Flexible with end sleeve without/with plastic sleeve: 0.25-1/0.5-1.5 mm²
Stripped length	7 mm
Tightening torque	0.5 - 0.6 Nm

Table 6- 23   Assignment of terminals for the electronics power supply

Terminal XP1	Connection	Function	Technical data
5U1 5W1 5N1	NC	400 V infeed	2-ph. 380 V AC (– 25 %) to 480 V (+10 %); In=1 A (– 35 % for 1 min.) Internal protection with F200, F201 on module C98043-A7105 or -A7106 External protection max. 6 A, characteristic C recommended
or			
5U1 5W1 5N1		230 V infeed	1-ph. 190 V AC (– 25 %) to 240 V (+10 %); In=2 A (– 35 % for 1 min.) Internal protection with F200, F201 on module C98043-A7105 or -A7106 External protection max. 6 A, characteristic C recommended
Module C98043-A7105, Power Interface 400 - 600 V or C98043-A7106, Power Interface 690 - 950 V			

Note

In the case of line voltages that fall outside the tolerance range specified in Chapter 4, the electronic supply voltage, exciter circuit line supply connection, and unit fan connection must be adapted using transformers in order to comply with the value indicated as permissible by Chapter 4. It is absolutely essential that you use an isolation transformer for rated line voltages above 480 V for safe electrical isolation.

The rated supply voltage for the armature circuit (index 0) and for the field circuit (index 1) must be set at p50078.

With option L05

Table 6- 24   Terminal type, electronics power supply

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
	Flexible with end sleeve 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

Table 6- 25   Assignment of terminals for the electronics power supply

Terminal XP24V	Function	Technical specifications
+ -	24 V infeed	18 V to 30 V DC; current consumption 1 A ... 5 A Recommended conductor cross-section 1.5 mm^2 Internal protection with F200 fuses (6.3 A, time-lag), External protection 6 A ... 16 A, B or C characteristic
Module C98043-A7107, Power Interface 400 - 600 V or C98043-A7108, Power Interface 690 - 950 V		

6.9.4   Fan

Table 6- 26   Terminal type, fan connections for units ≥ 400 A with forced ventilation

Type	DFK-PC4 plug-in terminal
Connection capacity	Rigid/flexible/conductor sizes (mm^2/mm^2/AWG): 0.2-4 / 0.2-4 / 24-10

The connecting leads must be insulated up to the point where they meet the terminal enclosure.

Table 6- 27   Terminal assignment for fan connection

Terminal	Function	Technical data
4U1 4V1 4W1	400 to 460 V infeed	3-ph. 400 V to 460 V AC For additional data, refer to the technical data in Chapter 4.
⏚	Protective conductor PE	
or		
4U1 4N1	230 V infeed	1-ph. 230 V AC For additional data, refer to the technical data in Chapter 4.
⏚	Protective conductor PE	

> ⚠️ **WARNING**
>
> An incorrect phase sequence (fan rotates the wrong way) may create a risk of the unit overheating.
>
> To test this, check whether, looking from above, the fan is rotating in a counterclockwise direction (i.e. to the left).
>
> Notice: Risk of injury due to rotating parts.

6.9.5 Open-loop and closed-loop control section

Table 6- 28   Terminal type, open-loop and closed-loop control section

X177:	
Type	SPT 1.5 spring-loaded terminal
Connection capacity	Rigid/flexible/conductor sizes (mm^2/mm^2/AWG): 0.2-1.5/0.2-1.5/24-16 Flexible with end sleeve without/with plastic sleeve: 0.25-1.5/0.25-0.75 mm^2 (stripped length 8 mm)
Stripped length	10 mm
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 Flexible with end sleeve without/with 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 Flexible with end sleeve without/with 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)

Terminals on connector board C98043-A7125

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

Table 6- 29   Assignment, terminal X177

Terminal X177	Function		Technical specifications
Analog inputs (assignable inputs)			
1 2	AI 3 + AI 3 -	Analog input 3	Input type (signal type): Differential input ±10 V; 150 kΩ Resolution approx. 5.4 mV (±11 bits) Common-mode controllability: ±15 V
3 4	AI 4 + AI 4 -	Analog input 4	
5 6	AI 5 + AI 5 -	Analog input 5	
7 8	AI 6 + AI 6 -	Analog input 6	
Digital inputs (assignable inputs)			
9 10	24 V DC	24 V supply (output)	24 VDC, short-circuit proof Max. load 200 mA (terminals 9 and 10 together), internal supply related to internal ground terminal
11	DI 0	Digital input 0	H signal: +15 to +30 V L signal: – 30 to +5 V or terminal open 8.5 mA at 24 V
12	DI 1	Digital input 1	
13	DI 2	Digital input 2	
14	DI 3	Digital input 3	
Digital inputs/outputs (assignable inputs/outputs)			
15	DI/ DO 4	Digital input /output 4	Type, input/output parameterizable Features of inputs: H signal: +15 to +30 V L signal: 0 V to +5 V or terminal open 8.5 mA at 24 V
16	DI/ DO 5	Digital input /output 5	
17	DI/ DO 6	Digital input /output 6	Features of outputs: H signal: +20 V to +26 V L signal: 0 to +2 V
18	DI/ DO 7	Digital input /output 7	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 internal protection circuit (freewheeling diode) If overload occurs: alarm A60018
19	DO 0	Digital output 0	H signal: +20 V to +26 V L signal: 0 to +2 V short-circuit proof; max. current carrying capacity: 100 mA per DO; max. total load of all DO (CUD left X177:15-22 + CUD right X177:15-22): 800 mA internal protection circuit (freewheeling diode) If overload occurs: alarm A60018
20	DO 1	Digital output 1	
21	DO 2	Digital output 2	
22	DO 3	Digital output 3	
23, 24	M	Ground, digital	
Analog inputs, setpoint inputs (assignable inputs)			
25 26	AI 0 + AI 0 -	Analog input 0 Main setpoint	Input type (signal type), parameterizable: - Differential input ±10 V; 150 kΩ

Terminal X177	Function		Technical specifications
27 28	AI 1 + AI 1 -	Analog input 1	- Current input 0 - 20 mA; 300 Ω or 4 - 20 mA; 300 Ω Resolution approx. 0.66 mV (±14 bits) Common-mode controllability: ±15 V
29 30	AI 2 + AI 2 -	Analog input 2	Input type (signal type): - Differential input ±10 V; 150 kΩ Resolution approx. 0.66 mV (±14 bits) Common-mode controllability: ±15 V Note: 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 32	P10 N10	Reference voltage ±10 V (output)	Tolerance ±1% at 25 °C Stability 0.1% per 10 °K 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) If overload occurs: alarm A60018
42		Incremental encoder ground	
43		Track 1 positive connection	Load: ≤ 5.25 mA at 15 V (without switching losses) Pulse duty factor: 1:1 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	
Connections for temperature sensor (motor interface 1)			
53		Temp 1	Sensor acc. to p50490 (refer to SINAMICS DCM List Manual
54		Temp 2 (sense cable)	The cable to the temperature sensor on the motor must be shielded

Terminal X177	Function		Technical specifications
55	Temp 3		and connected to ground at both ends. The cables for the Temp 1 and Temp 3 connections to the temperature sensor must be approximately the same length. The sense 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. Connection with/without sense cable:
56	M	Ground, analog	
Module C98043-A7125 (connector board)			

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 the section titled "Additional system components").

CAUTION

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:

160

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:

$$LG = \pm (90° - f_p \times T_{min} \times 360°)$$

LG = Phase error
fp = Pulse frequency
Tmin = Minimum edge distance

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").

Terminals at the Power Interface (analog tachometer, E-STOP, relay for line contactor)

Table 6- 30   Terminals XR1, XS1, XT1

Terminal	Function	Technical specifications
Analog tachometer		
XT1-103	Tachometer connection 8 to 270 V	±270 V Input resistance 159 kΩ Resolution ±14 bits
XT1-104	Ground, analog M	
Safety shutdown E-STOP		
XS1-105	Input (switch)	Ie = 20 mA
XS1-106	Supply (output)	24 V DC, max. load 50 mA, short-circuit proof
Potential-free relay output		
XR1-109 XR1-110	Relay for line contactor	Current carrying capacity: ≤ 250 V AC, 4 A; cosφ = 1 ≤ 250 V AC, 2 A; cosφ = 0.4 ≤ 30 V DC, 2 A External protection: max. 4 A, characteristic C recommended Units that have option L05 (with Power Interface A98043-A7107/A7108) require external protection with max. 6.3 A.
Module C98043-A7105/A7107, Power Interface 400 - 600 V or C98043-A7106/A7108 , Power Interface 690 - 950 V		

Serial interface to AOP30/USS interface

Table 6- 31   Terminal X178

Terminal X178	Function	Technical data
1	Supply (output)	24 VDC short-circuit proof, maximum load 200 mA Internal supply related to internal ground terminal
2	Ground, AOP M	
3	RX+/TX+	Send and receive cable, RS485, two-wire Positive differential input/output
4	RX-/TX-	Send and receive cable, RS485, two-wire Negative differential input/output
5	Ground, digital M	
6	Ground, digital M	
Module C98043-A7100-L1/L2, Standard/Advanced CUD		

Table 6- 32   Terminal X179

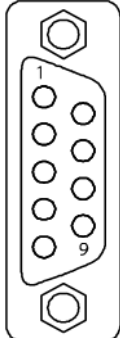| Terminal X179	Function	Technical data
1	Supply (output)	4.4 to 5.4 VDC short-circuit proof, maximum load 300 mA Internal supply related to internal ground terminal
2	Ground, digital M	
3	TXD1	Send cable, RS232 standard (V.24)
4	RXD1	Receive cable, RS232 standard (V.24)
5	TXD2	Send cable, RS232 standard (V.24)
6	RXD2	Receive cable, RS232 standard (V.24)
Module C98043-A7100-L1/L2, Standard/Advanced CUD		

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

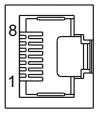Figure 6-49   Arrangement X178 and X179

PROFIBUS connection

Table 6- 33   PROFIBUS connector assignment

Connector X126	Pin	Signal name	Technical data
	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
Module C98043-A7100-L1/L2, Standard/Advanced CUD			

DRIVE-CLiQ

Table 6- 34   DRIVE-CLiQ connector assignment

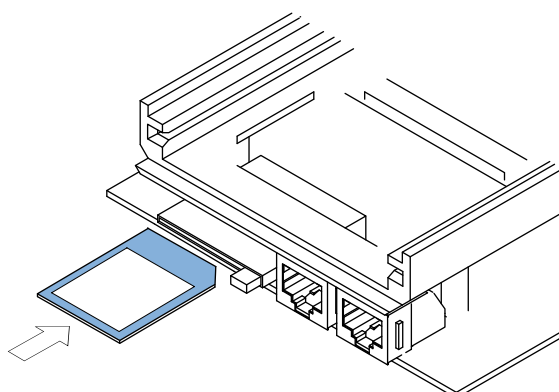| Connector X100, X101	Pin	Signal name	Technical data
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	-	Reserved, do not use
	5	-	Reserved, do not use
	6	RXN	Receive data -
	7	-	Reserved, do not use
	8	-	Reserved, do not use
	-	Shield	Permanently connected to ground
Module C98043-A7100-L2, Advanced CUD			

Memory Card slot

Figure 6-50   Module C98043-A7100 CUD, slot for Memory Card

CAUTION
• The Memory Card may only be inserted as shown in the figure above.
• 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 module (C98043-A7100 (CUD)), do not return the Memory Card along with it - instead, keep it so that you can use it in the replacement module.

No Memory Card is required to operate the CUD.

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.

- Software update
  A software update is easy to carry out using a Memory Card.

- Loading additional languages onto the Advanced Operator Panel AOP30.

- Performing an offline long-time trace

- Loading the DCC block library into the drive

- SINAMICS Link function: The SINAMICS Link function requires that the memory card is always inserted.

6.9.6 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.
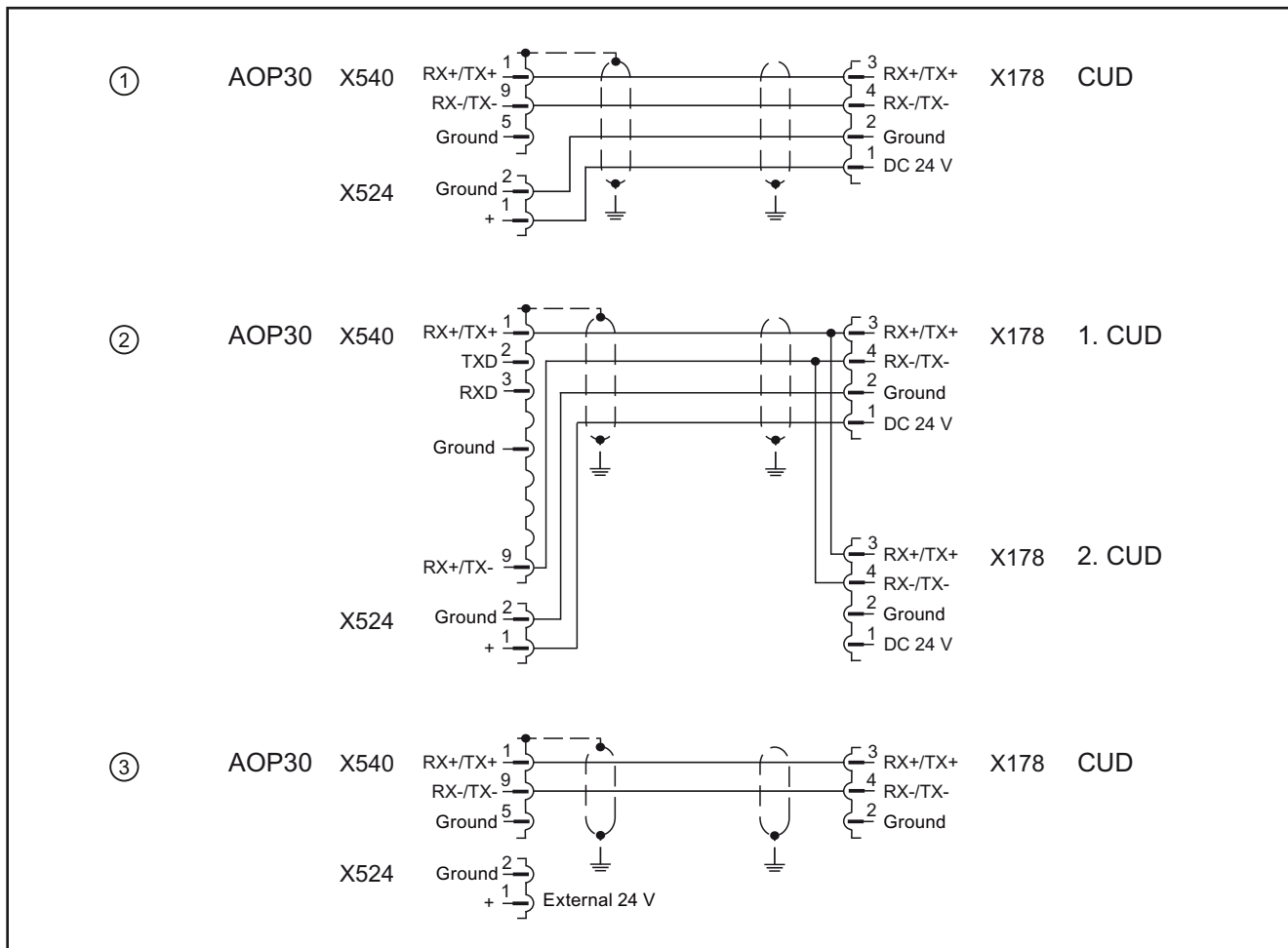
①   RS485 cable with 24 V DC power supply from the CUD - max. 50 m

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 6-51   Assignment, RS485 cable

6.10 Installation notes for installation according to UL 508C

Note

The following text has been taken from excerpts from the UL file E203250.

- "Solid state motor overload protection at 110 % of full-load current is provided in each model", or equivalent.

- "Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes", or the equivalent.

- Blower motor protection type 3RV1011-0DA1 trimmed to 0.26 A manufactured by Siemens is to be provided for blower motor type R2D225-AP02-09 in drive model sizes C and D.

- Blower motor protection type 3FV1011-0EA1 trimmed to 0.38 A manufactured by Siemens is to be provided for blower motor Type R2D250-AM20-09 in drive model size E.

- Blower motor protection type 3FV1011-0KA1 trimmed to 1.25 A manufactured by Siemens is to be provided for blower motor Type RH28M-2DK.3F.1R in Drive model size F.

Table 6- 35   Overview of Frame Sizes (in mm)

Size	Width	Height	Depth	Line voltage (V)	Output current (A)
A	385	268	210	400, 480	15 - 30
B	385	268	250	400, 480, 575	60 - 280
C	625	268	275	400, 480, 575	400 - 600
D	700	268	310	400, 480, 575	760 - 850
E	780	268	435	400, 480, 575	1000 - 1200
F	880	448	505	400, 480, 575	1600 - 3000

Additional system components

<div align="right">

7

</div>

Note

The components described here are used in several units in the SINAMICS family. The next section 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
SMC30	Sensor Module Cabinet-Mounted
TM15	Terminal Module
TM31	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 2.

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

DRIVE-CLiQ interface

On the SINAMICS DC MASTER, up to 3 terminal modules TM15 / TM31 can be connected to the DRIVE-CLiQ in any desired combination and in addition 1 Sensor Module Cabinet-Mounted SMC30 can be connected.

The CUD features 2 DRIVE-CLiQ ports (X100, X101). Any combination of the modules can be connected in series or in parallel. An SMC30 only possesses one DRIVE-CLiQ interface and is, therefore, always the last module on the bus.

7.1 Option Board: Communication Board Ethernet CBE20

7.1.1 Description

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

The option board has an X1400 interface with 4 ports for communication.

The Communication Board CBE20 allows SINAMICS Link connections to be established.

Note

By inserting the CBE20, the IF1 communication channel switches over from PROFIBUS to PROFINET. Communication is therefor no longer possible via PROFIBUS.

7.1.2 Safety instructions

CAUTION
The Option Board should only be inserted and removed when the Control Unit and Option Board are disconnected from the power supply.

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

7.1.3 Interface description
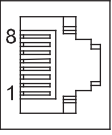
7.1.3.1 Overview
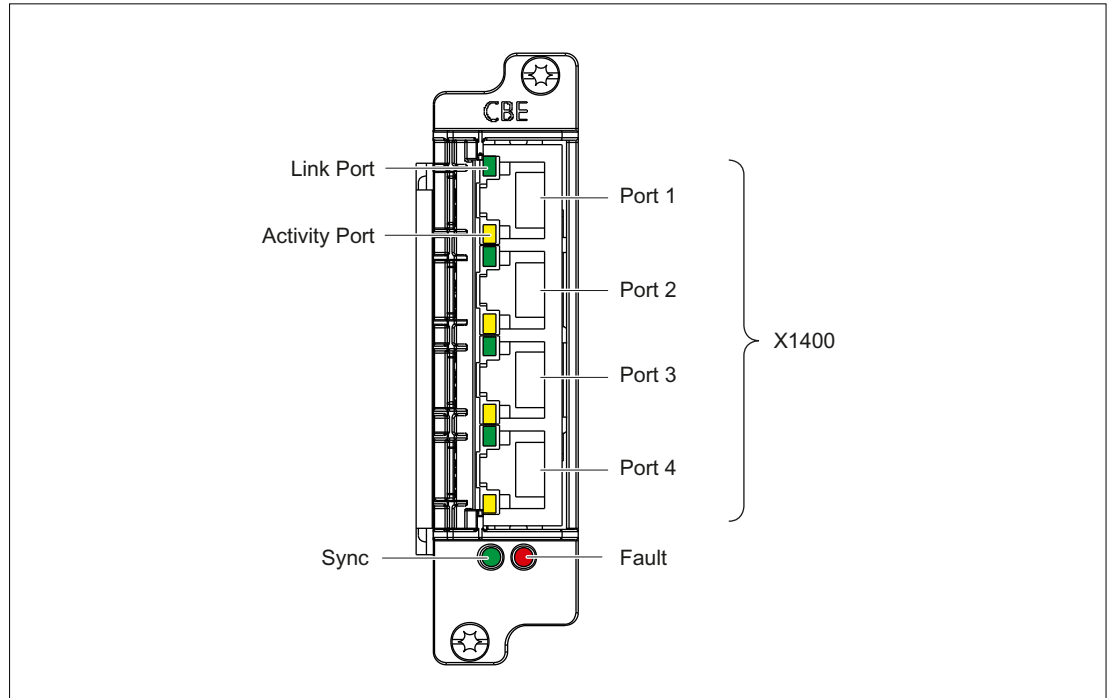
Figure 7-1   Interface description CBE20

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 (refer to "Meaning of the LEDs" for descriptions)

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: The CBE20 is operating normally, data is being exchanged with the configured IO Controller.
	Red	Flashing	- The response monitoring interval has elapsed. - Communications is interrupted. - The IP address is incorrect. - Incorrect or no configuration. - Incorrect parameter settings. - Incorrect or missing device name. - IO Controller not connected/switched off, although an Ethernet connection has been established. - Other CBE20 errors
		Continuous light	CBE20 bus error - No physical connection to a subnet/switch. - Incorrect transmission rate - Full duplex transmission is not activated.
Sync	–	Off	If the link port LED is green: Control Unit task system is not synchronized with the IRT clock. An internal substitute clock is generated.
	Green	Flashing light	Control Unit task system 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. Communication Board either defective or not inserted.	–
	Green	Continuous light	Communication Board is ready and cyclic communication is taking place.	–
		0.5 Hz flashing light	The Communication Board is ready, but cyclic communications is not running. Possible causes: • At least one fault is present. • Communication is being established.	–
	Red	Continuous light	Cyclic communication via PROFINET has not yet been established. However, non-cyclic communication is possible. SINAMICS waits for a parameterizing/configuring telegram	–
		0.5 Hz flashing light	The firmware update into the CBE20 has been completed with an error. Possible causes: • The CBE20 is defective. • The memory card for the Control Unit is defective. CBE20 cannot be used in this state.	–
		2 Hz flashing light	There is a communications error between the Control Unit and the CBE20. Possible causes: • Board was withdrawn after booting. • The board is defective	Correctly insert the board, if required, replace.
	Orange	0.5 Hz flashing light	Firmware is being updated.	–

7.1.5 Installation

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

Installing the CBE20

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

175

7.2 Sensor Module Cabinet-Mounted SMC30

Supported types

The SINAMICS DC MASTER only supports the Sensor Module Cabinet-Mounted SMC30 with order number (MLFB) 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- 6   SMC30 types

SMC30 order 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.

7.2.1 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.

7.2.2 Safety instructions

⚠ WARNING
The cooling clearances of 50 mm above and below the components must be observed.

NOTICE
Only one encoder system may be connected per Sensor Module.

Note

There must be no electrical connection between the encoder system housing and the encoder 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).

CAUTION

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

⚠ CAUTION

Connecting cables to temperature sensors must always be installed with shielding. The cable shield must be connected to the ground potential at both ends over a large surface area. Temperature-sensor cables that are routed together with the motor cable must be twisted in pairs and shielded separately.

7.2.3 Interface description

7.2.3.1 Overview

X500
DRIVE-CLiQ interface

X524
Electronics power
supply

LEDs

X520
encoder system interface
HTL, TTL with
track monitoring,
SSI

Alternative encoder system
interface
HTL, TTL with
track monitoring,
SSI

X521

X531

Shield connection

Protective conductor
connection
M4 / 1.8 Nm
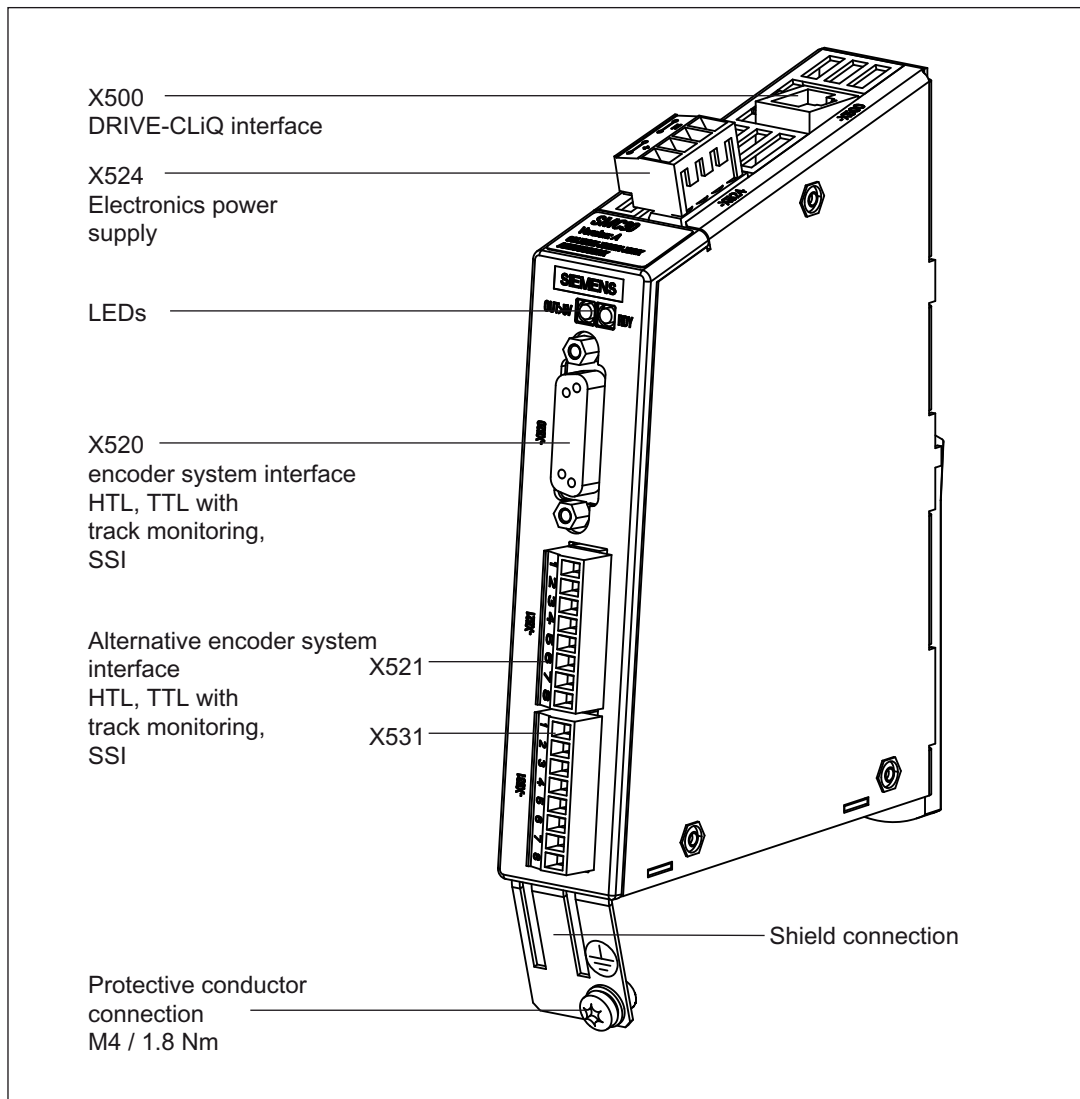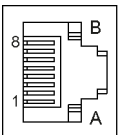
Figure 7-2   SMC30 interface description

7.2.3.2 X500 DRIVE-CLiQ interface
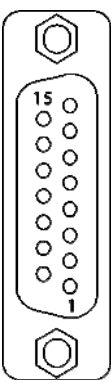
Table 7- 7   DRIVE-CLiQ interface X500

	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	GND (0 V)	Electronics ground
Connector type: RJ45 socket; blanking plate for DRIVE-CLiQ interface included in the scope of delivery; blanking plate (50 pieces) Order number: 6SL3066-4CA00-0AA0			

7.2.3.3 X520 encoder system interface

Table 7- 8   X520 encoder system interface

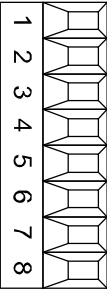|	Pin	Signal name	Technical specifications
	1	Reserved	Do not use
	2	Clock	SSI clock
	3	Clock*	Inverse SSI clock
	4	P encoder 5 V/24 V	Encoder power supply
	5	P encoder 5 V/24 V	
	6	P sense	Sense input encoder power supply
	7	M encoder (M)	Ground for encoder power supply
	8	Reserved	Do not use
	9	M sense	Ground 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			
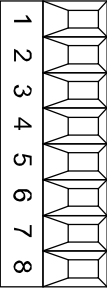
CAUTION
The encoder power supply can be parameterized to 5 V or 24 V. The encoder may be destroyed if you enter the wrong parameters.

7.2.3.4   X521/X531 alternative encoder system interface

Table 7- 9   X521/X531 alternative encoder system interface

	Pin	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 power supply
	2	M_Encoder	Ground for encoder power 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			
When using unipolar HTL encoders, at the terminal block A*, B*, R* must be connected to (jumper) 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.

CAUTION

When the encoder system is connected via terminals, make sure that the cable shield is connected to the component. Refer to the section titled "Electrical connection".

NOTICE

The KTY temperature sensor must be connected with the correct polarity.
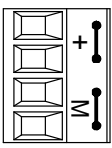
⚠ DANGER

Hazard due to electric shock

Only temperature sensors that meet the protective separation specifications in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp". There is a risk of electric shock if this is not carefully observed.

7.2.3.5 X524 electronic power supply

Table 7- 10   X524 terminal strip

	Terminal	Function	Technical specifications
	+	Electronics power supply	Voltage: 24 V (20.4 – 28.8 V)
	+	Electronics power supply	Power consumption: Max. 0.55 A
	M	Electronics ground	Max. current via the jumper in the connector: 20 A
	M	Electronics ground	
Terminal type: Spring-loaded terminal Connectable conductor cross-section: Flexible, 0.08 mm^2 to 2.5 mm^2 Stripped length: 8 to 9 mm Tool: 0.4 × 2.0 mm screwdriver			

Note

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

7.2.4 Connection examples

Connection example 1: HTL encoder, bipolar, with reference signal
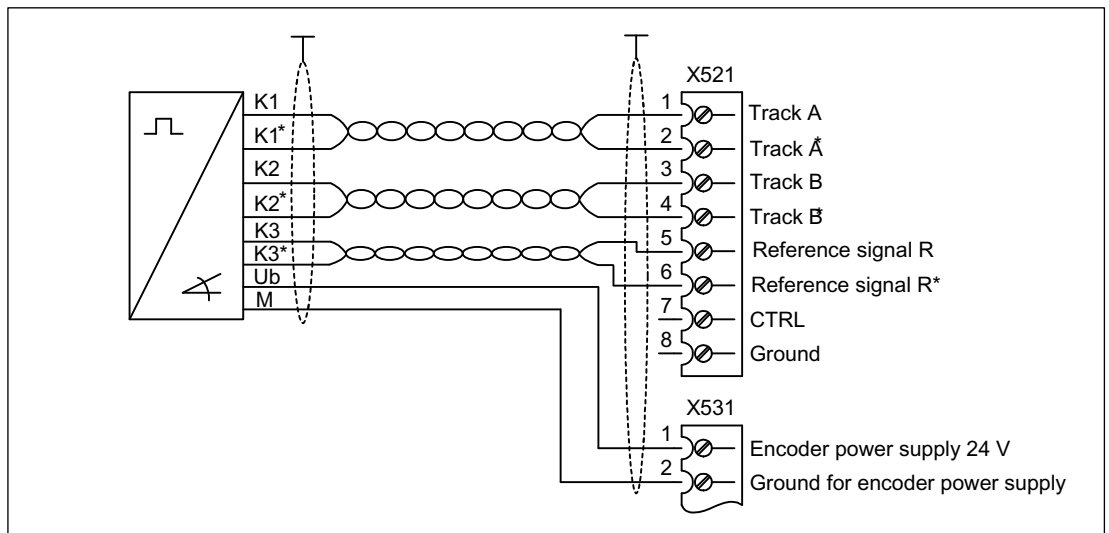
Figure 7-3   Connection example 1: HTL encoder, bipolar, with reference signal

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

Connection example 2: HTL encoder, unipolar, with reference signal
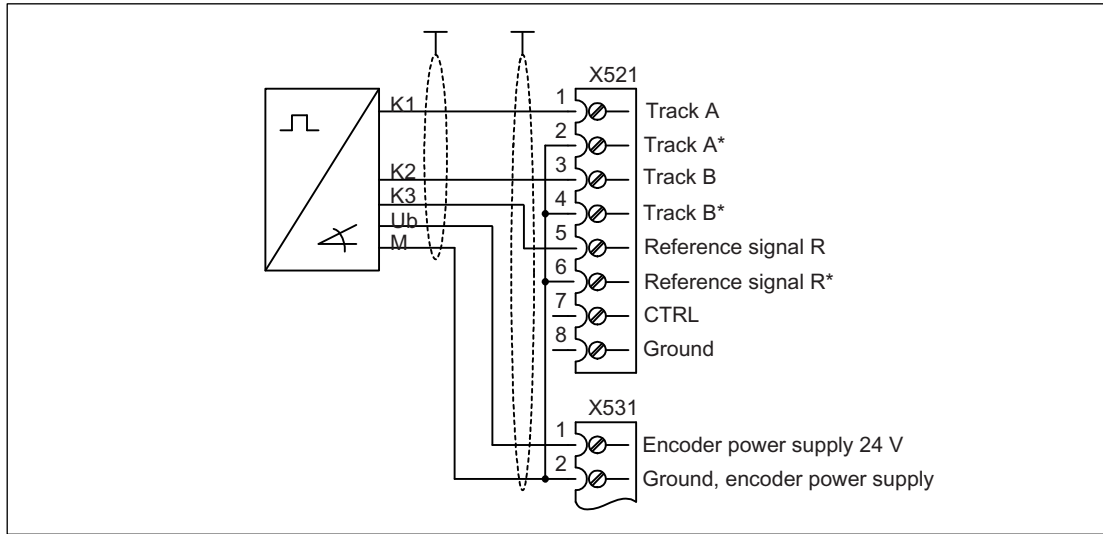
Figure 7-4   Connection example 2: HTL encoder, unipolar, with reference signal[1]

[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.
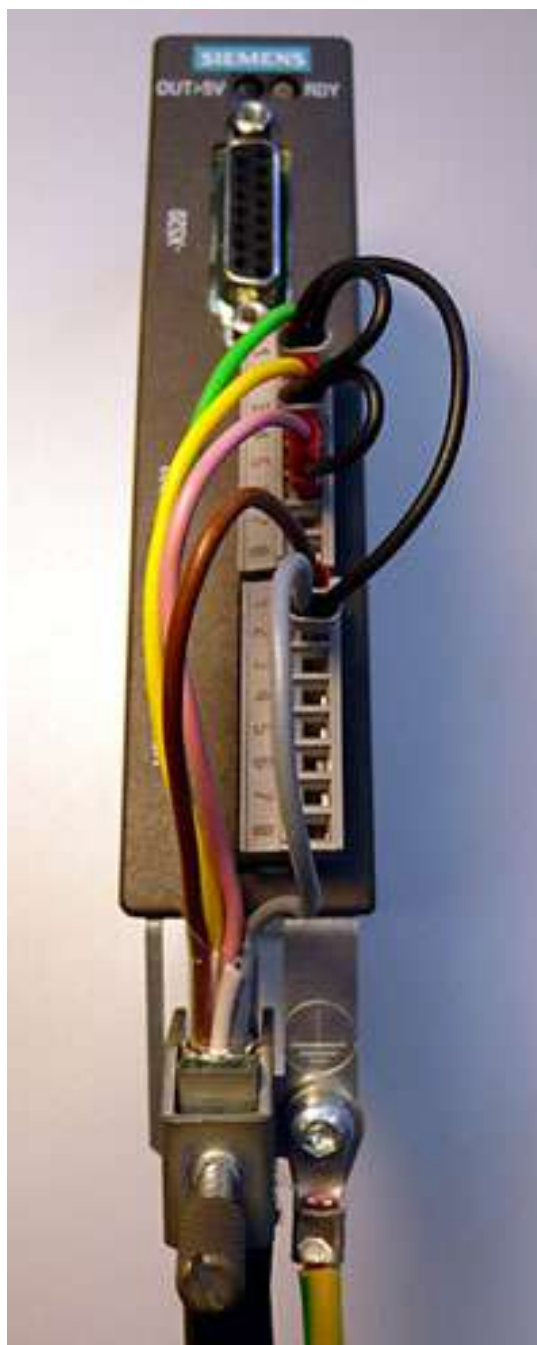
Figure 7-5   Photo of connection example 2

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

7.2.5 Meaning of the LEDs

Table 7- 11   Meaning of LEDs on the Sensor Module Cabinet SMC30

| LED	Color	Status	Description, cause	Remedy
RDY 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. **Note:** The LED is activated regardless 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 or Red/orange	Flashing light	Component recognition via LED is activated (p0144). **Note:** Both options depend on the LED status when component recognition is activated via p0144 = 1.	–
OUT > 5 V	-	Off	Electronics power supply is missing or outside permissible tolerance range. Power supply ≤ 5 V.	–
	Orange	Continuous light	Electronics power supply for encoder system available. Power supply > 5 V. **Important:** 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.	–

7.2.6   Dimension drawing
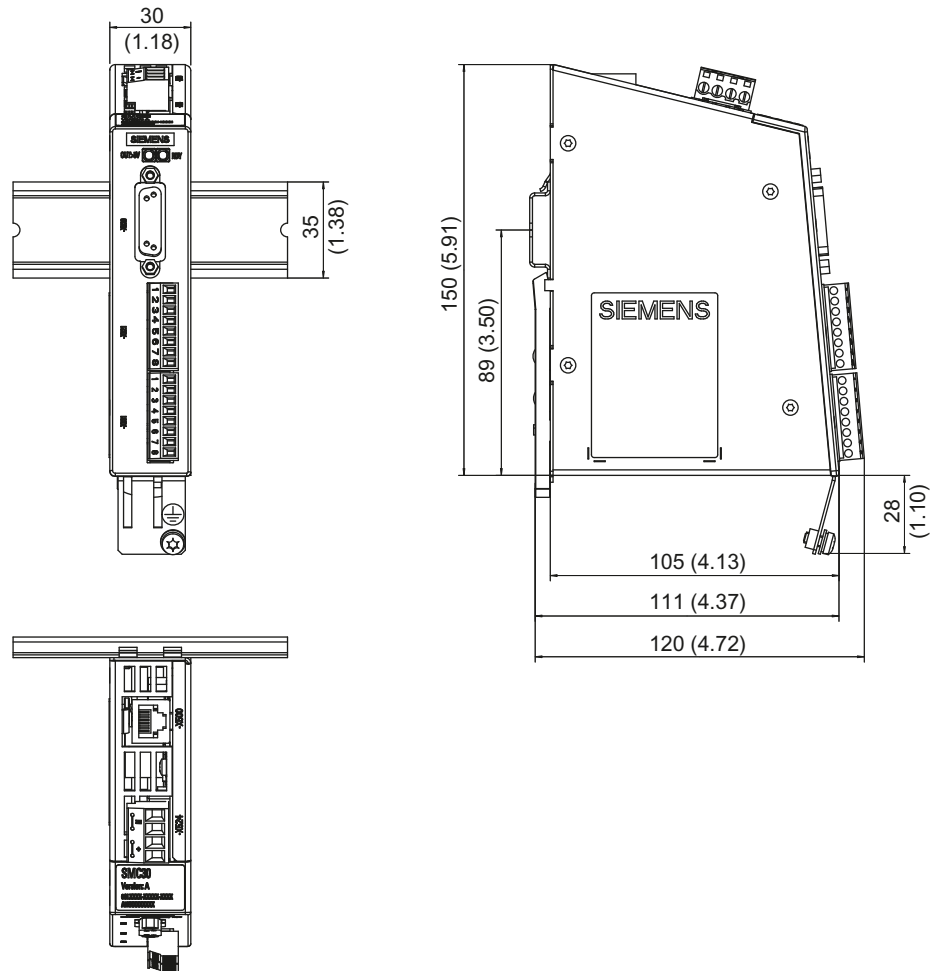
Figure 7-6   Dimension drawing of the Sensor Module Cabinet SMC30, all data in mm and (inches)

7.2.7   Installation

Installation

1. Tilt the component backwards slightly and snap it onto the mounting rail using the hook.

2. Push the component towards the mounting rail until you hear the mounting slide at the rear latch into position.

3. You can now move the component to the left or right along the mounting rail, until it reaches its final position.

185

Deinstalling

1. The lug on the mounting slide must first be pushed down to release the interlock from the mounting rail.

2. The component can now be tilted towards the front and removed from the mounting rail.
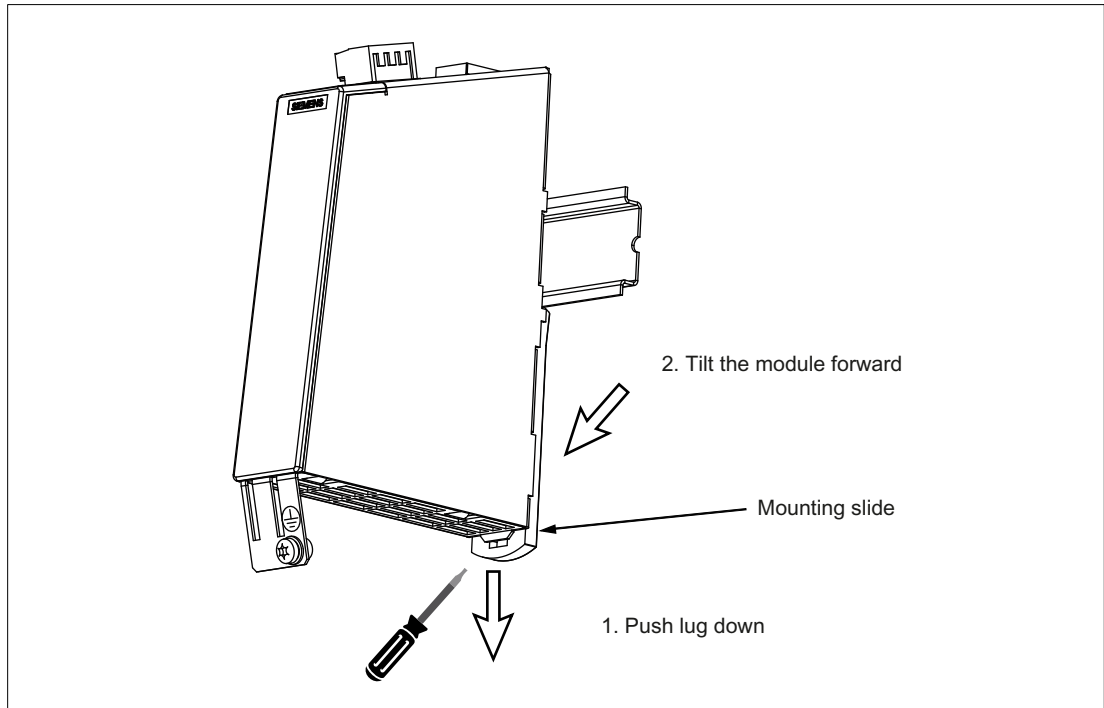
Figure 7-7   Removing from a mounting rail

7.2.8 Protective conductor connection and shield support

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

Protective conductor connection
M4 / 1.8 Nm

Weidmüller
Type: KLBÜ CO 1
Order no. 1753311001
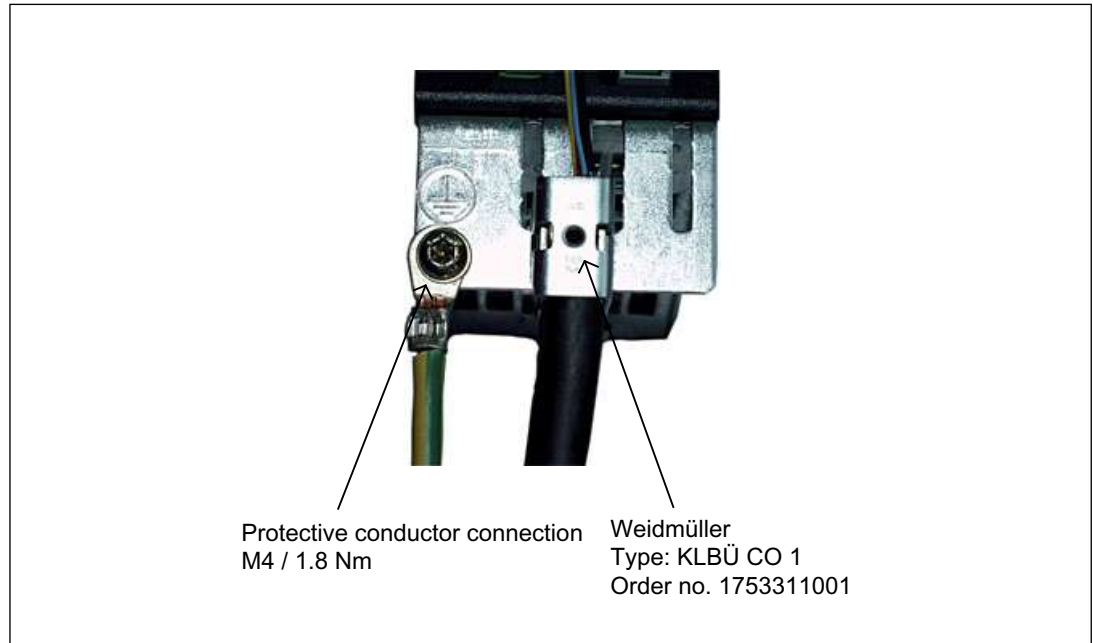
Figure 7-8   Shield supports for the SMC30

Weidmüller: http://www.weidmueller.com

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

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

7.2.9 Technical data

Table 7- 12   Technical data

Sensor Module Cabinet-Mounted SMC30	Unit	Value
Electronics power supply Voltage Current (without encoder system) Current (with encoder system) Power loss	V_{DC} A_{DC} A_{DC} W	24 DC (20.4 – 28.8) ≤ 0.20 ≤ 0.55 ≤ 10
Encoder system power supply Voltage Current	$V_{encoder}$ $A_{encoder}$	5 V DC (with or without Remote Sense) [1] or V_{DC} - 1 V 0.35
Encoder frequency that can be evaluated ($f_{encoder}$)	kHz	≤ 300
SSI baud rate	kHz	100 - 250
PE/ground connection		On enclosure with M4/1.8 Nm screw
Weight		0,45
Degree of protection		IP20 or IPXXB

[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.

Table 7- 13   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 manual: /FH1/ SINAMICS S120, Function Manual, tolerant encoder monitoring for SMC30.

Table 7- 14   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).

Table 7- 15   Maximum encoder cable length

Encoder type	Maximum encoder cable length in m
TTL[1]	100
HTL unipolar[2]	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.

For encoders with a 5 V supply at X521/X531, the cable lengths depend on the encoder current (for 0.5 mm^2 cable cross-sections):
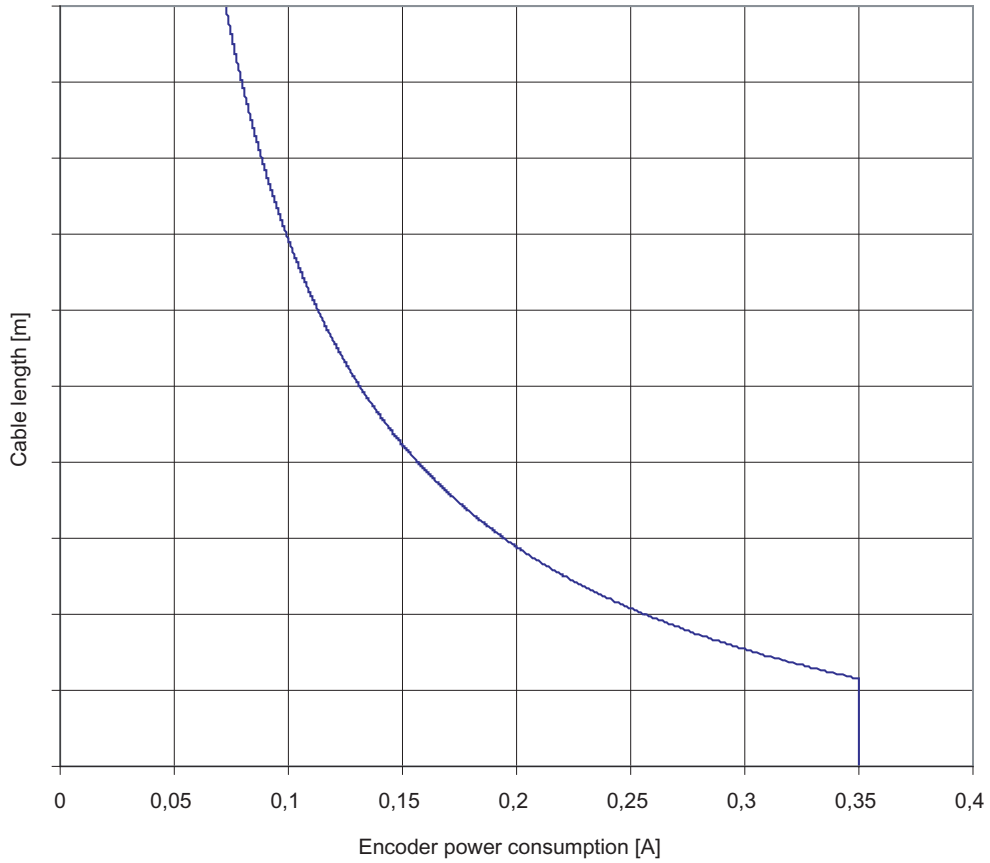

Figure 7-9   Max. cable length as a function of the encoder current drawn

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).
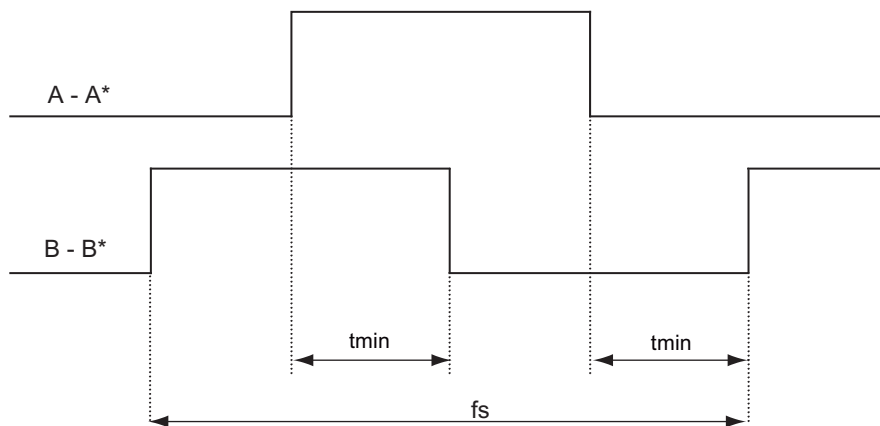

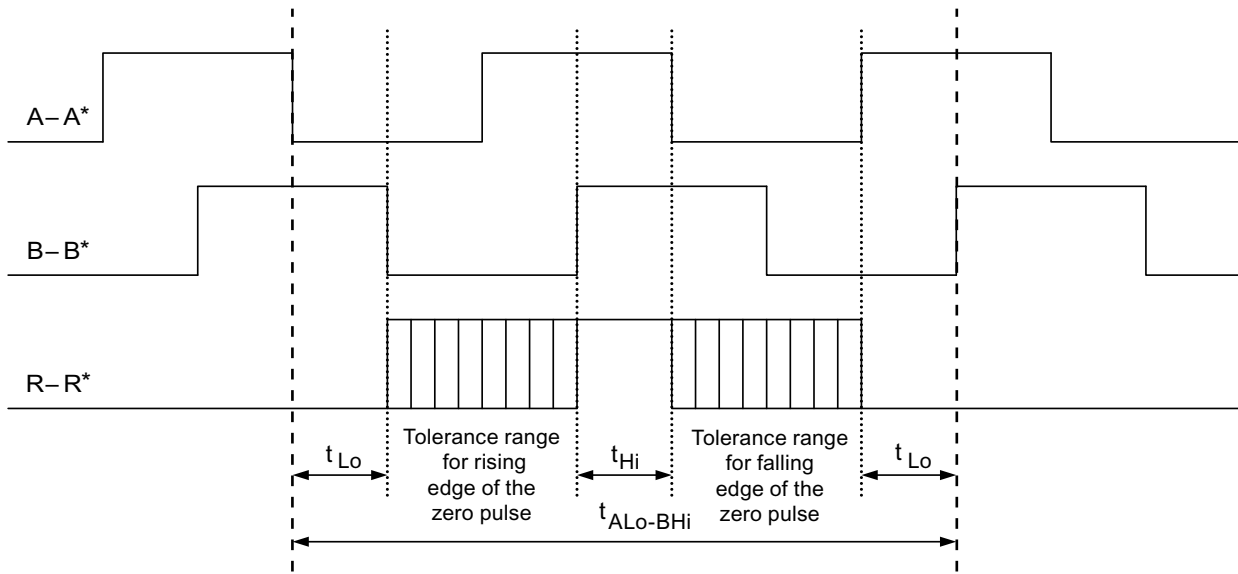Figure 7-10   Signal characteristic of track A and track B between two edges: Time between two edges with incremental encoders

Figure 7-11   Position of the zero pulse to the track signals

7.3 Terminal Module TM15

7.3.1 Description

The Terminal Module TM15 is a terminal expansion for snapping on to an EN 60715 mounting rail. The TM15 can be used to increase the number of available digital inputs/outputs within a drive system.

Table 7- 16   Interface overview of the TM15

Type	Quantity
Digital inputs/outputs	24 (electrical isolation in 3 groups each with 8 DI/O)

7.3.2 Safety Information

⚠ WARNING
The 50 mm cooling clearances above and below the components must be observed.

7.3.3   Interface description

7.3.3.1   Overview
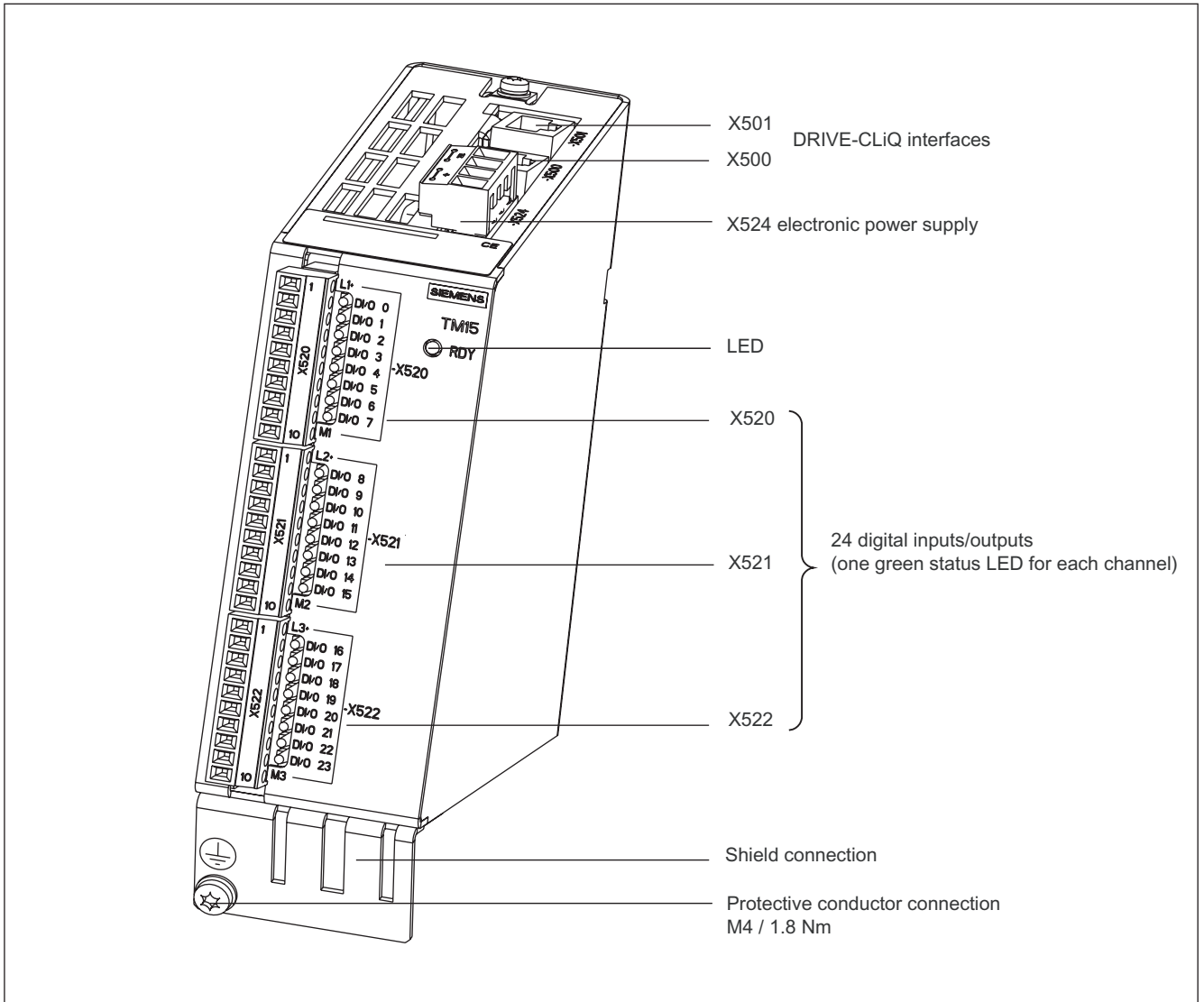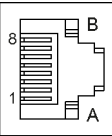
Figure 7-12   TM15 interface description

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Terminal type

X520, X521, X522		
Terminal type	Spring-loaded terminal	
Connectable conductor cross-section	Rigid/flexible	0.14 mm^2 ... 0.5 mm^2
	Flexible, with end sleeve without plastic sleeve	0.25 mm^2 ... 0.5 mm^2
	AWG / kcmil	26 ... 20
Stripped length	8 mm	
Tool	0.4 × 2.0 mm screwdriver	
X524		
Terminal type	Spring-loaded terminal	
Connectable conductor cross-section	Flexible	0.08 mm^2 ... 2.5 mm^2
Stripped length	8 ... 9 mm	
Tool	0.4 × 2.0 mm screwdriver	
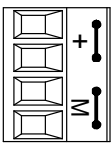
7.3.3.2 X500 and X501 DRIVE-CLiQ interface

Table 7- 17   DRIVE-CLiQ interfaces X500 and X501

	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	GND (0 V)	Electronics ground
Blanking plate for DRIVE-CLiQ interfaces included in the scope of delivery; blanking plate (50 pieces) Order number: 6SL3066-4CA00-0AA0			

7.3.3.3 X524 electronic power supply

Table 7- 18   Terminals for the electronics power supply

	Terminal	Designation	Technical specifications
	+	Electronics power supply	Voltage: 24 VDC (20.4 – 28.8 V)
	+	Electronics power supply	Power consumption: Max. 0.15 A
	M	Electronics ground	Max. current via jumper in connector:
	M	Electronics ground	20 A
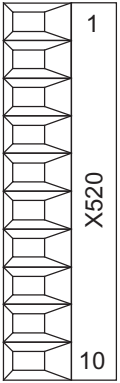
> **Note**
>
> The two "+" or "M" terminals are jumpered in the connector. This ensures that the supply voltage is looped through.
>
> The power consumption increases by the value for the DRIVE-CLiQ node. The digital outputs are supplied via terminals X520, X521, and X522.

