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SINAMICS G150 NEMA

Converter Cabinet Units 150 HP (110 kW) to 800 HP (560 kW)

Operating Instructions

Edition 04/2014

Answers for industry.

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SINAMICS G150 NEMA Enclosed Drives

Operating Instructions

Preface

Safety instructions 1

Device overview 2

Mechanical installation 3

Electrical installation 4

Commissioning 5

Operation 6

Setpoint channel and closed-loop control 7

Output terminals 8

Functions, monitoring and protective functions 9

Diagnostics / faults and alarms 10

Maintenance and servicing 11

Technical specifications 12

Appendix A

Firmware Version V4.7

04/2014

A5E03586526A

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

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

Qualified Personnel

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

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Note the following:

⚠WARNING

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

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Disclaimer of Liability

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

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A5E03586526A
℗ 08/2014 Subject to change

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Preface

Structure of this documentation

The customer documentation comprises general and individual documentation.

The general documentation describes the topics that apply to all enclosed drives:

- **Operating Instructions**
  The Operating Instructions consist of the following sections:
  - Device description
  - Mechanical installation
  - Electrical installation
  - Commissioning guide
  - Description of function
  - Maintenance instructions
  - Technical specifications
- **List Manual**
  The List Manual consists of the following parts:
  - Parameter list
  - Function diagrams
  - Fault / alarm list
- **Documentation for Drive Control Chart (DCC)**
  - Programming and Operating Manual: DCC Editor description
  - Function Manual: Description of the standard DCC blocks

The individual documentation describes a specific configured enclosed drive and contains the following:

- Dimension drawing
  The dimension drawing documents the dimensions of the ordered enclosed drive.
- Layout diagram
  The layout diagram shows the components installed in the ordered enclosed drive along with the equipment identifiers and location designations.
- Circuit diagram
  The circuit diagram shows the electrical components installed in the ordered enclosed drive with the equipment identifiers and location designations, their interconnections, and the customer interfaces.
- Terminal diagram
  The terminal diagram shows all the customer terminals in the ordered enclosed drive and the associated internal wiring in the enclosed drive. This diagram documents the line-side target wiring.
- Spare parts list
  The spare parts list contains all the available spare parts for the ordered enclosed drive.
- Additional operating instructions
  The instructions for supplier components installed in the ordered enclosed drive are included as original documentation.

Technical support

Technical advice is available at the following address:

- techsupport.sea@siemens.com
  Phone: 1-800-333-7421
  Phone: +1 (423) 262-2522 (outside the U.S.)
- http://www.sea.siemens.com/support

Helpline for spare parts and repairs

- helpline.sea@siemens.com
  Phone: 1-800-241-4453
  Phone: +1 (770) 740-3505 (outside the U.S.)

Internet address

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

EMC limits for South Korea

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

The mandatory EMC limits for Korea correspond to the limits of EN 61800-3 (EMC product standard for adjustable speed electrical power drive systems) for category C2 or to limit class A, Group 1 according to EN 55011.
Compliance with the limits according to category C2 or class A, group 1 is achieved with suitable additional measures. Additional measures, such as the use of an additional RFI suppression filter (EMC filter), may be necessary.
In addition, measures for proper plant design to meet EMC requirements are described in detail in this manual and the "SINAMICS Low Voltage Configuration Manual".

Certification

Manufacturing sites for SINAMICS G150 NEMA have a UL listing for the manufacturing of Industrial Control Panels and Control Panel Enclosures:

- Siemens Industry Inc.
  100 Technology Dr, Alpharetta, GA 30005 USA
  UL file # E83449
- Siemens AG I DT LD S4
  Vogelweiherstrasse 1-15, 90441 Nuremberg, Germany
  UL file # E251147

Table of contents

Preface **5**

1 Safety instructions **19**

1.1 General safety instructions 19

1.2 Safety instructions for electromagnetic fields (EMF) 23

1.3 Handling electrostatic sensitive devices (ESD) 24

1.4 Industrial security 25

1.5 Residual risks of power drive systems 26

2 Device overview **29**

2.1 Chapter content 29

2.2 Applications, Features 29
2.2.1 Area of application 29
2.2.2 Features, quality, service 30

2.3 Design 31
2.3.1 Enclosed drive type A 32
2.3.2 Enclosed chassis type C 33

2.4 Block diagram 34

2.5 Nameplate 36

3 Mechanical installation **41**

3.1 Content of this chapter 41

3.2 Transportation and storage 41

3.3 Installation 43
3.3.1 Mechanical installation: checklist 44
3.3.2 Preparation 45
3.3.2.1 Requirements for installation location 45
3.3.2.2 Requirements on the levelness of the floor 46
3.3.2.3 Shipping and handling indicators 47
3.3.2.4 Unpacking 49
3.3.2.5 Required tools 49
3.3.3 Installation 50
3.3.3.1 Lifting the enclosure off the transport pallet 50
3.3.3.2 Disassembling the lifting hardware 51
3.3.3.3 Connection to the foundation 53
3.3.4 Changing the enclosure type, options M23 and M54 53
3.3.5 Motor connection from above (option M78) 54
3.3.6 Mechanical door lock (option M39) 55

4 Electrical installation 57

4.1 Content of this chapter 57
4.2 Checklist for electrical installation 58
4.3 Important safety precautions 63
4.4 Introduction to EMC 64
4.5 EMC-compliant design 66
4.6 Power connections 68
4.6.1 Cable lugs 69
4.6.2 Connection cross-sections, cable lengths 70
4.6.3 Connecting the motor and power cables 71
4.6.4 Adjusting the fan voltage (-T1-T10) 74
4.6.5 Adjusting the internal power supply (-A1 -T10, enclosed drive type A only) 76
4.6.6 Removing the connection clip for the basic interference suppression module for operation on an ungrounded / IT power network 77
4.7 External supply of the auxiliary supply from a secure line 82
4.7.1 115 V AC auxiliary supply 83
4.7.2 24 V DC auxiliary supply 83
4.8 Signal connections 83
4.8.1 Control Unit CU320-2 DP 83
4.8.2 Customer terminal module 99
4.8.2.1 Customer terminal block (-A60) (for types A and C) 101
4.8.2.2 Customer terminal block (-X65) (for type A with option G65) 103
4.8.2.3 Terminal descriptions 105
4.9 Other connections 111
4.9.1 dv/dt filter plus Voltage Peak Limiter (option L10) 112
4.9.2 Input contactor (Option L13) 115
4.9.3 Feeder for external auxiliaries / motor blower (option L17) 115
4.9.4 3-contactor bypass (option L29) 117
4.9.5 Soft starter bypass (option L30) 118
4.9.6 Enclosure light with service socket (option L50) 120
4.9.7 Enclosure space heater (option L55) 120
4.9.8 ALL STOP, coast to stop (Option N55) 121
4.9.9 EMERGENCY OFF category 0; 115 V AC or 24 V DC (option N57) 122
4.9.10 EMERGENCY STOP category 1; 115 V AC (option N59) 123
4.9.11 EMERGENCY STOP category 1; 24 V DC (option L60) 125
4.9.12 25-kW braking unit (option L61); 50-kW braking unit (option L62) 126
4.9.12.1 Commissioning 130
4.9.12.2 Diagnostics and duty cycles 131
4.9.12.3 Threshold switch 131
4.9.13 Line-side surge arrester (option L96) 136
4.9.14 RTD monitor (option L97) 136
4.9.15 Insulation monitor (option L87) 137
4.9.16 Control power supply, 115 V AC, 5 A (option N70) 140
4.9.17 CAN Communication Board CBC10 (option G20) 141
4.9.18 PROFINET Communication Board CBE20 (option G33) 144
4.9.19 Temperature sensor module TM150 (option G51) 147
4.9.19.1 Description 147
4.9.19.2 Connecting 148

4.9.19.3 Connection examples 151
4.9.20 Sensor Module Cabinet-Mounted SMC30 (option K50) 153
4.9.20.1 Description 153
4.9.20.2 Connection 157
4.9.20.3 Connection examples 161
4.9.21 Voltage Sensing Module for determining the actual motor speed and the phase angle (option K51) 162
4.9.22 Additional SMC30 Sensor Module Cabinet-Mounted (option K52) 163
4.9.23 Additional customer terminal block TM31 (option G61) 163
4.9.24 TM31 wired to customer terminal block (option G65) 164
4.9.25 Safety license for 1 axis (option K01) 164
4.9.26 Terminal module for activation of "Safe Torque Off" and "Safe Stop 1" (option K82) 165
4.9.27 TM54F Terminal Module (option K87) 166
4.9.28 Safe Brake Adapter SBA 230 V AC (option K88) 168
4.9.29 Control Unit CU320-2 PN (option K95) 169

5 Commissioning 183

5.1 Chapter content 183

5.2 The STARTER commissioning tool 184
5.2.1 Installing the STARTER commissioning tool 186
5.2.2 Layout of the STARTER user interface 187

5.3 Procedure for commissioning via STARTER 188
5.3.1 Creating the project 188
5.3.2 Configuring the drive unit 196
5.3.3 Transferring the drive project 220
5.3.4 Commissioning with STARTER via Ethernet 222

5.4 Operator panel AOP30 228

5.5 First commissioning with the AOP30 229
5.5.1 Initial startup 229
5.5.2 Basic commissioning 231

5.6 Status after commissioning 240

5.7 Commissioning an encoder with gear factor 241

5.8 Parameter reset to factory settings 241

6 Operation 243

6.1 Chapter content 243

6.2 General information about command and setpoint sources 244

6.3 Basic information about the drive system 245
6.3.1 Parameters 245
6.3.2 Drive objects 248
6.3.3 Data sets 249
6.3.4 BICO technology: Interconnecting signals 255
6.3.5 Propagation of faults 260

6.4 Command sources 261
6.4.1 "PROFIdrive" default setting 261
6.4.2 "TM31 terminals" default setting 263

6.5 Setpoint sources 265

6.5.1 Analog inputs ... 265
6.5.2 Motorized potentiometer ... 267
6.5.3 Fixed speed setpoints ... 268

6.6 Control via the operator panel ... 270
6.6.1 Operator panel (AOP30) overview and menu structure ... 270
6.6.2 Operation screen menu ... 272
6.6.3 Parameterization menu ... 273
6.6.4 Fault/alarm memory menu ... 275
6.6.5 Commissioning/service menu ... 276
6.6.5.1 Drive commissioning ... 276
6.6.5.2 Device commissioning ... 276
6.6.5.3 Drive diagnostics ... 277
6.6.5.4 AOP settings ... 279
6.6.5.5 AOP diagnostics ... 285
6.6.6 Language selection ... 287
6.6.7 Operation via the operator panel (LOCAL mode) ... 287
6.6.7.1 LOCAL/REMOTE key ... 288
6.6.7.2 ON key / OFF key ... 288
6.6.7.3 CCW/CW selection ... 289
6.6.7.4 Jog ... 289
6.6.7.5 Increase setpoint / decrease setpoint ... 289
6.6.7.6 AOP setpoint ... 290
6.6.7.7 Timeout monitoring ... 291
6.6.7.8 Operator input inhibit / Parameterization inhibit ... 291
6.6.8 Faults and alarms ... 293
6.6.9 Saving the parameters permanently ... 295
6.6.10 Parameterization errors ... 295

6.7 Communication according to PROFIdrive ... 296
6.7.1 General information ... 296
6.7.2 Application classes ... 298
6.7.3 Cyclic communication ... 303
6.7.3.1 Message frames and process data ... 303
6.7.3.2 Structure of the message frames ... 306
6.7.3.3 Overview of control words and setpoints ... 306
6.7.3.4 Overview of status words and actual values ... 307
6.7.4 Acyclic communication ... 307
6.7.4.1 Structure of requests and responses ... 309
6.7.4.2 Determining the drive object numbers ... 315
6.7.4.3 Example 1: Reading parameters ... 315
6.7.4.4 Example 2: Writing parameters (multi-parameter request) ... 317
6.7.5 Further information about PROFIdrive communication ... 321

6.8 Communication via PROFIBUS DP ... 321
6.8.1 PROFIBUS port ... 321
6.8.2 Control via PROFIBUS ... 326
6.8.3 Monitoring: Message frame failure ... 328
6.8.4 Further information about communication via PROFIBUS DP ... 329

6.9 Communication via PROFINET IO ... 330
6.9.1 Activating online operation: STARTER via PROFINET IO ... 330
6.9.2 General information about PROFINET IO ... 334
6.9.2.1 General information about PROFINET IO for SINAMICS ... 334

6.9.2.2 Real-time (RT) and isochronous real-time (IRT) communication 335
6.9.2.3 Addresses 336
6.9.2.4 Data transmission 338
6.9.2.5 Communication channels 339
6.9.3 PROFIenergy 340
6.9.3.1 Description 340
6.9.3.2 Tasks of PROFIenergy 342
6.9.3.3 PROFIenergy - Properties of the drive system 343
6.9.3.4 PROFIenergy - Commands 343
6.9.3.5 PROFIenergy - Measurement values 344
6.9.3.6 PROFIenergy - Energy-saving mode 345
6.9.3.7 Transition to energy-saving mode from PROFIdrive Operation state (S4) 345
6.9.3.8 Disabling PROFIenergy 345
6.9.3.9 PROFIenergy applications 345
6.9.3.10 Function diagrams and parameters 346
6.9.4 Further information about communication via PROFINET IO 346

6.10 Communication via SINAMICS Link 347
6.10.1 Basic principles of SINAMICS Link 347
6.10.2 Topology 349
6.10.3 Configuring and commissioning 350
6.10.4 Example 354
6.10.5 Communication failure when booting or in cyclic operation 356
6.10.6 Transmission times for SINAMICS Link 357
6.10.7 Function diagrams and parameters 358

6.11 Communication services and used port numbers 358

6.12 Parallel operation of communication interfaces 361

6.13 Engineering Software Drive Control Chart (DCC) 364

7 Setpoint channel and closed-loop control 365

7.1 Chapter content 365

7.2 Setpoint channel 366
7.2.1 Setpoint addition 366
7.2.2 Direction reversal 367
7.2.3 Skip frequency bands and minimum speed 368
7.2.4 Speed limiting 369
7.2.5 Ramp-function generator 370

7.3 V/f (V/Hz) control 374
7.3.1 Voltage boost 377
7.3.2 Resonance damping 380
7.3.3 Slip compensation 381

7.4 Vector speed/torque control with/without an encoder 383
7.4.1 Vector control without an encoder 384
7.4.2 Vector control with encoder 391
7.4.3 Actual speed value filter 392
7.4.4 Speed controller 393
7.4.4.1 Speed controller feedfoward control (integrated feedfoward control with balancing) 396
7.4.4.2 Reference model 399
7.4.4.3 Speed controller adaptation 400
7.4.4.4 Droop 402

7.4.4.5 Open actual speed value ... 403
7.4.5 Torque control ... 405
7.4.6 Torque limiting ... 408
7.4.7 Current setpoint filter ... 409
7.4.8 Permanent-magnet synchronous motors ... 410

8 Output terminals ... 415

8.1 Chapter content ... 415

8.2 Analog outputs ... 416
8.2.1 List of signals for the analog signals ... 417

8.3 Digital outputs ... 419

9 Functions, monitoring and protective functions ... 421

9.1 Content of this chapter ... 421

9.2 Drive functions ... 422
9.2.1 Motor data identification and automatic speed controller optimization ... 422
9.2.1.1 Motor data identification ... 423
9.2.1.2 Rotating measurement and speed controller optimization ... 426
9.2.1.3 Shortened rotating measurement ... 428
9.2.1.4 Parameters ... 429
9.2.2 Efficiency optimization ... 429
9.2.3 Fast magnetization for induction motors ... 431
9.2.4 Vdc control ... 433
9.2.5 Automatic restart function ... 438
9.2.6 Flying restart ... 441
9.2.6.1 Flying restart without an encoder ... 442
9.2.6.2 Flying restart with an encoder ... 445
9.2.6.3 Parameters ... 446
9.2.7 Motor changeover ... 447
9.2.7.1 Description ... 447
9.2.7.2 Example of changing over between two motors ... 447
9.2.7.3 Function diagrams ... 448
9.2.7.4 Parameter ... 449
9.2.8 Friction Characteristic ... 449
9.2.9 Armature short-circuit braking, DC braking ... 451
9.2.9.1 General information ... 451
9.2.9.2 External armature short-circuit braking ... 451
9.2.9.3 Internal armature short-circuit braking ... 453
9.2.9.4 DC braking ... 454
9.2.10 Increasing the output frequency ... 456
9.2.10.1 Description ... 456
9.2.10.2 Default pulse frequencies ... 457
9.2.10.3 Increasing the pulse frequency ... 457
9.2.10.4 Maximum output frequency achieved by increasing the pulse frequency ... 458
9.2.10.5 Parameter ... 458
9.2.11 Derating behavior with increased pulse frequency ... 459
9.2.12 Pulse frequency wobbling ... 460
9.2.13 Runtime (operating hours counter) ... 462
9.2.14 Simulation mode ... 463
9.2.15 Direction reversal ... 465
9.2.16 Switching unit systems (SI/US/%) ... 466

9.2.17 Simple brake control 468
9.2.18 Synchronization 470
9.2.19 Energy savings indicator for pumps, fans, and compressors 472
9.2.20 Write protection 475
9.2.21 Know-how protection 477
9.2.21.1 Description 477
9.2.21.2 Activating know-how protection 479
9.2.21.3 Deactivating know-how protection 480
9.2.21.4 Changing the know-how protection password 481
9.2.21.5 OEM exception list 481
9.2.21.6 Memory card copy protection 482
9.2.21.7 Spare part replacement when know-how protection with copy protection is activated 482
9.2.21.8 Overview of important parameters 483
9.2.22 Emergency operation 484
9.2.23 Web server 487
9.2.23.1 Description 487
9.2.23.2 Starting the Web server 489
9.2.23.3 Web server configuration 491
9.2.23.4 Display areas 492
9.2.23.5 Overview of important parameters 494

9.3 Extended functions 494
9.3.1 Technology controller 494
9.3.2 Bypass function 497
9.3.2.1 Synchronized bypass with overlap (p1260 = 1) 498
9.3.2.2 Synchronized bypass without overlap (p1260 = 2) 500
9.3.2.3 Bypass without synchronization (p1260 = 3) 502
9.3.2.4 Function diagram 504
9.3.2.5 Parameters 505
9.3.3 Extended brake control 506
9.3.4 Extended monitoring functions 510

9.4 Monitoring functions and protective functions 513
9.4.1 Power unit protection, general 513
9.4.2 Thermal monitoring and overload responses 514
9.4.3 Blocking protection 516
9.4.4 Stall protection (vector control only) 517
9.4.5 Thermal motor protection 518
9.4.5.1 Description 518
9.4.5.2 Temperature sensor connection to customer terminal module TM31 (option G60) 518
9.4.5.3 Temperature sensor connection to a sensor module (option K50) 519
9.4.5.4 Temperature sensor connection directly to the control interface module 519
9.4.5.5 Temperature sensor evaluation 520
9.4.5.6 Thermal motor models 521
9.4.5.7 Function diagram 522
9.4.5.8 Parameter 523
9.4.6 Temperature measurement via TM150 (option G51) 524
9.4.6.1 Description 524
9.4.6.2 Measurement with up to 6 channels 526
9.4.6.3 Measurement with up to 12 channels 526
9.4.6.4 Forming groups of temperature sensors 527
9.4.6.5 Evaluation of temperature channels 528
9.4.6.6 Function diagram 529

9.4.6.7 Parameters ... 529

10 Diagnostics / faults and alarms ... 531

10.1 Chapter content ... 531

10.2 Diagnostics ... 532
10.2.1 Diagnostics via LEDs ... 532
10.2.2 Diagnostics via parameters ... 540
10.2.3 Indicating and rectifying faults ... 543

10.3 Overview of alarms and faults ... 544
10.3.1 "External alarm 1" ... 545
10.3.2 "External fault 1" ... 545
10.3.3 "External fault 2" ... 546
10.3.4 "External fault 3" ... 546

11 Maintenance and servicing ... 547

11.1 Chapter content ... 547

11.2 Maintenance ... 548
11.2.1 Cleaning ... 548

11.3 Servicing ... 549
11.3.1 Installation device ... 551
11.3.2 Using lifting lugs to transport power blocks ... 552

11.4 Replacing components ... 554
11.4.1 Replacing the filter mats ... 554
11.4.2 Replacing the Control Interface Module, frame size FX ... 555
11.4.3 Replacing the Control Interface Module, frame size GX ... 557
11.4.4 Replacing the Control Interface Module, frame size HX ... 559
11.4.5 Replacing the Control Interface Module, frame size JX ... 561
11.4.6 Replacing the power block, frame size FX ... 563
11.4.7 Replacing the power block, frame size GX ... 566
11.4.8 Replacing the power block, frame size HX ... 569
11.4.9 Replacing the power block, frame size JX ... 574
11.4.10 Replacing the fan, frame size FX ... 579
11.4.11 Replacing the fan, frame size GX ... 581
11.4.12 Replacing the fan, frame size HX ... 583
11.4.13 Replacing the fan, frame size JX ... 587
11.4.14 Replacing cylindrical fuses ... 591
11.4.15 Replacing the LV HRC fuses ... 592
11.4.16 Replacing the door-mounted operator panel ... 594
11.4.17 Replacing the backup battery for the door-mounted operator panel ... 594

11.5 Forming the DC link capacitors ... 596

11.6 Messages after replacement of DRIVE-CLiQ components ... 597

11.7 Upgrading the drive firmware ... 598

11.8 Downloading new operator panel firmware from the PC ... 599

12 Technical specifications 601

12.1 Chapter content 601

12.2 General specifications 602
12.2.1 Derating data 603
12.2.2 Overload capability 607

12.3 Technical specifications 608
12.3.1 Enclosed drive type A, 380 V - 480 V 3 AC 608
12.3.2 Enclosed chassis type C, 380 V - 480 V 3 AC 612
12.3.3 Enclosed drive type A, 500 V - 600 V 3 AC 618
12.3.4 Enclosed chassis type C, 500 V - 600 V 3 AC 621

A Appendix 627

A.1 Acronyms and abbreviations 627

A.2 Parameter macros 629

Index 641

Safety instructions

1

1.1 General safety instructions



DANGER

Lockout/Tagout is designed for your safety

Lockout/Tagout is a safety procedure that neutralizes and secures hazardous energy in a machine, device, or system so that employees can work on it safely. Lockout/Tagout rules and procedures are found in OSHA regulation - 29 CFR 1910.147 - The Control of Hazardous Energy (Lockout/Tagout). You can read the regulation on the OSHA website: http://www.osha.gov.

These are the 6 steps for accomplishing lockout/tagout

1. **Prepare for shutdown**
   This includes notifying team members who will be affected by the procedure.
2. **Shut down the machine**
   This may involve reviewing the procedure to make sure that it was done correctly.
3. **Identify all the hazardous energy sources**
   Electricity is just one source. Be sure to identify "hidden" sources of energy, these may be residual energy or stored energy sources.
4. **Isolate or neutralize all hazardous energy sources**
   This includes closing switches, grounding or short-circuiting, closing valves, and other actions.
5. **Lockout the energy sources**
   This is usually done at the same time you perform step 4. Be sure to neutralize the residual energy and stored energy sources.
6. **Verify your lockout procedure**
   Make sure that the machine is completely locked out…and that you have the right machine!



DANGER

Danger to life due to live parts and other energy sources

Death or serious injury can result when live parts are touched.

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

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify all those who will be affected by the procedure.
2. Disconnect the machine from the voltage supply.
   - Switch off the machine.
   - Wait until the discharge time specified on the warning labels has elapsed.
   - Verify the zero-voltage state, from phase conductor to phase conductor and phase conductor to protective earth.
   - Check to determine whether any auxiliary circuits are de-energized.
   - Ensure that the motors cannot move.
3. Identify all other dangerous energy sources, e.g., compressed air, hydraulic, or water.
4. Isolate or neutralize all hazardous energy sources, for example by closing switches, grounding or short-circuiting, or closing valves.
5. Take measures to prevent reconnection of the energy sources.
6. Ensure that the correct machine is completely interlocked.

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



WARNING

Danger to life due to hazardous voltage when an unsuitable power supply is connected

Death or serious injury can result when live parts are touched in the event of a fault.

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



⚠ WARNING

Danger to life from touching live parts on damaged devices

Improper handling of devices can damage them.

In the case of damaged devices, hazardous voltages can be present at the enclosure or at exposed components. If touched, these can result in death or severe injury.

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



⚠ WARNING

Danger to life from electric shock due to unconnected cable shields

Hazardous contact voltages can occur as a result of capacitive cross-coupling due to unconnected cable shields.

- Connect cable shields and unused cores of power cables at least at one end at the grounded enclosure potential.



⚠ WARNING

Danger to life from electric shock when device is not grounded

When the protective earth connection of devices with protection class I is missing or incorrectly implemented, high voltages can be present at open, exposed parts. When touched, these can result in death or serious injury.

- Ground the device in compliance with the applicable regulations.



⚠ WARNING

Danger to life from electric shock when plug-in connections are disconnected during operation

When plug-in connections are disconnected during operation, arcs can result in serious injury or death.

- Only open plug-in connections when the equipment is de-energized, unless it has been explicitly stated that they can be disconnected during operation.

⚠ WARNING

Danger to life from spread of fire with inadequate enclosures

Fire and smoke generation can cause serious injury or property damage.

- Install devices without protective enclosures in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire inside and outside the device is prevented.
- Ensure that smoke can escape via designated paths.

⚠ WARNING

Danger to life due to unexpected movement of machines when mobile radio units or mobile phones are used

When mobile radio units or mobile phones with a transmitting power > 1 W are used at distances less than approximately 2 m from the components, device malfunctions can occur that can affect the functional safety of machines and thus endanger people or cause property damage.

- Switch off radio units and mobile phones in the direct vicinity of the components.

⚠ WARNING

Danger to life from motor fire when insulation is overloaded

A ground fault in an IT system produces greater stress on the motor insulation. A possible result is breakdown of the insulation with a risk of personnel injury due to smoke generation and fire.

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

⚠ WARNING

Danger to life from fire when overheating occurs because of inadequate ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk of personnel injury due to smoke generation and fire. In addition to this, failures may increase and the service life of devices/systems may be reduced.

- Ensure compliance with the specified minimum clearances as ventilation clearances for the respective component. These can be found in the dimension drawings or in the "Product-specific safety instructions" at the start of the respective section.

⚠ WARNING

Risk of accident due to missing or illegible warning labels

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

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

- Disconnect the devices before carrying out a voltage/insulation test of the machine/system, because all drives and motors have been high voltage-tested at the manufacturer, and therefore it is not necessary to perform an additional test within the machine/system.

⚠ WARNING

Danger to life due to inactive safety functions

Inactive or non-adapted safety functions can trigger machine malfunctions that can cause serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- For safety-relevant functions, carry out a safety analysis of the entire system, including all safety-relevant components.
- Assign parameters appropriately to ensure that the utilized safety functions are adapted to your drives and automation tasks and are activated.
- Perform a function test.
- Only put your plant into productive operation after you have ensure the correct sequence of the safety-relevant functions.

Note

Important safety instructions for Safety Integrated functions

If you want to use Safety Integrated functions, you must observe the safety instructions in the Safety Integrated manuals.

1.2 Safety instructions for electromagnetic fields (EMF)



⚠ WARNING

Danger to life due to electromagnetic fields

Power engineering equipment such as transformers, frequency converters, and motors generate electromagnetic fields (EMF) during operation.

Individuals with pacemakers or implants, in particular, are at risk when they are in the immediate vicinity of these devices/systems.

- Ensure that such persons maintain the necessary distance (at least 2 m).

1.3 Handling electrostatic sensitive devices (ESD)

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



NOTICE

Damage caused by electric fields or electrostatic discharge

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

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

The necessary ESD protective measures are clearly illustrated in the following diagram:

- a = conductive floor surface
- b = ESD table
- c = ESD shoes
- d = ESD overall
- e = ESD wristband
- f = enclosure ground connection
- g = contact with conductive flooring

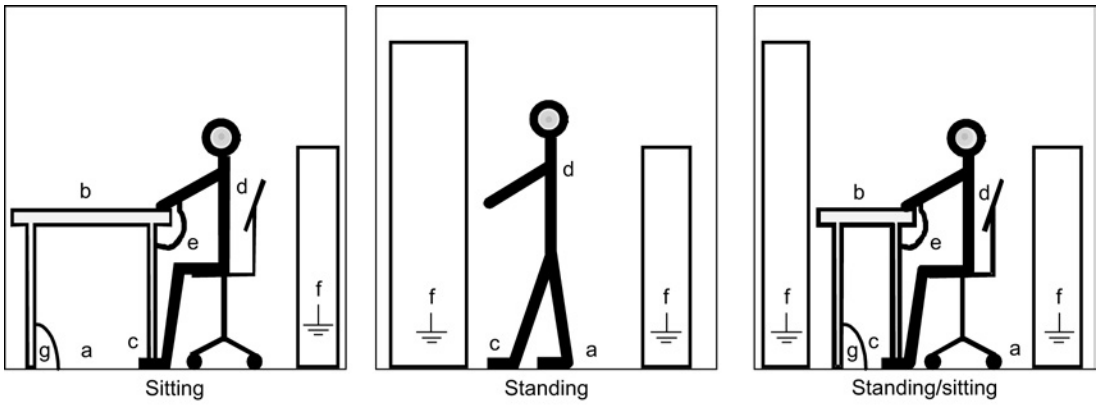


Figure 1-1 ESD protective measures

1.4 Industrial security

Note

Industrial security

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit Hotspot-Text (http://www.siemens.com/industrialsecurity).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit Hotspot-Text (http://support.automation.siemens.com).

WARNING

Danger as a result of unsafe operating states resulting from software manipulation

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can result in death, severe injuries and/or material damage.

- Keep the software up to date.

  You will find relevant information and newsletters at this address (http://support.automation.siemens.com).
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.

  You will find further information at this address (http://www.siemens.com/industrialsecurity).
- Make sure that you include all installed products into the holistic industrial security concept.

1.5 Residual risks of power drive systems

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

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

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

When performing the risk assessment for its machine in accordance with the respective local regulations (e.g., EC Machinery Directive), the machine manufacturer must take into account the following residual risks associated with the control and drive components of a power drive system:

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware faults and/or software errors in sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions outside of specification
   - Condensation/conductive contamination
   - Parameter assignment, programming, cabling, and installation errors
   - Use of radio units/mobile phones in the immediate vicinity of the controller
   - External influences / damage
2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the drive in the event of a fault caused, for example, by:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions outside of specification
   - External influences / damage

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

3. Shock-hazard voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions outside of specification
   - Condensation/conductive contamination
   - External influences / damage
4. Electric, magnetic, and electromagnetic fields generated during operation that can pose a risk to individuals with pacemakers, implants, or metal replacement joints if they fail to maintain sufficient distance
5. Release of environmental pollutants or emissions as a result of improper operation and/or improper disposal of components

Note

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

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

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

Device overview

2

2.1 Chapter content

This chapter provides information on the following:

- Introduction to the enclosed drives
- The main components and features of the enclosed drives
- The drive wiring
- Explanation of the nameplate

2.2 Applications, Features

2.2.1 Area of application

SINAMICS G150 NEMA enclosed drives are specially designed to meet the requirements of drives for the North American market for loads with quadratic and constant torque characteristics, medium performance requirements, and no regenerative feedback. Applications include:

- Pumps and fans
- Compressors
- Extruders and mixers
- Grinders

2.2.2 Features, quality, service

Features

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

Optionally, applications with system-specific requirements for an encoder can use a speed feedback encoder (requires optional interface module).

SINAMICS G150 NEMA takes this into account specifically and offers a low-cost drive solution tailored to the actual requirements.

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

- Compact, modular, service-friendly design
- Straightforward planning/design and commissioning thanks to the SIZER and STARTER tools
- Ready to connect to facilitate the installation process
- Quick, menu-driven commissioning with no complex parameter assignment
- Clear and convenient drive monitoring/diagnostics, commissioning and operation via a user-friendly graphic operator panel with measured values displayed in plain text or in a quasi-analog bar display.
- SINAMICS is an integral part of Totally Integrated Automation (TIA). The TIA concept offers an optimized range of products for automation and drive technology. This concept is characterized by planning/design, communication, and data management procedures that are consistent throughout the product range. SINAMICS is totally integrated in the TIA concept.
  Separate S7/PCS7 blocks and faceplates for WinCC are available.
- Integration in SIMATIC H systems is possible via a Y link.
- Drive Control Chart (DCC)
  Drive Control Chart (DCC) expands the facility for the simplest possible configuring of technological functions for the SINAMICS drive system.
  The block library encompasses a large selection of closed-loop, arithmetic and logic function blocks, as well as more comprehensive open-loop and closed-loop control functions. The user-friendly DCC editor enables easy graphical configuration and a clear representation of control loop structures as well as a high degree of reusability of existing diagrams. DCC is an add-on to the STARTER commissioning tool.

Quality

SINAMICS G150 NEMA converter enclosed drives are manufactured to meet high standards of quality and exacting demands.

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

The development, design, and manufacturing processes, as well as order processing and the logistics supply center have been independently certified to ISO 9001-2000.

Service

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

For detailed contact information and the current link to our Internet pages, refer to chapter "Diagnostics/Faults and Alarms", section "Service and Support".

2.3 Design

The SINAMICS G150 handling indicators feature a compact, modular, and service-friendly design.

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

Two types are offered depending on the options that are chosen.

2.3.1 Enclosed drive type A

Standard features include circuit breakers (per NEC motor feeder protection requirements), line fuses, and line reactors. Additional line side and load side components can also be installed as required. These include an input contactor, output reactor or filter, and additional protection and monitoring devices.

The enclosed drive comprises to two cabinets with a total width of between 39.4" (1000 mm) and 63" (1600 mm).



Figure 2-1 Example of an enclosed drive type A (e.g., 200 HP, 460 V 3 AC) (configuration and components shown may vary by type)

2.3.2 Enclosed chassis type C

This version is particularly compact in design an can be provided with an (optional) built-in line reactor.

It can be used, for example, when the power supply connection components, such as the input contactor and circuit-breaker disconnect as well as fuses for semi-conductor protection, are installed in an existing central low-voltage MCC.

Circuit breakers or line fuses are required as per NFPA 70: National Electrical Code® (NEC®). External circuit breakers (UL-listed) and line fuses are also required to ensure short-circuit strength (SCCR as per UL 508A) of the power converter.

The enclosed chassis simply comprises a single cabinet with a width of 15.8" (400 mm), 23.6" (600 mm), or 39.4" (1000 mm).

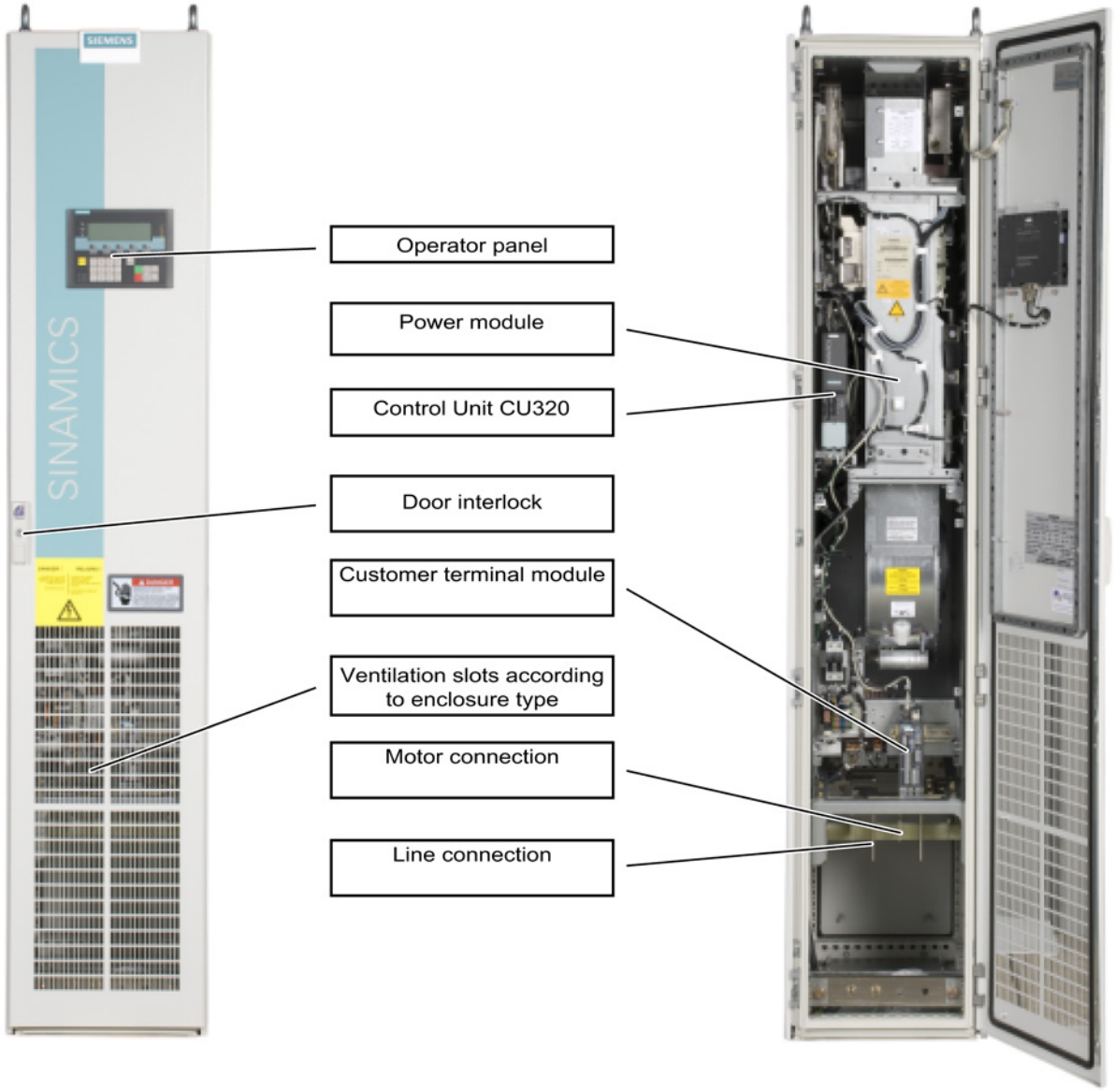


Figure 2-2 Example of an enclosed chassis type C (e.g., 250 HP, 460 V 3 AC) (configuration and components shown may vary by type)

2.4 Block diagram

Block diagram of enclosed drive type A

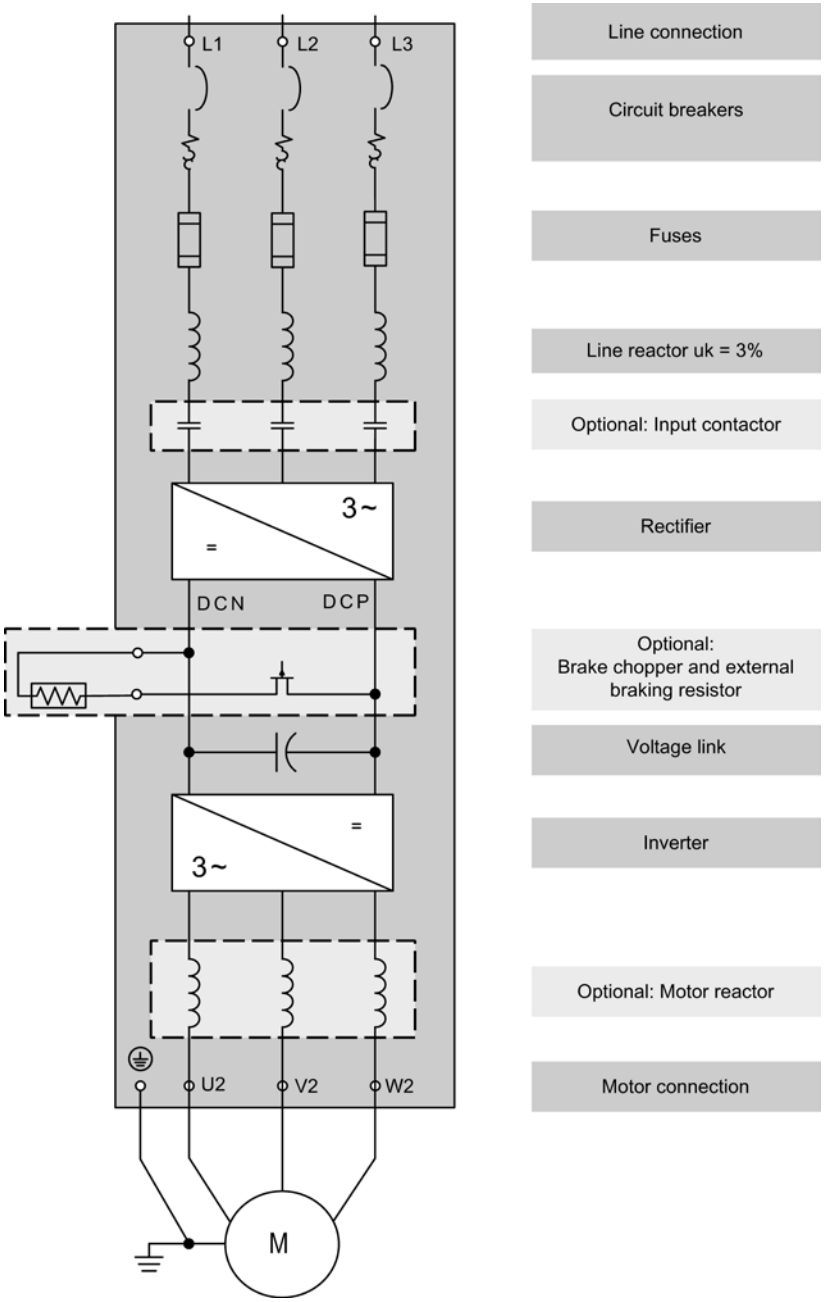


Figure 2-3 Block diagram of enclosed drive type A

Note

PE connection of the motor

The motor ground (PE) connection must be routed directly to the drive enclosure.

Block diagram of enclosed chassis type C

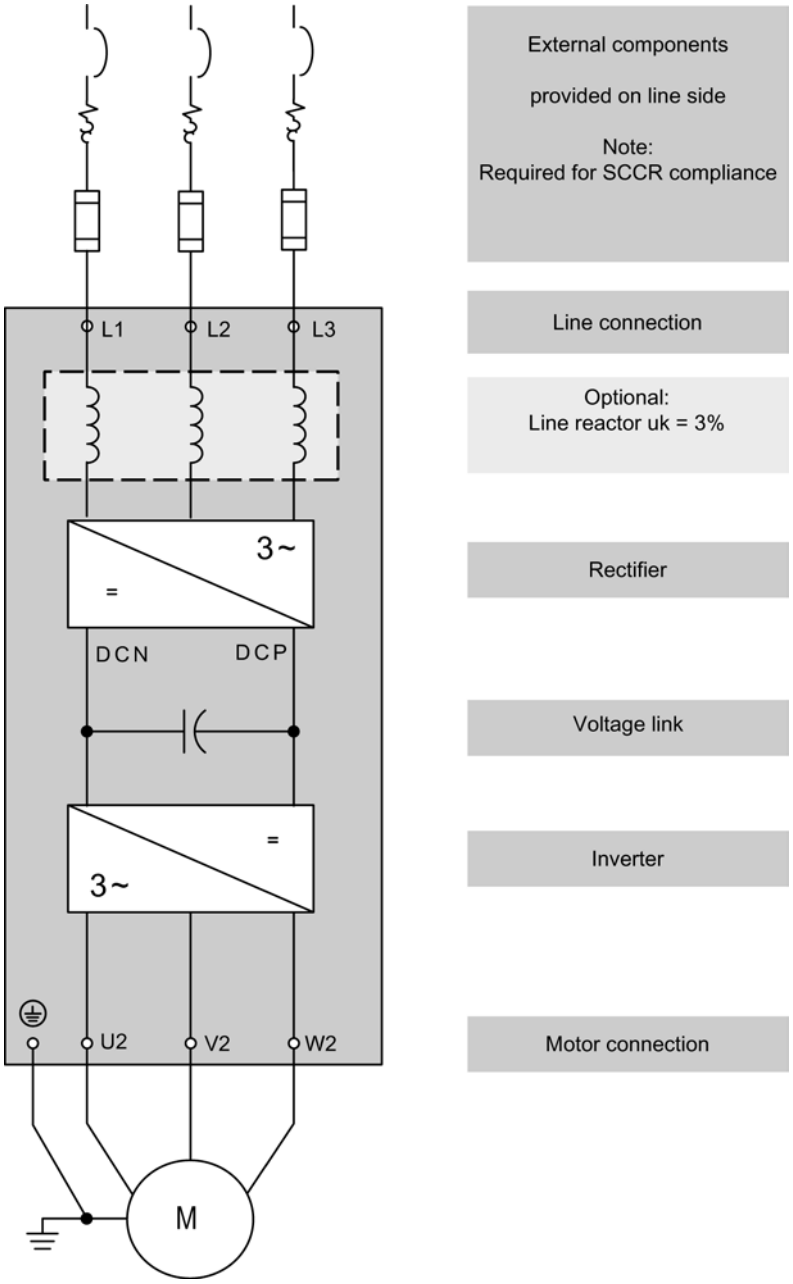


Figure 2-4 Block diagram of enclosed chassis type C

Note

PE connection of the motor

The motor ground (PE) connection must be routed directly to the drive enclosure.

2.5 Nameplate

Rating plate specifications

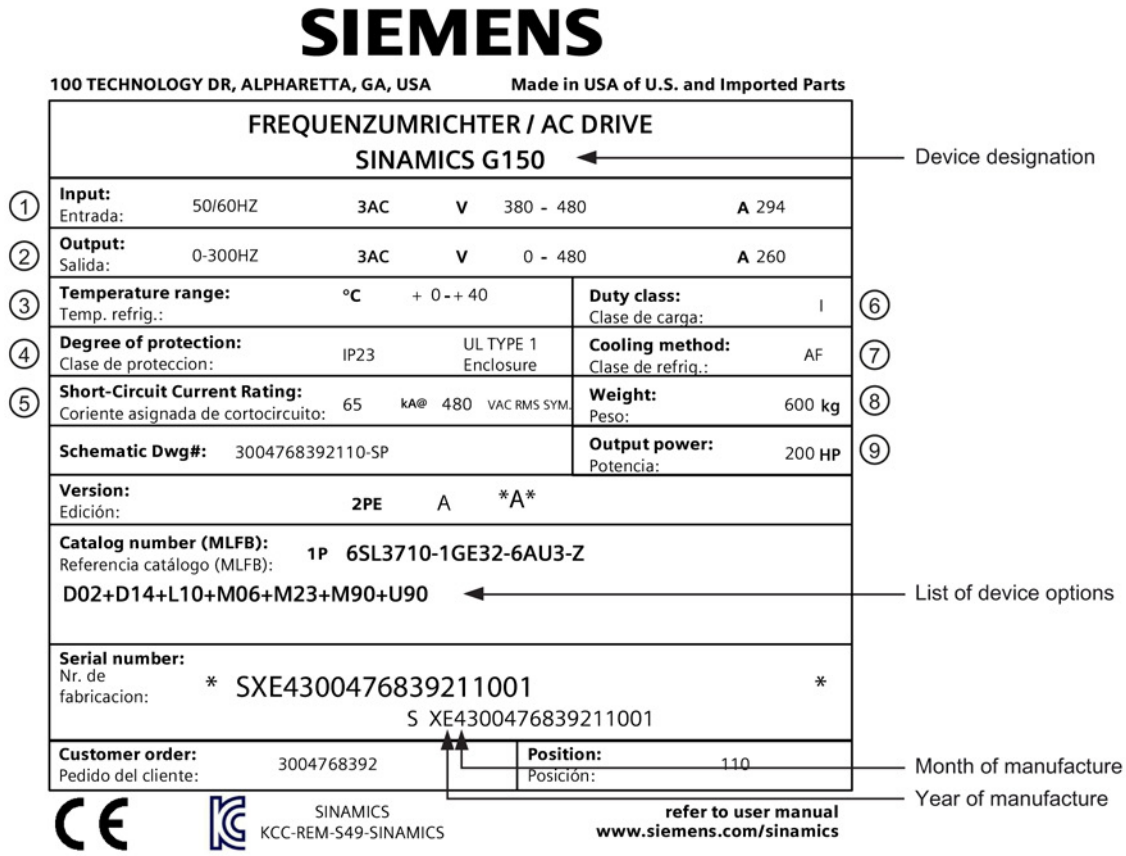


Figure 2-5 Rating plate on the enclosed drive

Rating plate specifications (from rating plate above)

Table 2- 1 Rating plate specifications

Item	Specification	Value	Description
①	Input	50/60HZ 3AC 380 ... 480 V 294 A	Line frequency 3-phase connection Rated input voltage Rated input current
②	Output	0-300HZ 3AC 0 ... 480 V 260 A	Output frequency 3-phase connection Rated output voltage Rated output current
③	Temperature range	+0 ... +40 °C	Ambient temperature range within which the enclosed drive can operate under 100% load
④	Degree of protection	IP23 UL TYPE 1 Enclosure	Enclosed drive degree of protection
⑤	Short-Circuit Current Rating	65 kA@480 VAC	SCCR per UL 508A: maximum permissible voltage for short circuit current
⑥	Duty class	I	I: Duty class I to IEC 60146-1-1 = 100% continuous (at the specified current values, the enclosed drive can operate continuously under 100% load)
⑦	Cooling method	AF	A: Cooling medium: air F: Circulation method: forced cooling, blower inside drive enclosure
⑧	Weight	600 kg	Weight of the enclosed drive
⑨	Output power	200 HP	Type rating

Date of manufacture

The date of manufacture can be determined as follows:

Table 2- 2 Production year and month

Letter/number	Year of manufacture		Letter/number	Month of manufacture
C	2012		1 ... 9	January to September
D	2013		O	October
E	2014		N	November
F	2015		D	December
H	2016			
J	2017			

Explanation of the option short codes

Table 2- 3 Explanation of the option short codes

		Enclosed drive type A	Enclosed chassis type C
Enclosure Options			
M06	Base (plinth), 4" (100 mm) high, RAL 7022	✓	✓
M07	Cable marshalling compartment 8" (200 mm) high, RAL 7035	✓	✓
M23	Enclosure NEMA 1 filtered	✓	✓
M39	Mechanical door lock (slam latch) [doors without c/b operator]	✓	-
M43	Enclosure IP43	✓	✓
M54	Enclosure NEMA 12 (ventilated) [requires current derate to 95 %]	✓	✓
M78	Motor-side top cable exit	✓	–
M90	Crane transport aid / eyebolts [Recommended: required to lift the drive off pallet]	✓	✓
Y09	Special enclosure paint color	✓	✓
Power options			
L08	Motor reactor	✓	–
L10	Output dv/dt filter with VPL [Requires add-on options cabinet]	✓	–
L13	Main contactor	✓	–
L22	Input line reactor not included in scope of delivery	✓	–
L23	Input line reactor uk = 3 %	–	✓
L61	Braking unit 25 kW/125 kW	✓	–
L62	Braking unit 50 kW/250 kW	✓	–
Miscellaneous Options			
L17	Feeder for external auxiliaries / motor blower, 460 or 575 V 3 ph. AC, max. 5 A	✓	–
L29	3-contactor bypass	✓	–
L30	Soft starter bypass	✓	–
L50	Cabinet lighting with power outlet, 120 V 1-ph. AC, 5 A	✓	–
L55	Cabinet anti-condensation heating	✓	✓
U90	UL listing per UL 508A [Requires M23, M43, or M54]	✓	✓
U91	cUL listing per UL 508A [Requires M23, M43, or M54]	✓	✓
Safety Integrated			
K01	Safety license for 1 axis	✓	–
K52	Additional SMC30 Sensor Module Cabinet-Mounted	✓	–
K82	Terminal module for controlling the "Safe Torque Off" and "Safe Stop 1" safety functions	✓	–
K87	TM54F Terminal Module	✓	–
K88	Safe Brake Adapter SBA 230 V AC	✓	–

		Enclosed drive type A	Enclosed chassis type C
Control options			
G20	CBC10 Communication Board (CANopen)	✓	✓
G33	CBE20 Communication Board with 4 x RJ45 ports	✓	✓
G51	TM150 Temperature Sensor Module	✓	✓
G61	Additional TM31 customer terminal module	✓	–
G65	TM31 wired to customer terminal block	✓	–
K50	SMC30 Sensor Module Cabinet-Mounted for speed measurement	✓	✓
K51	VSM10 Sensor Module Cabinet-Mounted	✓	–
K95	CU320-2 PN Control Unit	✓	✓
L87	Insulation monitor for ungrounded power networks	✓	–
L96	Line-side surge arrester	✓	–
L97	PT100 tripping unit (for 8 PT100)	✓	–
N55	ALL STOP, coast to stop	✓	–
N57	EMERGENCY OFF category 0, 120 V AC or 24 V DC, coast to stop	✓	–
N59	EMERGENCY STOP category 1, 120 V AC, controlled ramp-down	✓	–
N60	EMERGENCY STOP category 1, 24 V DC, controlled ramp-down	✓	–
N70	Control power supply, 120 V AC, 5 A	✓	–
Documentation & Languages			
D02	Customer drawings in DXF format	✓	✓
D04	Customer documentation in paper format, one set	✓	✓
D14	Advance copy of customer documentation (PDF)	✓	✓
D58	Documentation, English/French	✓	✓
D76	Additional manual, English	✓	✓
D77	Additional manual, French	✓	✓
D78	Additional manual, Spanish	✓	✓
T58	Rating plate data in English/French	✓	✓
Drive acceptance test in customer's presence (not shown on the rating plate)			
F03	Visual acceptance test	✓	✓
F71	Function test of the drive without motor connected	✓	✓
F75	Function test of the drive with test bay motor (no load)	✓	✓
F77	Insulation test of drive	✓	✓
F97	Witnessed customer-specific drive-acceptance test (on request)	✓	✓

✓ indicates that this option is available for that drive type.

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

Mechanical installation 3

3.1 Content of this chapter

This chapter provides information on the following:

- The conditions for transporting, storing, and installing the enclosed drives
- Preparing and installing the drives

3.2 Transportation and storage

Transport

⚠ WARNING

Danger to life due to improper transport of the device

The device can tip over if you transport it incorrectly or if you use non-approved transport equipment. Death, serious injury, and property damage can result.

- Ensure that only trained personnel transport the device with approved transport equipment and lifting tools.
- Comply with the information regarding the center of gravity. A label or stamp with exact information regarding the center of gravity of the cabinet is attached to each transport unit.
- Transport the unit only in the original marked upright position. Do not tilt the device.
- The forks of the forklift must protrude from the rear of the transport pallet. The floor panels of the transport units do not support loading.

⚠ WARNING

Danger to life due to use of non-approved forklifts

If the forks are too short, this can cause the transport unit/cabinet to tip over resulting in death, serious injury, or damage to the cabinet.

- The forks of the forklift must protrude from the rear of the transport pallet. The floor panels of the transport units do not support loading.
- Transport the units only with forklifts approved for this purpose.

Note

Shipping

- The devices are packaged by the manufacturer in accordance with the climatic conditions and stress encountered during transit and in the recipient country.
- The packaging instructions relating to transportation, storage, and proper handling must be observed.
- For transportation using forklifts, the devices must be set down on a wooden pallet.
- Once the devices are unpacked, they can be transported using the optional transport eyebolts or beams on the cabinet (option M90). The load must be distributed evenly for this. Strong shocks or impacts must be avoided during transit and when the devices are being set down, for example.
- Shock and tilt indicators affixed to the packaging will signal if the device is subjected to impermissible shocks or tilting when in transit (see "Shipping and handling indicators").
- Permissible ambient temperatures:
  -13 °F (-25 °C) to 158 °F (+70 °C), class 2K3 acc. to IEC 60 721-3-2
  Down to -40 °F (-40 °C) for max. 24 hours

Note

Damage in transit

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

Storage

The devices must be stored in clean, dry rooms. Temperatures between -13 °F (-25 °C) and 131 °F (+55 °) are permissible. Temperature fluctuations greater than 20 K per hour are not permitted.

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

3.3 Installation

⚠ WARNING

Danger to life resulting from failure to observe the general safety instructions and residual risks

If the general safety instructions and residual risks are not observed, accidents can occur causing serious injuries or death.

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

3.3.1 Mechanical installation: checklist

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

Note

Checking the checklist

Check the first box in the column on the right if the action applies to your enclosed drive. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

Item	Action	Yes	Completed
1	Check the shipping and handling indicators prior to installation. Refer to "Mechanical installation/Assembly/Preparatory steps/Shipping and handling indicators".	☐	☐
2	The environmental conditions must be permissible. See "Technical specifications, General technical specifications". The enclosed units must be firmly attached using the anchor points provided. Enclosed chassis type C, 15.8" (400 mm) wide: The enclosed unit can be secured to a non-flammable vertical surface, if necessary, by means of the wall support supplied (see "Mechanical installation/preparation"). The flow of cooling air is thus unobstructed.	☐	☐
3	The minimum ceiling height (for unobstructed air outlet) specified in the Operating Instructions must be observed. The cooling air supply must be not be obstructed (see "Mechanical installation/preparation").	☐	☐
4	Components that are supplied separately for transport reasons (e.g., top hats) must be fitted (see "Mechanical installation/Fitting top hats").	☐	☐
5	The clearance around an open door (escape route) specified in the applicable accident prevention guidelines must be observed.	☐	☐
6	Option M78: Select the required metric screw connections or heavy-gauge threaded joints based on the cable cross-section, and drill the required holes in the mounting plates. When the cable is fed in from above, ensure that enough room is available if the cable has to be bent because of the cable feeder and cross-sections. The cable entries should be fed in vertically to minimize transverse forces on the entries (see "Mechanical installation/Motor connection from above (option M78)").	☐	☐

3.3.2 Preparation

3.3.2.1 Requirements for installation location

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

The operating areas must be dry and free of dust. The air supplied must not contain any electrically conductive gas, vapors, or dust that could impair operation. It may be necessary to filter the air supplied to the installation room. If the air contains dust, filter mats (option M54) can be installed in front of the ventilation grills of the cabinet doors and also in front of the optional top hats. Option M54 offers additional protection against water sprayed against the enclosure from any direction and corresponds to enclosure type NEMA 12 ventilated (IP54).

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

At temperatures greater than 104 °F (40 °C) and altitudes above 6600 ft (2000 m), the devices must be derated.

The basic versions of the enclosed drives have a NEMA 1 enclosure.

The enclosed drives are installed in accordance with the dimension drawings supplied. The clearance between the top of the cabinet and the ceiling is also specified on the dimension drawings.

The cooling air for the power module is drawn in from the front through the ventilation grills in the lower part of the cabinet doors. The heated air is released through the ventilation grills in the roof assembly. Cooling air can also be supplied from below through raised floors or air ducts, for example. To allow this, openings must be made in the 3-section bottom plate or bottom plates must be removed.

In accordance with IEC 61800-3, the enclosed drive is not intended for use in public low-voltage networks that supply residential buildings. High-frequency interference may occur if they are used in this type of power network.

3.3.2.2 Requirements on the levelness of the floor

The foundation at the installation location of the enclosed drives must be horizontal and level to ensure proper functioning of the enclosed drives.

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

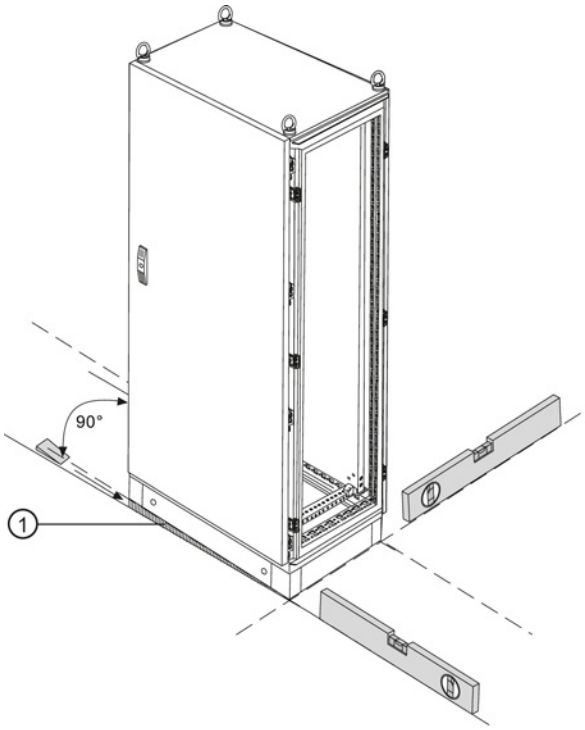


Figure 3-1 Requirements on the levelness of the floor

The following points must be observed to ensure full functionality of the enclosed drives:

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

3.3.2.3 Shipping and handling indicators

The enclosed drives are equipped with tilt and shock indicators to monitor for damage during transit.



Figure 3-2 Tilt indicator



Figure 3-3 Shock indicator

Position of the shipping and handling indicators

The tilt indicators are affixed to the top of the enclosed drive, inside the doors.

The shock indicators are affixed to the bottom of the enclosed drive, inside the doors.

Checking the shipping and handling indicators prior to commissioning

It is essential to check the shipping and handling indicators prior to commissioning the drive.



Figure 3-4 Tilt indicator tripped

The tilt indicator provides immediate visible evidence of whether the enclosed drives have been transported and stored upright. When the unit is tipped, blue-colored quartz sand begins to flow into the arrow-shaped indicator area. The tilt indicator has tripped when the blue color extends beyond the middle line of the arrowhead.



Figure 3-5 Shock indicator tripped

The shock indicator shows if an acceleration has exceeded 98.1 m/s² (10 x g) and indicates the direction of acceleration. The black color of the arrows indicates that an impermissible shock load has occurred in the direction of the arrow.

WARNING

Danger to life due to device damage when shock or tilt indicators are tripped

When shock or tilt indicators have been tripped, safe operation of the device is not guaranteed.

Death, serious injury, and property damage can result.

- Do not put the drive into operation if one of the shock or tilt indicators has been tripped.
- Contact Technical Support immediately for clarification.

Removing the shipping and handling indicators prior to commissioning

NOTICE
Property damage caused by transport indicators remaining in the device during operation If transport indicators are left in the device, property damage due to detachment of transport indicators or temperature damage can occur during operation. • Remove the transport indicators before putting the drive into operation.

Ethyl alcohol can be used to remove any remains of adhesive after removing the transport indicators from the control cabinet.

3.3.2.4 Unpacking

Check the delivery against the delivery note to ensure that all the items have been delivered. Check that the cabinet is intact.

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

3.3.2.5 Required tools

You require the following for installation:

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

A socket wrench set with two long extensions is recommended.

3.3.3 Installation

3.3.3.1 Lifting the enclosure off the transport pallet

Lifting from the transport pallet

The applicable local guidelines for transporting the cabinet from the transport pallet to the installation location must be observed.

Crane transport aids (option M90) can also be fitted on the top of the cabinet.

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



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

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

⚠ WARNING

Danger to life resulting from failure to observe the weight and center of gravity

Failure to observe the weight and center of gravity can cause death or serious injury during lifting and transport activities.

- The weight specified on the packaging and the specified center of gravity must always be taken into account when the cabinet is lifted and transported.
- Particular attention must be paid to this hazard potential after unscrewing the enclosed drives from the transport pallet.

Center of gravity of the cabinet

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

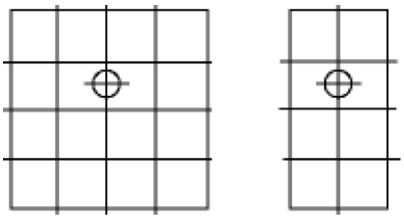


Figure 3-7 Center of gravity of the cabinet

Note

Center of gravity of the cabinet

A sticker with the precise position of the center of gravity of the cabinet is attached to all cabinets/transport units.

3.3.3.2 Disassembling the lifting hardware

With option M90 (crane transport aid), the enclosed drives are equipped with either transport eyebolts or beams.



Figure 3-8 Option M90, transport beams

Disassembling

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

⚠ WARNING

Risk of accident due to improper handling of the mounting rails

Improper handling of the heavy mounting rails during disassembly can cause injuries or property damage.

- Ensure careful handling of the mounting rails during disassembly.
- Prevent screws from falling into the device during disassembly and causing property damage during operation.

Original roof screws



Figure 3-9 Original roof screws accessory kit

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

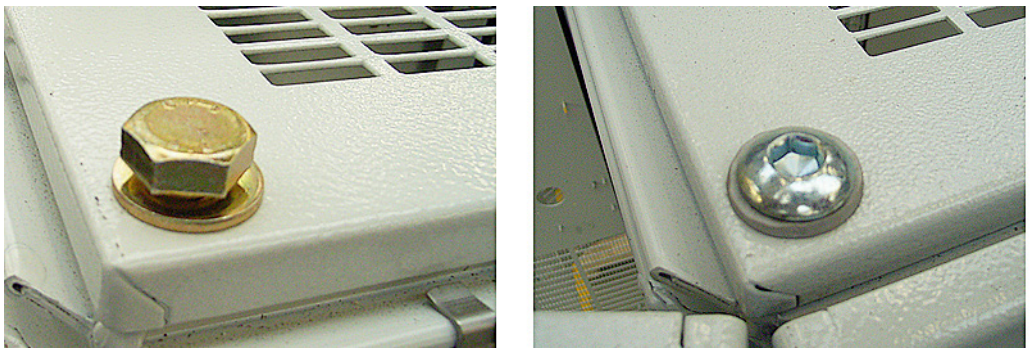


Figure 3-10 Factory state (left), original roof screws (right)

3.3.3.3 Connection to the foundation

Connection to the foundation

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

Every cabinet panel must be attached to the ground using at least 2 opposing fixing points (1 screw each in the front and rear part of the cabinet panel).
If this is not possible for reasons of accessibility, the fixing points of the adjacent cabinet panels must be correspondingly raised.
Generally, as many fixing points as possible should be used.

For 15.8" (400 mm) wide enclosures, the product package includes two wall supports (steel brackets) for attaching the top of the enclosure to the wall to provide extra security.

3.3.4 Changing the enclosure type, options M23 and M54

To change the type of enclosure from NEMA 1 (standard) to NEMA 1 filtered (IP23), IP43, or NEMA 12 ventilated (IP54), filter mats are fitted to the ventilation slots in the doors and top hats. The top hats are mounted after the enclosures have been installed.

Description

Enclosure NEMA 1 filtered

The ventilation slots of enclosed drives with a NEMA 1 filtered enclosure are fitted with foam filters in the air inlet (doors) and air outlet (top hats).

Enclosure IP43

The ventilation slots of enclosed drives with an IP43 enclosure are fitted with foam filters and wire mesh in the air inlet (doors) and air outlet (top hats).

Enclosure NEMA 12 ventilated

The ventilation slots of enclosed drives with a NEMA 12 ventilated enclosure are fitted with fine paper filters in the air inlet (doors) and air outlet (top hats).
Maintaining the integrity of the NEMA 12 ventilated enclosure requires an intact filter medium, which must be replaced on a regular basis according to environmental conditions. Filters can be easily fitted and replaced from outside the enclosure.

3.3.5 Motor connection from above (option M78)

Description

With option M78, the busbar studs for connecting the power cables and the clamping bar for mechanically securing the cables are located within the top hat.

The busbars for connection from above are already installed when the system is delivered. For transport reasons, the top hats are delivered separately and must be installed at the plant. With options M23, M43, and M54, plastic ventilation grilles and filter mats are also supplied.

Based on the number of cables and the cable cross-sections used, holes must be drilled for attaching cable glands through which cables will be inserted.

Note

Connecting the control cables

The control cable and optional brake resistors are still connected from below.

Attaching the top hat

1. Remove the crane transport aids (if present).
2. Secure the contact surfaces of the top hat to the top of the cabinet using the sealing tape provided.
3. Fit the top hat to the top of the cabinet at the positions specified (fixing points of the crane transport aid).
4. To secure the power cables, remove the front panel of the top hat.

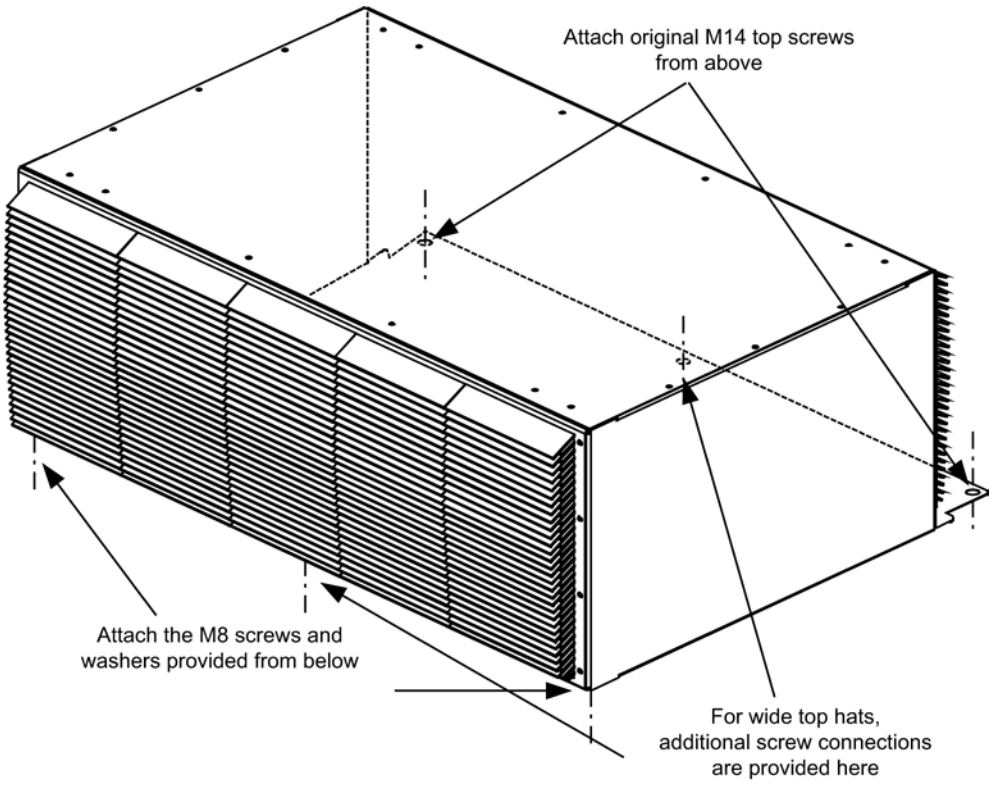


Figure 3-11 Attaching the top hat for M78

3.3.6 Mechanical door lock (option M39)

Description

The door of the enclosure in which the circuit breaker is located (the Line Connection Module) provides the only mechanical interlock for the circuit breaker lever. All other enclosures of the enclosed drive have a door lock that uses a special key; these can be opened at any time, regardless of whether or not the drive is running.

Option M39 provides a mechanical door lock for all other enclosure doors in the form of a spring-loaded pin that is inserted into a plate. This prevents an enclosure door from being opened as long as the circuit breaker is On (provided the opening mechanism for the circuit breaker has not been overridden).

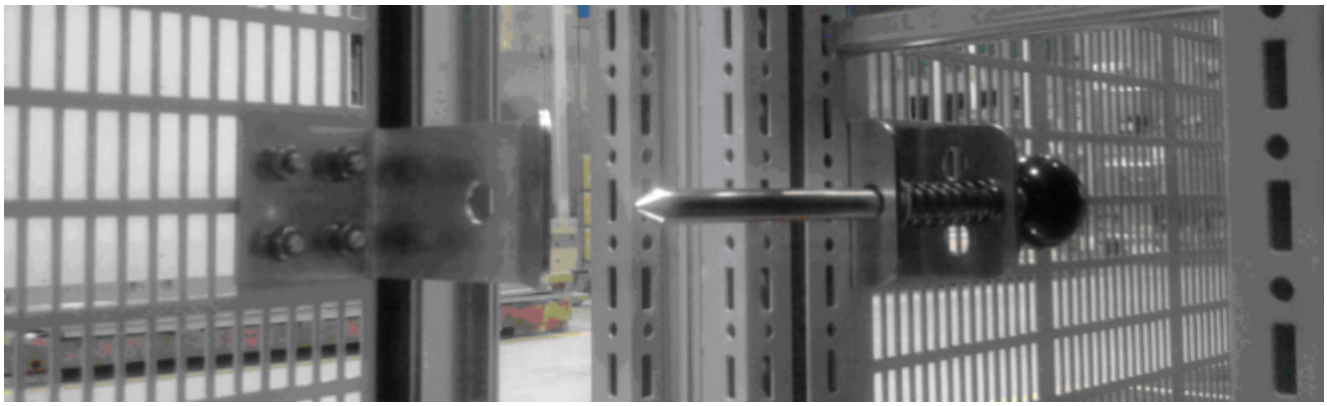


Figure 3-12 Mechanical door lock (slam latch): view from inside the enclosure, unlocked

With this option, the door to the Line Connection Module must first be opened, which requires the circuit breaker to be switched off (or overridden). After this, the spring-loaded pin must be pulled out to release the second door, which can then be opened if it is unlocked. If the enclosed drive has a third door, the second door must be opened first to access the pin that locks the third door.

The slam latch engages automatically when the door is closed. The door should then be locked with the key to engage the 3-point lock. The slam latch is merely an additional component for preventing access to the enclosed drive when the drive is running; it is not a substitute for the door lock or the 3-point lock.

⚠ DANGER

Danger to life due to unlocked doors during operation

Open doors or a faulty door locks during operation and in the event of a fault can cause opening of the doors and exposure of any persons in the vicinity to an arc flash or flying parts. This can cause death or serious injury.

- Keep all cabinet doors locked during operation using the door lock and the 3-point lock.

Electrical installation

4

4.1 Content of this chapter

This chapter provides information on the following:

- Establishing the electrical connections for the enclosed drive
- Adjusting the fan voltage and the internal power supply to local conditions (supply voltage)
- The customer terminal module and its interfaces
- The interfaces for additional options

4.2 Checklist for electrical installation

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

Note

Checking the checklist

Check the first box in the column on the right if the action applies to your enclosed drive. In the same way, check the boxes once you have finished the installation procedure to confirm that the activities are complete.