7.3.3.4 X520 digital inputs/outputs

Table 7- 19   Screw terminal X520

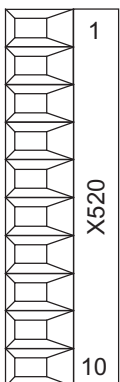|	Terminal	Designation[1]	Technical data
	1	L1+	See the section titled "Technical data"
	2	DI/O 0	
	3	DI/O 1	
	4	DI/O 2	
	5	DI/O 3	
	6	DI/O 4	
	7	DI/O 5	
	8	DI/O 6	
	9	DI/O 7	
	10	M1 (GND)	

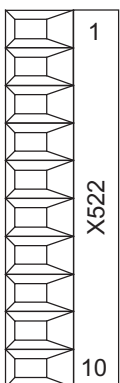[1] L1+: A 24 VDC infeed for DI/O 0 to 7 (first potential group) must always be connected if at least one DI/O of the potential group is used as an output.
M1: A ground reference for DI/O 0 to 7 (first potential group) must always be connected if at least one DI/O of the potential group is used as either an input or an output.
DI/O: Digital input/output

7.3.3.5 X521 digital inputs/outputs

Table 7- 20   Screw terminal X521

	Terminal	Designation[1]	Technical data
	1	L2+	See the section titled "Technical data"
	2	DI/O 8	
	3	DI/O 9	
	4	DI/O 10	
	5	DI/O 11	
	6	DI/O 12	
	7	DI/O 13	
	8	DI/O 14	
	9	DI/O 15	
	10	M2 (GND)	

[1] L2+: A 24 VDC infeed for DI/O 8 to 15 (second potential group) must always be connected if at least one DI/O of the potential group is used as an output.
M2: A ground reference for DI/O 8 to 15 (second potential group) must always be connected if at least one DI/O of the potential group is used as either an input or an output.
DI/O: Digital input/output

7.3.3.6 X522 digital inputs/outputs

Table 7- 21   Screw terminal X522

	Terminal	Designation[1]	Technical data
	1	L3+	See the section titled "Technical data"
	2	DI/O 16	
	3	DI/O 17	
	4	DI/O 18	
	5	DI/O 19	
	6	DI/O 20	
	7	DI/O 21	
	8	DI/O 22	
	9	DI/O 23	
	10	M3 (GND)	

[1] L3+: A 24 VDC infeed for DI/O 16 to 23 (third potential group) must always be connected if at least one DI/O of the potential group is used as an output.
M3: A ground reference for DI/O 16 to 23 (third potential group) must always be connected if at least one DI/O of the potential group is used as either an input or an output.
DI/O: Digital input/output

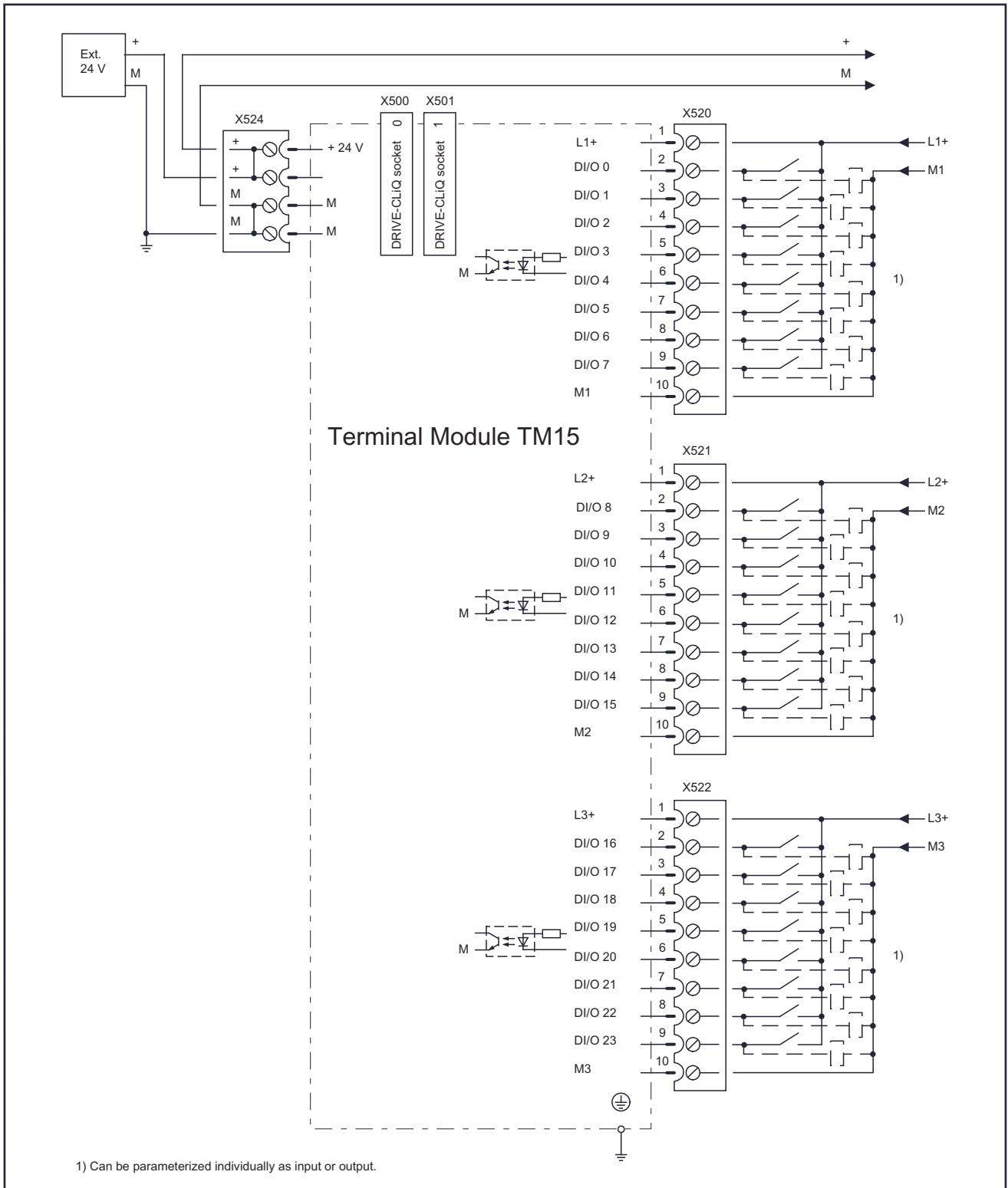### 7.3.4 Connection example

Figure 7-13   Example connection of TM15

7.3.5 Meanings of the LEDs on the Terminal Module TM15

Table 7- 22   Terminal Module TM15 - description of LEDs

LED	Color	State	Description, cause	Remedy
READY	-	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE-CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this component. **Note:** The LED is activated regardless of whether the corresponding messages have been reconfigured.	Remedy and acknowledge fault
	Green/red	Flashing 0.5 Hz	Firmware is being downloaded.	–
		Flashing 2 Hz	Firmware download is complete. Wait for POWER ON	Carry out a POWER ON
	Green/orange or Red/orange	Flashing	Component recognition via LED is activated (p0154). **Note:** Both options depend on the LED status when component 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 (IH1)

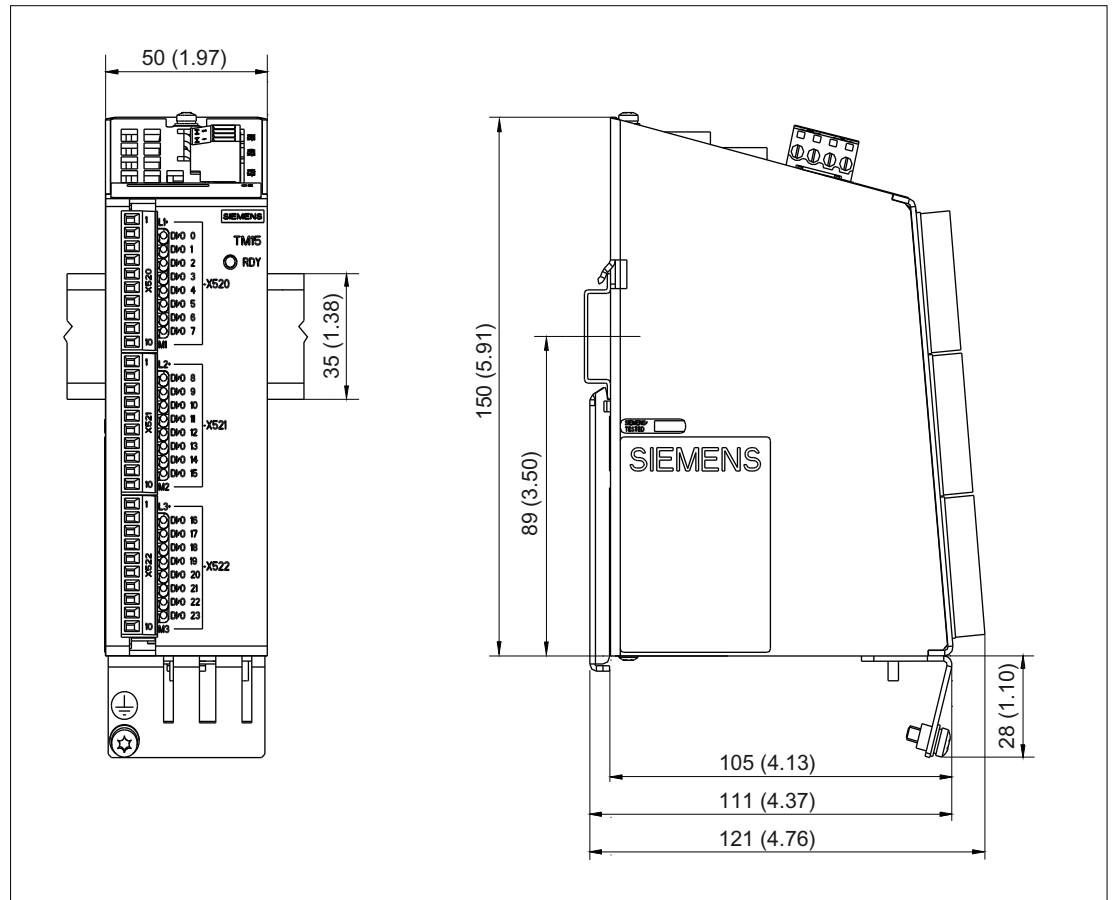SINAMICS DCM List Manual

7.3.6 Dimension drawing

Figure 7-14   Dimension drawing of Terminal Module TM15, all data in mm and (inches)

7.3.7 Installation

Installation

1. Tilt the component backwards slightly and snap it onto the mounting rail using the hook.

2. Push the component towards the mounting rail until you hear the mounting slide at the rear latch into position.

3. You can now move the component to the left or right along the mounting rail, until it reaches its final position.

Deinstalling

1. The lug on the mounting slide must first be pushed down to release the interlock from the mounting rail.

2. The component can now be tilted towards the front and removed from the mounting rail.
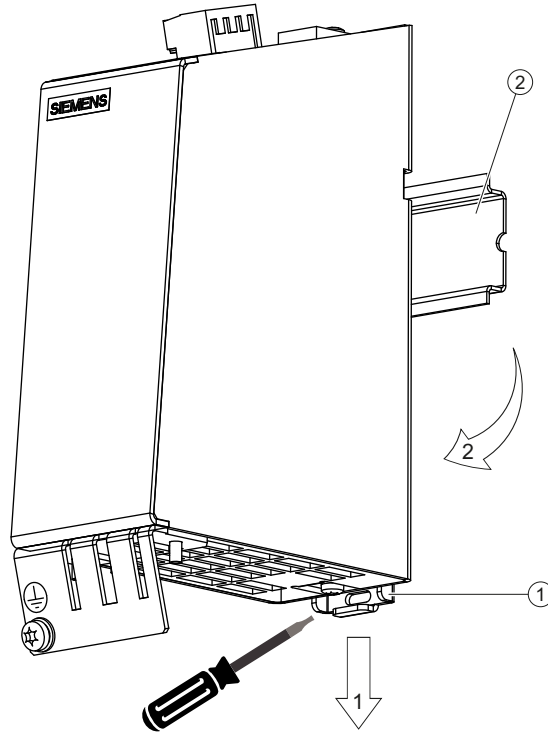
Figure 7-15   Removing from a mounting rail

7.3.8 Protective conductor connection and shield support

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

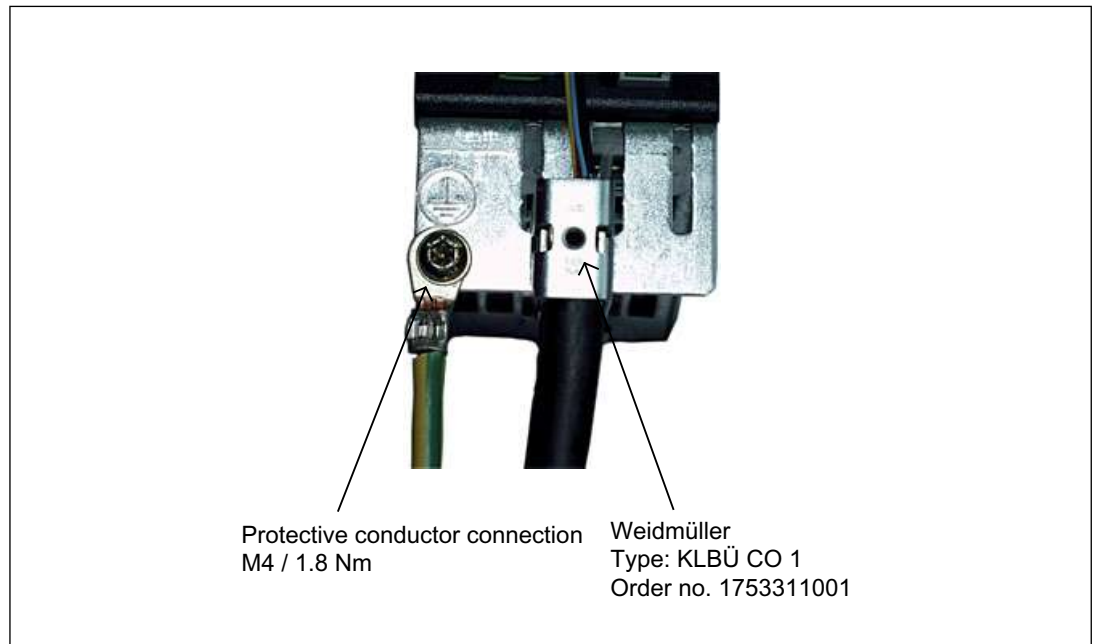The following diagrams show typical Weidmüller shield connection terminals for the shield supports.

Protective conductor connection
M4 / 1.8 Nm

Weidmüller
Type: KLBÜ CO 1
Order no. 1753311001

Figure 7-16   Shield supports and protective conductor connection

Weidmüller website address: http://www.weidmueller.com

> ⚠ **DANGER**
>
> If the shielding procedures described and the specified cable lengths are not observed, the machine may not operate properly.

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

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

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7.3.9 Connector coding

Siemens supplies a series of coding keys ("coding sliders") with each Terminal Module TM15. To encode a connector, you must insert at least one coding slider and cut off a coding lug on the connector:
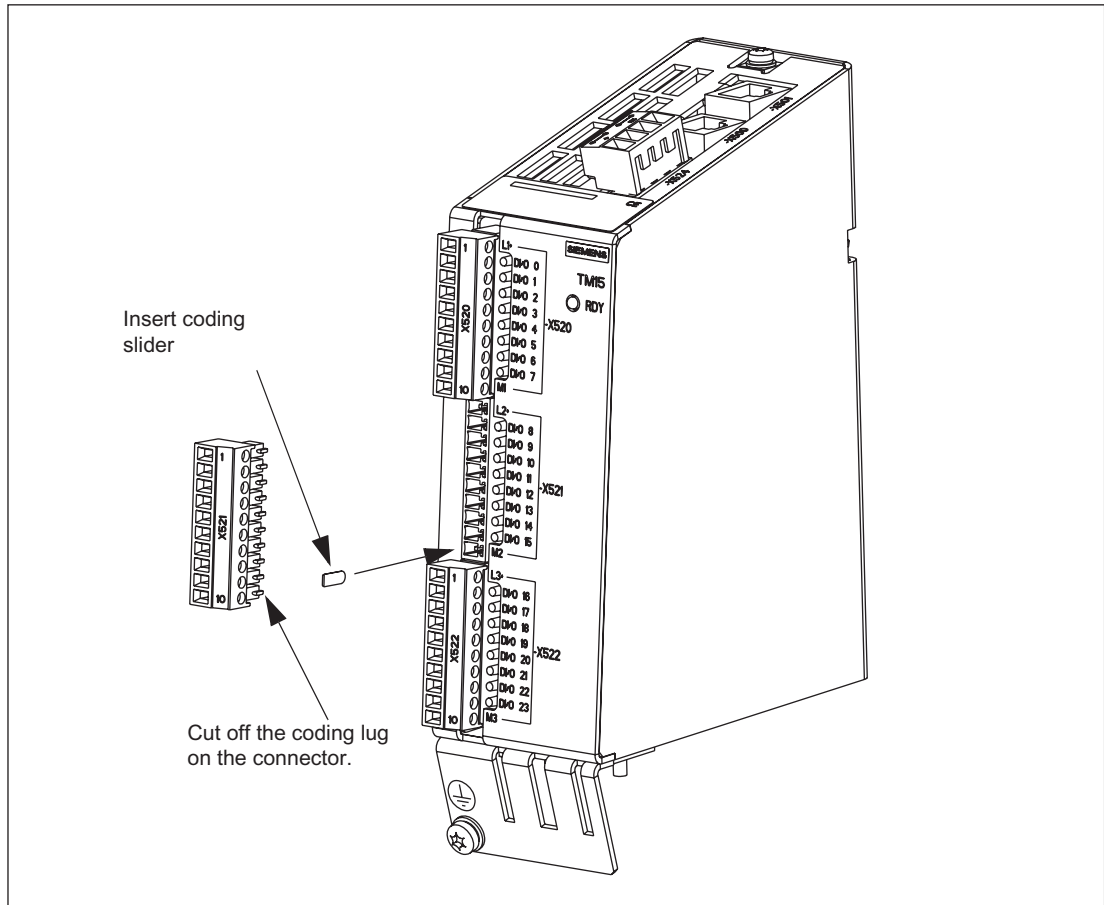

Figure 7-17   Procedure for encoding a connector

To prevent wiring errors, unique encoding schemes can be defined for the X520, X521, and X522 connectors. Examples of possible schemes:

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

7.3.10 Technical data

Table 7- 23   Technical data

6SL3055-0AA00-3FAx	Unit	Value
Electronics power supply Voltage Current (without DRIVE-CLiQ or digital outputs) Power loss	V_{DC} A_{DC} W	24 DC (20.4 – 28.8) 0.15 < 3
Ambient temperature up to an altitude of 2000 m	°C	0 - 60
Storage temperature	°C	-40 to +85
Relative humidity	5% to 95%, no condensation	
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	
Max. cable length	m	30
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
Power consumption (at 24 VDC)	mA	11
Max. voltage in OFF state	V_{DC}	5
Current in OFF state	mA	0.0 to 1.0 (per channel)
Typical input delay of the digital inputs	µs	"0" → "1": 50 "1" → "0": 100
Digital outputs (continuously short-circuit proof)		
Voltage	V_{DC}	24
Max. load current per digital output	A_{DC}	0,5
Output delay (resistive load)		
Typical	µs	"0" → "1": 50 "1" → "0": 150
Maximum	µs	"0" → "1": 100 "1" → "0": 225
Min. output pulse (100% amplitude, 0.5 A with resistive load)	µs	125 (typ.) 350 (max.)
Switching frequency For resistive load For inductive load For lamp load Maximum lamp load	Hz Hz Hz W	max. 100 max. 0.5 max. 10 5
Max. switching frequency (100% amplitude, 50%/50% duty cycle; with 0.5 A and a resistive load)	kHz	1 (typ.)

6SL3055-0AA00-3FAx	Unit	Value
Voltage drop in ON state	V_{DC}	0.75 (max.) for maximum load in all circuits
Leakage current in OFF state	µA	Max. 10 per channel
Voltage drop, output (I/O power supply to the output)	V_{DC}	0,5
Max. total current of outputs (per group) up to 60 °C up to 50 °C up to 40 °C	A_{DC} A_{DC} A_{DC}	2 3 4
IEC enclosure specification	IP20 protection	
Protective conductor connection	On enclosure with M4/1.8 Nm screw	
Response time	The response time for the digital inputs/outputs (TM15 DI/DO) consists of the following elements: • Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle). • Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle). • Evaluation on the Control Unit (see function diagram) For additional information: SINAMICS DCM List Manual, Chapter "Function block diagrams"	
Weight	kg	0,86
Approvals	UL und cULus http://www.ul.com File: E164110, Vol. 2, Sec. 9	

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7.4 Terminal Module TM31

Supported types

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

Table 7- 24   TM31 types

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

7.4.1 Description

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

The TM31 contains the following terminals:

Table 7- 25   Interface overview of the TM31

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

7.4.2 Safety Information

> ⚠ **WARNING**
>
> The 50 mm clearances above and below the components must be observed.

> ⚠ **CAUTION**
>
> Connecting cables to temperature sensors must always be installed with shielding. The cable shield must be connected to the chassis potential at both ends over a large surface area. Temperature sensor cables that are routed together with the motor cable must be twisted in pairs and shielded separately.
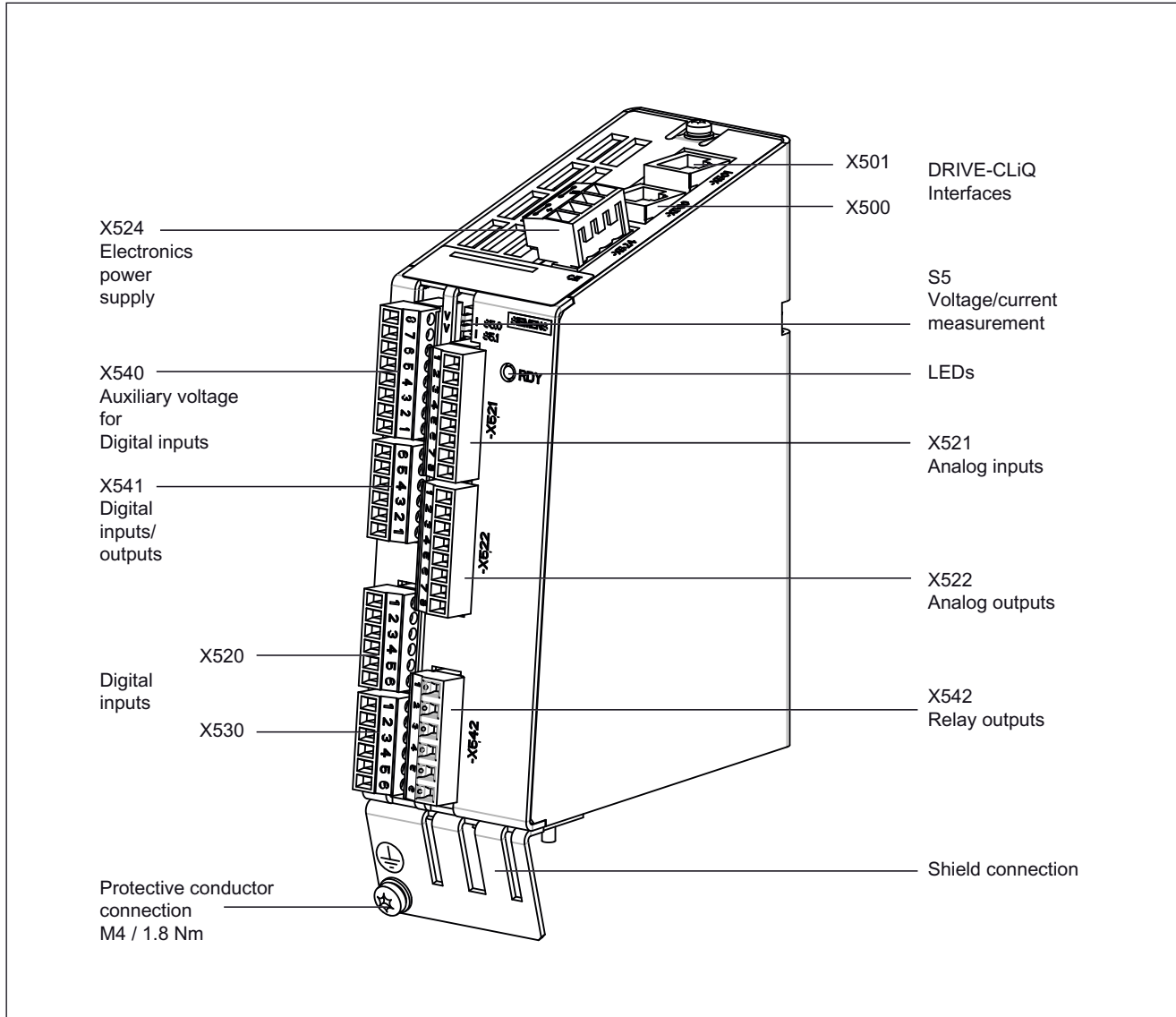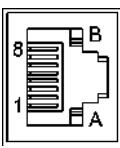
7.4.3 Interface description

7.4.3.1 Overview

Figure 7-18   Interface description TM31

Terminal type

X520, X521, X522, X530, X540, X541		
Terminal type	Spring-loaded terminal	
Connectable conductor cross-section	Rigid/flexible	0.14 mm^2 ... 0.5 mm^2
	Flexible, with end sleeve without plastic sleeve	0.25 mm^2 ... 0.5 mm^2
	AWG / kcmil	26 ... 20
Stripped length	8 mm	
Tool	0.4 × 2.0 mm screwdriver	
X524		
Terminal type	Spring-loaded terminal	
Connectable conductor cross-section	Flexible	0.08 mm^2 ... 2.5 mm^2
Stripped length	8 ... 9 mm	
Tool	0.4 × 2.0 mm screwdriver	
X542		
Terminal type	Spring-loaded terminal	
Connectable conductor cross-section	Rigid	0.2 mm^2 to 1 mm^2
	Flexible	0.2 mm^2 to 1.5 mm^2
	Flexible, with end sleeve without plastic sleeve	0.25 mm^2 to 1.5 mm^2
	Flexible, with end sleeve with plastic sleeve	0.25 mm^2 to 0.75 mm^2
	AWG / kcmil	24 ... 16
Stripped length	8 mm	
Tool	0.4 × 2.0 mm screwdriver	

7.4.3.2   X500 and X501 DRIVE-CLiQ interface

Table 7- 26   DRIVE-CLiQ interfaces X500 and X501

	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; blanking plate (50 pieces) order number: 6SL3066-4CA00-0AA0			

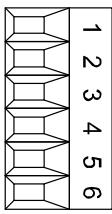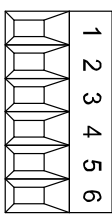### 7.4.3.3 X520, X530 digital inputs

Table 7- 27　Screw terminal X520

	Terminal	Designation [1]	Technical specifications
1 2 3 4 5 6	1	DI 0	Voltage: - 3 to +30 V Typical power consumption: 10 mA at 24 VDC Input delay: - For "0" to "1": typ. 50 µs max. 100 µs - For "1" to "0": typ. 130 µs max. 150 µs Electrical isolation: Reference potential is Terminal M1 Level (including ripple) High level: 15 to 30 V Low level: -3 to +5 V
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	
	6	M	

Table 7- 28　Screw terminal X530
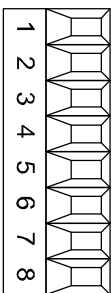
	Terminal	Designation [1]	Technical specifications
1 2 3 4 5 6	1	DI 4	Voltage: - 3 to +30 V Typical power consumption: 10 mA at 24 VDC Input delay: - For "0" to "1": typ. 50 µs max. 100 µs - For "1" to "0": typ. 130 µs max. 150 µs Electrical isolation: Reference potential is Terminal M2 Level (including ripple) High level: 15 to 30 V Low level: -3 to +5 V
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	
	6	M	

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

NOTICE
An open input is interpreted as "low".
Terminal M1 or M2 must be connected in order that digital inputs (DI) can function.
This is carried out by:
1) Providing the ground reference of the digital inputs, or
2) a jumper to M (caution! This removes electrical isolation for these digital inputs).

7.4.3.4 X521 analog inputs

Table 7- 29   X521 terminal strip

	Terminal	Designation [1]	Technical specifications
1 2 3 4 5 6 7 8	1	AI 0+	The analog inputs can be toggled between current and voltage input using switches S5.0 and S5.1. Voltage: -10 to 10 V; R_i = 100 kΩ Resolution: 11 bits + sign Current: R_i = 250 Ω Resolution: 10 bits + sign
	2	AI 0-	
	3	AI 1+	
	4	AI 1-	
	5	P10	Auxiliary voltage: P10 = 10 V N10 = -10 V Continuous short-circuit proof
	6	M	
	7	N10	
	8	M	

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

CAUTION
If more than ±35 mA flows through the analog current input, then the component could be destroyed. Permissible input voltage ±30 V (destruction limit). Permissible common-mode voltage ±10 V, increased faults if exceeded. Permissible back-EMF at the auxiliary voltage outputs ±15 V.
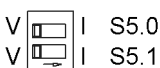
Note

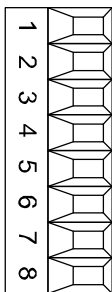The power supply for the analog inputs can be taken internally or from an external power supply unit

7.4.3.5 Analog inputs current/voltage switch

Table 7- 30   Current/voltage selector switch S5

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

7.4.3.6 X522 analog outputs/temperature sensor

Table 7- 31   X522 terminal strip

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

[1] AO xV: Analog output voltage; AO xC: Analog output current
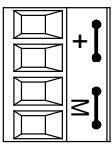
CAUTION
Permissible back-EMF at the outputs: ±15 V

NOTICE
The KTY temperature sensor must be connected with the correct polarity.

⚠ DANGER
Hazard due to electric shock
Only temperature sensors that meet the protective separation specifications in EN 61800-5-1 may be connected to terminals "+Temp" and "-Temp".
There is a risk of electric shock if this is not carefully observed.

7.4.3.7 X524 electronic power supply

Table 7- 32   Terminals for the electronic power supply

	Terminal	Designation	Technical data
	+	Electronic power supply	Voltage: 24 VDC (20.4 – 28.8 V)
	+	Electronic power supply	Power consumption: Max. 0.5 A
	M	Electronics ground	Max. current via bridge in connector:
	M	Electronics ground	20 A at 55 ℃
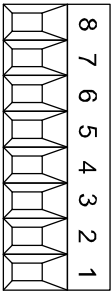
Note

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

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

7.4.3.8 X540 auxiliary voltage for the digital inputs
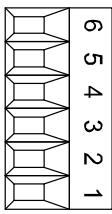
Table 7- 33   Screw terminal X540

	Terminal	Designation	Technical data
	8	+24 V	Voltage: +24 VDC
	7	+24 V	Max. total load current of +24 V auxiliary voltage for terminals X540 and X541 combined: 150 mA
	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.

7.4.3.9 X541 bidirectional digital inputs/outputs

Table 7- 34   Terminals for bidirectional digital inputs/outputs

	Terminal	Designation [1]	Technical specifications
6 5 4 3 2 1	6	M	Auxiliary voltage: Voltage: +24 V DC Max. total load current of +24 V auxiliary voltage for terminals X540 and X541 together: 150 mA
	5	DI/DO 11	
	4	DI/DO 10	
	3	DI/DO 9	**As input:** Voltage: -3 to 30 V
	2	DI/DO 8	Typical power consumption: 10 mA at 24 VDC Input delay: - For "0" to "1": Typ. 50 µs - For "1" to "0": Typ. 100 µs
	1	+24 V	**As output:** Voltage: 24 VDC Max. load current per output: 500 mA Max. total current of outputs (including currents in the inputs): 100 mA/1 A (can be parameterized) Continuous short-circuit proof Output delay: - For "0" to "1": Typ. 150 µs for 0.5 A resistive load (500 µs maximum) - For "1" to "0": Typ. 50 µs for 0.5 A resistive load Switching frequency: For resistive load: max. 100 Hz For inductive load: max. 0.5 Hz For lamp load: Max. 10 Hz Maximum lamp load: 5 W

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

Note

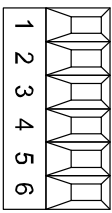An open input is interpreted as "low".

Note

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

7.4.3.10 X542 relay outputs

Table 7- 35   X542 terminal strip

	Terminal	Designation [1]	Technical specifications
1 2 3 4 5 6	1	DO 0.NC	Contact type: Two-way contact max. load current: 8 A
	2	DO 0.COM	Max. switching voltage: 250 V_{AC}, 30 V_{DC}
	3	DO 0.NO	max. switching power at 250 V_{AC}: 2000 VA (cosϕ = 1) max. switching power at 250 $V_{AC:}$ 750 VA (cosϕ = 0.4)
	4	DO 1.NC	max. switching power at 30 V_{DC}: 240 W (resistive load)
	5	DO 1.COM	Required minimum current: 100 mA Output delay: ≤ 20 ms [2]
	6	DO 1.NO	Overvoltage category: Class III to EN 60 664-1

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

[2] depending on the parameters assigned and the supply voltage (P24) of the TM31
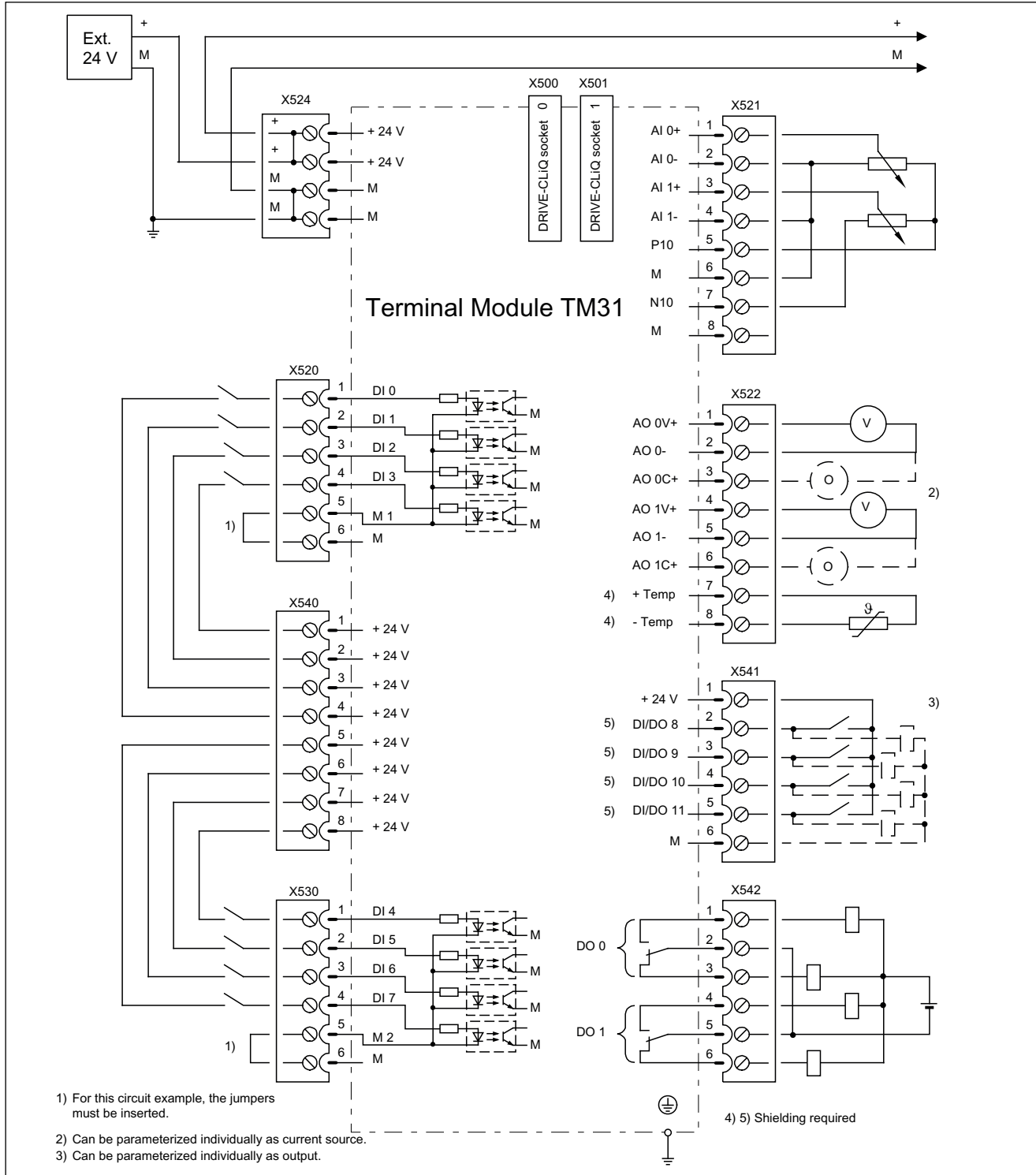
7.4.4 Connection example

Figure 7-19   TM31 connection example

7.4.5 Meanings of the LEDs on the Terminal Module TM31

Table 7- 36   Terminal Module TM31 - description of LEDs

LED	Color	State	Description, cause	Remedy
READY	-	OFF	Electronics power supply is missing or outside permissible tolerance range.	–
	Green	Continuous	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.	–
	Orange	Continuous	DRIVE-CLiQ communication is being established.	–
	Red	Continuous	At least one fault is present in this component. **Note:** The LED is activated regardless of whether the corresponding messages have been reconfigured.	Remedy and acknowledge fault
	Green/red	Flashing 0.5 Hz	Firmware is being downloaded.	–
		Flashing 2 Hz	Firmware download is complete. Wait for POWER ON	Carry out a POWER ON
	Green/orange or Red/orange	Flashing	Component recognition via LED is activated (p0154). **Note:** Both options depend on the LED status when component 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 (IH1)
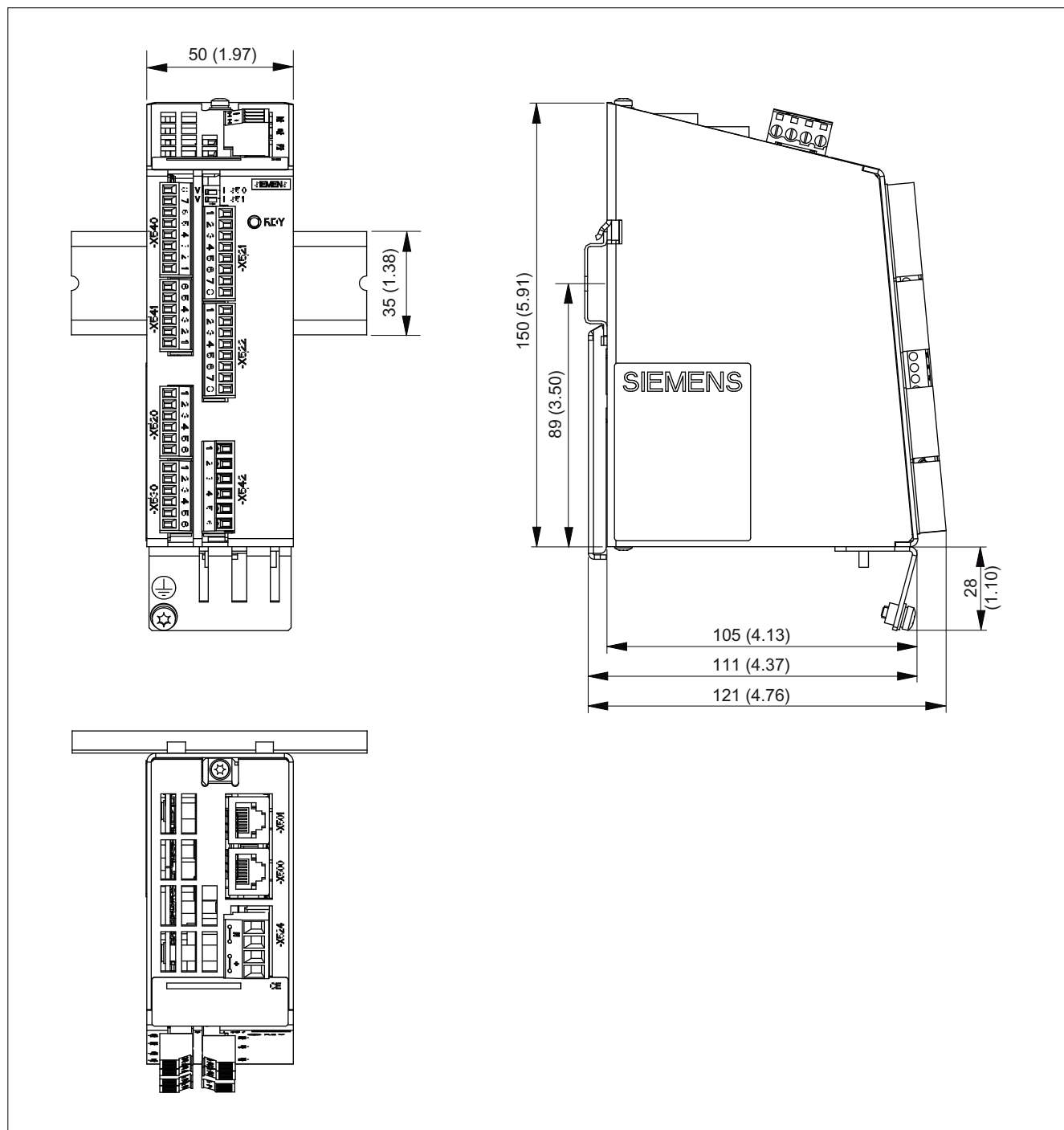SINAMICS DCM, List Manual

7.4.6 Dimension drawing

Figure 7-20   Dimension drawing of Terminal Module TM31, all data in mm and (inches)

7.4.7 Installation

Installation

1. Tilt the component backwards slightly and snap it onto the mounting rail using the hook.

2. Push the component towards the mounting rail until you hear the mounting slide at the rear latch into position.

3. You can now move the component to the left or right along the mounting rail, until it reaches its final position.

Deinstalling

1. The lug on the mounting slide must first be pushed down to release the interlock from the mounting rail.

2. The component can now be tilted towards the front and removed from the mounting rail.
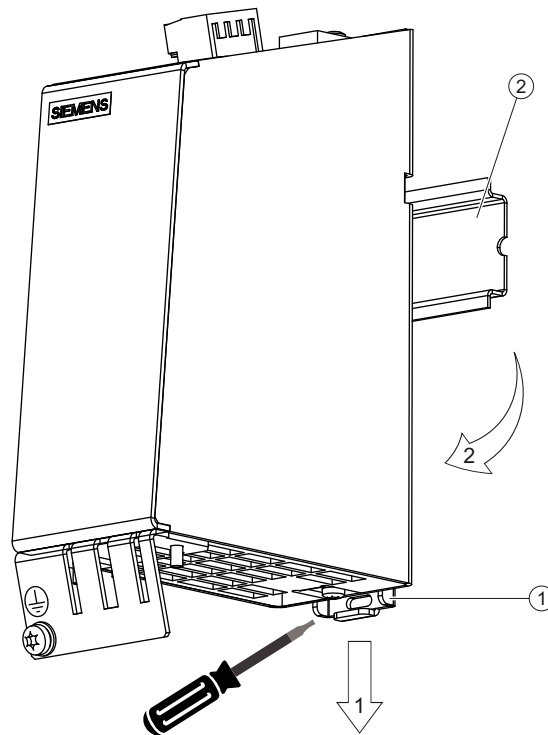
Figure 7-21   Removing from a mounting rail

217

7.4.8 Protective conductor connection and shield support

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

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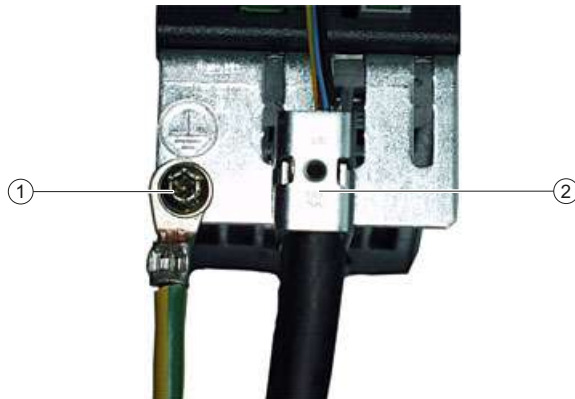

Figure 7-22   Shield supports

Weidmüller website address: http://www.weidmueller.com

⚠ DANGER
If the shielding procedures described and the specified cable lengths are not observed, the machine may not operate properly.

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

7.4.9 Connector coding

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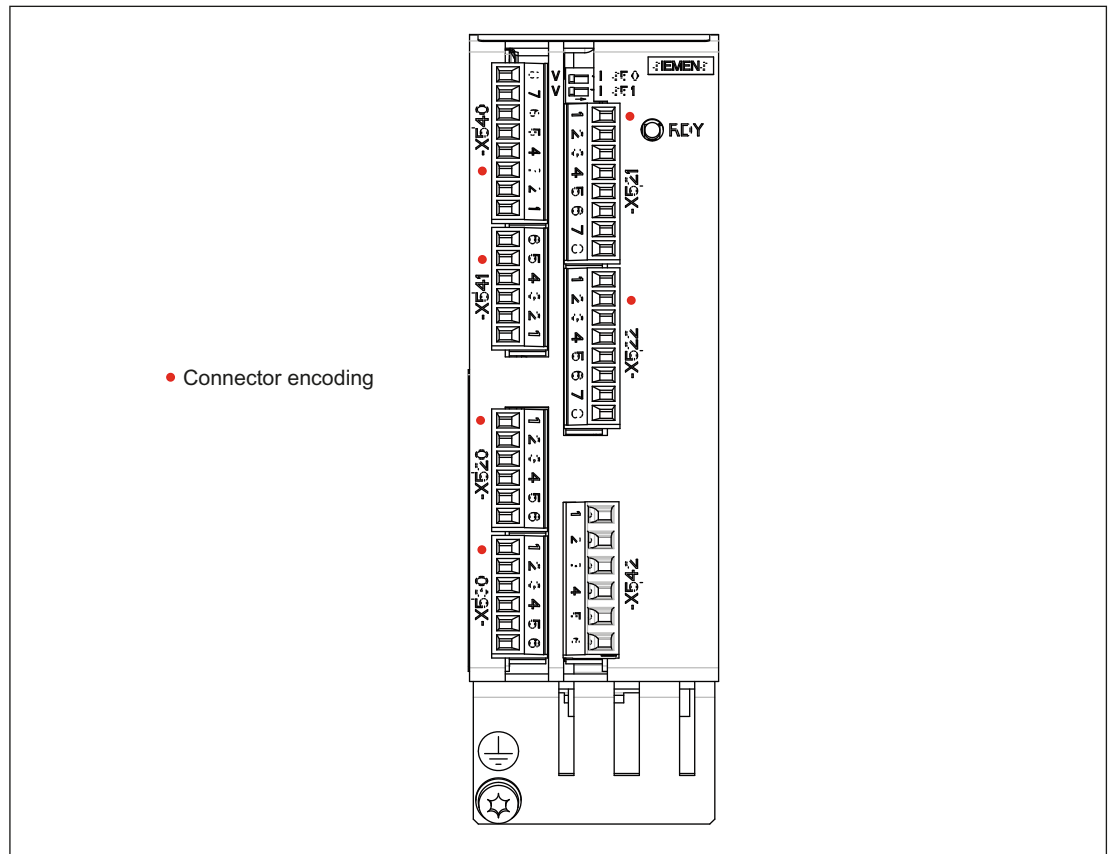

Figure 7-23   TM31 connector coding

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

7.4.10 Technical data

Table 7- 37   Technical data

	Unit	Value
Electronics power supply Voltage Current (without DRIVE-CLiQ or digital outputs) Power loss	V_{DC} A_{DC} W	24 DC (20.4 – 28.8) 0,5 <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: • Response time on the component itself (approx. 1/2 DRIVE-CLiQ clock cycle). • Transmission time via the DRIVE-CLiQ connection (approx. 1 DRIVE-CLiQ clock cycle) • Evaluation on the Control Unit (see function diagram) Further information: SINAMICS DCM List Manual, chapter, "Function diagrams"	
Weight	kg	1

Commissioning

<div style="text-align: right; font-size: 4em;">8</div>

> ⚠️ **WARNING**
>
> This unit is subject to hazardous voltage levels and contains dangerous rotating machine parts (fans). Failure to comply with these Operating Instructions can lead to death, serious physical injury, and material damage.
>
> Dangerous voltage levels may be present at the signaling relays at the customer's site.
>
> The units 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.
>
> Only qualified personnel who are familiar with all the safety instructions in this description, as well as the installation, operating, and maintenance instructions, should carry out work on this unit.
>
> Perfect, safe, and reliable operation of this unit is conditional upon it having been transported, stored, mounted, and installed correctly, as well as carefully operated and serviced.
>
> The unit is subject to dangerous voltage levels even when the converter unit's line contactor is open. The control module (Power Interface) contains several circuits that are subject to dangerous voltage levels. Before commencing maintenance or servicing work, disconnect all current sources of the converter infeed and disable them.
>
> To operate the SINAMICS DC MASTER, both front cover fixing screws must be tight.
>
> These instructions are not exhaustive and as such cannot outline all the measures required in order to operate the unit safely. Where necessary, additional information or instructions may be required for special applications. If you encounter specific problems which have not been handled in enough detail for the purposes of the buyer, please contact your local Siemens office.
>
> The use of non-approved parts for carrying out repair work on the unit or handling of the unit by inadequately qualified personnel will result in dangerous conditions with the risk of death, serious physical injury, or extensive damage to equipment. All safety measures listed in these Operating Instructions, as well as all warning signs attached to the unit, must be followed.
>
> Observe all the warning information outlined in Chapter 1 of these Operating Instructions.

CAUTION
Before coming into contact with modules (and in particular the CUDs), the operator must be electrostatically discharged in order to protect electronic components against high voltages that are produced by electrostatic charging. The easiest way to do this is to touch a conductive, grounded object immediately beforehand (for example, the bare metal part of a control cabinet).
Modules must not come into contact with highly insulating materials (such as plastic sheets, insulated desktops, or articles of clothing manufactured from man-made fibers).
Modules must only be set down on conductive surfaces.

NOTICE
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 the "Description of functions" chapter, "Description of the LEDs on the CUD" section)
• The BOP20 flashes
Interrupting the power supply while saving can lead to the loss of the current device parameter assignments. Also refer to the "Operation" chapter, "Memory Card functions" section.

8.1 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 DP1: Red	POWER ON
-	RDY: Orange DP1: Red	15 s
Display "run up"	RDY: Orange DP1: Red	35 s
Operating state 12.4	RDY: Green DP1: -	40 s
Operating state 7.0	RDY: Green DP1: -	45 s
[1] Power-up with saved parameters (RAM to ROM was carried out)		

The status of the LEDs on the CUD (refer also to the "Description of functions" chapter, "Description of the LEDs on the CUD" section) is only visible if the device cover is open.

Note

If options are being used (DCC, CBE20, SMC30, TM15, TM31, 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 (refer also to the "Operation" chapter, "Memory Card functions" section).

8.2 Commissioning using the BOP20 operator panel

8.2.1 Preconditions

SINAMICS basics

If you are not yet familiar with SINAMICS basics (parameters, drive objects, BICO technology, and so on), please read "Basics" in the section titled "Operation" before starting commissioning.

BOP20 operator panel

If you are not yet familiar with the BOP20 operator panel, please read "Assigning parameters using the BOP20" in the section titled "Operation" before starting commissioning.

Notation of the parameters

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

(oo)pxxxxx[ii]   for indexed parameters

(oo)pxxxxx   for non-indexed parameters

To make these easier to read, in this chapter the drive object specification has been omitted from all parameters belonging to the "automatic speed 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).

8.2.2 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 9, Section, Displaying and operation using the BOP20.

Access level

(1)p0003 = 1   Standard

(1)p0003 = 2   Advanced

(1)p0003 = 3   Expert

〈2〉 Adjust the rated unit currents

NOTICE
The US rating must be set at p50067 for base drives (type 6RA80xx-2xxxx) manufactured in North America.

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

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

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

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

〈3〉 Adjust to the actual unit supply voltage

p50078[0]   Rated input voltage for converter armature (in volts)
p50078[1]   Rated input voltage for converter field (in volts)

〈4〉 Enter the motor data

The motor data, as specified on the motor rating plate, must be entered in the following parameters (see also the sections titled *"Thermal overload protection for the DC motor"* and *"Speed-dependent current limitation"*):

Figure 8-1   Example of a rating plate

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)

〈5〉 Data for actual speed value acquisition

〈5.1〉 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 that the physical speed can only be displayed correctly for one data set (DDS).

〈5.2〉 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.

〈5.3〉 **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 unit 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 that the physical speed can only be displayed correctly for one data set (DDS).

〈5.4〉 **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. For that reason, the physical speed can only be displayed correctly for one data set (CDS).

〈5.5〉 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

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

〈6〉 Data for field

〈6.1〉 Control of the field

p50082 = 0 Internal field is not used
(e.g. in the case of permanent-magnet motors)

p50082 = 1 The field is activated with the line contactor
(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

〈6.2〉 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

〈7〉 Set basic technological functions

〈7.1〉 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)

〈7.2〉 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)

〈7.3〉 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)

〈8〉 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.

〈9〉 Execute optimization runs

Perform the optimization runs one after the other:

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

See Chapter "Drive optimization" for more details

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.

> **⚠ DANGER**
>
> During optimization runs, the drive initiates motor movements that can reach the maximum motor speed. The EMERGENCY OFF functions must be fully operational during commissioning. To protect man and machines, the relevant safety regulations must be observed.

〈10〉 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.

〈11〉 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.

〈12〉 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".

〈13〉 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. Also refer to the "Operation" chapter, "Memory Card functions" section.

〈14〉 Documentation of set values

The following facilities are available to document the executed settings outside the device:

● External Memory Card was inserted during the RAM to ROM (p0977=1). The parameters were therefore also transferred to the external Memory Card.

● Write the parameters to a Memory Card (p0804).

● Document the parameters in a STARTER project (load to PG). Also refer to the "Operation" chapter, "Memory Card functions" section and "Commissioning with the STARTER commissioning tool" chapter.

8.3 Commissioning using the AOP30 operator panel

8.3.1 First commissioning

> **Note**
>
> To operate the AOP30, p2030=3 must be set.

8.3.1.1 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:
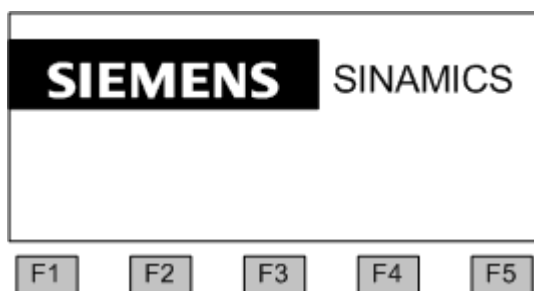

Figure 8-2   Splash screen

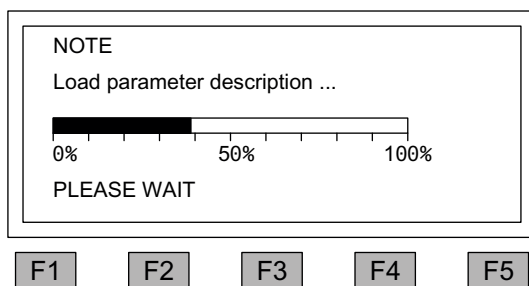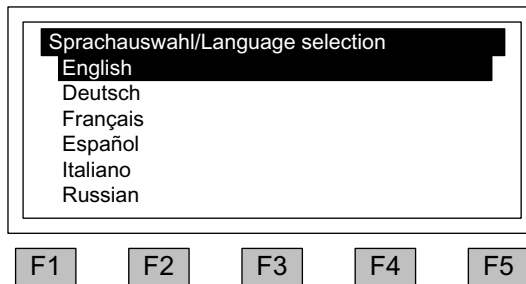While the system is powering up, the parameter descriptions are loaded to the operator panel (remark: The Memory Card does not have to be inserted)

Figure 8-3   Loading the parameter descriptions while powering up the system

Selecting the language

When the system is first powered up, a screen for selecting the language appears.

```
Sprachauswahl/Language selection
 English
 Deutsch
 Français
 Español
 Italiano
 Russian
```

```
 F1      F2      F3      F4      F5
```

You can select the language in the dialog screen.

To change the language, choose <F2> or <F3>.
To select the language, choose <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.

8.3.1.2   Full drive commissioning

Adjust the rated unit currents

NOTICE
The US rating must be set at p50067 for base drives (type 6RA80xx-2xxxx) manufactured in North America.

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

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

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

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

Adapt to the actual unit supply voltage

p50078[0]	Rated input voltage for converter armature (in volts)
p50078[1]	Rated input voltage for converter field (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

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 See the section titled "Thermal overload protection for the DC motor (I2t monitoring of the motor)"

When you have finished entering the motor data, choose "Continue" underneath 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 "Continue" 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 = 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

See Chapter "Drive optimization" for more details

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.

> ⚠ **DANGER**
>
> During optimization runs, the drive initiates motor movements that can reach the maximum motor speed. The EMERGENCY OFF functions must be fully operational during commissioning. To protect man and machines, the relevant safety regulations must be observed.

8.3.2　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.

8.3.3　Resetting parameters to factory settings

The factory settings represent the defined original status of the unit 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.

8.4 Commissioning with the STARTER commissioning tool

8.4.1 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. This file can be called from the starting page of the SINAMICS DCM documentation on DVD.

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.

8.4.1.1 Installing the STARTER commissioning tool

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

8.4.1.2 Layout of the STARTER user interface
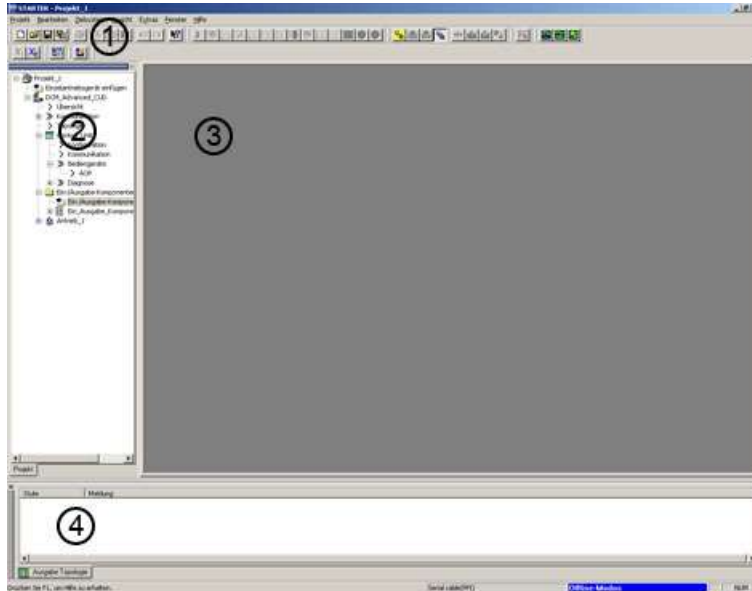
STARTER provides these 4 operating areas:

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.

8.4.2 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.

NOTICE
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).

8.4.2.1 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.
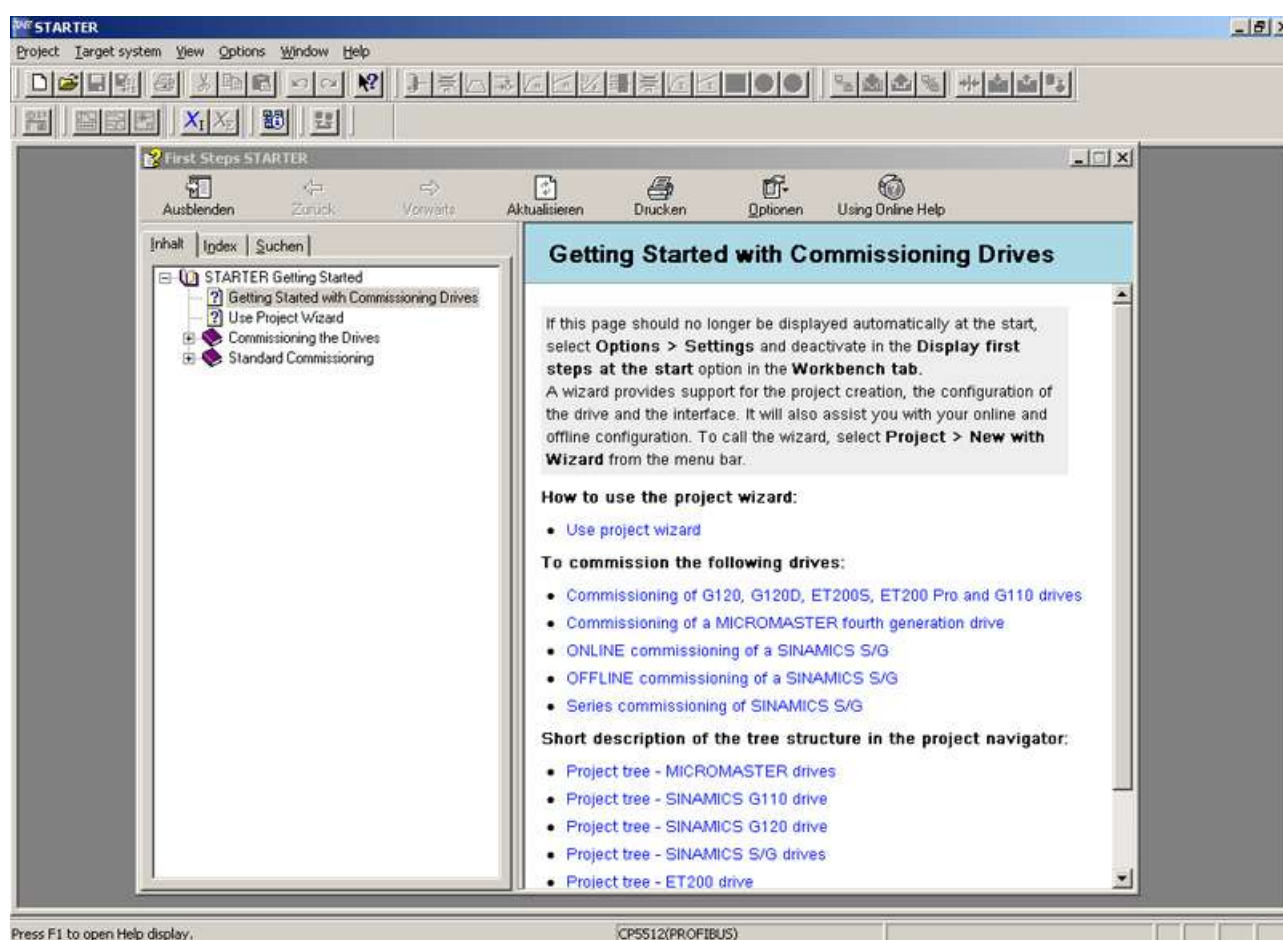
Accessing the STARTER project wizard

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
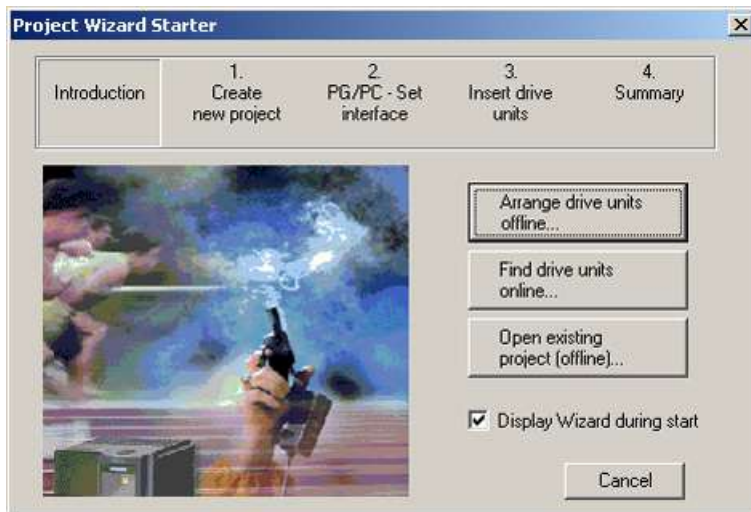
Figure 8-7   STARTER project wizard

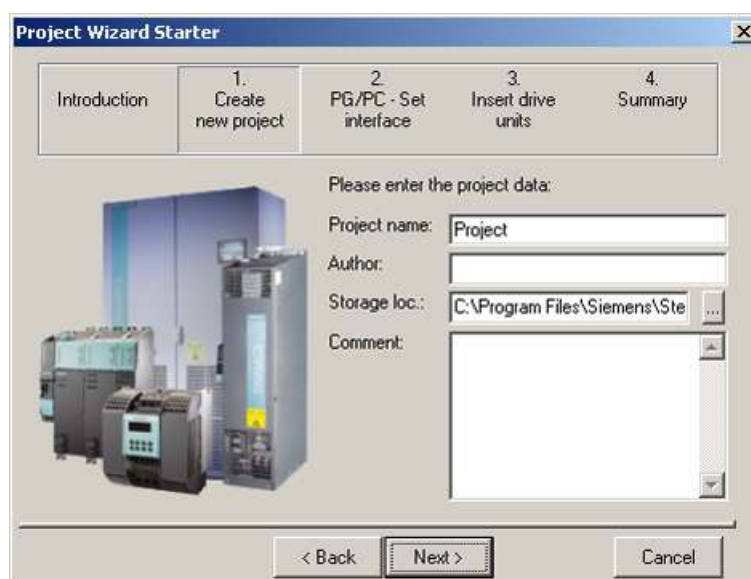⇒ Click **Arrange drive units offline...** in the STARTER project wizard

Figure 8-8   Creating a new project

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

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

Figure 8-9   Interface setup

⇒ Click **Change and test...** and set up the interface in accordance with your device configuration.
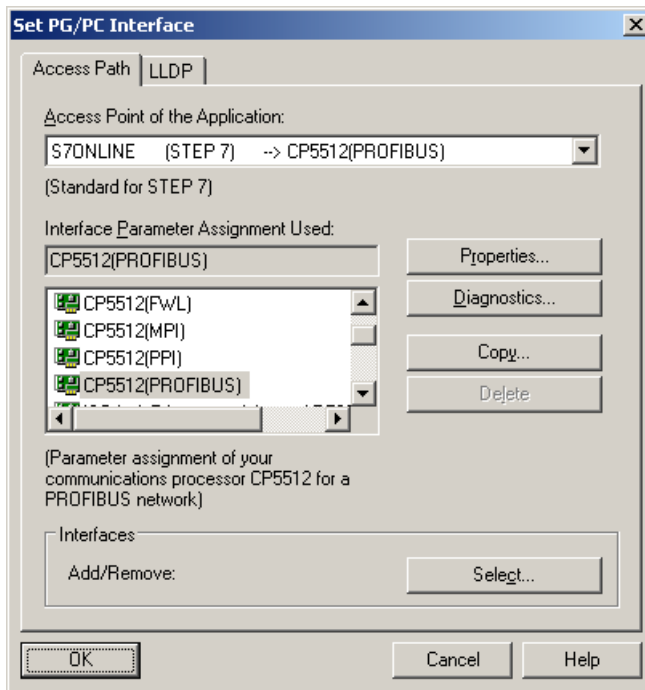The **Properties...**, **Copy...** and **Select...** buttons are available.

Figure 8-10   Setting up the interface

Note

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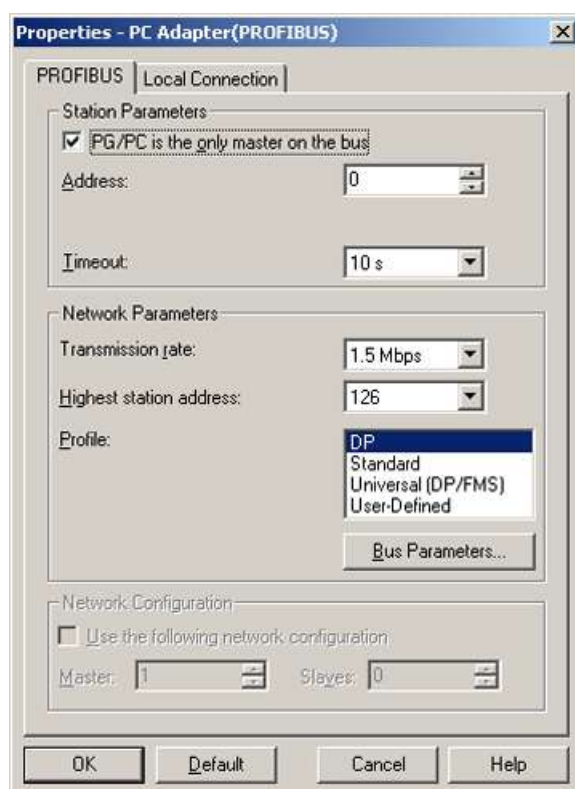

242

Figure 8-11   Setting up the interface - properties

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

Note

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

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

⇒ After completion, click **OK** to confirm the setup and to return to the project wizard.
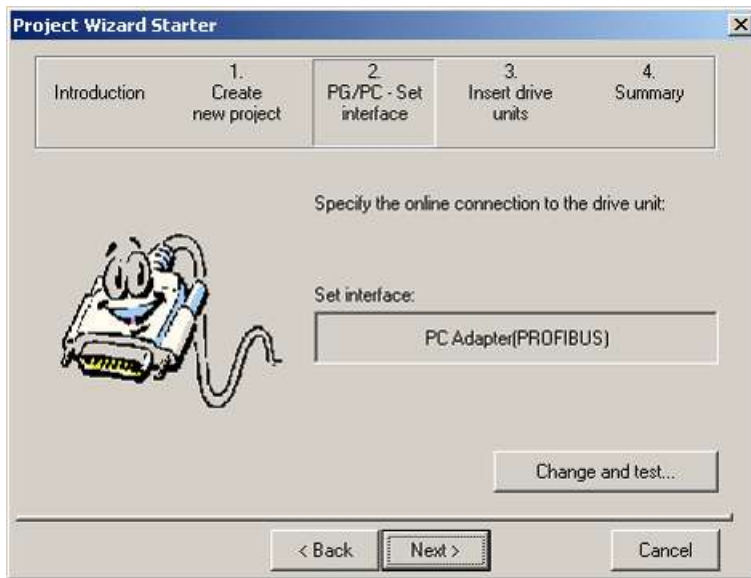
Figure 8-12   Setting up the interface

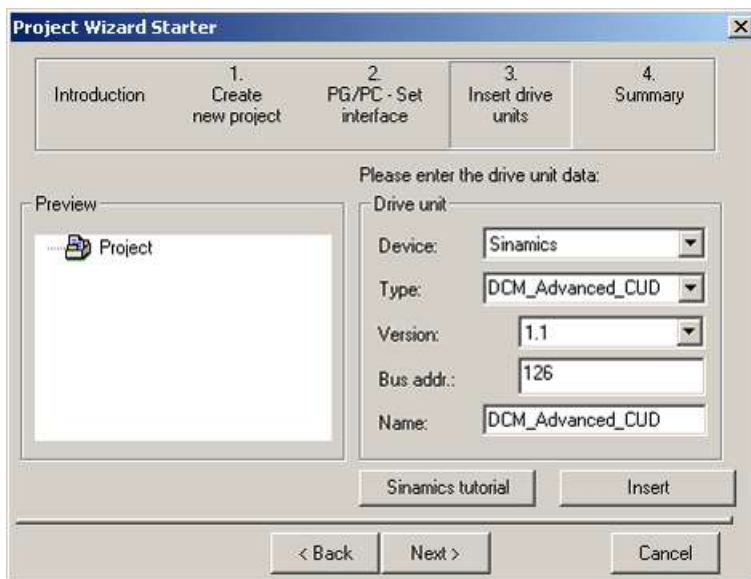⇒ Click **Continue >** to set up a drive unit in the project wizard.