Item	Action	Yes	Completed
Power connections			
1	The line-side and motor-side power cables must be dimensioned and routed in accordance with the ambient and routing conditions. The maximum permissible cable lengths between the drive and motor must be observed depending on the type of cable used (see "Electrical installation/Power connections/Conductor cross-sections and cable lengths"). The ground (PE) connection from the motor must be fed back directly to the enclosed drive. The cables must be properly connected with a torque of 50 Nm to the terminals of the enclosed drive. The cables for the motor and low-voltage switchgear must also be connected with the required torques.	☐	☐
2	The cables between the low-voltage switchgear and the enclosed drive must be protected in compliance with NFPA 70 (National Electric Code) guidelines for conductor protection. With Type C, additional circuit breakers and fuses must be used to ensure adequate short-circuit strength (SCCR). See "Technical specifications" for the appropriate components.	☐	☐
3	For strain relief, the cables must be clamped to the cable C-type mounting bar.	☐	☐
4	When EMC-shielded cables are used, screwed glands that connect the shield to ground with the greatest possible surface area must be provided on the motor terminal box (see "Electrical installation/EMC-compliant installation").	☐	☐
5	The cable shields must be properly applied and the cabinet properly grounded at the points designated for that purpose (see "Electrical installation/EMC-compliant installation").	☐	☐
6	The voltage for the fan transformer (-T1-T10) for types A and C, and the internal power supply (-A1-T10) for type A (option N70 only) must be adapted to the supply voltage for the enclosed drive. Larger enclosed drives have 2 fan transformers (-T1 -T10/-T20), which must be set jointly (see "Electrical installation/Power connections/Adjusting the fan voltage (-T 1-T10)" and "Electrical installation/Power connections/Adjusting the internal power supply (-A1 -T10)").	☐	☐

Item	Action		Yes	Completed
7	A yellow warning label is attached to each connection clip for the basic interference suppression module. • The warning label must be removed from the connection clip (by pulling it off) if the connection clip is to remain in the unit (operation on a grounded power network). • The warning label must be removed together with the connection clip if the unit is operated on an ungrounded / IT power network. (See "Electrical installation/Power connections/Removing the connection clip for the basic interference suppression module for operation on an ungrounded / IT power network").		☐	☐
8	The nameplate can be used to ascertain the date of manufacture. If the period from the date of manufacture to initial commissioning or the downtime of the enclosed drive is less than 2 years, the DC link capacitors do not have to be reformed. If the downtime period is longer than two years, reforming must be carried out (see "Maintenance and Servicing/Forming of DC Link Capacitors").		☐	☐
9	With an external auxiliary supply, the cable for the 115 V AC supply must be connected to terminal -X40, while the cable for the 24 V DC supply must be connected to terminal –X9 (see "Electrical installation/Power connections/External supply of the auxiliary infeed from a fused power network").		☐	☐
10	Option L10 dv/dt filter plus voltage peak limiter	During commissioning, the filter must be selected via STARTER or AOP30. You are advised to check the selection by ensuring that p0230 is set to 2. The required parameters are set automatically (see "Electrical installation/Other connections/dv/dt filter plus voltage peak limiter (option L10)").	☐	☐
11	Option L17 Connection for external auxiliaries (e.g., motor blower)	The external motor blower must be correctly connected to terminals -X155:1 (L1) to -X155:3 (L3). The supply voltage of the motor blower must match the input voltage of the enclosed drive. The load current must not exceed 5 A and must be set at -Q155 in accordance with the load connected (see "Electrical installation/Other connections/Connection for external devices (option L17)").	☐ Set value: _____	☐
12	Option L50 Cabinet light with service socket	The 115 V auxiliary supply for the cabinet light with an integrated service socket must be connected to terminal -X390 and protected with a fuse (max. 10 A) on the line end (see "Electrical installation/Other connections/Cabinet light with service socket (option L50)").	☐	☐
13	Option L55 Anti-condensation heater	The 115 V auxiliary supply for the enclosure anti-condensation heater (115 V/60 Hz, 100 W, or 115 V/60 Hz 2 x 100 W for enclosure widths ranging from 31.5" (800 mm) to 47.2" (1200 mm)) must be connected to terminals -X240: 1 ... 3 and protected with fuses (max. 16 A) (see "Electrical installation/Other connections/Cabinet anti-condensation heater (option L55)").	☐	☐
Signal connections				

Item	Action		Yes	Completed
14	Enclosed drive operation from higher-level controller/control room. The control cables must be connected in accordance with the interface assignment and the shield applied. Due to potential electrical interference, the digital and analog signals must be routed with separate cables, and an appropriate distance from power cables must be observed. When the analog inputs on the customer terminal module are used as current or voltage inputs, selectors S5.0 and S5.1 must be set accordingly (see "Electrical installation/Signal connections/Customer terminal module (-A60)").		☐	☐
15	Option K50 Sensor Module Cabinet-Mounted SMC30	The SMC30 Sensor Module is used for determining the actual motor speed. For SINAMICS G150 NEMA, the following encoders are supported by the SMC30 Sensor Module: • TTL encoder • HTL encoder The motor temperature can also be detected using KTY84-130 or PTC thermistors. In the factory state, an HTL encoder is bipolar with 1024 pulses per revolution (see "Electrical installation/Other connections/Sensor Module Cabinet-Mounted SMC30 (option K50)").	☐	☐
16	Option K52 Additional SMC30 Sensor Module Cabinet-Mounted	For reliable actual value acquisition when using the Safety Integrated Extended Functions, the additional SMC30 sensor module is used (see "Electrical installation/Other connections/Additional SMC30 Sensor Module Cabinet-Mounted (option K52)").	☐	☐
Connecting protection and monitoring devices				
17	Option G51 TM150 Temperature Sensor Module	A maximum of 12 temperature sensors (PT100, PT1000, KTY84, PTC, bimetallic NC contact) can be be connected to the TM150 Terminal Module (see "Electrical installation/Other connections/TM150 Temperature Sensor Module (option G51)").	☐	☐
18	Option N57 EMERGENCY OFF category 0, 115 V AC or 24 V DC	EMERGENCY OFF category 0 stops the drive in an uncontrolled manner. No additional wiring is needed when using the EMERGENCY OFF pushbutton. If the enclosed drive is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120 (see "Electrical installation/Other connections/EMERGENCY OFF category 0; 115 V AC or 24 V DC (option N57)").	☐	☐
19	Option N59 EMERGENCY STOP category 1, 115 V AC	EMERGENCY STOP category 1 stops the drive in a controlled manner. Based on the load characteristic and the required shutdown times, it may be necessary to use braking units with this option. No additional wiring is needed when using the EMERGENCY OFF pushbutton. If the enclosed drive is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120. The timer relay at -A121 must be adapted to match system requirements ("Electrical installation/Other connections/EMERGENCY STOP category 1, 115 V AC (option L59)").	☐	☐

Item	Action		Yes	Completed
20	Option N60 EMERGENCY STOP category 1, 24 V DC	EMERGENCY STOP category 1 stops the drive in a controlled manner. Based on the load characteristic and the required shutdown times, it may be necessary to use braking units with this option. No additional wiring is needed when using the EMERGENCY OFF pushbutton. If the enclosed drive is integrated in an external safety circuit, however, the contact must be looped in via terminal block -X120. The timer relay at -A120 must be adapted to match system requirements (see "Electrical installation/Other connections/EMERGENCY STOP category 1, 24 V DC (option L60)").	☐	☐
21	Option L61/L62 25 kW/125 kW 50 kW/250 kW braking unit	The connecting cables and ground for the braking resistor must be connected to terminal block –X5: 1/2. A connection must be made between the braking resistor thermostatic switch and customer terminal module –A65. When commissioning via AOP30, the settings for evaluating "external fault 3" must be made. The settings for evaluating the thermostatic switch as "external fault 2" must be made (see "Electrical installation/Other connections/Braking unit 25 kW / 125 kW (option L61); braking unit 50 kW / 250 kW (option L62)").	☐	☐
22	Option L87 Insulation monitor for ungrounded supplies	The insulation monitor can be operated only on an ungrounded / IT power network. Only one insulation monitor can be used in an electrically-connected network. For plant-side control, the signaling relays must be connected accordingly or, with individual drives (enclosed drive is fed via a converter transformer assigned to the enclosed drive), integrated in the enclosed drive alarm circuit (see "Electrical installation/Other connections/Insulation monitoring (option L87)"). The information in step 7 must also be noted: "Before the drive is operated on an ungrounded / IT power network, the connection clip for the basic interference suppression module must be removed" (see "Electrical installation/Power connections/Removing the connection clip for the basic interference suppression module for operation on an ungrounded / IT power network").	☐	☐
23	Option L97 PT100 tripping unit	The PT100 RTDs must be connected to the monitoring units -B141, -B142, -B143 for the evaluation. A three-wire system can be used here to connect the PT100 sensors. The sensors are divided into three groups (see "Electrical installation/Other connections/PT100 tripping unit (option L97)"). This must be taken into account for the evaluation (factory setting).	☐	☐

Item	Action		Yes	Completed
Safety Integrated				
24	Option K01 Safety license for 1 axis	The Safety Integrated Extended Functions require one license for each axis with safety functions. With Option K01, the safety license for 1 axis is contained and activated on the CompactFlash card (see "Electrical installation/Other connections/Safety license for 1 axis (option K01)").	☐	☐
25	Option K82 "Safe Torque Off" and "Safe Stop 1" safety functions	The terminal block -X41 must be connected at the plant end and the safety functions must be activated prior to use via parameter assignment. In addition, an acceptance test must be performed and an acceptance report must be prepared (see "Electrical installation/Other connections/Terminal module for activating "Safe Torque Off" and "Safe Stop 1" safety functions (option K82)").	☐	☐
26	Option K87 TM54F Terminal Module	The terminal blocks of the TM54F Terminal Module must be connected at the plant end, and the Safety Integrated Extended Functions must be activated prior to use via parameter assignment. In addition an acceptance test must be performed and an acceptance report must be prepared (see "Electrical installation/Other connections/TM54F Terminal Module (option K87)").	☐	☐
27	Option K88 Safe Brake Adapter AC 230 V	To control the brake, a connection must be established between -X14 on the Safe Brake Adapter and the holding brake (see "Electrical installation/Other connections/Safe Brake Adapter SBA 230 V AC (option K88)").	☐	☐

Required tool

To install the connections, you will require:

- Wrench or socket wrench (w/f 10)
- Wrench or socket wrench (w/f 13)
- Wrench or socket wrench (w/f 16/17)
- Wrench or socket wrench (w/f 18/19)
- Hexagon-socket wrench (size 8)
- Torque wrench up to 50 Nm
- Screwdriver, size 2
- Screwdriver Torx T20
- Screwdriver Torx T25
- Screwdriver Torx T30

4.3 Important safety precautions

WARNING

Danger to life resulting from failure to observe the general safety instructions and residual risks

If the general safety instructions and residual risks are not observed, accidents can occur causing serious injuries or death.

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



WARNING

Danger to life from electric shock when unsuitable fuses are used

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

- Use only fuses recommended in the technical specifications.
- Observe the required minimum short-circuit current for the relevant fuse.



DANGER

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

Because of the DC link capacitors, a hazardous voltage is still present for a while after switching off the infeed voltage.

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

- Open the unit only after the time specified on the warning label has elapsed.
- Before starting work, check the absence of voltage by an all-pole measurement, including to ground.

NOTICE

Property damage resulting from switching on the device without forming of the DC link capacitors

After a storage duration exceeding two years, switching on the device without forming of the DC link capacitors can damage it.

- If the device has been stored for more than two years, form it before switching it on; see "Maintenance and service".

Note

Touch protection

The enclosed drives are provided with touch protection when the cabinet door is open according to BGV A3 in compliance with EN 50274.

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

4.4 Introduction to EMC

What is EMC?

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

EMC therefore represents a quality feature for the

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

To ensure that the enclosed drive functions satisfactorily in the system, an environment subject to interference must not be neglected. For this reason, special EMC requirements exist for the system.

Operational reliability and noise immunity

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

Noise emissions

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

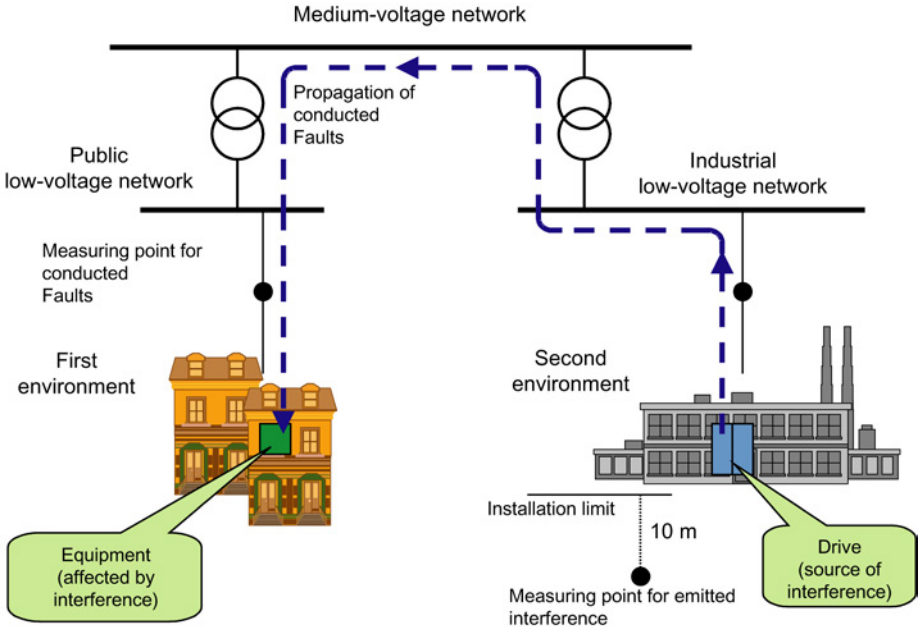


Figure 4-1 Definition of the first and second environments

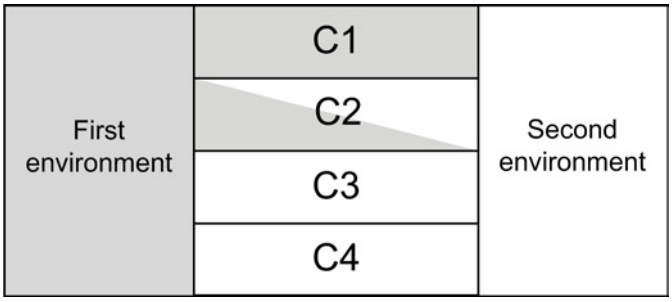


Figure 4-2 Definition of categories C1 to C4

Table 4- 1 Definition of the first and second environments

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

Table 4- 2 Definition of categories C1 to C4

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

4.5 EMC-compliant design

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

Cabinet assembly

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

Shield gaps

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

Use large cross-sections

- Use grounding wires or straps with large cross-sections or, better still, with finely stranded wires or flexible straps.

Lay the motor supply cable separately

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

Laying the equipotential bonding cable

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

Use interference suppressors

- If relays, contactors, and inductive or capacitive loads are connected, the relays or contactors must be fitted with interference suppressors.

Cable installation

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

Shield connection

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

I/O interfacing

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

Filtering cables

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

Protective ground conductors

- According to NFPA70 National Electrical Code Article 250, the minimum cross-section of the protective ground conductor must conform to the local safety regulations for protective ground conductors for equipment with a high leakage current.

4.6 Power connections

⚠ WARNING

Danger to life from electric shock due to interchanging or short-circuiting of device connections

Interchanging the power connections or short-circuiting of the DC link connections will destroy the device, which can result in death or serious injuries.

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

Note

Ground fault circuit interrupter

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

4.6.1 Cable lugs

Cable lugs

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

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

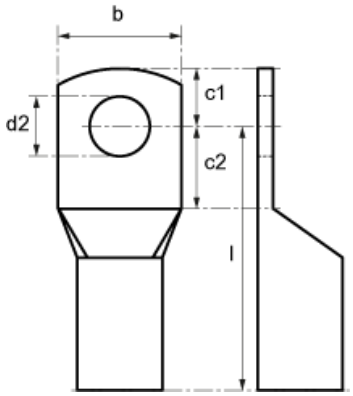


Figure 4-3 Dimensions of the cable lugs

Table 4- 3 Dimensions of the cable lugs

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

4.6.2 Connection cross-sections, cable lengths

Conductor cross-sections

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

Cable lengths

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

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

- Unshielded cable (e.g., Protodur NYY): max. 1485 ft (450 m)
- Shielded cable (e.g., Protodur NYCWY, Protoflex EMV 3 Plus): max. 990 ft (300 m).

Note
Cable lengths

The cable lengths specified are also valid if a motor reactor is used (option L08).

Note
Shielded cables

The PROTOFLEX-EMV-3 PLUS shielded cable recommended by Siemens has three symmetrically-arranged ground conductors. Each ground conductor must be fitted with cable lugs and connected to ground. The cable also has a concentric flexible braided copper shield. To comply with IEC 61800-3 regarding radio interference suppression, the shield must be contacted at both ends with the greatest possible surface area.

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

4.6.3 Connecting the motor and power cables

Connecting the motor and power cables on the enclosed drive

Note

Position of the connections

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

Enclosed drive type A

Connect the power cable according to the numbers in the following diagram.

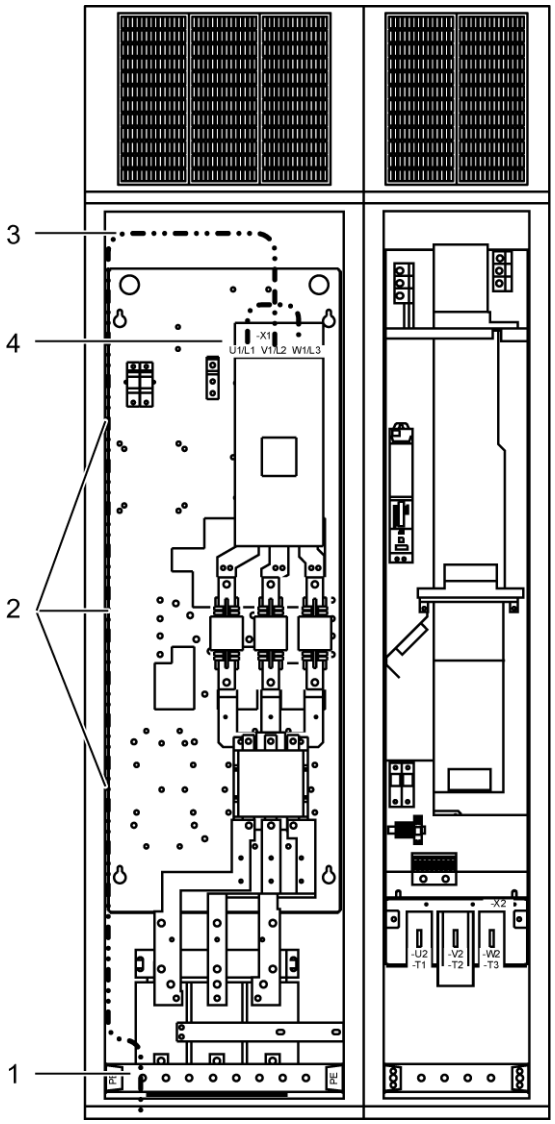


Figure 4-4 Power cable connection for enclosed drive type A

1. Open the cabinet, remove any covers in front of the terminals for the motor cables (connections U2/T1, V2/T2, W2/T3; X2) and power cables (connections U1/L1, V1/L2, W1/L3; X1).
   Remove or move the base plate under the terminals for inserting the power or motor cables.
   Feed the power cable from the top or bottom into the enclosure and take it up as far as the circuit breaker terminals as indicated by the dashed line in the diagram (4).
   Connect the ground (PE) conductor to the ground terminal provided in the enclosure, marked with the ground symbol (50 Nm at M12).
2. Secure the power cable to the strain relief on the C-rails located inside the enclosure on the sides.
3. Lay the cable according to the permissible bending radius, and route it, if required, also through the top hat.
4. Connect the power cable with the prescribed torque to the circuit breaker (connections U1/L1, V1/L2, W1/L3; X1).

Then screw the motor cables onto the terminals.
Make sure that the conductors have been connected properly (U2/T1, V2/T2, W2/T3).

Note

Pay attention to the torque

The tightening torques for the network connections at the mains switch -Q1 are specified in the respective technical data of the enclosed drive.

Enclosed chassis type C

1. Open the cabinet, remove the covers (if necessary) in front of the motor cable (terminals U2/T1, V2/T2, W2/T3; X2) and power cable (terminals U1/L1, V1/L2, W1/L3; X1) terminals.
2. Move or remove the bottom plate below the terminals through which the motor cables are fed.
3. Connect the ground (PE) conductor to the ground terminal provided in the enclosure, marked with the ground symbol (50 Nm at M12).
4. Connect the line and motor cables to the corresponding terminals.
   Make sure that you connect the conductors in the correct sequence: U2/T1, V2/T2, W2/T3 and U1/L1, V1/L2, W1/L3!

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

Note

PE connection of the motor

The motor ground (PE) must be routed directly to the drive enclosure.

Direction of motor rotation

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

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

An electric motor rotates clockwise if the shaft is turning clockwise when viewing the drive end (DE).

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

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

Table 4- 4 Enclosed drive and motor connection terminals

Enclosed drive (connection terminals)	Motor (connection terminals)
U2/T1	U
V2/T2	V
W2/T3	W

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

Note

Information on the phase sequence

If an incorrect phase sequence was connected when the motor was connected, p1821 (phase sequence direction reversal) can be used to correct the incorrect phase sequence without physically changing it over (see "Functions, monitoring and protective functions/direction reversal").

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

4.6.4 Adjusting the fan voltage (-T1-T10)

The power supply for the fan(s) (230 V 1 AC) in the Power Module (-T1- T10) is taken from the main supply system using a transformer.
The location of the transformer is indicated in the layout diagrams supplied.
The transformer is fitted with primary taps so that it can be adapted to the line voltage.

If necessary, the connection fitted in the factory, shown with a dashed line, must be reconnected to the actual line voltage.

Note

Enclosed drives with two transformers

Two transformers (-T1-T10, and -T1-T20) are installed in the following enclosed drives. The two primary terminals of these devices must be connected in parallel.

- For 380 to 480 V 3 ph. AC: 6SL3710-1GE41-0_U0
- For 500 to 600 V 3 ph. AC: 6SL3710-1GF37-4_U0, 6SL3710-1GF38-1_U0

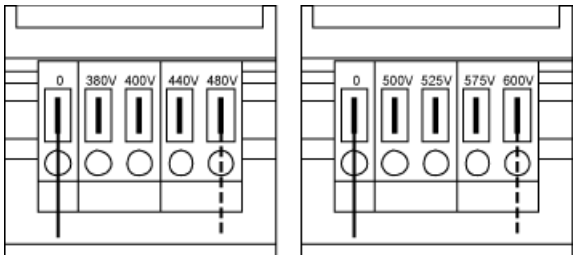


Figure 4-5 Setting terminals for the fan transformer (380 to 480 V 3 ph. AC / 500 to 600 V 3 ph. AC)

The line voltage assignments for making the appropriate setting on the fan transformer are indicated in the following tables.

WARNING

Risk of fire due to overheating when device fan voltage is insufficient

If the terminals are not reconnected to the actual line voltage, this can lead to overheating with a risk of personal injury due to smoke generation and fire.
This can also cause the fan fuses to blow due to overload.

- Set the terminals in accordance with the actual line voltage.

Note

Order numbers for fan fuses

The order numbers for fan fuses that have blown can be found in the spare parts list.

Table 4- 5 Line voltage assignments for setting the fan transformer (380 to 480 V 3 ph. AC)

Line voltage	Tap of the fan transformer (-T1 -T10)
380 V ± 10 %	380 V
400 V ± 10 %	400 V
440 V ± 10 %	440 V
480 V ± 10 %	480 V

Table 4- 6 Line voltage assignments for setting the fan transformer (500 to 600 V 3 ph. AC)

Line voltage	Tap of the fan transformer (-T1 -T10)
500 V ± 10 %	500 V
525 V ± 10 %	525 V
575 V ± 10 %	575 V
600 V ± 10 %	600 V

4.6.5 Adjusting the internal power supply (-A1 -T10, enclosed drive type A only)

A transformer (-A1-T10) is installed for the internal 115 V AC power supply of the cabinet. The location of the transformer is indicated in the layout diagrams supplied.

When delivered, the taps are always set to the highest level. The line-side terminals of the transformer may need to be reconnected according to the existing line voltage.

The line voltage assignments for making the appropriate setting on the transformer for the internal power supply are indicated in the following tables.

NOTICE
Property damage due to voltage set too high If the terminals are not reconnected to the actual line voltage, this can result in damage to the device when the voltage is set too high. • Set the terminals in accordance with the actual line voltage.

Table 4- 7 Line voltage assignment for the internal power supply (380 to 480 V AC, 3 phase)

Line voltage range	Tap	Taps of matching transformer (-A1-T10) LH1 – LH2
342 ... 390 V	380 V	1 – 2
391 ... 410 V	400 V	1 – 3
411 ... 430 V	415 V	1 – 4
431 ... 450 V	440 V	1 – 5
451 ... 470 V	460 V	1 – 6
471 ... 528 V	480 V	1 – 7

Table 4- 8 Line voltage assignment for the internal power supply (500 to 600 V AC, 3 phase)

Line voltage range	Tap	Taps of matching transformer (-A1-T10) LH1 – LH2
450 ... 515 V	500 V	1 – 8
516 ... 540 V	525 V	1 – 9
541 ... 560 V	550 V	1 – 10
561 ... 590 V	575 V	1 – 11
591 ... 670 V	600 V	1 – 12

4.6.6 Removing the connection clip for the basic interference suppression module for operation on an ungrounded / IT power network

If the enclosed drive is operated on an ungrounded power network (IT power network), the connection clip to the basic interference suppression module of the drive (-T1) must be removed.

Note

Warning label on the connection clip

A yellow warning label is attached to each connection clip so that it is easier to find.

- The warning label must be removed from the connection clip (by pulling it off) if the connection clip is to remain in the unit (operation on a grounded power network).
- The warning label must be removed together with the connection clip if the unit is operated on an ungrounded / IT power network.



Figure 4-6 Warning label on the connection clip

NOTICE

Device damage resulting from failure to remove the connection clip on an ungrounded power network

Failing to remove the connection clip for the basic interference suppression module on an ungrounded / IT power network can cause significant damage to the device.

- Remove the connection clip to the basic interference suppression module on an ungrounded power network (IT power network).

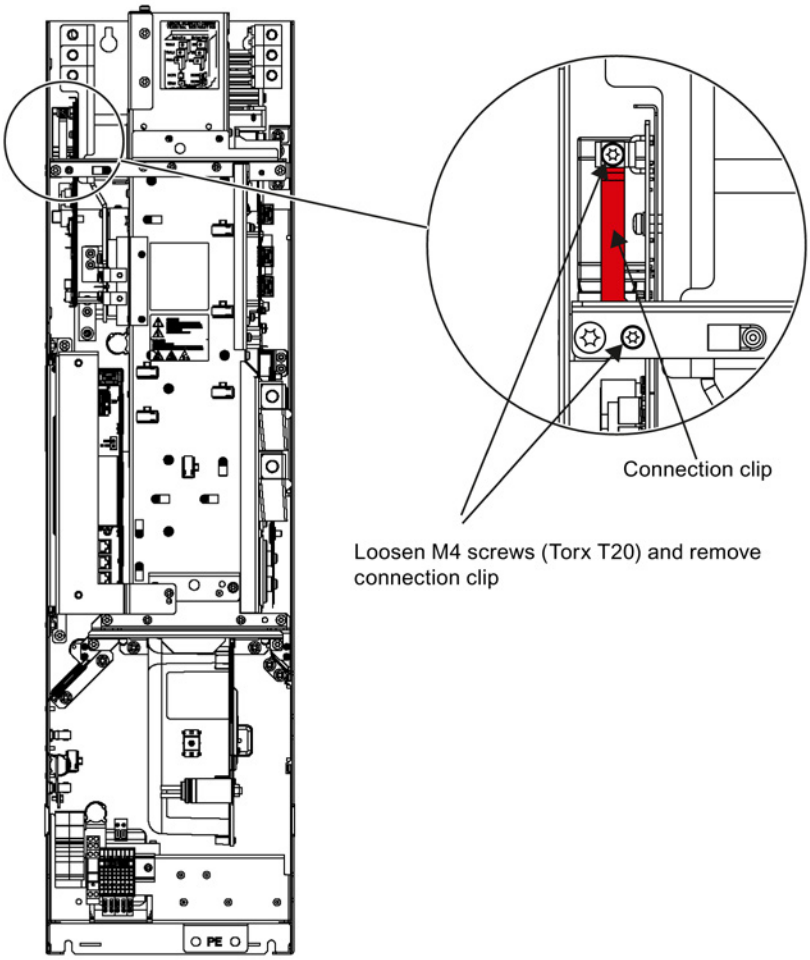


Figure 4-7 Removing the connection clip for the basic interference suppression module, frame size FX

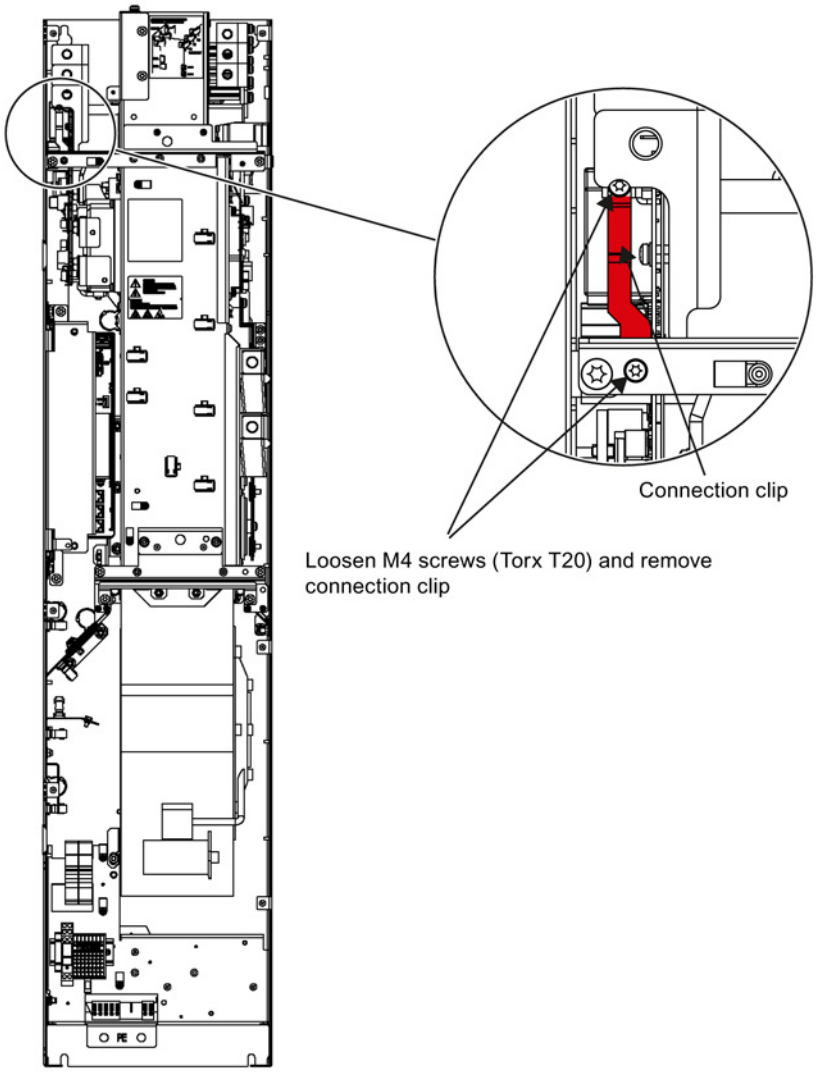


Figure 4-8 Removing the connection clip for the basic interference suppression module, frame size GX

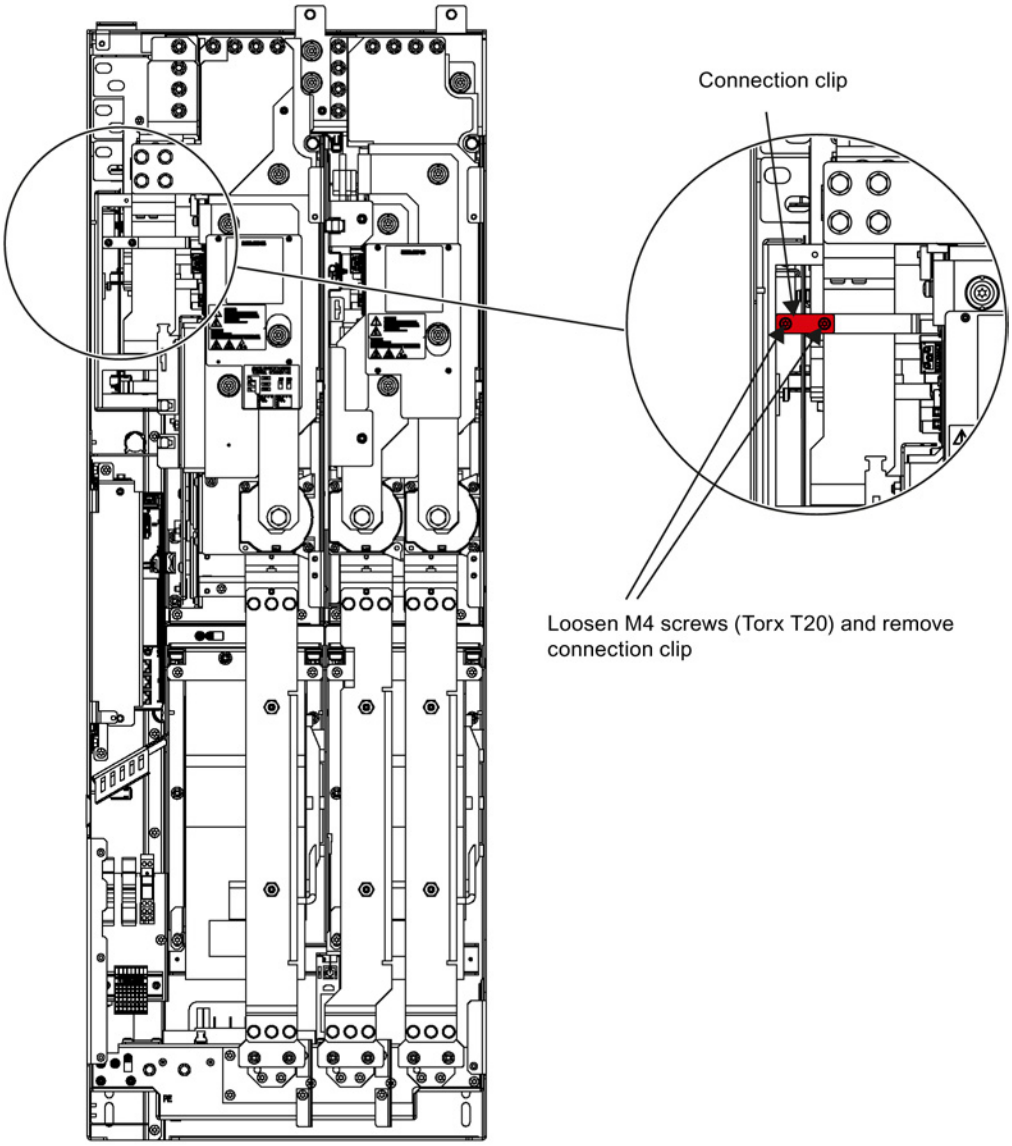


Figure 4-9 Removing the connection clip for the basic interference suppression module, frame size HX

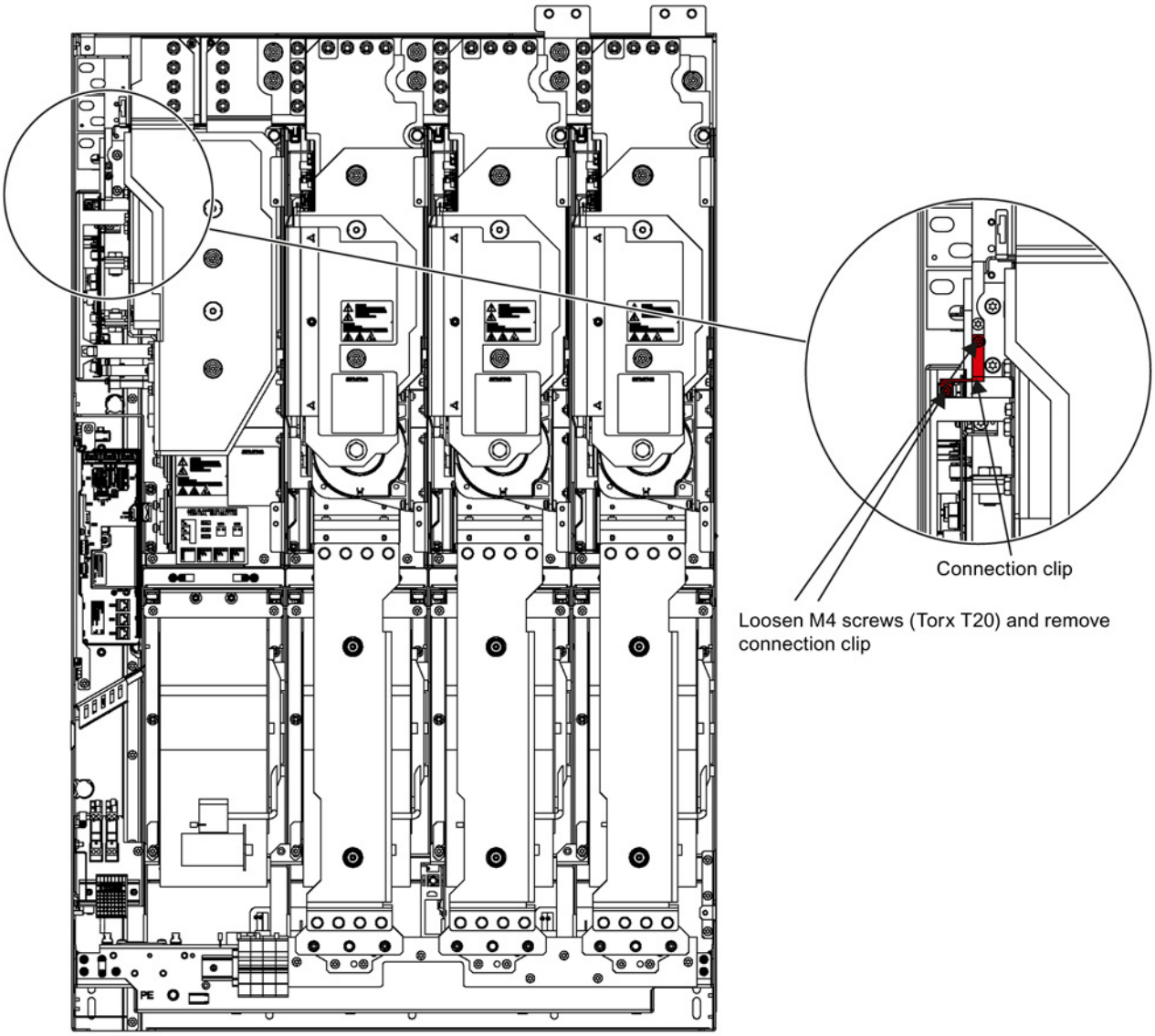


Figure 4-10 Removing the connection clip for the basic interference suppression module, frame size JX

4.7 External supply of the auxiliary supply from a secure line

Description

A secure external control power supply (for example, from a UPS) is always recommended if communication and closed-loop control are to be independent of the drive power supply. An external control power supply is particularly recommended for low-power lines susceptible to short-term voltage dips or power failures.

With a secure external supply independent of the main supply, alarms and fault codes can still be displayed on the operator panel and internal protection and monitoring devices if the main supply fails.



WARNING

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

When the external auxiliary supply is connected, dangerous voltages continue to be present in the enclosed drive even when the mains switch is open. Death or serious injury can result when live parts are touched.

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

Note

External auxiliary supply for automatic restart

A secure external control power supply must always be used if the automatic restart (WEA) function is to be used with an integrated EMERGENCY OFF option (N57) or EMERGENCY STOP option (N59, N60).
Otherwise, the automatic restart function does not work.

Table 4- 9 Possible connections for the external auxiliary voltage based on selected options

Drive option	External supply of auxiliary voltage independent of the main supply			
	24 V DC terminal –X9	115 V AC terminal –X40	24 V DC (terminal–X9) 115 V AC (terminal –X40) [1]	115 V AC (terminal –X40) in conjunction with option L13
- With no further options - Enclosed chassis type C	X			
N70		X		
L87			X	X
L97			X	X

[1] This is required if, in addition to the open and closed-loop control, 115 V AC consumers (PT100 monitor or insulation monitor) are also to remain in operation if the main supply fails.

4.7.1 115 V AC auxiliary supply

The fuse must not exceed 10 A.