Figure 8-13   Inserting a drive unit

⇒ Select the following data from the list fields:

Unit: SINAMICS DCM

Type: Standard CUD /

                        Advanced CUD, if you have purchased Option G01

                        Standard CUD [2] for a Standard CUD in the right-hand slot

                        Advanced CUD [2] for a Advanced CUD in the right-hand slot

244

Version:	actual version
Bus address:	The corresponding drive bus address (the default is 126)
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 p918.

To keep p918 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 p918 using BOP20 or AOP30.

Note

A second CUD for expanding the computing capacity is created in the STARTER as an independent device, type "Sinamics 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**
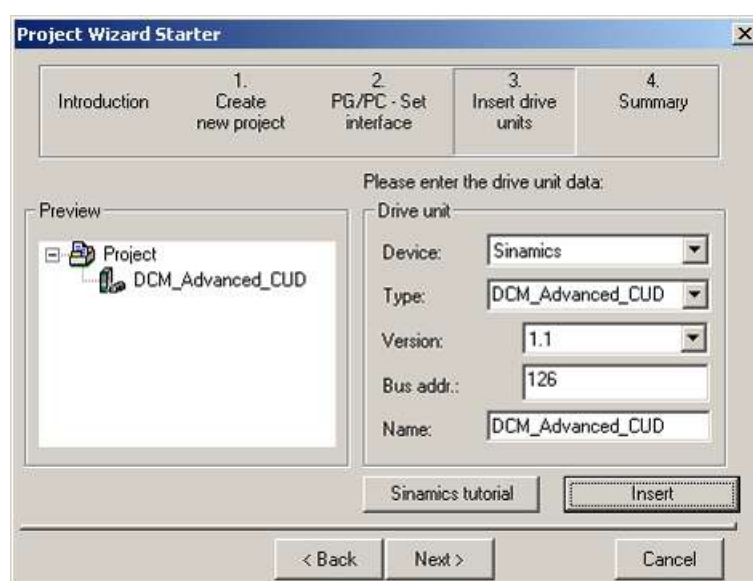The selected drive unit is displayed in the project wizard preview window.

Figure 8-14   Inserting a drive unit

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

245

Figure 8-15   Summary

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

8.4.2.2   Configuring a drive unit

Note: STARTER must be offline.

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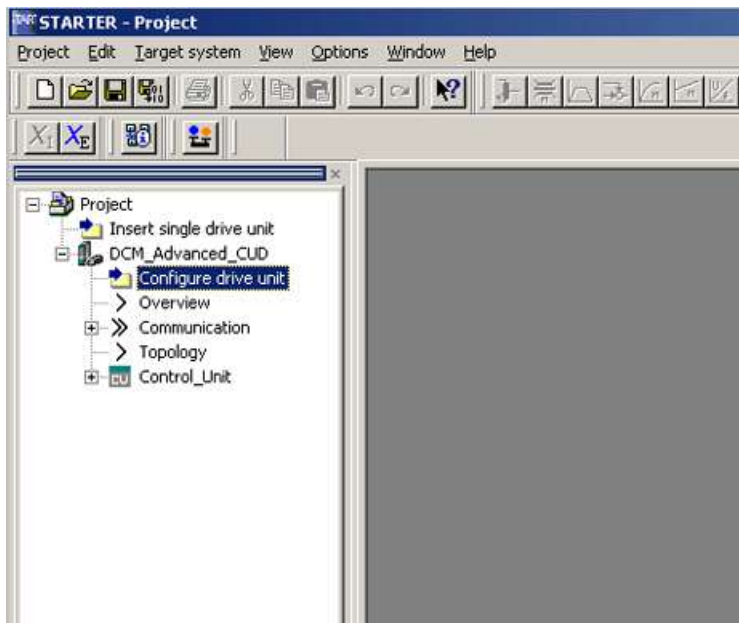

Figure 8-16   Configuring the project navigator drive unit

⇒ 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**
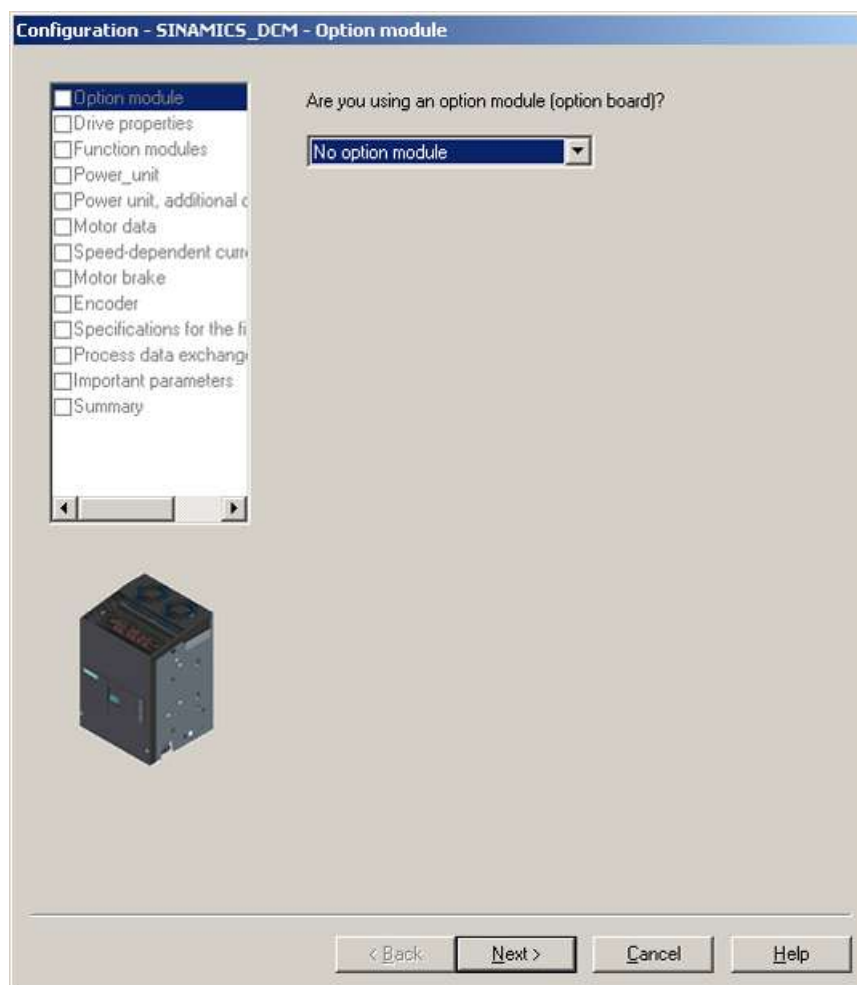
Configuring a drive unit

Figure 8-17   Configuring a drive unit

⇒ If you have plugged in a Profinet CBE20 module (option G20), the module needs to be activated here

⇒ Click **Continue >**

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

⇒ Click **Continue >**

Selecting the function modules

Figure 8-18   Selecting options

⇒ If you want to use the free function blocks, you can activate them here.

⇒ Click **Continue >**
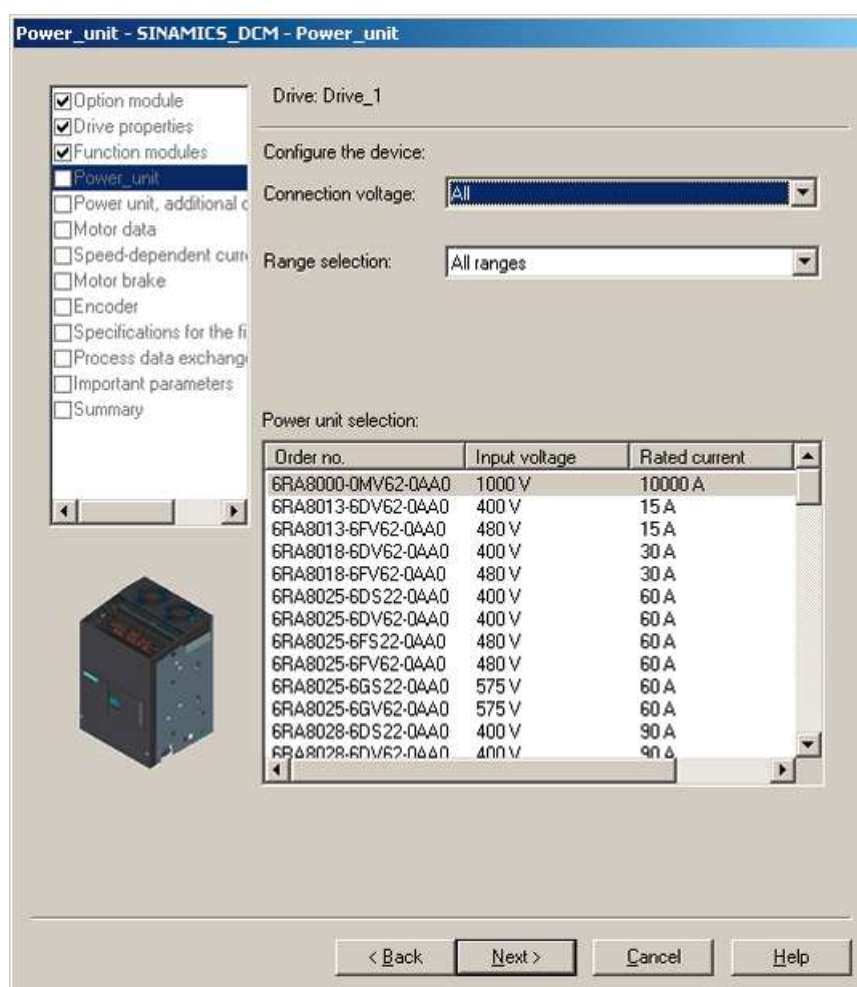
Selecting the size of the unit

Figure 8-19   Selecting the size of the unit

You can filter the MLFB list with the supply voltage and range selection (2Q/4Q) boxes

⇒ Select the corresponding unit according to the MLFB on the rating plate.

⇒ Click **Continue >**

Adapting unit data and entering motor data

Figure 8-20   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

⇒ Enter the **motor rating data** according to the motor rating plate here.

CAUTION
The data are very important to protect against overloading and must be entered correctly.

⇒ Click **Continue >**

Brake control

Figure 8-21   Motor brake

⇒ If a motor brake is available, the type and properties can be set here.

⇒ Click **Continue >**
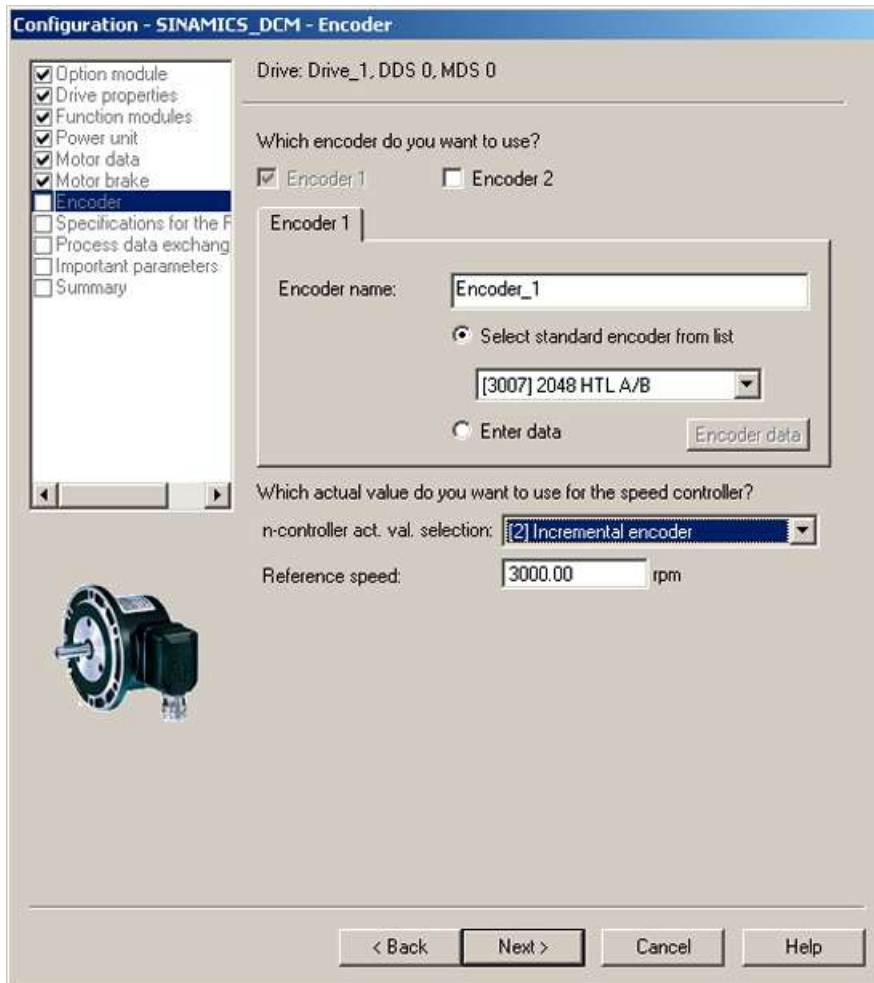
Entering the actual value source

Figure 8-22   Configuring the motor - specifying the actual value source

"Encoder 1" is the encoder evaluation on the CUD.

"Encoder 2" is the evaluation of an optional encoder using SMC30

⇒ Enter the type of tachometer or other actual value source. The drive cannot be operated if no selection is made.

⇒ Enter the reference speed. For display on the AOP30 or to transfer the speed variables via PROFIBUS, the physical speed at 100 % is specified here.

⇒ Click **Continue >**

Encoder data - analog tachometer

⇒ Enter the tachometer voltage at maximum speed.

⇒ Click **Continue >**

Encoder data - incremental encoder

Figure 8-23   Entering the encoder data

⇒ Enter the encoder type (usually HTL/TTL), the number of pulses per revolution, the level and the zero mark configuration

CAUTION
Terminal X177.41 always delivers +15 V to supply the incremental encoder. That is independent of the "voltage supply" setting selected in the box.

Note

The SMC30 supplies 5 V / 24 V encoder supply.

⇒ Click **Continue >**

Encoder data - Actual EMF value

⇒ Enter the tachometer voltage at maximum speed.

⇒ Click **Continue >**

Encoder data - Freely wired actual value

⇒ Enter the source with the actual value for the closed-loop controller via the BICO interconnection.

⇒ Click **Continue >**

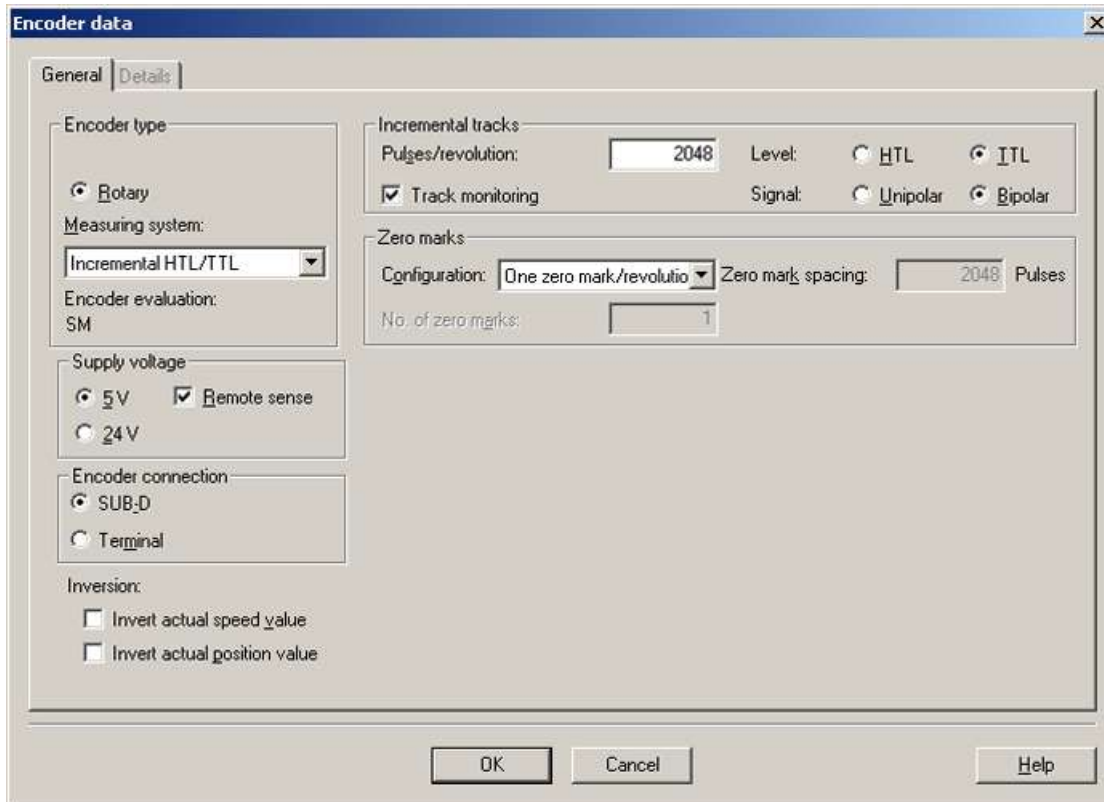## Encoder data – Encoder on the SMC30 evaluation module

Figure 8-24   Entering the encoder data (DRIVE-CLiQ)

⇒ Enter the encoder type (usually HTL/TTL), the number of pulses per revolution, the level and the zero mark configuration

⇒ Click **Continue >**

Data on field

Figure 8-25   Data on field

⇒ Select the behavior of the field control and, if applicable, the field weakening.

Note

If field weakening is activated, the field characteristic curve must be recorded with the optimization run p50051= 27 on the drive before the drive can be switched on.

⇒ Click **Continue >**

Telegram selection

Figure 8-26 Selecting the telegram type

⇒ Select a standard telegram type or, with free configuration, the process data lengths.

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 **Continue >**

Entering important parameters

Figure 8-27   Important parameters

If necessary, enter important technological parameters.

Summary
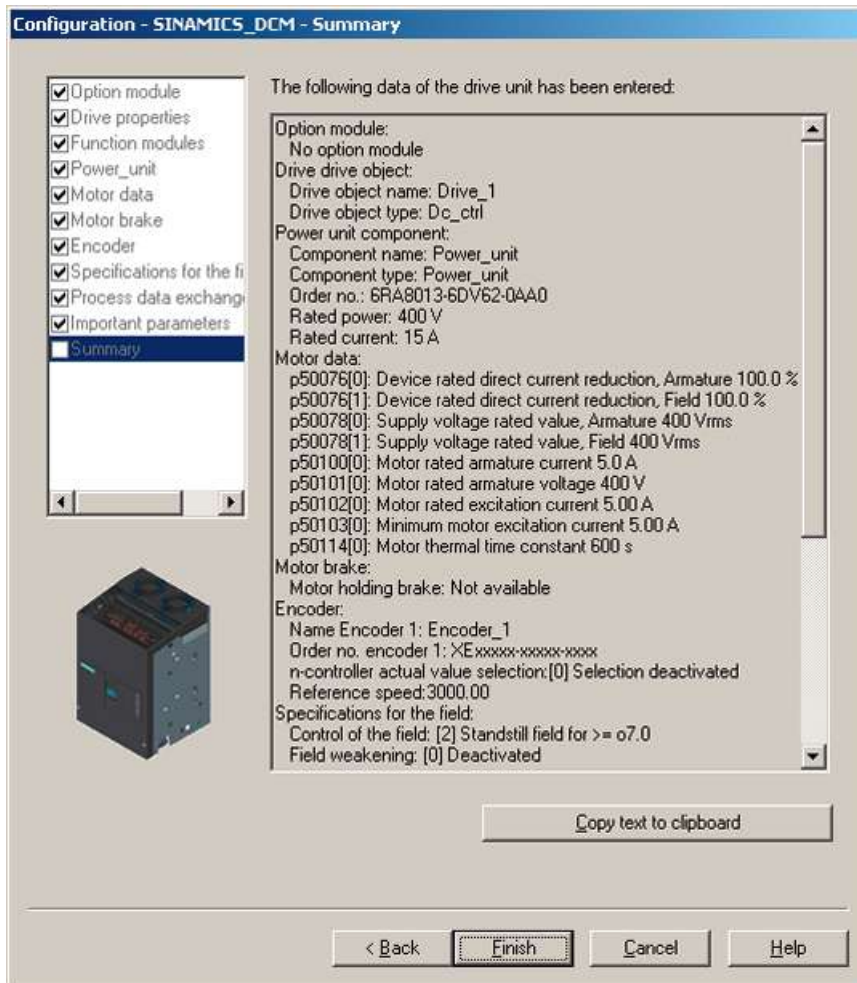
Figure 8-28   Summary

⇒ 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**.

8.4.2.3 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		Selection in the toolbar
1	Select the menu command **Project > Connect to target system**	

If the following screen appears after step 1, select the **Download to target device** menu command and continue with step 3. Otherwise, continue with step 2.

Figure 8-29   Online/offline comparison

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

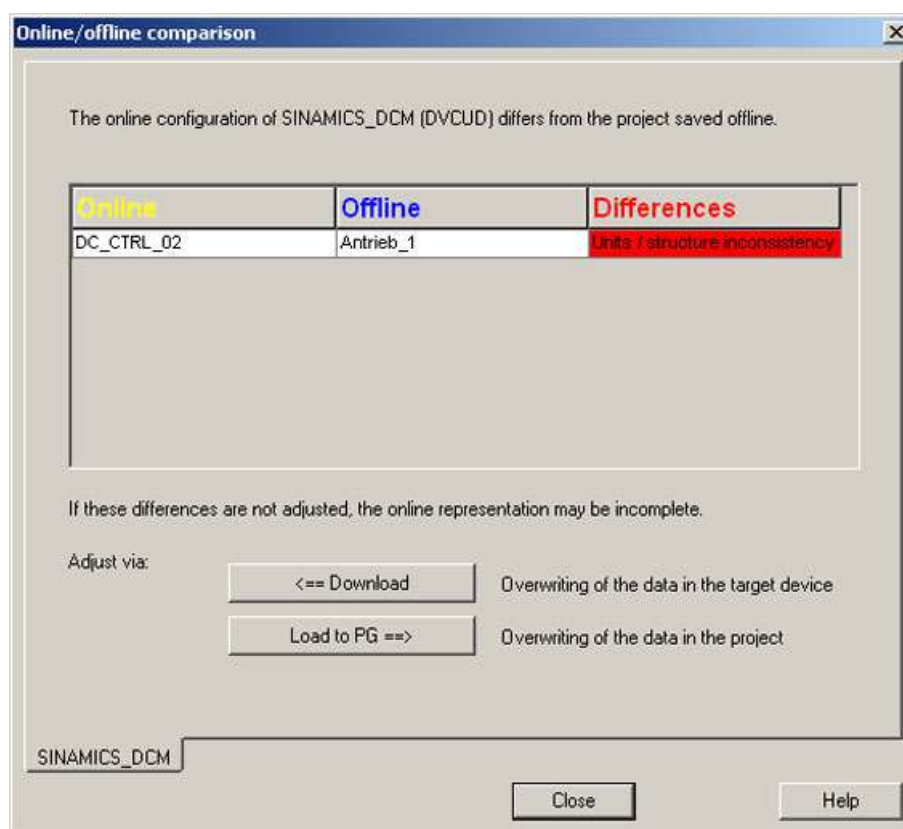| NOTICE |
|---|
| Your project data has now been transferred to the drive unit. Presently, this data is only in the volatile memory (RAM) of the drive unit, however, neither saved in the non-volatile memory (ROM) nor on an optionally inserted memory card (see also Chapter "Memory card functions").

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		Selection in the toolbar
3	Select the menu command **Target system > Copy RAM to ROM**	

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

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8.4.2.4 Connection through a serial interface

Along with the connection through the PROFIBUS, there is also a facility for data exchange via the serial interface.

Preconditions

- A serial interface (COM) must be available on the PC from which the connection will be made.
- An AOP30 must not be connected with the drive.

Connecting cables
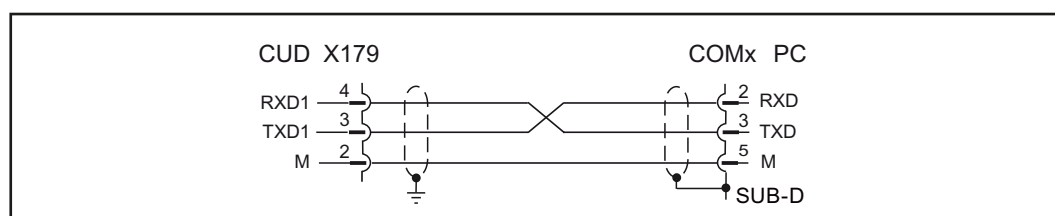
Figure 8-30   Assignment, RS232 cable

Settings

1. In STARTER, from **Project > Set PG/PC interface**, select the **Serial cable (PPI)** interface. If this is not available in the dropdown list, you first have to add it using **Select**.

Note

If the interface cannot be added to the selection menu , the drive for the serial interface still needs to be installed.
This is located in the following path on the STARTER CD:
\installation\starter\starter\Disk1\SerialCable_PPI\
STARTER must not be active while the driver is being installed.

---

2. Enter the following settings. The "0" address and the transmission rate 19.2 kbit/s are important here.
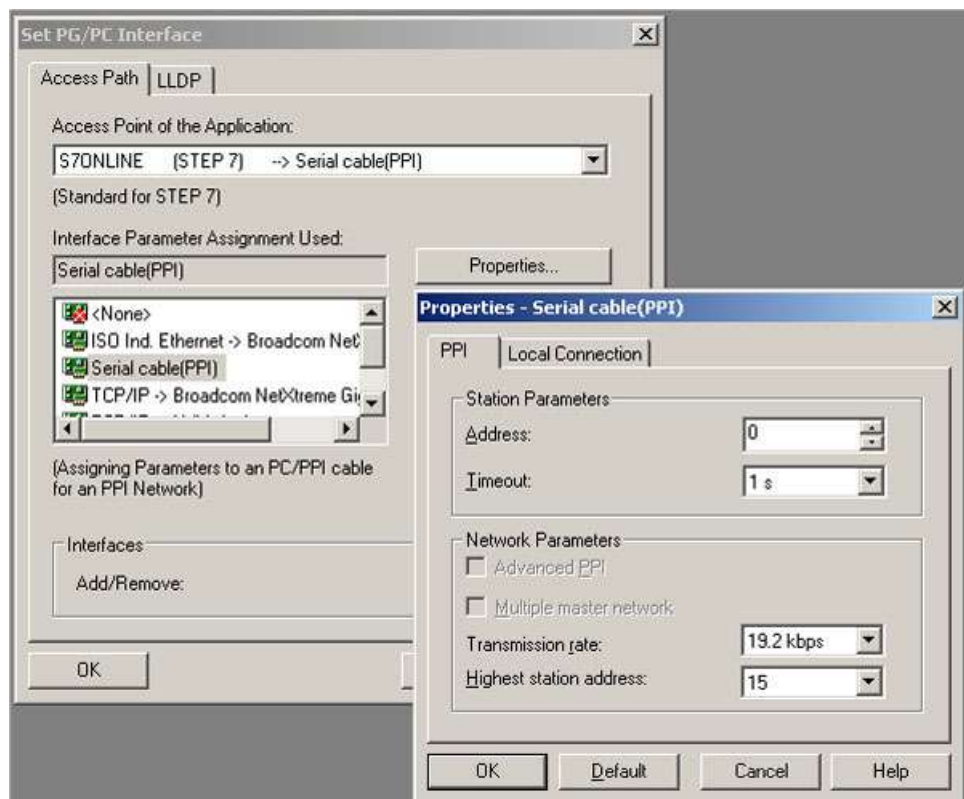
Figure 8-31   Setting up the interface

3. The PPI bus address for a drive unit with a CUD is fixed at 3, for an expansion CUD in the right slot it is fixed at 5.

4. When creating the drive unit, also set the corresponding bus address.
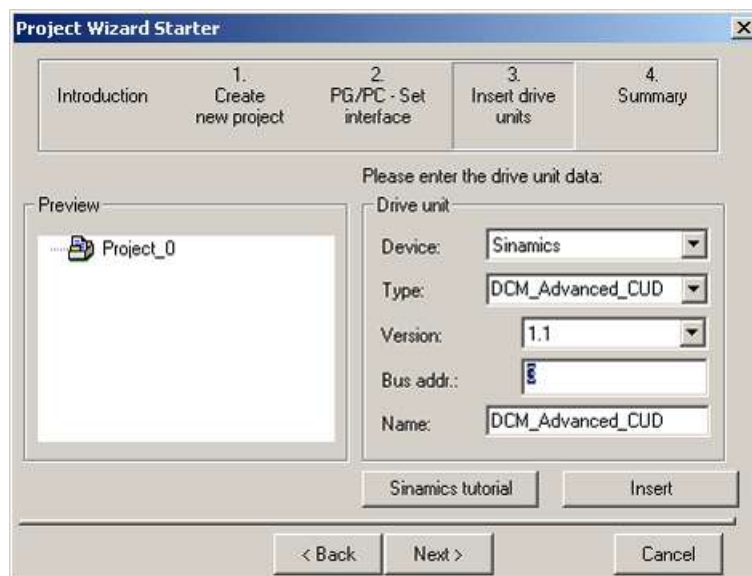
Figure 8-32   Setting the bus address

8.5 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

8.5.1 Activating offline with STARTER

Function modules can be defined for all DOs by using the properties dialog (activate by clicking with the right mouse button on the DO in the project navigator). Shown as example for the closed-loop control DO "Drive_1":
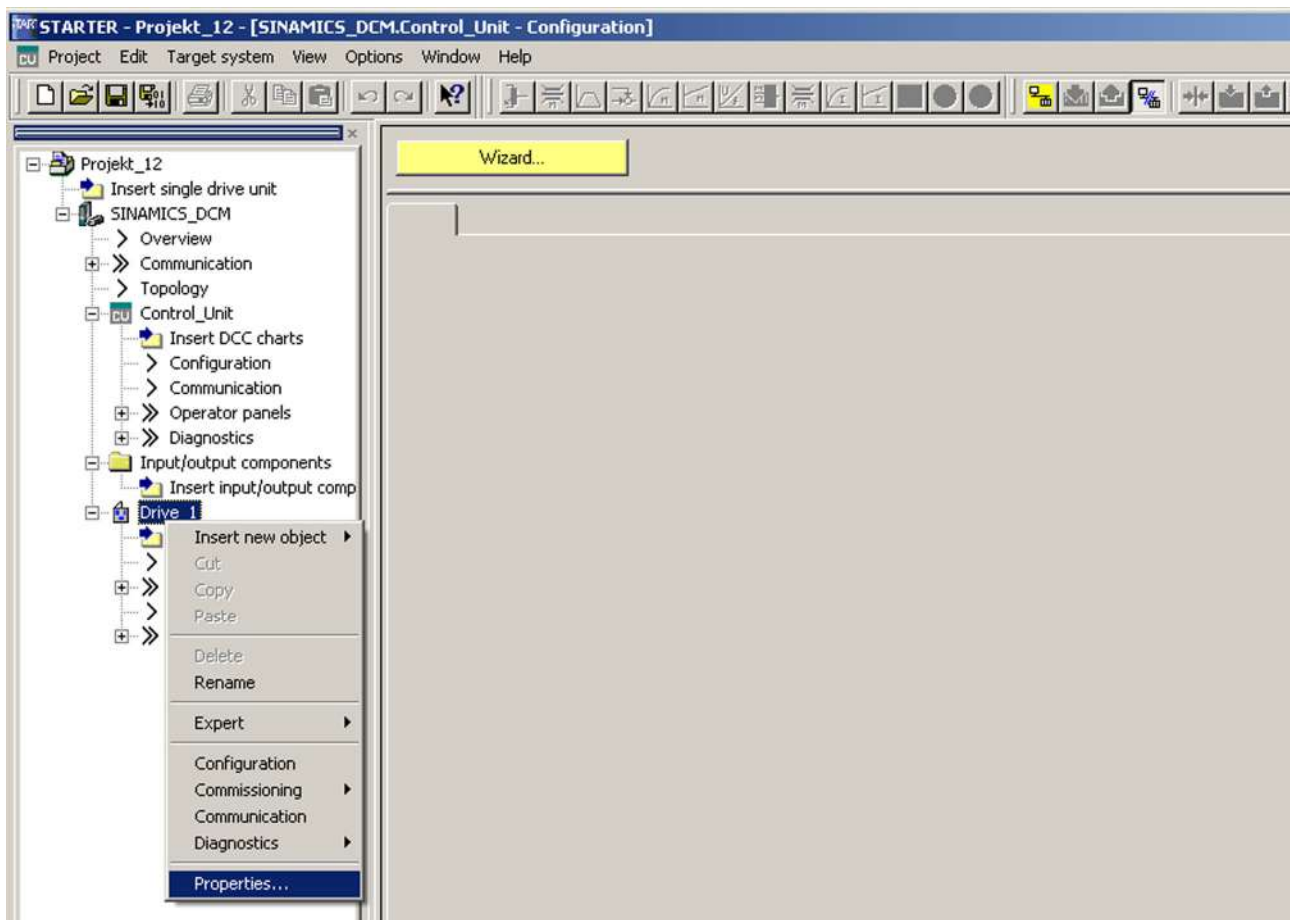
Figure 8-33   Properties

The function modules can be reached in the "Function modules" tab in the opening dialog.
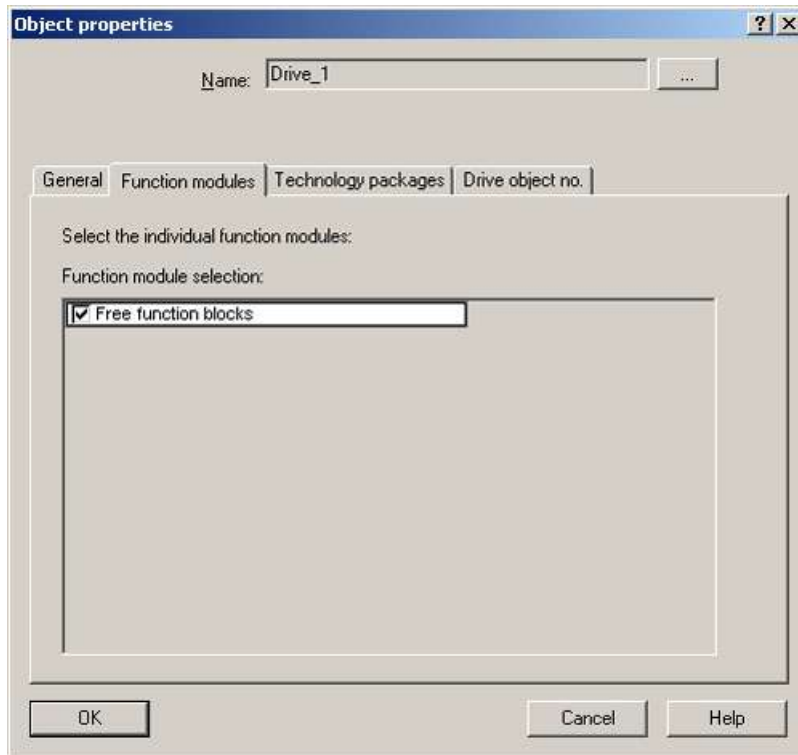
Figure 8-34   Selecting the function modules

Accept the settings by clicking **OK**.

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

8.5.2   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. In this case, the index corresponds to the DO.
Index 0 stands for the CU,
Index 1 for the first DO – the default is the closed loop control DO DC_CTRL,
Index 2 optionally the 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

- Correspondingly set or delete p0108[i] bits

- p0009=0

This triggers the software 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.

8.6 Commissioning optional additional modules

Additional modules can be integrated through Drive-CLiQ (TM15, TM31, SMC30) or OMI slot (CBE20).

The components must be logged in to the software 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 or

- By adding the components through the parameter assignments on BOP20 / AOP30

8.6.1 Terminal Modules (TM31, TM15)

8.6.1.1 Commissioning with STARTER

Requirement

The project must be consistent with the drive before adding the TMxx (loading to PG accomplished)
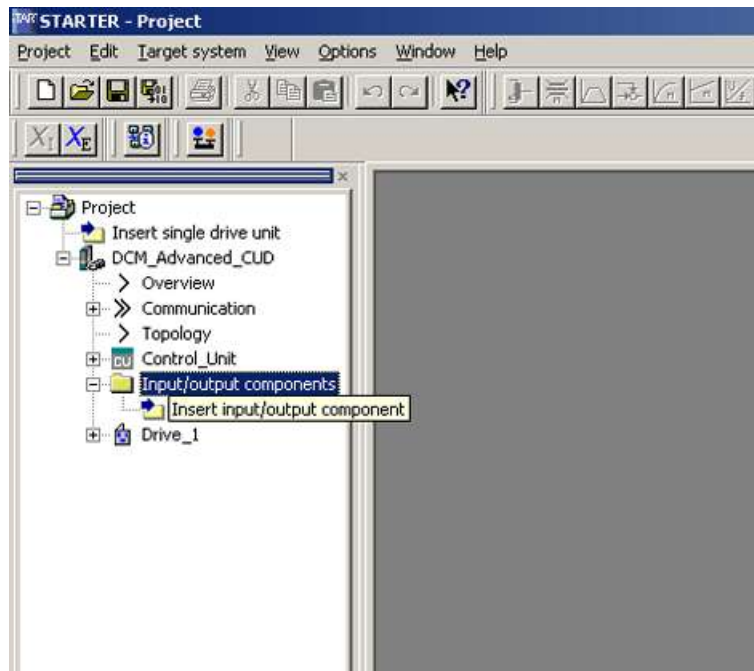
Figure 8-35   Inserting I/O component (1)
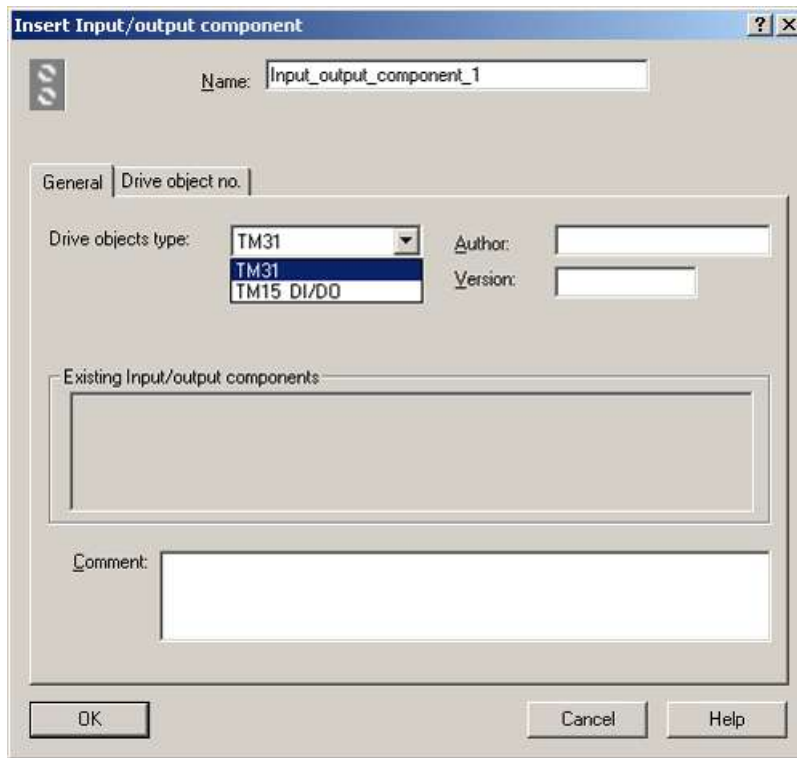
Figure 8-36   Inserting I/O component (2)

- Select the desired type
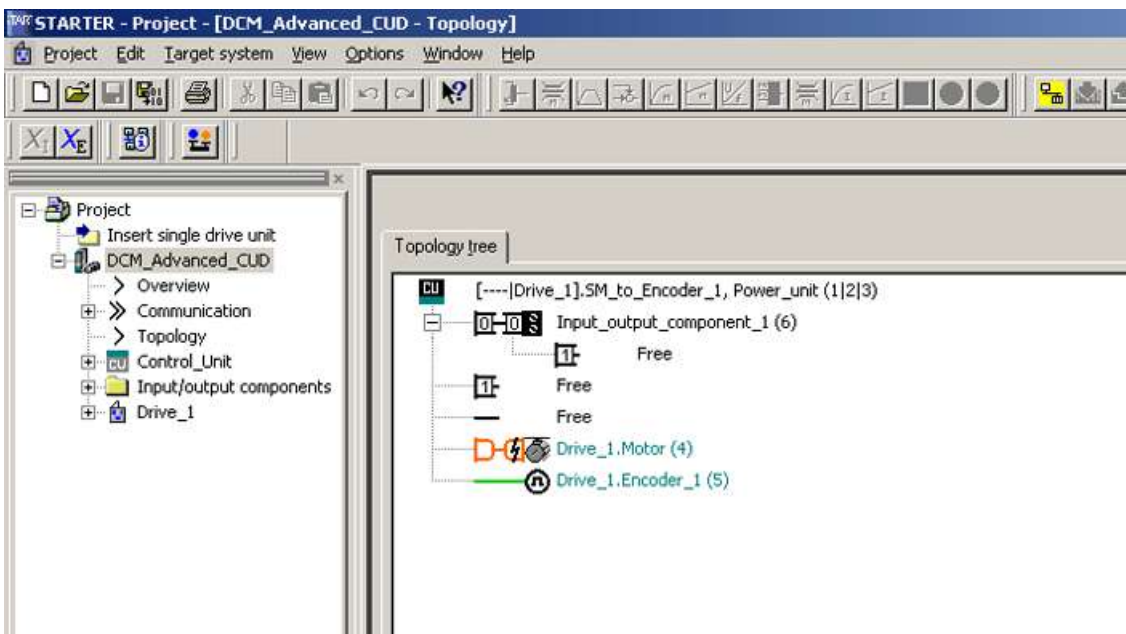
Figure 8-37   Topology

- In the topology view, check which interface the TMxx is to be connected to and connect it there (0 = X100, 1 = X101)

267

- Load the project into the drive with "Download"

- Persistently save with RAM→ROM.

- The LEDs on the Terminal Module now light up green and the parameters of the additional DOs can be accessed.

8.6.1.2 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 software will, if required, be loaded into the Terminal Module. After successful loading, the LED on the SMC30 flashes red/green and alarm A1007 is output. A POWER OFF/ON is required before the component can be used.

---

p0009=1
p9910=1 (= accept components)
p0009=0

The software restarts and accepts the additional components.

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

8.6.2 Encoder evaluation (SMC30)

With an optional SMC30 encoder evaluation, a second incremental encoder can be evaluated. Subsequently adding or deleting an SMC30 to/from an existing project is only possible with the STARTER commissioning tool.

8.6.2.1 Add/commissioning (with STARTER)

Note: STARTER must be offline.

- Start the drive wizard via Configuration – DDS configuration
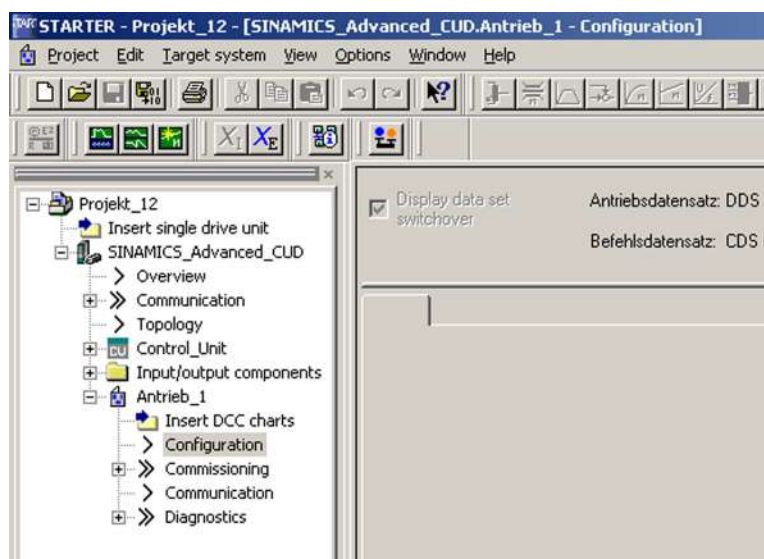
Figure 8-38 Configuring DDS

- Continue to the "Encoder" screen and activate the second encoder there

269
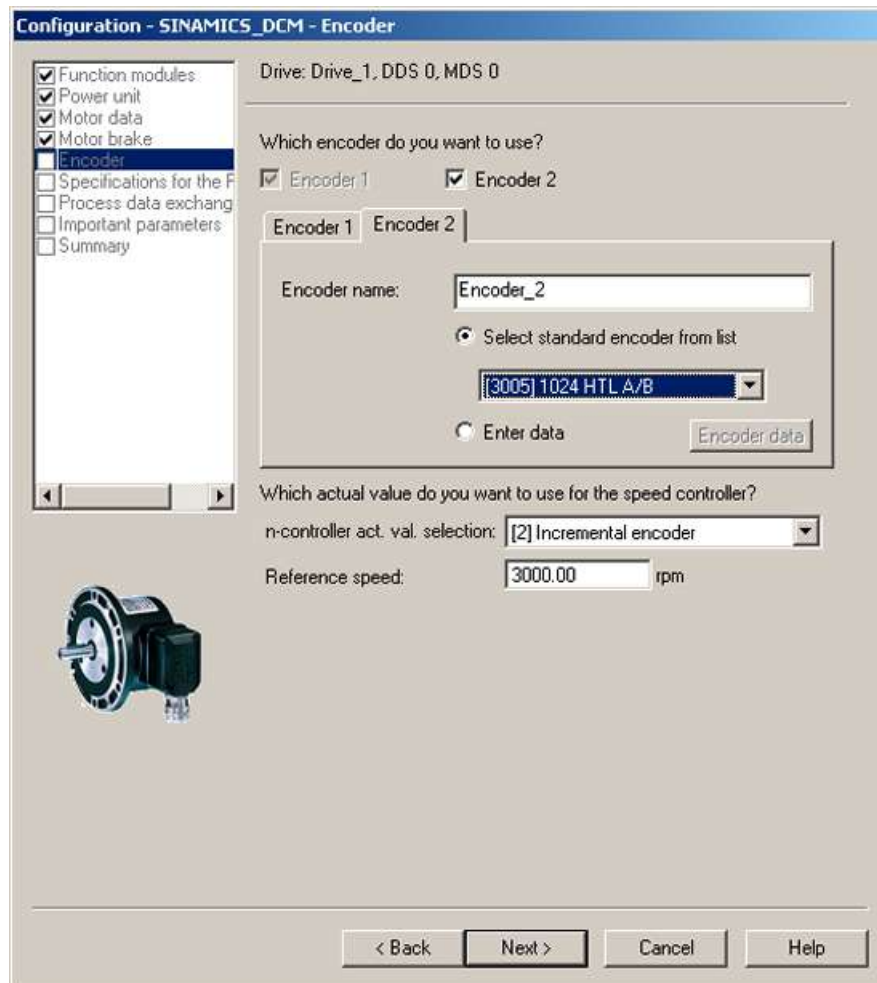
Figure 8-39   2. Activating the encoder

- Use the "Encoder data" button to enter the data of this encoder.
- If you also want to use the encoder connected to the SMC30 as the actual value for the speed controller, you have to select as the source for the actual value "5: encoder on SMC30"
- Run through the wizard until the end and load the expanded project into the drive.

8.6.2.2   Remove (with STARTER)

Note: It is only possible to remove the encoder evaluation from the project in the offline mode

- Start the drive wizard via Configuration - configure DDS
- With Continue>, go to the "Encoder" screen form, and there, deselect encoder 2
- Run through the wizard until the end
- Unplug the encoder evaluation SMC30
- Go online
- Load the project to the drive

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8.6.3 PROFINET module (CBE20)

8.6.3.1 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; refer to the Chapter "Function descriptions", Section "PROFINET IO".

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).

8.6.3.2 Adding offline in STARTER
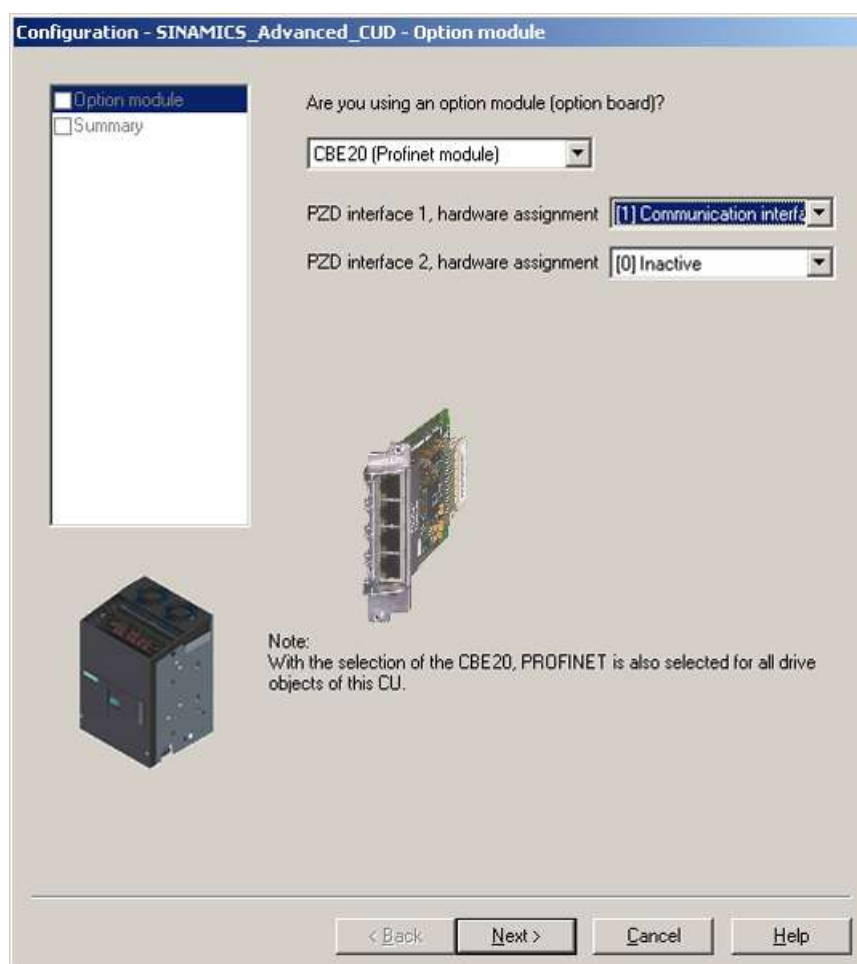
Figure 8-40   Configuration

8.6.3.3 Deleting from the drive online

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

p0009=30
p0976=1
(re-commissioning)

8.6.3.4 Deleting offline with STARTER

In STARTER, using the Control Unit configuration wizard a

CBE20 can also be subsequently added or deleted (see adding offline in STARTER)

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

8.7 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 Chapter "Manual optimization").

Quick commissioning

Procedure

- Start the quick commissioning with p10 = 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, p10 and p3900 are reset to 0)

Commissioning using the BOP20 operator panel:
This procedure is explained for the commissioning steps in Chapter "Commissioning using the BOP20" operator panel.

Commissioning using the AOP30 operator panel:
Quick commissioning is completed (p3900 = 3) as part of the final confirmation. (see Chapter "Commissioning using the AOP30 operator panel", Section "Complete drive commissioning").

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 "Commissioning using the STARTER commissioning tool", Section "Configuring the drive unit"). After successfully "Loading the project into the target system" (see Chapter "Commissioning using the STARTER commissioning tool", Section "Start drive project"), quick commissioning is completed in the SINAMICS DCM.

Optimization runs

⚠ WARNING
During optimization runs, the drive initiates motor movements that can reach the maximum motor speed. The EMERGENCY OFF functions must be fully operational during commissioning. To protect man and machines, the relevant safety regulations must be observed

Procedure

⟨1⟩ The drive must be in operating state o7.0 or o7.1 (enter SHUTDOWN!).

⟨2⟩ 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

⟨3⟩ The SINAMICS DC MASTER 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 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 above.

Details on the individual optimization runs

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)

CAUTION

Motors with a permanent field, a very high level of retentiveness, or a series field must be locked during this optimization run.

⚠️ **WARNING**

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.

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 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 of the actual speed controller value that is set at p50200; and if p50083 = 1, also filtering of the main actual value, which is parameterized at p50745.
For p50200 <20 ms, P50225 (gain) is limited to a value of 30.00. The speed controller optimization run always sets p50228 (speed setpoint filtering) to 0.

⚠ WARNING

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.

---

p50051 = 27   **Optimization of closed-loop EMF control (incl. field characteristic plotting)**

(Duration, approx. 1 min)

This optimization run must be executed whenever 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   Field characteristic (magnetization characteristic) of motor
p50139

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 reaction.

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
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).

p50051 = 28   **Plotting the friction characteristic**

(Duration, approx. 1 min)

The following parameters are set automatically:

p50520 to   Friction characteristic
p50530

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
During this optimization run, the drive accelerates up to its maximum speed.

p50051 = 29 **Optimization of closed-loop 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

This optimization run must not be executed if the motor is connected to a mechanical load that is able to move the motor while it is in a torque-free state (e.g. a suspended load).

NOTICE

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 electronics 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.

8.8 Manual optimization

Manual optimization is best performed using the STARTER commissioning tool.

For this purpose, STARTER provides the functions

- function generator and
- trace.

8.8.1 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 motor armature voltage [V]
p50100 =	Rated motor armature current [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 unit supply voltage, armature [V]
p50100 =	Rated motor armature current [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).

8.8.2 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, actual field current value of 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.

8.8.3 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.
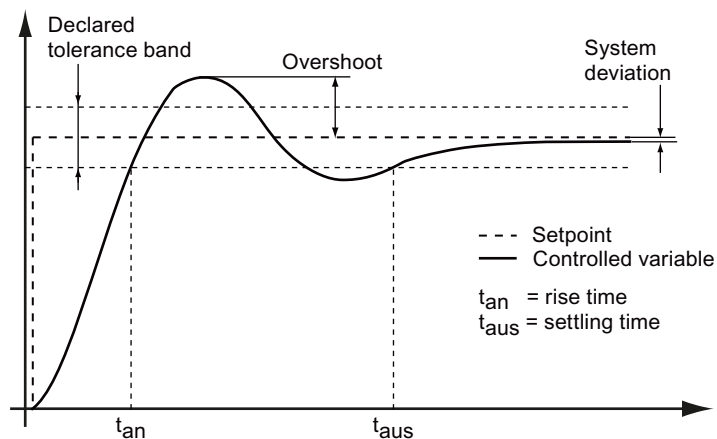
Figure 8-41   Setpoint step to evaluate a controller

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

<div style="text-align: right; font-size: 3em;">9</div>

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
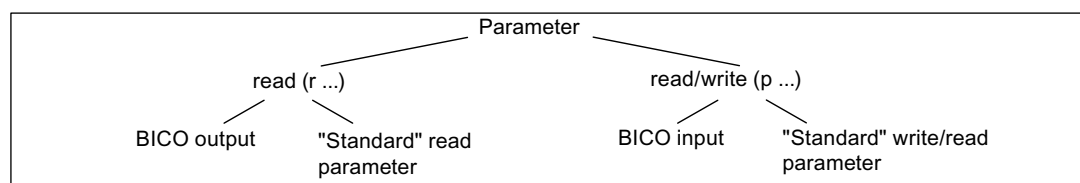
Figure 9-1   Parameter types

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
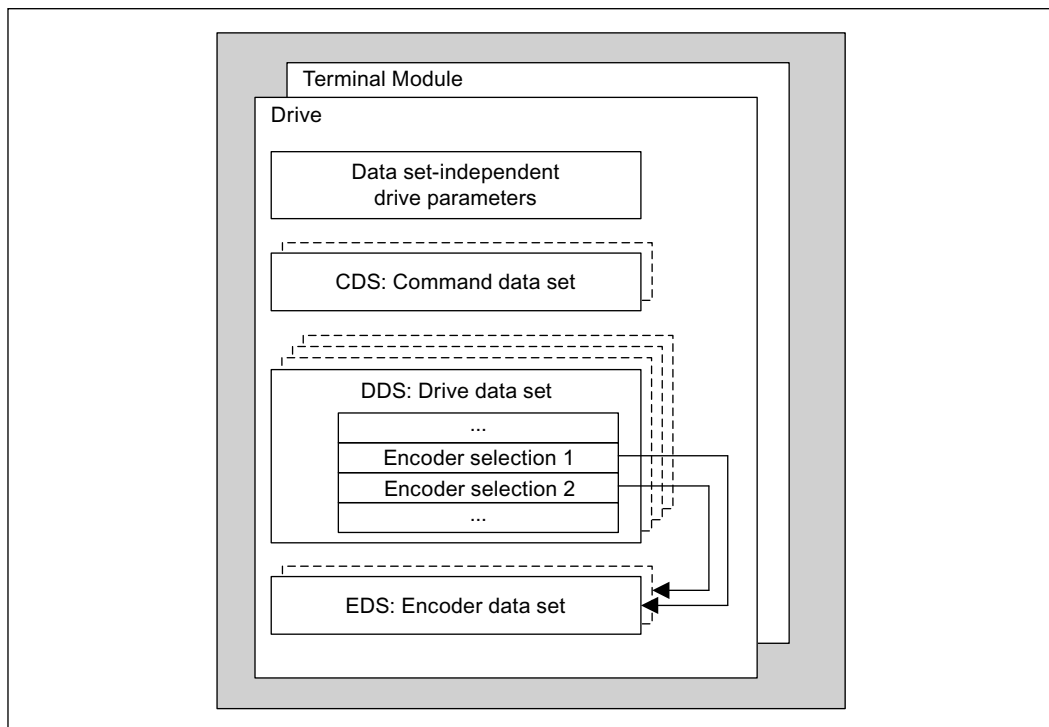
Figure 9-2   Parameter categories

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.

● Saving parameters with STARTER
See "Copy RAM to ROM" function

● Saving parameters
p0977 = 1; automatically reset to 0

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

p0009 = 30   Parameter reset

p0976 = 1   Start restoring all parameters to their factory settings

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

Deleting all user data

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

● DCC charts

● The DCC block library

● Additional parameter data sets (see p0802, p0803, p0804)

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

p0009 = 30   Parameter reset

p0976 = 200   Start to delete all user data

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

Note

Data on the memory card are 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 power-up after p0976=200, as usual, the data would be read from the memory card (see also Chapter "Memory card functions"). The unit 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 unit
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)

288

A drive object can manage 2 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
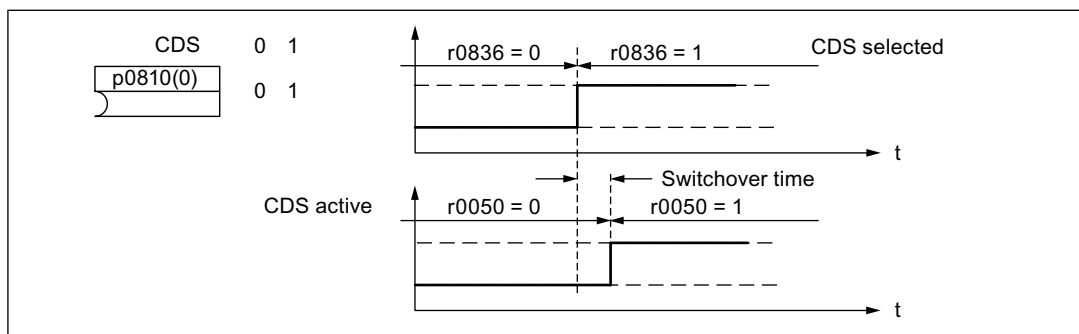
Figure 9-3   Switching the command data set (example)

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
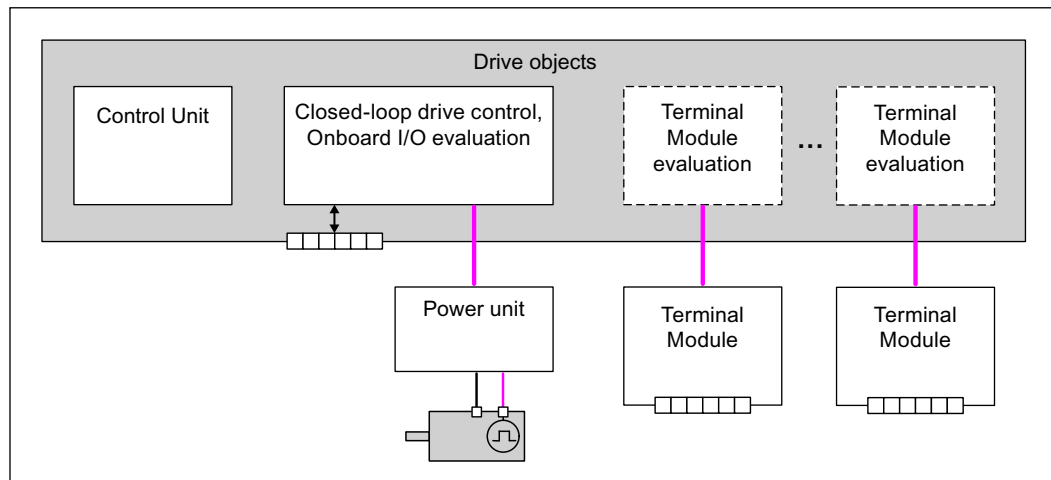
Figure 9-4   Drive objects

- 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 (refer to the chapter *Commissioning optional additional modules*).

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 section 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, refer to Chapter 2, "Ordering information for options and accessories" section.

SINAMICS DCM does not accept other Memory Cards.

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, refer to the "Commissioning " chapter, "Copying 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 software updates

- For using an AOP30 in languages other than German and English

- 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 unit software. These files are required to update the software 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 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 amounts of data can be saved in the 3 memory areas:

- ROM: Four parameter data sets with the indices 0, 10, 11, and 12

- The parameter data set with the index 0 is active in the RAM

- Memory card: Depending on the free storage space, up to 101 parameter data sets (indices 0 to 100)

Note

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

Copying parameter data sets from non-volatile memory to the Memory Card

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

- **The system is powered down**

  – Insert a memory card into the CUD

  – Switch on the system

  – The system is put into operation by the software in the "ROM"

  – Then the complete updated parameter data set with the index 0 is automatically copied from the "ROM" to the Memory Card **without a prompt appearing**.

- **The system is switched on**

  – Insert a memory card into the CUD

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

- **The system is switched on**

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

NOTICE

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

Note

When options are being used (DCC, SMC30, TM15, TM31, etc.) and with certain device configurations, the duration of the power-up can take several minutes.

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.

Copying parameter data sets from the Memory Card to non-volatile memory

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

- **The system is powered down**

    – Insert a Memory Card containing a parameter data set with the index 0 into the CUD.

    – Switch on the system. The new parameter data set will be copied to the ROM automatically. The parameter data set with the index 0 which was previously in the ROM will be overwritten.

    – The system will then boot with the new parameter data set.

- **The system is switched on**
  The user starts data transmission from the Memory Card to the ROM with parameters p0802, p0803 and p0804:

    – p0804 = 1

    – p0802 = (0...100) as source (from the Memory Card) and p0803 = (0/10/11/12) as target to the ROM.

Note

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

---
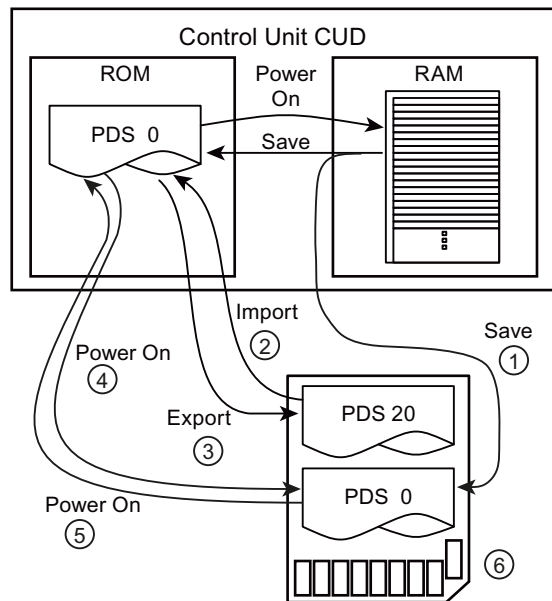
①   Memory card available: PDS 0 is copied to the card in parallel

②   p802=20; p803=0; p804=1

③   p802=20; p803=0; p804=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 units with the same parameter assignment.
Procedure:

- Completely commission a "sample" drive. As soon as all of the parameters have been correctly set, carry out "RAM to ROM".

- Switch-off the system and insert a memory card into the CUD. Switch on the system.

- 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.

- Remove the card.

- Insert the card into a CUD that is switched-off and has still not been parameterized. Switch on the system (POWER ON).

- When powering up, the parameter assignment is transferred into the CUD and copied both into the ROM as well as also into the RAM. If DCC charts and the DCC library were saved on the memory card, then these are also copied.