The connection is protected inside the cabinet with a 10 A fuse.

Connecting

- On terminal block -X40, remove the jumpers between terminals 1 and 2 as well as 5 and 6.
- Connect the external 115 V AC supply to terminals 2 (L1) and 6 (N).

Maximum connectable cross-section: #12 AWG (4 mm²)

4.7.2 24 V DC auxiliary supply

The fuse must not exceed 10 A.

The maximum current demand is 5 A.

Connecting

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

Maximum connectable cross-section: #14 AWG (2.5 mm²)

4.8 Signal connections

4.8.1 Control Unit CU320-2 DP

In the standard version, the cabinet unit contains a CU320-2 DP control unit, which handles the communication and open-loop/closed-loop control functions.

A PROFIBUS interface is available for higher-level communication.

Connection overview

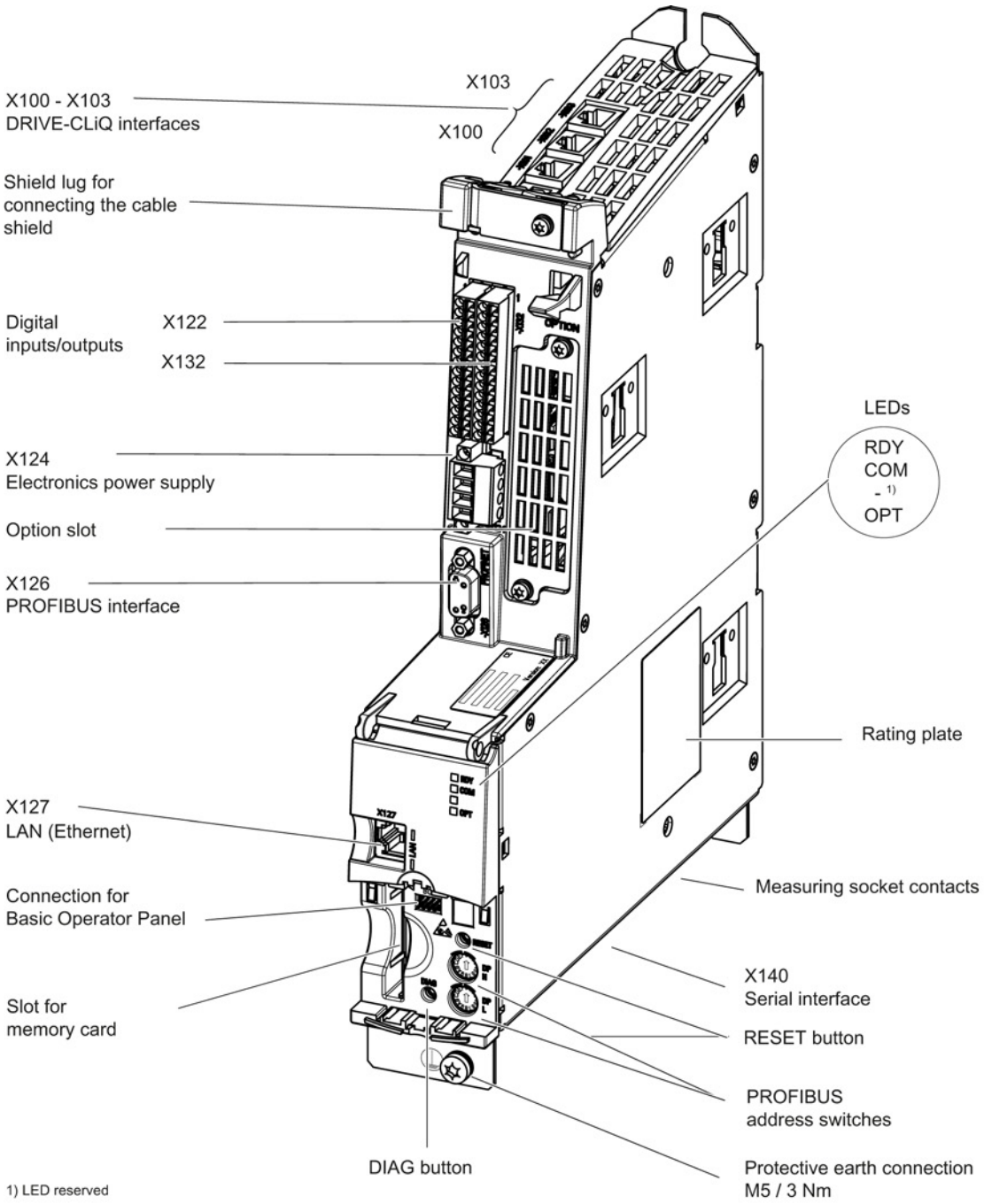


Figure 4-11 Connection overview of the CU320-2 DP Control Unit (without cover)

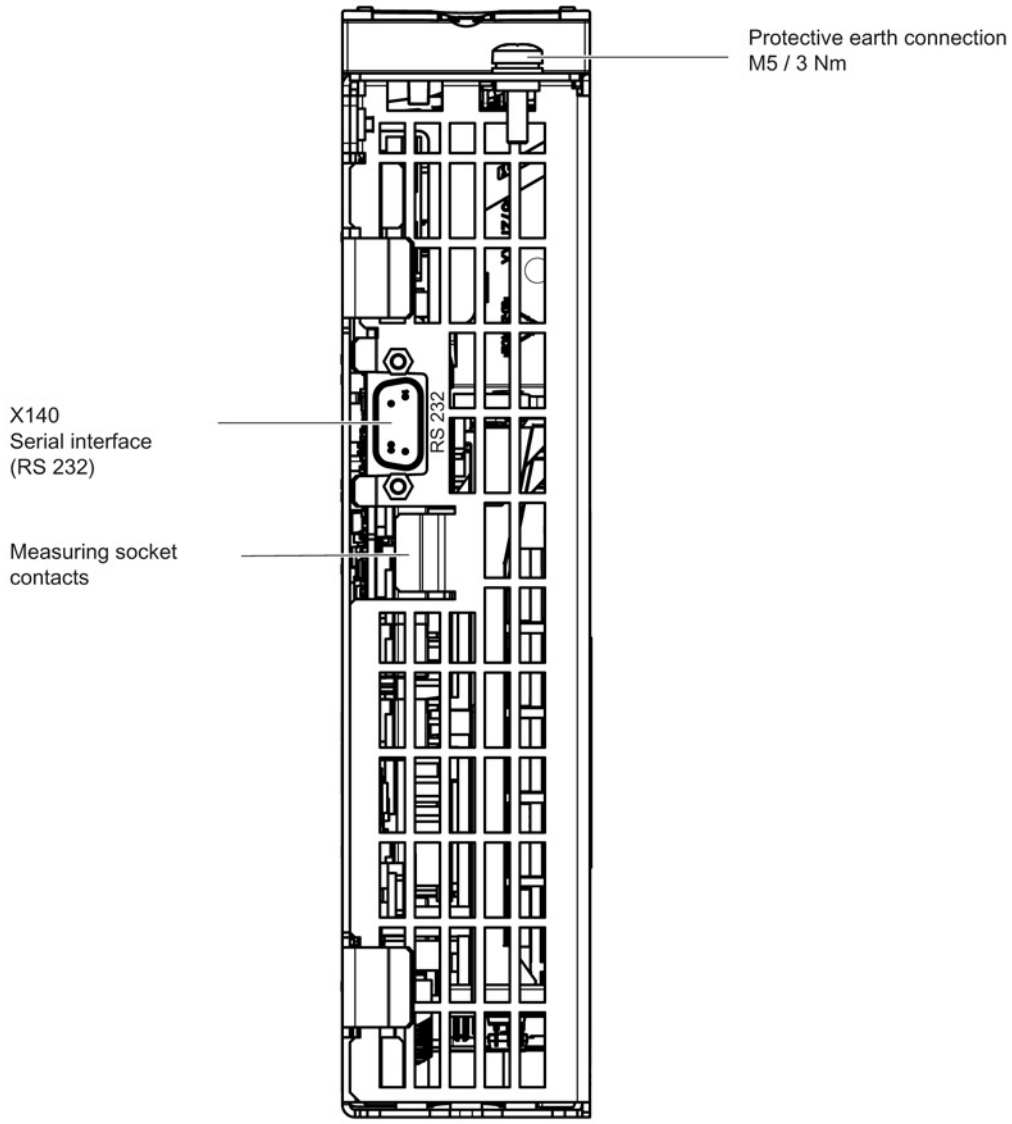


Figure 4-12 Interface X140 and measuring sockets T0 to T2 - CU320-2 DP (view from below)

NOTICE
Malfunctions or damage to the Option Board by pulling and plugging it during operation Pulling and plugging the Option Board during operation can damage it or cause it to malfunction. • Only pull and plug the Option Board when the Control Unit is de-energized.

Connection example

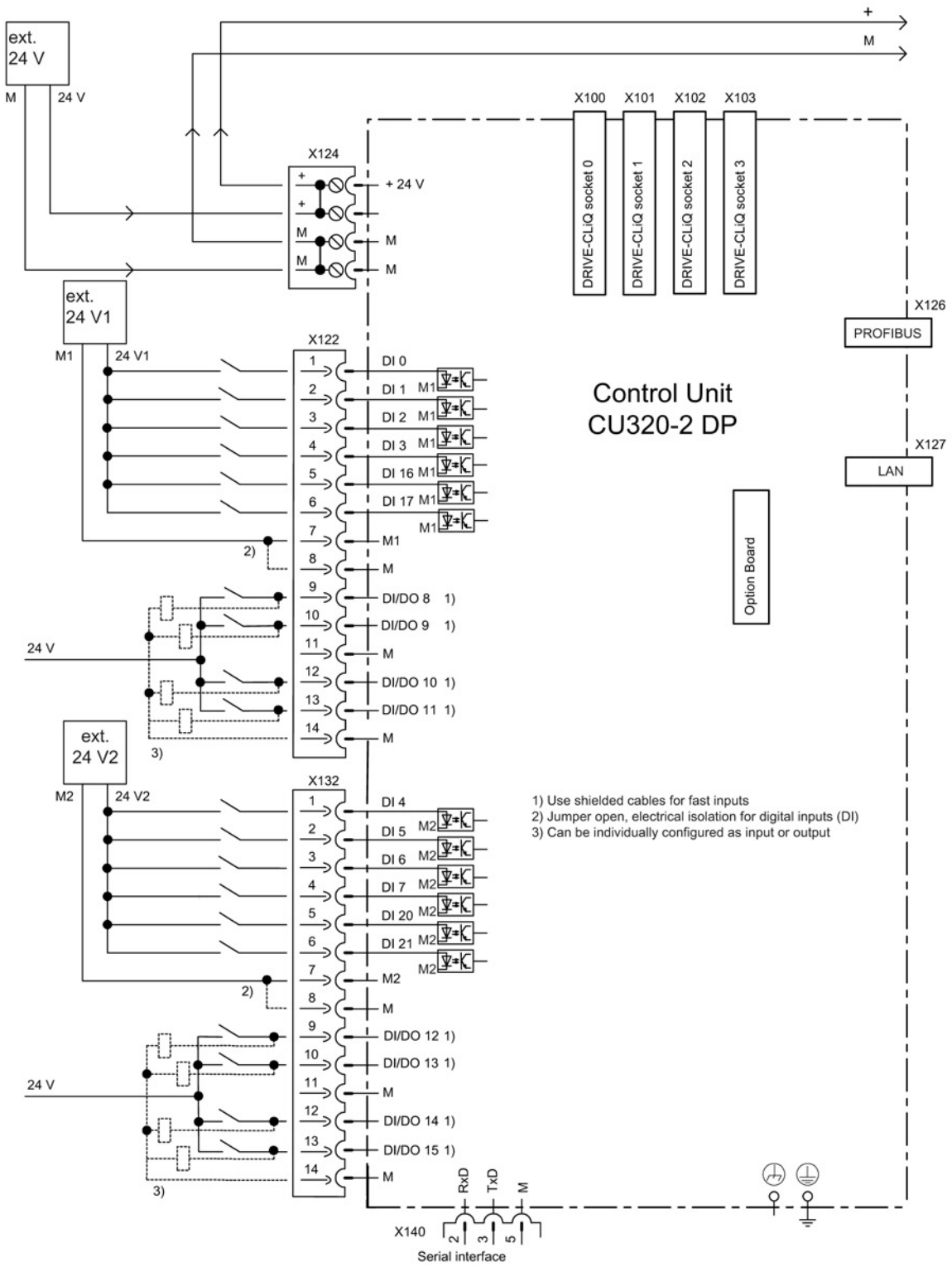
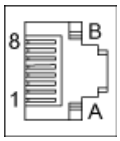


Figure 4-13 Connection example for CU320-2 DP

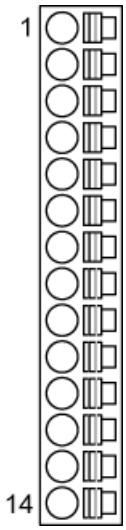
X100 to X103 DRIVE-CLiQ interface

Table 4- 10 DRIVE-CLiQ interface X100 – X103

	Pin	Signal name	Technical specifications
	1	TXP	Send data +
	2	TXN	Send 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
Connector type: RJ45 socket Blanking plate for DRIVE-CLiQ interfaces (50 pcs.) Order number: 6SL3066-4CA00-0AA0			

X122: Digital inputs/outputs

Table 4- 11 Terminal block X122

	Pin	Designation[1)]	Technical specifications
	1	DI 0	Voltage (max.): -3 ... 30 V Current consumption, typical: 9 mA at 24 V DC Electrical isolation: reference potential is terminal M1 Signal level (with ripple) High level: +15 ... +30 V Low level: -3 ... +5 V Input delay (typ.): For "0" → "1": 50 µs For "1" → "0": 150 µs
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	DI 16	
	6	DI 17	
	7	M1	Reference potential for terminal 1 ... 6
	8	M	Electronics ground
	9	DI/DO 8	**As input**: Voltage: -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Signal level (with ripple) High level: 15 … 30 V Low level: -3 … +5 V DI/DO 8, 9, 10, and 11 are "fast inputs" [2)] Input delay (typ.) For "0" → "1": 5 µs For "1" → "0": 50 µs **As output**: Voltage: 24 V DC Max. load current per output: 500 mA Sustained short-circuit-proof Output delay (typ./max):[3)] For "0" → "1": 150 µs / 400 µs For "1" → "0": 75 µs / 100 µs 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
	10	DI/DO 9	
	11	M	
	12	DI/DO 10	
	13	DI/DO 11	
	14	M	
Max. connectable cross-section: 1.5 mm²			

1) DI: Digital input; DI/DO: Bidirectional digital input/output; M: Electronics ground; M1: Reference potential

2) The fast inputs can be used as probe inputs or as inputs for the equivalent zero mark.

3) Data for: V_{cc} = 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

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

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

Terminal M1 must be connected so that the digital inputs (DI) can function.

This is achieved through one of the following measures:

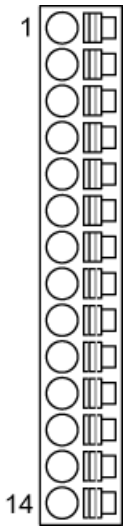
1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

Note

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

X132: Digital inputs/outputs

Table 4- 12 Terminal block X132

	Pin	Designation[1]	Technical specifications
	1	DI 4	Voltage (max.): -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Electrical isolation: reference potential is terminal M2 Signal level (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V Input delay (typ.): For "0" → "1": 50 µs For "1" → "0": 150 µs
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	DI 20	
	6	DI 21	
	7	M2	Reference potential for terminal 1 ... 6
	8	M	Electronics ground
	9	DI/DO 12	**As input**: Voltage: -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Signal level (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V DI/DO 12, 13, 14, and 15 are "fast inputs" [2] Input delay (typ.): For "0" → "1": 5 µs For "1" → "0": 50 µs **As output**: Voltage: 24 V DC Max. load current per output: 500 mA Sustained short-circuit proof Output delay (typ./max):[3] For "0" → "1": 150 µs / 400 µs For "1" → "0": 75 µs / 100 µs 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
	10	DI/DO 13	
	11	M	
	12	DI/DO 14	
	13	DI/DO 15	
	14	M	
Max. connectable cross-section: 1.5 mm²			

[1] DI: Digital input; DI/DO: Bidirectional digital input/output; M: Electronics ground; M2: Reference potential

[2] The fast inputs can be used as probe inputs or as inputs for the equivalent zero mark

[3] Data for: V_{cc} = 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

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

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

To enable the digital inputs (DI) to function, terminal M2 must be connected.

This is achieved through one of the following measures:

1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

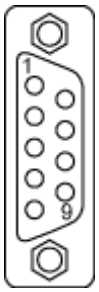
Note

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

X126: PROFIBUS connection

PROFIBUS is connected using a 9-pin sub D socket (X126); the terminals are isolated.

Table 4- 13 PROFIBUS interface X126

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

A teleservice adapter can be connected to the PROFIBUS interface for remote diagnostics. The power supply for the teleservice (terminals 2 and 7) can have a load of up to 150 mA.

NOTICE

Damage to the Control Unit or other PROFIBUS nodes due to high leakage currents

If a suitable equipotential bonding conductor is not used, significant leakage currents can flow along the PROFIBUS cable and destroy the Control Unit or other PROFIBUS nodes.

- An equipotential bonding conductor with a cross-section of at least 25 mm² must be used between components in a system that are located at a distance from each other.

NOTICE

Damage to the Control Unit or other CAN bus nodes due to the connection of a CAN cable

If a CAN cable is connected to the X126 interface, this can destroy the Control Unit or other CAN bus nodes.

- Do not connect a CAN cable to the X126 interface.

PROFIBUS connector

The terminating resistors must be inserted for the first and last nodes in a line; otherwise, data transmission will not function correctly.

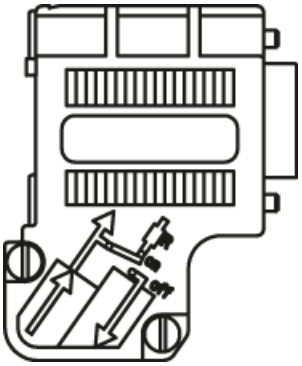
The bus terminating resistors are activated in the connector.

The cable shield must be connected at both ends and over a large surface area.

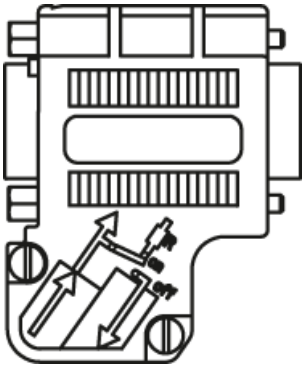
Connectors

Cables must be connected via PROFIBUS connectors because they have the necessary bus terminating resistors.

The figure below shows the correct PROFIBUS connector with and without a PG/PC connector.



PROFIBUS connector
without PG/PC connection
6ES7972-0BA42-0XA0



PROFIBUS connector
with PG/PC connection
6ES7972-0BB42-0XA0

Bus terminating resistor

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

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

The cable shield must contact at both ends with the greatest possible surface area.

Note

Connector type

The proper connector assignment (IN/OUT) in conjunction with the terminating resistor must be observed according to the connector type.

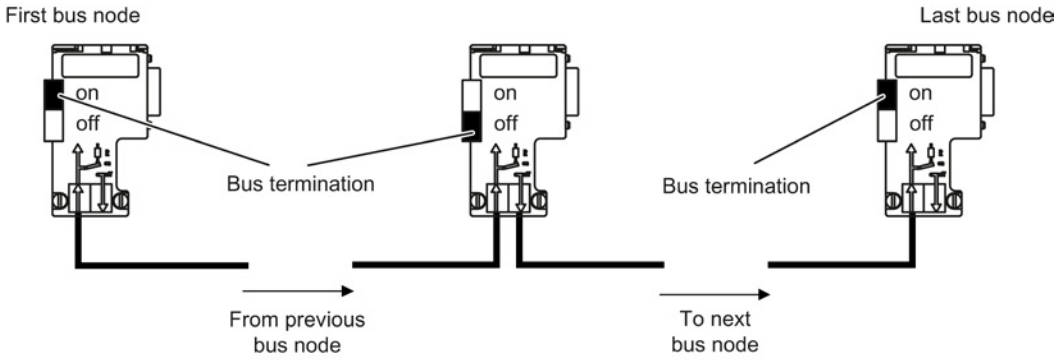
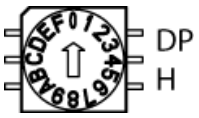
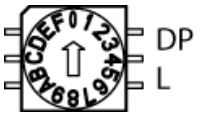


Figure 4-14 Position of the bus terminating resistors

PROFIBUS address switches

The PROFIBUS address is set as a hexadecimal value via two rotary coding switches. Values between 0_{dec} (00_{hex}) and 127_{dec} ($7F_{hex}$) can be set as the address. The upper rotary coding switch (H) is used to set the hexadecimal value for 16^1, and the lower rotary coding switch (L) is used to set the hexadecimal value for 16^0.

Table 4- 14 PROFIBUS address switches

Rotary coding switches	Significance	Examples		
		21_{dec}	**35_{dec}**	**126_{dec}**
		15_{hex}	**23_{hex}**	**$7E_{hex}$**
	$16^1 = 16$	1	2	7
	$16^0 = 1$	5	3	E

Setting the PROFIBUS address

The factory setting for the rotary coding switches is 0_{dec} (00_{hex}).

There are two ways to set the PROFIBUS address:

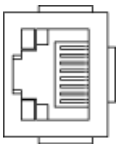
1. Via p0918
   - To set the bus address for a PROFIBUS node using STARTER, first set the rotary code switches to 0_{dec} (00_{hex}) and 127_{dec} ($7F_{hex}$).
   - Then use parameter p0918 to set the address to a value between 1 and 126.
2. Via the PROFIBUS address switches on the Control Unit
   - The address is set manually to values between 1 and 126 using the rotary coding switches. In this case, p0918 is only used to read the address.

Note

The rotary coding switches used to set the PROFIBUS address are located beneath the cover.

X127: LAN (Ethernet)

Table 4- 15 X127 LAN (Ethernet)

	Pin	Designation	Technical specifications
	1	TXP	Ethernet transmit data +
	2	TXN	Ethernet transmit data -
	3	RXP	Ethernet receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Ethernet receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
Connector type: RJ45 socket			

Note

The LAN (Ethernet) interface does not support Auto MDI(X). For this reason, only crossed cables may be used to connect devices.

For diagnostic purposes, the X127 LAN interface features a green and a yellow LED. These LEDs indicate the following status information:

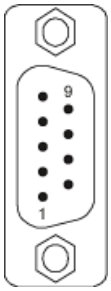
Table 4- 16 LED states for the X127 LAN interface

LED	Color	Status	Description
Link port	-	Off	Missing or faulty link
	Green	Continuous light	10 or 100 Mbit link available
Activity port	-	Off	No activity
	Yellow	Flashing light	Sending or receiving

X140: serial interface (RS232)

The AOP30 operator panel for operating/configuring the device can be connected via the serial interface. The interface is located on the underside of the Control Unit.

Table 4- 17 Serial interface (RS232) X140

	Pin	Designation	Technical specifications
	2	RxD	Receive data
	3	TxD	Send data
	5	Ground	Ground reference
Connector type: 9-pin sub D connector			

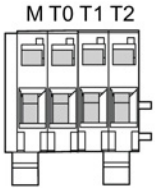
Note

Connecting cable to the AOP30

The connection cable to AOP30 may only contain the three contacts which are shown in the drawing; a completely allocated cable may not be used.

T0, T1, T2: Measuring socket contacts

Table 4- 18 Measuring socket contacts T0, T1, T2

	Socket	Function	Technical specifications
	M	Ground	Voltage: 0… 5 V Resolution: 8 bits Load current: max. 3 mA Sustained short-circuit-proof The reference potential is terminal M
	T0	Measuring socket contact 0	
	T1	Measuring socket contact 1	
	T2	Measuring socket contact 2	
PCB plug connector from Phoenix Contact, type: ZEC 1.0/ 4-ST-3.5 C1 R1.4, order number: 1893708			

Note

Cable cross-section

The measuring socket contacts are only suitable for cable cross-sections of 0.2 mm^2 to 1 mm^2.

Note

Use of the measuring socket contacts

The measuring socket contacts are used to support commissioning and diagnostics. Connection during operation is not permitted.

DIAG button

The DIAG pushbutton is reserved for service functions.

Slot for the memory card



Figure 4-15 Slot for the memory card

WARNING

Danger to life due to software manipulation when using exchangeable storage media

Storing files on exchangeable storage media poses an increased risk of infection, for example, by viruses and malware. Incorrect parameter assignment can cause machines to malfunction, which can lead to injuries or death.

- Protect files stored on exchangeable storage media from malicious software with suitable protection measures, for example, virus scanners.

Note

Possible plant standstill by withdrawing or inserting the memory card in operation

If the memory card is withdrawn or inserted during operation, then data can be lost, possibly resulting in a plant standstill.

- Pull and plug the memory card only when the Control Unit is de-energized.

Note

Insertion direction of the memory card

Only insert the memory card as shown in the photo above (arrow at top right).



NOTICE

Damage to memory card due to electric fields or electrostatic discharge

Electrical fields or electrostatic discharge may result in damage to the memory card and therefore malfunctions.

- When removing and inserting the memory card, always observe the ESD regulations.

Note

Possible data loss when returning the Control Unit with memory card

When a defective Control Unit is returned, the data on the memory card (parameters, firmware, licenses, etc.) may be lost during repair and testing.

- Do not return the memory card with the Control Unit. Instead, keep it in a safe place so that it can be inserted in the replacement unit.

Note

Please note that only SIEMENS memory cards can be used to operate the Control Unit.

4.8.2 Customer terminal module

Note

Preassignment and position of the customer terminal block

The factory setting and description of the customer terminal module can be found in the circuit diagrams.

The location of the customer terminal module in the enclosed drive is indicated in the layout diagram.

Types A and C

In the Type C enclosed chassis, the TM31 Terminal Module is used as the customer terminal module; the external signals must be connected to it.

Type A with option G65

For Type A enclosed drives with option G65, the connections of the TM31 Terminal Module are routed to an intermediate terminal block (-X65), which can be used for customer connections with a larger conductor cross-section.

Shield connection

The shield connection of shielded control cables on the customer terminal module (-A60 or -X65) is established in the immediate vicinity of the terminal module. For this purpose, the customer terminal module –A60 and the mounting plates have cut-out sections which are used to snap the enclosed shield springs into place. The shields of incoming and outgoing cables must be applied directly to these shield connections. It is important here to establish the greatest possible area of contact and a good conductive connection.

Note

Shield springs

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

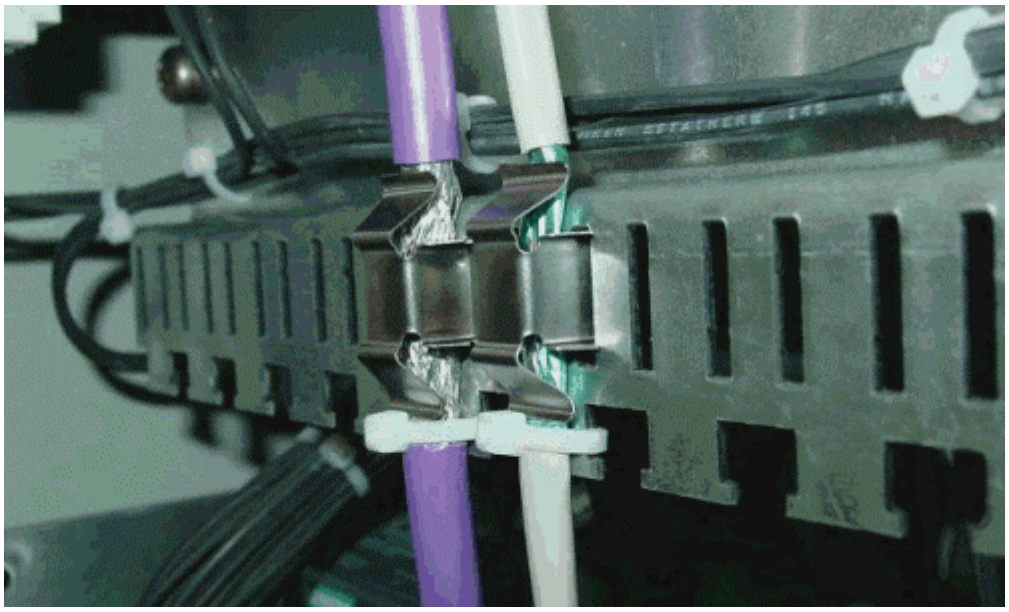


Figure 4-16 Shield connection

4.8.2.1 Customer terminal block (-A60) (for types A and C)

Overview

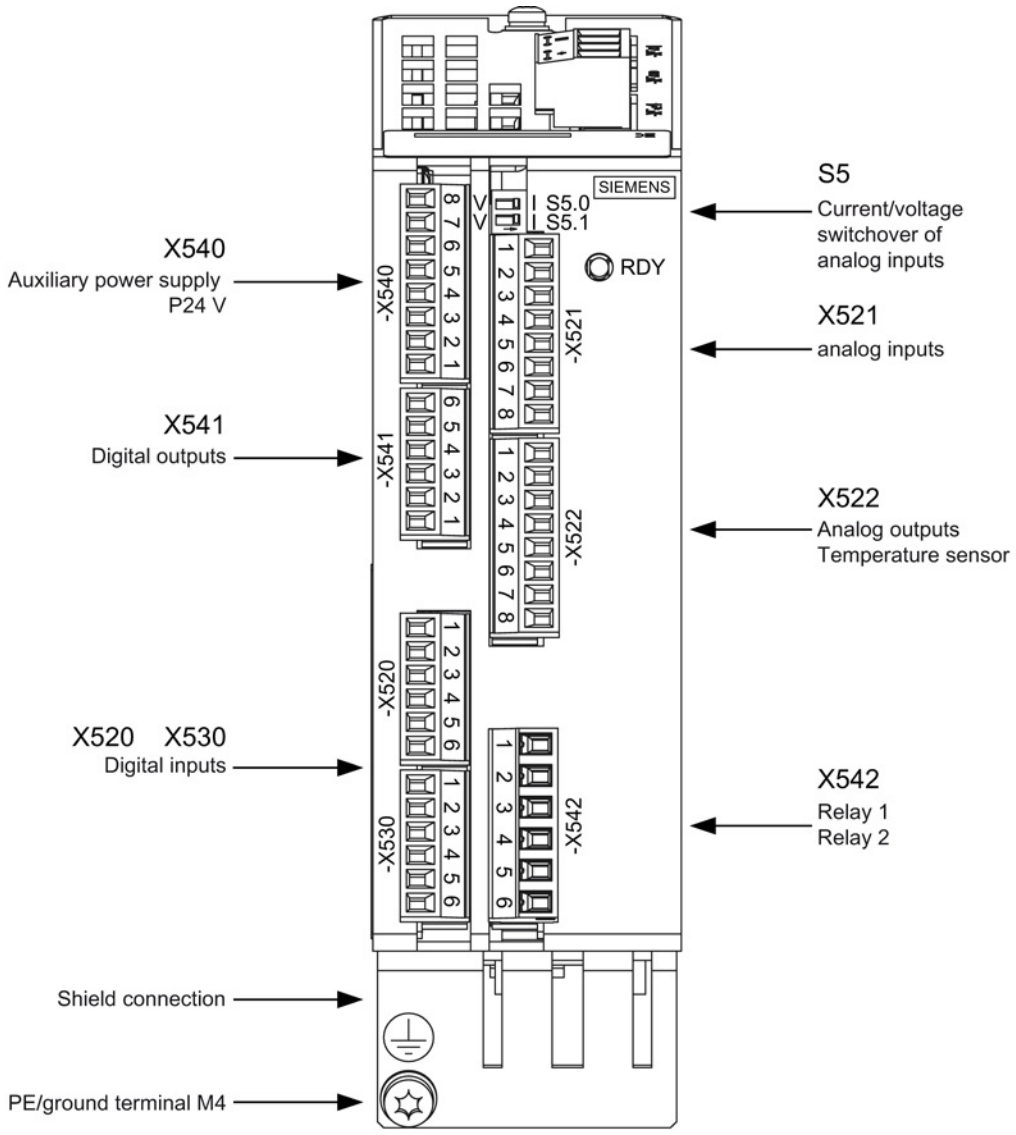


Figure 4-17 TM31 customer terminal module

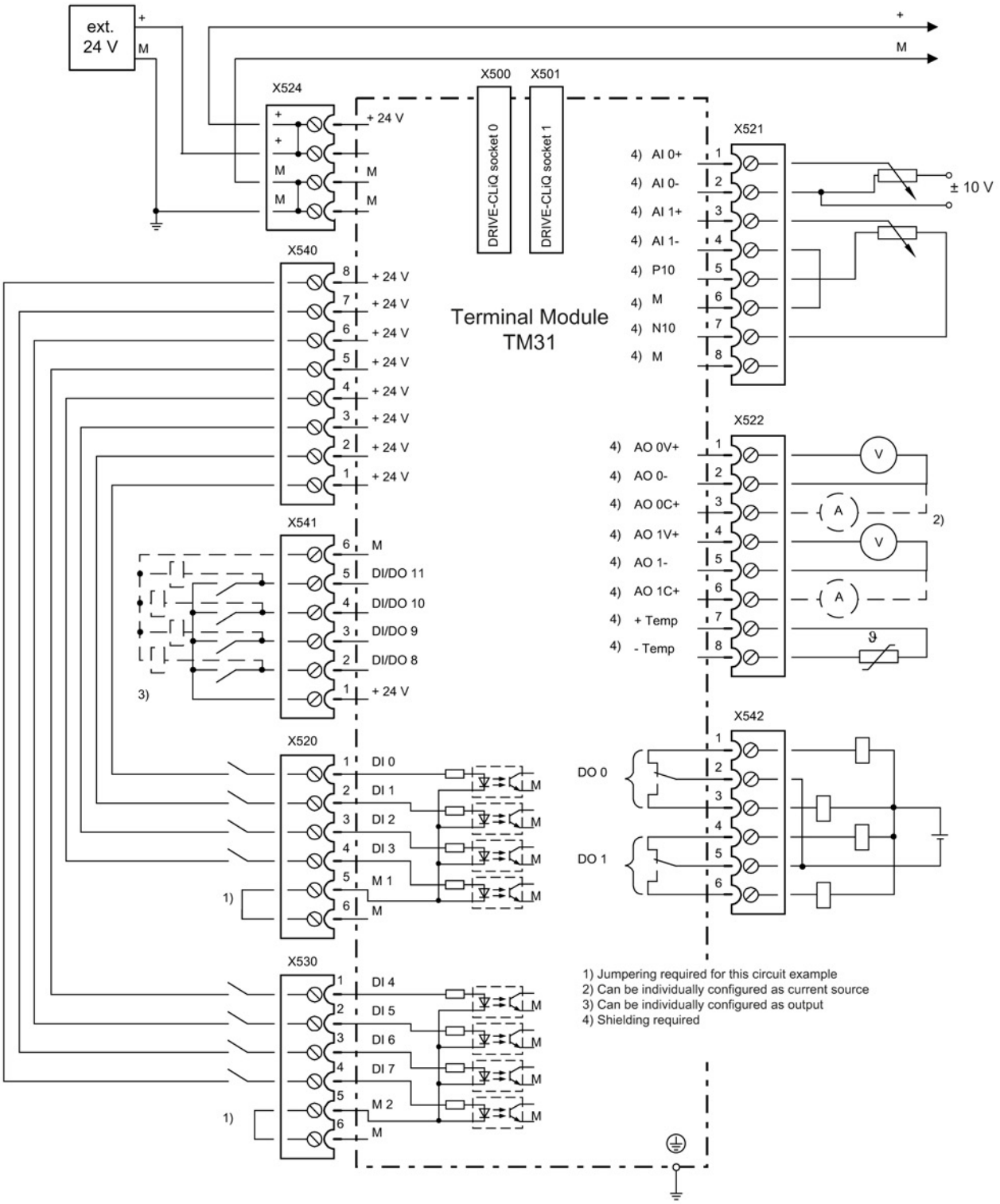


Figure 4-18 Connection overview of TM31 customer terminal module

4.8.2.2 Customer terminal block (-X65) (for type A with option G65)

Overview

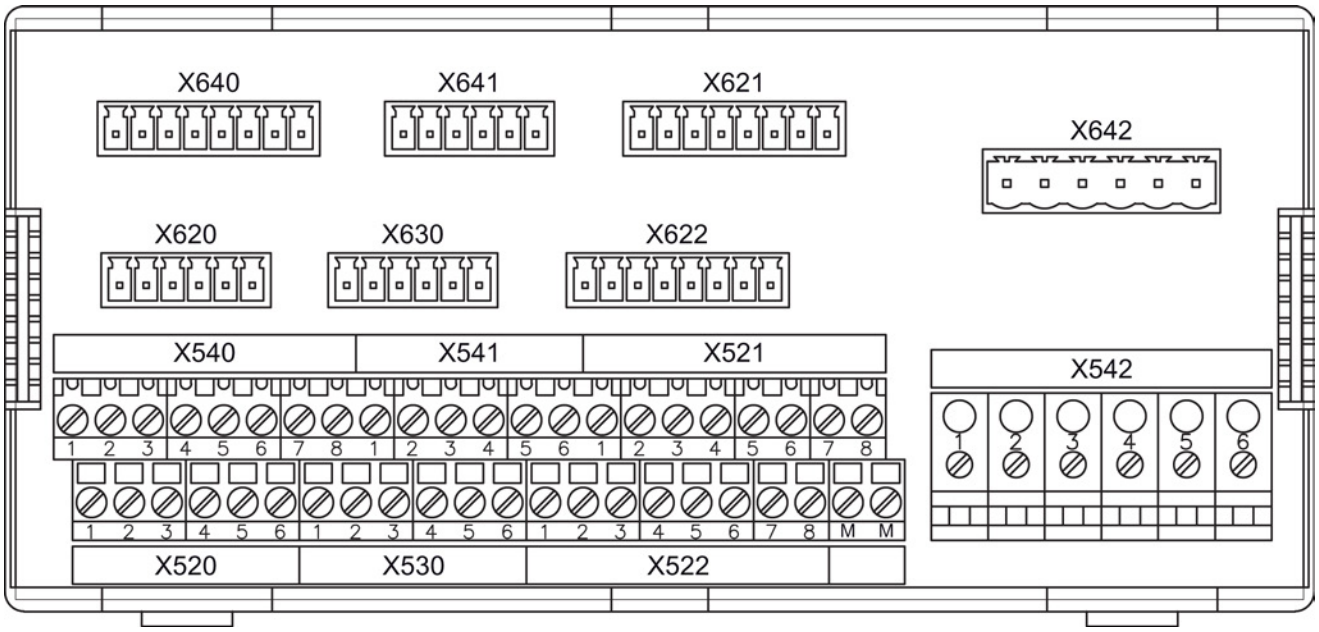


Figure 4-19 Customer terminal module

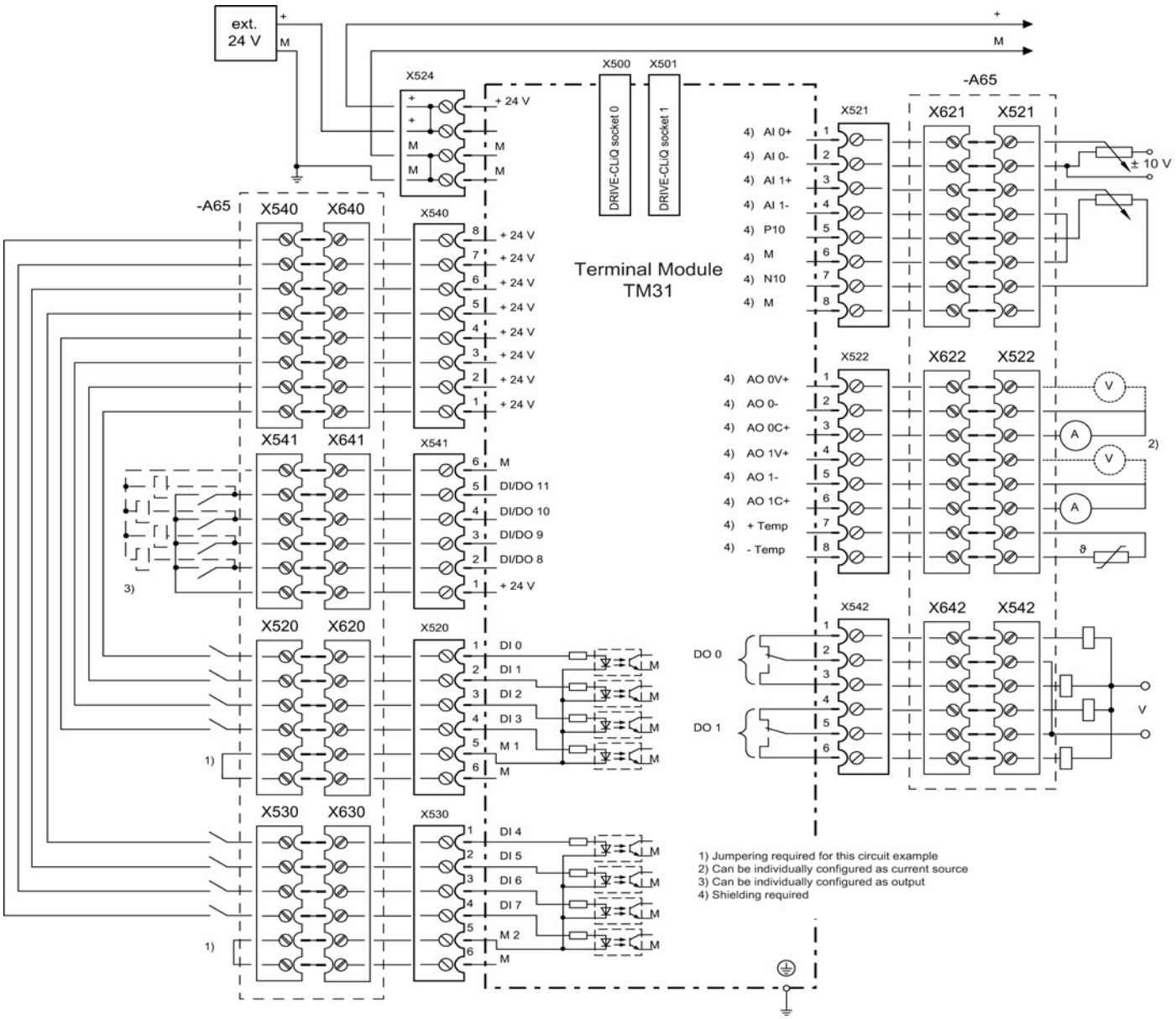
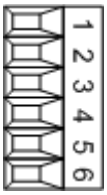


Figure 4-20 Connection overview of customer terminal module

4.8.2.3 Terminal descriptions

X520: 4 digital inputs

Table 4- 19 Terminal block X520

	Terminal	Designation [1]	Technical specifications
	1	DI 0	**Voltage**: - 3 … +30 V **Current consumption** typical: 10 mA at 24 V DC **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 **Signal level** (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	
	6	M	

[1] DI: digital input; M1: ground reference; M: Electronics ground

Max. connectable cross-section:
- Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

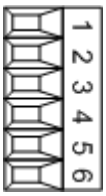
Terminal M1 must be connected so that the digital inputs (DI) can function.

This is achieved through one of the following measures:

1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

X530: 4 digital inputs

Table 4- 20 Terminal block X530

	Terminal	Designation [1]	Technical specifications
	1	DI 4	**Voltage**: - 3 … +30 V **Current consumption** typical: 10 mA at 24 V DC **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 **Signal level** (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	
	6	M	

[1] DI: digital input; M2: ground reference; M: Electronics ground

Max. connectable cross-section:
- Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

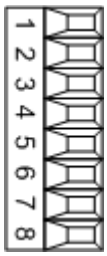
To enable the digital inputs (DI) to function, terminal M2 must be connected.

This is achieved through one of the following measures:

1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

X521: 2 analog inputs (differential inputs)

Table 4- 21 Terminal block X521

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

[1] AI: analog input; P10/N10: auxiliary voltage, M: Ground reference

Max. connectable cross-section:
- Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)

NOTICE

Damage or malfunction due to impermissible voltage values

If a current exceeding ±35 mA flows through the analog current input, then the component could be destroyed.

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

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

Note

The voltage supply for the analog inputs can be taken internally or from an external voltage source.

S5: Selector for voltage/current AI0, AI1

Note
Position of the selector

The selector is located on the customer terminal block TM31 (-A60), a selector setting also has to be made on TM31 for enclosed drives of type A with option G65.

Table 4- 22 Selector for voltage/current S5

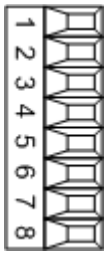
	Switch	Function
	S5.0	Selects voltage (V) / current (I) AI0
	S5.1	Selects voltage (V) / current (I) AI1

Note
Factory state

The factory state for both switches is current measurement (switch set to "I").

X522: 2 analog outputs, temperature sensor connection

Table 4- 23 Terminal block X522

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

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

Max. connectable cross-section:
- Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)



WARNING

Danger to life from electric shock in the event of voltage flashovers at the temperature sensor

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

- Use temperature sensors that fully comply with the specifications of the safety isolation.

NOTICE

Damage or malfunction due to impermissible voltage values

If the back EMF is impermissible, the components may be damaged or malfunction.

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

NOTICE

Damage to motor when KTY temperature sensor is connected incorrectly

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

- Connect a KTY temperature sensor with the correct polarity.

X540: Joint auxiliary voltage for the digital inputs

Table 4- 24 Terminal block X540

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

Max. connectable cross-section:
- Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)

Note

Use of the voltage supply

This voltage supply is used only for supplying the digital inputs.

X541: 4 non-floating digital inputs/outputs

Table 4- 25 Terminal strip X541

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

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

Connectable cross-section:

- max. Types A and C: #16 AWG (1.5 mm²)
- Type A with option G65: #14 AWG (2.5 mm²)

Note

Open input

An open input is interpreted as "low".

Note

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

X542: 2 relay outputs (two-way contact)

Table 4- 26 Terminal block X542

	Terminal	Designation [1]	Technical specifications
	1	DO 0.NC	Contact type: Change-over contact max. load current: 8 A Max. switching voltage: 250 V_{AC}, 30 V_{DC} Max. switching power at 250 V_{AC}: 2000 VA (cosϕ = 1) Max. switching power at 250 V_{AC}: 750 VA (cosϕ = 0.4) Max. switching power at 30 V_{DC}: 240 W (resistive load) Required minimum current: 100 mA Output delay: ≤ 20 ms [2] Overvoltage category: Class II acc. to EN 60664-1
	2	DO 0.COM	
	3	DO 0.NO	
	4	DO 1.NC	
	5	DO 1.COM	
	6	DO 1.NO	

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

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

Max. connectable cross-section:
- Types A and C: #14 AWG (2.5 mm²)
- Type A with option G65: #12 AWG (4.0 mm²)

Note

Additional protective earth

If 115 V AC is applied to the relay outputs, the terminal module (-A60) must also be grounded via a #14 AWG (2.5 mm²) ground conductor.

4.9 Other connections

Depending on the options installed, further connections may need to be established, for example, dv/dt filter plus Voltage Peak Limiter, input contactor, sine-wave filter, connection for external auxiliary equipment, enclosure light with service socket, enclosure space heater, safety relay combination (EMERGENCY OFF / EMERGENCY STOP), braking unit, RTD monitor, insulation monitor, communication modules, or speed encoder module.

More detailed information on how to interconnect individual options with interfaces is provided on customer DVD supplied with the unit.

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

Description

The dv/dt filter plus voltage peak limiter comprises two components: the dV/dt reactor and the **V**oltage **P**eak **L**imiter, which limits transients and returns the energy to the DC link.

The dv/dt filters plus voltage peak limiter must be used for motors for which the dielectric strength of the insulation system is unknown or insufficient. Standard Siemens 1LA5, 1LA6, and 1LA8 series motors only require these at supply voltages > 500 V +10 %.

The dv/dt filter plus voltage peak limiter limits the voltage gradient to values < 500 V/µs and the typical transients to the values indicated below (motor cable lengths < 150 m):

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

Option L10 requires an additional cabinet with a width as shown in the table below.

Table 4- 27 Accommodating the voltage limiting network in an additional cabinet

Voltage range	Installation of the voltage limiting network in an additional cabinet Width = 23.6" (600 mm)	Installation of the voltage limiting network in an additional cabinet Width = 15.8" (400 mm)
380 ... 480 V AC 3-ph.	6SL3710-1GE32-1AUx 6SL3710-1GE32-6AUx 6SL3710-1GE33-1AUx 6SL3710-1GE33-8AUx 6SL3710-1GE35-0AUx	6SL3710-1GE36-1AUx 6SL3710-1GE37-5AUx 6SL3710-1GE38-4AUx 6SL3710-1GE41-0AUx
500 ... 600 V AC 3-ph.	6SL3710-1GF31-8AUx 6SL3710-1GF32-2AUx 6SL3710-1GF32-6AUx 6SL3710-1GF33-3AUx	6SL3710-1GF34-1AUx 6SL3710-1GF34-7AUx 6SL3710-1GF35-8AUx 6SL3710-1GF37-4AUx 6SL3710-1GF38-1AUx

Restrictions

The following restrictions should be noted when a dv/dt filter plus voltage peak limiter is used:

- The output frequency is limited to no more than 150 Hz.
- Maximum permissible motor cable lengths:
  - Shielded cable: max. 980 ft (300 m)
  - Unshielded cable: max. 1480 ft (450 m)

NOTICE

Damage to the dv/dt filter from exceeding the maximum output frequency

The maximum permissible output frequency when using a dv/dt filter is 150 Hz. The dv/dt filter can be damaged if the output frequency is exceeded.

- Operate the dv/dt filter with a maximum output frequency of 150 Hz.

NOTICE

Damage to the dv/dt filter from exceeding the maximum pulse frequency

The maximum permissible pulse frequency when using a dv/dt filter is 2.5 kHz or 4 kHz. The dv/dt filter can be damaged if the pulse frequency is exceeded.

- When using the dv/dt filter, operate the Power Module with a maximum pulse frequency of 2.5 kHz or 4 kHz.

NOTICE

Damage to the dv/dt filter if it is not activated during commissioning

The dv/dt filter may be damaged if it is not activated during commissioning.

- Activate the dv/dt filter during commissioning via parameter p0230 = 2.

NOTICE

Damage to the dv/dt filter when a motor is not connected

dv/dt filters that are operated without a motor being connected can be damaged or destroyed.

- Never operate a dv/dt filter connected to the Power Module without a connected motor.

Note

Setting of pulse frequencies

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

Table 4- 28 Max. pulse frequency when a dv/dt filter plus voltage peak limiter is used in units with a rated pulse frequency of 2 kHz

Order no. 6SL3710-...	Unit rating [HP / kW]	Output current for a pulse frequency of 2 kHz [A]	Max. pulse frequency when a dV/dt filter is used
Supply voltage 380 to 480 V AC			
1GE32-1UAx	150 / 110	210	4 kHz
1GE32-6UAx	200 / 132	260	4 kHz
1GE33-1UAx	250 / 160	310	4 kHz
1GE33-8UAx	300 / 200	380	4 kHz
1GE35-0UAx	400 / 250	490	4 kHz

Table 4- 29 Max. pulse frequency when a dv/dt filter plus voltage peak limiter is used in units with a rated pulse frequency of 1.25 kHz

Order no. 6SL3710-...	Unit rating [HP / kW]	Output current for a pulse frequency of 1.25 kHz [A]	Max. pulse frequency when a dV/dt filter is used
Supply voltage 380 to 480 V AC			
1GE36-1UAx	500 / 315	605	2.5 kHz
1GE37-5UAx	600 / 400	745	2.5 kHz
1GE38-4UAx	700 / 450	840	2.5 kHz
1GE41-0UAx	800 / 560	985	2.5 kHz
Supply voltage 500 to 600 V AC			
1GF31-8UAx	150 / 110	175	2.5 kHz
1GF32-2UAx	200 / 132	215	2.5 kHz
1GF32-6UAx	250 / 160	260	2.5 kHz
1GF33-3UAx	300 / 200	330	2.5 kHz
1GF34-1UAx	400 / 250	410	2.5 kHz
1GF34-7UAx	500 / 315	465	2.5 kHz
1GF35-8UAx	600 / 400	575	2.5 kHz
1GF37-4UAx	700 / 500	735	2.5 kHz
1GF38-1UAx	800 / 560	810	2.5 kHz

Commissioning

During commissioning, the dv/dt filter plus voltage peak limiter must be logged on using STARTER or the AOP30 operator panel (p0230 = 2).

Note

Reset when establishing the factory setting

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

4.9.2 Input contactor (Option L13)

Description

The enclosed drive is designed as standard without an input contactor. Option L13 (input contactor) is needed if a switching element is required for disconnecting the drive from the supply (necessary with EMERGENCY OFF). The contactor is controlled and powered from within the cabinet.

Connecting

Table 4- 30 Terminal block X50 – checkback contact "input contactor closed"

Terminal	Designation [1]	Technical specifications
4	NO	Max. load current: 10 A
5	NC	Max. switching voltage: 250 V AC
6	COM	Max. switching capacity: 250 VA
		Required minimum load: ≥ 1 mA

[1] NO: normally-open contact, NC: normally-closed contact, COM: mid-position contact

Max. connectable cross section: #12 AWG (4 mm²)

4.9.3 Feeder for external auxiliaries / motor blower (option L17)

Description

This option includes a switched three-phase output at line voltage for an external device such as a motor blower which is fused at max. 5 A. The voltage is tapped at the drive input upstream of the input contactor/circuit breaker and, therefore, has the same level as the supply voltage. The outgoing circuit can be switched within the drive or externally.

Connecting

Table 4- 31 Terminal block X155 - Connection for external device/motor blower

Terminal	Designation [1]	Technical specifications
1	L1	380 to 480 V 3 ph. AC 500 to 600 V 3 ph. AC
2	L2	
3	L3	
11	Contactor control	115 V AC
12		
13	NO: Checkback motor circuit breaker	115 V AC / 0.5 A 24 V DC / 2 A
14		
15	NO	NO contact for checkback signal for 115 V AC / 6 A contactor
16	COM	Mid-position contact for terminals 15 and 17
17	NC	NC contact for checkback signal for 115 V AC / 6 A contactor
PE	PE	PE

[1] NO: normally-open contact, NC: normally-closed contact, COM: mid-position contact

Max. connectable cross-section: #12 AWG (4 mm²)

Note

Protection setting

The connection for external device/motor blower must be set in accordance with the load connected (-Q155).

Circuit proposal for controlling the auxiliary contactor from within the drive

The following circuit, for example, can be used if the auxiliary contactor is to be controlled from within the drive. The “Operation” message is then no longer available for other purposes.

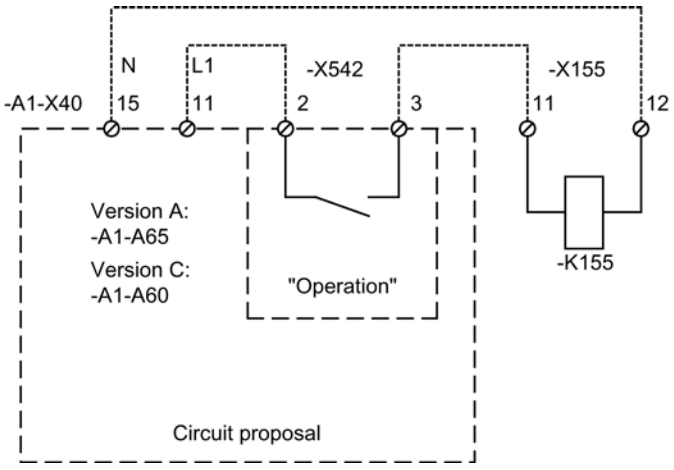


Figure 4-21 Circuit proposal for controlling the auxiliary contactor from within the drive

Note

Additional protective conductor

If 115 V AC is applied to the relay outputs, the customer terminal module must also be grounded via a #14 AWG (2.5 mm²) ground conductor.

4.9.4 3-contactor bypass (option L29)

Description

The 3-contactor bypass circuit with allows the motor to be switched from the drive to the bypass circuit in the event of a drive fault, for example. The switchover to the bypass or to the drive takes place manually, as does the motor startup (direct line operation (DOL Start)).

The option includes:

- Contactor disconnectors at the drive input and output
- Bypass contactor
- Mechanical interlock on the output contactor and bypass contactor, in addition to the electrical interlock on all three contactors
- Electronic overload relay in the bypass circuit
- Changeover switch for VFD OFF bypass
- Pushbuttons for bypass ON and bypass OFF
- Indicator lights for bypass READY (green) and RUN (yellow)

The principle of operation is as follows:

- Under normal circumstances, the motor operates in drive mode (VFD):
  - The selector is in the "VFD" position.
  - The contactor at the drive output is closed.
  - On receiving a starting signal, the drive closes the input contactor to connect the line to the drive circuit.
- If the selector is switched to the "OFF" position:
  - The drive receives an "OFF2" signal, disconnecting the line supply and causing the motor to coast down.
  - Neither drive mode nor bypass mode is possible in this position. The bypass contactor and the contactors at the drive input and output are open.

- If the selector is switched to the "Bypass" position, and the electronic overload relay does not trip:
  - The "Bypass READY" indicator lights up.
  - The contactors at the drive input and output are open.
- The "Bypass ON" command closes the bypass contactor, connecting the motor directly to the line:
  - The motor starts up.
  - The "Bypass RUN" indicator lights up.
- The "Bypass OFF" command opens the bypass contactor:
  - The motor coasts down.
  - The "Bypass RUN" indicator goes dark, and the "Bypass READY" indicator lights up.
- If the electronic overload relay trips:
  - The bypass contactor is opened, and the motor coasts down.
  - The "Bypass READY" and "Bypass RUN" indicators go dark.
  - After the electronic overload relay is reset, the "Bypass READY" indicator lights up, and the motor can be switched on again.

4.9.5 Soft starter bypass (option L30)

Description

The soft starting bypass circuit allows the motor to be switched from the drive to the bypass circuit in the event of a drive fault, for example. The switchover to the bypass or to the drive takes place manually, as does the motor startup with a soft starter (RVSS).

The option includes:

- Contactor disconnectors at the drive input and output
- Contactor disconnectors at the soft starter input and output
- Mechanical interlock on the output contactor and soft starter contactor, in addition to the electrical interlock on all four contactors
- Siemens soft starter model 3RW44 with an internal bypass contactor and electronic motor overload protection
- Changeover switch for VFD OFF bypass
- Pushbuttons for bypass ON and bypass OFF
- Indicator lights for bypass READY (green), RUN (yellow), and FAULT (red)

The principle of operation is as follows:

- Under normal circumstances, the motor operates in drive mode (VFD):
  - The selector is in the "VFD" position.
  - The contactors at the soft starter input and output are open.
  - The output contactor on the drive is closed.
  - On receiving a starting signal, the drive closes the input contactor to connect the line to the drive circuit.
- If the selector is switched to the "OFF" position:
  - The drive receives an "OFF2" signal, disconnecting the line supply and causing the motor to coast down.
  - Neither drive mode nor bypass mode is possible in this position. The soft starter contactor and the contactors at the drive input and output are open.
- If the selector is switched to the "Bypass" position, and the soft starter has no error messages:
  - The "Bypass READY" indicator lights up.
  - The contactors at the drive input and output are open.
  - The contactors at the soft starter input and output are closed.

Please consult the Soft Starter 3RW44 System Manual for information on the soft starter functions and commissioning procedure.

General:

- The "Bypass ON" command activates the soft starter to start the motor:
  - The motor starts up.
  - The "Bypass RUN" indicator lights up.
- The "Bypass OFF" initiates the procedure for stopping the motor:
  - The motor decelerates on a ramp or coasts down, depending on the soft starter settings.
  - The "Bypass RUN" indicator goes dark, and the "Bypass READY" indicator lights up.
- If a soft starter monitor trips:
  - The "Bypass FAULT" indicator lights up, and the motor coasts down.
  - The "Bypass READY" and "Bypass RUN" indicators go dark.
  - After the soft starter is reset, the "Bypass FAULT" indicator goes dark, the "Bypass READY" indicator lights up, and the motor can be switched on again.

4.9.6 Enclosure light with service socket (option L50)

Description

With this option, a universal lamp with an integrated service socket is installed in the enclosure. The power supply for the enclosure light and socket must be provided externally and fused at max. 10 A. The light is switched on manually with a slide switch.

Connecting

Table 4- 32 Terminal block X390 – connection for enclosure light with service socket

Terminal	Designation	Technical specifications
1	L1	115 V AC power supply
2	N	
3	PE	Protective conductor

Max. connectable cross section: #12 AWG (4 mm²)

4.9.7 Enclosure space heater (option L55)

Description

The enclosure space heater is used at low ambient temperatures and high levels of humidity to prevent condensation from forming.

For enclosure widths 15.8" (400 mm) and 23.6" (600 mm), one 100-W heater is used. For enclosure widths ranging from 31.5" (800 mm) to 47.2" (1200 mm), two heaters, 100 W each, are installed. The power supply for the heating (115 V AC) must be provided externally and protected with a fuse (max. 10 A).



⚠ WARNING

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

When an external supply voltage for the cabinet anti-condensation heating is connected, dangerous voltages continue to be present in the enclosed drive even when the mains switch is open. Death or serious injury can result when live parts are touched.

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

⚠ CAUTION

Risk of injury when hot surfaces on the cabinet anti-condensation heating are touched

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

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

Note

Providing supply voltage with temperature control

The supply voltage can be provided by means of a temperature control, to avoid unnecessary operation of the anti-condensation heating at higher ambient temperatures.

Connecting

Table 4- 33 Terminal block X240 – connection for enclosure space heater

Terminal	Designation	Technical specifications
1	L1	115 V AC power supply
2	N	
3	PE	Protective earth

Max. connectable cross-section: #12 AWG (4 mm²)

4.9.8 ALL STOP, coast to stop (Option N55)

Description

The mushroom pushbutton with protective collar and interlock is mounted in the door of the enclosed drive and its contacts are wired to the OFF2 terminal of the Control Unit. After the pushbutton is actuated, the motor coasts to a stop.

The enclosed drive is disconnected from the supply system in conjunction with the L13, L29, and L30 options.

4.9.9 EMERGENCY OFF category 0; 115 V AC or 24 V DC (option N57)

Description

EMERGENCY OFF category 0 for uncontrolled stop according to IEC 60204-1. This function disconnects the cabinet unit from the energy supply via the line contactor, while bypassing the electronics by means of a safety combination according to IEC 60204-1. The motor then coasts to a stop. To prevent the input contactor from switching under load, an OFF2 is triggered simultaneously.

No additional wiring is needed when using the EMERGENCY OFF pushbutton.

The operational status and the function are indicated by three LEDs (-K120).

In the factory state, the type with 115 V AC button circuit is set.

Note

Pressing the EMERGENCY OFF button

When the EMERGENCY OFF pushbutton is pressed, an uncontrolled stop of the motor takes place and the main motor voltage is disconnected in accordance with IEC 60204-1. Auxiliary voltages (e.g., for separately-driven fans or anti-condensation heating) may still be present. Certain sections of the converter (e.g., the closed-loop controller or any auxiliary equipment) also remain live. If all the voltages have to be completely disconnected, the EMERGENCY OFF pushbutton must be integrated in a protection concept, which must be implemented on the line side. A normally closed contact is available at terminal -X120 for this purpose.

Connecting

Table 4- 34 Terminal block X120 – connection for EMERGENCY OFF category 0, 115 V AC and 24 V DC

Terminal	115 V AC and 24 V DC button circuit
4	Jumper wired at the factory
5	
7	Loop in EMERGENCY OFF button from line side: Remove jumpers 7-8 and connect button:
8	
9	Jumper wired at the factory
10	
11	Jumper wired at the factory
14	
12	Jumper wired at the factory
13	
15	"On" for monitored start: Remove jumpers 15–16 and connect button
16	
17	NO: "trip safety combination" checkback
18	

[1] NO: NO contact

Max. connectable cross-section: #12 AWG (4 mm²)

Reconnection to the 24 V DC button circuit

When using the 24 V DC button circuit, you must remove the following jumpers at terminal block -X120:

- 4-5, 9-10, and 11-14

You must also insert the following jumpers at terminal block -X120:

- 4-11, 5-10, and 9-14

Diagnostics

For a description of messages output during operation and in the event of faults (meaning of LEDs on -K120), refer to the Operating Instructions on the customer DVD supplied with the unit.

4.9.10 EMERGENCY STOP category 1; 115 V AC (option N59)

Description

EMERGENCY STOP category 1 for controlled stopping according to ISO 60204-1. This function stops the drive by means of a quick stop along a deceleration ramp that must be parameterized. The enclosed drive is then disconnected from the energy supply via the line contactor, while bypassing the electronics by means of a safety combination (according to IEC 60204-1).
The operating state and the function are indicated by eight LEDs (-K120, -K121).

Connecting

Table 4- 35 Terminal block X120 – connection for EMERGENCY STOP category 1 (115 V AC)

Terminal	Technical specifications
4	Jumper wired at the factory
5	
7	Loop in EMERGENCY OFF button from line side: Remove jumpers 7-8 and connect button.
8	
9	Jumper wired at the factory
10	
11	Jumper wired at the factory
14	
12	Jumper wired at the factory
13	
15	"On" for monitored start: Remove jumpers 15–16 and connect button.
16	
17	NO [1]: "trip safety combination" checkback
18	

[1] NO: NO contact

Max. connectable cross section: #12 AWG (4 mm²)

Setting

The time (0.5 to 30 s) set for the contactor safety combination (-K121) should be greater than (or at least equal to) the time that the drive requires to reach a standstill via the quick stop (OFF3 ramp-down time, p1135), because the converter is disconnected from the energy supply when the time runs out (at -K121).

Diagnostics

Messages output during operation and in the event of faults (meaning of LEDs on -K120, -K121) are described in the operating instructions included on the customer DVD supplied with the device.

4.9.11 EMERGENCY STOP category 1; 24 V DC (option L60)

Description

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

Connecting

Table 4- 36 Terminal block X120 – connection for EMERGENCY STOP category 1 (24 V DC)

Terminal	Technical specifications
4	Jumper wired at the factory
11	
5	Jumper wired at the factory
10	
7	Loop in EMERGENCY OFF button from line side: Remove jumpers 7-8 and connect button.
8	
9	Jumper wired at the factory
14	
12	Jumper wired at the factory
13	
15	"On" for monitored start: Remove jumpers 15–16 and connect button.
16	
17	NO [1]: "trip safety combination" checkback
18	

[1] NO: NO contact

Max. connectable cross section: #12 AWG (4 mm²)

Setting

The time (0.5 to 30 s) set for the contactor safety combination (-K120) should be greater than (or at least equal to) the time that the drive requires to reach a standstill via the quick stop (OFF3 ramp-down time, p1135), because the converter is disconnected from the energy supply when the time runs out (at -K120).

Diagnostics

For a description of messages output during operation and in the event of faults (meaning of LEDs on -K120), refer to the Operating Instructions on the customer DVD supplied with the unit.

4.9.12 25-kW braking unit (option L61); 50-kW braking unit (option L62)

Description

Braking units are used when regenerative energy occurs occasionally and briefly, for example when the brake is applied to the drive (EMERGENCY STOP). The braking units comprise a braking chopper and a load resistor, which must be mounted externally of the drive. To monitor the braking resistance, a thermostat contact integrated in the trip circuit of the drive is provided in the braking resistor.

Table 4- 37 Load data for the braking units

Line voltage	Continuous chopper power P_{DB}	Peak chopper output P_{15}	Chopper P_{20} output P_{20}	Chopper P_{40} output P_{40}	Braking resistor R_B	Max. current
380 V to 480 V	25 kW	125 kW	100 kW	50 kW	4.4 Ω ±7.5 %	189 A
380 V to 480 V	50 kW	250 kW	200 kW	100 kW	2.2 Ω ± 7.5 %	378 A
500 V to 600 V	50 kW	250 kW	200 kW	100 kW	3.4 Ω ±7.5 %	306 A

Installing the braking resistor

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

- The braking resistors are suitable for floor mounting only.
- The maximum cable length between the enclosed drive and braking resistor is 330 ft (100 m).
- Sufficient space must be available for dissipating the energy converted by the braking resistor.
- A sufficient distance from flammable objects must be maintained.
- The braking resistor must be installed as a free-standing unit.
- Objects must not be placed on or anywhere above the braking resistor.
- The braking resistor should not be installed underneath fire detection systems, since these could be triggered by the resulting heat.
- A roof is required for compliance with NEMA 1. For outdoor installation, braking resistors must be installed in an enclosure (NEMA 3R) for protection against falling rain or sleet.

WARNING

Danger to life from fire when installation is inadequate

When installation is inadequate (failure to observe the cooling clearances or insufficient distances from combustible objects), there is a risk of fire leading to death or serious injury.

- Maintain a cooling clearance of 7.9 inches (200 mm) on all sides of the braking resistor with ventilation grills.
- Maintain a sufficient distance from combustible objects.

CAUTION

Risk of injury when hot surfaces on the braking resistor are touched

During operation, the braking resistor can reach high temperatures and can cause burns if touched.

- Allow the braking resistor to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g., gloves.

Table 4- 38 Dimensions of the braking resistors

	Unit	25-kW resistor (option L61)	50-kW resistor (option L62)
Width	inch (mm)	29.1 (740)	31.9 (810)
Height	inch (mm)	23.8 (605)	52.1 (1325)
Depth	inch (mm)	19.1 (485)	19.1 (485)

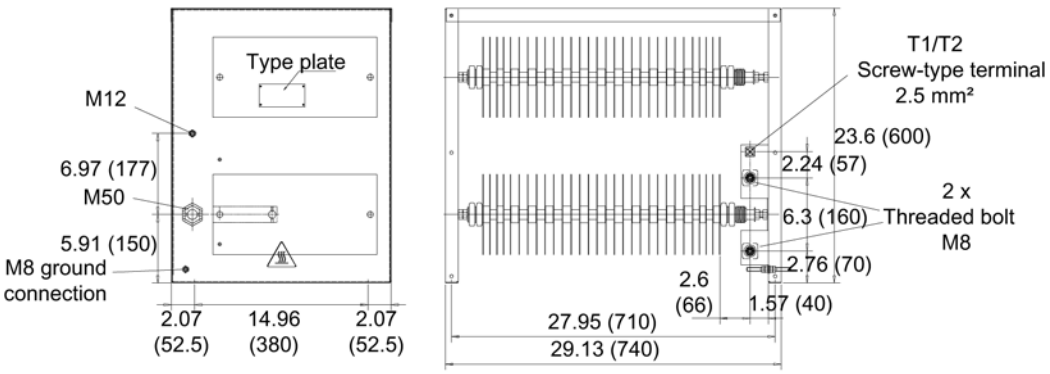


Figure 4-22 Dimension drawing of braking resistor rated 25 kW - specifications in inches (mm)

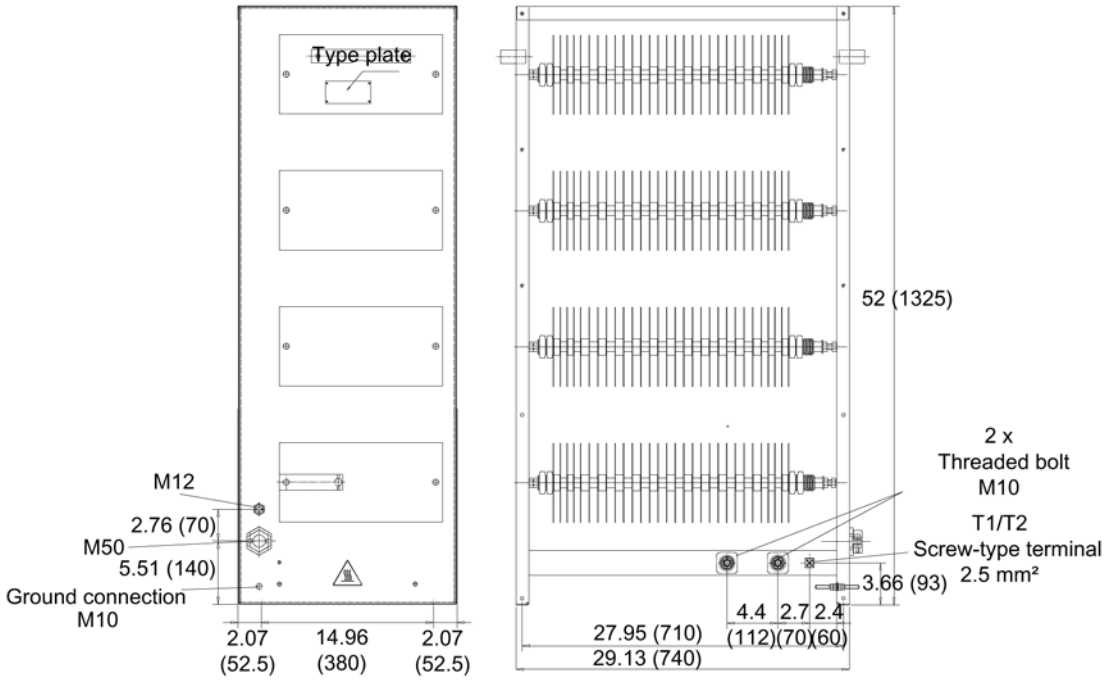


Figure 4-23 Dimension drawing of braking resistor rated 50 kW - specifications in inches (mm)

Connecting the braking resistor

WARNING

Danger to life from fire caused by ground fault / short-circuit when connections to the braking resistor are not fused

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

- Install the connections to the braking resistor in such a way that a ground fault or short-circuit can be excluded.
- Comply with local installation regulations, which allow this fault to be ruled out.
- Protect the cables from mechanical damage.
- Take one of the following measures:
  - Use cables with double insulation.
  - Maintain adequate distances, e.g., using spacers.
  - Route the cables in separate cable ducts or pipes.

NOTICE
Material damage when exceeding the maximum permitted cable length Exceeding the maximum permitted cable length to the braking resistor can cause property damage due to component failure. • Comply with the maximum cable length between the enclosed drive and the braking resistor of 330 ft (100 m).

Table 4- 39 Terminal block -X5 – connection for external braking resistor

Terminal	Description of function
1	Braking resistor connection
2	Braking resistor connection

Max. connectable cross-section: 2/0 (70 mm²)

Recommended conductor cross-sections:

- For L61 (25 kW): #1 AWG (35 mm²)
- For L62 (50 kW): 1/0 (50 mm²)

Connecting the thermostatic switch

Table 4- 40 Connecting the thermostatic switch for the external braking resistor in the trip circuit of the enclosed drive

Terminal	Description of function
T1	Thermostatic switch connection: connection to terminal X541:1 (P24 V)
T2	Thermostatic switch connection: connection to terminal X541:5 (DI11)

Max. connectable cross-section:

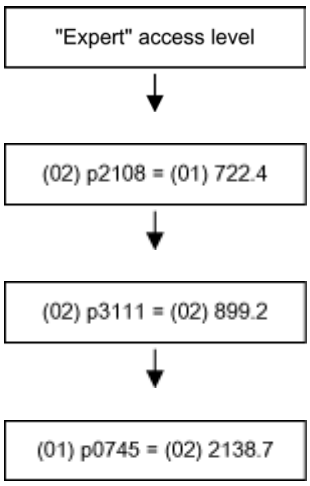
- Type A: #12 AWG (2.5 mm²)
- Type C: (due to TM31): #14 AWG (1.5 mm²)

4.9.12.1 Commissioning

Commissioning

When commissioning via STARTER, parameters are assigned to "external fault 3" and acknowledged automatically when option L61 or L62 is selected.

When commissioning via AOP30, the necessary parameter settings must be made subsequently.



Set the "Expert" access level on the operator panel
<Key button> - <Access level> - Set "Expert" and confirm.

Connect digital input 4 (DI4) on the Control Unit to the first input of "External fault 3".

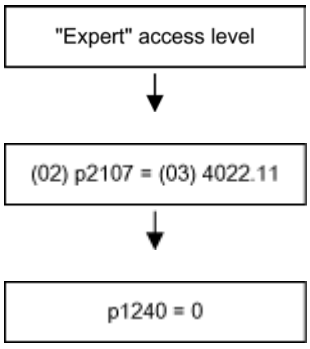
Connect the "Operation" signal to the second input of "External fault 3".

Connect "Acknowledge fault" to digital output 15 (DO15) on the Control Unit.

Drive settings

If the thermostat for the braking resistor is connected to digital input 11, appropriate settings must be made so that the drive is stopped if a fault occurs.

Once the device has been successfully commissioned, you have to make the following changes:



Set the "Expert" access level on the operator panel
<Key button> - <Access level> - Set "Expert" and confirm.