- 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 MLFB of the unit from which the parameter data set originated is also saved in a parameter data set. If the parameter data set is loaded into a unit with another MLFB (POWER ON with the memory card inserted), then the unit signals an inconsistent topology (power-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 unit is loaded into a 60 A unit. In this state, the user can accept the parameter set by setting p9906 to 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"
Remove the memory card

p9400 = 100 Feedback: "It is not possible to safely remove the memory card"
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

NOTICE

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. 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. 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 in order to interconnect a binector/connector input with 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

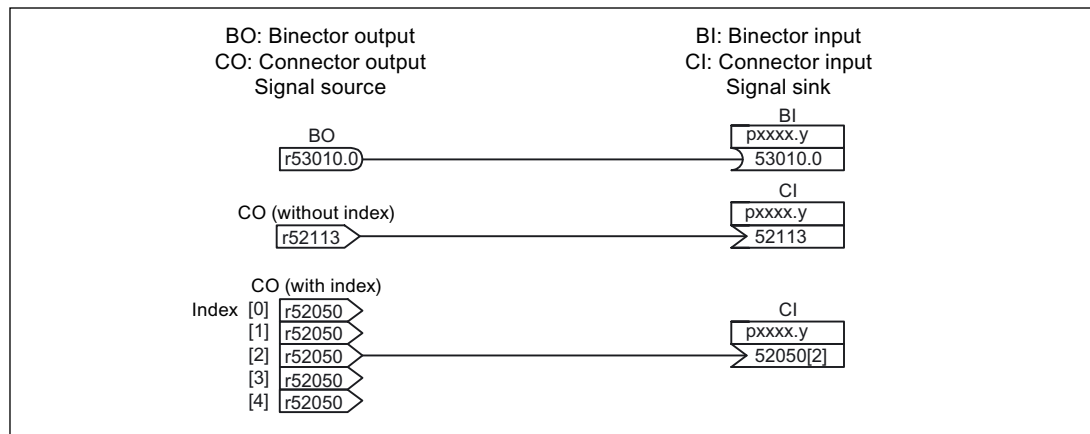● Data type (signal source for connector output parameter)

Figure 9-6   Interconnecting signals using BICO technology

Note

A connector input (CI) cannot be interconnected with all connector outputs (CO, signal source). The same applies to the binector input (BI) and binector output (BO).
For each CI and BI parameter, the parameter list shows the information on the data type of the parameter and the data type of the BICO parameter under "data type".
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 interconnections can be implemented in different command data sets (CDS). The different interconnections are activated by switching data sets. Drive object interconnections 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.

Parameter number	Drive object	Index number	
Bit 31 … 16	15 … 10	9 … 0	
	↑		
	0 Unit (CUD)		
	63 Separate object		
Examples of signal sources			
0000 1000 0000 0010 bin 2050 dec	1111 11 bin 63 dec	00 0000 0010 bin 2 dec	0802 FC02 hex → CO: 2050[2]
0000 0000 0000 0001 bin	0000 00 bin	00 0000 0000 bin	0001 0000 hex → Feste "1"
0000 0000 0000 0000 bin	0000 00 bin	00 0000 0000 bin	0000 0000 hex → Feste "0"
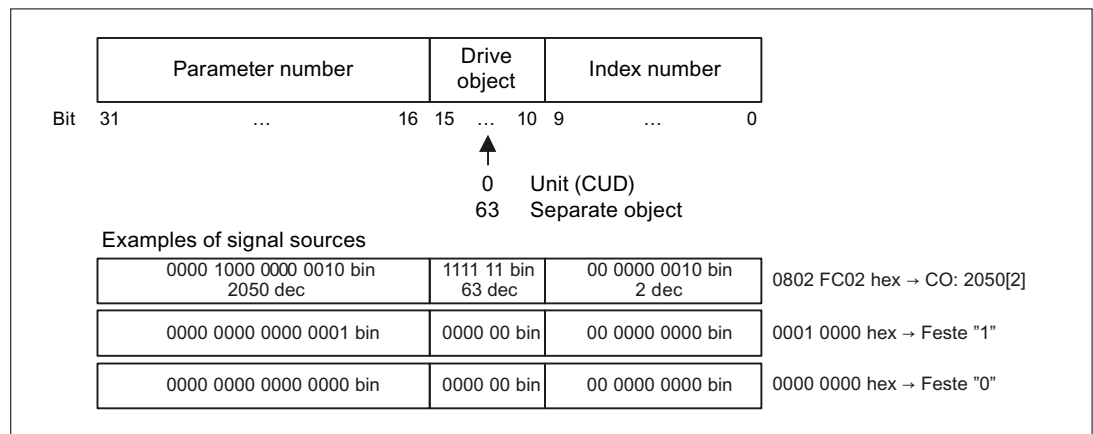
Figure 9-7   Internal encoding of the binector/connector output parameters

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.
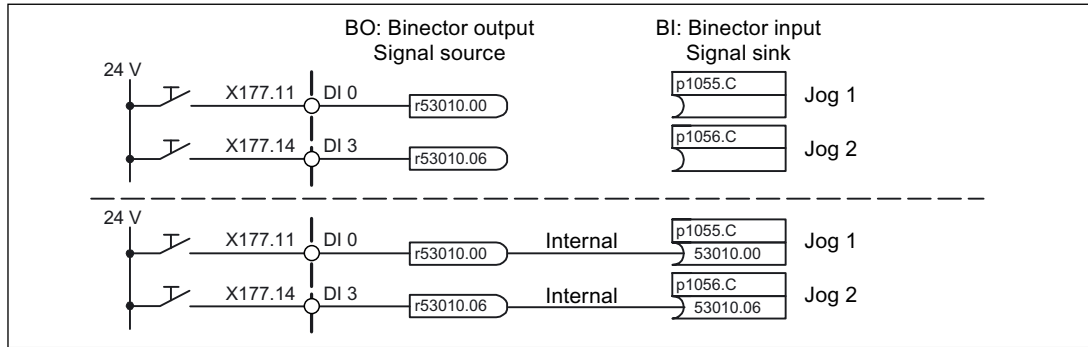
Figure 9-8   Interconnecting digital signals (example)

9.1.5.5 Information on BICO technology

Binector-connector converters and connector-binector converters

Binector-connector converters

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

Connector-binector converters

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

Fixed values for interconnection using BICO technology

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

- p2900[0...n] CO: Fixed value_%_1
- p2901[0...n] CO: Fixed value_%_2
- 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
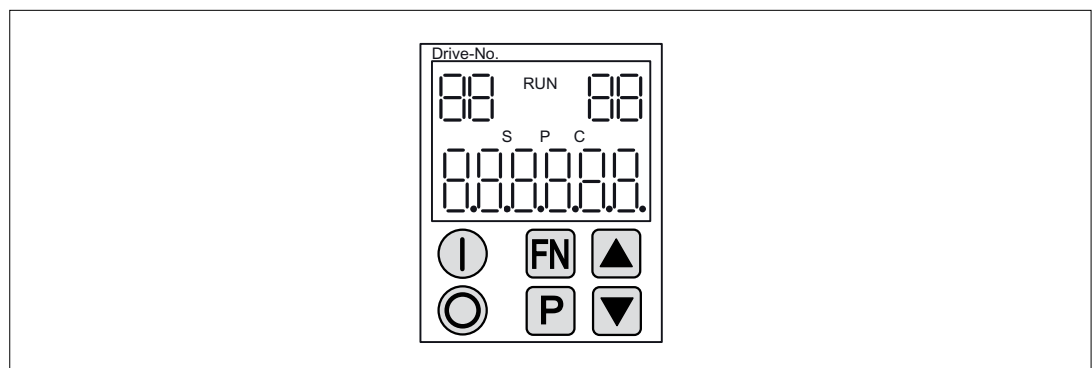
Figure 9-9   Overview of displays and keys

Information on the displays

Table 9- 5   Displays

Display	Meaning
Top left 2-digit	The active drive object of the BOP is displayed here. The displays and key operations always refer to this drive object.
RUN	Lights up if at least one drive in the drive line-up is in the RUN state (in operation). RUN is also displayed via bit r0899.2 of the drive.
Top right 2-digit	The following is displayed in this field: • More than 6 digits: Characters that are present but cannot be seen (e.g. "r2" —> 2 characters to the right are invisible, "L1" —> 1 character to the left is invisible) • Faults: Selects/displays other drives with faults • Designation of BICO inputs (bi, ci) • Designation of BICO outputs (bo, co) • Source object of a BICO interconnection with a drive object different than the active one
S	Lights up if at least one parameter was changed and the value has not yet been transferred to the non-volatile memory.
P	Lights up if, for a parameter, the value only takes effect after the P key is pressed

Display	Meaning
C	Lights up if at least one parameter was changed and the calculation for consistent data management has still not been initiated
Bottom, 6-digit	Displays. parameters, indices, faults, and alarms, for example

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. 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. Binector outputs r0019.0, .1 and .2 are simultaneously reset when this key is pressed. After the key has been released, binector outputs r0019.1 and .2 are again set to a "1" signal. **Note**: 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).
FN	Functions	The significance of these keys depends on the actual display. **Note**: Whether this key is active with respect to acknowledging faults can be defined by assigning appropriate BICO parameters.
P	Parameter	The significance of these keys depends on the actual display. 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 a BOP perspective, the active drive is defined using p0008 or the keys "FN" and "Arrow up".
Units	The units are not displayed on the BOP.
Access level	The access level for the BOP is defined using p0003. The higher the access level, the more parameters can be selected 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. The status display can be set using p0006.
User parameter list	Parameters can be selected for access using the user parameter list in p0013.

Unplug while voltage is present	The BOP can be unplugged and connected while under voltage.
	 • The ON and OFF keys have a function.
	    The drives are stopped when the BOP is unplugged.
	    After connecting it, the drives must be powered up again.
	 • The ON and OFF keys have no function.
	    Unplugging and connecting has no effect on the drives.

Key operation	The following applies to the "P" and "FN" keys: • 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

NOTICE
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 the "Description of functions" chapter, "Description of the LEDs on the CUD" section)
• The BOP20 flashes
Interrupting the electronics power supply while saving can lead to the loss of the actual unit parameter assignment. Also refer to the "Operation" chapter, "Memory Card functions" section.

Drive object (DC_CTRL)

- p0010 Commissioning, parameter filter

9.2.2 Displays and using the BOP20

Features

- Operating display
- Changing the active drive object
- Displaying/changing parameters
- Displaying/acknowledging faults and alarms
- Controlling the drive using the BOP20

Operating 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 key "FN" and "Arrow up" -> the drive object number at the top left flashes
  - Select the required drive object using the arrow keys
  - Acknowledge using the "P" key
- Parameter display
  - Press the "P" key.
  - The required parameters can be selected using the arrow keys.
  - Press the "FN" key -> parameter r0000 is displayed
  - Press the "P" key -> changes back to the operating display

Parameter display

The parameters are selected in the BOP20 using the 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 keys "FN" and the arrow keys. You can toggle between r0000 and the parameter that was last displayed by pressing the "FN" key in the parameter display.
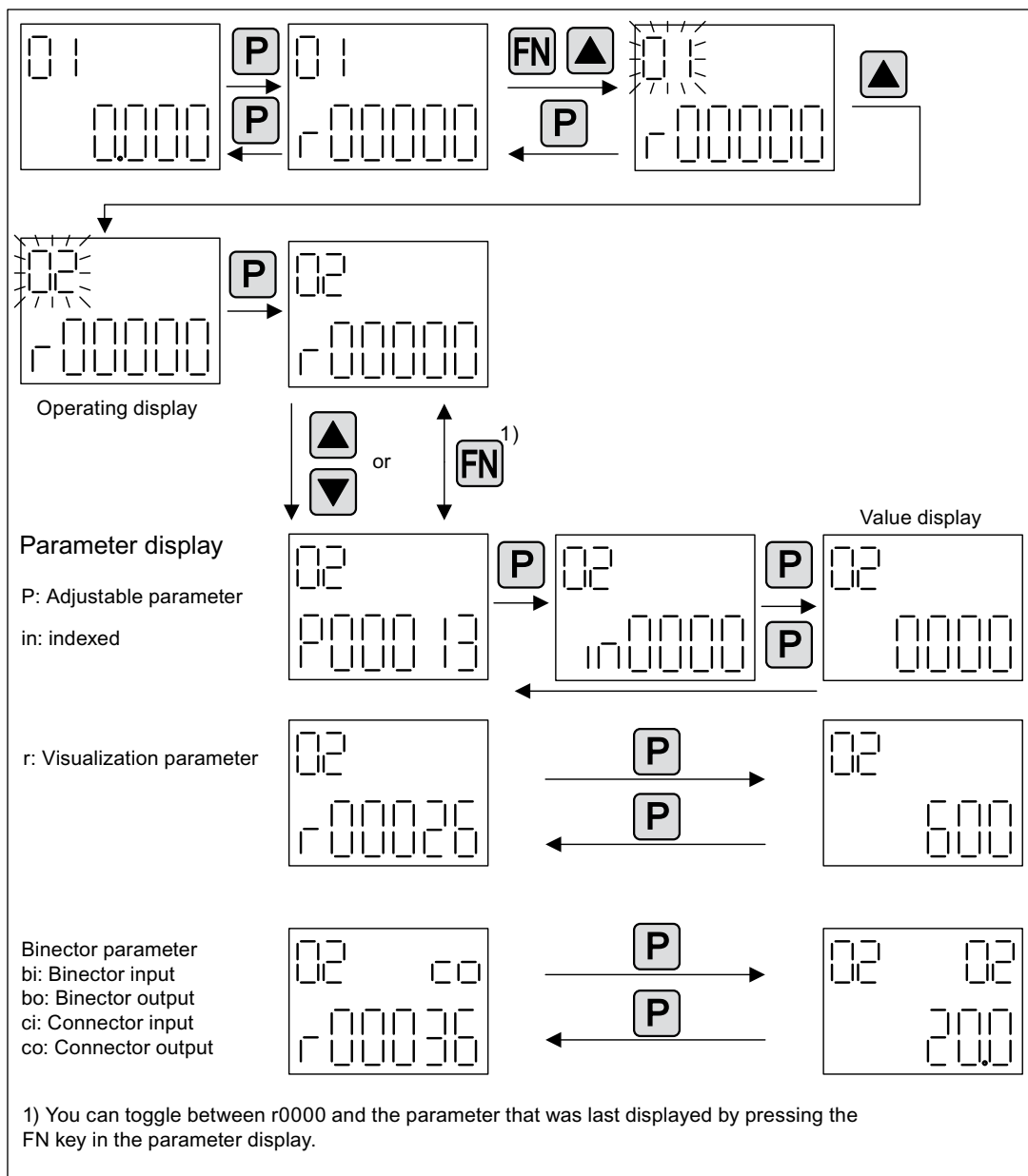
Figure 9-10   Parameter display

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.
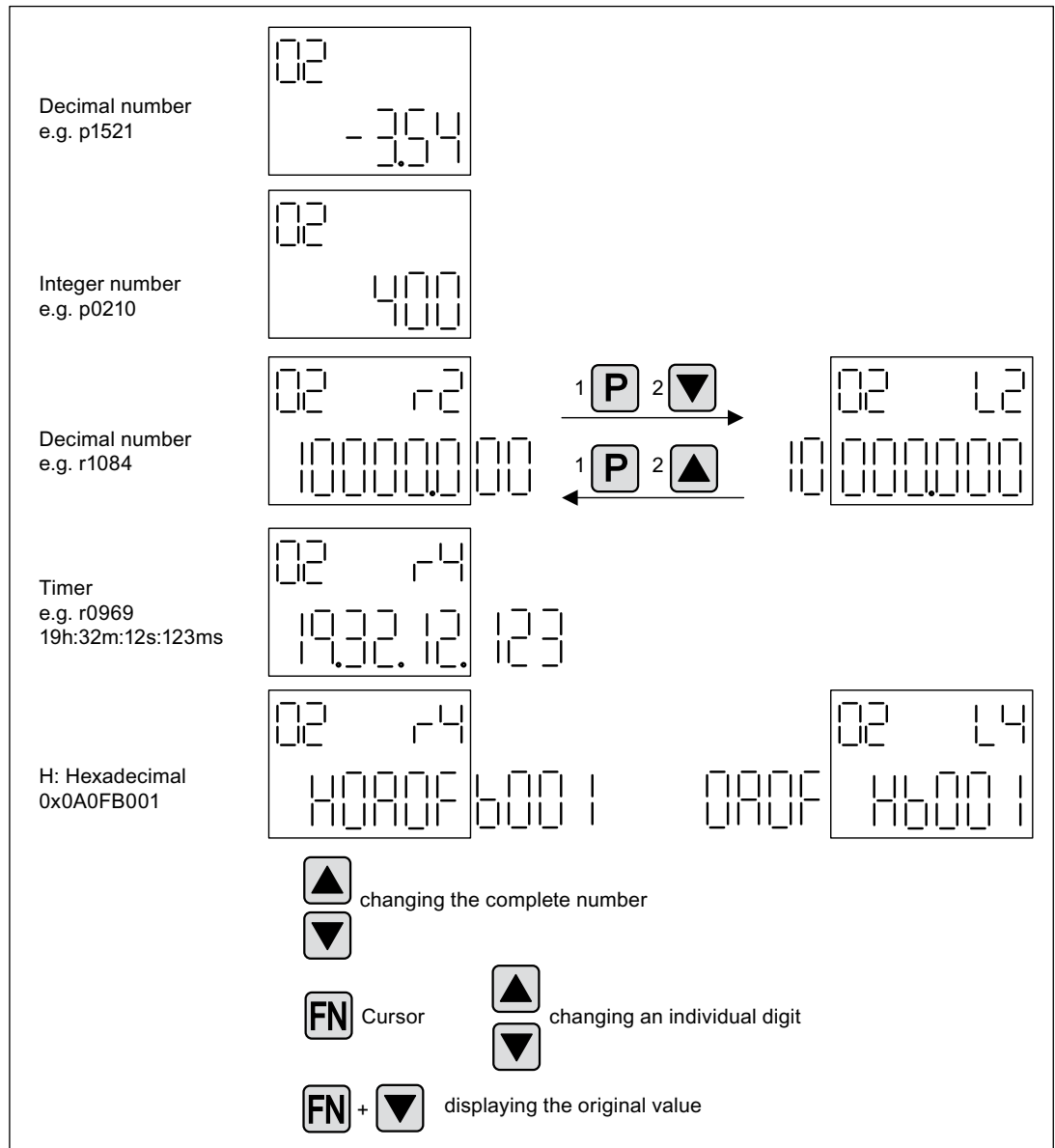
Figure 9-11   Value display

Example: Changing a parameter

Precondition: The appropriate access level is set
(for this particular example, p0003 = 3).
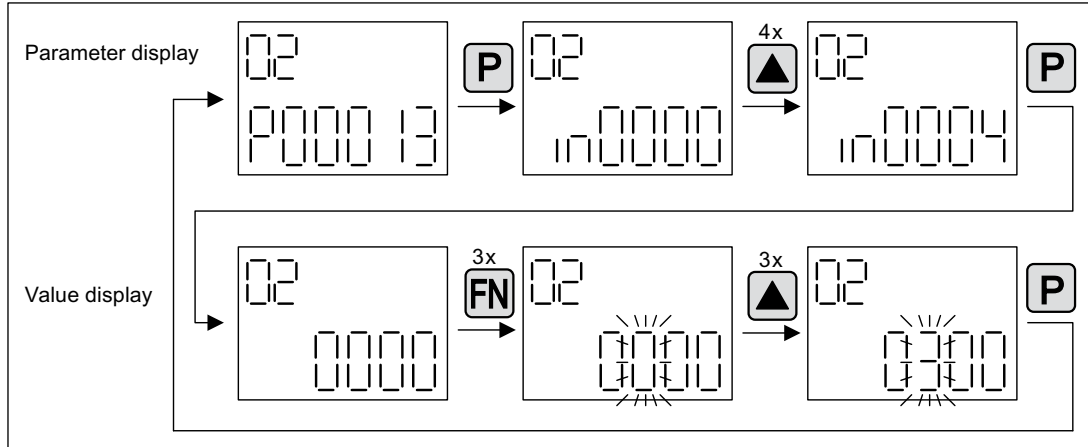
Figure 9-12   Example: Changing p0013[4] from 0 to 300

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.
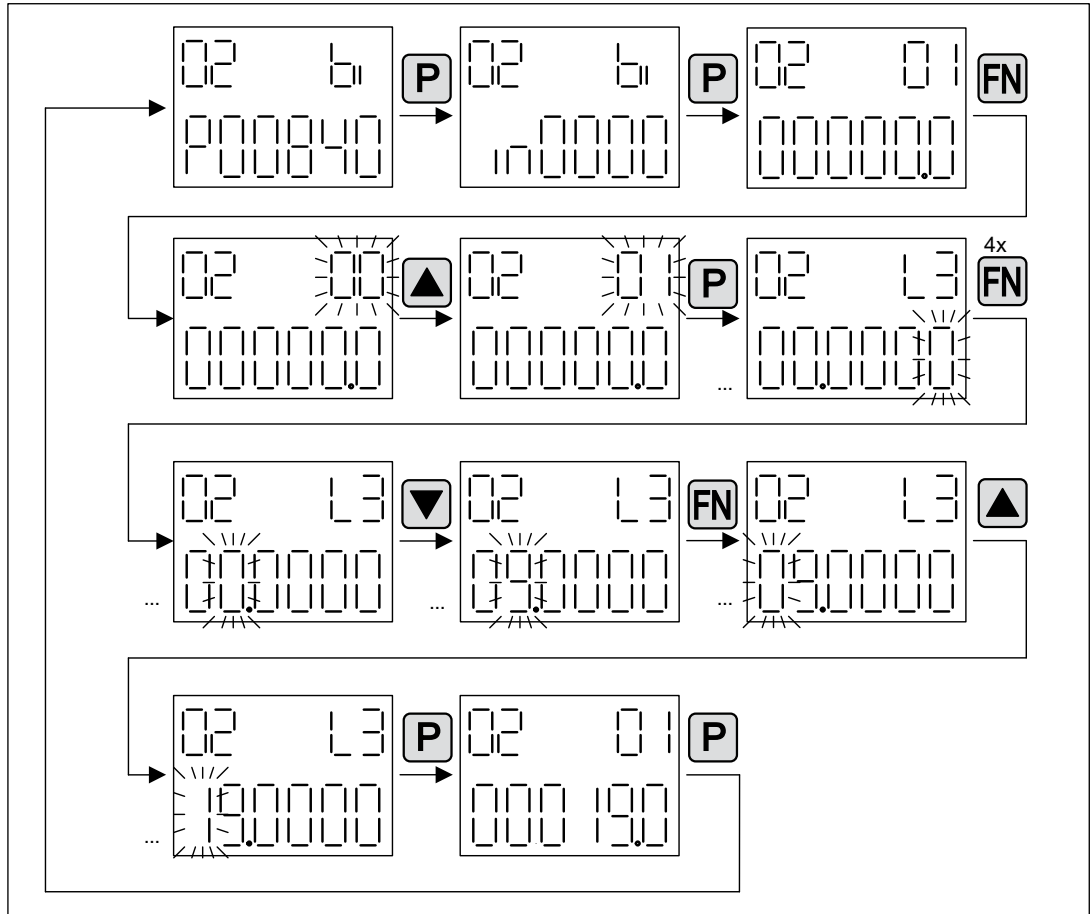
Figure 9-13   Example: Changing indexed binector parameters

311

9.2.3 Displaying faults and alarms
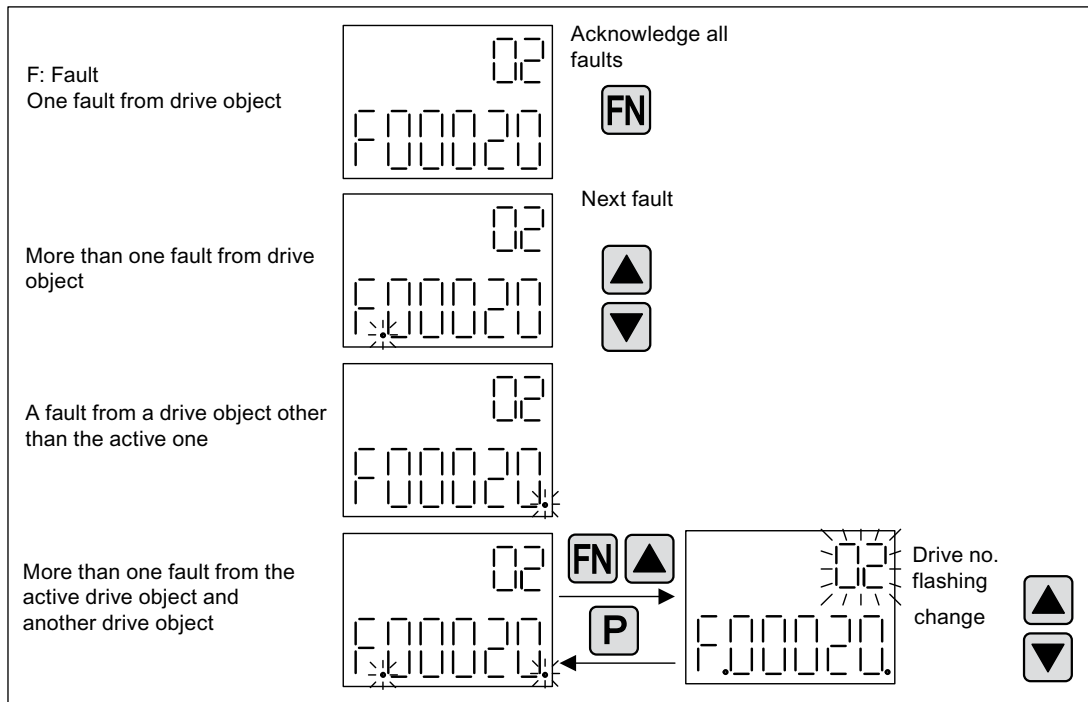
Displaying faults

Figure 9-14   Faults

Displaying alarms
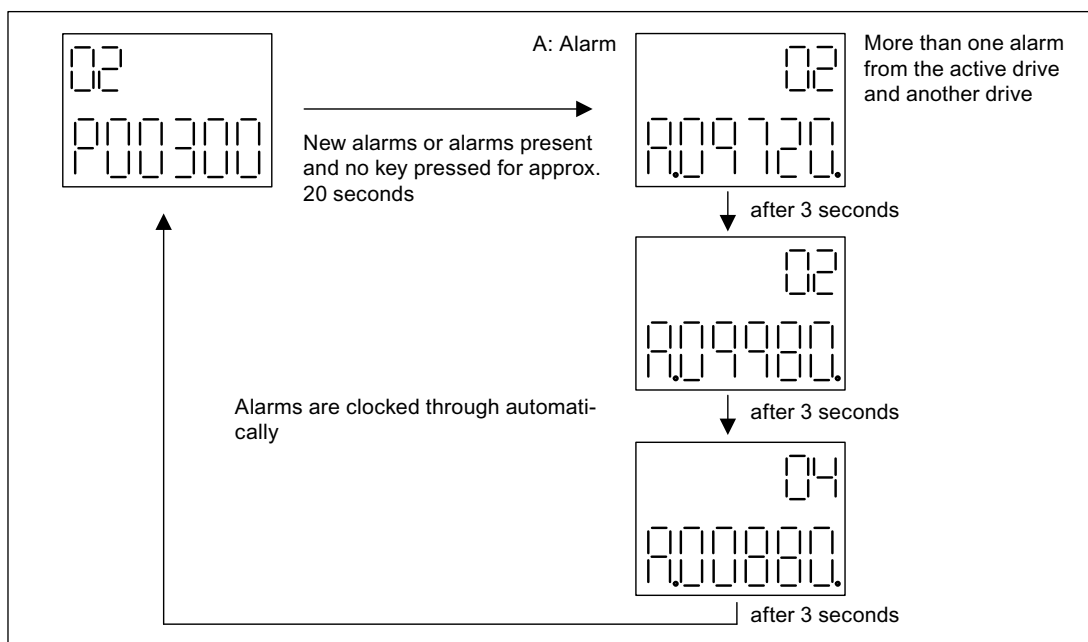
Figure 9-15   Alarms

9.2.4 Controlling the drive using the BOP20

Description

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
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.		
7	Acknowledge fault (0 -> 1)	p2102
13	Motorized potentiometer, raise	p1035
14	Motorized potentiometer, lower	p1036

313

9.3 Controlling via the AOP30 operator panel

> ⚠ **WARNING**
>
> The OFF switch on the AOP30 operator panel does not have an EMERGENCY OFF function.
>
> In order to avoid dangerous incorrect operator actions, the EMERGENCY OFF pushbutton must be installed in a plant or system at an adequate distance from the AOP30.

> **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 (as installed)
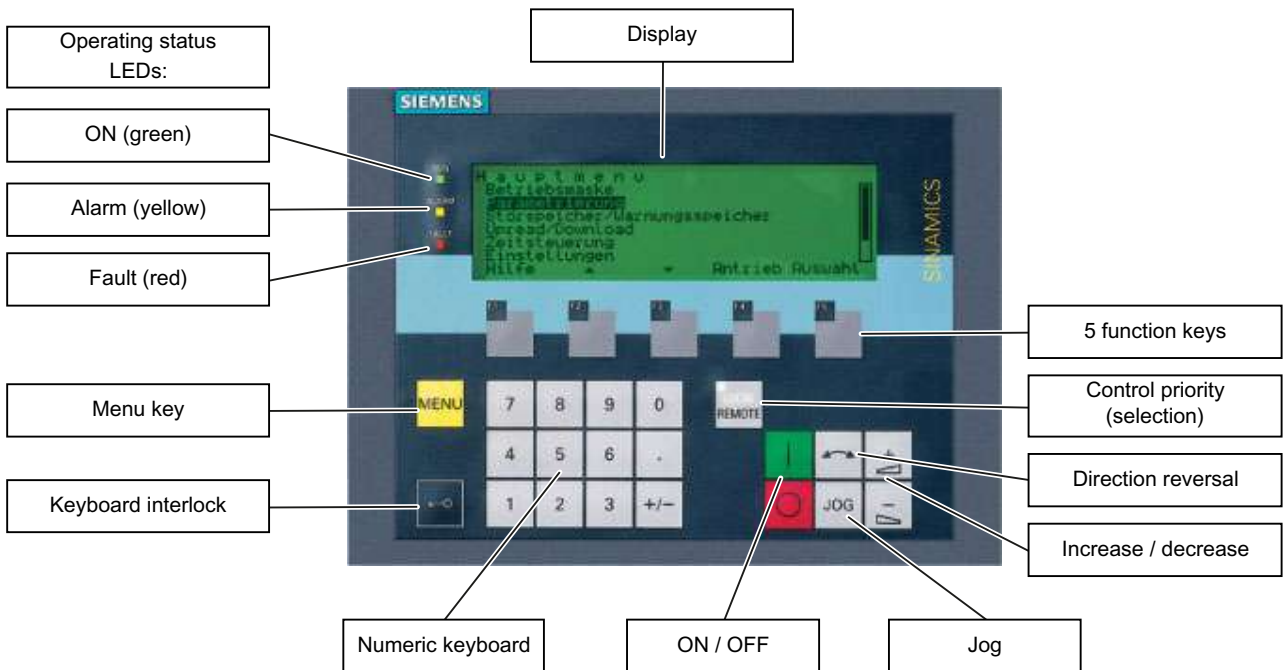
Figure 9-16   Components of the cabinet unit operator panel (AOP30)

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:
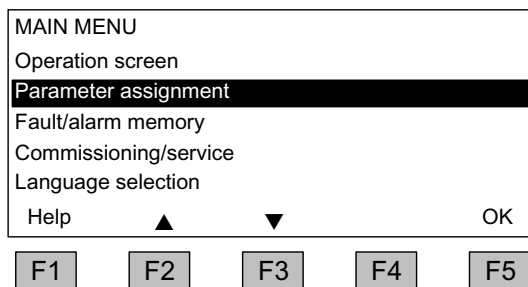
Dialog screen for the main menu:
This can be accessed at any time with the "MENU" key.

Press "F2" or "F3" to navigate through the menu options in the main menu.

315

Menu structure of the operator panel
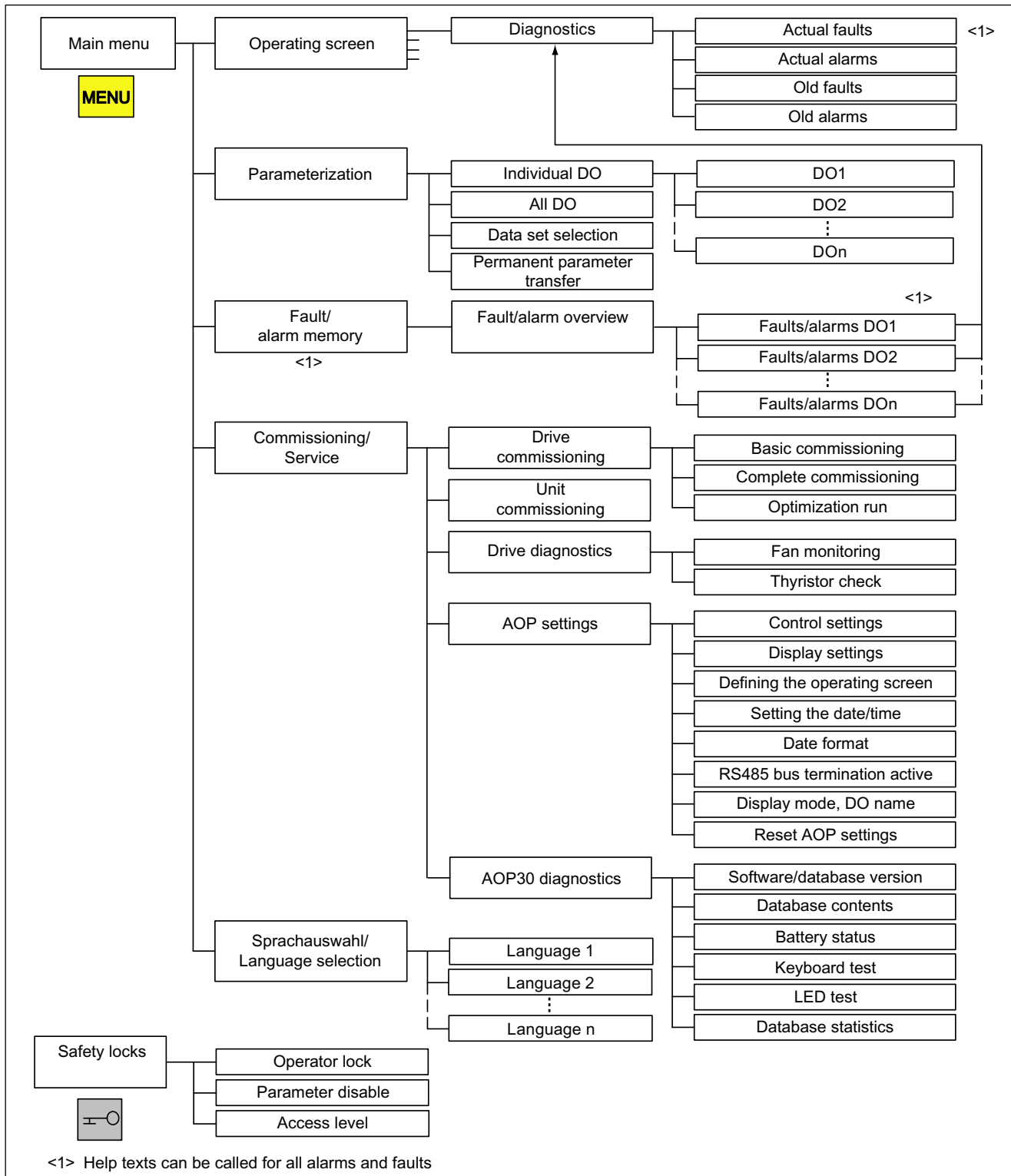
Figure 9-17   Menu structure of the AOP30 operator panel

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

```
{2:DC_CTRL} OPERATION        ▶        12:25:30 S
NSET =      1,450.000 rpm  STAT  =              12.5
EMF    =            100.0%  I_F    =          120.15%
N_ACT [rpm] ███████████████████████
     1450.0  0%                 50%            100%
I_ACT[A]     ███████████████████████
      450.0  0%                 50%            100%
     Help       (n-set)      Change    sel.par      Diag
```

[F1]   [F2]   [F3]   [F4]   [F5]
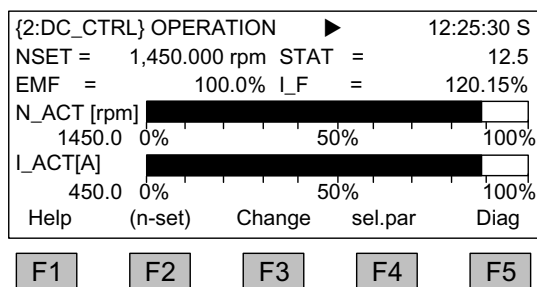
Figure 9-18   Operation screen

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.

The "Define operation screen" menu can be selected directly using F3 ("Change").

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

By selecting Commissioning/Service –> AOP settings –> Define operation screen, you can adjust the display type and the values displayed as required (see the section titled "Operation/AOP30 settings").

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:

- **Individ DO**

Shows the parameters of a DO to be selected in advance

- **All DO**

Shows the parameters of all DOs in list format (as described above)

- **Data set selection**
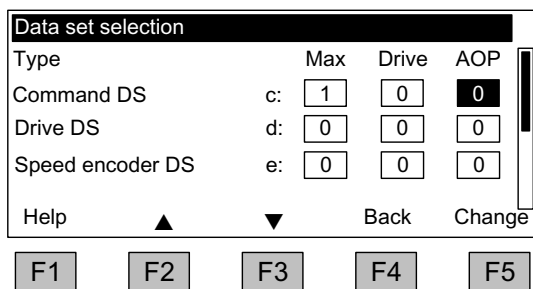
Figure 9-19   Data set selection

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.

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 the "Operation" chapter, "Memory Card functions" section.

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 drive object in question).

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

1:CU_DC                    ...        ...
2:DC_CTRL               Fault      Warning
3:TM31                     ...        ...

          ▲        ▼        Tools+     Diag
   [ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]   [ F5 ]
```
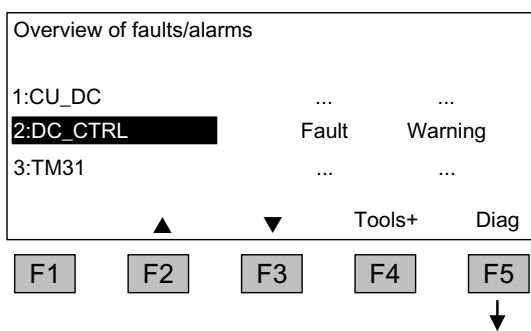
Overview of faults/alarms

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.

```
{2:DC_CTRL} Display diagnostics
 Current faults
 Current alarms
 Old faults
 Old alarms

          ▲        ▼        Back       OK
   [ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]   [ F5 ]
```
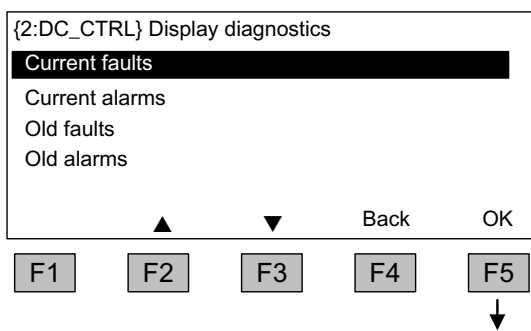
Displaying diagnostics

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.