Switch external fault 2 to DI 11 on the TM31.

Disabling the Vdc-max controller
When the brake chopper is used, the Vdc-max controller must be switched off.

4.9.12.2 Diagnostics and duty cycles

Diagnostics

If the thermostat contact opens due to a thermal overload on the braking resistor, fault F7861 ("External Fault 2") is triggered and the drive is switched off with OFF2.

If the brake chopper triggers a fault, fault F7862 "External fault 3" is triggered in the drive.

You can acknowledge malfunctions in the braking unit by pressing the "Acknowledge" button on the operator panel (when DC link voltage is present).

Duty cycles

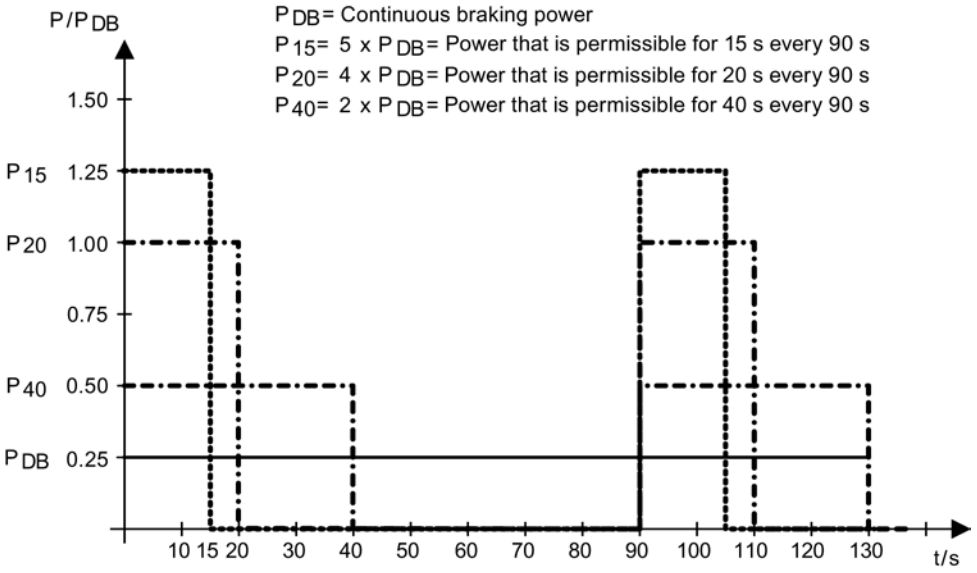


Figure 4-24 Duty cycles for the braking resistors

4.9.12.3 Threshold switch

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

⚠ WARNING

Danger to life from electric shock when operating the threshold switch

Operating the threshold switch when a voltage is present can cause death or serious injury.

- Only operate the threshold switch when the enclosed drive is switched off and the DC link capacitors are discharged.

Table 4- 41 Response thresholds of the braking units

Rated voltage	Response threshold	Switch position	Comments
380 ... 480 V AC 3-ph.	673 V	1	774 V is the factory setting. For line voltages of 380 ... 400 V AC 3-ph., the response threshold can be set to 673 V to reduce the voltage stress on the motor and drive. However, this reduces the possible braking power to the square of the voltages (673/774)² = 0.75. The maximum available braking power is therefore 75 %.
	774 V	2	
500 ... 600 V AC 3-ph.	841 V	1	967 V is the factory setting. With a supply voltage of 500 V AC 3-ph., the response threshold can be set to 841 V to reduce the voltage stress on the motor and drive. However, this reduces the possible braking power to the square of the voltages (841/967)² = 0.75. The maximum available braking power is therefore 75 %.
	967 V	2	

Position of the threshold switch

The braking module is located in the exhaust air duct of the Power Module at the top of the enclosed drive. The position of the threshold switch is indicated in the figures below.

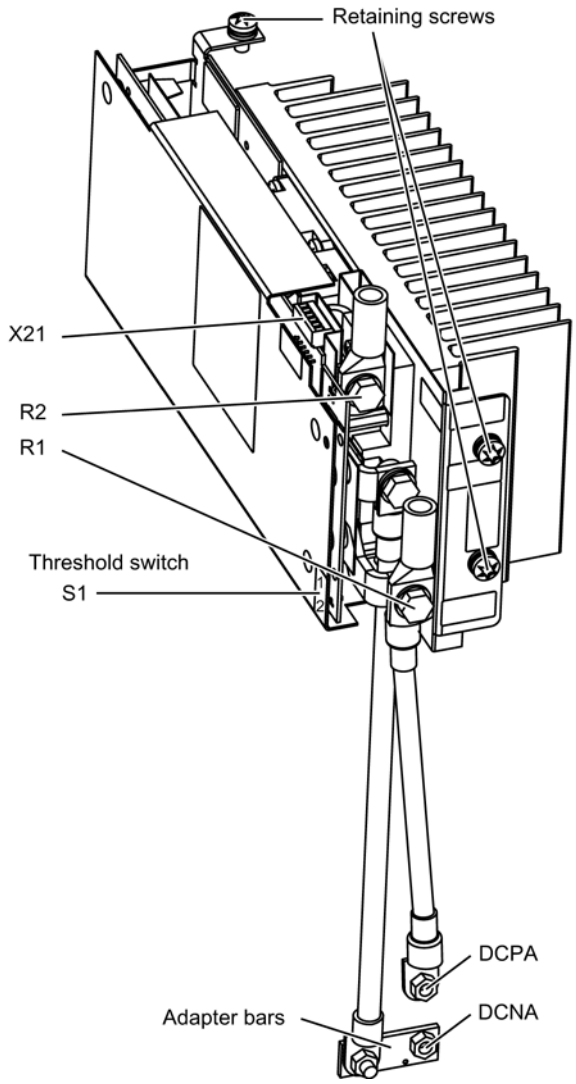


Figure 4-25 Braking modules for frame size FX

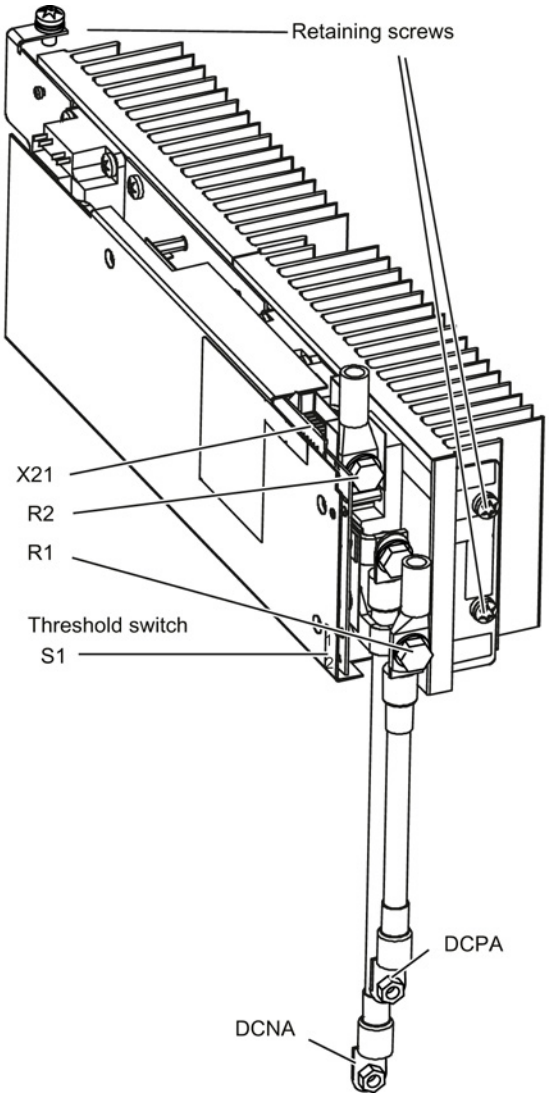


Figure 4-26 Braking modules for frame size GX

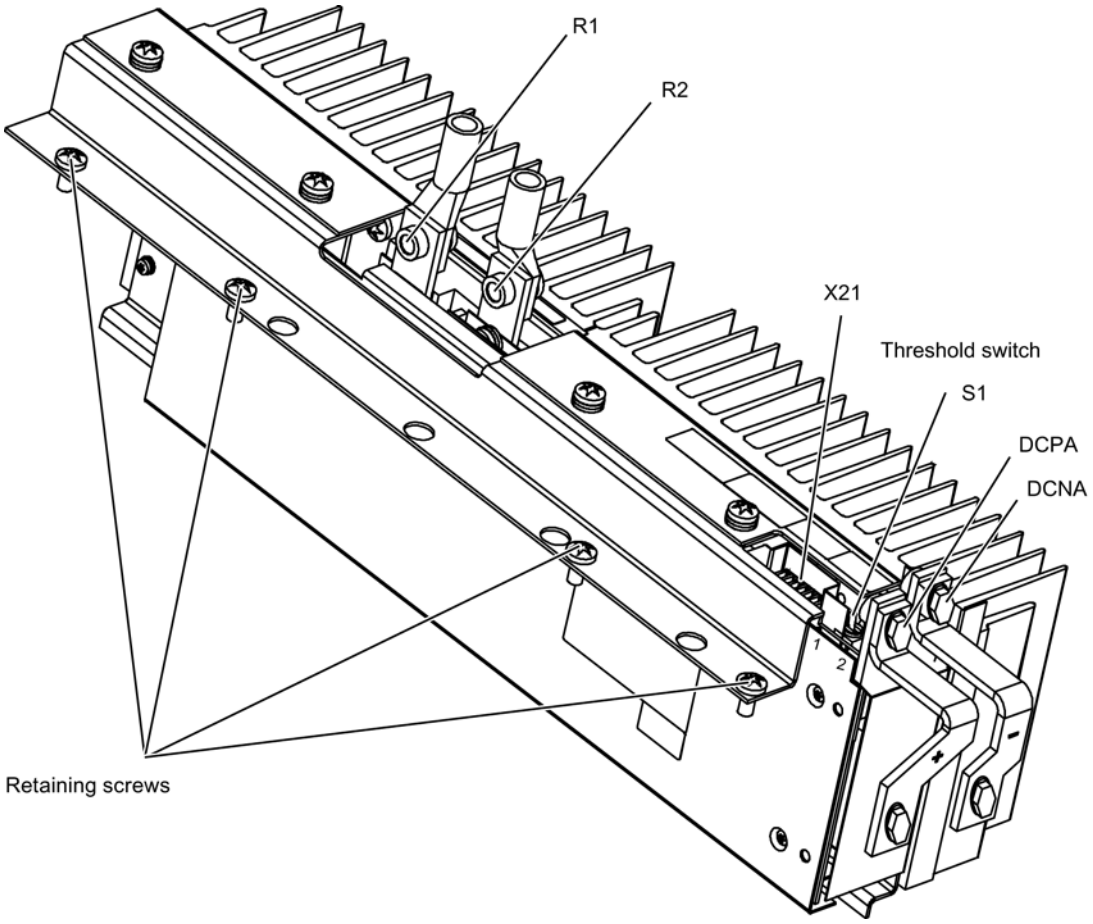


Figure 4-27 Braking modules for frame sizes HX and JX

Position of the threshold switch

Note

Switch positions

The threshold switches for the braking modules are positioned on the panel as follows:

- Braking modules for frame sizes FX and GX: Position "1" is up; position "2" is down
- Braking modules for frame sizes HX and JX: Position "1" is at the back; position "2" is at the front

4.9.13 Line-side surge arrester (option L96)

Description

The Siemens TPS3-03 surge arrester protects the cabinet components from overvoltages. The device is connected after the mains switch.

A green LED on the device (equipment designation -A96) indicates the correct functioning. If this LED is dark when voltage is applied, the device must be replaced.

4.9.14 RTD monitor (option L97)

Description

Note

Additional operating instructions

The PT100 monitor and the parameters for the measurement channels are described in the "Additional operating instructions" section of this documentation package.

The PT100 monitors can monitor up to 9 sensors. The sensors can be connected in a two- or three-wire system. With the two-wire system, inputs xT1 and xT3 must be assigned. With the three-wire system, input xT2 must also be connected to -B141, -B142, and -B143 (x = 1, 2, 3). The limit values can be freely programmed for each channel. Shielded signal cables are recommended. If this is not possible, the sensor cables should at least be twisted-pair.

In the factory state, the measurement channels are divided into three groups of 3 channels each. With motors, for example, this means that 2 sets of three PT100s in the stator windings and two PT100s in the motor bearings can be monitored. Unused channels can be suppressed via parameters.

The output relays are integrated in the internal fault and alarm circuit of the drive. The power supply for the PT100 monitor comes from within the drive, and the evaluation takes place within the drive.

When the temperature setting for "alarm" is exceeded, "external alarm 1" (A7850) is returned. When the temperature setting for "fault" is exceeded, "external fault 1" (F7860) is returned.

Connecting

Table 4- 42 Terminals -A1-B141, -A1-B142, -A1-B143 – connection for PT100 monitor

Terminal	Technical specifications
-B141: 1T1-1T3	24–240 V AC/DC; PT100; sensor 1; group 1
-B141: 2T1-2T3	24–240 V AC/DC; PT100; sensor 2; group 1
-B141: 3T1-3T3	24–240 V AC/DC; PT100; sensor 3; group 1
-B142: 1T1-1T3	24–240 V AC/DC; PT100; sensor 1; group 2
-B142: 2T1-2T3	24–240 V AC/DC; PT100; sensor 2; group 2
-B142: 3T1-3T3	24–240 V AC/DC; PT100; sensor 3; group 2
-B143: 1T1-1T3	24–240 V AC/DC; PT100; sensor 1; group 3
-B143: 2T1-2T3	24–240 V AC/DC; PT100; sensor 2; group 3
-B143: 2T1-3T3	24–240 V AC/DC; PT100; sensor 3; group 3

Max. connectable cross-section: #14 AWG (2.5 mm²)

Diagnostics

For a description of messages output during operation and in the event of faults (meaning of LEDs on -B141, -B142, -B143), refer to the Operating Instructions on the customer DVD supplied with the unit.

4.9.15 Insulation monitor (option L87)

Description

On ungrounded / IT power networks, the insulation monitor checks the entire electrically-connected circuit for insulation faults. The insulation resistance as well as all insulation faults from the line supply to the motor in the cabinet are detected. Two response values (between 1 kΩ and 10 MΩ) can be set. If a set value is undershot, an alarm is output to the terminal. A system fault is output via the signaling relay system.

In its factory state, the cabinet unit is not configured for a specific plant constellation (one or several loads in one electrically-connected network) or protection concept (immediate shutdown in the event of an insulation fault or restricted continued operation), as these are unknown. The signaling relays of the insulation monitor must be integrated into the fault and alarm circuit by the customer.

Safety instructions

Note

Number of insulation monitors

Only one insulation monitor can be used within one electrically-connected network.

Note

Removing the connection clip for the interference suppression capacitor

When the insulation monitor is used, the connection clip for the interference suppression capacitor must be removed (see "Electrical installation/Removing the connection clip for the interference suppression capacitor for operation on an ungrounded / IT power network").

Controls and displays on the insulation monitor

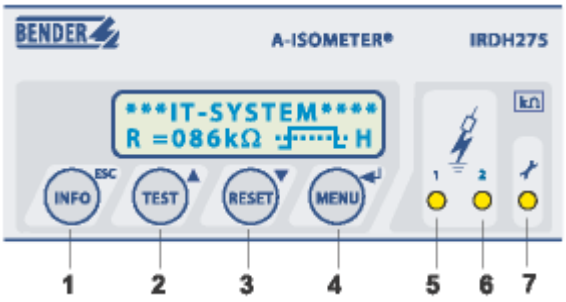


Figure 4-28 Controls and displays on the insulation monitor

Table 4- 43 Meaning of the controls and displays on the insulation monitor

Position	Meaning
1	INFO key: Requests standard information/ ESC key: Back menu function
2	TEST key: Brings up self-test Arrow key up: Parameter change, scroll function
3	RESET button: Deletes insulation messages and fault codes Arrow key down: Parameter change, scroll function
4	Menu key: Brings up menu system Enter key: Confirms parameter change
5	Alarm LED 1 is lit: Insulation fault, first alarm threshold reached
6	Alarm LED 2 is lit: Insulation fault, second alarm threshold reached
7	LED is lit: System error present

Connecting

Table 4- 44 Connections on the insulation monitor

Terminal	Technical specifications
A1	Supply voltage via 6 A melting fuse:
A2	88 to 264 V AC, 77 to 286 V DC
L1	Connection of the 3 ph. AC system to be monitored
L2	
AK	Connection to coupling device
KE	PE connection
T1	External test button
T2	External test button
R1	External reset key (NC contact or wire jumper, otherwise the fault code is not stored)
R2	External reset key (NC contact or wire jumper)
F1	STANDBY with aid of F1, F2 function input:
F2	
M+	External kΩ display, analog output (0 to 400 µA)
M-	External kΩ display, analog output (0 to 400 µA)
A	Serial interface RS 485
B	(termination by means of 120-ohm resistor)
11	Signaling relay ALARM 1 (mid-position contact)
12	Signaling relay ALARM 1 (NC contact)
14	Signaling relay ALARM 1 (NO contact)
21	Signaling relay ALARM 2 (mid-position contact)
22	Signaling relay ALARM 2 (NC contact)
24	Signaling relay ALARM 2 (NO contact)

Max. connectable cross-section: #14 AWG (2.5 mm²)

Diagnostics

For a description of messages output during operation and in the event of faults (meaning of LEDs on -B101), refer to the Operating Instructions on the customer DVD supplied with the unit.

4.9.16 Control power supply, 115 V AC, 5 A (option N70)

Description

The control power supply provides the auxiliary voltages required for external line-side control circuits of the enclosed drive.

Adapting the auxiliary power supply (-T10)

A transformer is installed in the Line Connection Module (-T10) to produce the auxiliary voltages of the enclosed drive. The location of the transformer is indicated in the layout diagrams supplied.

When delivered, the taps are always set to the highest level. The line-side terminals of the transformer may need to be reconnected according to the existing line voltage.

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

Table 4- 45 Line voltage assignment for the internal power supply (380 to 480 V 3 ph. AC)

Line voltage range	Tap	Taps of the matching transformer (-T10) LH1 – LH2
342 ... 390 V	380 V	1 - 2
391 ... 410 V	400 V	1 – 3
411 ... 430 V	415 V	1 – 4
431 ... 450 V	440 V	1 – 5
451 ... 470 V	460 V	1 – 6
471 ... 528 V	480 V	1 – 7

Table 4- 46 Line voltage assignment for the internal power supply (500 to 600 V 3 ph. AC)

Line voltage range	Tap	Taps of the matching transformer (-T10) LH1 – LH2
450 ... 515 V	500 V	1 - 8
516 ... 540 V	525 V	1 – 9
541 ... 560 V	550 V	1 – 10
561 ... 590 V	575 V	1 – 11
591 ... 670 V	600 V	1 – 12

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

NOTICE

Property damage due to voltage set too high

If the terminals are not reconnected to the actual line voltage, this can result in damage to the device when the voltage is set too high.

- Set the terminals in accordance with the actual line voltage.

4.9.17 CAN Communication Board CBC10 (option G20)

Description

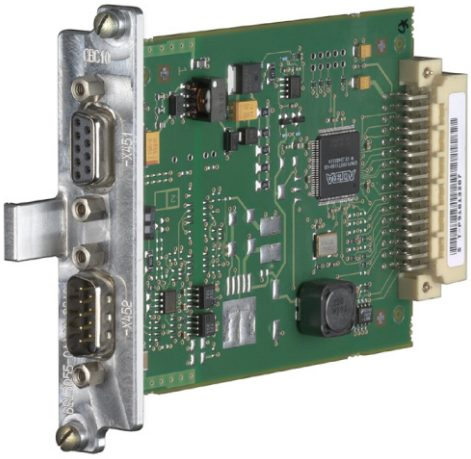


Figure 4-29 CAN CBC10 Communication Board

The CBC10 CANopen communication board (CAN Communication Board) is used to connect drives in the SINAMICS drive system to higher-level automation systems with a CAN bus.

The CANopen Option Board uses two 9-pin sub D connectors for the connection to the CAN bus system.

The connectors can be used as inputs or outputs. Unused pins are plated through.

Among others, the following transmission rates are supported: 10, 20, 50, 125, 250, 500, 800 kBaud, and 1 Mbaud.

NOTICE
Damage to or malfunction of Option Boards by pulling and plugging them during operation
Pulling and plugging Option Boards during operation can cause them to be damaged or to malfunction. • Only pull and plug Option Boards when the Control Unit is de-energized.

The module is installed in the option slot of the Control Unit at the factory.

Interface overview

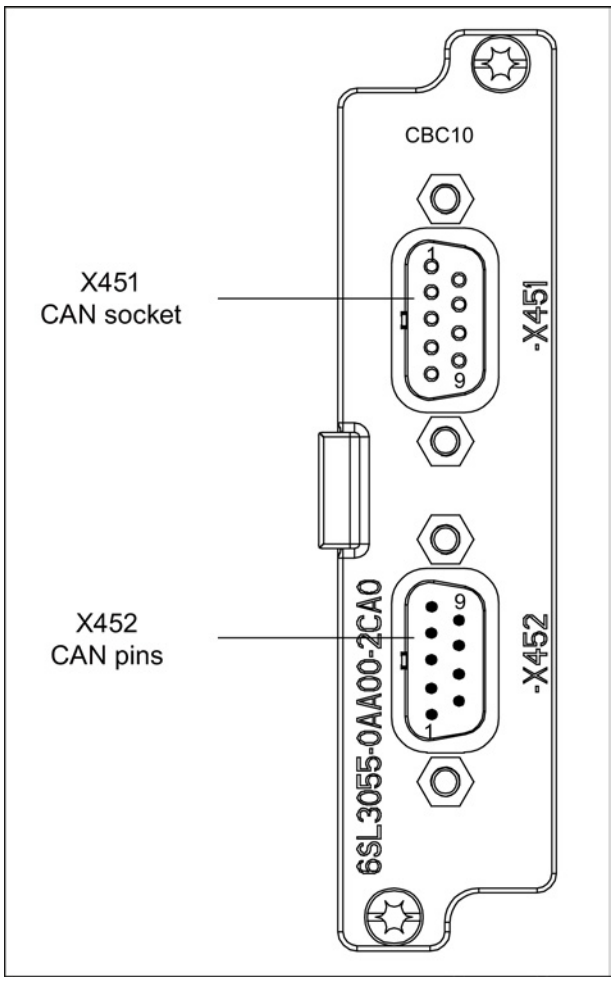
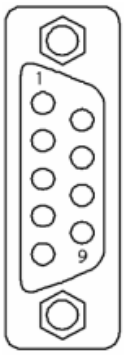


Figure 4-30 CAN CBC10 Communication Board

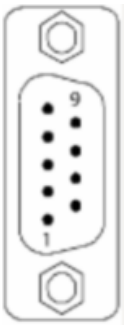
CAN bus interface -X451

Table 4- 47 CAN bus interface -X451

	Pin	Designation	Technical specifications
	1	Reserved, do not use	
	2	CAN_L	CAN signal (dominant low)
	3	CAN_GND	CAN ground
	4	Reserved, do not use	
	5	CAN_SHLD	Optional shield
	6	GND	CAN ground
	7	CAN_H	CAN signal
	8	Reserved, do not use	
	9	Reserved, do not use	
Connector type: 9-pin sub D socket			

CAN bus interface -X452

Table 4- 48 CAN bus interface -X452

	Pin	Designation	Technical specifications
	1	Reserved, do not use	
	2	CAN_L	CAN signal (dominant low)
	3	CAN_GND	CAN ground
	4	Reserved, do not use	
	5	CAN_SHLD	Optional shield
	6	GND	CAN ground
	7	CAN_H	CAN signal
	8	Reserved, do not use	
	9	Reserved, do not use	
Connector type: 9-pin sub D connector (pins)			

Additional information about communication via CAN bus

Note

Additional information

Detailed, comprehensive instructions and information about the CANopen interface can be found in the accompanying function manual. This manual is included under additional documentation on the accompanying customer DVD.

4.9.18 PROFINET Communication Board CBE20 (option G33)

Description

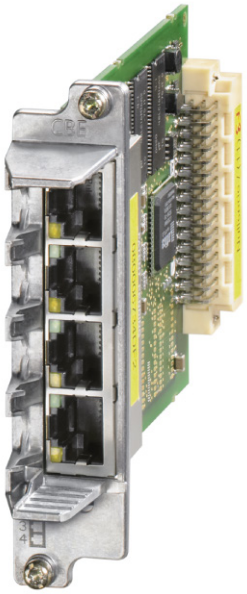


Figure 4-31 CBE20 Ethernet Communication Board

Interface module CBE20 is used for communication via PROFINET.

The module is installed in the option slot of the Control Unit at the factory.

There are 4 Ethernet interfaces available on the module. Diagnosis of the function mode and communication are possible via LEDs.

Interface overview

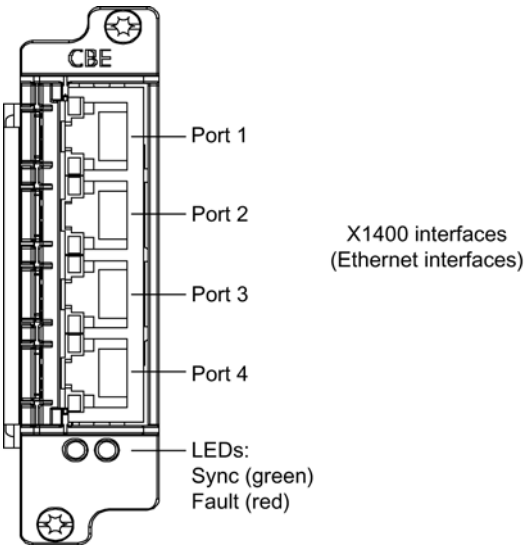


Figure 4-32 CBE20 Ethernet Communication Board

MAC address

The MAC address of the Ethernet interfaces is indicated on the top side of the CBE20. The plate is not visible when the module is installed.

Note

Note the MAC address

Remove the module from the option slot on the Control Unit and jot down the MAC address so you will have it available later for commissioning.

Installation

NOTICE
Damage to or malfunction of Option Boards by pulling and plugging them during operation
Pulling and plugging Option Boards during operation can cause them to be damaged or to malfunction. • Only pull and plug Option Boards when the Control Unit is de-energized.

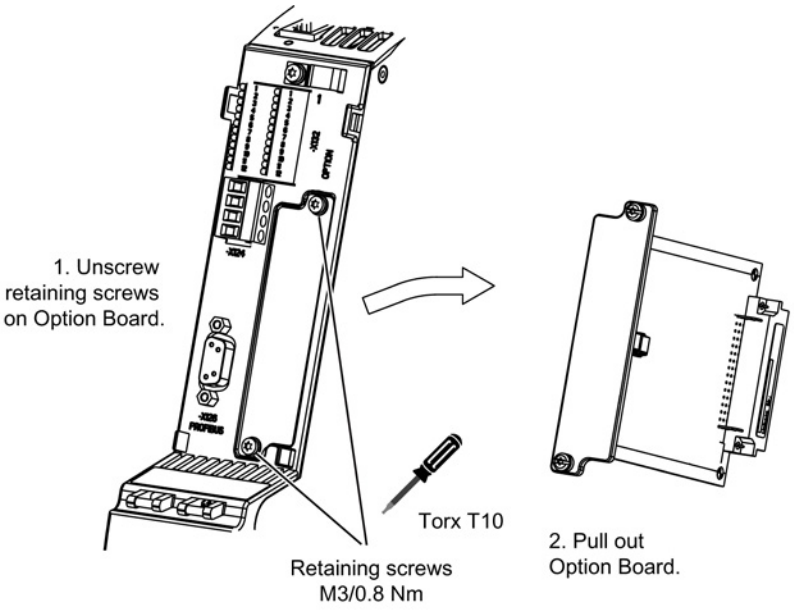
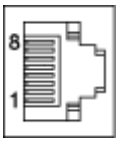


Figure 4-33 Removing the CBE20 from the option slot on the Control Unit

X1400 Ethernet interface

Table 4- 49 Connector X1400, port 1 - 4

	Pin	Signal name	Technical specifications
	1	RX+	Receive data +
	2	RX-	Receive data -
	3	TX+	Send data +
	4	---	Reserved, do not use
	5	---	Reserved, do not use
	6	TX-	Send data -
	7	---	Reserved, do not use
	8	---	Reserved, do not use
	Screened backshell	M_EXT	Shield, permanently connected

4.9.19 Temperature sensor module TM150 (option G51)

4.9.19.1 Description

The Terminal Module TM150 is used to record and evaluate several temperature sensors. The temperature is measured in a temperature range from -99 °C to +250 °C for the following temperature sensors:

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

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

A maximum of 12 temperature sensors can be connected to terminal module TM150.

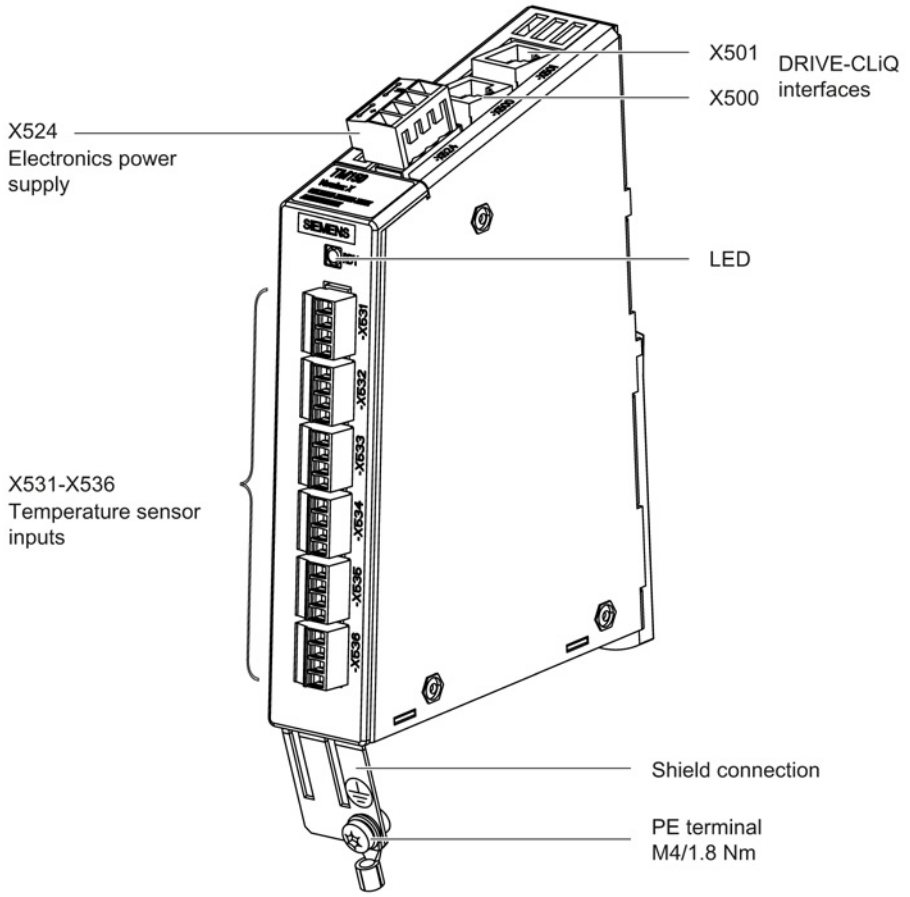
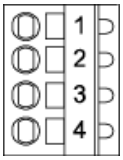


Figure 4-34 Terminal Module TM150

4.9.19.2 Connecting

Temperature sensor connections

Table 4- 50 X531-X536 temperature sensor inputs

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

Max. connectable cross-section: 1.5 mm^2
Measuring current via temperature sensor connection: approx. 0.83 mA

When connecting temperature sensors with 3 wires, a jumper must be inserted between X53x.2 and X53x.4.

Table 4- 51 Channel assignment

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



⚠WARNING

Danger to life from electric shock in the event of voltage flashovers at the temperature sensor

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

- Use temperature sensors that fully comply with the specifications of the safety isolation.

NOTICE

Damage to motor when KTY temperature sensor is connected incorrectly

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

- Connect a KTY temperature sensor with the correct polarity.

NOTICE

Overheating of the motor due to jumpering of the temperature sensor connections

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

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

NOTICE

Overheating of the motor due to cables with too high resistance

Cable length and cable cross-section can falsify the temperature measurement (10 Ω cable resistance for a PT100 can falsify the measurement result by 10%). Damage to the motor can result if the overheating is not detected.

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

NOTICE

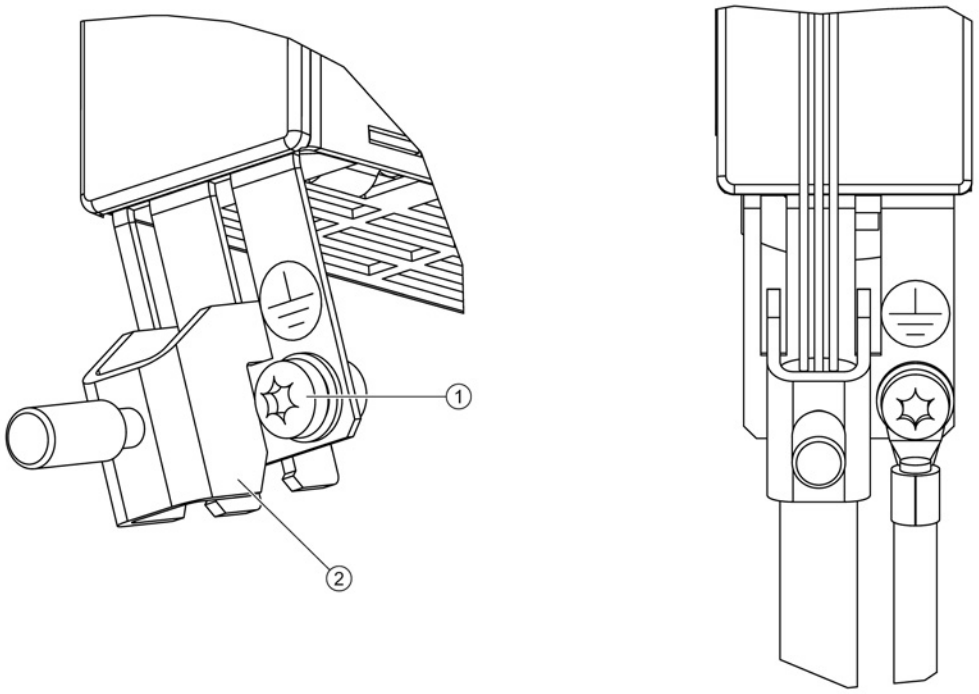
Device failure due to unshielded or incorrectly routed cables to temperature sensors

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

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

Protective earth connection and shield support

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



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

Figure 4-35 Shield support and protective earth connection of the TM150

4.9.19.3 Connection examples

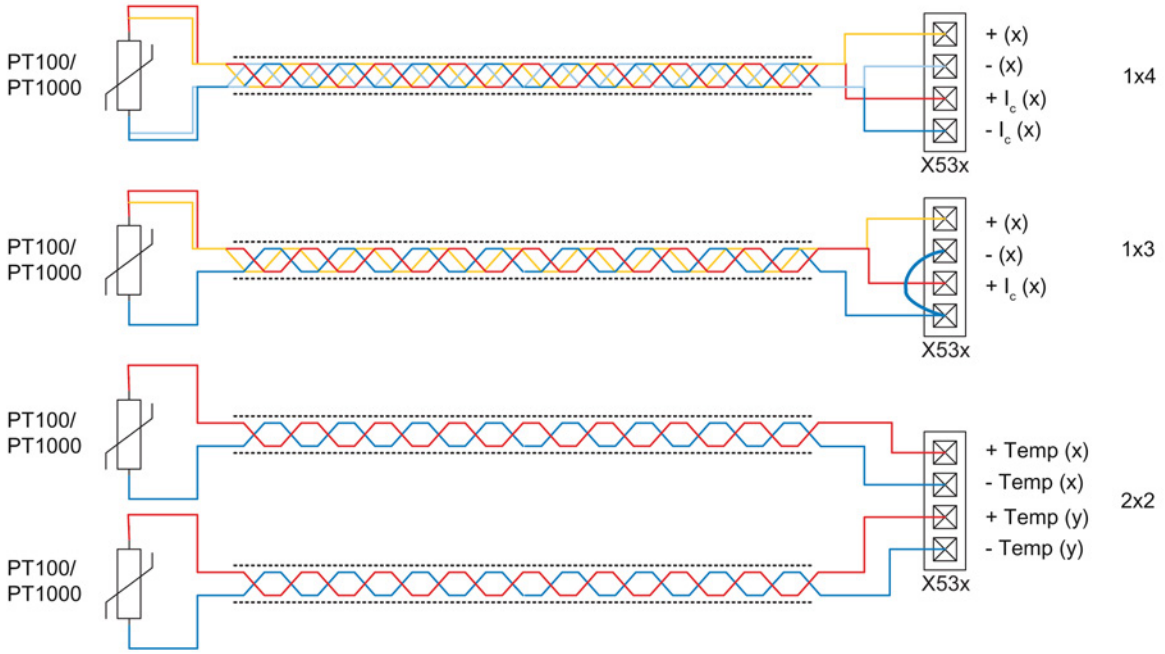


Figure 4-36 Connecting a PT100/PT1000 with 2x2, 3 and 4 wires to the temperature sensor inputs X53x of Terminal Module TM150

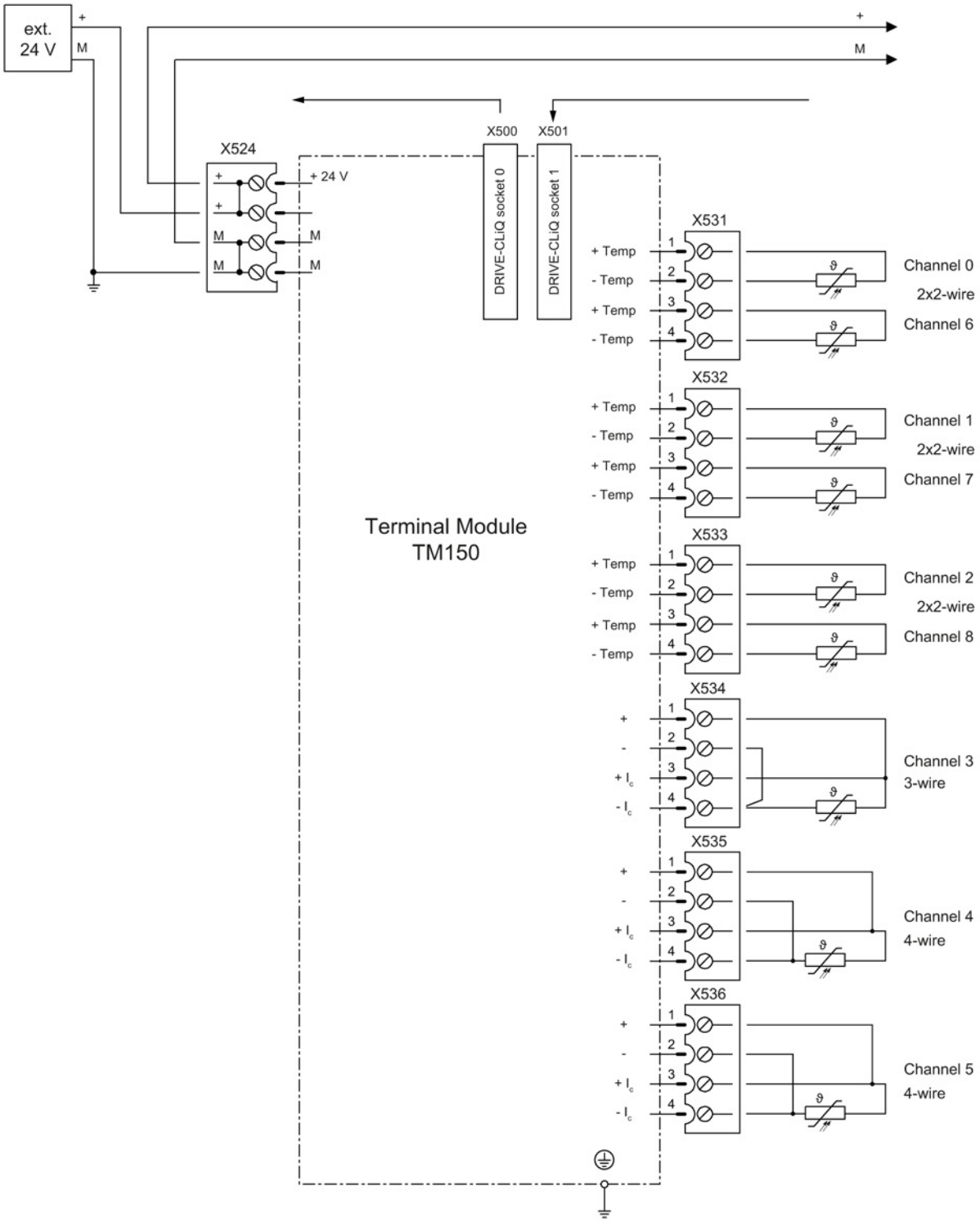


Figure 4-37 Connection example for a Terminal Module TM150

4.9.20 Sensor Module Cabinet-Mounted SMC30 (option K50)

4.9.20.1 Description

The SMC30 Sensor Module is used for determining the actual motor speed. The signals coming from the rotary pulse encoder are converted here and made available to the closed-loop controller via the DRIVE-CLiQ interface for evaluation purposes.

For SINAMICS G150 NEMA, the following encoders can be connected to the SMC30 Sensor Module:

- TTL encoder
- HTL encoder
- KTY or PTC temperature sensor

Table 4- 52 Connectable encoders with supply voltage

Encoder type	X520 (SUB-D)	X521 (terminal)	X531 (terminal)	Open-circuit monitoring	Remote sense
HTL bipolar 24 V	Yes	Yes	Yes	Yes	No
HTL unipolar 24 V	Yes	Yes	Yes	No	No
TTL bipolar 24 V	Yes	Yes	Yes	Yes	No
TTL bipolar 5 V	Yes	Yes	Yes	Yes	To X520
TTL unipolar	No	No	No	No	No

Table 4- 53 Maximum signal cable lengths

Encoder type	Maximum signal cable length
TTL	330 ft (100 m)
HTL unipolar	330 ft (100 m)
HTL bipolar	990 ft (300 m)

Note

Prefer a bipolar connection

Because the physical transmission media is more robust, the bipolar connection should always be used for HTL encoders. The unipolar connection should only be used if the encoder type does not output push-pull signals.

Note

Only connect one encoder system

Only one encoder system may be connected to the encoder module, either at X520 or at X521/X531. The corresponding unused interface must not be used.

Table 4- 54 Specification of measuring systems that can be connected

Parameter	Designation	Threshold [4]	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 [4]	High	17	V_{CC}	V
		Low	10	V_{CC}	V
Low signal level (HTL unipolar)	U_L [4]	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
Signal frequency	f_S		-	300	kHz
Edge clearance	t_{min}		100	-	ns
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)	t_{Hi}		640	$t_{ALo-BHi} - 2 \times t_{Lo}$ [3]	ns

[1] Other signal levels according to the RS 422 standard.

[2] The absolute level of the individual signals varies between 0 V and V_{CC} of the measuring system.

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

[4] The threshold can be set via p0405.04 (switching threshold); the factory state setting is "Low".

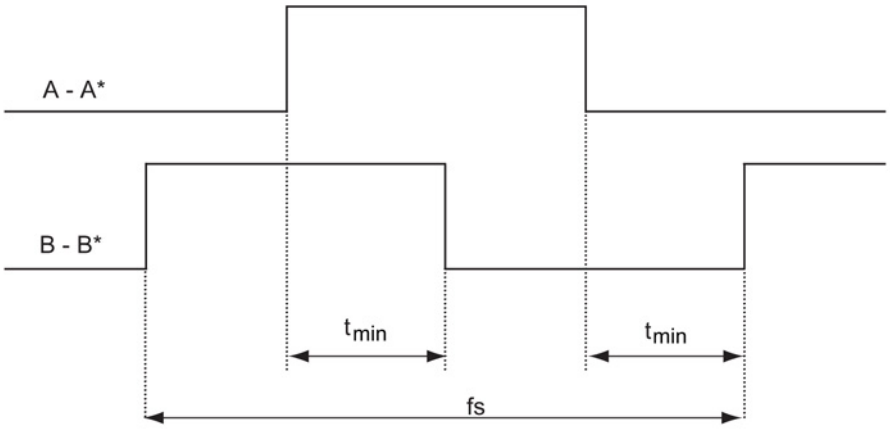


Figure 4-38 Signal characteristic of the A and B track between two edges: Time between two edges with pulse encoders

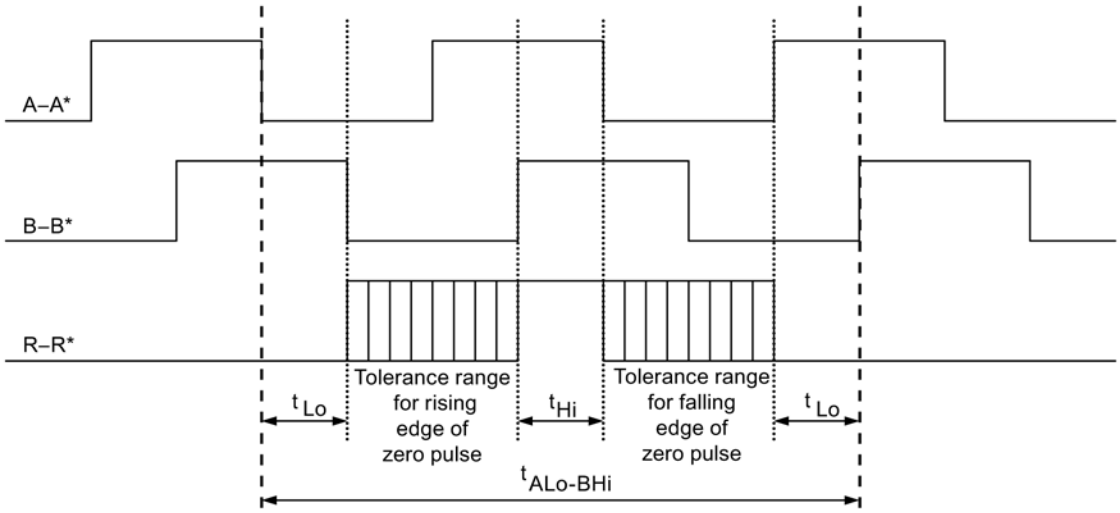


Figure 4-39 Position of the zero pulse to the track signals

For encoders with a 5 V supply at X521/X531, the cable length is dependent on the encoder current (applies to cable cross-sections of 0.5 mm²):

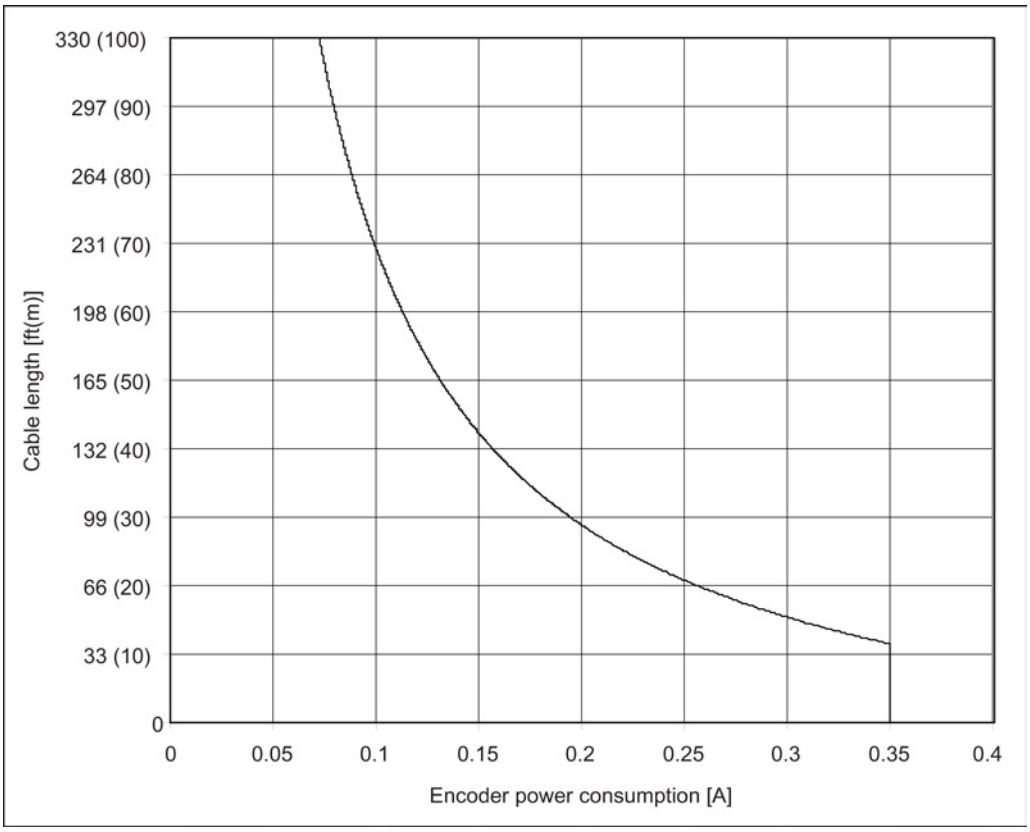


Figure 4-40 Signal cable length as a function of the encoder current consumption

For encoders without Remote Sense, the permissible cable length is restricted to 330 ft (100 m) (reason: The voltage drop depends on the cable length and the encoder current).

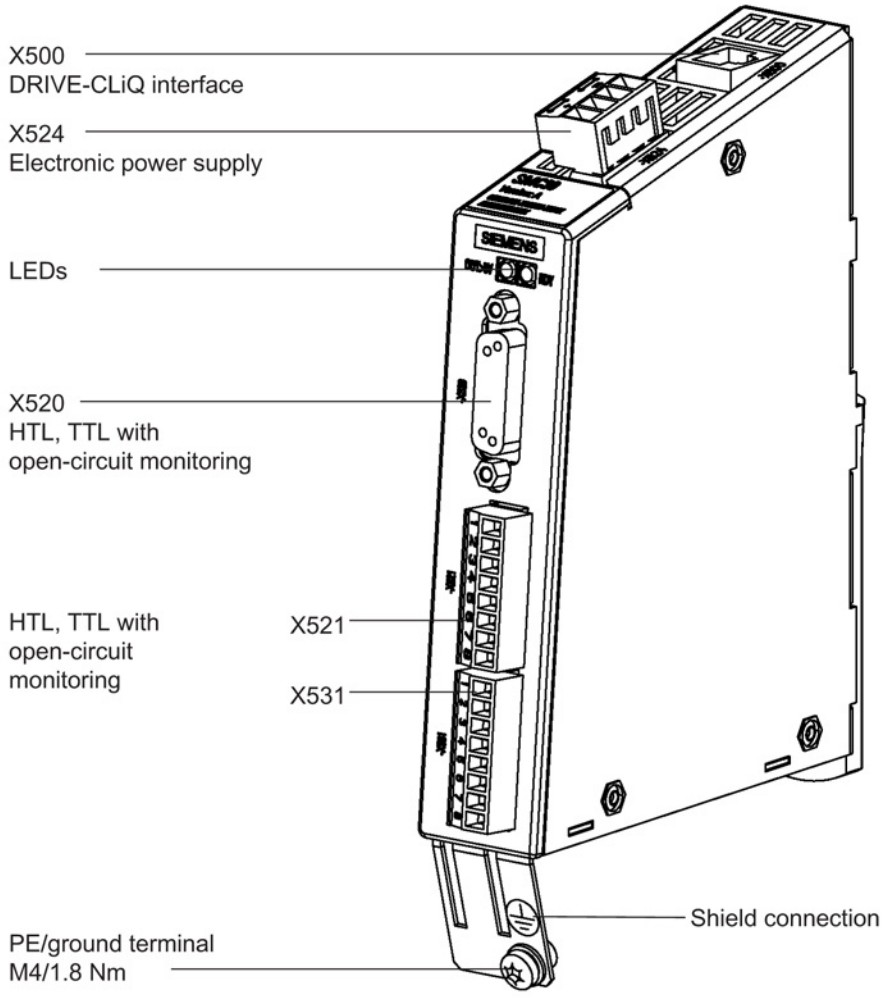
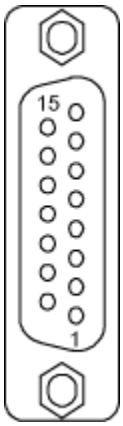


Figure 4-41 Sensor Module SMC30

4.9.20.2 Connection

X520: Encoder connection 1 for HTL/TTL encoder with open-circuit monitoring

Table 4- 55 Encoder connection X520

	Pin	Signal name	Technical specifications
	1	+Temp [1)]	Temperature sensor connection KTY84-1C130/PTC
	2	Reserved, do not use	
	3	Reserved, do not use	
	4	P encoder 5 V/24 V	Encoder supply
	5	P encoder 5 V/24 V	Encoder supply
	6	P sense	Sense input, encoder supply
	7	M encoder (M)	Ground, encoder supply
	8	-Temp [1)]	Temperature sensor connection KTY84-1C130/PTC
	9	M sense	Ground, sense input
	10	R	Reference signal R
	11	R*	Inverted reference signal R
	12	B*	Inverted incremental signal B
	13	B	Incremental signal B
	14	A*	Inverted incremental signal A
	15	A	Incremental signal A
Connector type: 15-pin sub D socket			
Measuring current via temperature sensor connection: 2 mA			

[1)] Accuracy of temperature measurement:
- KTY: ±7 °C (including evaluation)
- PTC: ±5 °C (including evaluation)



WARNING

Danger to life from electric shock in the event of voltage flashovers at the temperature sensor

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

- Only use temperature sensors that fully comply with the specifications of the safety isolation.

NOTICE

Device failure due to unshielded or incorrectly routed cables to temperature sensors

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

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

NOTICE

Damage to motor when KTY temperature sensor is connected incorrectly

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

- Connect a KTY temperature sensor with the correct polarity.

NOTICE

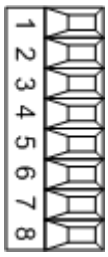
Damage to the encoder due to incorrect supply voltage

The encoder power supply can be set to 5 V or 24 V. The encoder may be damaged due to an incorrect parameter assignment.

- Select the appropriate supply voltage.

X521 / X531: Encoder connection 2 for HTL/TTL encoder with open-circuit monitoring

Table 4- 56 Encoder connection X521

	Terminal	Signal name	Technical specifications
	1	A	Incremental signal A
	2	A*	Inverted incremental signal A
	3	B	Incremental signal B
	4	B*	Inverted incremental signal B
	5	R	Reference signal R
	6	R*	Inverted reference signal R
	7	CTRL	Control signal
	8	M	Ground via inductivity

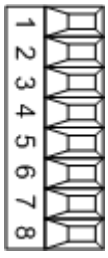
Max. connectable cross-section: #16 AWG (1.5 mm²)

Note

Operation of unipolar HTL encoders

When unipolar HTL encoders are used, A*, B*, and R* on the terminal block must be jumpered with M_Encoder (X531).

Table 4- 57 Encoder connection X531

	Terminal	Signal name	Technical specifications
	1	P encoder 5 V/24 V	Encoder supply
	2	M encoder	Ground, encoder supply
	3	-Temp [1)]	Temperature sensor connection KTY84-1C130/PTC
	4	+Temp [1)]	Temperature sensor connection KTY84-1C130/PTC
	5	Reserved, do not use	
	6	Reserved, do not use	
	7	Reserved, do not use	
	8	Reserved, do not use	

Max. connectable cross-section: #16 AWG (1.5 mm²)

Measuring current via temperature sensor connection: 2 mA

1) Accuracy of temperature measurement:
- KTY: ±7 °C (including evaluation)
- PTC: ±5 °C (including evaluation)



WARNING

Danger to life from electric shock in the event of voltage flashovers at the temperature sensor

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

- Only use temperature sensors that fully comply with the specifications of the safety isolation.

NOTICE

Device failure due to unshielded or incorrectly routed cables to temperature sensors

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

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

NOTICE

Damage to motor when KTY temperature sensor is connected incorrectly

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

- Connect a KTY temperature sensor with the correct polarity.

NOTICE

Damage to the encoder due to incorrect supply voltage

The encoder power supply can be set to 5 V or 24 V. The encoder may be damaged due to an incorrect parameter assignment.

- Select the appropriate supply voltage.

Note

Cable shield for the encoder connection via terminals

Note that when the encoder is connected via terminals, the cable shield must be applied to the module.

4.9.20.3 Connection examples

Connection example 1: HTL encoder, bipolar, without zero mark -> p0405 = 9 (hex)

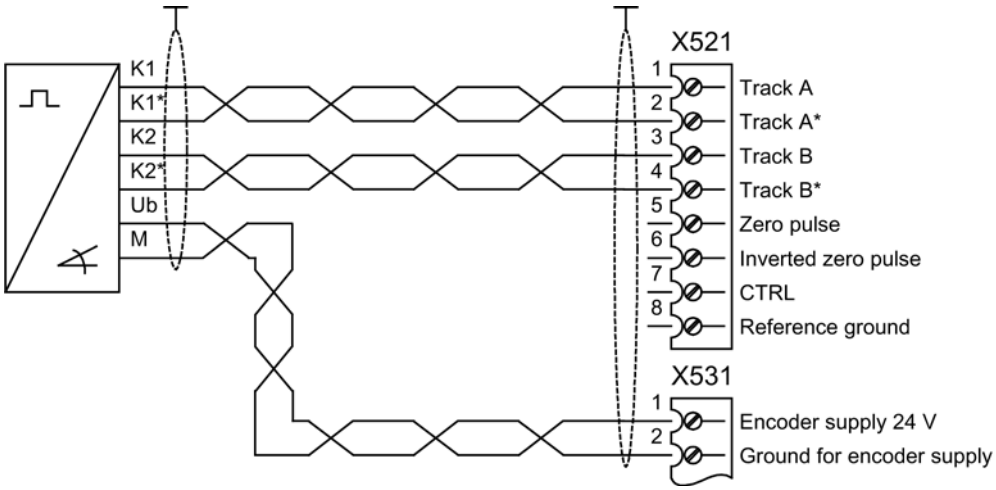


Figure 4-42 Connection example 1: HTL encoder, bipolar, without zero mark

Connection example 2: TTL encoder, unipolar, without zero track -> p0405 = A (hex)

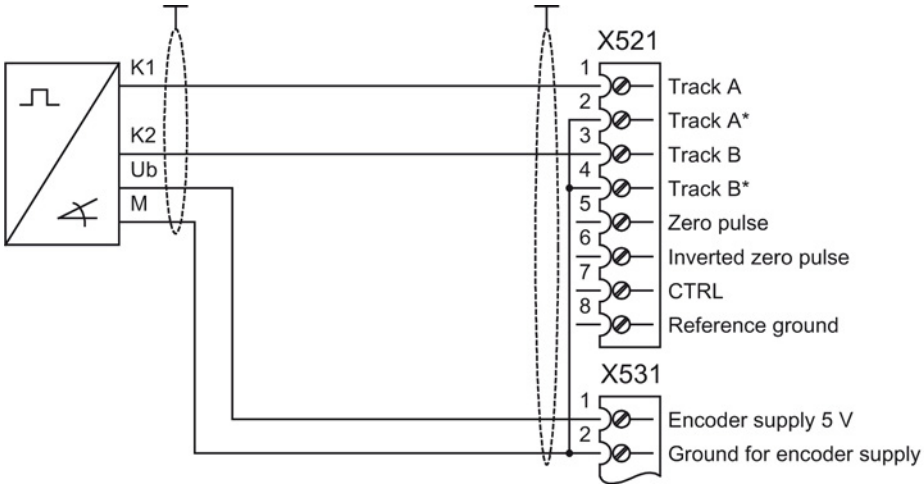


Figure 4-43 Connection example 2: TTL encoder, unipolar, without zero track

4.9.21 Voltage Sensing Module for determining the actual motor speed and the phase angle (option K51)

Key statement

The VSM10 Voltage Sensing Module is used for operation of a permanent-field synchronous machine without encoder with the requirement for starting in a running machine (flying restart function).

The terminals on the Voltage Sensing Module (-B51) are pre-assigned in the factory and must not be changed by the customer.

For commissioning, the permanent-field synchronous machine without encoder must be entered, and the "flying restart" function must be activated via p1200.

Removing the connector jumper in the VSM10 Voltage Sensing Module

If a device is operated on an ungrounded network (IT network), the connector jumper in terminal X530 on the button of the component must be removed from the Voltage Sensing Module (VSM10).

Use two screwdrivers or a suitable tool in order to relieve the holding springs in the terminal and then withdraw the connector jumper.

	
Terminal X530 with connector jumper	Relieve the springs and withdraw the connector jumper

Note

False tripping caused by not removing the connection clip with a non-grounded line supply

Failure to remove the connector jumper on a non-grounded line supply (IT system) can cause false tripping in case of sensitive IT network monitoring.

- On an ungrounded power network (IT power network), remove the jumper.

4.9.22 Additional SMC30 Sensor Module Cabinet-Mounted (option K52)

Description

With option K50, an SMC30 Sensor Module is included in the cabinet unit. The additional SMC30 Sensor Module enables reliable actual-value acquisition when using Safety Integrated Extended Functions (requires a license: option K01).

Note

Safety Integrated Function Manual

A detailed description of the full functionality and handling of the Safety Integrated functions can be found in the accompanying Function Manual. This manual is available as additional documentation on the customer DVD supplied with the device.

4.9.23 Additional customer terminal block TM31 (option G61)

Description

An interface module TM31 (customer terminal module –A60 or –X65) is already installed as standard. A second module (–A61) provides the following additional digital and analog inputs/outputs in the drive system:

- 8 digital inputs
- 4 bidirectional digital inputs/outputs
- 2 relay outputs with changeover contact
- 2 analog inputs
- 2 analog outputs
- 1 temperature sensor input (KTY84-130/PTC)

Inputs and outputs of the second TM31 must be assigned by the customer; default settings of the terminals are not provided.

4.9.24 TM31 wired to customer terminal block (option G65)

Description

The standard version contains a TM31 interface module (–A60) as a customer terminal block.

With option G65, the connections of the TM31 (-A60) are routed to an intermediate terminal block (-X65), which can be used for customer connections with a larger conductor cross section.

The pin assignment of the interfaces is described in "Electrical installation", "Signal interfaces".

4.9.25 Safety license for 1 axis (option K01)

Description

The Safety Integrated Basic functions do not require a license. A license is, however, required for each axis with safety functions in the case of Safety Integrated Extended functions. It is irrelevant which safety functions are used and how many.

With option K01, the Safety license for 1 axis is included on the CompactFlash Card and activated.

Licenses

The required license can optionally be ordered with the CompactFlash card.

Subsequent licensing is realized in the Internet using the "WEB License Manager" by generating a license key:
http://www.siemens.com/automation/license

Activation

The associated license key is entered into parameter p9920 in the ASCII code. The license key can be activated via parameter p9921=1.

Diagnostics

An insufficient license is indicated via the following alarm and LED:

- Alarm A13000 → License not sufficient
- LED READY → Flashes green/red at 0.5 Hz

Note

Safety Integrated Function Manual

Detailed and comprehensive instructions and information for the Safety Integrated functions can be found in the accompanying Function Manual. This manual is available as additional documentation on the customer DVD supplied with the device.

4.9.26 Terminal module for activation of "Safe Torque Off" and "Safe Stop 1" (option K82)

Description

Option K82 (terminal module for activating "Safe Torque Off" and "Safe Stop 1") is used for isolated activation via a variable control-voltage range of the safety functions already present in the standard version, which can also be used without option K82.

Use option K82 to activate the following Safety Integrated functions (terminology according to EN 61800-5-2):

- Safe torque off (STO)
- Safe Stop 1 (SS1, time-controlled)

Note

Standard requirements

The integrated safety functions, starting from the Safety Integrated (SI) input terminals of the SINAMICS components (Control Unit, Motor Module), satisfy the requirements according to EN 61800-5-2, EN 60204-1, EN ISO 13849-1 Category 3 (formerly EN 954-1) for Performance Level (PL) d and EN 61508 SIL 2.

In combination with option K82, the requirements specified in EN 61800-5-2, EN 60204-1 as well as in EN ISO 13849-1 Category 3 (formerly EN 954-1) are satisfied for Performance Level (PL) d and EN 61508 SIL 2.

Note

Safety Integrated Function Manual

Detailed and comprehensive instructions and information for the Safety Integrated functions can be found in the accompanying Function Manual. This manual is available as additional documentation on the customer DVD supplied with the device.

4.9.27 TM54F Terminal Module (option K87)



Figure 4-44 TM54F Terminal Module (option K87)

Description

The TM54F Terminal Module is a terminal expansion module with safe digital inputs and outputs for controlling the Safety Integrated Extended functions of SINAMICS.

The TM54F is directly connected to a Control Unit via DRIVE-CLiQ.

TM54F features the following interfaces:

Table 4- 58 Overview of the TM54F interfaces

Type	Quantity
Fail-safe digital outputs (F-DO)	4
Fail-safe digital inputs (F-DI)	10
Sensor[1] power supplies, dynamic response supported [2]	2
Sensor[1] power supply, no dynamic response	1
Digital inputs to check F_DO for a test stop	4

[1] Sensors: Fail-safe devices to issue commands and sense, for example, emergency stop pushbuttons and safety locks, position switches and light arrays/light curtains.

[2] Dynamic response: The sensor power supply is switched on and off by the TM54F when the forced dormant error detection is active for the sensors, cable routing, and the evaluation electronics.

The TM54F provides 4 fail-safe digital outputs and 10 fail-safe digital inputs. A fail-safe digital output consists of a 24 V DC switching output, a ground switching output, and a digital input for checking the switching state. A fail-safe digital input comprises two digital inputs.

Note

Rated values of the F-DO

The rated values of the F-DO meet the requirements of EN 61131-2 for digital DC outputs with 0.5 A rated current.

The operating ranges of the F-DI meet the requirements of EN 61131-2 for Type 1 digital inputs.

Note

Shielding cables

Please note that the F-DIs must take the form of shielded cables if they are > 30 m in length.

Note

Safety Integrated Function Manual

A detailed description of the full functionality and handling of the Safety Integrated functions can be found in the accompanying Function Manual. This manual is available as additional documentation on the customer DVD supplied with the device.

4.9.28 Safe Brake Adapter SBA 230 V AC (option K88)

Description

Safe Brake Control (SBC) is a safety function that is used in safety-related applications. In the no-current state, the brake acts on the motor of the drive using spring force. The brake is released (opened) when current flows through it (=low active).

The Safe Brake Adapter 230 V AC is installed in the enclosed drive in the factory. An infeed is connected to terminal -X12 on the Safe Brake Adapter for the power supply. For control, a connection is established between the Safe Brake Adapter and the Control Interface Module using a cable harness installed in the factory.

For controlling the brake, a connection must be established on site between terminal -X14 on the Safe Brake Adapter and the rectifier of the brake. Direct connection of AC brakes is not permissible.

NOTICE

Device failure due to connection of a 24 V DC brake

Connection of a 24 V DC brake to option K88 (Safe Brake Adapter 230 V AC) can cause damage to the Safe Brake Adapter and even failure (closing of the brake is not indicated via an LED, the fuse can be tripped, the contact service life of the relay is reduced).

- Do not connect a 24 V DC brake to the Safe Brake Adapter 230 V AC.

Note

Maximum cable length of the brake control

The maximum permissible cable length of 300 m between the Safe Brake Adapter 230 V AC and the brake must be observed. To accurately calculate the maximum cable length, see the SINAMICS Low Voltage Engineering Manual on the customer DVD supplied with the device.

Fast de-energization

Some brake rectifier types are equipped with two additional connections for switching the brake load on the DC side. This allows the brake coil to be quickly de-energized, i.e. braking starts earlier.

The Safe Brake Adapter supports such a fast de-energization using the two additional connections -X15:1 and -X15:2. This function does not belong to the safe brake control.

Notes

Note

Replacement fuses

The order numbers for spare fuses can be taken from the spare parts list supplied.

Note

Standard requirements

The integrated safety functions, starting from the Safety Integrated (SI) input terminals of the SINAMICS components (Control Unit, Motor Module), satisfy the requirements according to EN 61800-5-2, EN 60204-1, DIN EN ISO 13849-1 Category 3 (formerly EN 954-1) for Performance Level (PL) d and IEC 61508 SIL2.

With the Safe Brake Adapter (option K88), the requirements specified in EN 61800-5-2, EN 60204-1, DIN EN ISO 13849-1 Category 3 (formerly EN954-1) as well as for Performance Level (PL) d and IEC 61508 SIL 2 are fulfilled.

Note

Safety Integrated Function Manual

A detailed description of the full functionality and handling of the Safety Integrated functions can be found in the accompanying Function Manual. This manual is available as additional documentation on the customer DVD supplied with the device.

4.9.29 Control Unit CU320-2 PN (option K95)

With Option K95, the enclosed drive contains a CU320-2 PN control unit, which takes over the communication and open-loop/closed-loop control functions.

A PROFINET interface is available for higher-level communication.

Connection overview

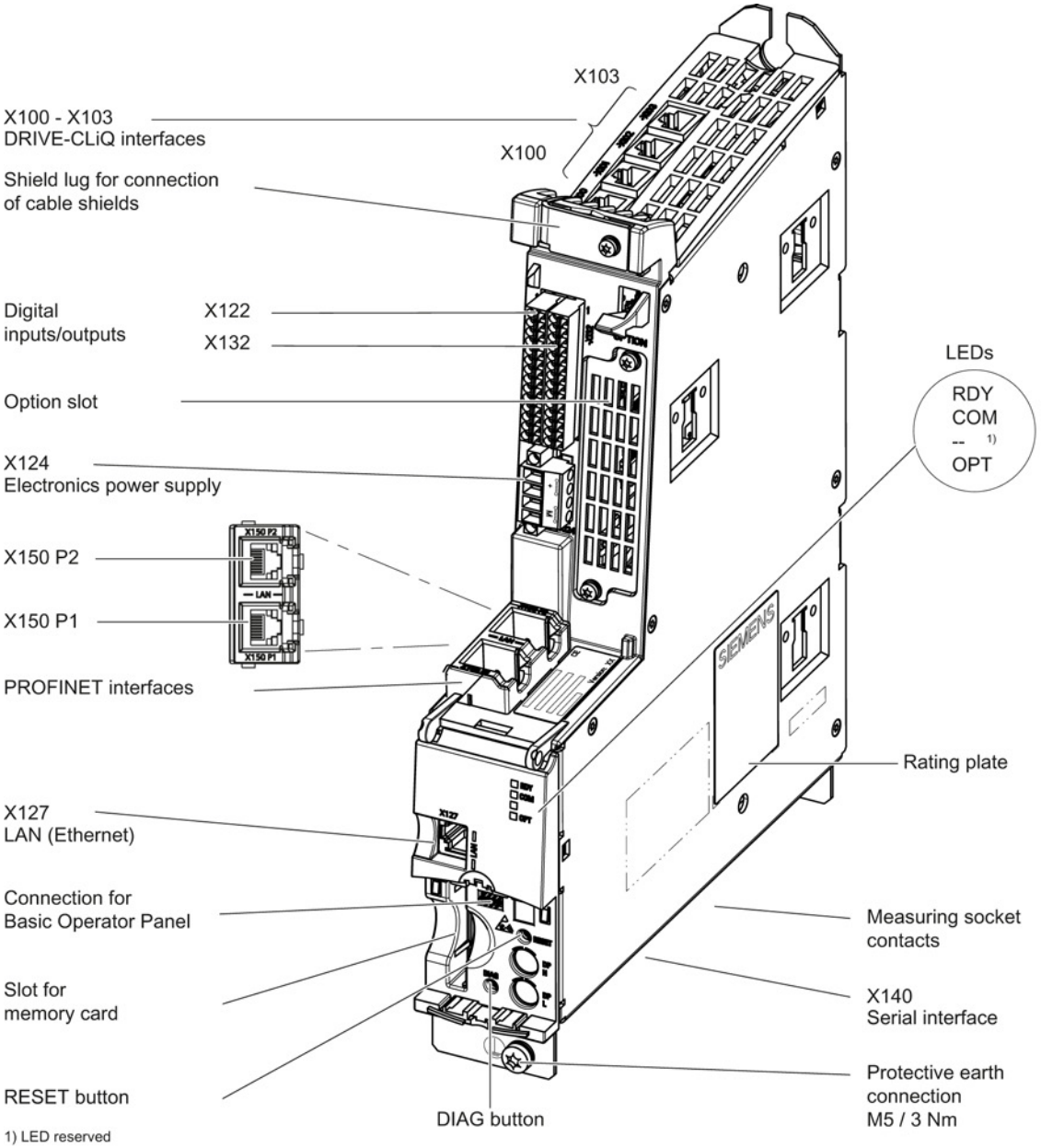


Figure 4-45 Connection overview of CU320-2 PN Control Unit (without cover)

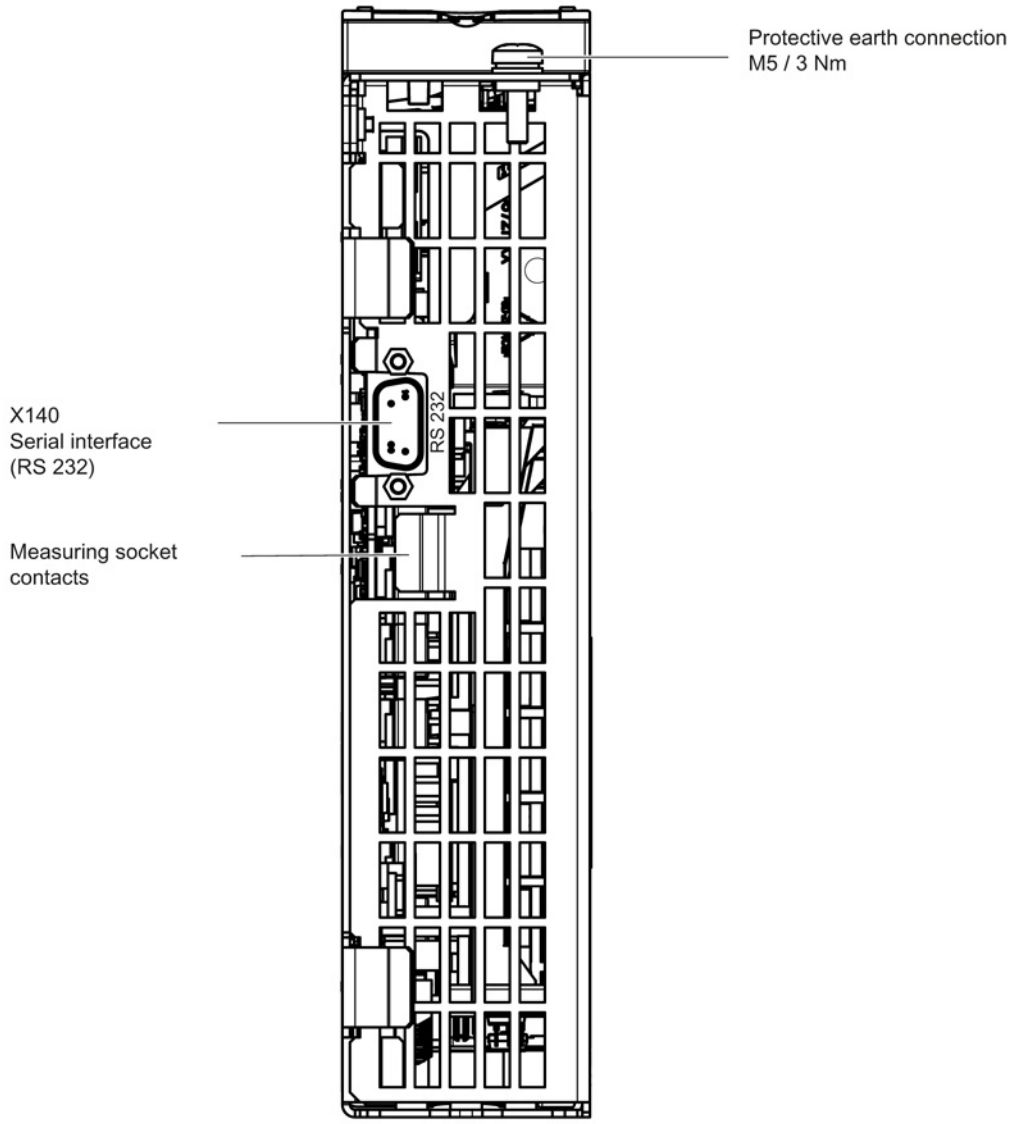


Figure 4-46 Interface X140 and measuring sockets T0 to T2 - CU320-2 PN (view from below)

NOTICE
Malfunctions or damage to the Option Board by pulling and plugging it during operation Pulling and plugging the Option Board during operation can damage it or cause it to malfunction. • Only pull and plug the Option Board when the Control Unit is de-energized.