```
{2:DC_CTRL} Faults          0067:21:11:07
 F07860  External fault 1




 Help     ▲        ▼        Back       Ack
   [ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]   [ F5 ]
```
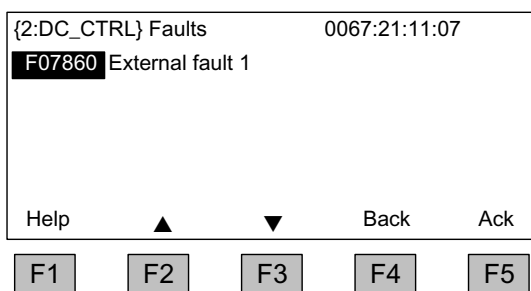
Display of current faults

A maximum of eight current faults are displayed along with their fault number and name.

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 that you can reset parameters to their factory settings, 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

This menu is where you make the lighting, brightness, and contrast settings for the display.

Define operation screen

In this menu, you can switch between five operation screens. You can set the parameters that are to be displayed.
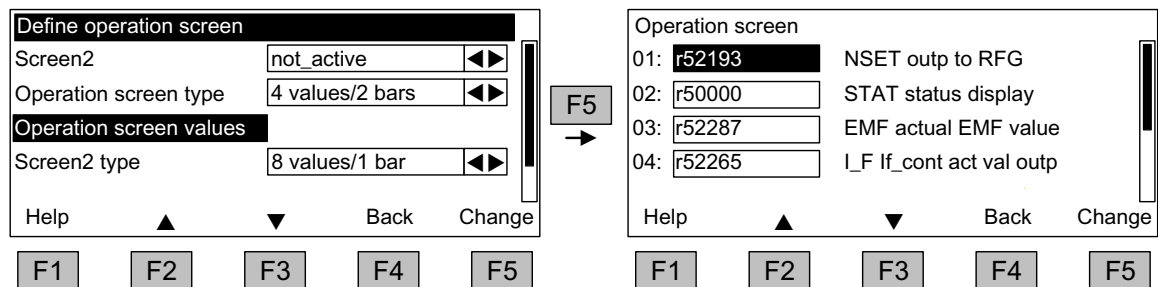
Figure 9-20   Define operation screen

The figure below shows how the entries are assigned to the screen positions:
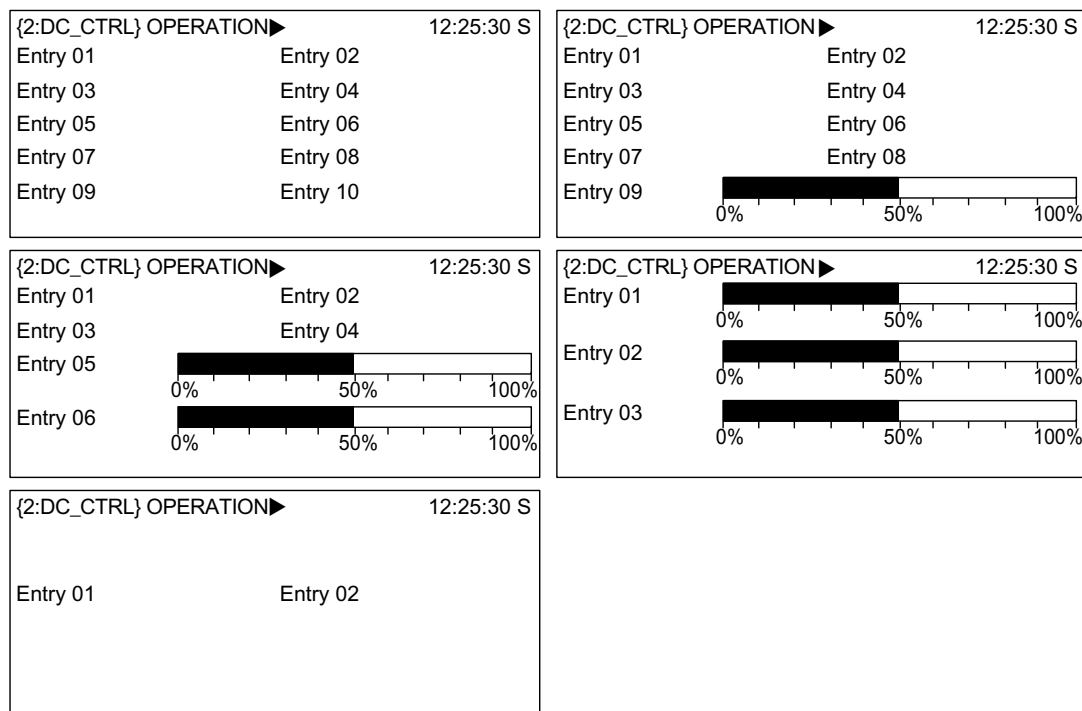
Figure 9-21   Layout of the entries on the operation screen

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	NSETP	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	NSETP	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	PBSOL	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 six characters of texts that are 8 to 25 characters in length are displayed with "..." as the seventh character.

2. DO names in the overview of faults and alarms (alarm overview)
    The maximum text length is 12 characters. Example 2:HOIST 12345
    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

Selecting this menu command resets the AOP factory settings for the following:

- Language
- Display (brightness, contrast)
- Operating screen
- Control settings

NOTICE
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

Activation of 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 or REMOTE, a check is carried out to determine whether the drive is in the "Operation" state. If yes, the system does not switch to LOCAL/REMOTE and outputs the error message "LOCAL/REMOTE mode during operation not possible". 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 "Increase" key mean:
  The setpoint displayed 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 occurs even 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 AOP setpoint and saved.
  If the system is switched from REMOTE to LOCAL mode while the drive is switched off, the AOP setpoint that was last saved is used.

- **No**: When the system is switched on 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 error from the AOP (factory setting: Yes)

- **Yes**: Errors can be acknowledged via the AOP.

- **No**: Errors 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
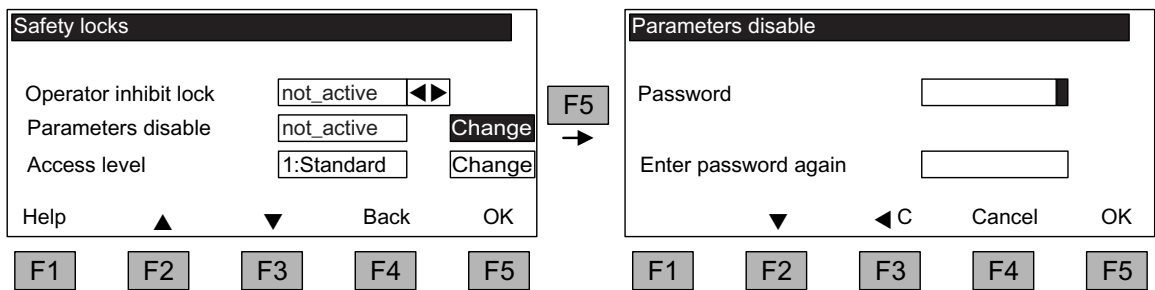
Figure 9-22   Setting safety inhibits

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 2 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.
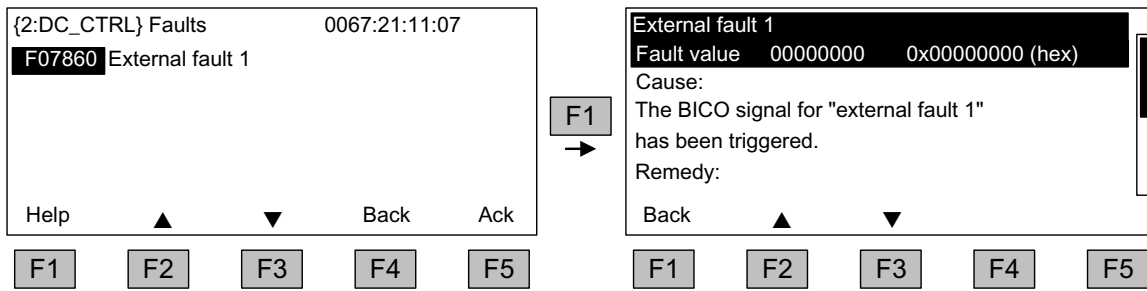
Figure 9-23   Fault screen

You can use F5 (Ack.) to acknowledge a stored fault.
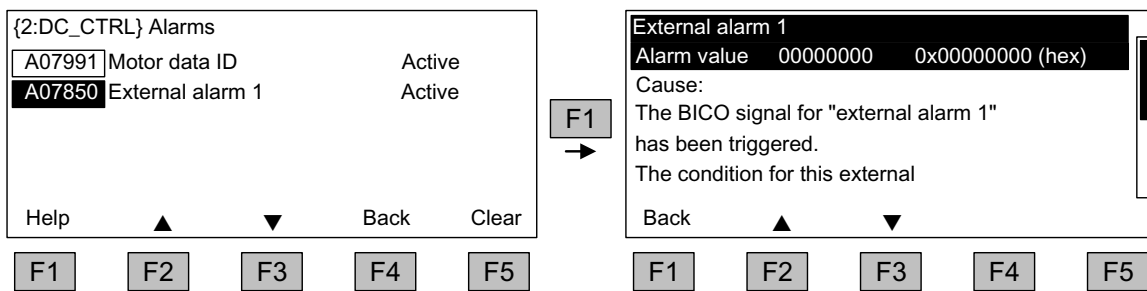
Figure 9-24   Alarm screen

Alarms that are no longer active are removed from the alarm memory with F5 (Clear).

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 "Memory Card functions" chapter.

> **NOTICE**
>
> 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 the "Description of functions" chapter, "Description of the LEDs on the CUD" section)
> - The BOP20 flashes
>
> Interrupting the power supply while saving can lead to the loss of the current device parameter assignments. Also refer to the "Operation" chapter, "Memory Card functions" section.

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. This function can be activated with the following steps:

- On the AOP30 in the *"Menu/Commissioning/Service/AOP settings/Date and Time"* menu command activate to *"AOP sets clock in SINAMICS"*.
- The current clock 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 clock time can be read from the parameters p3100, p3102 and p3103. For details, please see the SINAMICS DCM List Manual.

The current clock time is resynchronized at each power-up. (The AOP30 must be switched on together with the drive). During uninterrupted duty, a 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) • 4 bidirectional inputs/outputs • 4 outputs • 1 incremental encoder input	• 7 inputs • 2 outputs • 1 temperature sensor input
Power unit	• 1 relay output	• 1 input for analog tachometer
TM15	• 24 bidirectional inputs/outputs	-
TM31	• 8 inputs • 4 bidirectional inputs/outputs • 2 relay outputs	• 2 inputs • 2 outputs • 1 temperature sensor input
Technical data for inputs and outputs: • For the CUD and power unit, refer to the section titled "Connecting". • For the TM15 and TM31, refer to the section titled "Additional system components".		

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

10.1.3 Analog inputs

Properties

Table 10- 2   Properties of the analog inputs

Inputs	Properties
AI 0, AI 1	• Differential inputs • Voltage inputs -10 to +10 V or Current inputs -20 to +20 mA or 4 to 20 mA • Hardware input filter: T = 1 ms • Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format.
AI 2	• Differential input • Voltage input -10 to +10 V • Hardware input filter: T = 1 ms • Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format. 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 • Voltage inputs -10 to +10 V • Hardware input filter: T = 100 µs • Sampling measuring procedure. Sampling time = 250 µs. The mean value taken from 4 sampling values is provided in BICO format. An external actual armature current value can also be connected to these inputs (see FP6850).
Tachometer input XT1.103/104	• Input referred to ground • High-voltage input -270 to +270 V • Hardware input filter: T = 1 ms • Integrating measuring procedure. Averaging time = 1 ms. The average value determined during this time is provided in BICO format. This input is designed for connecting an analog tachometer, but can also be used in other ways.

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

10.1.4 Analog outputs

See function diagram 2095 in the SINAMICS DCM List Manual.

10.2 PROFIBUS

10.2.1 PROFIBUS connection
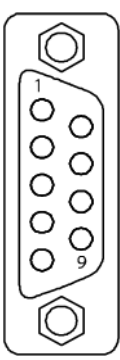
Position of PROFIBUS connection and diagnostics LEDs

The PROFIBUS connection and diagnostics LEDs are located on the Control Unit (CUD).

The PROFIBUS connection is established using a 9-pin Sub-D socket (X126). The connections are electrically isolated.

PROFIBUS connection

Table 10- 3   PROFIBUS connector assignment

Connector X126	Pin	Signal name	Technical data
	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
Module C98043-A7100-L1/L2, Standard/Advanced CUD			

Bus connector

The cables must be connected using PROFIBUS bus connectors as these contain the necessary bus terminating resistors.

Matching PROFIBUS bus connector, Order No. 6GK1500-0FC10:
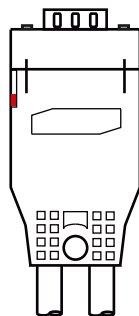
Figure 10-1   PROFIBUS bus connector

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.
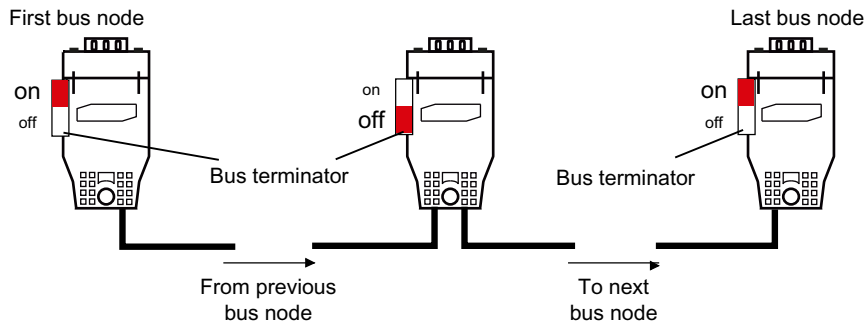
Figure 10-2   Position of the bus terminating resistors

10.2.2   Setting the PROFIBUS address

The PROFIBUS address must be set at parameter p0918.

The factory setting is

- for the lefthand CUD: 126
- for the righthand CUD: 125

The PROFIBUS address can be changed

- using the BOP20 (only possible on the lefthand CUD)
- using the AOP30 (if available)
- via PROFIBUS

The PROFIBUS address must be saved in a non-volatile fashion using the "Copy from RAM to ROM" function. Each change made to the PROFIBUS address is only effective after POWER ON.

10.2.3 Control via PROFIBUS

"DP1 (PROFIBUS)" diagnostics LED

The PROFIBUS diagnostics LED is located on the Control Unit (CUD). It can be seen when you remove the front cover of the SINAMICS DC MASTER. The table below outlines the different meanings its states have.

Table 10- 4   Description of the LED

Color	State	Description
-----	Off	Cyclic communication has not (yet) taken place.
Green	Continuous	PROFIBUS is ready for communication and cyclic communication is taking place.
Green	0.5 Hz flashing light	Cyclic communication is not yet running fully. Possible reason: The master is not transmitting setpoints.
Red	Continuous	Cyclic communication has been interrupted.

10.2.4 Monitoring, telegram failure

After a telegram failure and after a 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 a delay time (p2044) has elapsed, fault F01910 is output and fault reaction OFF3 (quick stop) is triggered. 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 PROFIBUS.
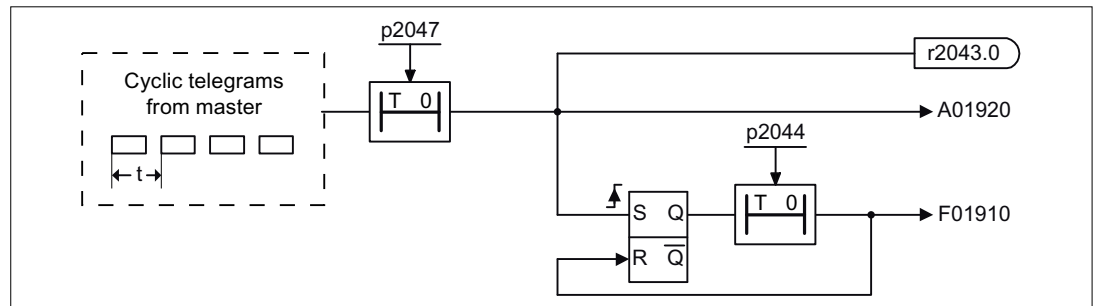
Figure 10-3   Monitoring, telegram failure

10.2.5 Telegrams and process data

General information

Selecting a telegram via CU parameter p0922 determines which process data is transferred between the master and slave.

From the perspective of the slave (SINAMICS DC MASTER), the received process data comprises the receive words, and the process data to be sent comprises the send words.

The receive and send words comprise the following elements:

- Receive words: Control words and setpoints
- Send words: Status words and actual values

User-defined telegram selection

a. Standard telegrams

Standard telegrams are structured in accordance with the PROFIdrive profile or internal company specifications. The internal process data links are established automatically in accordance with the telegram number setting in CU parameter p0922.

The following standard telegrams can be set via parameter p0922:

- p0922 = 1   → Speed setpoint, 16-bit
- p0922 = 20   → Speed setpoint, 16-bit VIK-NAMUR
- p0922 = 352   → Speed setpoint, 16 PCS7

b. Free telegrams (p0922 = 999)

Send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive words. The default process data assigned under a) is retained during the changeover to p0922 = 999, although it can be changed or supplemented at any time.

To maintain compliance with the PROFIdrive profile, however, the following assignments should be retained:

- Interconnect PZD receive word 1 as control word 1 (STW 1)

- Interconnect PZD send word 1 as status word 1 (STW 1)

Please refer to function diagrams FP2460 and FP2470 for details on interconnection options.

Information on telegram interconnections

After changing p0922 = 999 (factory setting) to p0922 ≠ 999, the telegram interconnection is made and blocked automatically.

Note

Telegrams 20 and 352 are the exceptions. Here, PZD06 in the send telegram and PZD03 to PZD06 in the receive telegram can be interconnected as required.

When you change p0922 ≠ 999 to p0922 = 999, the previous telegram interconnection is retained and can be changed.

Note

If p0922 = 999, a telegram can be selected in p2079. A telegram interconnection is automatically made and blocked. However, the telegram can also be extended.

This is an easy method of creating extended telegram interconnections on the basis of existing telegrams.

Table 10- 5   Structure of the telegrams

Telegr.	PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9	PZD 10
1	STW1	NSET_A								
	ZSW1	NACT_A								
20	STW1	NSET_A								
	ZSW1	NACT_A_ SMOOTH	IAACT_ SMOOTH	MACT_ SMOOTH	PACT_ SMOOTH	SIG_ NAMUR				
352	STW1	NSET_A	PCS7_3	PCS7_4	PCS7_5	PCS7_6				
	ZSW1	NACT_A_ SMOOTH	IAACT_ SMOOTH	MACT_ SMOOTH	ALARM_ CODE	FAULT_ CODE				
999	STW1	Free	Free	Free	Free	Free	Free	Free	Free	Free
	ZSW1	Free	Free	Free	Free	Free	Free	Free	Free	Free

10.2.6 Description of control words and setpoints

Overview

Table 10- 6   Overview of control words and setpoints

Abbreviation	Description	Parameter	Function diagram
STW1	Control word 1	See table: "Control word 1"	FP2442
NSET_A	Speed setpoint A (16-bit)	p1070	FP3113
PCS7_x	PCS7-specific setpoints		

Control word 1 (STW1)

Table 10- 7   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 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.		

Bit	Meaning	Explanation	Operating condition	BICO
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".			
11	Reserved		-	-
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: If "Motorized potentiometer, higher" and "Motorized potentiometer, lower" both 0 or 1 at the same time, the current setpoint is frozen.			
15	1 = CDS bit 0 (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	-	-

Speed setpoint A, 16-bit (NSET_A)

- Speed setpoint with 16-bit resolution incl. sign bit
- Bit 15 determines the setpoint sign:
    - Bit = 0 → Positive setpoint
    - Bit = 1 → Negative setpoint
- The speed setpoint is scaled via parameter p2000.
  N_set_A = 4000 hex or 16384 dec = speed in p2000

PCS7-specific setpoints (PCS7 x)

Depending on the configuration, KP adaptation values for the speed controller and acceleration values or other setpoints, for example, are transferred here.

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10.2.7 Description of status words and actual values

Overview

Table 10- 8   Overview of status words and actual values

Abbreviation	Description	Parameter	Function diagram
ZSW1	Status word 1	See table "Status word 1"	FP2452
NACT_A	Speed setpoint A (16-bit)	r0063	FP6810
NACT_SMOOTH	Actual speed value, smoothed	r0021	FP6810
IAACT_SMOOTH	Actual current value, smoothed	r0068	FP6850
MACT_SMOOTH	Actual torque value, smoothed	r0080	-
PACT_SMOOTH	Actual power value, smoothed	r0032	-
ALARM_CODE	Alarm code	r2132	FP8065
ERROR_CODE	Fault code	r2131	FP8060

Status word 1 (ZSW1)

Table 10- 9   Status word 1 (ZSW1)

Bit	Meaning		Explanation	Parameter
0	Ready for Switching On	1	Ready for Switching On 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 Line voltage applied, i.e. line contactor closed (if present), field being built up	BO: r0899.1
		0	Not Ready for Operation Reason: No ON command has been issued.	
2	Operation Enabled	1	Operation Enabled Enable electronics and pulses, then ramp up to active setpoint	BO: r0899.2
		0	Operation Disabled	
3	Fault active	1	Fault active 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 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) An OFF2 command is active.	
5	Quick stop not active	1	Quick stop (OFF3) not active	BO: r0899.5

Bit	Meaning	Explanation		Parameter
	(OFF3 inactive)	0	Quick stop active (OFF3) An OFF3 command is active.	
6	Switching on inhibited active	1	Switching on inhibited Switching back on is only possible by means of OFF1 and then ON.	BO: r0899.6
		0	No switching on inhibited Switching on is possible.	
7	Alarm active	1	Alarm active The drive is operational again. No acknowledgement necessary. The active alarms are stored in the alarm buffer.	BO: r2139.7
		0	No alarm active No alarms in the alarm buffer.	
8	Speed setpoint/actual value deviation in tolerance	1	Setpoint/actual value monitoring in tolerance band 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	
9	Control request "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: The message is parameterized as follows: p50373 (threshold value), p50374 (hysteresis) 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: 0056.13 (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	Reserved			
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	

Actual speed value A 16-bit (NACT_A, NACT_SMOOTH)

- Actual speed value with 16-bit resolution incl. sign bit

- Bit 15 determines the actual value sign:

    – Bit = 0 → positive actual value

    – Bit = 1 → negative actual value

- The actual speed value is scaled using parameter p2000.
  N_act_A = 4000 hex or 16384 dec = speed in p2000

Actual current value (IAACT, IAACT_SMOOTH)

- Actual current value with 16-bit resolution

- The actual current value is scaled using parameter p2002.
  Ia_act = 4000 hex or 16384 dec = current in p2002

Actual torque value (MACT, MACT_SMOOTH)

- Actual torque value with 16-bit resolution incl. sign bit

- Bit 15 determines the actual value sign:

    – Bit = 0 → positive actual value

    – Bit = 1 → negative actual value

- The actual torque value is scaled using parameter p2003.
  M_act = 4000 hex or 16384 dec = torque in p2003

Actual power value (PACT, PACT_SMOOTH)

- Actual power value with 16-bit resolution incl. sign bit

- Bit 15 determines the actual value sign:

    – Bit = 0 → positive actual value

    – Bit = 1 → negative actual value

- The actual power value is scaled using parameter p2004.
  P_act = 4000 hex or 16384 dec = power in p2004

Alarm code (ALARM_CODE)

The number of the current alarm and the last alarm to occur are output here. Decimal notation is used (i.e. value 7910 dec = A07910 (motor overtemperature)).

Fault code (FAULT_CODE)

The number of the oldest fault still active is output here. Decimal notation is used (i.e. value 7860 dec = fault F07860 (external fault 1)).

10.2.8 Slave-to-slave communication

10.2.8.1 General information

For PROFIBUS DP, the master addresses 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 "slave-to-slave communication" function without direct involvement from the master.

The following terms are used for the functions described here:

- Slave-to-slave communication

- Data Exchange Broadcast (DXB.req)

- Slave-to-slave communication (is used in the following)

1) From the perspective of the Class 1 master

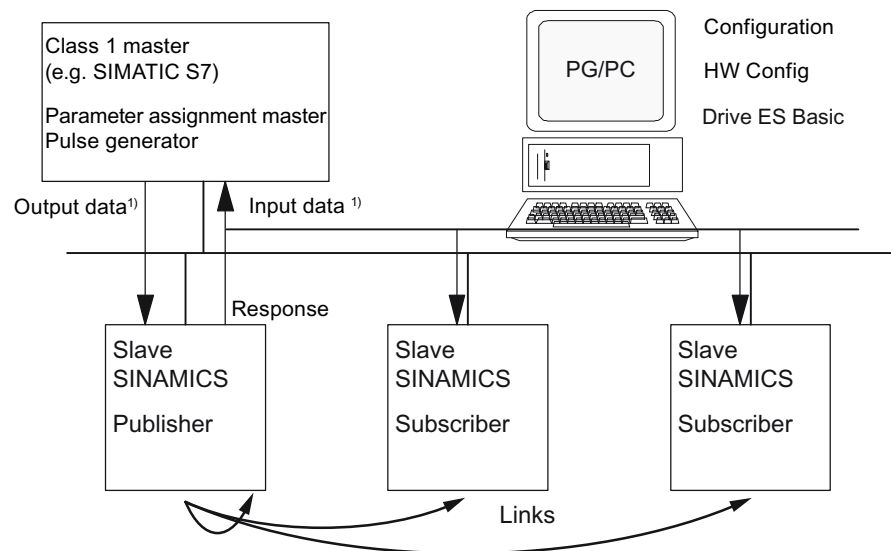Figure 10-4   Slave-to-slave communication with the publisher-subscriber model

Publisher

With the "slave-to-slave communication" function, at least one slave must act as the publisher.

The publisher is addressed by the master when the output data are transferred with a modified layer -2 function code (DXB.req). The publisher then sends its input data to 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. The setpoints 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 input data received?
- Which input data are there?
- Where do the additional setpoints come in?

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.

Prerequisites and supplementary conditions

The following supplementary conditions should be observed for the "slave-to-slave communication" function:

- Number of process data, max. per drive
- Number of links to publishers
- Number of taps per link

Applications

For example, the following applications can be implemented using the "slave-to-slave communication" function:

- Axis couplings
- Specifying binector connections from another slave

10.2.8.2 Setpoint assignment in the subscriber

Setpoints

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.

10.2.8.3 Activating/parameterizing slave-to-slave communications

The "slave-to-slave communication" function must be activated both 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 different layer 2 function code (DXB request) 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 via 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 dedicated block from the master to the slave with the parameterizing telegram when a bus communication is established.

Blockheader	Block-Len[1]	12 – 244
	Command	0xE2
	Slot	0x00
	Specifier	0x00
Filter table Header	Version identifier	0xE2
	Number of links	0 – 3
	Offset Link1[2]	
	...	
	Offset Link n[2]	
Link1	Publisher DP address	
	Publisher input length	
Tap1	Offset in the publisher data	
	Target offset in the subscriber	
	Length of the data access	
Tap2	...	
Link2	Publisher DP address	
	...	

1) Specification in bytes
2) Calculated from Version ID

Figure 10-5   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 slave-to-slave communication, 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.

10.2.8.4   Commissioning of the PROFIBUS slave-to-slave communication

The commissioning of slave-to-slave communication 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 10-6   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.
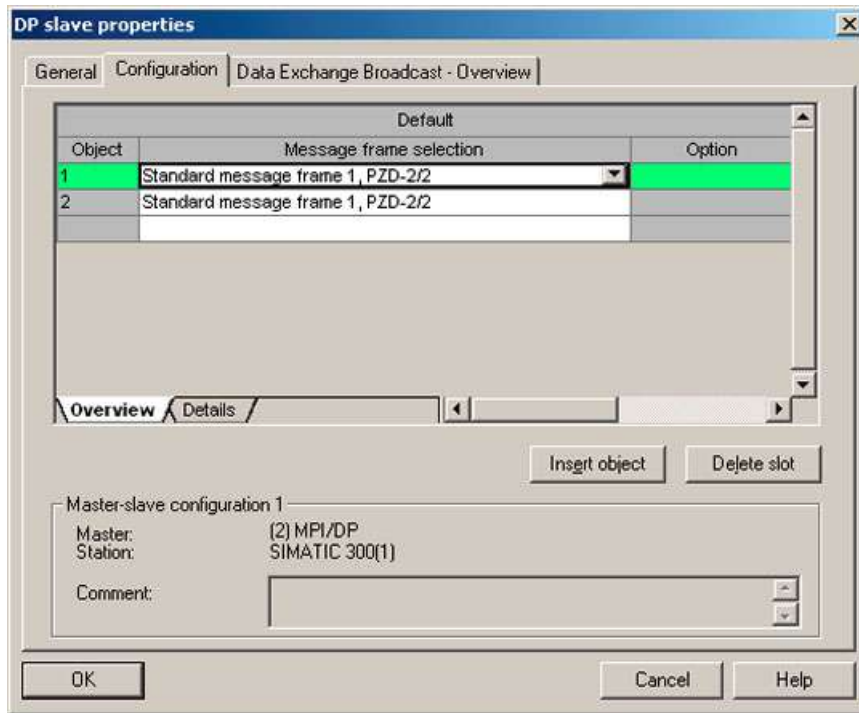
Figure 10-7   Telegram selection for drive object

3. Then go to the detail view.
   Slots 4/5 contain the actual value/setpoint for the drive object.
   The slots 7/8 are the telegram portions for the actual value/setpoint of the CU.
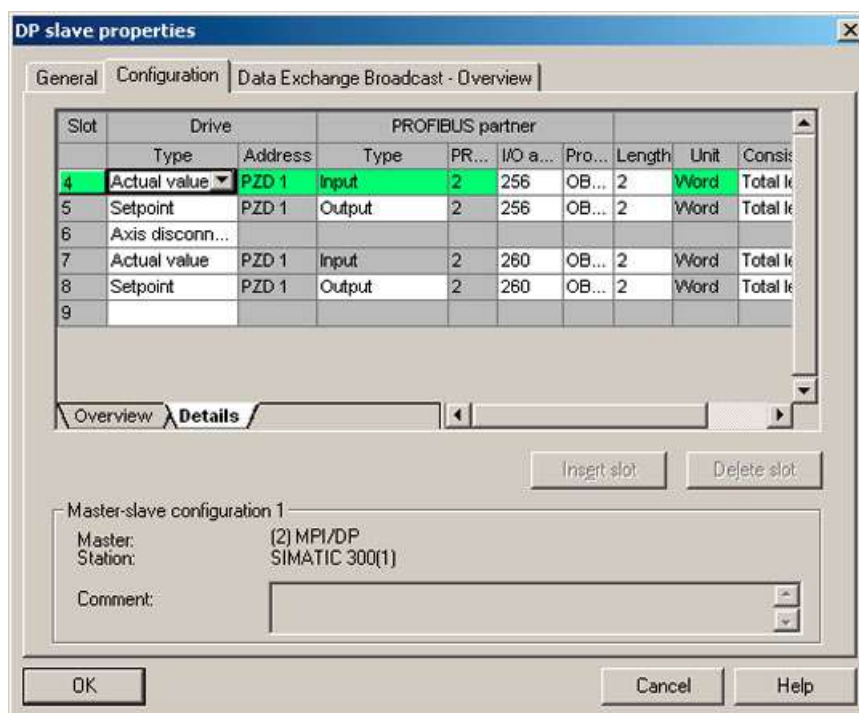
Figure 10-8   Detail view of slave configuration

4. The "Insert slot" button can be used to create a new setpoint slot for the SINAMICS DCM drive object.
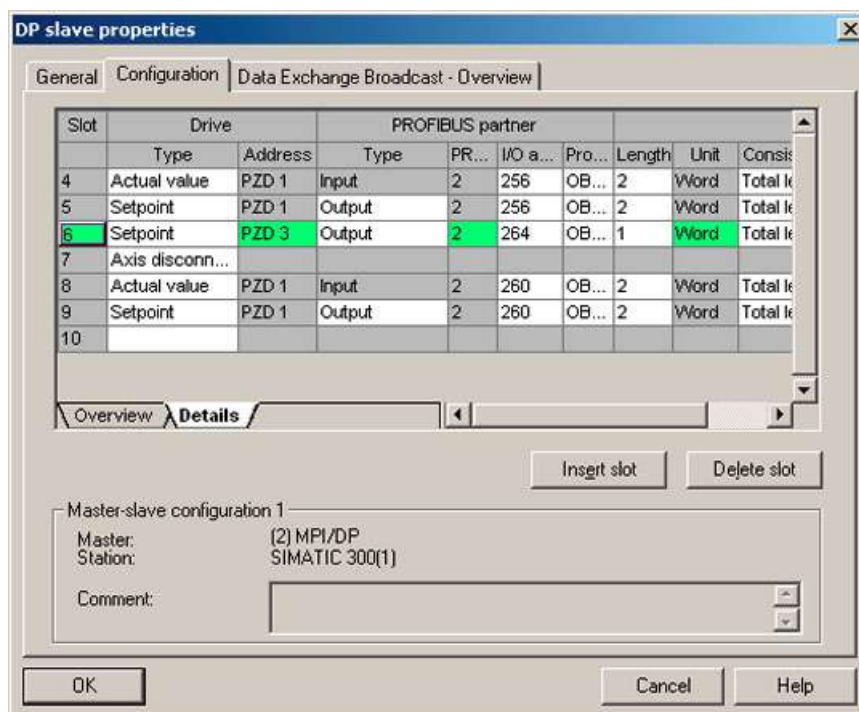
Figure 10-9   Insert new slot

5. Assign the setpoint slot the type "slave-to-slave communication".

6. Select the Publisher DP address in the "PROFIBUS address" column.
All PROFIBUS DP slaves are listed here from which actual value data can be requested.
It also provides the possibility of sharing data via slave-to-slave communication within the
same drive group.

7. The "I/O address" column displays the start address for every DO.
Select the start address of the data of the DO to be read. This is 200 in the example.
If the complete data of the Publisher are 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.
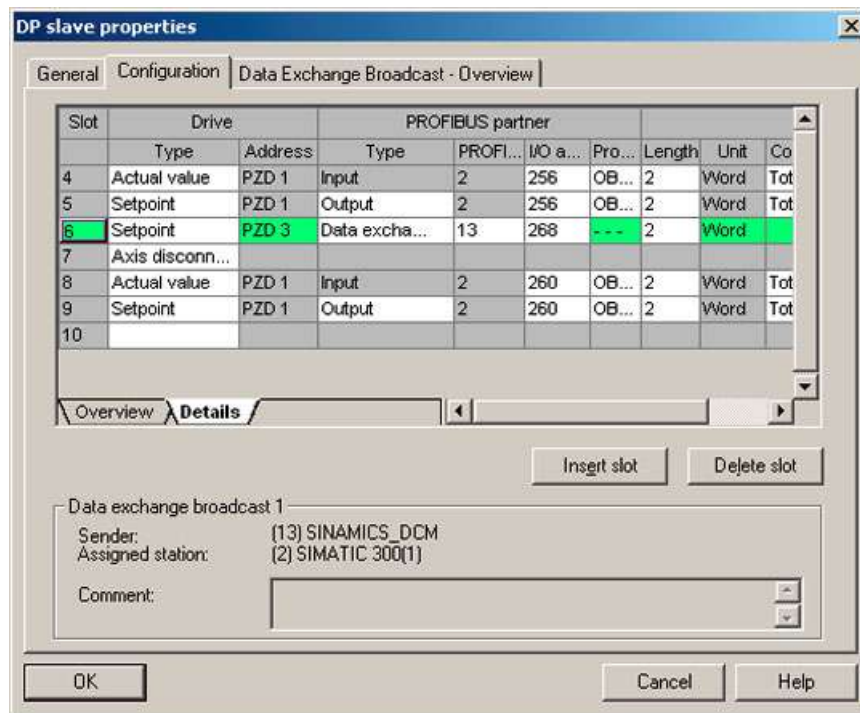
Figure 10-10 Configuring the slave-to-slave communication nodes

8. The "Slave-to-salve communication - Overview" tab shows you the configured slave-to-
slave communication relationships which correspond to the current status of the
configuration in HW Config.
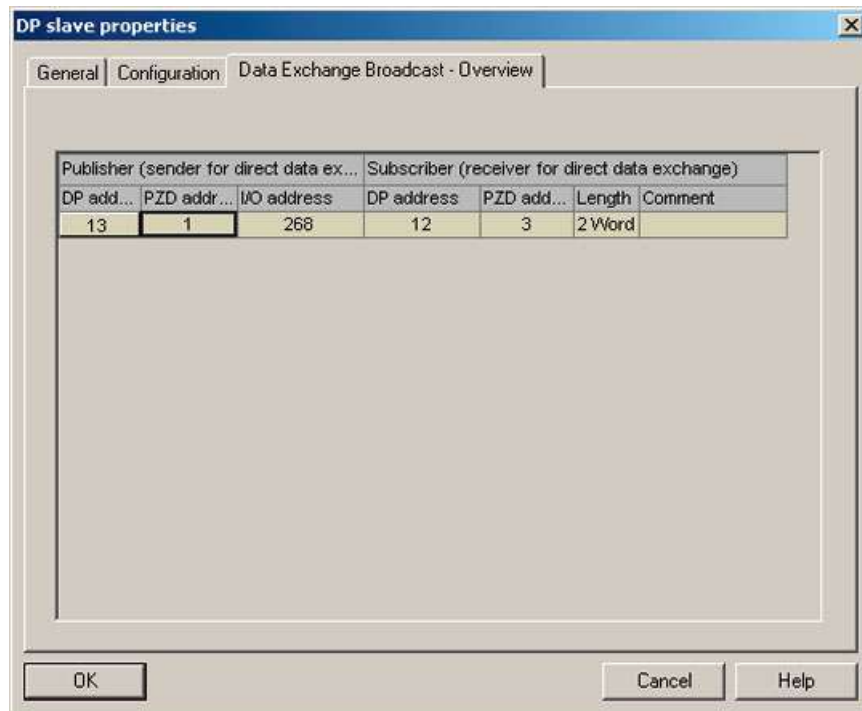
Figure 10-11   Slave-to-slave communication - overview

9. When the slave-to-slave communication link has been created, the standard telegram for the drive object is replaced with the "User-defined" telegram in the configuration overview.
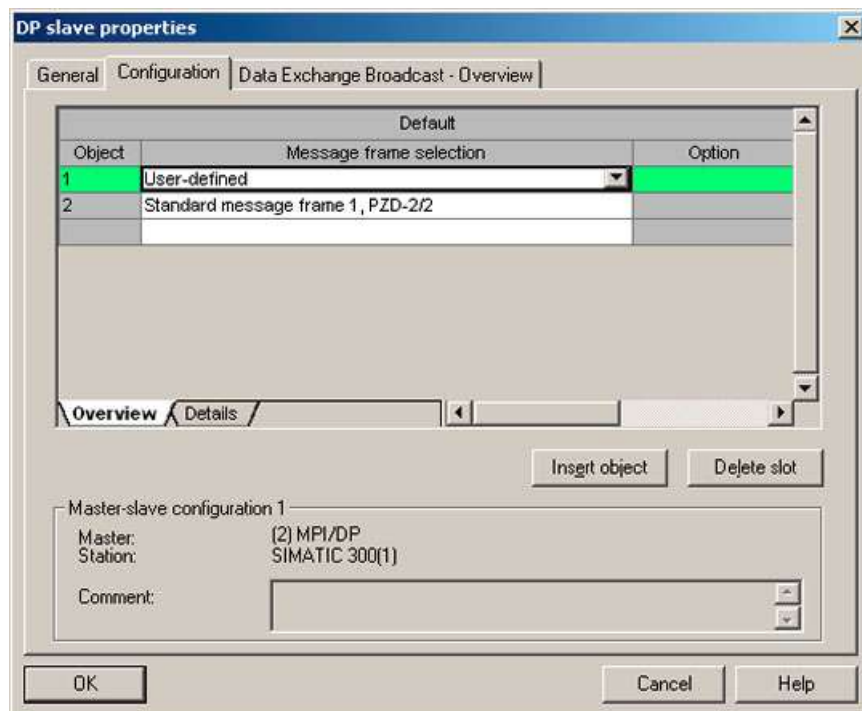
Figure 10-12   Telegram assignment for slave-to-slave communication

10. The details after the creation of the slave-to-slave communication link for the drive object of the SINAMICS DCM are as follows:

Figure 10-13   Details after the creation of the slave-to-slave communication link

11. You are required to adjust the standard telegrams accordingly for every DO (drive object) of the selected CU that shall actively participate in slave-to-slave communication.

Commissioning in STARTER

Slave-to-slave communication is configured in HWConfig and is simply an extension of an existing telegram. Telegrams can be extended in STARTER (e.g. p0922 = 999).
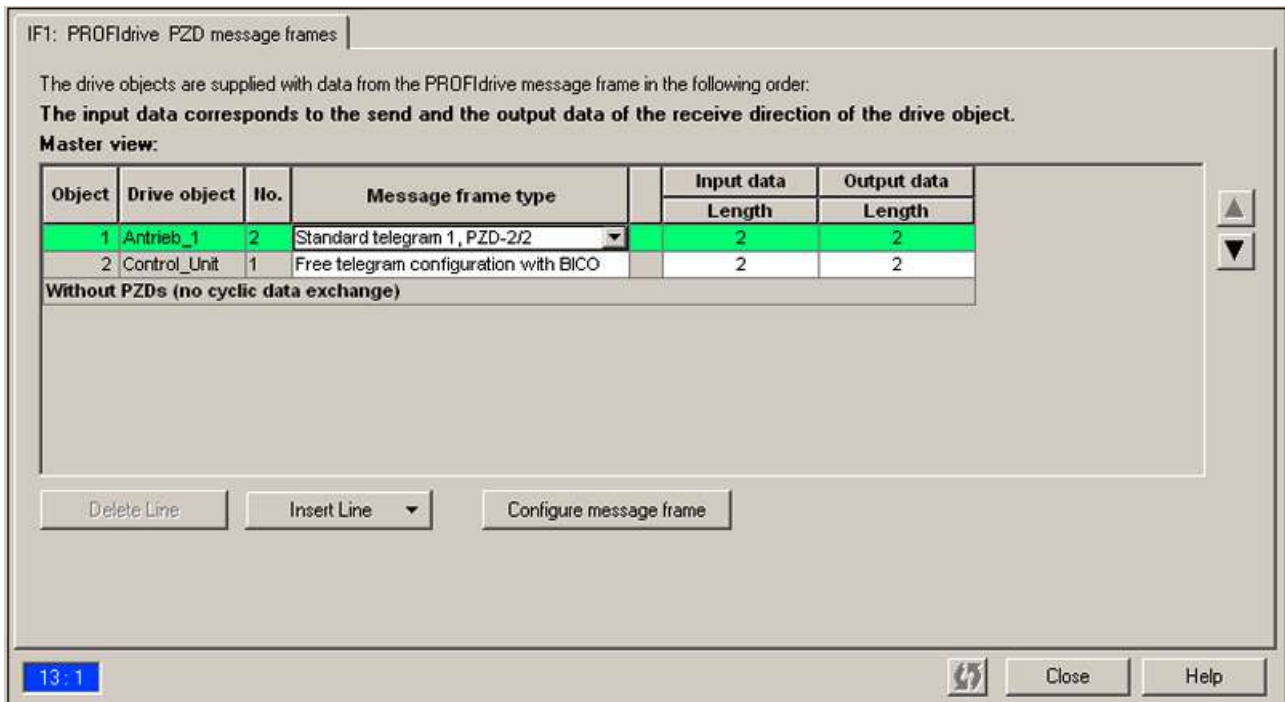
Figure 10-14 Configuring the slave-to-slave communication links in STARTER

In order to terminate the configuration of slave-to-slave communication 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 slave-to-slave communication links, the input data consists of the telegram component of the master and the slave-to-slave communication 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 slave-to-slave communication.

IF1: PROFIdrive PZD message frames

The drive objects are supplied with data from the PROFIdrive message frame in the following order:

The input data corresponds to the send and the output data of the receive direction of the drive object.

Master view:

Object	Drive object	No.	Message frame type		Input data Length	Output data Length
1	Antrieb_1	2	Standard telegram 1, PZD-2/2		2	2
			Message frame extension		0	2
2	Control_Unit	1	Free telegram configuration with BICO		2	2
Without PZDs (no cyclic data exchange)						

Delete Line   Insert Line ▼   Configure message frame

13 : 1   Close   Help

Figure 10-15 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 slave-to-slave communication.
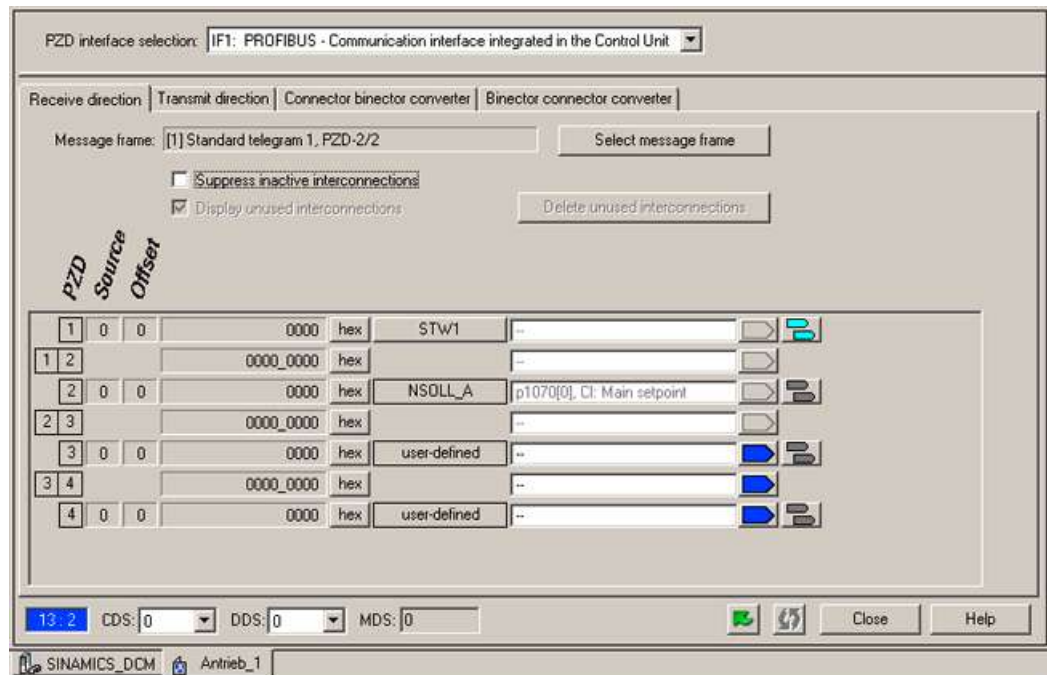
Figure 10-16 Configuring the PROFIBUS slave-to-slave communication in STARTER

For the connection of the

drive objects to the process data that are received via slave-to-slave communication, you must still interconnect the associated connectors to the corresponding signal sinks. A list for the connector shows all signals that are available for interconnection.
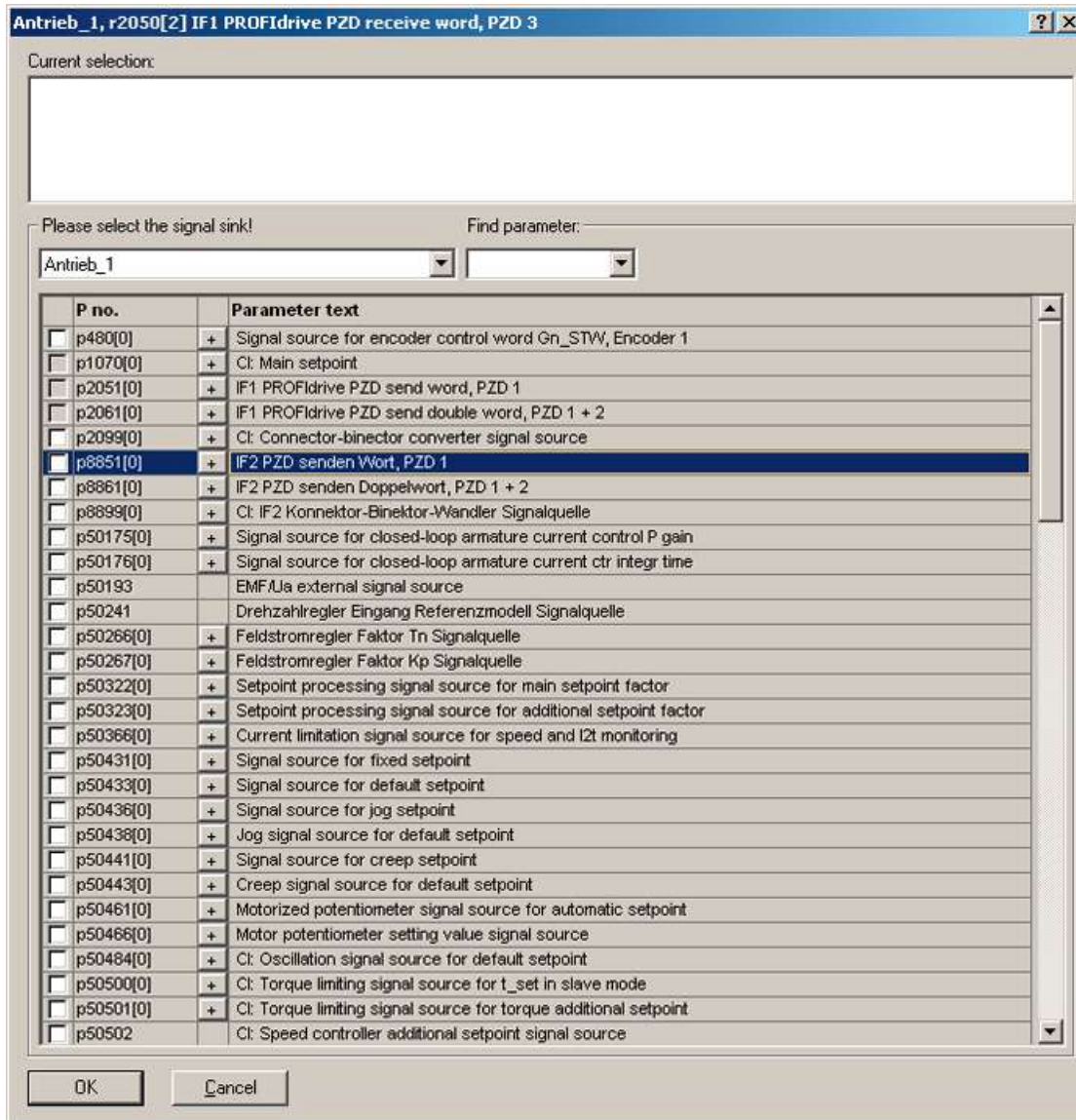
Figure 10-17   Linking the PZDs for slave-to-slave communication with external signals

10.2.8.5   Diagnosing the PROFIBUS slave-to-slave communication in STARTER

Since the PROFIBUS slave-to-slave communication 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 slave-to-slave communication. 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 slave-to-slave communication directly to the "master drive" (Publisher)!

For diagnostic purposes, there are the diagnostic parameters r2075 ("PROFIBUS diagnostics, receive telegram offset PZD") and r2076 ("PROFIBUS diagnostics, send 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 slave-to-slave communication 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 slave-to-slave communication

Alarm A01945 signals that the connection to a least one publisher of the drive device is missing or has failed. Any interruption to the publisher is also reported by the fault F01946 at the drive object involved. A failure of the publisher will therefore only affect the drive objects involved.

A description of the two messages can be found in the SINAMICS DCM list manual.

10.3 PROFINET IO

10.3.1 Activating online mode: STARTER via PROFINET IO

Description

The following options are available for activating online mode via PROFINET IO:

- Online mode via IP

Preconditions

- STARTER with Version ≥ 4.1.5 (SINAMICS DCM is supported starting only from STARTER Version 4.1.5)
- CBE20

STARTER via PROFINET IO (example)
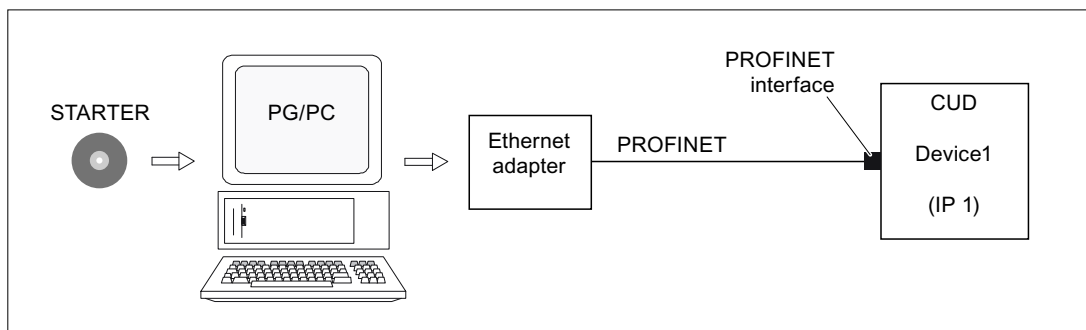
Figure 10-18   STARTER via PROFINET (example)

Procedure for activating online mode with PROFINET

1. Set the IP address in Windows XP
   This involves assigning a fixed, free IP address to the PC/PG.

2. Settings in STARTER

3. Enter the IP address and a name for the drive unit's PROFINET interface.
   The PROFIBUS interface must be named so that STARTER can establish communication.

4. Select online mode in STARTER.

Set the IP address in Windows XP.

On the desktop, right-click on "Network environment" -> Properties -> double-click on Network card and choose -> Properties -> Internet Protocol (TCP/IP) -> Properties -> Enter the freely-assignable addresses.
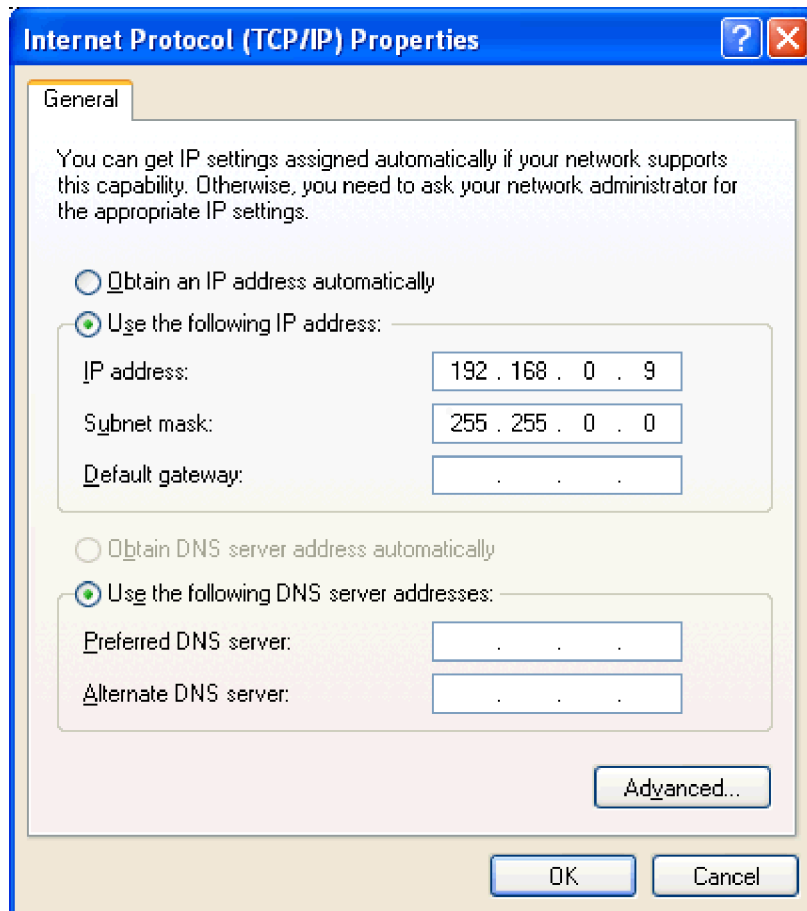
Figure 10-19 Internet Protocol (TCP/IP) properties

Settings in STARTER

The following settings are required in STARTER for communication via PROFINET:

- Tools → Set PG/PC interface...
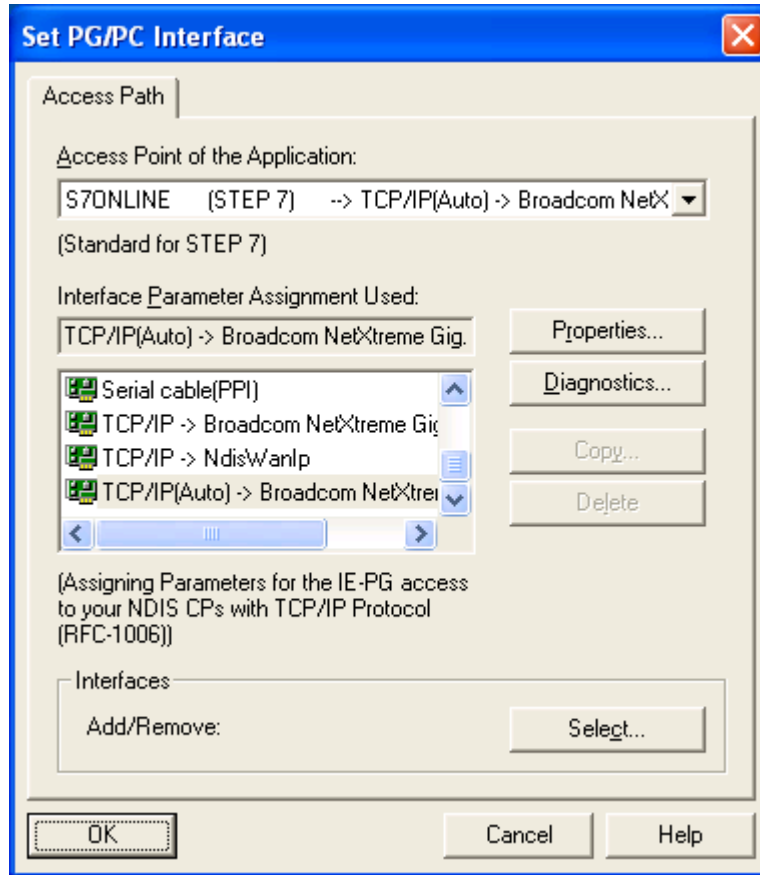
Figure 10-20 Set PG/PC interface

Assigning the IP address and name for the PROFINET interface of the drive unit

Use the STARTER to assign an IP address and a name to the PROFINET interface (e.g. CBE20).

Precondition:

- Connect the direct Ethernet cable from the PG/PC to the PROFINET interface of the Control Unit (CUD).

- Switch on the Control Unit (CUD).

The accessible nodes must be searched in STARTER:

- Project → Accessible nodes

The nodes are then displayed in the dialog screen.
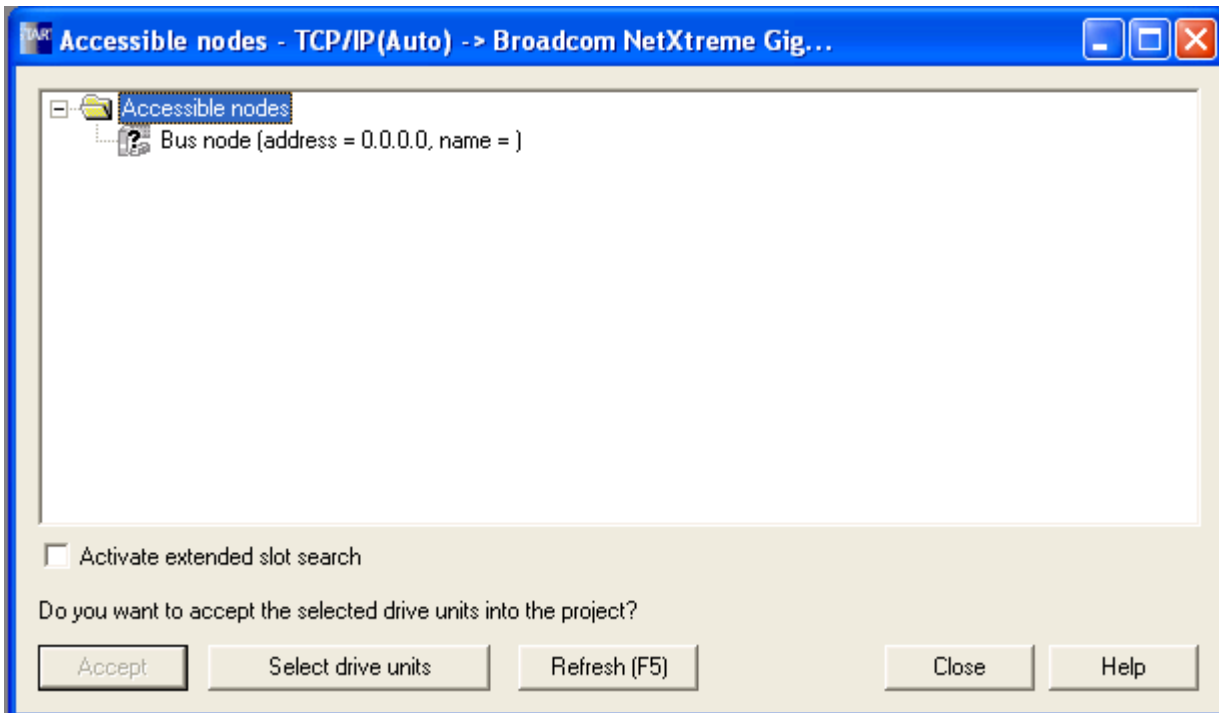
Figure 10-21 STARTER - Accessible nodes

The selected node is edited by right-clicking the field for the node and selecting the option "Edit Ethernet node...".
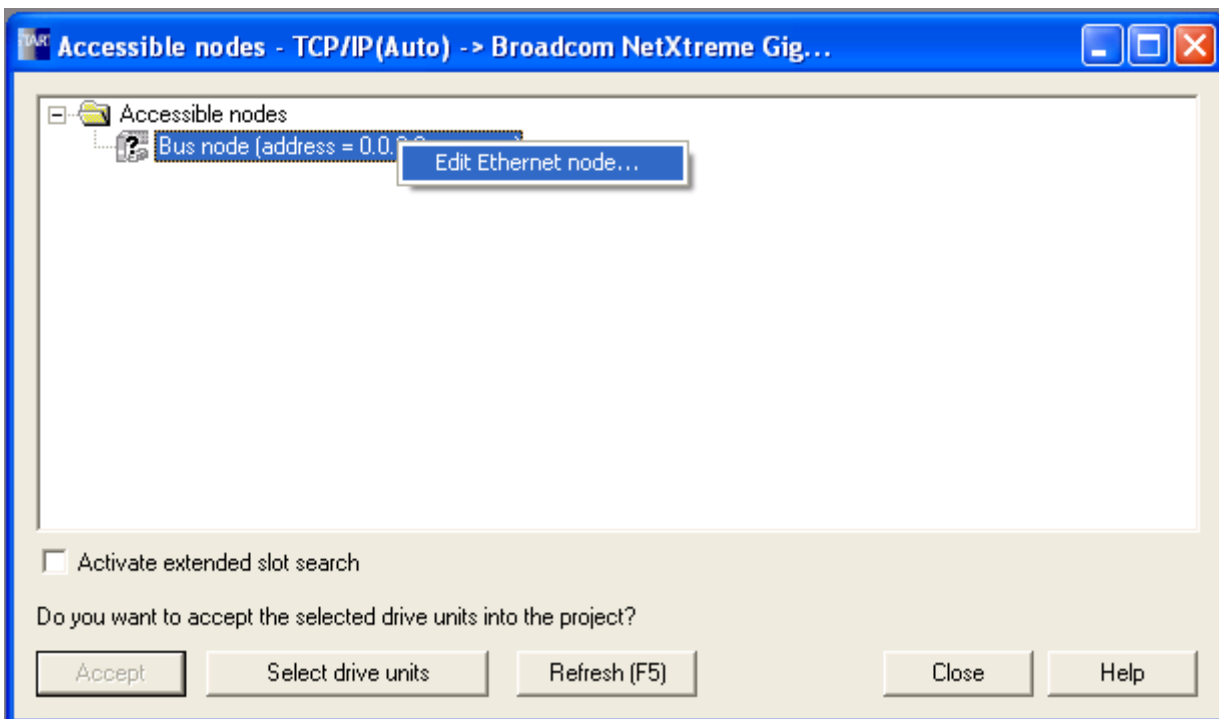
Figure 10-22 STARTER - Accessible nodes - Edit Ethernet node

In the dialog screen that appears next, enter a freely selectable unit name, the IP address, and subnet screen.

The subnet screens must match before STARTER can be run.
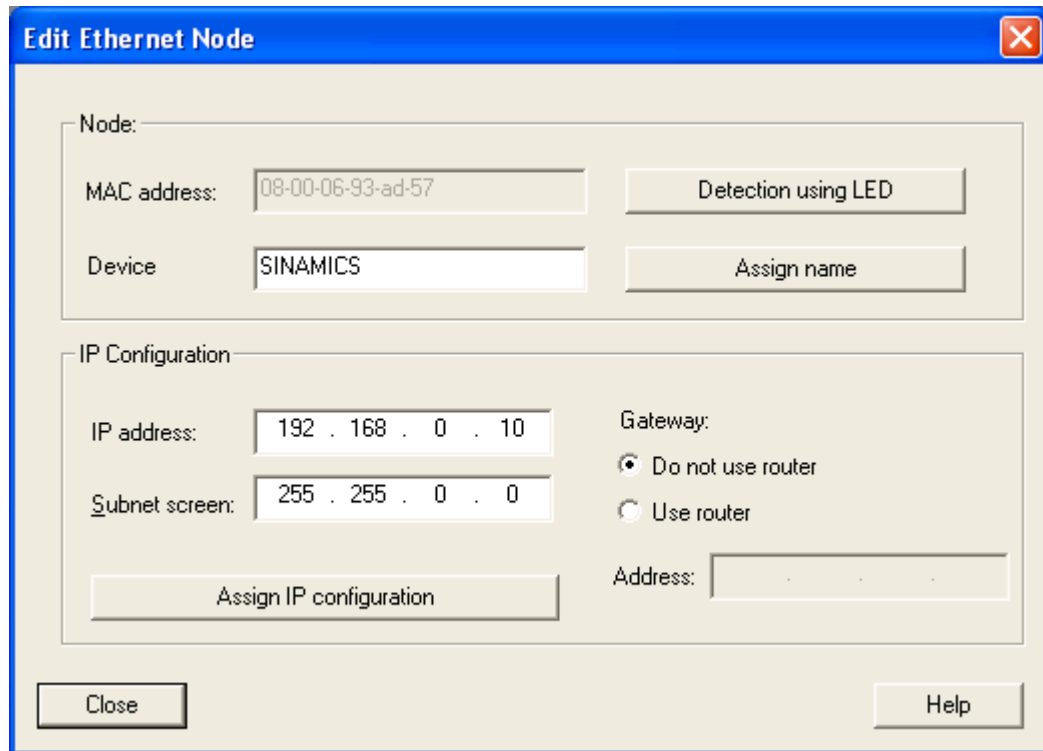
Figure 10-23 STARTER - Edit Ethernet Node

After selecting the "Assign name" button, the following confirmation will appear if the assignment was successful: In certain cases, a RAM to ROM is executed in the drive and you must wait until it has been completed.
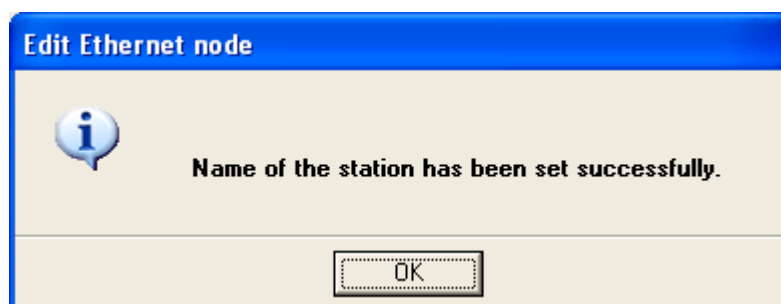
Figure 10-24 STARTER - Successful assignment of the unit name

After selecting the "Assign IP configuration" button, the following confirmation will appear if the assignment was successful: In certain cases, a RAM to ROM is executed in the drive and you must wait until it has been completed.
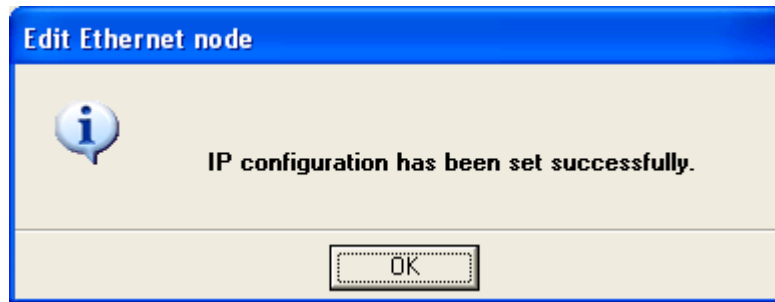
Figure 10-25   STARTER - Successful assignment of the IP configuration

Once the "Edit Ethernet Node" dialog screen has closed and the node overview has been updated (F5), a display indicates that the node properties have been successfully assigned.
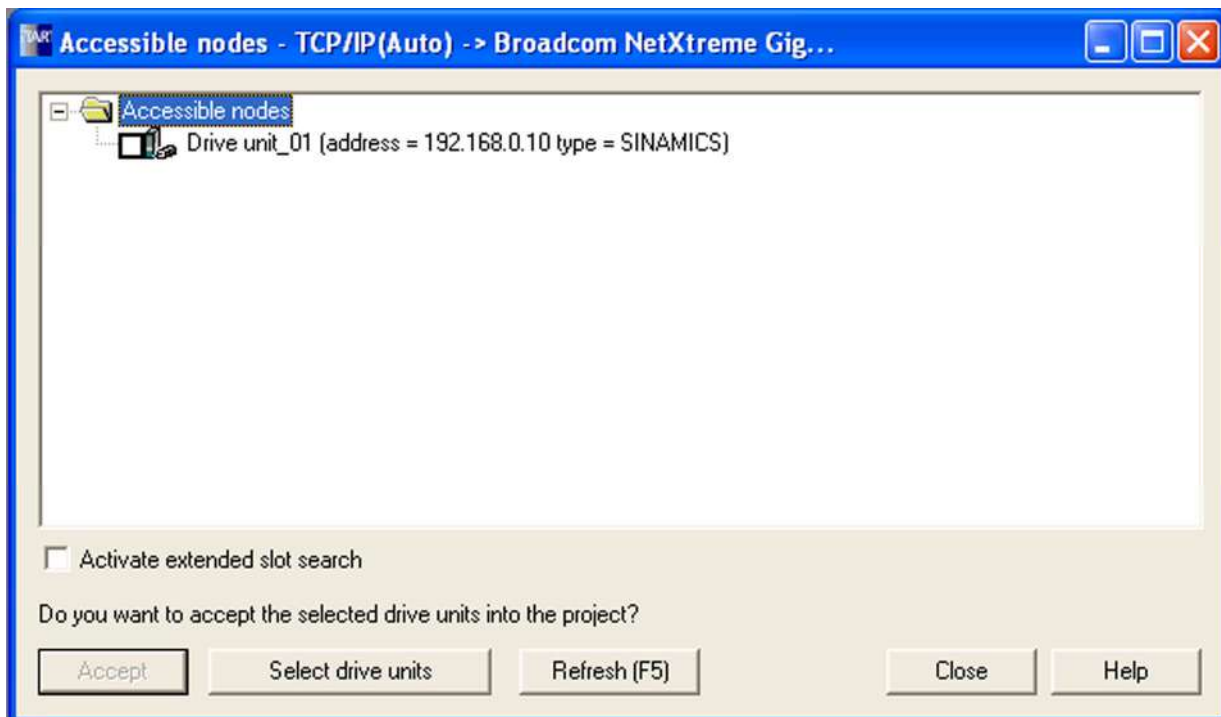
Figure 10-26   STARTER - Accessible nodes update completed

Note

The IP addresses allocated for the PC and the PROFINET interface in the drive must be different; otherwise communication between the PC and drive is not possible.

10.3.2 General information about PROFINET IO

10.3.2.1 General information about PROFINET IO for SINAMICS

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.

Signal processing in real time and determinism is important in industrial networks. PROFINET IO satisfies these requirements.

The following standards ensure open, multi-vendor systems:

● International standard IEC 61158

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 is the systematic development of the following systems:

● PROFIBUS DP, the established fieldbus,
  and

● Industrial Ethernet, the communication bus for the cell level

Experiences from both systems have been and are being integrated in PROFINET. As an Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET IO is a non-proprietary communication and engineering model.

PROFINET IO defines every aspect of the data exchange between IO controllers (devices with so-called "master functionality") and the IO Devices (those with so-called "slave functionality") as well as parameter assignment and diagnostic processes. An IO system is configured by virtually the same method used for PROFIBUS.

A PROFINET IO system is made up of the following devices:

● The 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.

● IO supervisor is an engineering tool typically based on a PC that is used to parameterize and diagnose individual IO Devices (drive units).

When a Communication Board CBE20 is inserted, a SINAMICS DC MASTER becomes an IO device in terms of PROFINET. The SINAMICS DC MASTER and CBE20 can be used for communication via PROFINET IO with RT.

Cycle communication using PROFINET IO with IRT or using RT is possible on all drive units equipped with a PROFINET interface. This means that problem-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

http://www.profibus.com
Order Number 3.172, spec. Chapter 6

* IEC 61800-7

CAUTION
Inserting the CBE20 Communication Board deactivates the cyclic PZD channel for PROFIBUS DP.

10.3.2.2 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

When communication takes place via TCP/IP, the resulting 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.

Definition: Real time (RT) and determinism

Real time means that a system processes external events over a defined period.

Determinism means that a system responds in a predictable manner (deterministically).

In industrial networks, both these requirements are important. PROFINET meets these requirements and is, therefore, implemented as a deterministic real-time network as follows:

* Transmission of time-critical data takes place at guaranteed time intervals. To achieve this, PROFINET provides an optimized communications channel for real-time communication: Real time (RT).

* It is possible to predict the exact time at which data transmission will take place.

* Problem-free communication using other standard protocols is guaranteed within the same network.

Definition: Isochronous real-time communication (IRT)

Isochronous real-time Ethernet: Real-time properties of PROFINET IO where IRT telegrams are transmitted deterministically via scheduled communication paths in a defined sequence to achieve the best possible synchronism and performance. This is also known as time-scheduled communication and uses knowledge about the network structure. IRT requires special network components that support scheduled data transmission.

Minimum cycle times of 500 µs and a jitter accuracy of less than 1 µs can be achieved when this data transfer method is implemented.
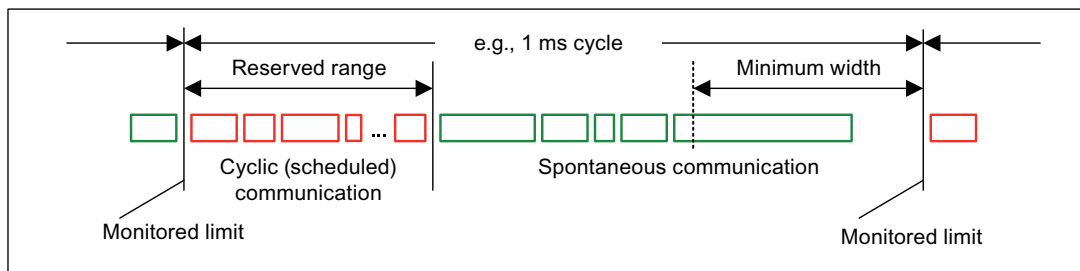
Figure 10-27   Bandwidth distribution/reservation, PROFINET IO IRT

10.3.2.3   Addresses

Definition: MAC address

Each PROFINET device is assigned a globally unique device identifier at the factory. This 6-byte long device identifier is the MAC address. The MAC address consists of:

- 3 bytes manufacturer's ID and
- 3-byte device identification (consecutive number)

The MAC address is usually indicated on the front of the device.

For example: 08-00-06-6B-80-C0

IP address

To enable a PROFINET device to be addressed as a node on Industrial Ethernet, this device also requires an IP address that is unique within 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 periods. The IP address is made up of

- The address of the (sub-) network and
- The address of the node (generally called the host or network node)

IP address assignment

The TCP/IP protocol is required to establish a connection and assign parameters; this is the reason that an IP address is required.

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. If the IP address is to be stored in a non-volatile memory, the address must be assigned using the Primary Setup Tool (PST).

This can also be performed with Hardware Config of STEP 7, where the function is called "Edit Ethernet node".

Note

If the network is part of an existing Ethernet company network, ask your network administrator for the information you need (IP address, subnet screen, and any router that may be in use.)

Device name (NameOfStation)

In its delivery state, an IO device does not have a device name. An IO device can only be addressed by an IO controller (in order to transmit project engineering data (including the IP address) during startup or exchange user data during cyclic operation, for example) after it has been assigned a device name with the IO supervisor.

NOTICE
The unit name must be saved in a non-volatile fashion using HW Config from STEP 7.

Replacing the Control Unit (CUD) (IO device)

The IP address and device name are stored in the non-volatile memory in the form of parameters (p61000 und p61001).

If a module is replaced, therefore, it is possible to continue running it as a PROFINET device by resetting the parameters.

Definition: Subnet screen

The bits set in the subnet screen define the part of the IP address that contains the address of the (sub)network. The following generally applies:

- The network address is obtained by an AND logic operation on the IP address and subnet screen.
- The node address is obtained by an AND NOT logic operation on the IP address and subnet screen.

Subnet screen example

Subnet screen: 255.255.0.0 (decimal) = 11111111.11111111.00000000.00000000 (binary), IP address: 140.80.0.2, significance: The first 2 bytes of the IP address determine the subnetwork; i.e. 140.80. The last two bytes address the node; i.e. 0.2.

Default router

If data needs to be forwarded via TCP/IP to a partner located outside the subnetwork, this is carried out via the default router. In the Properties dialog in STEP 7 (Properties of Ethernet interface > Parameters > Network transfer), the default router is referred to as the router. STEP 7 assigns the local IP address to the default router.

10.3.2.4 Data transmission

Properties

The Communication Board CBE20 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 and non-cyclic 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.

The total length of the Ethernet frame increases with the number of drive objects in a drive unit.

Sequence of drive objects during data transmission

The sequence of drive objects is displayed via a list in p0978[0...15]; it can also be changed using this parameter.

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

NOTICE
A ring-type topology is not permissible.

10.3.3   Hardware configuration (configuring SINAMICS drives with PROFINET)

Communication Board Ethernet CBE20

The CBE20 option module is inserted in the option slot of the CUD. The CBE20 is equipped with a PROFINET interface with 4 ports that can be used to connect the PROFINET subnetwork.

Note

The ports must not be interconnected in such a way that a ring topology is created.

Operation in PROFINET IO networks

A SINAMICS DCM with CBE20 can be integrated into PROFINET IO networks in all transmission modes

Note

SINAMICS DCM only supports Version V2.2 (IRTflex) for data transfer type IRT.

A SINAMICS DCM with CBE20 can only act as a synchronization slave within a PROFINET IO network.

- CBE20 module is plugged into CUD:
    - The cyclic DP interface is disabled.
    - Transmission type RT is configured. The SINAMICS DC MASTER uses a local clock cycle.
    - Transmission type IRT (option "not isochronous") has been configured: The CBE20 synchronizes itself with the send clock and operates as isochronous switch. The SINAMICS DCM uses a local clock cycle.
- CBE20 module is not inserted but configured:
    - Alarm A1487 "Topology fault" is present. Access via PROFINET is not available. There is no data exchange via PROFINET. The SINAMICS DCM uses a local clock cycle.

Telegrams

The following PROFIdrive telegrams can be selected for PROFINET IO communication:

- Isochronous standard telegrams 1, 20
- Telegram 352
- Telegram 999

DCP flashing

This function is used to check whether assignments to a module and its interfaces have been made correctly.

1. In HW Config or STEP7 Manager, select the menu command "Target system" > "Ethernet" > "Edit Ethernet node".

2. The "Edit Ethernet Node" dialog box opens.

3. Click the "Browse" button.

4. The "Browse Network" dialog box opens and displays the connected nodes.

5. After SINAMICS with CBE20 has been selected as a node, activate the "DCP flashing" function by means of 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 STEP7 V5.3 SP1 via Ethernet.

STEP 7 routing with CBE20

The CBE20 does not support STEP 7 routing between PROFIBUS and PROFINET IO.

Connecting the PC with the STARTER commissioning tool

You can go online with STARTER in a number of ways, which are illustrated below:
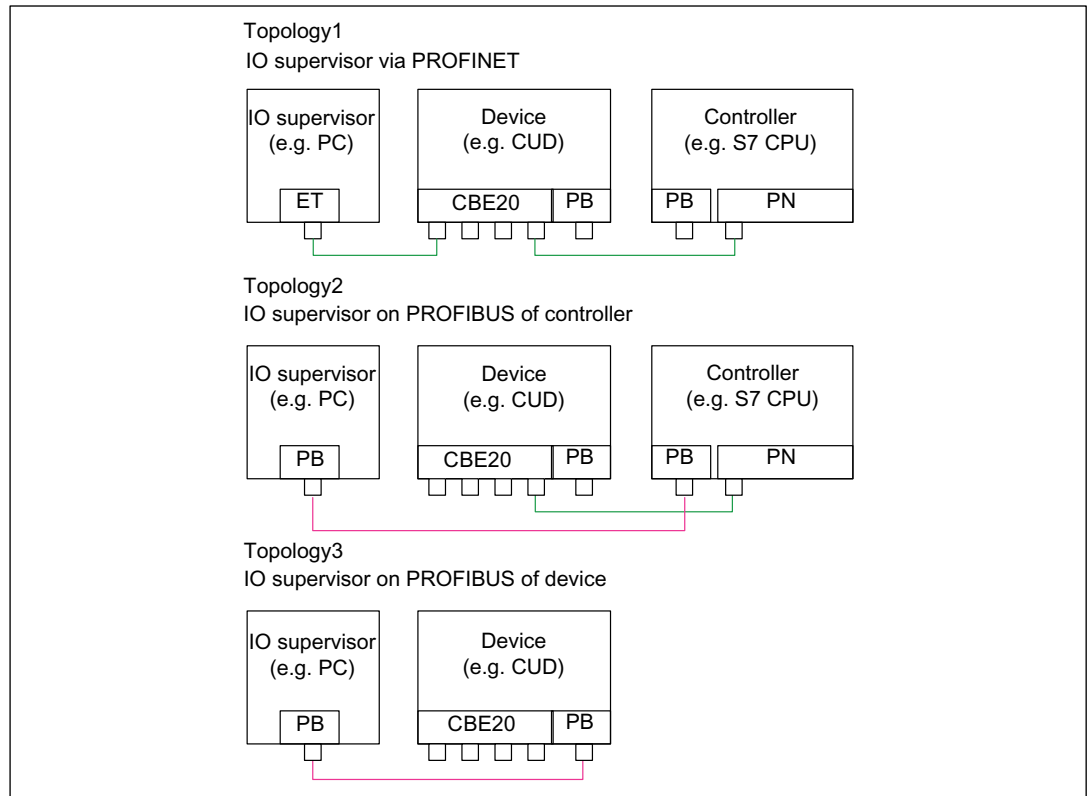
Figure 10-28   Connecting the IO supervisor

NOTICE
SINAMICS does not support routing from PROFIBUS to PROFINET and vice versa.

NOTICE
If a CBE20 module fails (e.g. due to a power failure) then communication with the subsequent nodes is interrupted at this point.

10.3.4   RT classes for PROFINET IO

PROFINET IO is a scalable real-time communication system based on Ethernet technology. The scalable approach is expressed in the form of three real-time 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 using PROFINET IO with RT. The real-time capability is comparable with the present 12-MBaud PROFIBUS DP solutions, i.e. a sufficiently large bandwidth portion is available for transmitting IT services in parallel on the same line.

The real update time during which cyclic data are exchanged depends on the bus load, the devices used, and the quantity structure of the I/O data. The update time is a multiple of the send cycle.

IRT

Two options are available with this RT class:

- IRT "high flexibility"
- IRT "high performance".

Software preconditions for configuring IRT:

- STEP 7 5.4 SP4 (HW Config)

Note

For further information about configuring the PROFINET interface for the I/O controller and I/O device, please refer to the following document: SIMOTION SCOUT Communication System Manual.

IRT "high flexibility"

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.

Note

IRT "high flexibility" cannot be used for isochronous applications.

IRT "high performance"

In addition to reserving the appropriate bandwidth, telegram traffic can be further optimized by defining the topology when configuring the system. 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 transmission function 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 transmission 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 transmitted according to a schedule.

Comparison between RT and IRT

Table 10- 10   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 schedule; 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 thanks to reserved bandwidth	Precisely scheduled transmission; times for transmitting 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 (position reservation is possible)	Whenever the topology or the communication relationships change
Maximum switching depth (number of switches in one line)	10 at 1 ms	61	32
For possible send cycles, see subitem "Send cycles and update times for RT classes" in table "Adjustable send cycles and update times"			

Note

SINAMICS DCM does not support isochronous communication.

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 for the relevant PROFINET device in HW Config.

1. In HW Config, double-click the PROFINET interface item in the module.

   The "Properties" dialog opens.

2. Select the RT class under "RT class" on the "Synchronization" tab.

3. Once you have selected "IRT", you can also choose between "high flexibility" and "high performance".

4. Confirm with "Update".

Synchronization domain

Taken as a whole, all of the devices that are to be synchronized form a synchronization domain. The entire 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 subnetwork.

Example:

● Synchronization domain IRT: SIMOTION 2 with SINAMICS

● SINAMICS, which is assigned to the IO system of SIMOTION 1, is arranged in the topology in such a way that its RT communication must be conducted through the IRT synchronization domain.

- - - - Communication outside synchronization domains
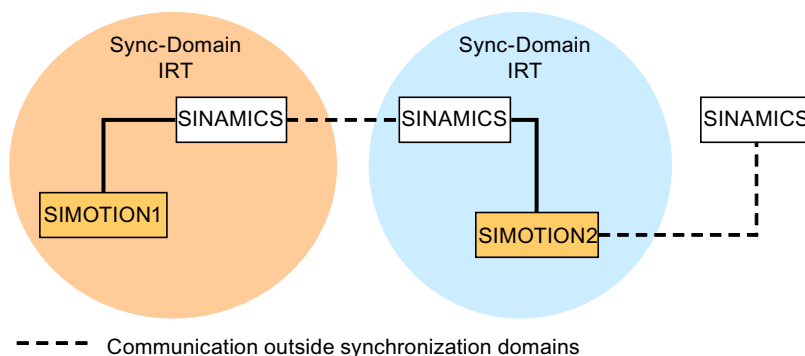
Figure 10-29 RT communication across the limits of synchronization domains

Update times and send cycles for RT classes

Definition of 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 time.

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

- Send cycles supported in the PROFINET devices assigned to a synchronization domain. 1 ms is an example of a typical send cycle.

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- 11   Adjustable send cycles and update times

Send cycle		Reduction ratios between update time and send cycle	
		RT IRT "high flexibility" [4]	IRT "high performance"
Range "even" [1]	250, 500, 1000 µs	1,2,4,8,16,32,64,128,256,512	1,2,4,8,16 [2]
	2000 µs	1,2,4,8,16,32,64,128,256	1,2,4,8,16 [2]
	4000 µs	1,2,4,8,16,32,64,128	1,2,4,8,16 [2]
Range "uneven" [3]	375, 625, 750, 875, 1125, 1250 to 3875 µs (increment 125 µs)	Not supported [5]	1

Note

There is no intersection between the send cycles for the "even" and "uneven" ranges.

Explanations for the above 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 the 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" pulldown menu). This means that STEP 7 will not automatically adjust the update time and, therefore, that the update time 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 between the send cycles supported by all the devices in the synchronization domain.

The reduction ratio between the update time of an IO device and the send cycle is set in the "Properties" of the PROFINET interface for the relevant device.

Send cycles for SINAMICS drive units

A SINAMICS drive unit with PROFINET interface which supports IRT permits send cycle settings of between 0.5 ms and 4.0 ms in a 250 µs time frame.

Topology rules

Topology rules for RT

- A topology can be configured for RT, but does not need to be. If a topology has been configured, the devices must be wired in accordance with the topology.

- Apart from this stipulation, the devices can be wired in any way you wish.

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. An "island" refers to the fact 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 unit family entry in the hardware catalog must then be configured. For the RT class IRT, these are all entries with the end identification ...PN-V2.2.

GSD:
The names of GSD files for devices that contain IRT end in …PN-V2.2.

10.3.5 Selecting the CBE20 firmware version

Only one of the possible PROFINET versions can be loaded into the Control Unit as firmware. All firmware files provided for different PROFINET variants are stored on the Control Unit's memory card.

The PROFINET variants required are each stored in a separate UFW file on the memory card. The pointer file **optboard.txt** contains the names of the UFW files to be loaded. The contents of the pointer file are modified in order to switch from one firmware variant to another. POWER ON must then be executed to activate the change in variant. During the subsequent system boot, the UFW file referenced in the pointer file is loaded.

The pointer file refers to PROFINET V2.2 by default.

Table 10- 12   UFW files and selected in the pointer file

UFW file and folder on memory card	Functionality	Pointer file content
/SIEMENS/SINAMICS/CODE/CB/ CBE20_1.UFW	PROFINET V2.2	CBE20=1
/SIEMENS/SINAMICS/CODE/CB/ CBE20_3.UFW	SINAMICS Link	CBE20=3
/OEM/SINAMICS/CODE/CB/ CBE20.UFW	Customized	CBE20=99

The contents of the pointer file optboard.txt can be modified or read out using parameter p8835. This file must be edited manually with other firmware versions. The factory setting for the parameter is p8835 = 1 (PROFINET V2.2).

Setting values of p8835:
1 = PROFINET V2.2
2 = PN Gate
3 = SINAMICS Link
99 = customer-specific

The versions can be switched between by modifying the parameter. A POWER ON must then be performed to activate the change.

Identification of firmware version:
The OMI diagnostic channel, parameter r8858 can be read to identify which firmware version of PROFINET interface is currently loaded.

10.4 Communication via SINAMICS Link

10.4.1 Basic principles of SINAMICS Link

SINAMICS Link enables data to be directly exchanged between several Control Units CU320-2 DP or CUD, which for this purpose must be equipped with the CBE20 supplementary module. Other nodes cannot be integrated into this communication. Possible applications include e.g.:

- 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

Send and receive data

The most frequently used node comprises a drive unit with a CU and a number of connected drive objects (DOs). A telegram of a SINAMICS Link has space retainers for 16 process data (PZD). Each PZD is precisely one word long. Slots that are not required are filled with zeros

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

SINAMICS Link

Every node can send a telegram with 16 PZD. A drive object can receive up to 16 PZD from every other DO of the connected nodes as long as the transferred data within a telegram does not exceed 16 words. Single words and double words can be sent and received. Double words require 2 consecutive PZDs. It is not possible to read in your own send data.

Transmission time

With SINAMICS Link, an average transmission time of 3.5 ms is possible (with controller cycle 1 ms; bus cycle 1 ms).

10.4.2 Topology

Only a line topology with the following structure is permitted for SINAMICS Link.
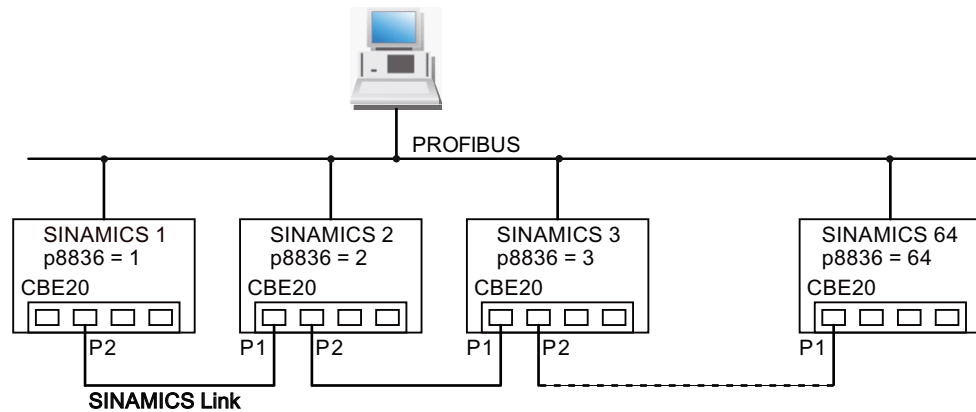
Figure 10-30 Maximum topology

- The numbers of the various nodes are entered into parameter p8836[0...63] in ascending order.

- Gaps in the numbering are not permitted.

- The node with the number 1 is automatically the sync master of the communication link.

- When configuring the communication, the **NameOfStation** (SINAMICSxLINKx001 … SINAMICSxLINKx064) and the **IP address** (169.254.123.001 … 169.254.123.064) of the particular node are automatically set up by allocating the node number and cannot be changed.

- For the CBE20 connection, the ports must be used as shown in the diagram above – this is mandatory. This means that Port 2 (P2) of node **n** is always connected with Port 1 (P1) of node **n+1**.

10.4.3 Configuring and commissioning

Commissioning

> **Note**
>
> In order that SINAMICS Link can be selected, a memory card with the actual software must be inserted in the drive.

When commissioning, proceed as follows for the Control Unit:

- On the CU, set parameter p0009 to 1 (unit configuration).

- On the CU, set parameter p8835 to 3 (SINAMICS Link).

- Using p8836, assign node numbers to the nodes (the first CU is always assigned the number 1). Observe the specifications under "Topology". Node number 0 means that SINAMICS Link is shut down.

- On the CU, set parameter p0009 to 0 (unit configuration).

- Save the changes saved in the RAM in a non-volatile fashion.

- Perform a Power ON (switch-off/switch-on).

Sending data

Proceed as follows to send data:

- In parameter p2051[x], for each drive object, define which data (PZDs) should be sent. p2061[x] must be used for double word quantities.

- In parameter p8871, for each drive object, assign the send parameter to the send slot of its own node. Double words (e.g. 2+3) are assigned two consecutive send slots, e.g. p8871[1] = 2 and p8871[2] = 3.

Receiving data

Proceed as follows to receive data:

Note

The first word of the receive data must be a control word, where bit 10 is set. If this is not the case, then you must deactivate the evaluation of bit 10 using p2037 = 2.

- Received data are saved in parameter r2050[x]/r2060[x].

- The address of the node from which the relevant PZD is to be read is defined in parameter p8872[0 … 15] (0 ≙ nothing is read in).

- In parameter p8870[0 … 15], the PZD is defined which is read from the sent telegram and is to be stored in its own receive slot, r2050 for PZD or r2060 for double PZD (0 ≙ no PZD selected).

Note

For double words, 2 PZD must be read; e.g.: Read in a 32-bit setpoint, which is located on PZD 2+3 for node 5 and map this to PZD 2+3 of its own node: p8872[1] = 5, p8870[1] = 2, p8872[2] = 5, p8870[2] = 3

Activation

To activate SINAMICS Link connections, perform a POWER ON for all nodes. The assignments of p2051[x]/2061[x] and the links of the read parameters r2050[x]/2060[x] can be changed without a POWER ON.

10.4.4 Example

Task

Configure the speed control of a SINAMICS DCM on a CU320-2 to increase the computational performance when using SINAMICS Link and DCC.

- Send data from SINAMICS DCM to CU320-2:
  - r0898 CO/BO: Control word SINAMICS DCM (1 PZD), in the example PZD 1
  - r0899 CO/BO: Status word SINAMICS DCM (1 PZD), in the example PZD 2
  - r52211 CO: Fixed setpoint output to AOP30 (1 PZD), in the example PZD3
  - r52013 CO: Analog input, main actual value (1 PZD), in the example, PZD4
- Send data from CU320-2 to SINAMICS DCM:
  - r21530 CO: Output, PI controller (1 PZD), in the example, PZD 1

Procedure

1. For all nodes, set the SINAMICS Link mode: DO1 p8835 = 3
2. Assign node numbers for the two devices:
   - SINAMICS DCM: DO1 p8836 = 1
   - CU320-2: DO1 p8836 = 2
3. Insert the DCC plan for the speed control at the CU320-2:
   - Ensure that the technology package is available on the CU320-2.
   - Create the DCC chart and generate the following chart
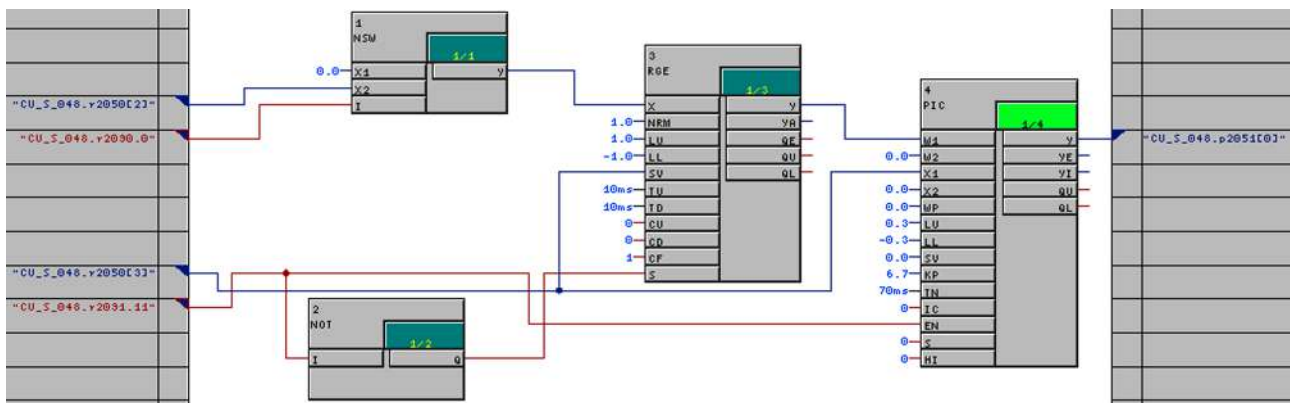
Figure 10-31 DCC chart

The values set in this example for LU, LL, TV, TD of the ramp-function generator and LU, LL, KP, TN of the PI controller must be appropriately adapted. The inputs and outputs of the DCC blocks must be correspondingly defined as BICO and interconnected with the corresponding parameters according to the diagram.

4. Define the send data (SINAMICS DCM):

   – Define the PZD to be sent for the SINAMICS DCM:
     DO2 p2051.0 = r0898
     DO2 p2051.1 = r0899
     DO2 p2051.2 = r52211
     DO2 p2051.3 = r52013

   – Assign this PZD to the send buffer (p8871) of its own DO:
     DO2 p8871.0 = 1 (SINAMICS Link send PZD 0 = DO2 p2051.0)
     DO2 p8871.1 = 2 (SINAMICS Link send PZD 1 = DO2 p2051.1)
     DO2 p8871.2 = 3 (SINAMICS Link send PZD 2 = DO2 p2051.2)
     DO2 p8871.3 = 4 (SINAMICS Link send PZD 3 = DO2 p2051.3)

   – This means that you have defined the position of the data in the 16-word telegram of the drive unit.

5. Define the receive data (SINAMICS DCM):

   – Define that receive buffer 0 should be filled with data from CU320-2:
     DO2 p8872.0 = 2

   – Define that PZD 1 of CU320-2 should be saved in this buffer:
     DO2 p8870.0 = 1

6. Define the send data (CU320-2):

   – For the CU320-2, define the PZD to be sent:
     DO1 p2051.0 = r21530 (output of the DCC closed-loop control)

7. Define the receive data (CU320-2):

   – Define that the receive buffer 0 should be filled with data from SINAMICS DCM:
     DO1 p8872.0 = 1
     DO1 p8872.1 = 1
     DO1 p8872.2 = 1
     DO1 p8872.3 = 1

   – Define that PZD1 of SINAMICS DCM should be saved in this buffer:
     DO1 p8870.0 = 1
     DO1 p8870.1 = 2
     DO1 p8870.2 = 3
     DO1 p8870.3 = 4

8. Carry out a RAM to ROM and then a power cycle at all components to activate the SINAMICS Link connections.

10.4.5 Diagnostics

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 the 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"

Overview of important parameters (refer to the List Manual):

- r2050[0...19] CO: IF1 PROFIdrive PZD receive word
- p2051[0...14] CI: IF1 PROFIdrive PZD send word
- r2060[0...18] CO: IF1 PROFIdrive PZD receive double word
- p2061[0...26] CI: IF1 PROFIdrive PZD send double word
- p8835 CBE20 firmware selection
- p8836 SINAMICS Link address
- p8870 SINAMICS Link telegram word PZD receive
- p8871 SINAMICS Link telegram word PZD send
- p8872 SINAMICS Link address PZD receive

10.5   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. Since the USS® protocol had not yet been replaced by PROFIBUS in some applications, it was implemented in the SINAMICS DCM.

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 DCM units 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 DC MASTER units cannot use the USS® protocol to exchange data with one another directly.

Connecting

Terminal X178, X178

Function diagrams

The function diagrams for the fieldbus interface are of relevance here:
See FP2410, FP2420, FP2440, FP2442, FP2450, FP2452, FP2460, FP2470, FP2472, FP2481, and FP2483.

Wiring example for a USS bus
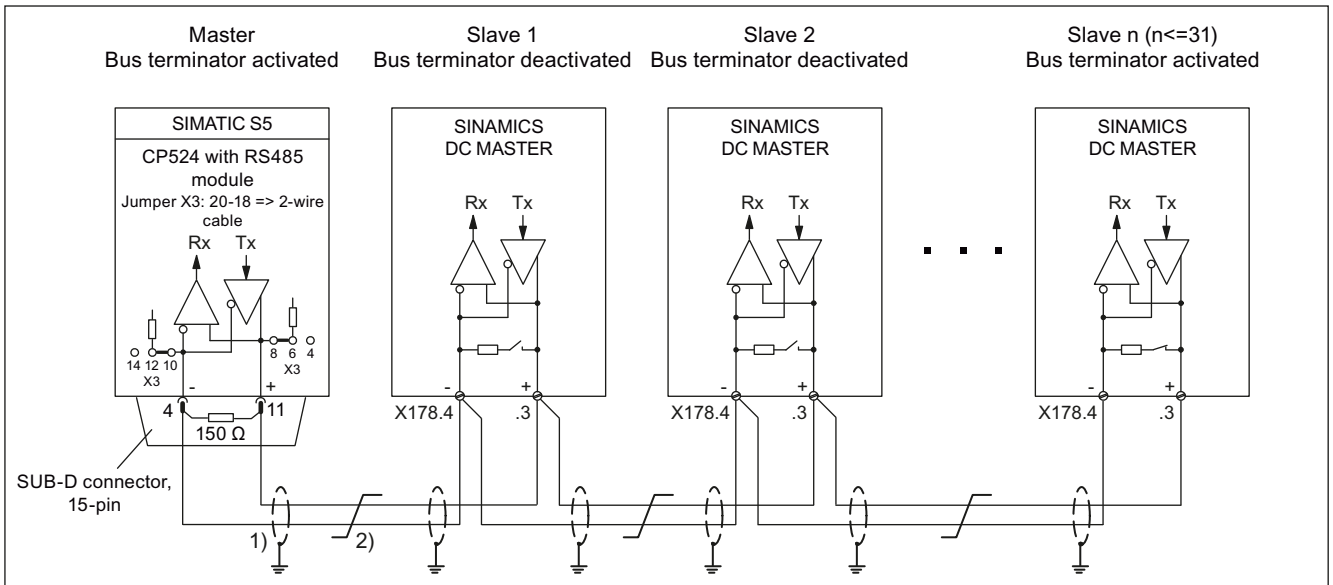
1) The shields for the interface cables must be connected directly on the units (using a clamp, for example) to unit or cabinet ground, with a low level of impedance.

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 10-32 USS bus

10.6 Parallel operation of communication interfaces

General information

Only one of the two available hardware communication interfaces could be used for the processing of the cyclic process data (setpoints/actual values) in the factory setting. This is either the

● onboard interface (PROFIBUS DP) or the

● additional option interface/COMM board (PROFINET).

The onboard interface is disabled when the COMM board (BDE20) is plugged in.

With the setting p8839 ≠ 99, it is possible to use the onboard interface (PROFIBUS DP) and COMM Board (PROFINET) in parallel in the SINAMICS system.

The following applications can then be implemented:

● PROFIBUS DP for drive control and PROFINET for the acquisition of 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).

● Use of redundant communication interfaces

Assignment of communication interfaces to cyclic interfaces

Two cyclic interfaces exist for setpoints and actual values, which differ by their parameter ranges used (BICO, etc.) and the usable functionalities. These two interfaces are designated IF1 (cyclic interface 1) and IF2 (cyclic interface 2).

The HW communication interfaces (onboard, COMM board) are firmly assigned to one of these cyclic interfaces (IF1, IF2), depending on their type (PROFIBUS DP, PROFINET). The respective other interface is disabled.

For the parallel operation of the communication interfaces, this formerly fixed assignment to the cyclic interfaces can be determined as desired by user parameterization.

Properties of the cyclic interfaces IF1 and IF2

The following table shows the different features of the two cyclic interfaces:

Table 10- 13   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	No	No
Slave-to-slave communication (PROFIBUS only)	Yes	Yes
List of drive objects (p0978)	Yes	Yes
Max. PZD (16bit) setpoint / actual value encoder	-	-
Max. PZD (16bit) setpoint / actual value at the DO TM31	5 / 5	-
Max. PZD (16bit) setpoint / actual value at the DO TM15	5 / 5	-
Max. PZD (16bit) setpoint / actual value at the DO CU_DC	5 / 15	-
Max. PZD (16bit) setpoint / actual value at the DO DC_CTRL	32 / 32	16 / 16

Table 10- 14   Implicit assignment of hardware to cyclic interfaces for p8839[0,1] = 99

Plugged hardware interface	IF1	IF2
No option, onboard interface only (PROFIBUS)	Onboard	--
PROFINET option (CBE20)	COMM board	Is deactivated

For parallel operation of the hardware interfaces and the explicit assignment to the cyclic interfaces IF1 and IF2, the parameter p8839[0,1] "PZD Interface hardware assignment" exists for the device DO in the expert list.

The default setting of p8839[0,1]=99 enables the implicit assignment (see table above).

An alarm is generated in case of unvalid or inconsistent parameterization of the assignment.

Additional parameters for IF2

Receive and send process data:
r8850, p8851, r8853, r8860, p8861, r8863

Diagnostic parameters (meaning of 88xx identical with 20xx):
r8874, r8875, r8876

Binector-connector converter (meaning of 88xx identical with 20xx):
p8880, p8881, p8882, p8883, p8884, r8889

Connector-binector converter (meaning of 88xx identical with 20xx):
r8894, r8895, p8898, p8899

Note

It is not possible in the HW Config configuration tool to represent a PROFIBUS / PROFINET slave with two interfaces. In parallel operation, SINAMICS will therefore appear twice in the project or in two projects although there is only one physical device.

Parameter

p8839	PZD Interface hardware assignment
Description:	Assigning the hardware for cyclic communication via PZD interface 1 and interface 2.
Values:	0: not active
	1: Communication interface integrated in the Control Unit
	2: Option board
	99: Automatic

The following rules apply to the setting of p8839:

- The setting of p8839 applies to all DOs of a CU (device parameter).

- For the setting p8839[0] = 99 and p8839[1] = 99 (automatic assignment, default), the assignment will be made on the basis of the plugged hardware. To render this automatic assignment active, it must be selected for both indexes; otherwise an alarm is generated, and the setting p8839[x] = 99 is treated in the same manner as 'not active'.

- An alarm is issued if the same hardware (onboard or COMM board) is selected in p8839[0] and p8839[1]. In this case, the setting of p8839[0] is effective. The setting of p8839[1] is treated as 'not active'.

- With the setting p8839[x] = 2 and the COMM board missing / defective, the respective interface is not automatically fed by the onboard interface. Message A08550 is output instead.

10.7 Switch on, switch off, enable

10.7.1 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 $0 \rightarrow 1$ 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.

   If "Operation enable" is applied:

5. With positive brake-release time (p50087):
The "Release holding or operational brake" (r53210.0 = 0) signal is output and p50087 is awaited in operating state o1.0.
With negative brake-release time (p50087 negative):
Procedure goes straight to step 6; brake not yet 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 "Shutdown" 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
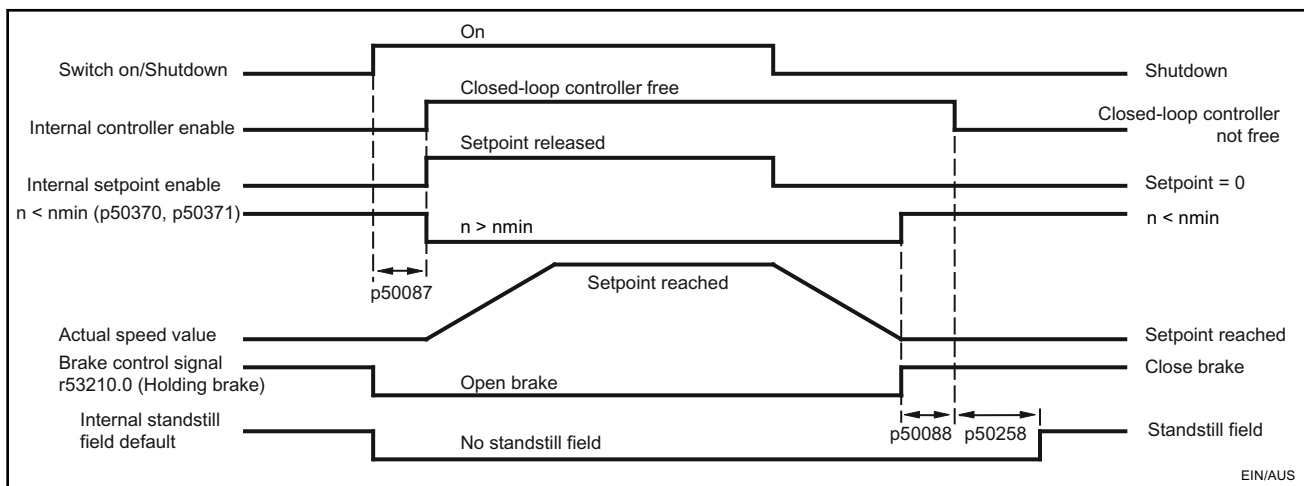
p50087   Brake-release time (positive in this case)

p50088   Brake-closing time

p50258   Wait time for automatic field-current reduction

Figure 10-33 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 pulse triggering is selected has an overriding effect on "Switch on", "Shutdown", and "Creep".

Note

The "Creep' function is described in the "Setpoint channel" chapter, "Creep" section.

- 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 I²t monitoring of the power unit are enabled.

10.7.2 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).

10.7.3 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 -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
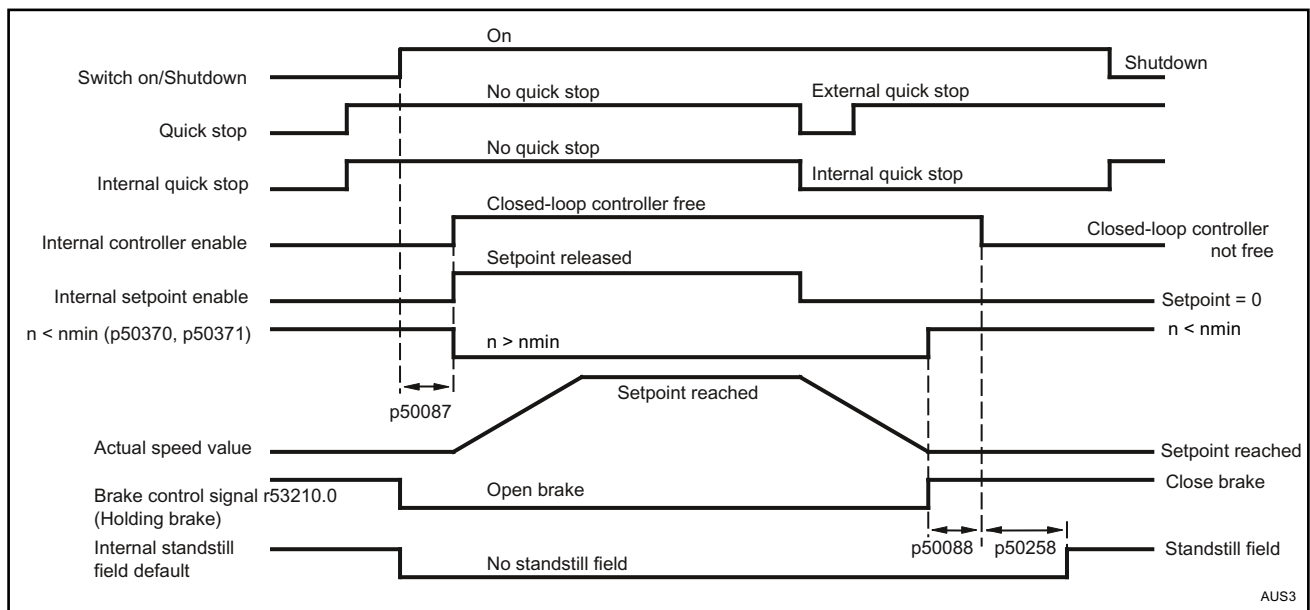
p50087   Brake-release time (positive in this case)

p50088   Brake-closing time

p50258   Wait time for automatic field-current reduction

Figure 10-34   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 I2t monitoring of the power unit are enabled.

10.7.4 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).

10.8 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 by opening terminal X177.12, for example.

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.

10.9 Setpoint channel

10.9.1 Ramp-function generator

Table 10- 15   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%: From -10% to 0 = ramp-down and From 0 to +50% = ramp-up, and vice versa
Rampup 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
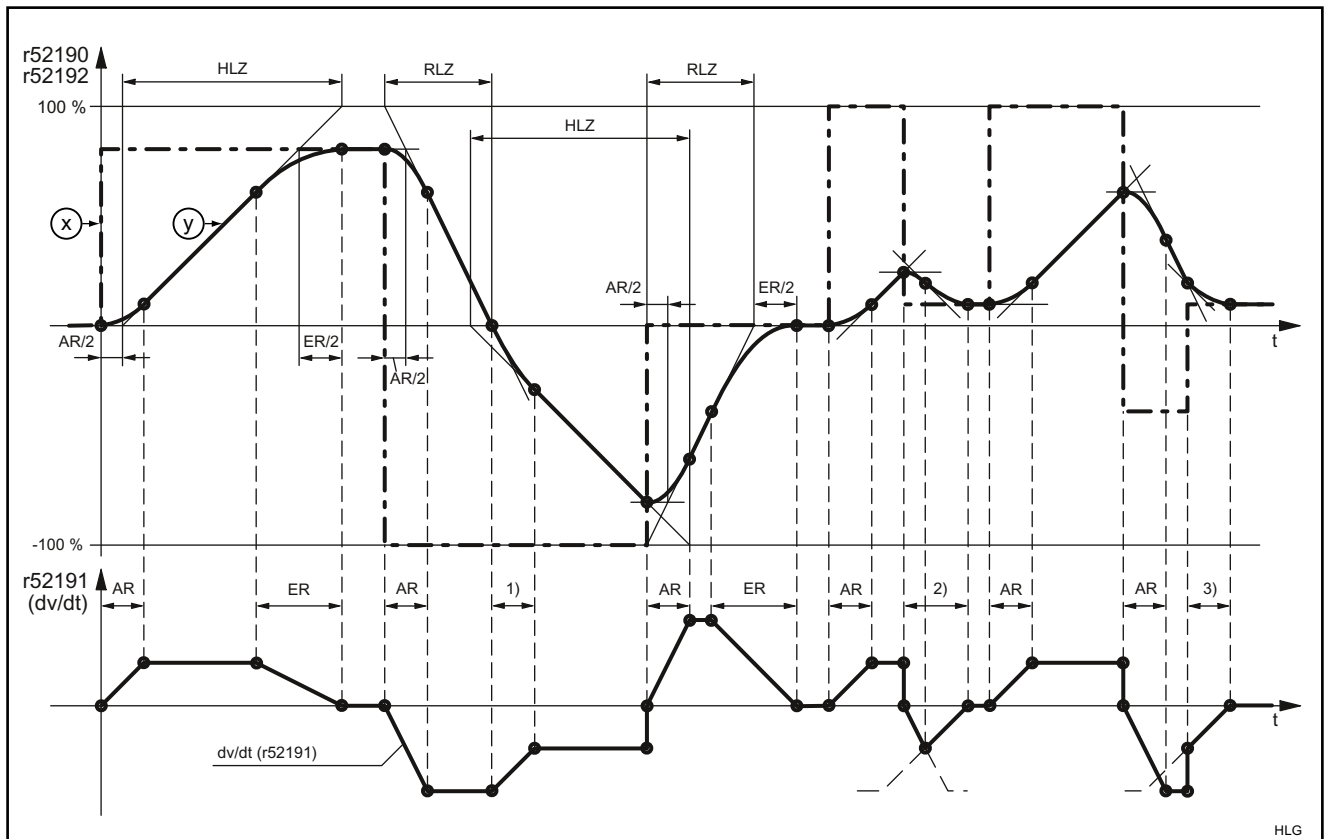
(x)	= Ramp-function generator setpoint	(y)	= Ramp-function generator output
RUT	= Rampup time	RDT	= Ramp-down time
IR	= Initial rounding	FR	= Final rounding

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 10-35 Ramp-function generator mode of operation

Operating modes for ramp-function generator rounding
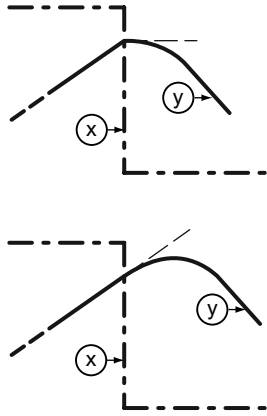
p50295 = 0:
When a setpoint reversal occurs during ramp-up (or ramp-down), the ramp-up (or ramp-down) process is interrupted and initial rounding for the ramp-down (or ramp-up) process starts immediately. This does not mean any additional increase (or decrease) in the setpoint, but rather a bend in the 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).

Table 10- 16   Control signals for the ramp-function generator operating mode

Ramp-function generator enable 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 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 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. 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 ($\rightarrow$ 0), the system switches back to ramp-function generator setting 1 and, when the signal is applied again ($\rightarrow$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:

(-Mlimit ×1.25 / Kp + nact) < RFG output < (+Mlimit ×1.25 / Kp + nact)

When p50170 = 1 (closed-loop torque control), the following applies:

(-IA.limit × Φmotor ×1.25 / Kp + nact) < RFG output < (+IA.limit × Φmotor ×1.25 / Kp + nact)

When p50170 = 0 (closed-loop current control), the following applies:

(-IA.limit × 1.25 / Kp + nact) < RFG output < (+IA.limit × 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, completely 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%.

Velocity 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 braking distance calculation is only correct if, during braking, the ramp-down time and the rounding-off do not change.
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 $p400 \times 2^{\wedge} p418$

The braking distance is available in two different data formats:

- r52047 has the Unsigned32 data type

- r52048 has the FloatingPoint32 data type

10.9.2   Jog

See also function diagram 3125 in the SINAMICS DCM List 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 (r898.8 & r898.9) (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.

10.9.3   Creep

See also function diagram 3130 in the SINAMICS DCM List 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 $0 \rightarrow 1$ 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.

10.9.4 Fixed setpoint

See also function diagram 3115 in the SINAMICS DCM List Manual.

The "Fixed setpoint" function can be applied via the binectors selected using p50435 index .00 to .07, 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.

10.10 Encoder evaluation

General information

The SINAMICS DC MASTER can evaluate speed/position encoders.

2 encoders can be evaluated simultaneously. Encoder 1 is connected to connector X177 on the CUD. Encoder 2 is connected to 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- 17   Supported encoder types

Setting for p0400	Encoder type	Encoder 1 p0400[0]	Encoder 2 p0400[1]
0	No encoder	✓	✓
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	✓
3090	4096, HTL, A/B, SSI, Singleturn	x	✓
9999	User Defined	✓	✓
20000	Encoder from OEM list	x	✓
✓ = encoder type is supported 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 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 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:

References: /P5/ PROFIdrive Profile Drive Technology

10.10.1 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, 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.

10.10.1.1 Encoder 1 actual position value 1 (G1_XIST1)

- Resolution: Encoder pulses × 2n
  n: Fine resolution, number of bits for the 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.
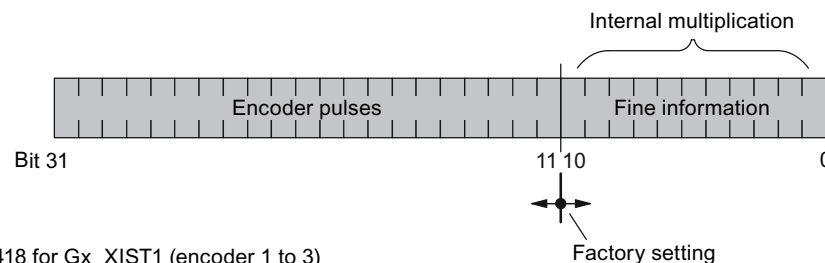
p0418 for Gx_XIST1 (encoder 1 to 3)

Figure 10-36   Classification and settings for Gx_XIST1

- Encoder pulses of incremental encoder
- After switching on: Gx_XIST1 = 0
- An overflow in Gx_XIST1 must be viewed from the higher-level controller.
- There is no modulo interpretation of Gx_XIST1 in the drive.

10.10.1.2 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:
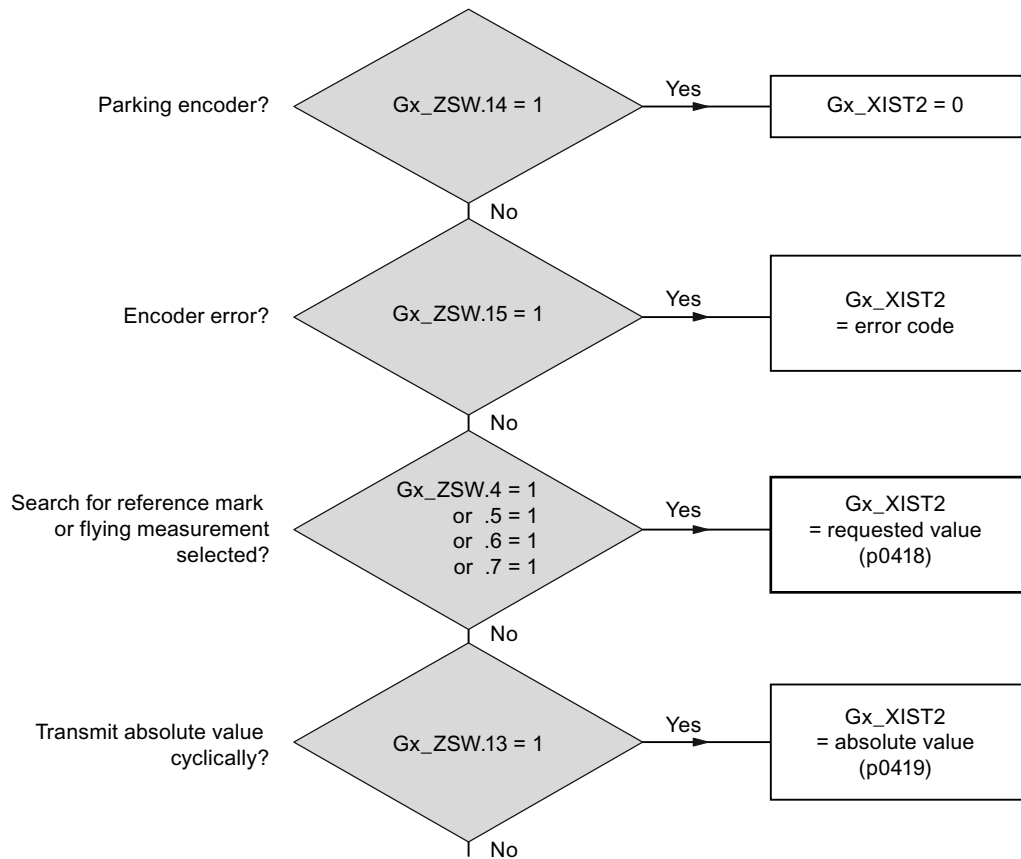
Figure 10-37 Priorities for functions and Gx_XIST2

- Resolution: Encoder pulses × 2n
  n: fine resolution, no. of bits for internal multiplication

The following applies to reference mark or
flying measurement:
p0418 for G1_XIST2 (encoder 1)
p0418 for G2_XIST2 (encoder 2)

Factory setting:
p0418: 11
p0419: 9

For read absolute value (EnDat encoder):
p0419 for G1_XIST2 (encoder 1)
p0419 for G2_XIST2 (encoder 2)

Figure 10-38 Subdivision and settings for Gx_XIST2

- Encoder pulses of incremental encoder

Error code in Gn_XIST2

Table 10- 18 Error code in Gn_XIST2

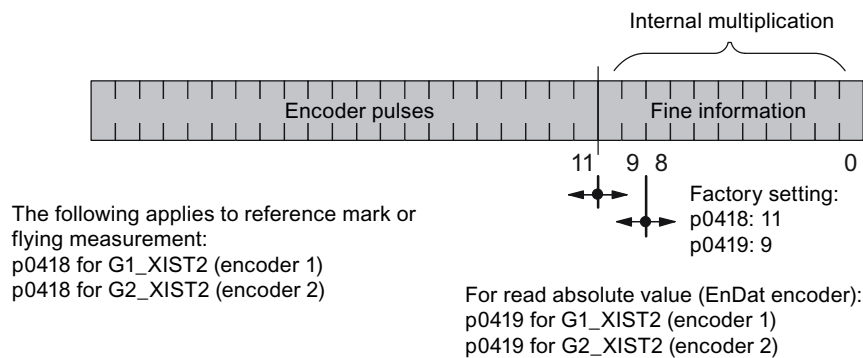| n_XIST2	Meaning	Possible causes / description
1	Encoder fault	One or more existing encoder faults. Detailed information in accordance with drive messages.
2	Zero mark monitoring	–
3	Abort parking sensor	• Parking drive object already selected.
4	Abort reference mark search	• A fault exists (Gn_ZSW.15 = 1) • Encoder has no zero marker (reference mark) • Reference mark 2, 3 or 4 is requested • Command "Read value x" set during search for reference mark • Inconsistent position measured value with distance-coded reference marks.
5	Abort, retrieve reference value	• More than four values requested • No value requested • Requested value not available
6	Not relevant	-
7	Abort get measured value	• More than one value requested • No value requested. • Requested value not available • Parking encoder active • Parking drive object active
8	Abort absolute value transmission on	• Absolute encoder not available • Alarm bit absolute value protocol set
3841	Function not supported	–

10.10.1.3   Encoder 2 actual position value 1 (G2_XIST1)

- See G1_XIST1

10.10.1.4   Encoder 2 actual position value 2 (G2_XIST2)

- See G1_XIST2

10.10.2 Control and status words for encoders

Description

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)

10.10.2.1 Encoder n control word (Gn_STW, n = 1, 2)

Encoder n control word (Gn_STW, n = 1, 2)

The encoder control word controls the encoder functions.

Table 10- 19 Description of the individual signals in Gn_STW

Bit	Name		Signal status, description		
0 1 2 3	Reference mark search	Functions	Request reference mark search:		
			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:		
			• Bit x = 1 Bit x = 0	Request function Do not request function	
			• The following applies if more than 1 function is activated: 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). • Reference mark search It is possible to search for a reference mark.		
4 5		Command	Bit 6, 5, 4	Meaning	
			000	–	

Bit	Name		Signal status, description	
6			001	Activate function x
			010	Read value x
			011	Cancel function
			(x: function selected via bit 0-3)	
7		Mode	0	Reference mark search (fine resolution via p0418)
			1	Not permitted
8...12	Reserved		–	
13	Request cyclic absolute value		1	Request cyclic transfer of the absolute actual position value in Gn_XIST2. Used for (e.g.): • Additional measuring system monitoring • Synchronization during power up
			0	No request
14	Parking encoder		1	Request parking encoder (handshake with Gn_ZSW bit 14)
			0	No request
15	Acknowledge encoder fault		0/1	Request to reset encoder errors Gn_ZSW.15 Encoder fault Gn_STW.15 Acknowledge encoder fault Gn_ZSW.11 Encoder fault acknowledge active 1) Clear fault 1) Signal must be reset by user.
			0	No request

Details on Gn_STW.14 (parking encoder)

When an encoder is parked, the encoder being addressed is switched to inactive (r0146 = 0). Monitoring of a certain encoder is suppressed.

Control is carried out via the encoder control/status words of the cyclic telegram (Gn_STW.14 and Gn_ZSW.14).

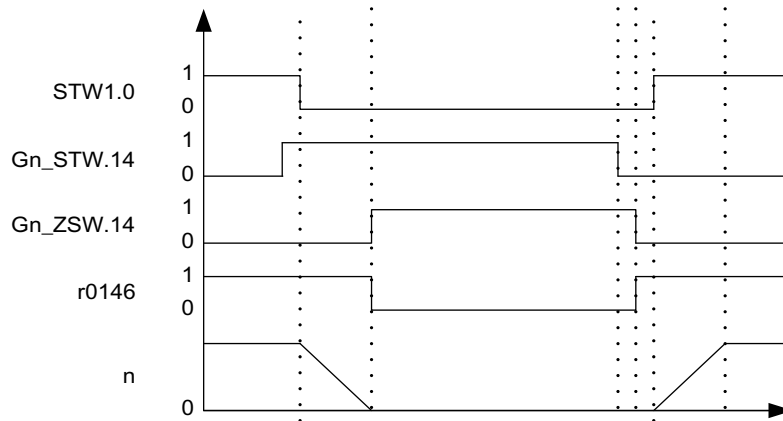To activate encoder parking, the drive must be stopped (e.g. via STW1.0 (OFF1).

Figure 10-39   Flow diagram: parking encoder

10.10.2.2 Encoder n status word (Gn_ZSW, n = 1, 2)

Encoder n status word (Gn_ZSW, n = 1, 2)

The encoder status word is used to display states, errors and acknowledgements.

Table 10- 20   Description of the individual signals in Gn_ZSW

Bit	Name		Signal status, description		
0 1 2 3	Reference mark search, measurement	Status: Function 1 - 4 active	Applies to reference mark search		
			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: • Bit x = 1 function active Bit x = 0 function inactive		
4 5 6 7		Status: Value 1 - 4 available	Applies to reference mark search		
			Bit	Meaning	
			4	Value 1	Reference mark 1
			5	Value 2	Reserved
			6	Value 3	Reserved
			7	Value 4	Reserved

			Note:
			
			• Bit x = 1 value available
			  Bit x = 0 value not available
			• Only one value can be retrieved at a time.
			
			  Reason: There is only one common status word Gn_XIST2 to read the values.		

Bit	Name		Signal status, description	
8		Reserved	1	-
			0	-
9	Reserved		1	-
			0	-
10	Reserved		-	
11	Encoder fault acknowledge active		1	Encoder fault acknowledge active **Note:** See STW.15 (acknowledge encoder fault)
			0	No acknowledgement active
12	Reserved		-	
13	Transmit absolute value cyclically		1	Acknowledgement for Gn_STW.13 (request absolute value cyclically) **Note:** Cyclic transmission of the absolute value can be interrupted by a function with higher priority. • 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	Fault from encoder or actual-value sensing pending. **Note:** The error code is stored in Gn_XIST2.
			0	No error is pending.

10.11 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 speed actual 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.

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 charts).

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.
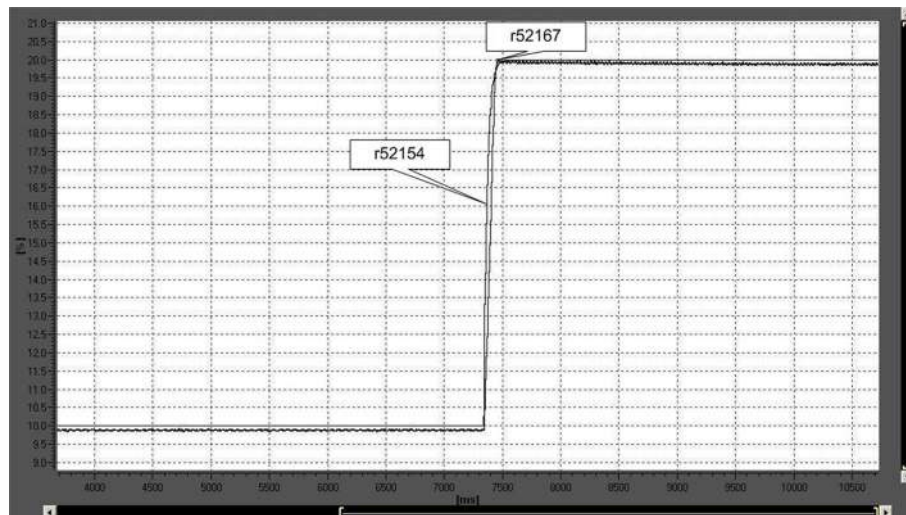
Example:

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   Speed actual value
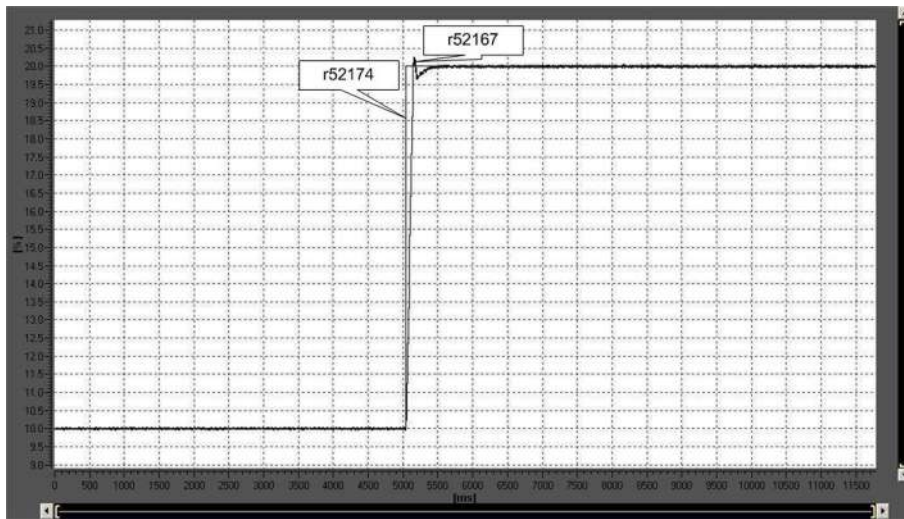

The following diagram shows the setting of the reference model.

r52154   Reference model output

r52167   Speed actual value

The following diagram shows the step response of the speed controller if the same controller parameters are set as above, however, with the reference model activated.

r52174   Speed setpoint

r52167   Speed actual value

Note

See Chapter "Commissioning", Section "Manual optimization" for the procedure to manually optimize the speed controller

## 10.12 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.
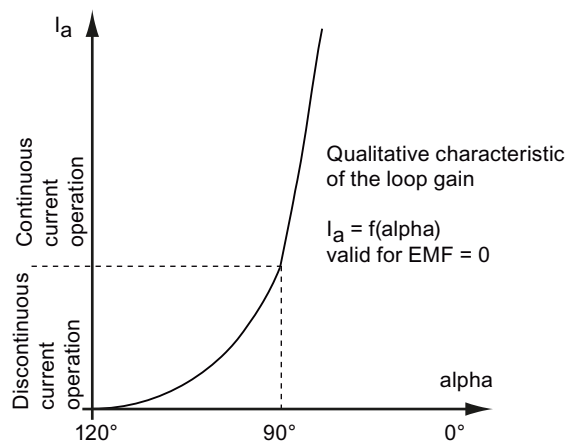
In the field circuit, the system is essentially always in the discontinuous current range, but the control characteristic of the B2Z or B2 bridge manifests a significant degree of non-linearity.
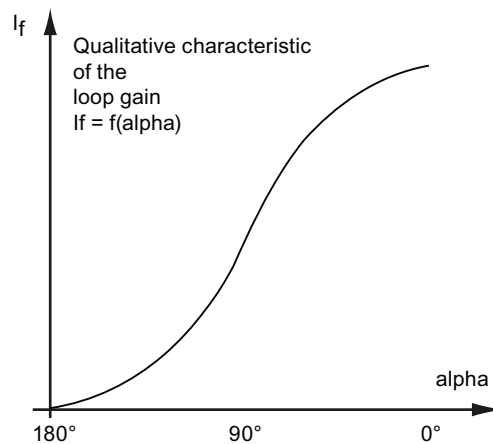
2. Non-linearity of the load inductance (= armature circuit or field circuit of the motor):

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:
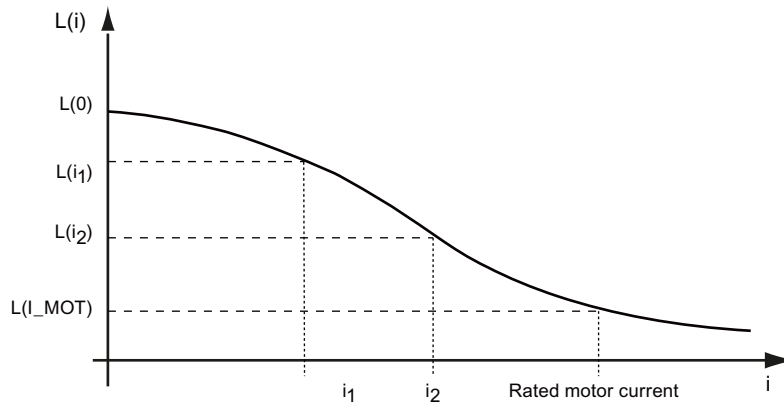
Inductance at a very low current:
$L(0) = p50111$ (La) or $p50116$ (Lf)
Inductance at the rated motor current:
$L(I\_Mot) = p50111 \times p51591$ (La×λ_a) or $p50116 \times p51597$ (Lf×λ_f)

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 can be increased or decreased depending on the field current actual value and/or setpoint (this is selected using p50570). The calculations of the adaptations are only set-up 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 (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 (p50267 = r52355 establishes the intervention)

10.13 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.
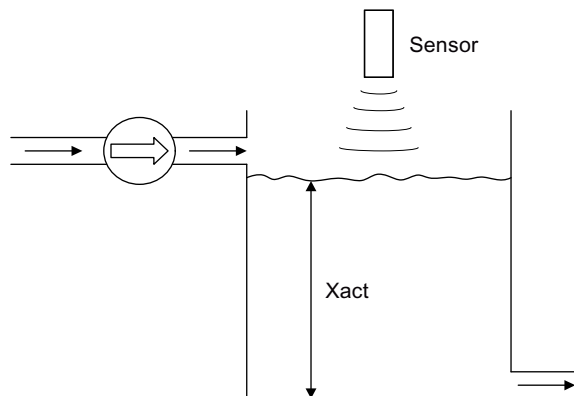

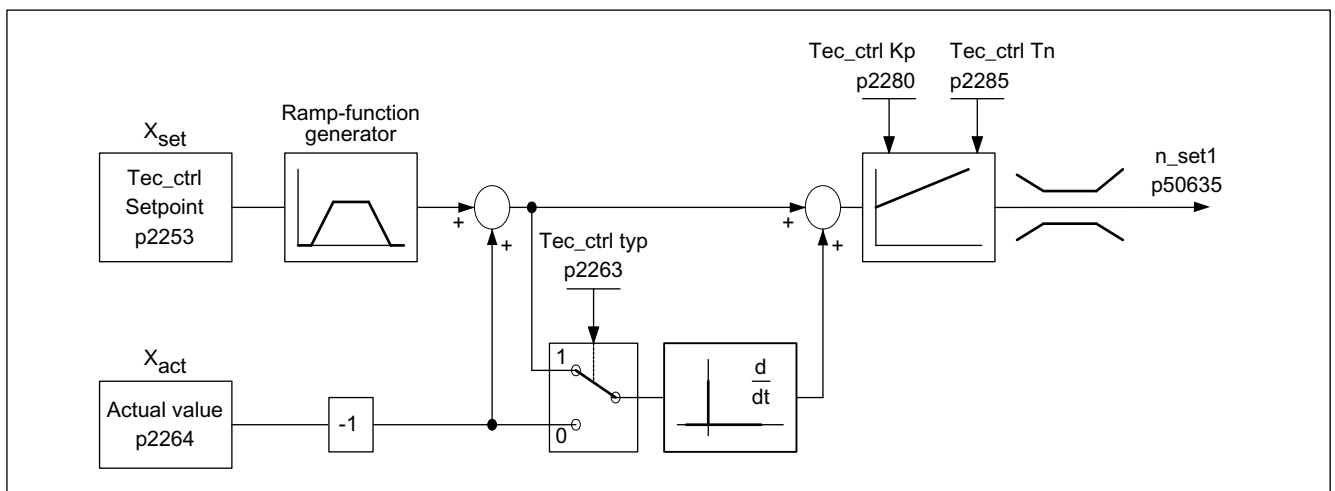Figure 10-40 Level control: Application

Figure 10-41 Level control: Controller structure

425

Table 10- 21   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

10.14   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 $\Rightarrow$ close brake
r53210[0] = 0 $\Rightarrow$ 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: The "Close brake" command is only applied when n < nmin (p50370, p50371).
p50080 = 2	The brake is an operational brake: The "Close brake" command is applied even if the motor is running.
p50087	Brake-release time: A positive value prevents the motor from working against a brake that is currently being released. 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: Causes the motor to keep applying torque while the brake is closing
p50319	Delay time for ramp-function generator enable: 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 = 24 and 25).

Figure 10-42   Operational brake (p50080 = 2), brake-release 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)

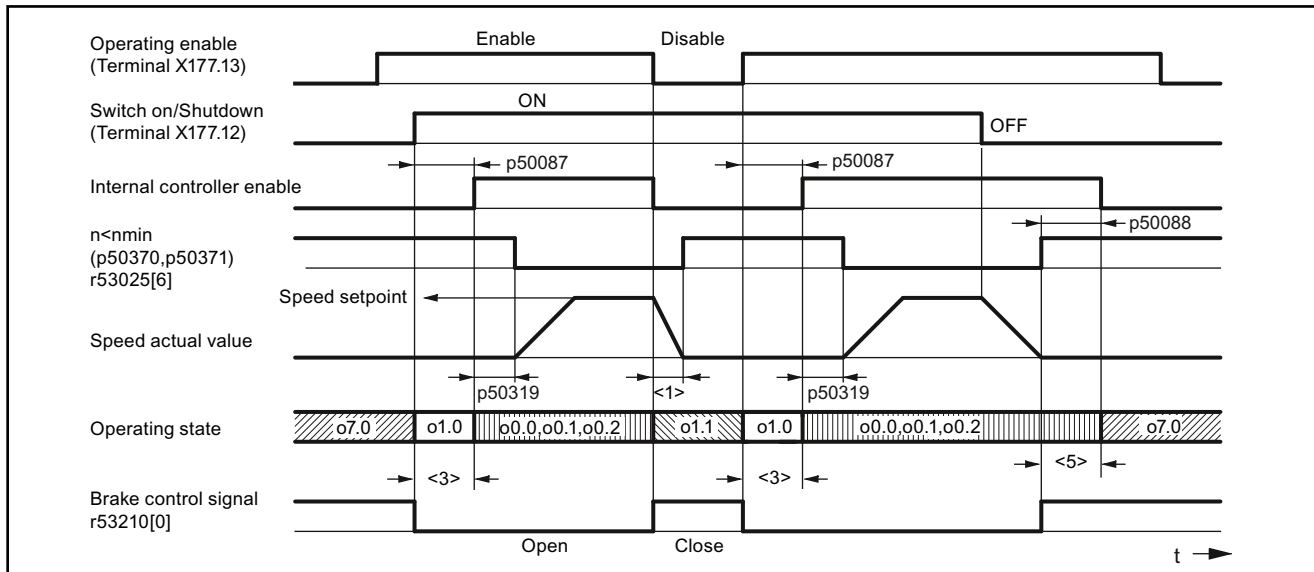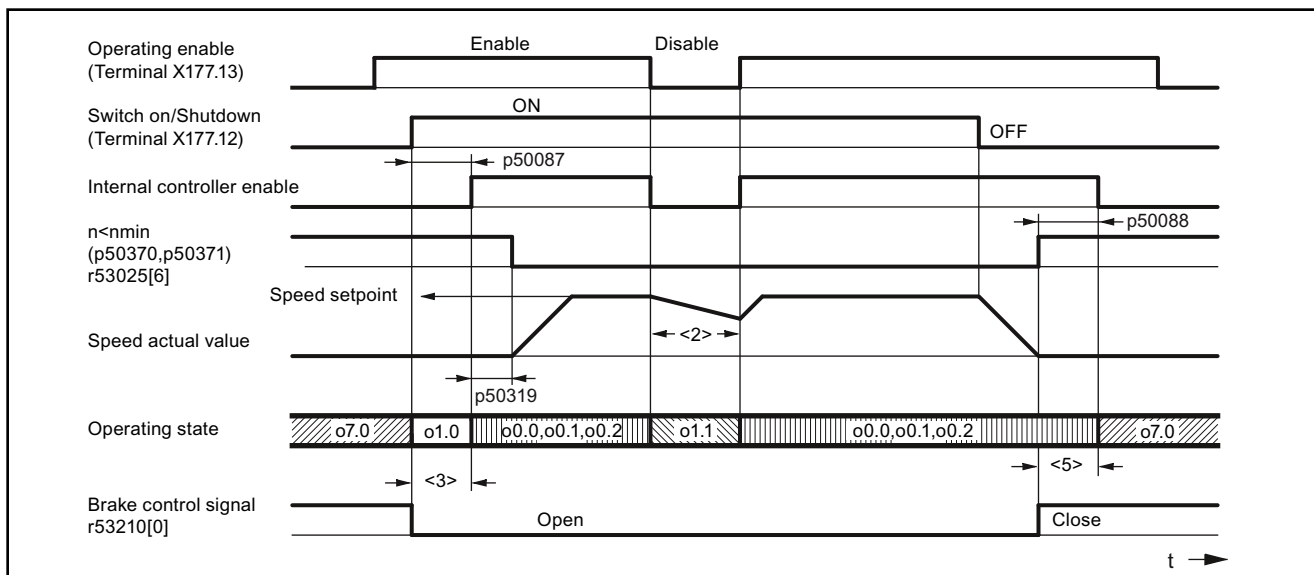Figure 10-43   Holding brake (p50080 = 1), brake-release time (p50087) positive

Figure 10-44   Operational brake (p50080 = 2), brake-release 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)

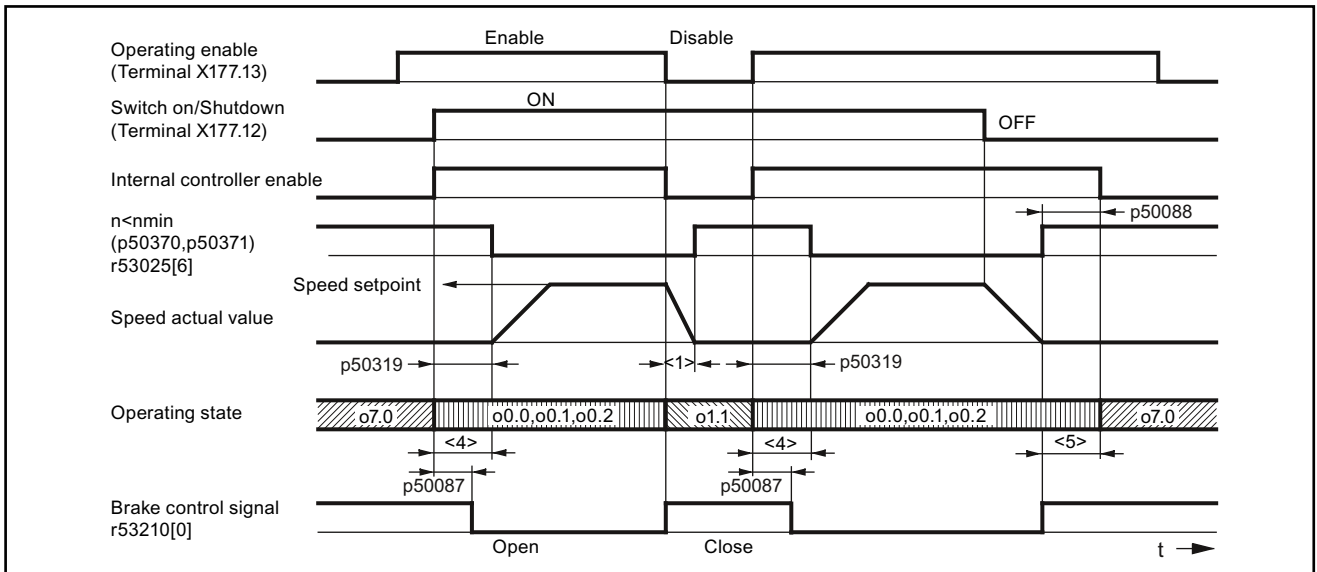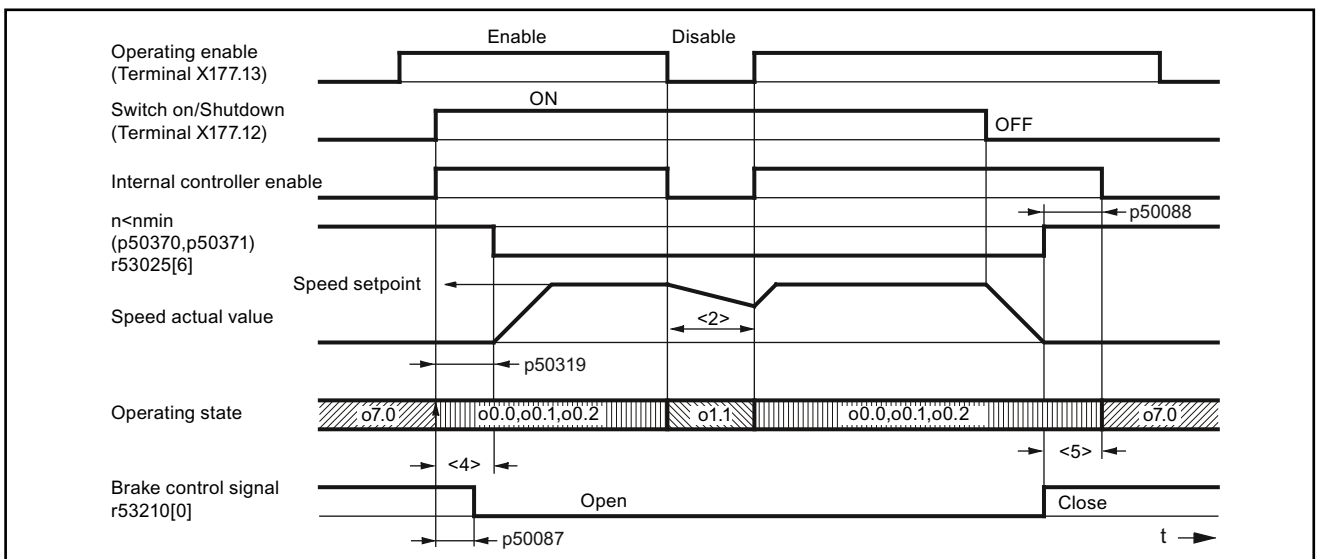Figure 10-45   Holding brake (p50080 = 1), brake-release time (p50087) negative

10.15 Switching on auxiliary circuits

This function serves as a switch on command for auxiliaries (e.g. motor fans).

The "Switch on auxiliaries" 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" signal goes to 1 at the same time as the "Switch on" command. After this, the system stays in operating state o6.0 for a time that can be parameterized (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 time that can be parameterized (p50094), the "Switch on auxiliaries" signal goes to 0. If, however, the "Switch on" command is issued before this time elapses, the system does not stay in operating state o6.0; instead, the line contactor is closed instantaneously.

10.16 Operating hours counter, unit fan

SINAMICS DCM converters with rated DC current of ≥210 A, are equipped with fans:

- Units <400 A: Two internally supplied fans
- Units ≥400 A: One fan that is connected to the line supply

Parameter r53136 displays which unit fan is used for the particular converter.

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.

The instructions on how to replace a fan are provided in Chapter 11.

10.17   Thermal overload protection for the DC motor (I2t monitoring of the motor)

I^2t monitoring protects the motor against impermissible loads.

CAUTION
No full motor protection
I^2t monitoring only provides an approximate representation of the motor's thermal image.
If the electronics power supply fails, then the calculated preload of the motor is lost. When switching-on again, the system assumes an unloaded motor!
For p50114 = 0, the I^2t monitoring is disabled.

Adaptation

Table 10- 22   Parameter settings for I2t 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: Permissible continuous current = p50100 × p50113
p50113	Continuous-current factor	

Advance-alarm characteristic/Shutdown characteristic

If, for example, the motor load is constantly at around 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.

I2t monitoring of the motor: Alarm triggering and fault triggering

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 .. - thermal time constant of motor
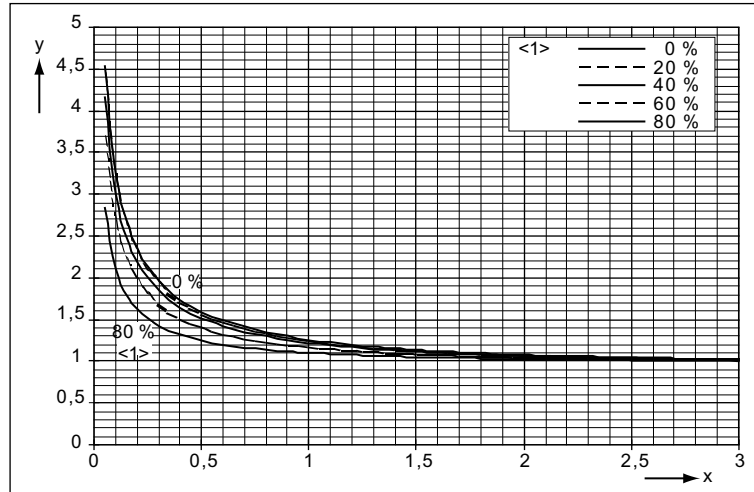
Figure 10-46   I2t monitoring of the motor: Alarm triggering
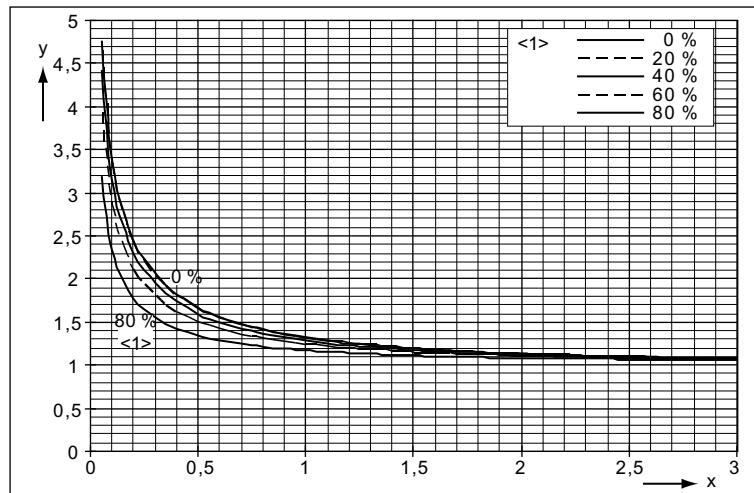
Figure 10-47   I2t monitoring of the motor: Fault triggering

<1> ... Preloading
y ... load current/permissible continuous current (p50100 × p50113)
x ... time/thermal time constant of motor

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):
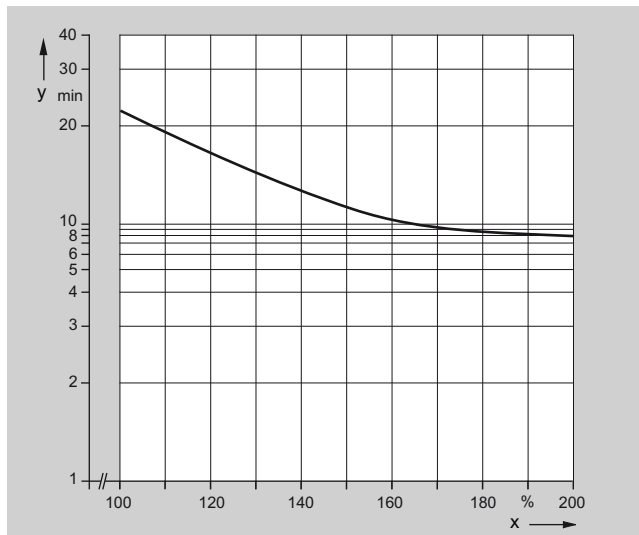
y ... T_{therm}, thermal equivalent time constant [min] (p50114)

x ... I/I_N [%]
       I = Maximum overcurrent at which the motor is operated
      I_N = Rated armature current for the motor (p50100)

Figure 10-48   Thermal equivalent time constant

Notes

- 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.

10.18 Measuring the motor temperature

SINAMICS DCM provides the possibility of evaluating a temperature sensor integrated in the motor. (see the SINAMICS DCM List Manual, function diagram 8030).

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 10-49   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 to approx. 280 Ω at -40 °C to +500 °C
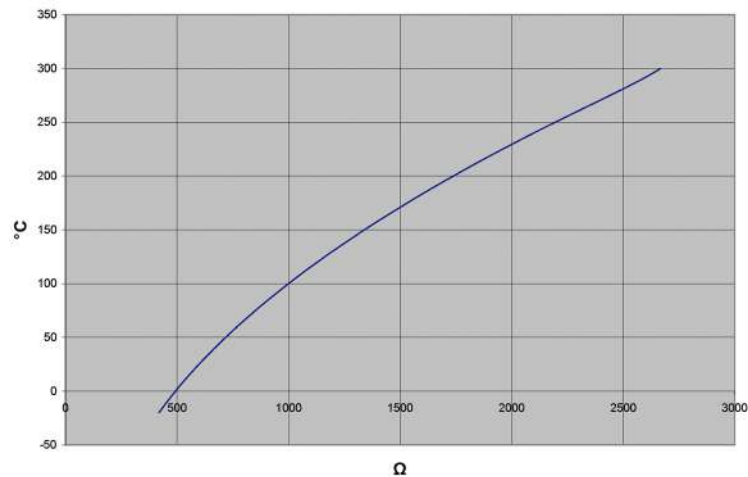 positive temperature coefficient, almost a linear characteristic

- **NTC thermistor** K227/S1/1.8 kΩ/KER
  approx. 200 Ω at 190 °C to 1.8 kΩ at 100 °C
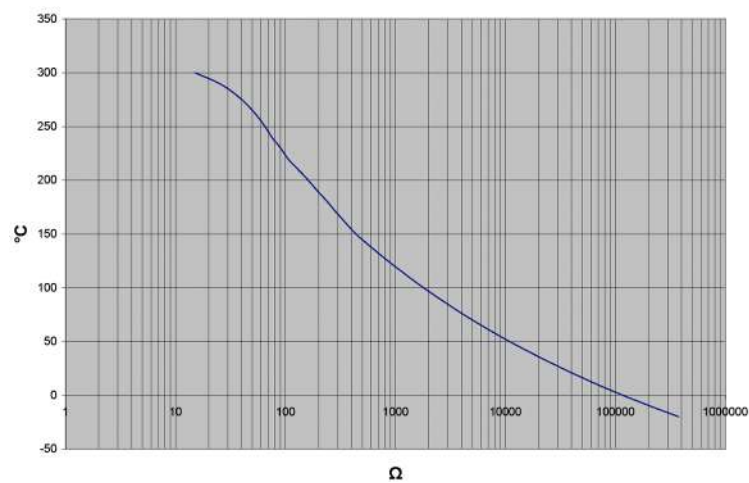
Figure 10-50   Characteristic K227

10.19 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.

CAUTION
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
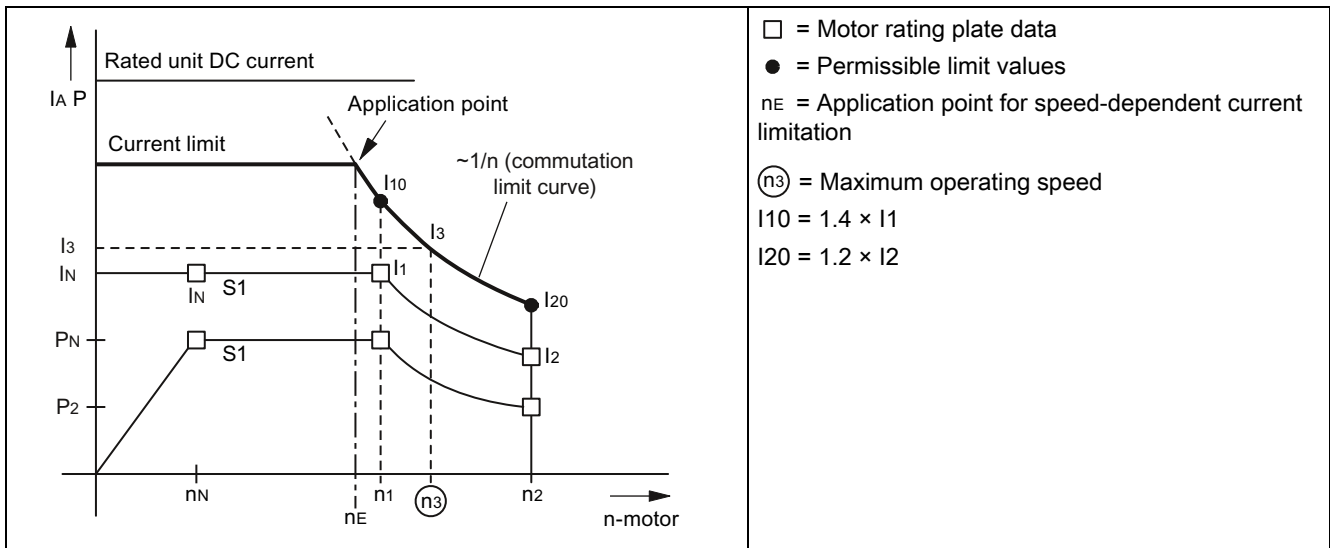
The current limitation curve is determined using n1, I10, n2, and I20.

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

```
*    S H U N T -MOT.        1GG5162-0GG4 . -6HU7-Z
               NRE                        EN 60034
     V        n1   1/MIN    n2    I1    A    I2    KW
  46-380          50-1490        78.0-78.5      0.880-26.0
   380          3400 / 4500  REG. 80.0 / 58.0   26.0 / 19.0
   ERR.           V      A       THYR.: B6C  LV=  0MH 380V/ 50HZ
   SEP.          310   2.85      IP 23          IM B3
                 77/51 0.87/0.60               I.CL.F
Z: A11  G18  K01  K20
  SEP.  VENTIL.
```

Figure 10-51 Example of a motor rating plate

Setting speed-dependent current limitation for motors without a bend in the commutation characteristic

Figure 10-52 Example of a motor rating plate

10.20 Dynamic overload capability of the power unit

10.20.1 Overview of functions

The rated unit DC current specified on the unit rating plate (= maximum permissible continuous DC current when p50077 = 1.00) may be exceeded during operation. The extent to which this value is exceeded and how long this lasts are subject to certain limits, which are explained in more detail in the section that follows.

The absolute upper limit for overload currents is 1.8x the rated unit DC current × p50077 (= 1.8 × r50072[0] × p50077). The maximum overload duration depends on the overload current's time characteristic as well as on the unit's load history, and differs from power unit to power unit.

Each overload must be preceded by an underload (load phase with load current < p50077 × rated unit DC current). Once the maximum permissible overload duration has elapsed, the load current must return to at least ≤ p50077 × rated unit DC current.

The dynamic overload for the power unit is monitored by a software algorithm (I^2t monitoring of the power unit). I^2t monitoring uses the time characteristic for the actual load current value to calculate the time characteristic for the thyristors' temperature rise above the ambient temperature. When the converter unit is switched on, the calculation process starts with the initial values that were determined before the electronic power supply was last shut down. The environmental conditions (ambient temperature, installation altitude) can be taken into account by setting parameter p50077. In the delivery condition, the ambient temperature is always set to the maximum possible value without derating (i.e. 45 °C for self-ventilated units and 40 °C for units with forced ventilation).

I^2t monitoring responds when the temperature rise calculated in the thyristors becomes too high. However, it is also possible to set the following alternative responses using parameters:

p50075 = 0: I^2t monitoring is disabled. The armature current is limited to p50077 × rated unit DC current (= p50077 × r50072[0]).

p50075 = 1: Alarm A60039 with reduction in armature current setpoint to p50077 × rated unit DC current

p50075 = 2: Fault F80139 with unit shutdown

Parameters r52310 and r50014[1] show the calculated thyristor temperature rise as a % of the maximum permissible thyristor temperature rise. This maximum temperature rise differs from power unit to power unit, but falls approximately between 80 °C and 90 °C.

10.20.2   Configuring for dynamic overload capability

The DVD documentation for the SINAMICS DCM provides the following information for each converter unit:

- The **maximum overload duration** t_{on} when starting up with a cold power unit and specified constant overload with overload factor X (i.e. load with X times the device rated DC current * p50077) (see the small table at the top right)

- The **maximum zero current interval** $t_{starting from}$(maximum cooling time) until the power unit reaches the thermal state "cold" (see below the small table at the top right)

- **Limiting characteristic fields for determining overload capability** during thermally stabilized, intermittent operation with overload (periodic duty cycles)

    – Tabular representation: Top left

    – Representation as curve with logarithmic y axis: Curve at bottom left

    – Representation as curve with linear y axis: Curve at bottom right

Note:
The power unit is "cold" when the calculated thyristor temperature rise is less than 5% of its maximum permissible value. This state can be queried using a binary assignable output.

Note:
If you start duty cycles with a cold power unit at least partially within the specified duty cycle limits, then the thermally stabilized state is reached without I^2t monitoring responding.

If I^2t monitoring is parameterized for a shutdown function (p50075 = 2), you should not come too close to the limiting characteristic when configuring periodic duty cycles that are longer than, slightly shorter than, or equal to 300 s.

In all other cases, however - and particularly when parameterizing I2t monitoring for a reduction in the armature current setpoint (p50075 = 1) - you can utilize the maximum overload capability determined by the limiting characteristic to its full extent.

Structure of limiting characteristic fields for intermittent operation with overload:

Each of the limiting characteristic fields relates to a duty cycle during intermittent overload operation with an **overall duration** (time period) of 300 s.

A duty cycle of this type consists of two time intervals:
The **base load duration** (actual armature current value ≤ p50077 * rated unit DC current) and
The **overload duration** (actual armature current value ≥ p50077 * rated unit DC current)

Each limiting characteristic represents the maximum permissible **overload duration Tp** in excess of the **maximum base-load current Ig** for a specific **overload factor X** and a specific device.
For the **remaining duration** of the duty cycle, the **base-load current** determined using the overload factor must not be exceeded.

If no limiting characteristic has been specified for the required overload factor, then it will be subject to the limiting characteristic for the next largest overload factor.

The limiting characteristic fields apply for a duty cycle duration of 300 s.
For cycle durations < 300 s, the overload duration must be reduced proportionally (cycle duration/300 s).
For cycle durations > 300 s, only the same overload duration as with a cycle duration of 300 s is permitted; the base load duration is correspondingly longer.

The limiting characteristic fields apply for p50077 = 1.00. When setting p50077 to ≤ 1.00, i.e. reducing the thermal load, the currents that are actually flowing must be evaluated with the factor 1/p50077:

Overload factor for characteristic X:

X =   Actual overload current / (p50077×rated unit DC current)

Actual maximum base-load current Ig:

Ig =   p50077 × maximum base-load current acc. to characteristic
          as a % of the rated unit DC current

Basic tasks for configuring periodic operation with overload

Designations:
Base load duration$_{300}$ = Minimum base load duration for 300 s cycle duration
Overload duration$_{300}$ = Maximum overload duration for 300 s cycle duration

Basic task 1

Known:
Device types, cycle duration, overload factor, overload duration

To be found:
Minimum base load duration and maximum base-load current

To reach solution:
Select the limiting characteristic for the known unit and overload factor

Cycle duration < 300 s:
Overload duration$_{300}$ = (300 s/cycle duration) × overload duration

Cycle duration ≥ 300 s:
Overload duration$_{300}$ = Overload duration

If: Overload duration$_{300}$ > overload duration$_{300}$ for base-load current = 0

Then: Required duty cycle cannot be configured

Otherwise: Read the maximum base-load current for overload duration$_{300}$ from the limiting
:   characteristic

Example 1:

Known:
30 A/4Q unit; cycle duration 113.2 s; overload factor = 1.45; overload duration = 20 s

To be found:
Minimum base load duration and maximum base-load current

Solution:
Limiting characteristic for 30 A/4Q unit, overload factor 1.5
Overload duration$_{300}$ = (300 s./113.2 s.)×20 s. = 53 s.
Base load duration$_{300}$ = 300 s. – 53 s. = 247 s. →
Maximum base-load current = approx. 45% of I_N = 13.5 A

Basic task 2

Known:
Device types, cycle duration, overload factor, base-load current

To be found:
Minimum base load duration and maximum overload duration

To find solution:
Select the limiting characteristic for the known unit and the known overload factor.
Read the overload duration$_{300}$ for the base-load current from the limiting characteristic.

Cycle duration < 300 s:
Max. overload duration = (cycle duration/300 s) * overload duration$_{300}$
Min. base load duration = cycle duration – max. overload duration

Cycle duration ≥ 300 s:
Max. overload duration = overload duration$_{300}$
Min. base load duration = cycle duration – max. overload duration

Example 2:

Known:
30 A/4Q unit; cycle duration 140 s; current-overload factor = 1.15; base-load current = 0.6*IN=18 A

To be found:
Minimum base load duration and maximum overload duration

Solution:
Limiting characteristic for 30 A/4Q unit, overload factor 1.2
Base-load current = 60% of I_N → overload duration$_{300}$ = 126.35 s.
Max. overload duration = (140 s./300 s.)×126.35 s. = approx. 58 s.
Min. base load duration = 140 s. – 58 s. = 82 s.

10.21 Sensor for the ambient and/or air intake temperature

For SINAMICS DC MASTER a sensor for the ambient and/or air intake temperature is available as option (order code L15, see the ordering data for options and accessories in Chapter 2). The sensor is mounted in the cooling air intake of the unit.

Please note that when ordering SINAMICS DCM, it is only possible to subsequently retrofit a sensor in the manufacturer's factory.

- The temperature sensor is indicated as being available at r52049[1].

- The measured temperature is available at r52050[1] and at r50013[1]. For example for

  – evaluation with "free function blocks" or "DCC charts" or

  – transfer to a higher-level automation system via fieldbus (PROFIBUS/PROFINET)

- The derating (see Chapter Derating (Page 67)) is automatically adapted to the measured air intake temperature.

Commissioning

If option L15 is being used, at p50077 the derating factor for the power reduction as result of increased installation altitude (K2 according to the following table) must be set and not the derating factor according to the tables in Chapter Derating (Page 67).

Installation altitude	Derating factor K2
1000 m	1,0
2000 m	0,835
3000 m	0,74
4000 m	0,71
5000 m	0,67

Function

- **Calculating the derating factor**
  Effective derating factor $K = K1 \times K2$
  K1 = derating as a result of increased air intake temperature
  K2 = derating as a result of increased installation altitude (see the table above)
  K1 is continually calculated, taking into account the measured air intake temperature (limited to max. 1.0) and used instead of parameter p50077 to generate the current limit r52130, see the function diagram 8042 in the SINAMICS DCM List Manual.

- **Monitoring the air intake temperature**
  For self-ventilated (self-cooling, cooling type AN) units, the following applies:
  Alarm threshold = 52 °C
  Fault threshold = 57 °C
  For force-ventilated (with forced air cooling, type AF) units, the following applies:
  Alarm threshold = 47 °C
  Fault threshold = 52 °C

Reaction:

Measured air intake temperature (r52050[1] or r50013[1])

• is greater than the alarm threshold	→	Alarm A60080
• is higher than the fault threshold	→	Fault F60067
• is greater than 115 °C	→	Fault F60096 with fault value 2 (i.e., the temperature sensor is short-circuited)
• is less than -25 °C	→	Fault F60096 with fault value 1 (i.e., the temperature sensor is interrupted)

Note

Use of the SINAMICS DCM in a SINAMICS DCM Cabinet drive cabinet with option L99

Option L99 of the SINAMICS DCM Cabinet offers – for units with software release V1.3 HF1 – the same function as for option L15 of the SINAMICS DCM DC Converter.

For higher software versions, the function may differ. The actual description for option L99 can be found in the operating instructions for the SINAMICS DCM Cabinet.

10.22 Calculating the thyristor blocking voltage

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:

- 2 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:

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 in the following cases:

- If a SIMOREG CCP is connected to the SINAMICS DCM.

- If a motor is not connected to the armature converter, but instead, a very large inductance.

Note

The thyristor blocking voltage calculation function is available from the following version of the power interface module
- C98043-A7105-L1-8
- C98043-A7105-L4-8
- C98043-A7106-L1-6
- C98043-A7106-L4-7
- C98043-A7107-... (option L05): All releases
- C98043-A7108-... (option L05): All releases

This information is provided on the bar code label on the printed circuit board.

10.23 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.

10.24 Operation on a single-phase line supply

SINAMICS DCM converters with rated DC currents of up to 125 A and a rated armature supply voltage of 575 V can also be operated on single-phase line supplies.

Areas 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 units 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
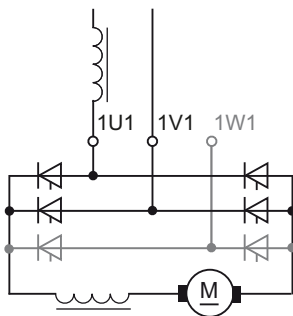
Figure 10-53   Connection to a single-phase line supply

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.

Parameter assignment

Selecting operation on a single-phase line supply with **p51799 = 1**

If single-phase operation is selected for a converter with more than 125 A rated DC current, then fault message F60058 is output when the converter is switched-on.

The high current ripple in this mode causes ripple in the actual speed. For smooth speed control, it is recommended to 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[0]) 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 Technical data in Chapter 4.

10.25 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 B2 + 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.

NOTICE
• 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 units with the same rated DC current rating may be used.

Note

More information about design is given in the associated application notes (see link in preface).

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 units are connected using 8-core shielded patch cables, type UTP CAT5 in acc. with 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 (Order No.: 6RY1707-0AA08). (n-1) cables are required to connect n units. The bus termination must be activated at the units at the start of the bus and at the end of the bus (p51805=1).

- The parallel interface also enables any BICOs (that can be parameterized by the user) to be exchanged between nodes. See function 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 to make use of in any way he or she wishes.

- For additional details on how units are connected in parallel, please refer to function diagrams 9350, 9352, and 9355.

Control

- 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, fast 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.

451

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 units 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 speed actual 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

NOTICE
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.

10.25.1   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.
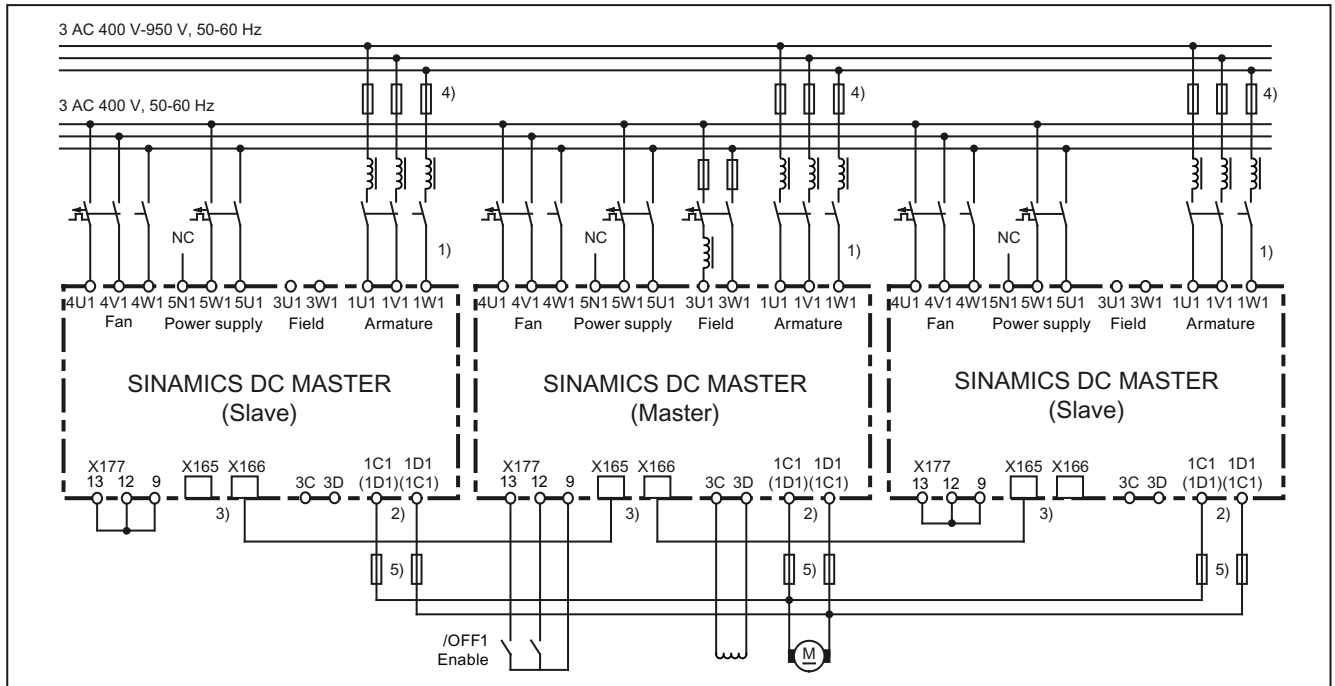
1)   The same phase sequence is required between 1U1/1V1/1W1.

2)   The same phase sequence is required between 1C1/1D1.

3)   The units 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 (order number: 6RY1707-0AA08).
      (n-1) cables are required for connecting n devices in parallel.
      The bus terminator must be activated for each unit positioned at the start or end of the bus (p51805 = 1).

4)   These fuses may only be used with units up to 850 A.

5)   Only with units up to 850 A during 4Q operation.

Figure 10-54   Connecting the units in parallel

- Up to 6 units can be connected in parallel.

- When connecting several units in parallel, the master unit should be positioned centrally due to the signal runtimes. Maximum cable length of the parallel-connection interface cable between master and slave units at each bus end: 15 m.

- Separate line reactors of the same type are required for each 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.
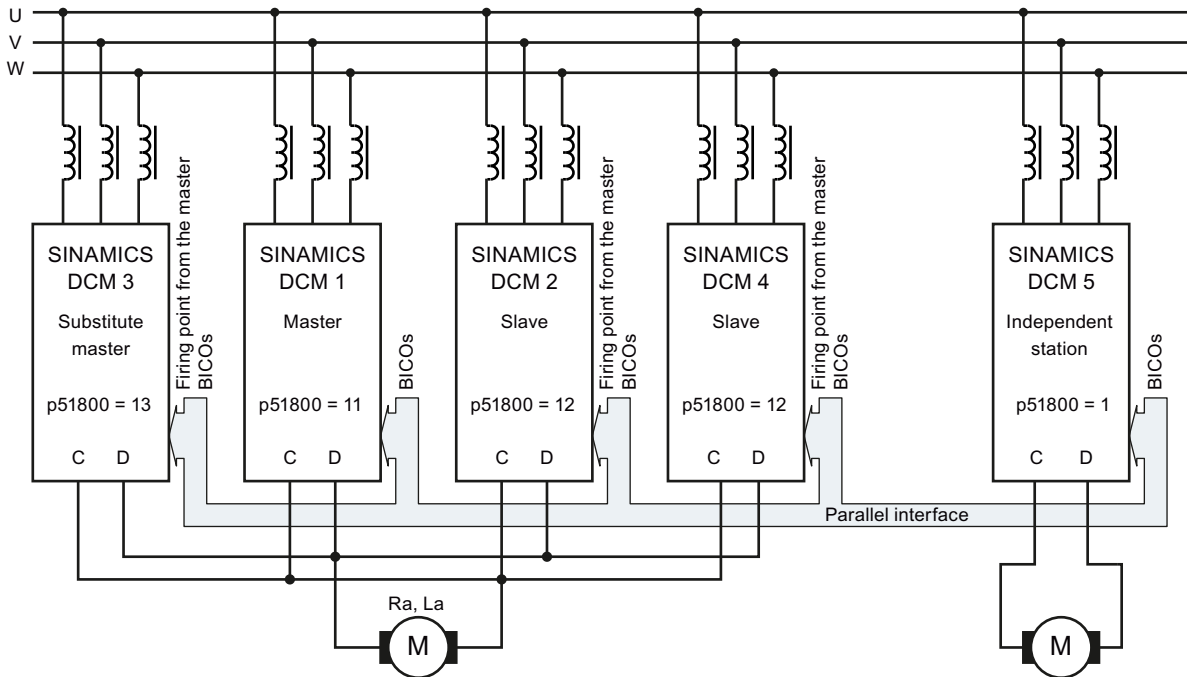
Figure 10-55   6-pulse parallel connection, extended topology

Operating modes of the 6-pulse parallel connection

There are 2 operating modes:

Standard mode:

A SINAMICS DCM is defined as the master. This unit 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 units; 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 unit 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 converter units. The SINAMICS DCM units 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 units continue to operate uninterrupted.

During configuration, it is important to note that the power produced by n units alone (rather than n+m units) 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.

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 units, 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 armature firing pulses and the upstream control (setpoint channel, speed control, armature current control) and
- the field firing pulses and the upstream control (EMF control, field current control)

are transferred to the substitute master.

Activation:
At the master and at the substitute master units, 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.

Notes:

- 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.
- 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 electronics power supply of the master and the substitute master – these are prerequisites.
  If this operating mode is also to be used after the electronics power supply of the master or the substitute master fails, then the total motor field current actual 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 guaranteed that the master/slave assignment will be correct. The electronics power supply must be switched off and back on again at all units!

Notes

- The control commands - switch-on/stop, operating enable, fast stop etc. - must also be entered at all of the substitute master units.
- The speed setpoint and the speed actual value must be entered at all substitute master units.

Parameter assignment

Table 10- 23   6-pulse parallel connection, standard mode

Parameter		Master	Slave
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
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 = 25) sets the correct values for these parameters.			

Table 10- 24   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
p51803	n+m mode	1 (only armature) 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) ≠ 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
p51591	La reduction factor [2]	-	The same as at the master	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 = 25) sets the correct values for these parameters.				

10.25.2   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 the Preface).

Topology

The following diagram shows the topology of a 12-pulse parallel connection.
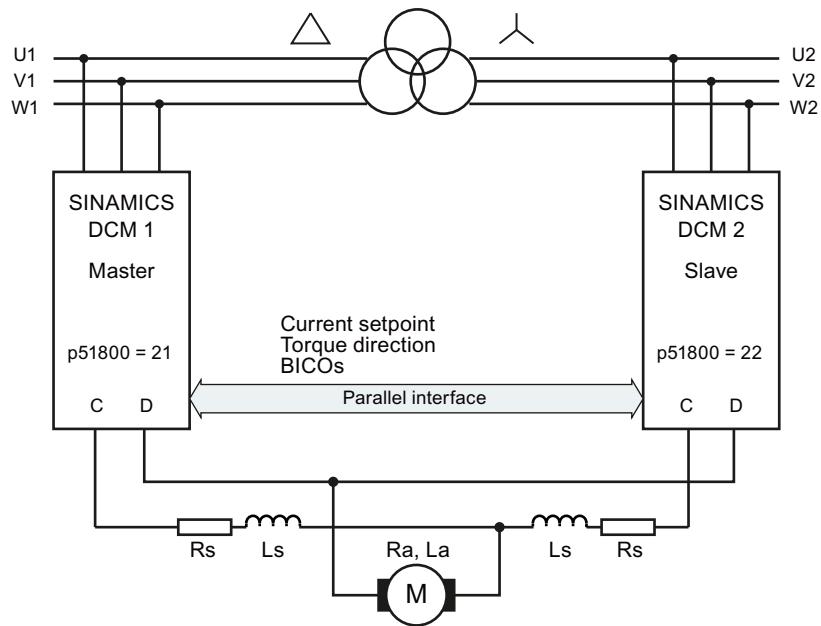
Figure 10-56   12-pulse parallel connection (1), block diagram

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.
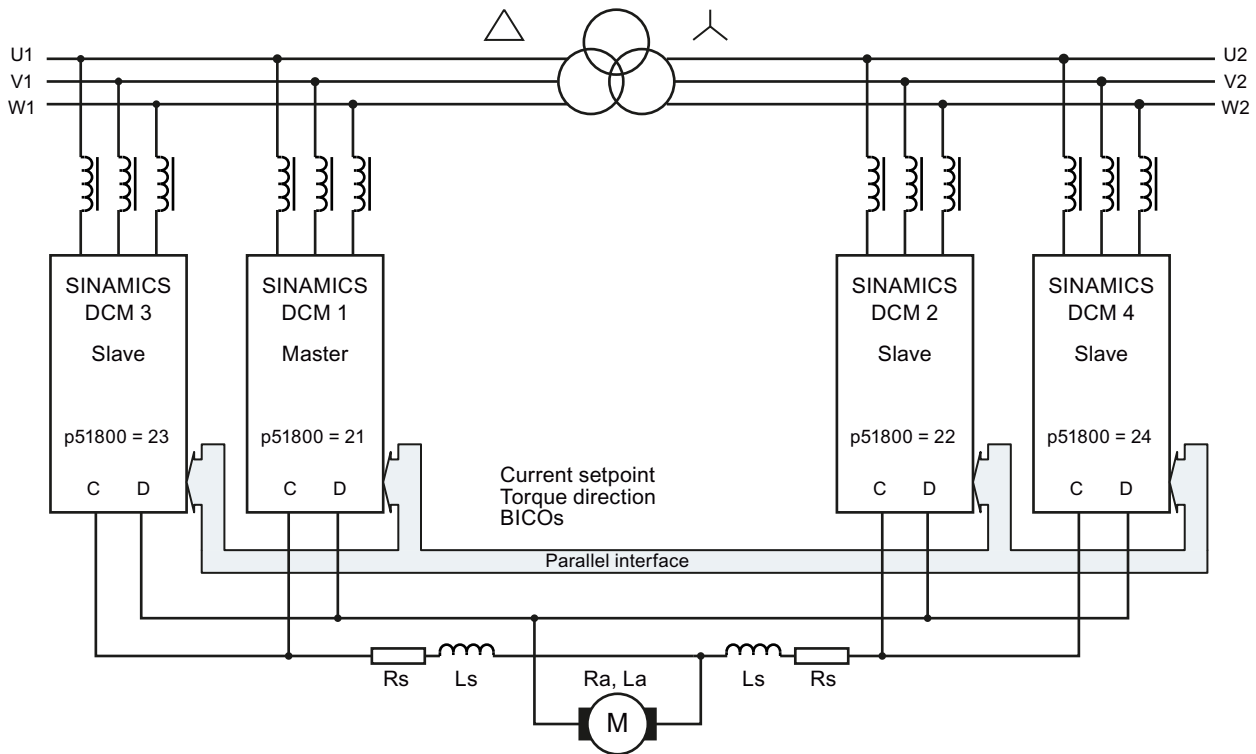
Figure 10-57   12-pulse parallel connection (2), block diagram

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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.

10.25.3 6-pulse series connection

Topology

The following diagram shows the topology of a 6-pulse series connection of two SINAMICS DCM.

Figure 10-58   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.

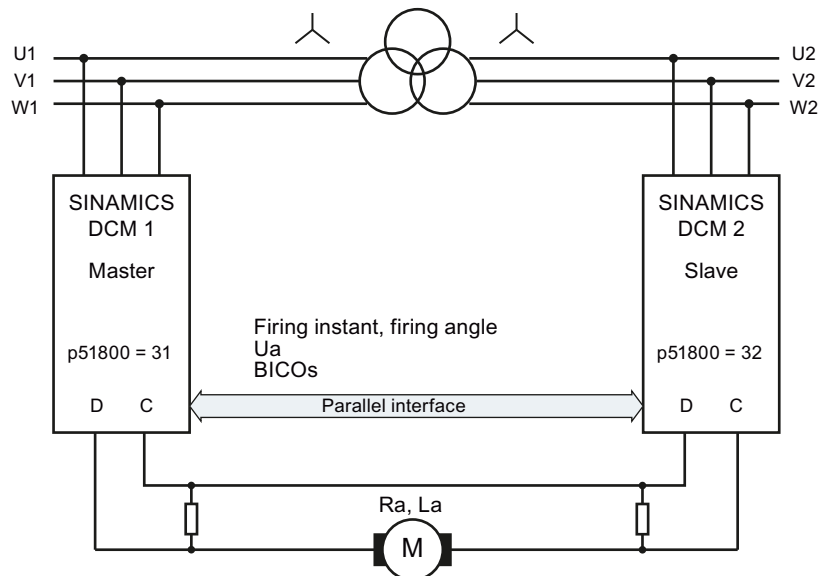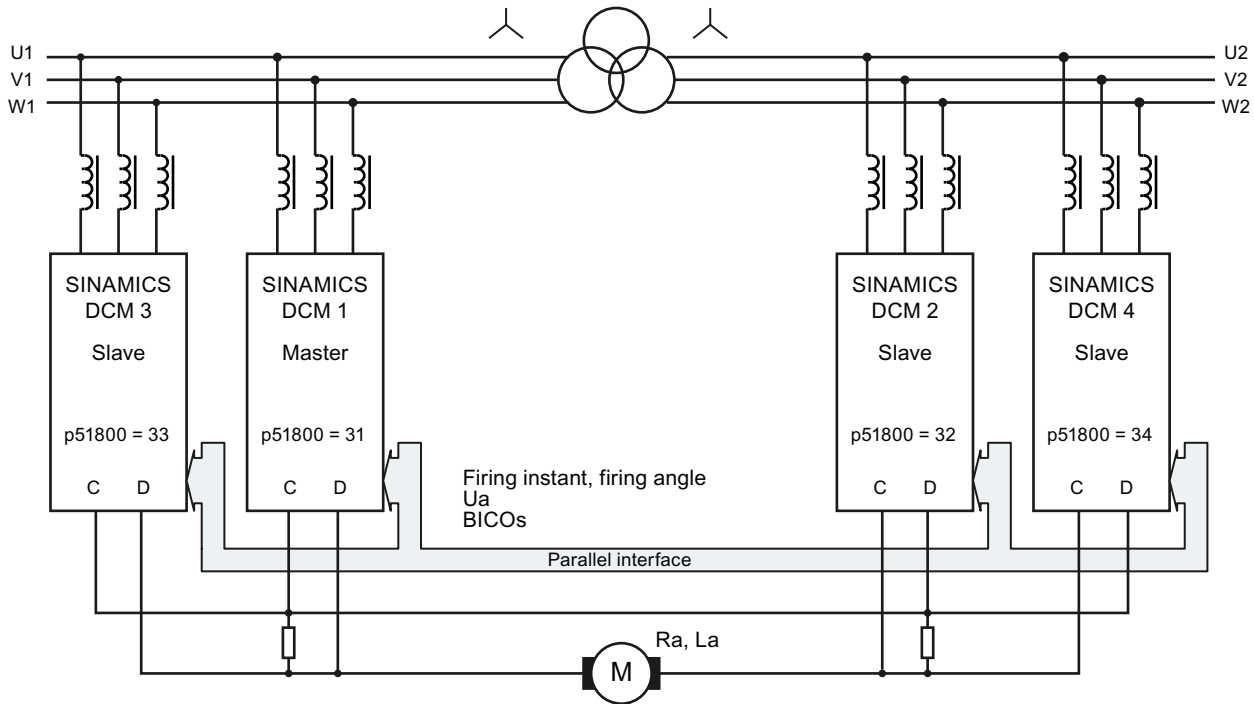Figure 10-59   6-pulse series connection (2)

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- 25   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) 33 (parallel to the master) 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
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 = 25) sets the correct values for these parameters.			

10.25.4   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)

Remark:
The incoming AC voltage of the controlled converter should be 10% to 15% higher than that at the uncontrolled converter, in order that the current can be reliably reduced down to 0.
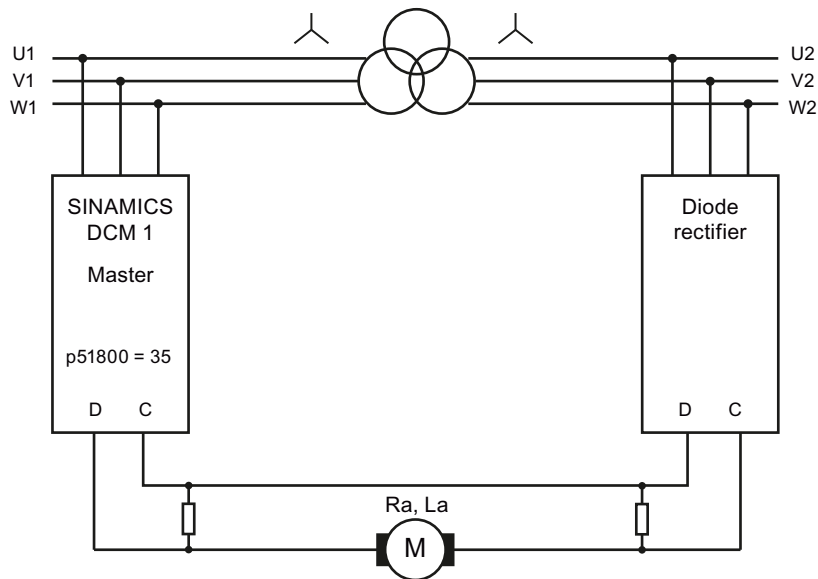

Figure 10-60   6-pulse series connection: controlled + uncontrolled rectifier

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- 26   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 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 = 25) sets the correct values for these parameters.			

10.25.5 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 the Preface).

Topology

The following diagram shows the topology of a 12-pulse series connection of two SINAMICS DCM.
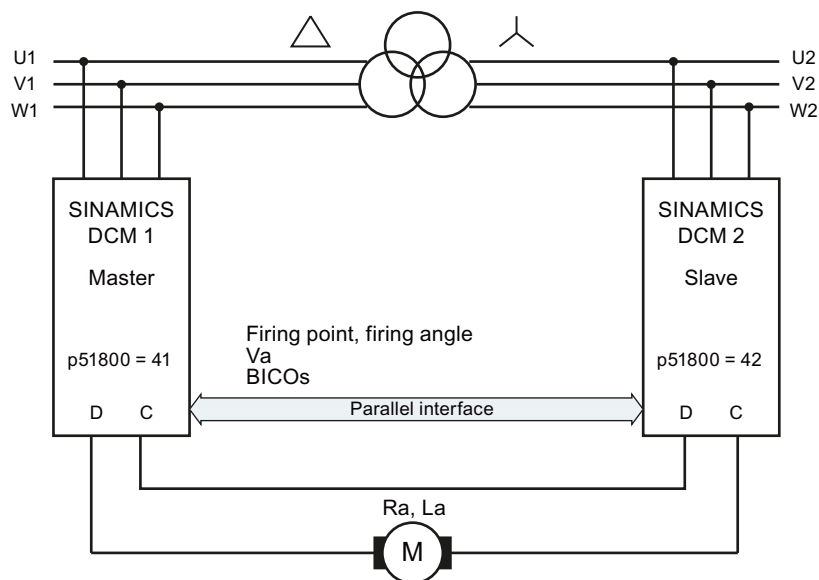

Figure 10-61   12-pulse series connection (1), block diagram

The following diagram shows the topology of a 12-pulse series connection, where an additional converter is connected in parallel to each of the two 12-pulse converters connected in series.
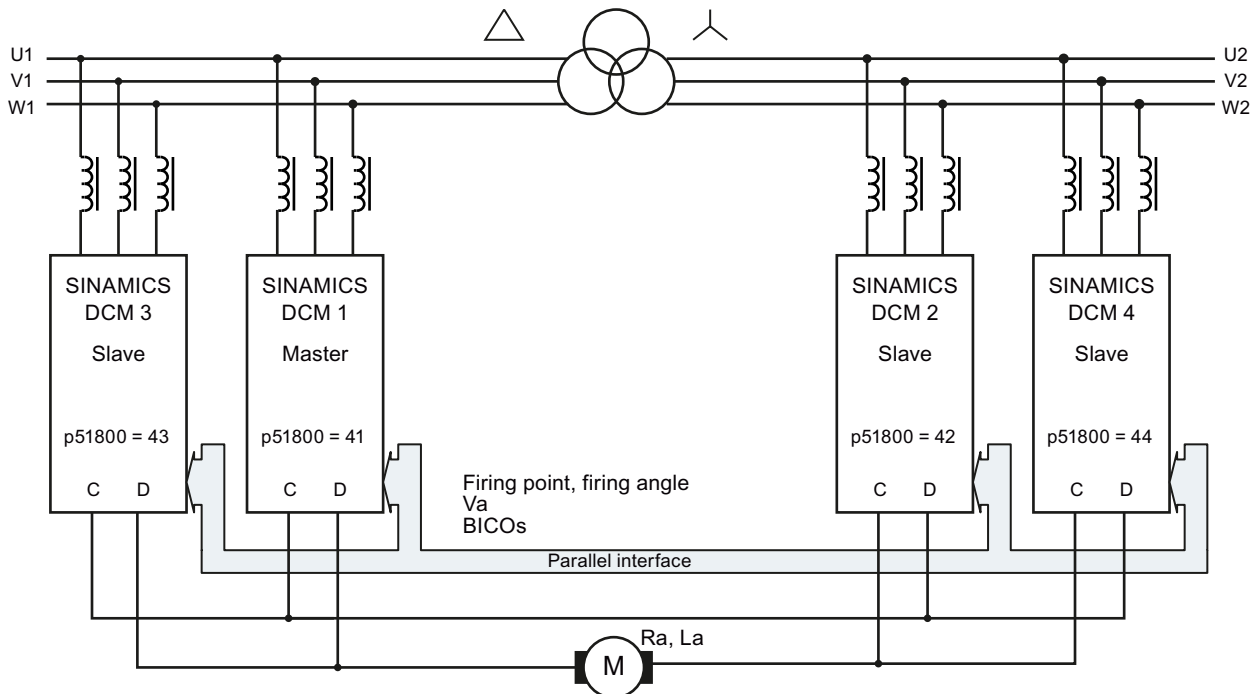

Figure 10-62   12-pulse series connection (2), block diagram

Operating modes

There are 2 operating modes:

- **Operation with the same firing pulses (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

If the two partial converters operate in the following mode, the current ripple is significantly higher than operation with the same firing angle. 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 pulses (p51799 = 41)

- low reactive power, but no reduction of the ripple:
  → operation with following control (p51799 = 42)

Note

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.

10.25.6   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 the Preface).

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)

Remark:
The incoming AC voltage of the controlled converter should be 10% to 15% higher than that at the uncontrolled converter, in order that the current can be reliably reduced down to 0.

Figure 10-63   12-pulse series connection: Controlled + uncontrolled rectifier, block diagram

10.25.7   Switchover of the power unit topology - option S50

Ordering information for option S50, see Chapter 2

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 the Preface).

For specific applications, there is a requirement that during operation it must be possible to switchover between two different power unit topologies (e.g. between a 12-pulse parallel connection and a 12-pulse series connection) using a control command.

SINAMICS DCM converter with option S50 provide the appropriate control. External contactors are used to actually switchover the power unit topology.

Requirements for using this functionality

- All participating SINAMICS DCM units must be must be equipped with option S50
- "n+m" operation is not permissible
- The "parallel switching master" function must remain at the same SINAMICS DCM for both power unit topologies

469

10.26 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

10.26.1 Direction of rotation reversal using field reversal

The function "Direction of rotation reversal using field reversal" is controlled via the connector input selected with p50580 - and this has a switch function. It defines the field direction and therefore also the direction of rotation for a positive speed setpoint.

Connector input = 0	A positive field direction is selected. "Close field contactor 1" (r53195[0]) = 1, "Close field contactor 2" (r53195[1] = 0
Connector input = 1	A negative field direction is selected. "Close field contactor 1" (r53195[0]) = 0, "Close field contactor 2" (r53195[1] = 1

Changing the logical level of the connector input 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 is at a standstill)

2. Specify "Direction of rotation reversal using field reversal" by changing the logical state of the connector input 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 actual 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[0] = 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 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.

471

10.26.2 Braking using field reversal

The function "Braking using field reversal" is controlled using the signal source set at binector input p50581 and this has a button-type function.

Binector input = 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 input = 0) and acknowledging using "Stop" and "Switch-on".

Control sequence when specifying "Braking using field reversal":

1. Drive rotates with direction of rotation 1

2. Specify "Braking using field reversal" using log. 1 (for ≥30 ms) at the binector input selected using p50581

3. The field is reversed.
   Preconditions: Line contactor is closed (for operating state ≤o5) and the drive is already braking anyway.
   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 actual 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[0] = 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 using binector level = 0 (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 actual 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[0] = 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
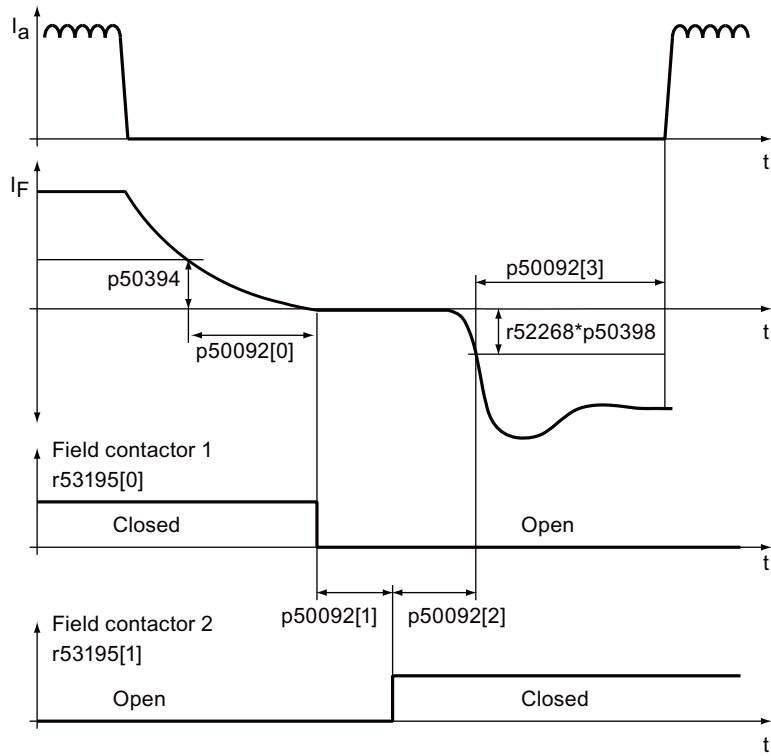reversal"

Figure 10-64   Wait times for field reversal (parameter p50092)

10.27 Serial interface with peer-to-peer protocol

General information

The peer-to-peer interface enables BICO interconnections across several SINAMICS DC MASTER units, as well as allowing the peer-to-peer interface to establish signal connections between converters in the SINAMICS DC MASTER range (MLFB = 6RA80...) and converters in other ranges, such as SIMOREG DC-MASTER (MLFB = 6RA70...) and SIMOREG K (MLFB = 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 unit 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 2 topologies:

- Point-to-point connection (see the series connection example further down)
  - 4-wire connection between 2 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.

Parameter assignment

Table 10- 27   Parameter assignment for 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 p50795 = 1: Bus terminator ON
Error statistics	r50799: Displays receive errors on the peer-to-peer interface

Examples of peer-to-peer connections

Series connection

Each drive receives its own individual setpoint from the previous drive (classic setpoint cascade).
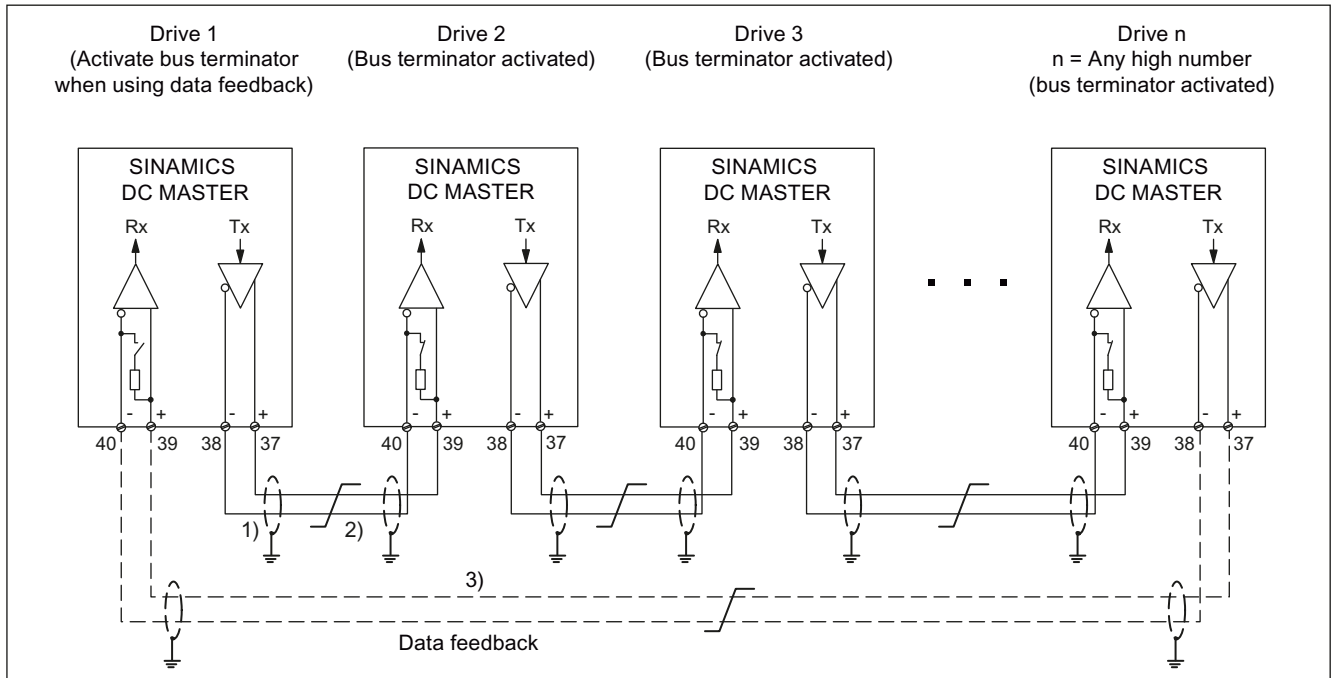
1)   The shields for the interface cables must be connected directly on the units (using a clamp, for example) to unit or cabinet ground, with a low level of impedance.

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 10-65   "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 units (using a clamp, for example) to unit or cabinet ground, with a low level of impedance.

2)   Twisted cable, e.g. LIYCY 2×0.5 mm²; 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 10-66   "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.
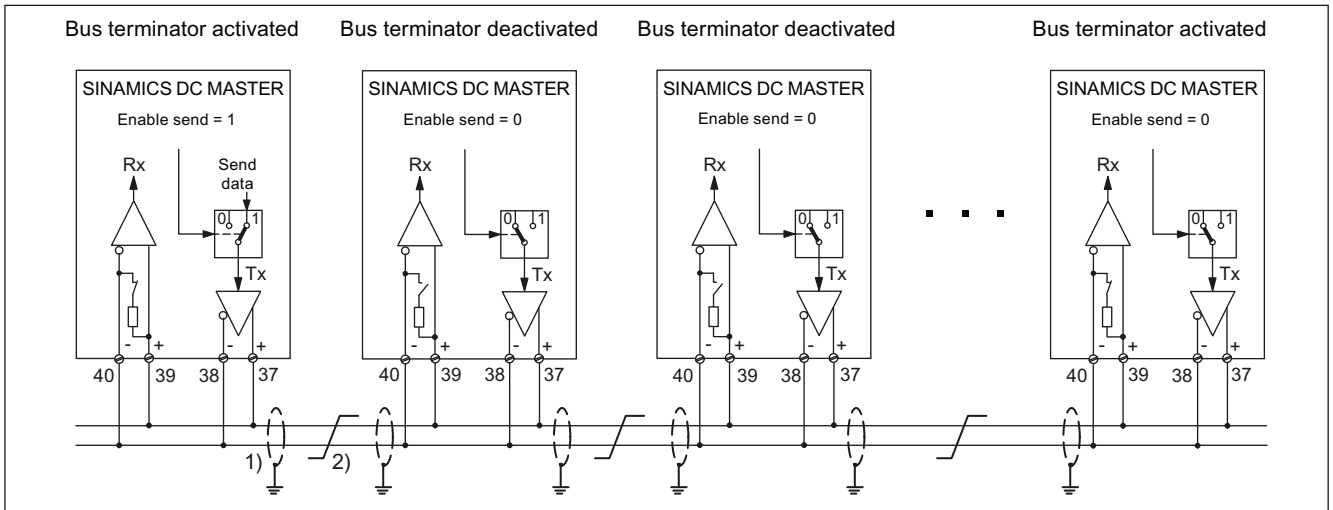

1)   The shields for the interface cables must be connected directly on the units (using a clamp, for example) to unit or cabinet ground, with a low level of impedance.

2)   Twisted cable, e.g. LIYCY 2×0.5 mm², 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 10-67   "Bus connection" peer connection type

10.28 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 the section titled "Ordering information for options and accessories".

CAUTION
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:

16 BICO connections can be established in each direction.
This involves using the parallel-connection interface. 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- 28   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- 29   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) are 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.

10.29 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 at switch 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 9, "Assigning parameters to AOP30 as the time-of-day master"), 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.

10.30 Diagnostics

10.30.1 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 SIEMENS experts.

Proceed as follows to read out the diagnostics file:

1. Insert the Memory Card in the drive.

2. Set p50832 to 1:
    This copies the diagnostics file to the Memory 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 around 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.

10.30.2 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 Memory 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 at p51706 – and p51705 is set to 0.

When starting via p51705 = 2, the oldest entries are overwritten after the number of entries set on 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 Memory Card.

For more details on the trend recorder function, please refer to function diagram FP8050.

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10.30.3 Thyristor diagnostics

SINAMICS DCM can perform a self-test of its own power unit. As a consequence, defective thyristors and other faults can be detected in the power unit.

Thyristor diagnostics cannot be used when SINAMICS DCM are connected in parallel and connected in series.

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 2 parts:

1. **Checking the thyristor for its blocking capability**
   All thyristors are individually fired and it is not permissible that current flows. Otherwise, a thyristor has failed (internally broken-down), triggers with forward breakover or there is a ground fault (i.e. connection 1C or 1D connected with ground).
   Notice:
   For IT line supplies (i.e. for line supplies with an ungrounded neutral point of the supply transformer), the thyristor diagnostics cannot detect a single-pole ground fault. For these types of line supply, it is recommended that a ground fault monitor is used.

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:
   The low current that flows during this test can cause the motor 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.

10.30.4 Description of the LEDs on the CUD

RDY
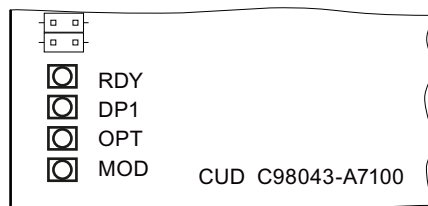DP1
OPT
MOD   CUD C98043-A7100

Figure 10-68 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 software and parameters.

- Once the unit has successfully ramped up, all the LEDs are switched off briefly.

- Once the unit has ramped up, the LEDs are controlled via the loaded software.

  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 software update

Table 10- 30   Software update

LED				Meaning
RDY	DP1	OPT	MOD	
Red	Off	Off	Off	Software being updated.
Red 2 Hz	Red	Off	Off	Software on the memory card is incomplete or defective.
				The software was not successfully updated. The CRC of the programmed firmware is incorrect.
Red 0.5 Hz	Red 0.5 Hz	Off	Off	Software was successfully updated. The electronics power supply must be switched off and back on again.
Red 2 Hz	Red 2 Hz	Off	Off	The software on the memory card does not belong to SINAMICS DCM.
Orange 0.5 Hz	x	x	Off	DRIVE-CLiQ component 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- 31   Ramp-up

LED				State	Comment
RDY	DP1	OPT	MOD		
Red	Red	Off	Off	BIOS loaded	-
Red 2 Hz	Red	Off	Off	BIOS error	-
Red	Off	Off	Off	Firmware loaded	-
Red 2 Hz	Red 2 Hz	Off	Off	File error	Memory Card not present or Flash file system faulty
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- 32   CUD - Description of the LEDs after ramp-up

LED	Color	Status	Description, cause	Remedy
RDY (READY)	-	Off	Electronics power supply is missing or outside permissible tolerance range.	-
	Green	Continuous light	The component is ready for operation. No errors are present.	-
		0.5 Hz flashing light	Commissioning/reset	-
		2 Hz flashing light	Writing to Memory Card or internal Flash memory **Notice!** The electronics power supply for the SINAMICS DC MASTER must not be switched off during this write process. Switching off the electronics power supply can lead to the loss of the parameter assignments. Also refer to the "Operation" chapter, "Memory Card functions" section.	-
	Red	2 Hz flashing light	General errors	-
	Orange	Continuous light	System ramp-up and DRIVE-CLiQ communication is being established.	–
	Green/ orange or red/ orange	1 Hz flashing light	Component detection via LED is activated (p0124[0]). **Note:** Both options depend on the LED state when component detection is activated via p0124[0] = 1.	-

LED	Color	Status	Description, cause	Remedy
DP1 PROFIdrive cyclic operation	-	Off	Cyclic communication has not (yet) taken place. **Note:** The PROFIdrive is ready to communicate when the CUD is ready for operation (see LED RDY).	-
	Green	Continuous light	Cyclic communication is taking place.	-
		0.5 Hz flashing light	Bus fault (dataEx, no operate) Full cyclic communication is not yet taking place. Possible cause: The controller is not transferring any setpoints.	-
	Red	Continuous light	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)	
			No link established	-
OPT (OPTION)	-	Off	Electronics power supply is missing or outside permissible tolerance range, component not ready for operation, Option Board not installed, no associated drive object has been created,	-
	Green	Continuous light	Option Board is ready for operation.	-
		0.5 Hz flashing light	Depends on the Option Board used	-
	Red	Continuous light	Cyclic communication via PROFINET has not yet been established. However, non-cyclic communication is possible. SINAMICS waits for a parameterizing/configuring telegram	-
		2 Hz flashing light	At least one fault is present in this component. Option board not ready (e.g. after switching on)	Remedy and acknowledge fault
MOD	-	Off	Reserved	-

10.30.5 Faults and alarms

10.30.5.1 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 PROFIBUS 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 PROFIBUS 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.

10.30.5.2 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.

NOTICE
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

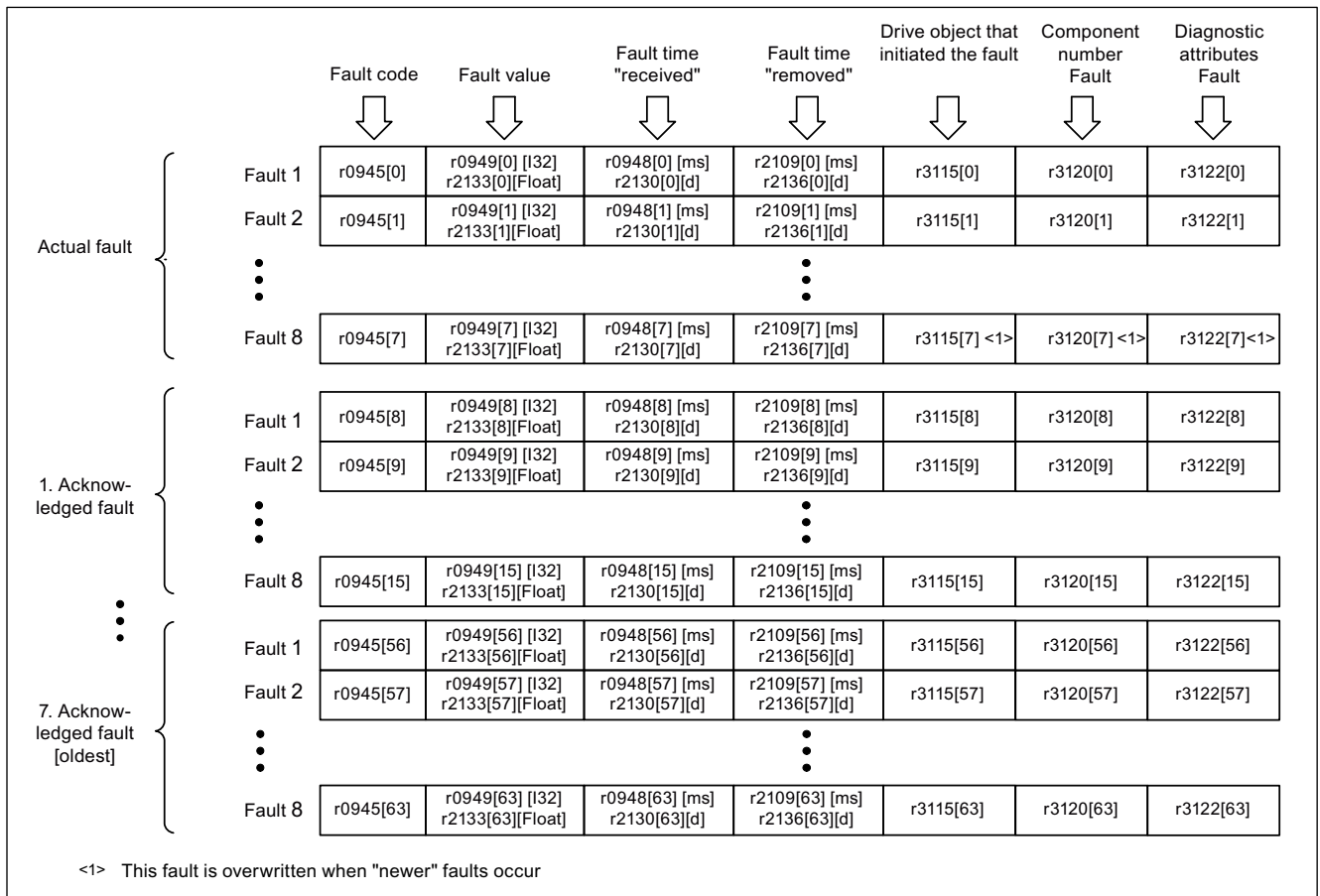Faults which occur are entered in the fault buffer as follows:

Figure 10-69 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.

	Alarm code	Alarm value	Alarm time "received"	Alarm time "removed"	Component number, alarm	Diagnostic attributes, alarm
Alarm 1 (oldest)	r2122[0]	r2124 [0] [I32] r2134[0] [Float]	r2123[0] [ms] r2145[0] [d]	r2125[0] [ms] r2146[0] [d]	r3121[0]	r3123[0]
Alarm 2	r2122[1]	r2124 [1] [I32] r2134[1] [Float]	r2123[1] [ms] r2145[1] [d]	r2125[1] [ms] r2146[1] [d]	r3121[1]	r3123[1]
Alarm 8 (most recent)	r2122[7]	r2124 [7] [I32] r2134[7] [Float]	r2123[7] [ms] r2145[7] [d]	r2125[7] [ms] r2146[7] [d]	r3121[7]	r3123[7]

Alarm history

	Alarm code	Alarm value	Alarm time "received"	Alarm time "removed"	Component number, alarm	Diagnostic attributes, alarm
Alarm 1 (most recent)	r2122[8]	r2124 [8] [I32] r2134[8] [Float]	r2123[8] [ms] r2145[8] [d]	r2125[8] [ms] r2146[8] [d]	r3121[8]	r3123[8]
Alarm 2	r2122[9]	r2124 [9] [I32] r2134[9] [Float]	r2123[9] [ms] r2145[9] [d]	r2125[9] [ms] r2146[9] [d]	r3121[9]	r3123[9]
Alarm 56 (oldest)	r2122[63]	r2124 [63] [I32] r2134[63] [Float]	r2123[63] [ms] r2145[63] [d]	r2125[63] [ms] r2146[63] [d]	r3121[63]	r3123[63]

Figure 10-70 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 to 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 to 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

10.30.5.3   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 reaction (example)

Select message	Set fault reaction	
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

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 1 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.

10.30.5.4 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

10.30.5.5   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 above drive object types with the aid of DCB STM.

10.31 CPU time load with SINAMICS DCM

The CPU time load of the SINAMICS DCM can be read out at r9976. 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).

2. The use of peripherals (AOP30, Starter, TM15, TM31, 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 through the main components is summarized in the table below.

3. The CPU time load must not exceed a utilization of 100% at r9976.

> ⚠ **WARNING**
>
> At a CPU time load of >100 % on r9976[1], the correct functioning of the drive is no longer ensured.

Note

When the time load of the CUD is too high (r9976 >100 %) fault 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- 33   Additional CPU time load through 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 SMC30	+2 %
1 CBE20	+1 %
Internal encoder (p50083=2)	+2 %
Parallel interface	+4 %
Peer-to-peer	+4 %
Thyristor blocking voltage calculation	+3 %
Is supported by the CCP	+3.5 %
Memory Card inserted	+1 %

Component	Additional CPU time load
Free function blocks	Depending on the number of free function blocks being used and their runtime groups, see the "Free function blocks" chapter
DCC	Depending on the number of DCC blocks being used and their runtime groups, see the "Drive Control Chart (DCC)" chapter

---

Note

The additional CPU time load stated above for TM15 and TM31 apply to 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 above.

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 by several percentage points.

10.31.1 Maximum configuration

The following configuration can be operated as the maximum on one CUD.

Table 10- 34   Maximum configuration with SINAMICS DCM

Number	Component	Note
3	TM15, TM31	Connection of any combination of TM15 and TM31 modules on Drive-CLiQ. The connection of other TM modules (TM17, TM41,..) and of more than 3 TM modules is locked.
		Sampling in 4 ms cycle (p4099=4000). Faster sampling increases the CPU time load, and precludes operation of this maximum configuration
1	SMC30	The connection of others (SMC10, SMC20,..) and of more than 1 external encoder module is locked.
1	CBE20	The connection of other OMI modules (CBE10) is locked.
1	Internal encoder	p500083 = 2
1	AOP30	Connection via PPI or RS232
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 slot). See the "Expanding the SINAMICS DCM to include a second CUD" chapter.

10.31.2   Computation examples

Example 1:

Project A is a single drive in a control cabinet. An AOP30 (PPI) is located in the control cabinet door. The motor has an incremental encoder, which is connected through the internal encoder input.

Base load	70 %
AOP30 via PPI	+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 slot). See the "Expanding the SINAMICS DCM to include a second CUD" chapter.

10.32 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.

Notes

- 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 loading. If that does not suffice, the application can be implemented with the DCC technology option. See the Drive Control Chart (DCC) chapter.

- In the SINAMICS DCM, simultaneous use of the free function blocks and the DCC technology option are feasible.

CPU time load through free function blocks with the SINAMICS DCM

Processing free function blocks requires considerable computation time. If the CPU time becomes meager, 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- 35   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

- The actual CPU time load of the CUD can be read out on r9976. Please refer to the "CPU time load with the SINAMICS DCM" chapter for more information about the CPU load with the SINAMICS DCM.

- To make own calculations, the above-illustrated CPU time loads can be taken as "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). 10 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.

10.33 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 Chapter "Loading the DCC technology option in the drive unit memory"). 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 resolve this fault, you have the following options:

1. Now install the DCC technology option as described in Chapter "Loading the DCC technology option into the memory of the drive unit". 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.

10.33.1 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:

501

- **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).
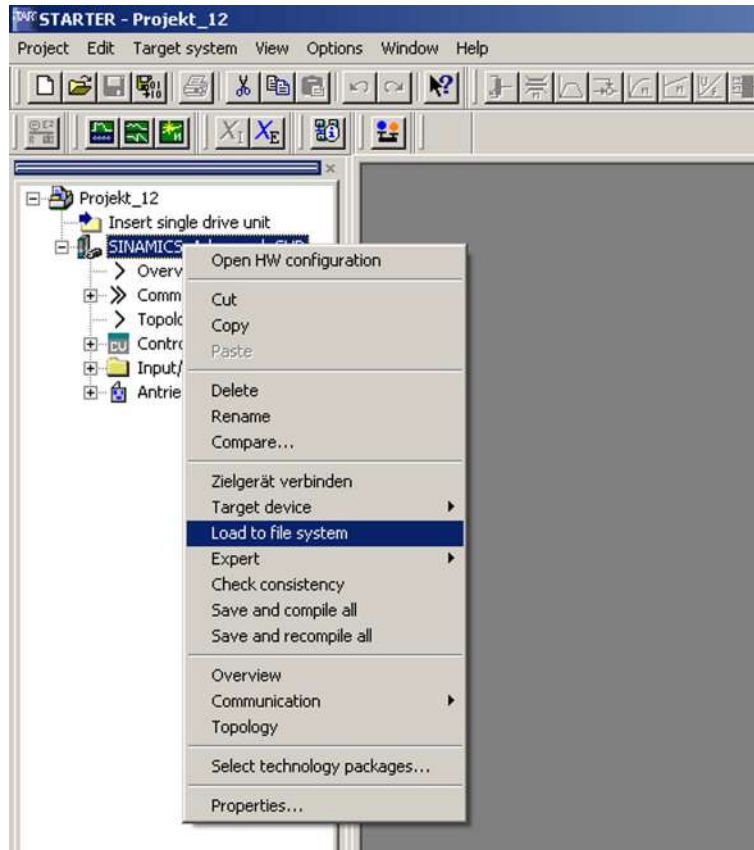

Figure 10-71 Loading into the file system

- **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 unit software. These files are only required to update software.

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 Memory 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.

10.33.2 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- 36 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 on r9976. Please refer to the "CPU time load with the SINAMICS DCM" chapter for more information about the CPU load on the SINAMICS DCM.

- To make own calculations, the above-illustrated CPU time loads can be taken as "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.

10.33.3   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- 37   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- 38   Additional memory load through optional components

Component	Additional memory load (expressed in DCC blocks)
AOP30	- 200 blocks
TM31	- 150 blocks
TM15	- 150 blocks
SMC30	- 25 blocks
CBE20	- 25 blocks

The final limits are determined by the total memory available on the CUD. If the above-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 2 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 on the right-hand slot.

- The computation rules stated above 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.

10.33.4   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 diagrams

When loading the diagram into the drive (loading into the target system) only the information about the type, time slices and interconnection of the DCB blocks (Point 1) are loaded into the drive.

The information about layout and graphics in the DCC diagrams (Point 2) are only available in the STARTER project. To be able to open the diagrams later in the editor, it is important to back up the STARTER project related to a drive.

Maintenance

11

<div style="border: 1px solid black;">

⚠ WARNING

Hazardous voltages are present in certain components of these electrical units during operation.

Dangerous voltage levels may be present at the signaling relays at the customer's site.

Therefore, failure to handle the units properly can result in death or serious physical injury as well as extensive property damage.

When performing maintenance on this unit, you should therefore observe all information provided in this section as well as any notices attached to the product itself.

- Only qualified personnel who are familiar with all the safety instructions in this description, as well as the installation, operating, and maintenance instructions, should carry out maintenance work on this unit.

- Before carrying out visual inspections and maintenance work, it must be ensured that the unit is disconnected from the AC power supply, disabled, and grounded. Before they are shut down, both the converter unit and the motor are subject to dangerous voltage levels; these may be present even when the converter unit's contactor is open.

- The TSE capacitors continue to carry dangerous voltage levels following disconnection. For this reason, the unit should not be opened until an appropriate period of time has elapsed.

Only spare parts approved by the manufacturer may be used.

</div>

The converter unit must be provided with extensive protection measures against contamination in order to prevent voltage flashovers and, therefore, destruction. Dust and foreign bodies, which are brought in by the cooling-air flow in particular, must be thoroughly removed at certain intervals; this depends on the rate of accumulation of dirt, but should be carried out at least every 12 months. The 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 maintenance work is carried out on the SINAMICS DCM.

Please note the following when working with converter units featuring increased air cooling:

The bearings for the fans are designed for an operating period of 30000 hours. The fans must be replaced in good time to ensure the continued availability of the thyristor sets.

11.1 Upgrading software releases

This chapter describes how you can upgrade a drive – including STARTER project – from one software version to a higher software version (e.g. V1.1 to V1.2).

Basic information

The following steps are necessary:

- Upgrading the unit software
    - Step 1: Backup the configuration
    - Step 2: Update the drive software (incl. the peripherals)
    - 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 to update the software (see Chapter "Ordering data for options and accessories").

When updating the software, always proceed as follows:

1. Software update of the drive
2. Update the STARTER project
3. Load the converted STARTER project into the drive (load into the target unit)

Do not proceed as follows:

1. Software 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 unit version (load into the PG before the software update) and then proceed as normal.

11.1.1 Upgrading the unit software

Step 1: Backup the configuration

The drive parameter assignment is not lost while updating the software. In spite of this, before starting the software update, backup the drive configuration:

- Backup the parameter assignment on a memory card (see Chapter "Functions of the memory card") and/or

- Backup the parameterization in a STARTER project (see Chapter "Commissioning using the STARTER commissioning tool")

Step 2: Software 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 software release: See preface

Procedure:

- Unzip the *.zip file to an empty memory card

- Insert the card in the drive, which has been switched-off, and switch the unit on again. The firmware is updated. The update has been completed if the RDY-LED and the DP1-LED flash at 0.5 Hz (the update takes about 12 min).

- Carry out a POWER OFF / POWER ON. The new software is now active. During the first power up

  - the connected TM modules and/or SMC30 carry out a SW update (after the software update of these components, it is necessary to carry out a POWER OFF / POWER ON for these components)

  - indicates to an optionally connected AOP30, that a new AOP software is available. Confirm the prompt after the update with "OK".

Note

As a result of the unit software update, DCC charts in the unit are not automatically upgraded to the new DCC version. This is also not absolutely necessary. See also step 5 (next chapter).

NOTICE

Electronics power supply must not be interrupted during the update, otherwise the update will need to be restarted.

Note

To safely remove the memory card, see Chapter "Functions of the memory card"

Step 3: Update the STARTER project

Install the SSP that matches the new SW version (e.g. SSP SINAMICS DCM 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 unit version). Right-click on the unit 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 unit version.

Note

STARTER does not support a "downgrade" of the software 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 software 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")
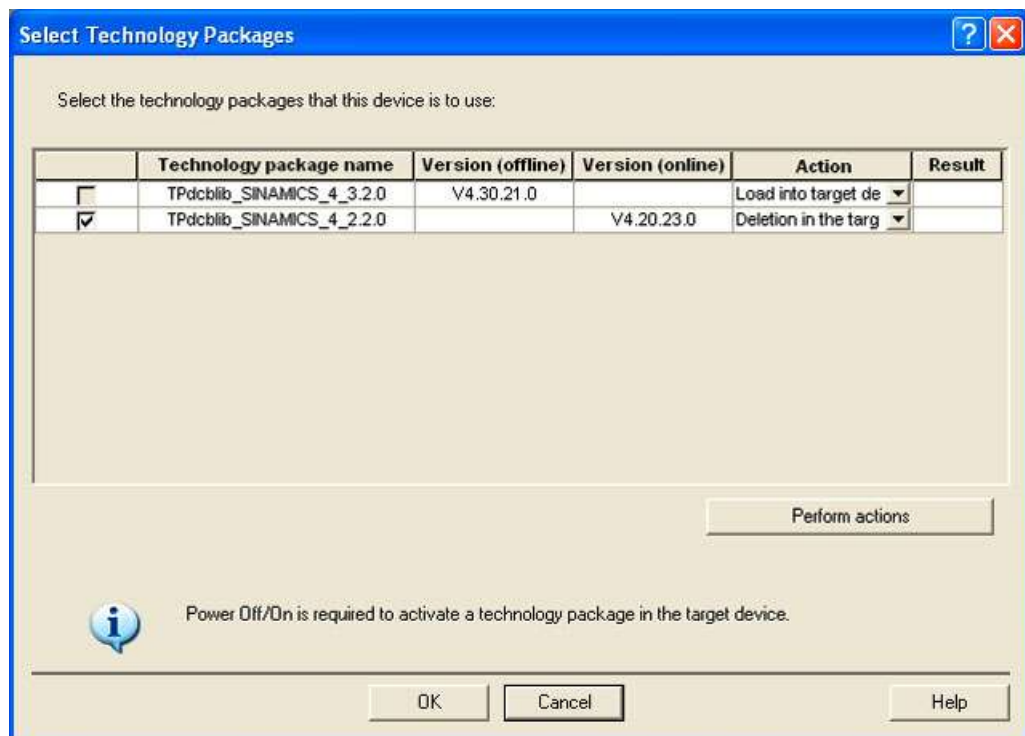
Figure 11-1   Selecting technology packages

- 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".
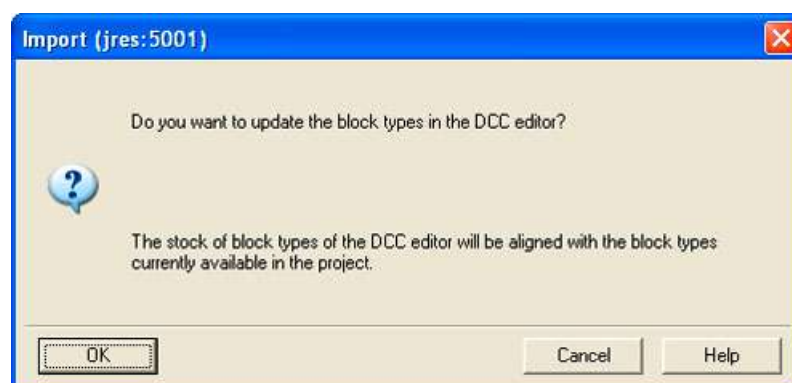
Figure 11-2   Importing the DCC library (1)

– Shift the DCC library, which appears in the "Libraries installed in Starter", to the right with ">>"
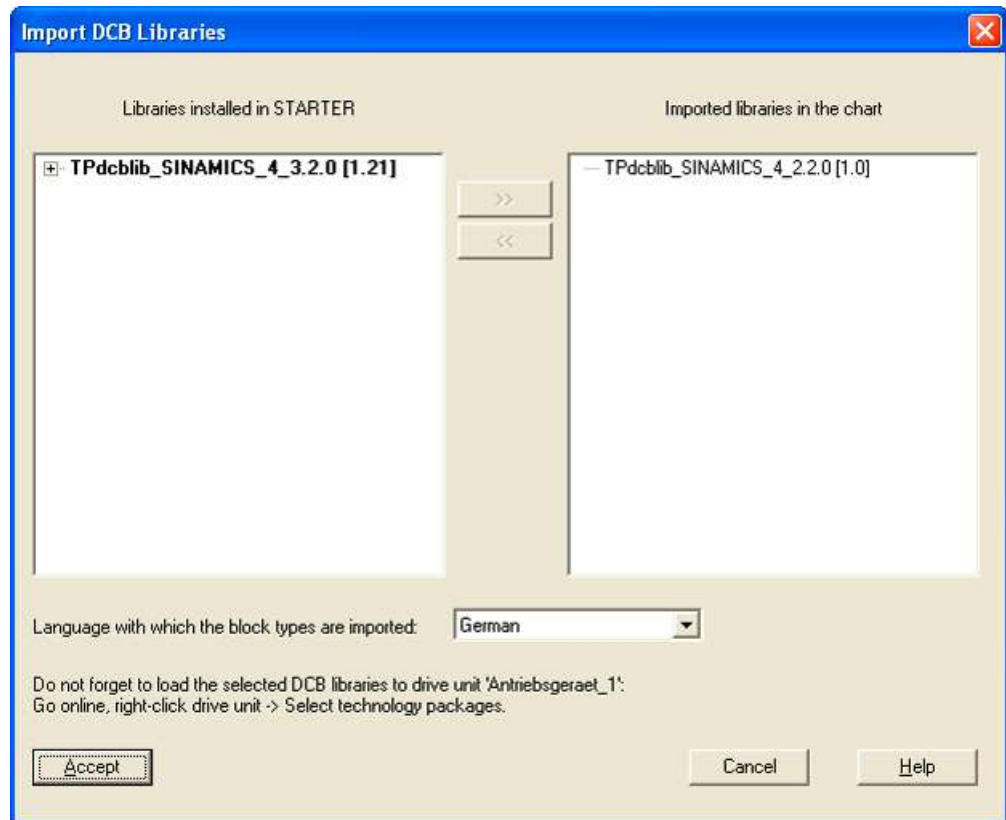
Figure 11-3   Importing the DCC library (2)

– 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 components

Note

Only authorized Siemens personnel are permitted to repair the power unit.

Exception: Fuses may also be changed by the customer.

11.2.1 Replacing the fan

⚠ WARNING
The fan must only be replaced by qualified personnel.
The TSE capacitors continue to carry dangerous voltage levels following disconnection. For this reason, the unit should not be opened until an appropriate period of time has elapsed.
Failure to observe this warning information can result in death, serious physical injury, or extensive material damage.

The recommendation to replace the fan is displayed in the form of alarm A60165, refer to Chapter 10, Section "Operating hours counter, equipment fan"

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Replacing fans in 210 to 280 A units
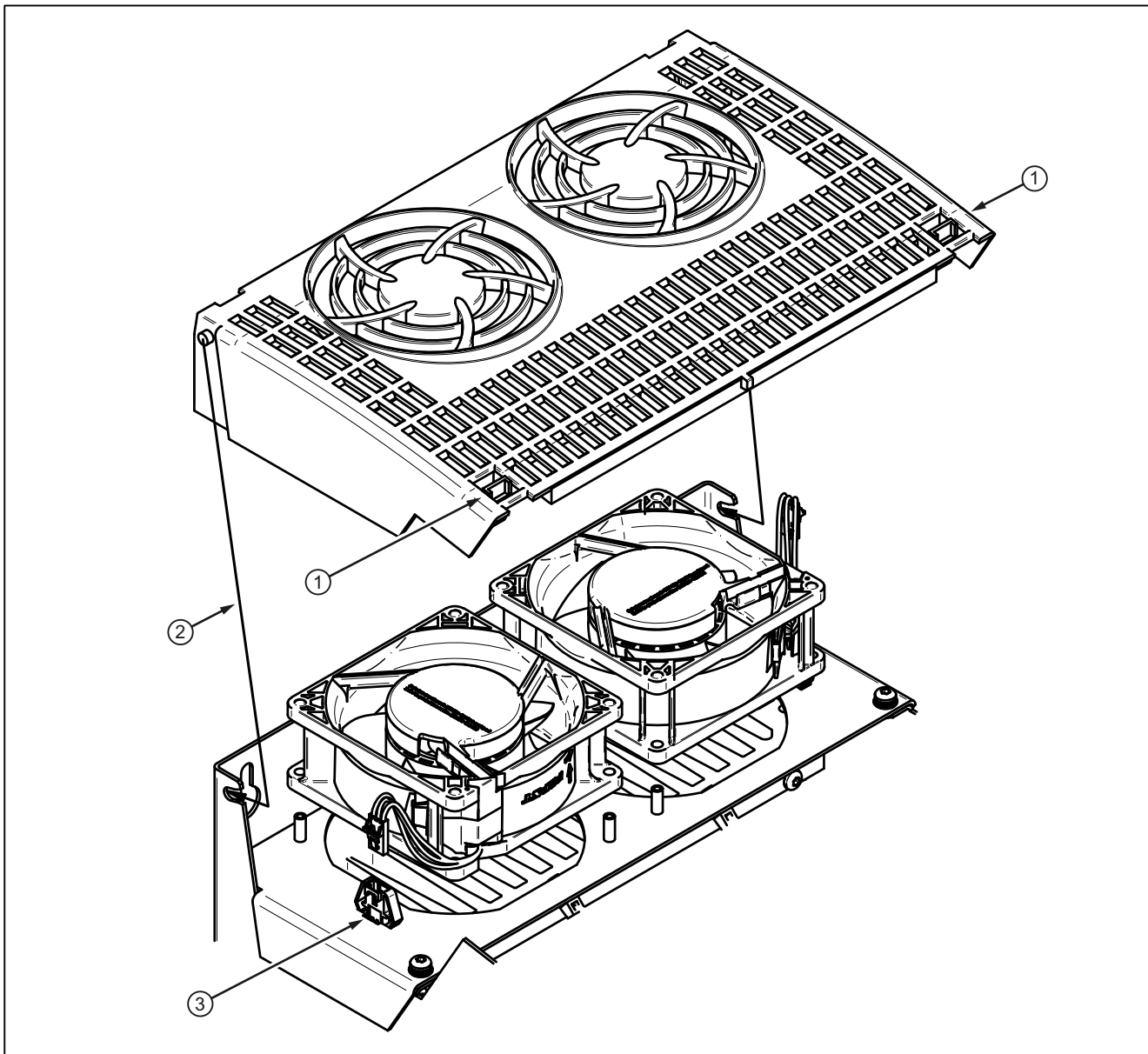
- Unlatch the fan cover at the top left and right ①
- Tilt the fan cover around 30° and pull it out towards you ②.
- Disconnect the fan connector ③.
- Replace the fans.
- Make sure you install the new fans in the correct position:
  The air must be blown upwards (see the arrow on the fan enclosure).
- Reconnect the fan connector and replace the fan cover.

Figure 11-4   Replacing fans in 210 - 280 A units

Replacing fans in 400 to 850 A units
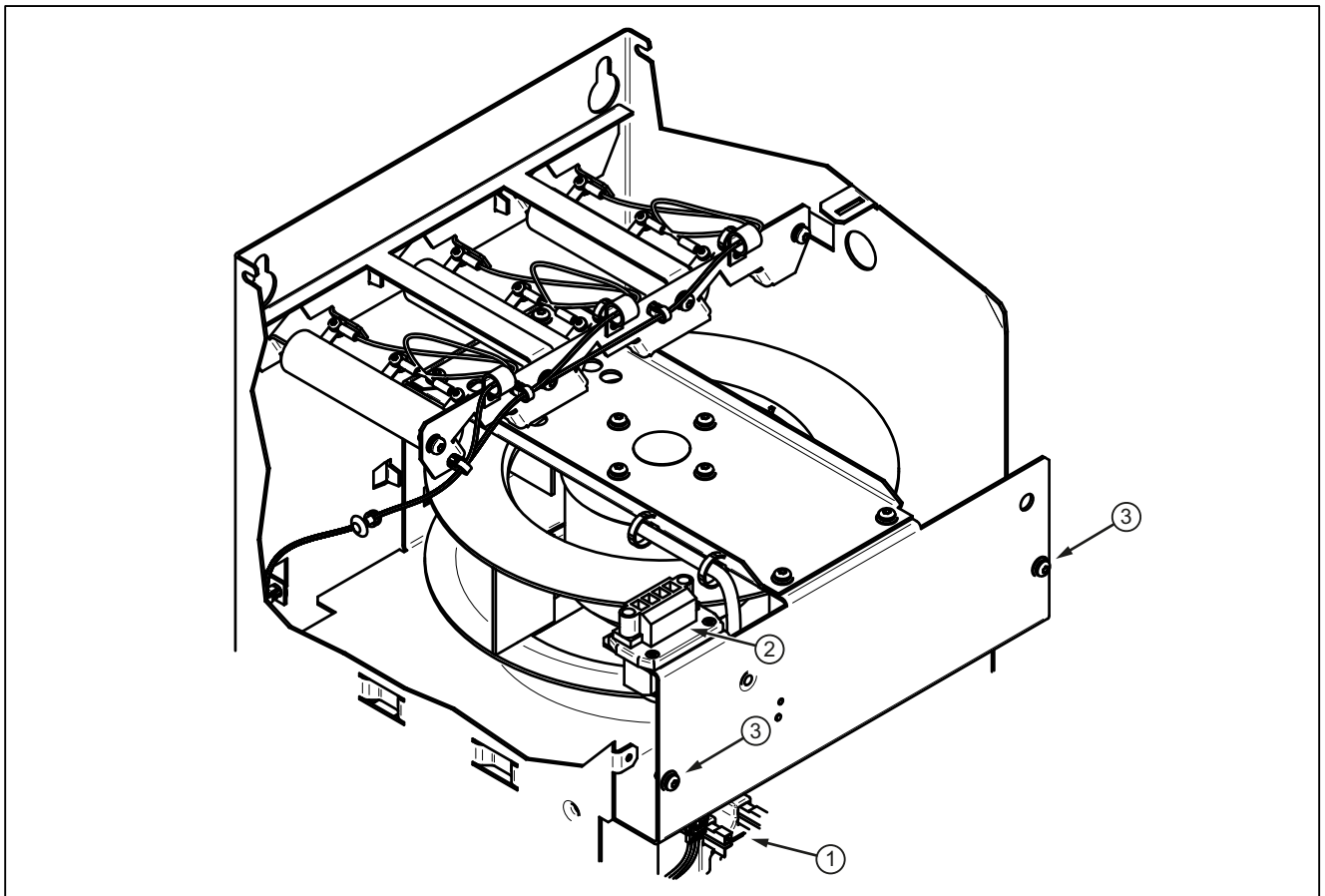
- Remove the front cover of the SINAMICS DC MASTER.
- Disconnect the fan-sensor connector ①.
- Disconnect the connector for the fan's power supply ②.
- Release the screws ③ (tool: Torx T20 screwdriver)
- Pull the slide-in fan unit out towards you.
- Insert a new fan module and screw it in place (tightening torque 1.5 Nm), reconnect the connectors, and replace the front cover.

Figure 11-5   Replacing fans in 400 - 850 A units

Replacing fans in 1,200 A units
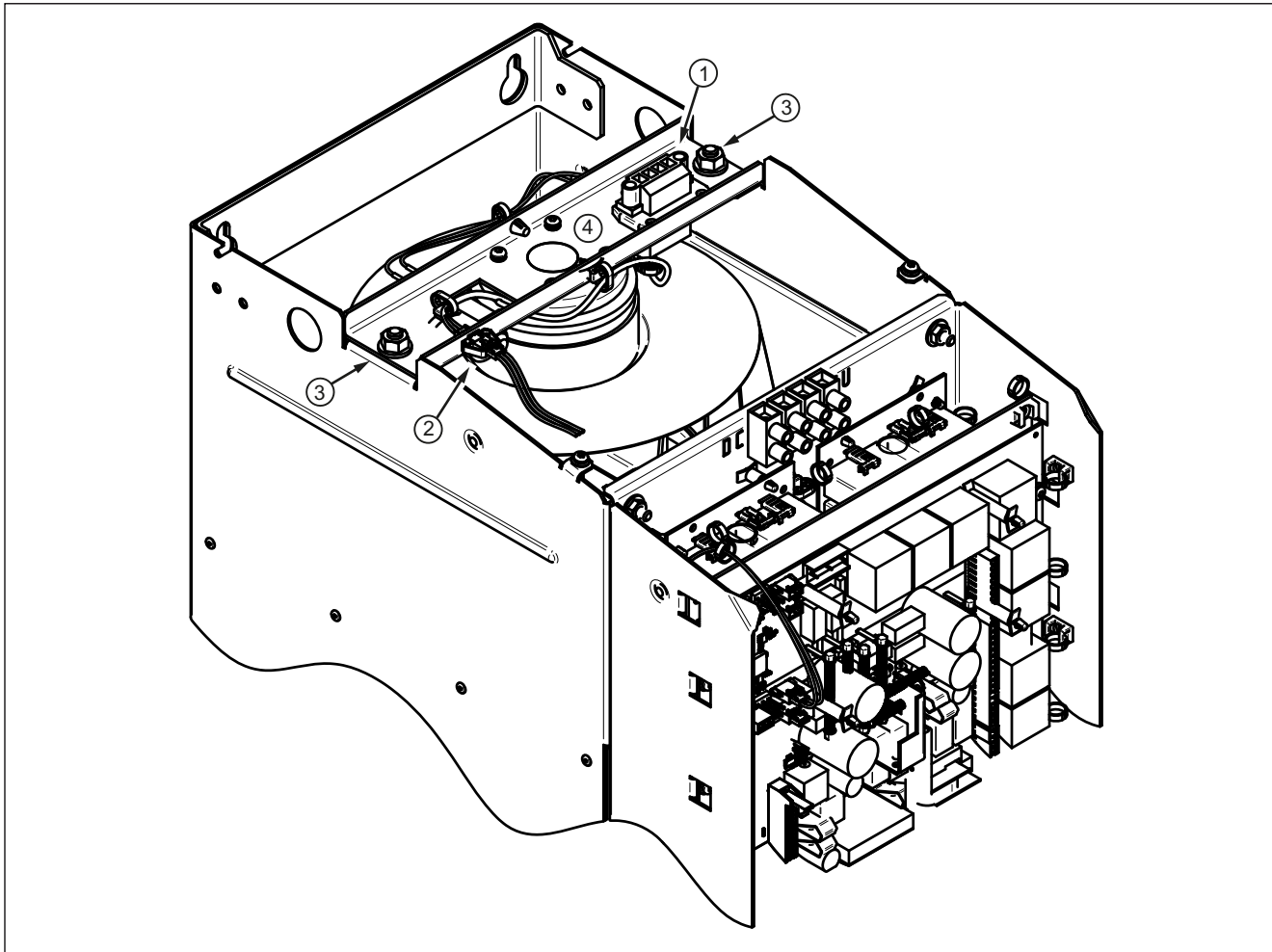
- Remove the front cover and cover at the top of the SINAMICS DC MASTER.
- Disconnect the fan connector ① and fan monitoring equipment ②.
- Release the nuts ③.
- Lift out the fan together with the fan stay.
- Install the new fan in the inverse sequence
  Tightening torque for the nuts ③ = 15 Nm

Figure 11-6   Replacing fans in 1,200 A units

Replacing fans in 1,500 to 3,000 A units
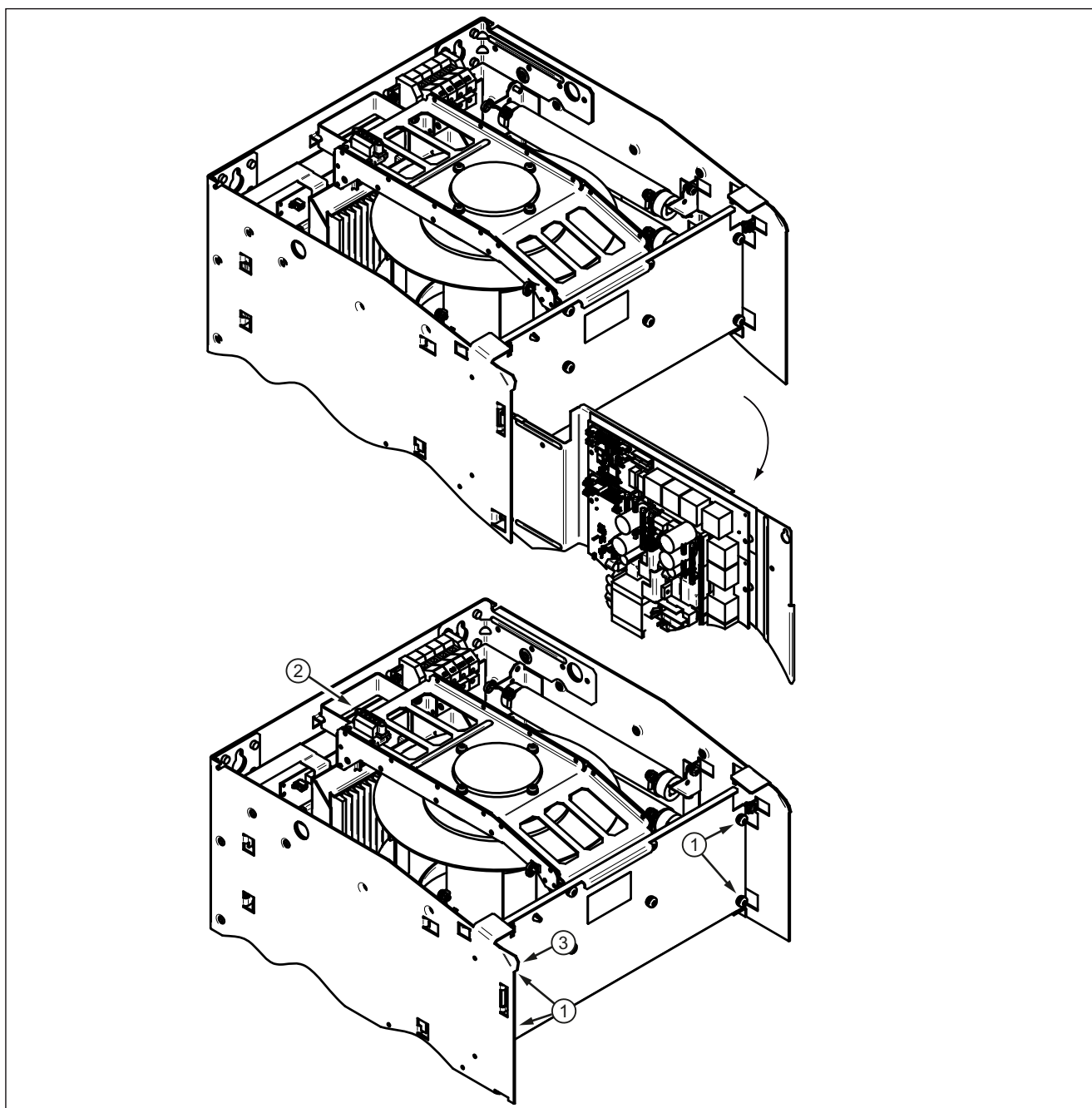
- Remove the front plate and cover at the top of the unit
- Release the support plate for the electronics and swing it out.
- Release the fixing screws for the slide-in fan unit ①.
- Disconnect the fan connector ② and fan monitoring equipment (3-pin) ③.

Figure 11-7   Replacing fans in 1,500 - 3,000 A units (1)
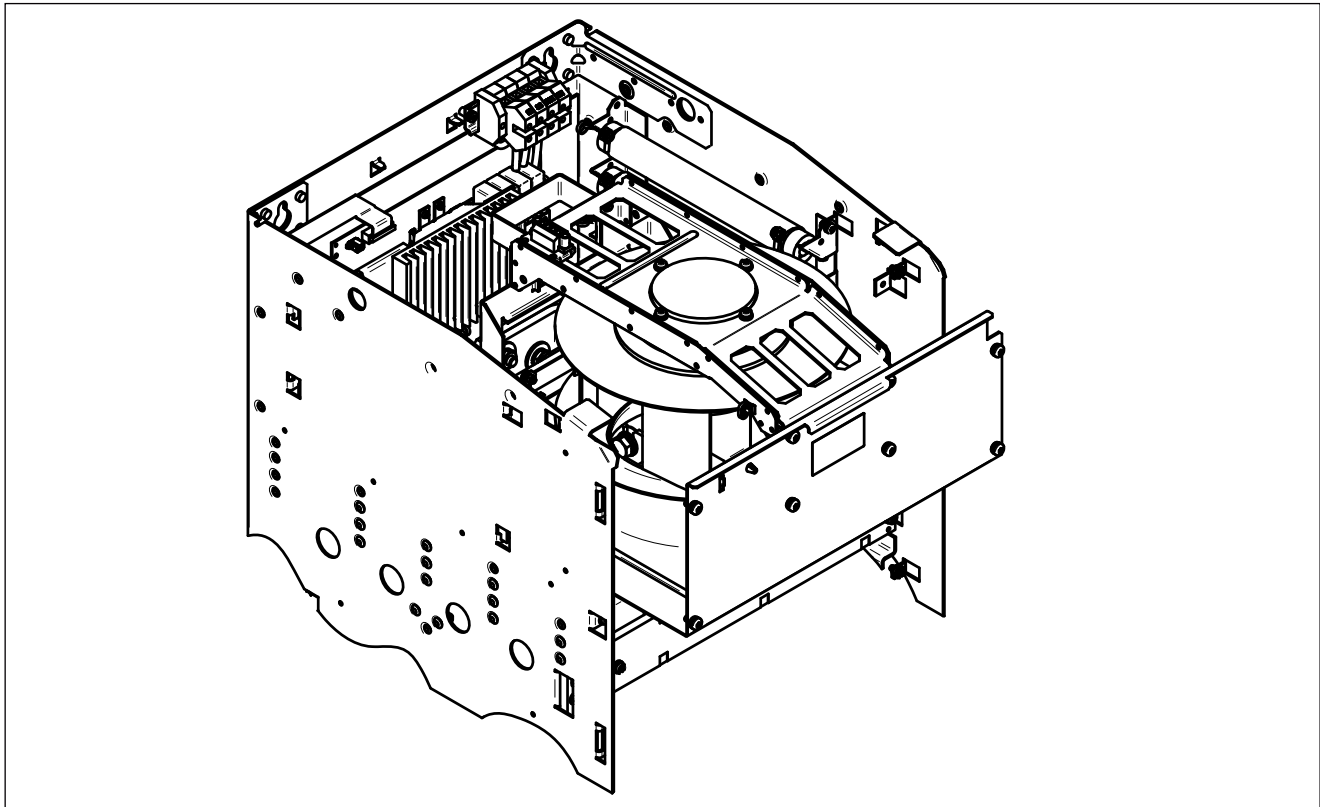
- Pull the slide-in fan unit out towards you.
- Insert the new fan module and screw into place, tightening torque = 6 Nm
- Re-insert the connector
- Swivel back the support plate for the electronics and screw into place, tightening torque = 3 Nm
- Re-attach the front plate and the top cover

Figure 11-8   Replacing fans in 1,500 - 3,000 A units (2)

11.2.2   Replacing fuses

NOTICE
Every time a fuse blows, all of the arm fuses must be replaced.
For units >850 A, as described here, these are the fuses installed in the unit.
For units ≤850 A, these are the externally installed fuses.

Replacing fuses for 900 A to 1200 A units

The fuses are accessible from the front after removing the front cover and swiveling the support plate for the electronics out of the way. The fuses are fixed with 2 hex screws each ① (width across flats 16). Tightening torque 25 Nm.
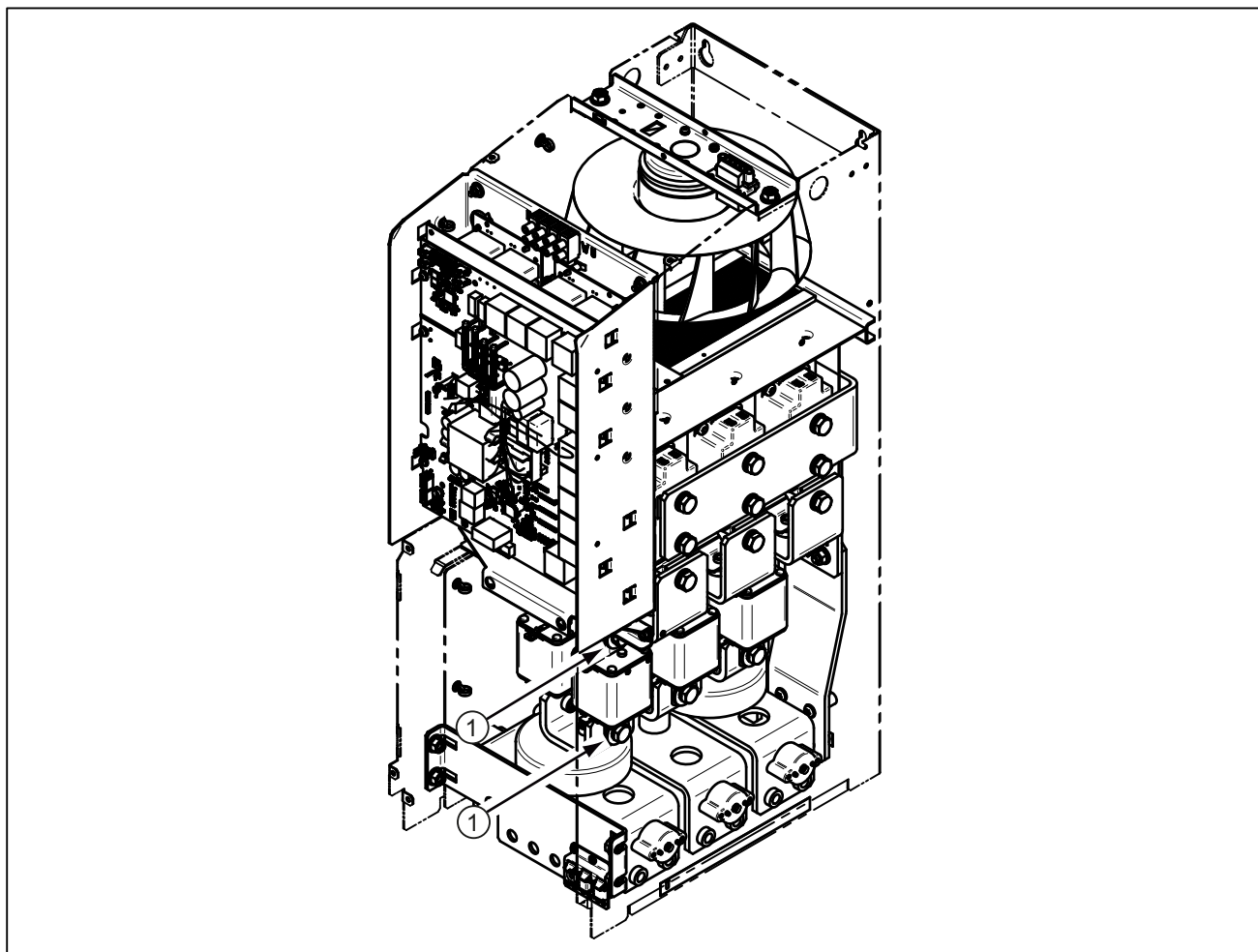
Figure 11-9   Replacing fuses for 900A to 1200 A units

Replacing fuses for 1500 A to 3000 A units

The fuses are accessible after removing the front cover and withdrawing the fan module (see the previous chapter). Each fuse is fixed with 2 hex screws. Tightening torque 25 Nm.

When installing the fuses, observe the following:

- Install the fuses with the same alignment as the fuses to be replaced. The rupture indicator of the fuses in the left-hand and right-hand series must point towards the center of the unit.

- The fixing screws have different lengths. Re-use the screws at the same position.
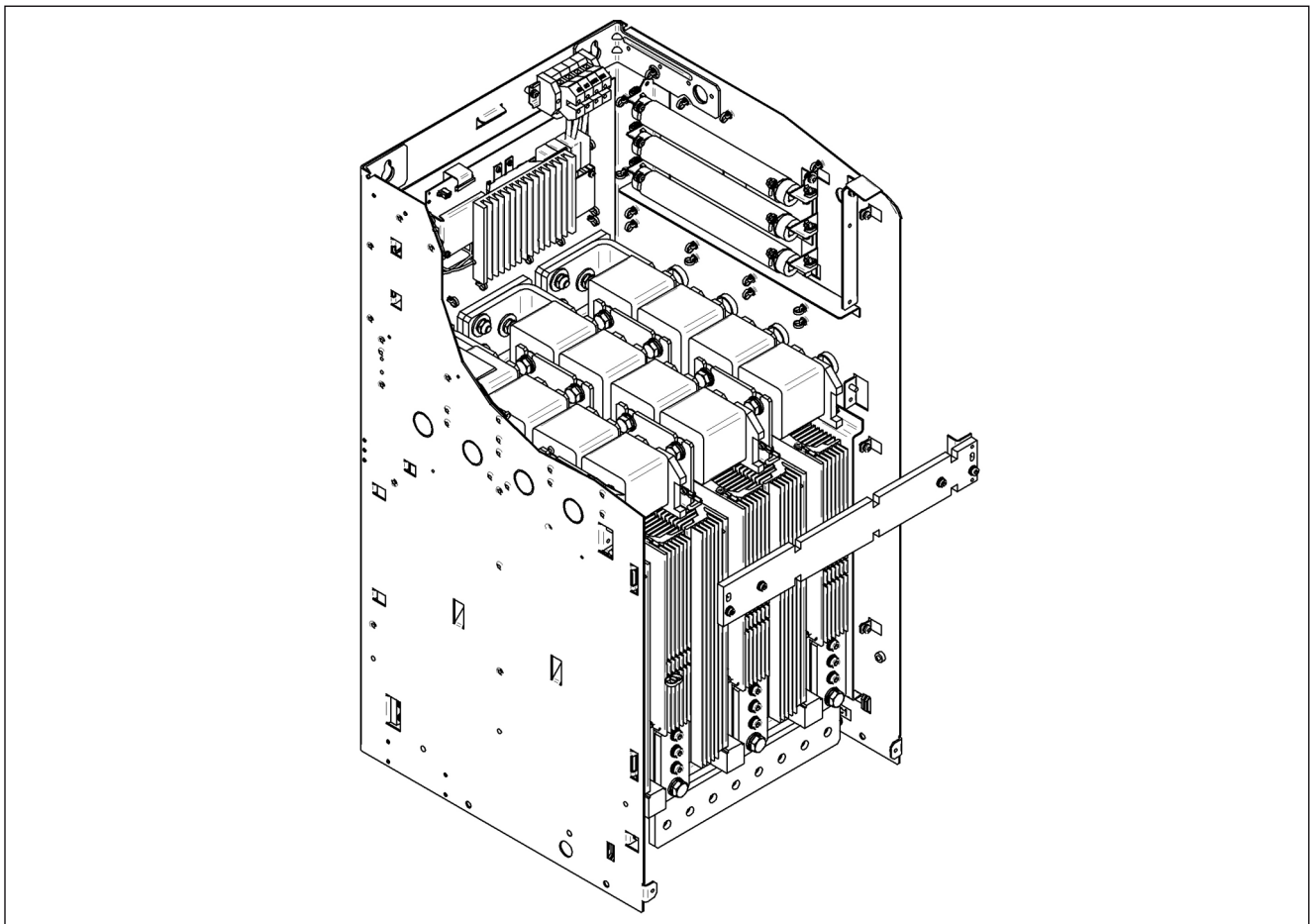
Figure 11-10 Replacing fuses for 1500A to 3000 A units

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.

NOTICE
The battery must be replaced within one minute to ensure that no AOP settings are lost.
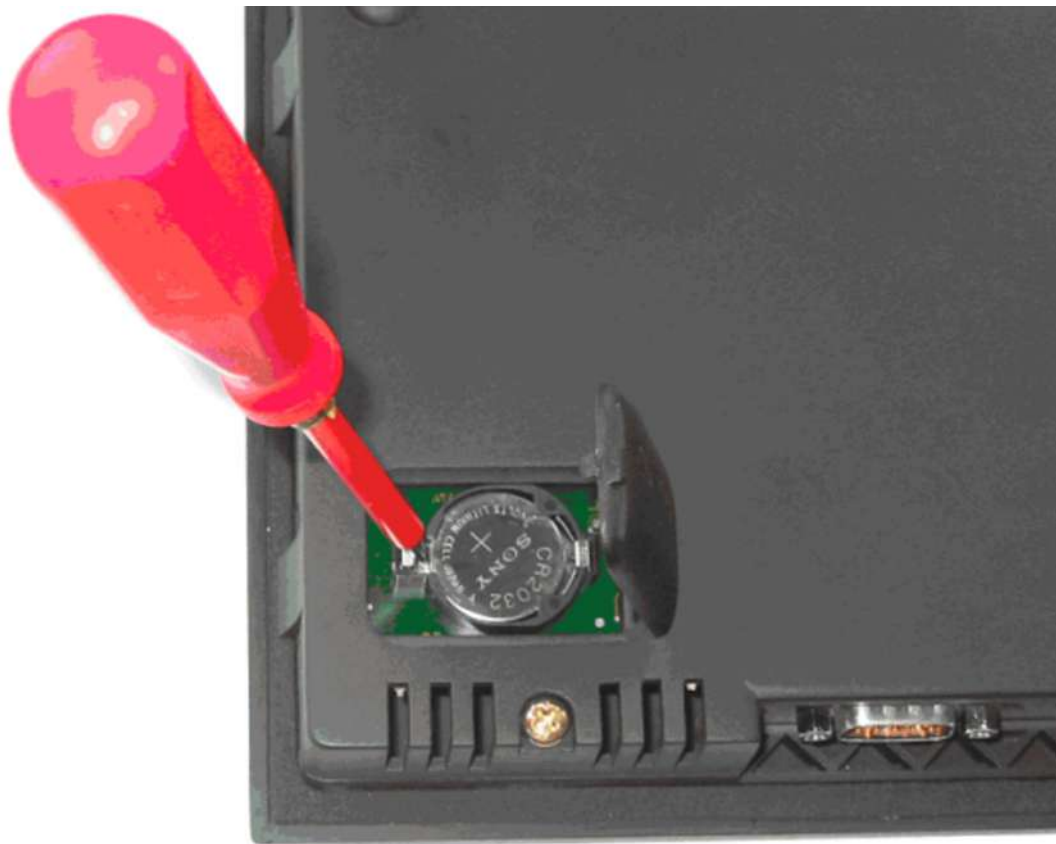
Figure 11-11   Replacing the backup battery for the cabinet operator panel

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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 6)
- EMC-compliant design according to Chapter 6
- Use coated modules (option M08). See the ordering data for options and accessories in Chapter 2.

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 6.

HTL encoder, bipolar, with zero signal
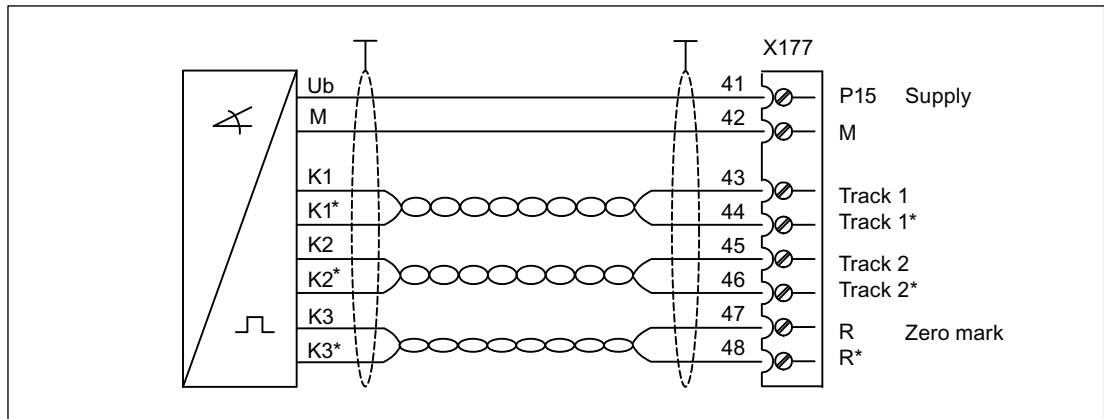
Improved protection against induced interference is achieved by twisting the signal lines in pairs.

Figure 12-1   Bipolar incremental encoder

HTL encoder, bipolar, with zero signal
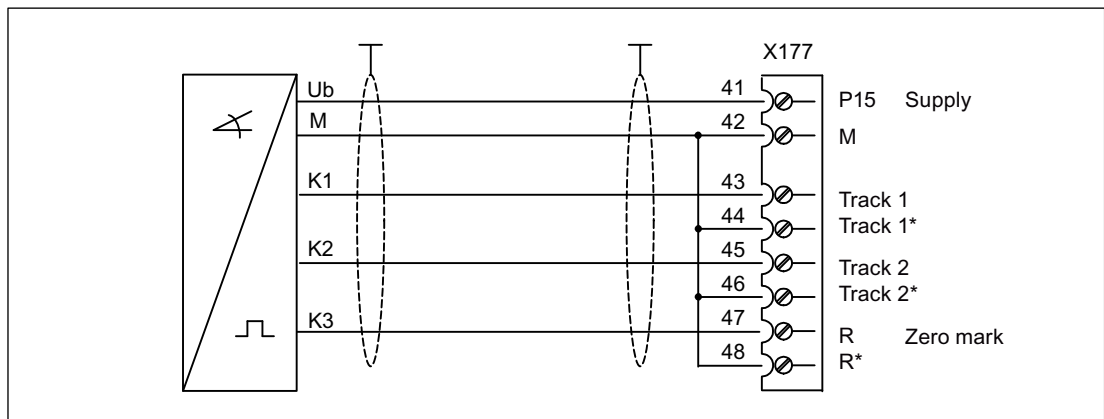
Figure 12-2   Unipolar incremental encoder

A

Appendix A

A.1 Certifications and standards

Certifications

Development, production, sales:

ISO 9001:2008	Quality management	
ISO 14001:2004	Environmental management	

Units:

UL, cULus		File No. E203250 [1]
GOST		РОСС DE.АЯ46.
Germanischer Lloyd	Shipbuilding [2]	11787-10HH
Lloyd's Register	Shipbuilding [2]	No. 06/20053
American Bureau of Shipping	Shipbuilding [2]	06-HG196689-1-PDA
Det Norske Veritas	Shipbuilding [2]	No. E-10357 (DC converters) No. E-10358 (Control Module)

Communication:

PROFIBUS slave (DP-V0, DP-V1, PROFIdrive 3.1.2)

[1] UL online certifications directory:
http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.htm

[2] In order to maintain the limit values decisive for certification for marine applications, the prerequisites as listed in chapter "Using SINAMICS DCM in shipbuilding (Page 523)" must be observed.

Korean Certification (KC)

Type of Equipment	User's Guide
A급 기기 (업무용 방송통신기자재)	이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
Class A Equipment (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 EN55011.

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, such as:

- The use in grounded line supplies
- And 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 up".

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
UL 508 C	Power Conversion Equipment
UL 840	Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

A.2 List of abbreviations

Note

The following list of abbreviations includes all abbreviations and their meanings used in the entire SINAMICS user documentation.

Abbreviation	Meaning, German	Meaning, English
A		
A...	Warnung	Alarm
AC	Wechselstrom	Alternating Current
ADC	Analog-Digital-Konverter	Analog Digital Converter
AI	Analogeingang	Analog Input
AIM	Active Interface Module	Active Interface Module
ALM	Active Line Module	Active Line Module
AO	Analogausgang	Analog Output
AOP	Advanced Operator Panel	Advanced Operator Panel
APC	Advanced Positioning Control	Advanced Positioning Control
ASC	Ankerkurzschluss	Armature Short-Circuit
ASCII	Amerikanische Code-Norm für den Informationsaustausch	American Standard Code for Information Interchange
ASM	Asynchronmotor	Induction motor
B		
BB	Betriebsbedingung	Operating condition
BERO	Firmenname für einen Näherungsschalter	Tradename for a type of proximity switch
BI	Binektoreingang	Binector Input
BIA	Berufsgenossenschaftliches Institut für Arbeitssicherheit	German Institute for Occupational Safety
BICO	Binektor-Konnektor-Technologie	Binector Connector Technology
BLM	Basic Line Module	Basic Line Module
BOP	Basic Operator Panel	Basic Operator Panel
C		
C	Kapazität	Capacitance
C...	Safety-Meldung	Safety message
CAN	Serielles Bussystem	Controller Area Network
CBC	Kommunikationsbaugruppe CAN	Communication Board CAN
CD	Compact 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

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Abbreviation	Meaning, German	Meaning, English
CO/BO	Konnektor-/Binektorausgang	Connector Output/Binector Output
COB-ID	CAN Object-Identification	CAN Object-Identification
COM	Mittelkontakt eines Wechselkontaktes	Common contact of a change-over relay
CP	Kommunikationsprozessor	Communications Processor
CPU	Zentrale Recheneinheit	Central Processing Unit
CRC	Checksummenprüfung	Cyclic Redundancy Check
CSM	Control Supply Module	Control Supply Module
CU	Control Unit	Control Unit
D		
DAC	Digital-Analog-Konverter	Digital Analog Converter
DC	Gleichstrom	Direct Current
DCB	Drive Control Block	Drive Control Block
DCC	Drive Control Chart	Drive Control Chart
DCN	Gleichstrom negativ	Direct Current Negative
DCP	Gleichstrom positiv	Direct Current Positive
DDS	Antriebsdatensatz	Drive Data Set
DI	Digitaleingang	Digital Input
DI/DO	Digitaleingang/-ausgang bidirektional	Bidirectional Digital Input/Output
DMC	DRIVE-CLiQ Module Cabinet (Hub)	DRIVE-CLiQ Module Cabinet (Hub)
DO	Digitalausgang	Digital Output
DO	Antriebsobjekt	Drive Object
DP	Dezentrale Peripherie	Decentralized Peripherals (Distributed I/Os)
DPRAM	Speicher mit beidseitigem Zugriff	Dual-Port Random Access Memory
DRAM	Dynamischer Speicher	Dynamic Random Access Memory
DRIVE-CLiQ	Drive Component Link with IQ	Drive Component Link with IQ
DSC	Dynamic Servo Control	Dynamic Servo Control
D		
EASC	Externer Ankerkurzschluss	External Armature Short-Circuit
EDS	Geberdatensatz	Encoder Data Set
EGB	Elektrostatisch gefährdete Baugruppen	Electrostatic Sensitive Devices (ESD)
ELP	Erdschlussüberwachung	Earth Leakage Protection
EMK	Elektromagnetische Kraft	Electromagnetic Force (EMF)
EMV	Elektromagnetische Verträglichkeit	Electromagnetic Compatibility (EMC)
EN	Europäische Norm	European Standard
EnDat	Geber-Schnittstelle	Encoder-Data-Interface
EP	Impulsfreigabe	Enable Pulses
EPOS	Einfachpositionierer	Basic positioner
ES	Engineering System	Engineering System
ESB	Ersatzschaltbild	Equivalent circuit diagram
ESR	Erweitertes Stillsetzen und Rückziehen	Extended Stop and Retract
F		

Abbreviation	Meaning, German	Meaning, English
F...	Störung	Fault
FAQ	Häufig gestellte Fragen	Frequently Asked Questions
FBL	Freie Funktionsblöcke	Free Blocks
FCC	Function Control Chart	Function Control Chart
FCC	Flussstromregelung	Flux Current Control
F-DI	Fehlersicherer Digitaleingang	Failsafe Digital Input
F-DO	Fehlersicherer Digitalausgang	Failsafe Digital Output
FEM	Fremderregter Synchronmotor	Separately excited synchronous motor
FEPROM	Schreib- und Lesespeicher nichtflüchtig	Flash-EPROM
FG	Funktionsgenerator	Function Generator
FI	Fehlerstrom-Schutzschalter	Earth Leakage Circuit-Breaker (ELCB)
FP	Funktionsplan	Function diagram
FPGA	Field Programmable Gate Array	Field Programmable Gate Array
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
HLG	Hochlaufgeber	Ramp-function generator
HMI	Mensch-Maschine-Schnittstelle	Human Machine Interface
HTL	Logik mit hoher Störschwelle	High-Threshold Logic
HW	Hardware	Hardware
I		
i. V.	In Vorbereitung: diese Eigenschaft steht zur Zeit nicht zur Verfügung	In preparation: this feature is currently not available
I/O	Eingang/Ausgang	Input/Output
IASC	Interner Ankerkurzschluss	Internal Armature Short-Circuit
IBN	Commissioning	Commissioning
ID	Identifizierung	Identifier
IEC	Internationale Norm in der Elektrotechnik	International Electrotechnical Commission
IF	Interface	Interface
IGBT	Bipolartransistor mit isolierter Steuerelektrode	Insulated Gate Bipolar Transistor
IL	Impulslöschung	Pulse suppression
IPO	Interpolatortakt	Interpolator clock
IT	Drehstromversorgungsnetz ungeerdet	Insulated three-phase supply network
IVP	Interner Spannungsschutz	Internal Voltage Protection

Abbreviation	Meaning, German	Meaning, English
J		
JOG	Tippen	Jogging
K		
KDV	Kreuzweiser Datenvergleich	Data cross-checking
KIP	Kinetische Pufferung	Kinetic buffering
Kp	Proportionalverstärkung	Proportional gain
KTY	Spezieller Temperatursensor	Special temperature sensor
L		
L	Induktivität	Inductance
LED	Leuchtdiode	Light Emitting Diode
LIN	Linearmotor	Linear motor
LR	Lageregler	Position controller
LSB	Niederstwertiges Bit	Least Significant Bit
LSS	Netzschalter	Line Side Switch
LU	Längeneinheit	Length Unit
LWL	Lichtwellenleiter	Fiber-optic cable
M		
M	Masse	Reference potential, zero potential
MB	Megabyte	Megabyte
MCC	Motion Control Chart	Motion Control Chart
MDS	Motordatensatz	Motor Data Set
MLFB	Maschinenlesbare Fabrikatebezeichnung	Machine-readable product designation
MMC	Mensch-Maschine-Kommunikation	Man-Machine Communication
MSB	Höchstwertiges Bit	Most Significant Bit
MSCY_C1	Zyklische Kommunikation zwischen Master (Klasse 1) und Slave	Master Slave Cycle Class 1
MSC	Motorstromrichter	Motor power converter
MT	Messtaster	Measuring probe
N		
N. C.	Nicht angeschlossen	Not Connected
N...	Keine Meldung oder Interne Meldung	No Report
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regeltechnik in der chemischen Industrie	Standardization association for instrumentation and control in the chemical industry
NC	Öffner	Normally Closed (contact)
NC	Numerische Steuerung	Numerical Control
NEMA	Normengremium in USA (United States of America)	National Electrical Manufacturers Association
NM	Nullmarke	Zero Mark
NO	Schließer	Normally Open (contact)
NSR	Netzstromrichter	Line power converter
O		
OA	Open Architecture	Open Architecture
OEM	Original Equipment Manufacturer	Original Equipment Manufacturer

Abbreviation	Meaning, German	Meaning, English
OLP	Busstecker für Lichtleiter	Optical Link Plug
OMI	Option Module Interface	Option Module Interface
P		
p...	Einstellparameter	Adjustable parameter
PB	PROFIBUS	PROFIBUS
PcCtrl	Steuerungshoheit	Master Control
PD	PROFIdrive	PROFIdrive
PDS	Leistungsteildatensatz	Power Unit Data Set
PE	Schutzerde	Protective Earth
PELV	Schutzkleinspannung	Protective Extra Low Voltage
PEM	Permanenterregter Synchronmotor	Permanent-magnet synchronous motor
PG	Programmiergerät	Programming terminal
PI	Proportional Integral	Proportional Integral
PID	Proportional Integral Differential	Proportional Integral Differential
PLC	Speicherprogrammierbare Steuerung (SPS)	Programmable Logic Controller (PLC)
PLL	Phase Locked Loop	Phase Locked Loop
PNO	PROFIBUS Nutzerorganisation	PROFIBUS user organization
PPI	Punkt zu Punkt Schnittstelle	Point to Point Interface
PRBS	Weißes Rauschen	Pseudo Random Binary Signal
PROFIBUS	Serieller Datenbus	Process Field Bus
PS	Stromversorgung	Power Supply
PSA	Power Stack Adapter	Power Stack Adapter
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
RJ45	Norm. Beschreibt eine 8-polige Steckverbindung mit Twisted-Pair Ethernet.	Standard. Describes an 8-pole plug connector with twisted pair Ethernet.
RKA	Rückkühlanlage	Recooling system
RO	Nur lesbar	Read Only
RPDO	Receive Process Data Object	Receive Process Data Object
RS232	Serielle Schnittstelle	Serial Interface
RS485	Norm. Beschreibt die Physik einer digitalen seriellen Schnittstelle.	Standard. Describes the physical characteristics of a digital serial interface.
RTC	Echtzeituhr	Real Time Clock
RZA	Raumzeigerapproximation	Space vector approximation (SVA)
S		

Abbreviation	Meaning, German	Meaning, English
S1	Dauerbetrieb	Continuous operation
S3	Aussetzbetrieb	Periodic duty
SBC	Sichere Bremsenansteuerung	Safe Brake Control
SBH	Sicherer Betriebshalt	Safe Operating Stop
SBR	Sichere Beschleunigungsüberwachung	Safe Acceleration Monitor
SCA	Sichere Nocke	Safe Cam
SE	Sicherer Software-Endschalter	Safe software limit switch
SG	Sicher reduzierte Geschwindigkeit	Safely reduced speed
SGA	Sicherheitsgerichteter Ausgang	Safety-related output
SGE	Sicherheitsgerichteter Eingang	Safety-related input
SH	Sicherer Halt	Safety standstill
SI	Safety Integrated	Safety Integrated
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
T		
TB	Terminal Board	Terminal Board
TIA	Totally Integrated Automation	Totally Integrated Automation
TM	Terminal Module	Terminal Module
TN	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
Tn	Nachstellzeit	Integral time
TPDO	Transmit Process Data Object	Transmit Process Data Object
TT	Drehstromversorgungsnetz geerdet	Grounded three-phase supply network
TTL	Transistor-Transistor-Logik	Transistor-Transistor Logic
Tv	Vorhaltezeit	Derivative-action time

Abbreviation	Meaning, German	Meaning, English
U		
UL	Underwriters Laboratories Inc.	Underwriters Laboratories Inc.
USV	Unterbrechungsfreie Stromversorgung	Uninterruptible Power Supply (UPS)
V		
VC	Vektorregelung	Vector Control
Vdc	Zwischenkreisspannung	DC link voltage
VdcN	Teilzwischenkreisspannung negativ	Partial DC link voltage negative
VdcP	Teilzwischenkreisspannung positiv	Partial DC link voltage positive
VDE	Verband Deutscher Elektrotechniker	Association of German Electrical Engineers
VDI	Verein Deutscher Ingenieure	Association of German Engineers
Vpp	Volt Spitze zu Spitze	Volt peak to peak
VSM	Voltage Sensing Module	Voltage Sensing Module
W		
WEA	Wiedereinschaltautomatik	Automatic restart
WZM	Werkzeugmaschine	Machine tool
X		
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
IR	Initial rounding
FR	Final rounding
CUD	Control Unit DC
RUT	Rampup time
Ia	Actual armature current value
IAlimit	Current limit
If	Actual field current value
ILG	Current at critical conduction
In	Rated current
Kp	P gain
La	Armature circuit inductance
Mlimit	Torque limit
Mact	Actual torque value
n	Speed
nact	Actual speed value
nmin	Minimum speed
NN	Normal zero
nsetp	Speed setpoint
Ra	Armature circuit resistance
RDT	Ramp-down time
Tn	Integral time
Tu	Ambient temperature
Ua	Armature voltage
Uf	Field voltage
ULine	Line voltage
USS	Universal serial interface
SICROWBAR	Overvoltage protection

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 unit:	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

The unit 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.

Services

Qualified personnel can perform repair work on your units 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.

Note

We would be grateful if you could specify the following unit data when contacting them with queries relating to this:

- Unit order number and serial number
- Software version
- Hardware version of electronics module CUD (printed on the component side)
- Hardware version and software 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	

540

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	

542

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	
WRP_US	Writing drive parameters (UNSIGNED SHORT INTEGER type)	17	
DCA	Diameter calculator	16	Technology
INCO	Axial winder moment of inertia	51	
TTCU	Winding characteristic	25	
OCA	Software cam group	8	
WBG	Wobble generator	50	

543

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 above 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)

    - Transfer the actual topology into the reference topology by setting p9905=1 or p9905=2. Power-up is continued.

- A memory card with a parameter data set, which comes from a SINAMICS DCM with a different MLFB is inserted in the drive

    - Accept the parameter data set by setting p9906=3. Power-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. Power-up is continued.

B.3   Feedback

We have made every effort to produce this manual error-free.
If you discover any errors, we would be grateful if you would inform us.
Please also give us your opinion of this manual and of our device.
Please send your suggestions, praise and criticism to your nearest Siemens regional office.
Many thanks!
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