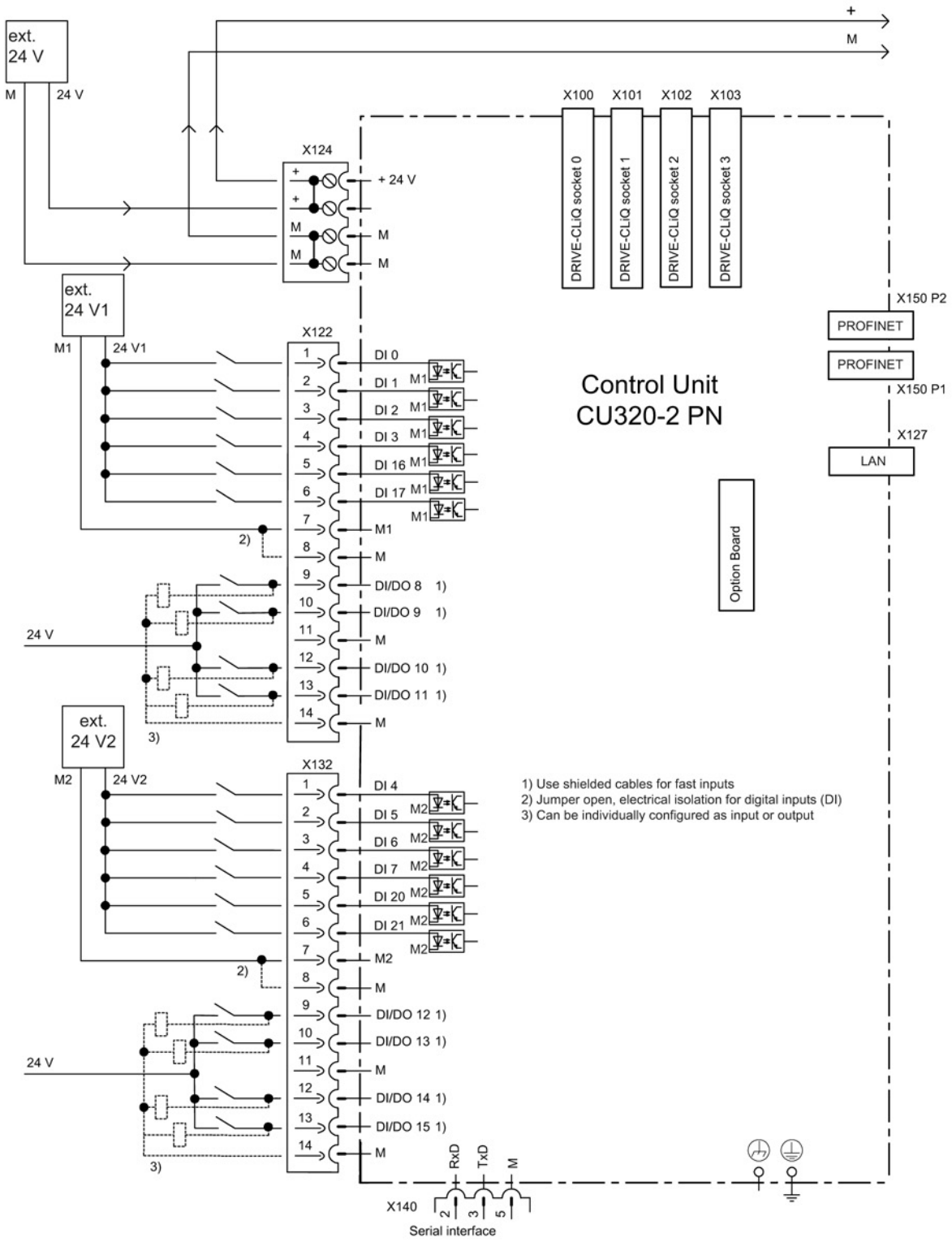
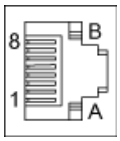


Figure 4-47 Connection example of a CU320-2 PN Control Unit

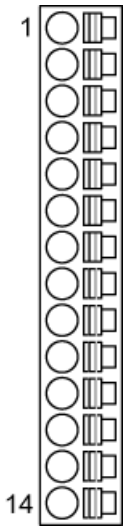
X100 to X103 DRIVE-CLiQ interface

Table 4- 59 DRIVE-CLiQ interface X100 – X103

	Pin	Signal name	Technical specifications
	1	TXP	Send data +
	2	TXN	Send 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
Connector type: RJ45 socket Blanking plate for DRIVE-CLiQ interfaces (50 pcs.) Order number: 6SL3066-4CA00-0AA0			

X122: Digital inputs/outputs

Table 4- 60 Terminal block X122

	Pin	Designation[1]	Technical specifications
	1	DI 0	Voltage (max.): -3 ... 30 V Current consumption, typical: 9 mA at 24 V DC Electrical isolation: reference potential is terminal M1 Signal level (with ripple) High level: +15 ... +30 V Low level: -3 ... +5 V Input delay (typ.): For "0" → "1": 50 µs For "1" → "0": 150 µs
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	DI 16	
	6	DI 17	
	7	M1	Reference potential for terminal 1 ... 6
	8	M	Electronics ground
	9	DI/DO 8	**As input**: Voltage: -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Signal level (with ripple) High level: 15 … 30 V Low level: -3 … +5 V DI/DO 8, 9, 10, and 11 are "fast inputs" [2] Input delay (typ.) For "0" → "1": 5 µs For "1" → "0": 50 µs **As output**: Voltage: 24 V DC Max. load current per output: 500 mA Sustained short-circuit-proof Output delay (typ./max):[3] For "0" → "1": 150 µs / 400 µs For "1" → "0": 75 µs / 100 µs 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
	10	DI/DO 9	
	11	M	
	12	DI/DO 10	
	13	DI/DO 11	
	14	M	
Max. connectable cross-section: 1.5 mm²			

[1] DI: Digital input; DI/DO: Bidirectional digital input/output; M: Electronics ground; M1: Reference potential

[2] The fast inputs can be used as probe inputs or as inputs for the equivalent zero mark.

[3] Data for: V_{cc} = 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

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

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

Terminal M1 must be connected so that the digital inputs (DI) can function.

This is achieved through one of the following measures:

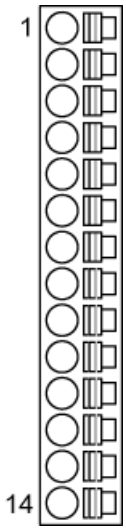
1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

Note

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

X132: Digital inputs/outputs

Table 4- 61 Terminal block X132

	Pin	Designation[1]	Technical specifications
	1	DI 4	Voltage (max.): -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Electrical isolation: reference potential is terminal M2 Signal level (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V Input delay (typ.): For "0" → "1": 50 µs For "1" → "0": 150 µs
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	DI 20	
	6	DI 21	
	7	M2	Reference potential for terminal 1 ... 6
	8	M	Electronics ground
	9	DI/DO 12	**As input**: Voltage: -3 ... +30 V DC Current consumption, typical: 9 mA at 24 V Signal level (including ripple) High level: 15 ... 30 V Low signal level: -3 … +5 V DI/DO 12, 13, 14, and 15 are "fast inputs" [2] Input delay (typ.): For "0" → "1": 5 µs For "1" → "0": 50 µs **As output**: Voltage: 24 V DC Max. load current per output: 500 mA Sustained short-circuit proof Output delay (typ./max):[3] For "0" → "1": 150 µs / 400 µs For "1" → "0": 75 µs / 100 µs 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
	10	DI/DO 13	
	11	M	
	12	DI/DO 14	
	13	DI/DO 15	
	14	M	
Max. connectable cross-section: 1.5 mm²			

[1] DI: Digital input; DI/DO: Bidirectional digital input/output; M: Electronics ground; M2: Reference potential

[2] The fast inputs can be used as probe inputs or as inputs for the equivalent zero mark

[3] Data for: V_{cc} = 24 V; load 48 Ω; high ("1") = 90% V_{out}; low ("0") = 10% V_{out}

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

Note

Ensuring the function of digital inputs

An open input is interpreted as "low".

To enable the digital inputs (DI) to function, terminal M2 must be connected.

This is achieved through one of the following measures:

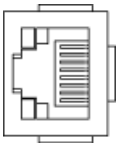
1. Provision of the ground reference of the digital inputs.
2. A jumper to terminal M (**Note the following:** This removes the electrical isolation for these digital inputs.)

Note

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

X127: LAN (Ethernet)

Table 4- 62 X127 LAN (Ethernet)

	Pin	Designation	Technical specifications
	1	TXP	Ethernet transmit data +
	2	TXN	Ethernet transmit data -
	3	RXP	Ethernet receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Ethernet receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
Connector type: RJ45 socket			

Note

The LAN (Ethernet) interface does not support Auto MDI(X). For this reason, only crossed cables may be used to connect devices.

For diagnostic purposes, the X127 LAN interface features a green and a yellow LED. These LEDs indicate the following status information:

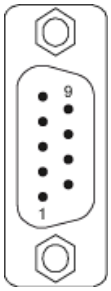
Table 4- 63 LED states for the X127 LAN interface

LED	Color	Status	Description
Link port	-	Off	Missing or faulty link
	Green	Continuous light	10 or 100 Mbit link available
Activity port	-	Off	No activity
	Yellow	Flashing light	Sending or receiving

X140: serial interface (RS232)

The AOP30 operator panel for operating/configuring the device can be connected via the serial interface. The interface is located on the underside of the Control Unit.

Table 4- 64 Serial interface (RS232) X140

	Pin	Designation	Technical specifications
	2	RxD	Receive data
	3	TxD	Send data
	5	Ground	Ground reference
Connector type: 9-pin sub D connector			

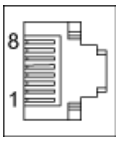
Note

Connecting cable to the AOP30

The connection cable to AOP30 may only contain the three contacts which are shown in the drawing; a completely allocated cable may not be used.

X150 P1/P2 PROFINET interface

Table 4- 65 X150 P1 and X150 P2 PROFINET

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

Note

Connection cables

The PROFINET interfaces support Auto MDI(X). It is therefore possible to use both crossed and uncrossed cables to connect the devices.

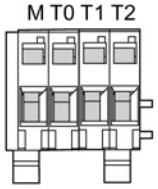
For diagnostic purposes, the two PROFINET interfaces are each equipped with a green and a yellow LED. These LEDs indicate the following status information:

Table 4- 66 LED states of the X150 P1/P2 PROFINET interface

LED	Color	Status	Description
Link port	-	Off	Missing or faulty link
	Green	Continuous light	10 or 100 Mbit link available
Activity port	-	Off	No activity
	Yellow	Flashing light	Data is being received or sent at port x

T0, T1, T2: Measuring socket contacts

Table 4- 67 Measuring socket contacts T0, T1, T2

	Socket	Function	Technical specifications
	M	Ground	Voltage: 0… 5 V Resolution: 8 bits Load current: max. 3 mA Sustained short-circuit-proof The reference potential is terminal M
	T0	Measuring socket contact 0	
	T1	Measuring socket contact 1	
	T2	Measuring socket contact 2	
PCB plug connector from Phoenix Contact, type: ZEC 1.0/ 4-ST-3.5 C1 R1.4, order number: 1893708			

Note

Cable cross-section

The measuring socket contacts are only suitable for cable cross-sections of 0.2 mm^2 to 1 mm^2.

Note

Use of the measuring socket contacts

The measuring socket contacts are used to support commissioning and diagnostics. Connection during operation is not permitted.

DIAG button

The DIAG pushbutton is reserved for service functions.

Slot for the memory card



Figure 4-48 Slot for the memory card

WARNING

Danger to life due to software manipulation when using exchangeable storage media

Storing files on exchangeable storage media poses an increased risk of infection, for example, by viruses and malware. Incorrect parameter assignment can cause machines to malfunction, which can lead to injuries or death.

- Protect files stored on exchangeable storage media from malicious software with suitable protection measures, for example, virus scanners.

Note

Possible plant standstill by withdrawing or inserting the memory card in operation

If the memory card is withdrawn or inserted during operation, then data can be lost, possibly resulting in a plant standstill.

- Pull and plug the memory card only when the Control Unit is de-energized.

Note

Insertion direction of the memory card

Only insert the memory card as shown in the photo above (arrow at top right).



NOTICE

Damage to memory card due to electric fields or electrostatic discharge

Electrical fields or electrostatic discharge may result in damage to the memory card and therefore malfunctions.

- When removing and inserting the memory card, always observe the ESD regulations.

Note

Possible data loss when returning the Control Unit with memory card

When a defective Control Unit is returned, the data on the memory card (parameters, firmware, licenses, etc.) may be lost during repair and testing.

- Do not return the memory card with the Control Unit. Instead, keep it in a safe place so that it can be inserted in the replacement unit.

Note

Please note that only SIEMENS memory cards can be used to operate the Control Unit.

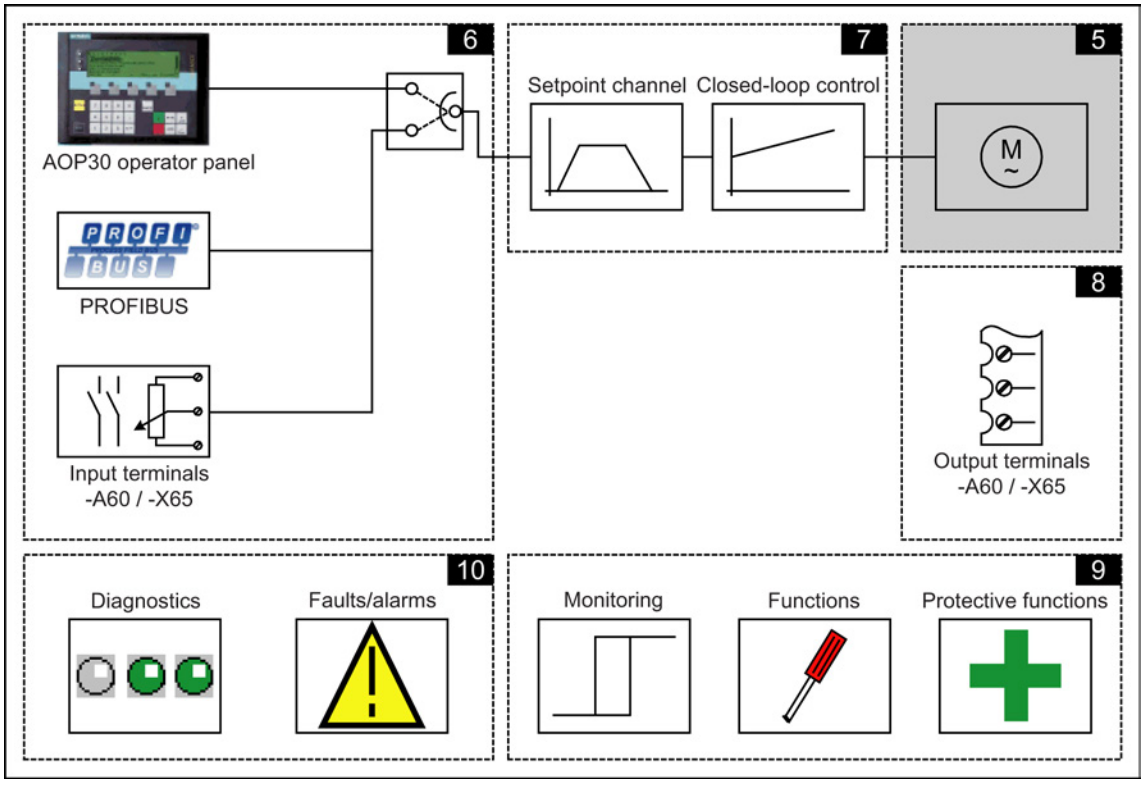
Commissioning

5

5.1 Chapter content

This section provides information on the following:

- An overview of the operator panel functions
- Initial commissioning of the cabinet unit (initialization) with STARTER and AOP30
  - Entering the motor data (drive commissioning)
  - Entering the most important parameters (basic commissioning), concluding with motor identification
- Data backup
- Parameter reset to factory settings



Important information prior to commissioning

The enclosed drive offers a varying number of internal signal interconnections depending on the factory state and the options installed. For the closed-sloop converter control to process signals correctly, several software settings must be made.

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

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

⚠ WARNING

Danger to life or malfunctions of the machine as a result of incorrect or changed parameter assignment

Machines can malfunction as a result of incorrect or changed parameter assignment, which in turn can lead to injuries or death.

- Protect parameter assignments against unauthorized access.
- Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

5.2 The STARTER commissioning tool

Description

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

Note

STARTER online help

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

STARTER Version prerequisite

The following STARTER version is required for commissioning SINAMICS with firmware V4.7:

- STARTER V4.4

Requirements for installing STARTER

Hardware

The following minimum requirements must be met:

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

Software

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

- Microsoft Internet Explorer V6.0 or higher

32-bit operating systems:

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

64-bit operating systems:

- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 7 Enterprise SP1 (Standard Installation)
- Microsoft Windows Server 2008 R2

*) Restricted scope of testing

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

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

Note

Requirements in conjunction with STEP 7

If STARTER is used in combination with other STEP 7 components, the requirements for these S7 components apply.

5.2.1 Installing the STARTER commissioning tool

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

Note

Time required for installation

The time required for installation depends on the computer capacity and from where it is installed (e.g., DVD, hard disk, network). We recommend installing it from a local data storage medium.

5.2.2 Layout of the STARTER user interface

STARTER features four operating areas:

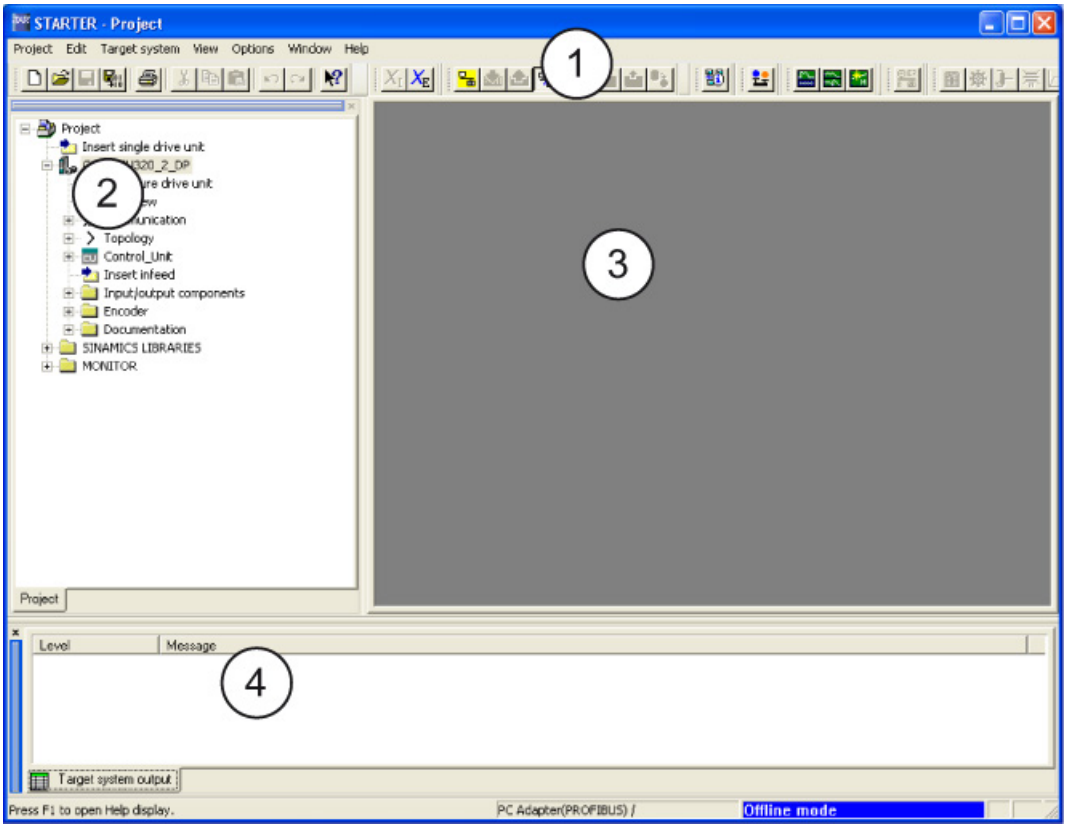


Figure 5-1 STARTER operating areas

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

5.3 Procedure for commissioning via STARTER

Basic procedure using STARTER

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

Note

Default settings in dialog screens

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

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

5.3.1 Creating the project

Click the STARTER icon on the desktop or select the Start > All programs > STARTER > STARTER menu command in the Windows start menu (e.g., in Windows 7) to start the STARTER commissioning tool.

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

- STARTER Getting Started
- STARTER project wizard

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

Accessing the STARTER project wizard

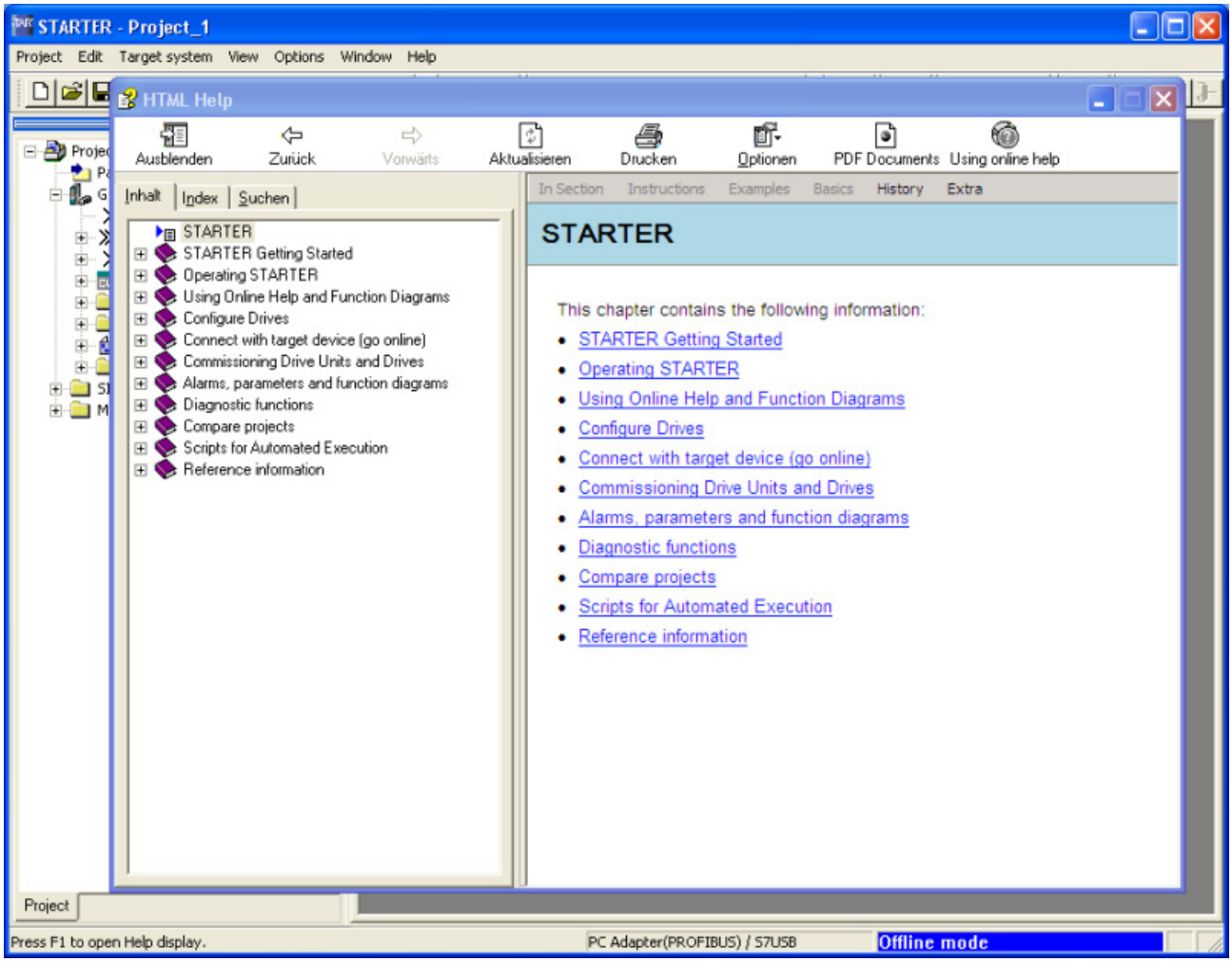


Figure 5-2 Main screen of the STARTER configuration and commissioning tool

⇒ Hide STARTER Getting Started Drive Commissioning using **HTML Help > Close**
The online help can be permanently hidden by deselecting **Options > Settings > Workbench > Show "Getting Started" at start**

Note

Project wizard

If you clear the **Display wizard during start** check box, the project wizard will not be displayed the next time you start STARTER.

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

The online help can be opened again at any time using **Options > Settings > Show "Getting Started" at start**.

STARTER features a detailed online Help system.

The STARTER project wizard

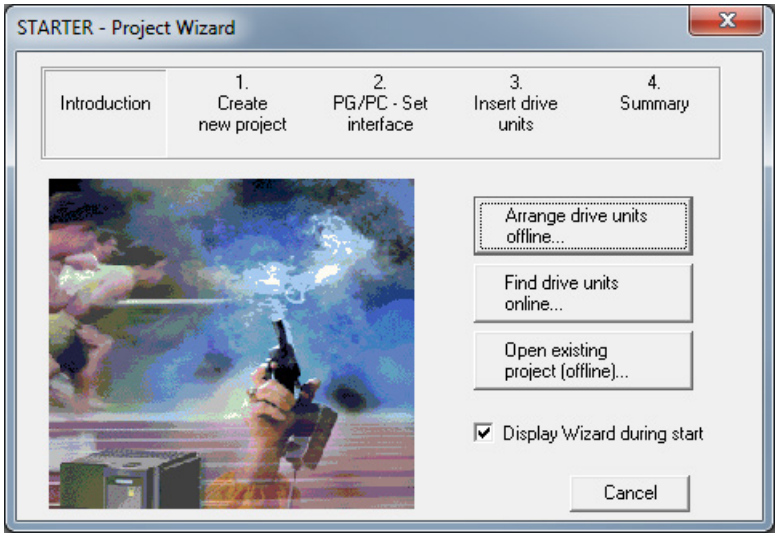


Figure 5-3 STARTER project wizard

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

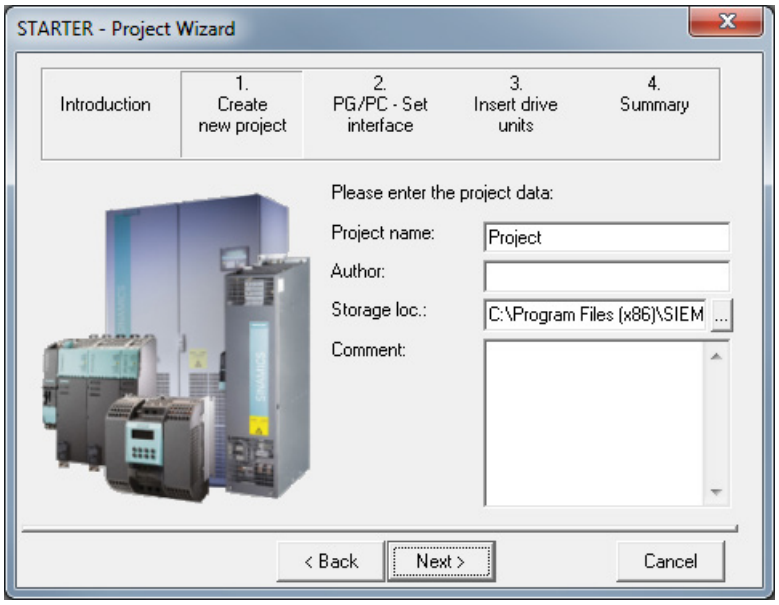


Figure 5-4 Creating a new project

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

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

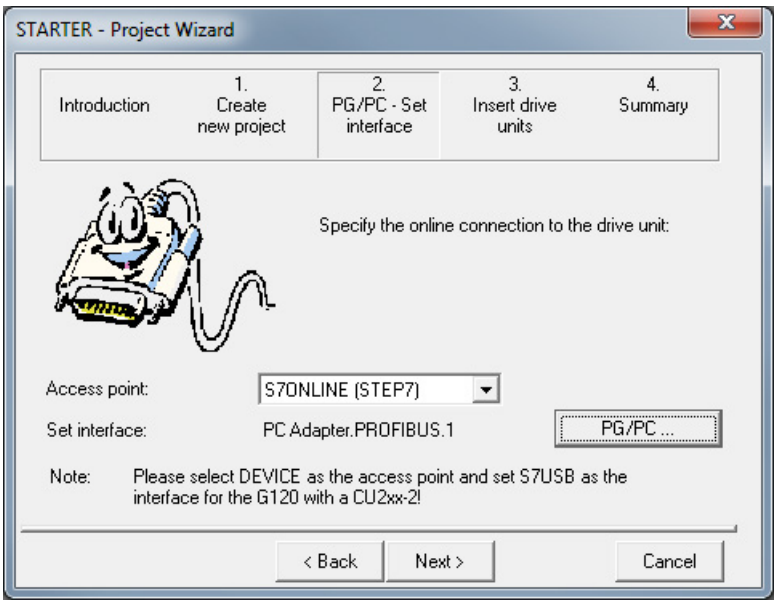


Figure 5-5 Setting the interface

⇒ In **Access point:**, select the interface according to your device configuration:

- Choose S7ONLINE (STEP 7) access, if the connection to the drive unit is made via PROFINET or PROFIBUS.
- Choose DEVICE access, if the connection to the drive unit is made via the Ethernet interface.

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

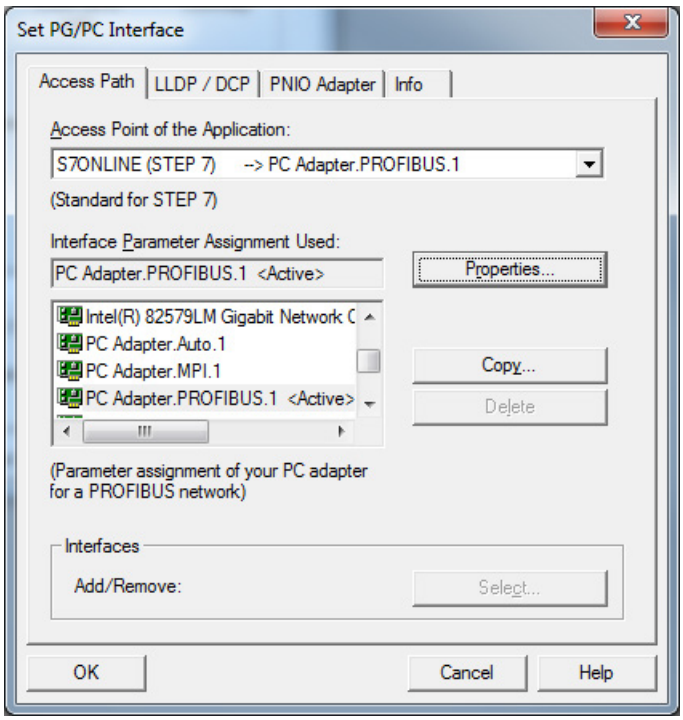


Figure 5-6 Setting the interface

Note

Requirement

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

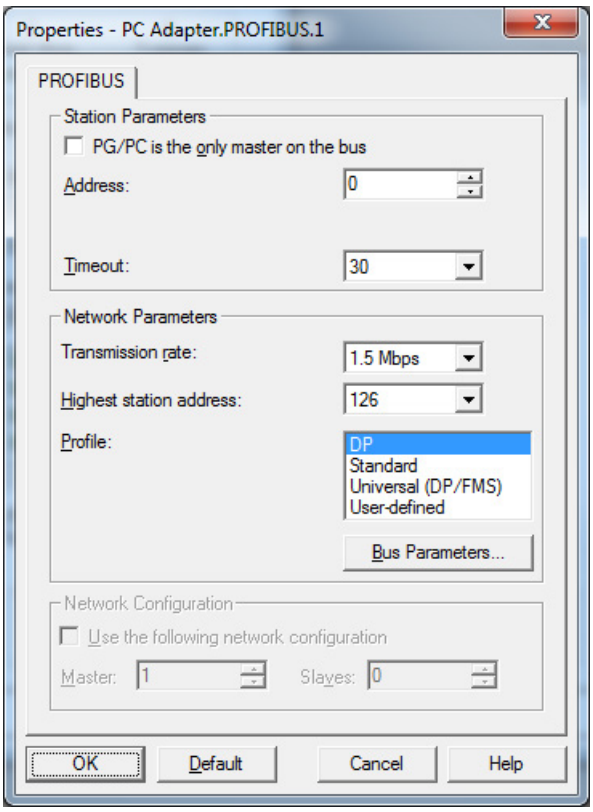


Figure 5-7 Setting the interface - Properties

Note

Activate PG/PC is the only master on the bus

You must activate **PG/PC is the only master on the bus** if no other master (PC, S7, etc.) is available on the bus.

Note

Configuring without an interface

Projects can be created and PROFIBUS addresses for the drive objects assigned even if a PROFIBUS interface has not been installed on the PC.

To prevent bus addresses from being assigned more than once, only the bus addresses available in the project are proposed.

If necessary, a previously assigned address can be entered again via manual address entry.

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

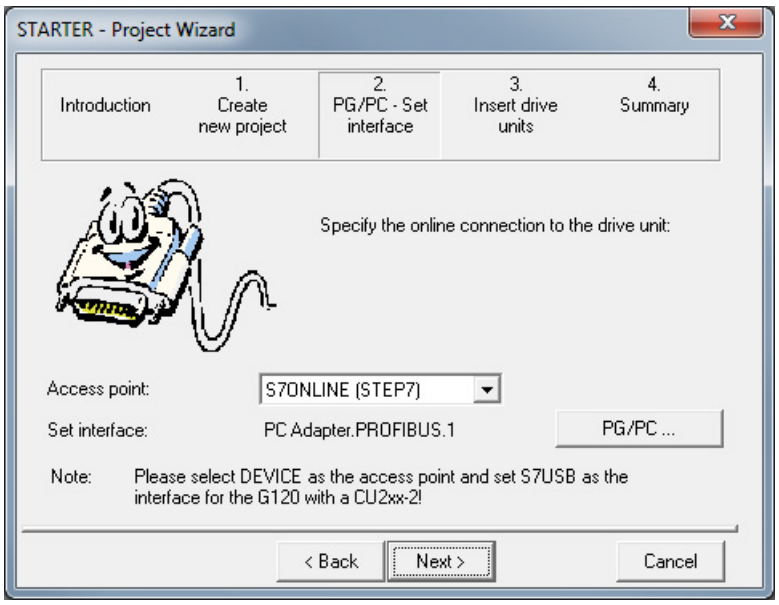


Figure 5-8 Setting the interface - Finished

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

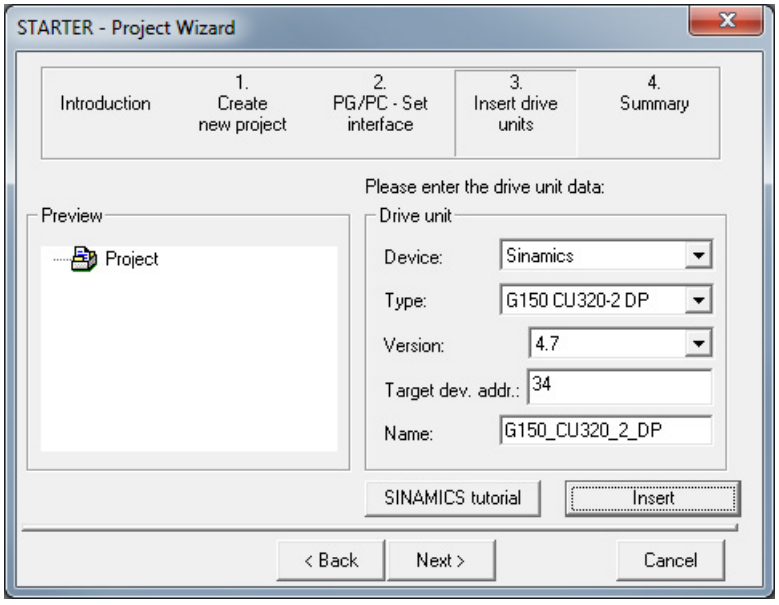


Figure 5-9 Inserting a drive unit

⇒ Choose the following data from the list boxes:
Device: Sinamics
Type: G150 CU320-2 DP or G150 CU320-2 PN with option K95
Version: 4.7
Target device address: the corresponding address for the enclosed drive
The entry in **Name:** field is user-defined.

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

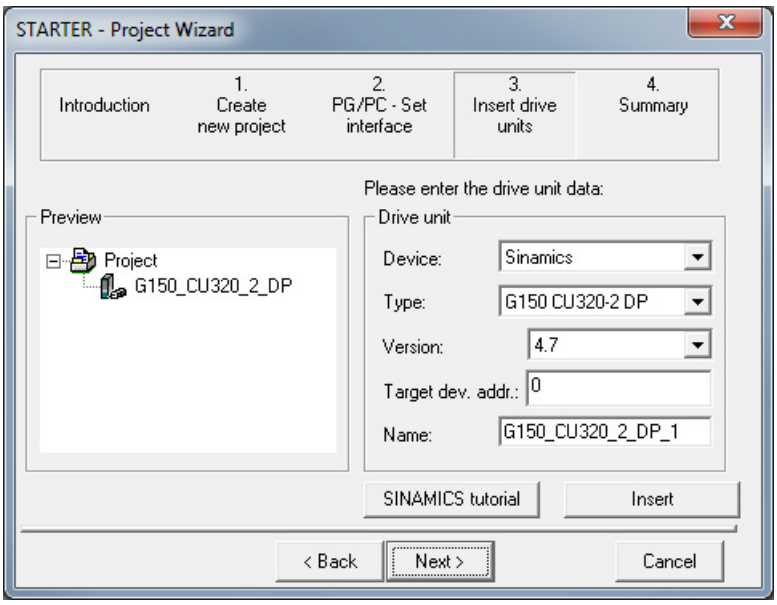


Figure 5-10 Drive unit inserted

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

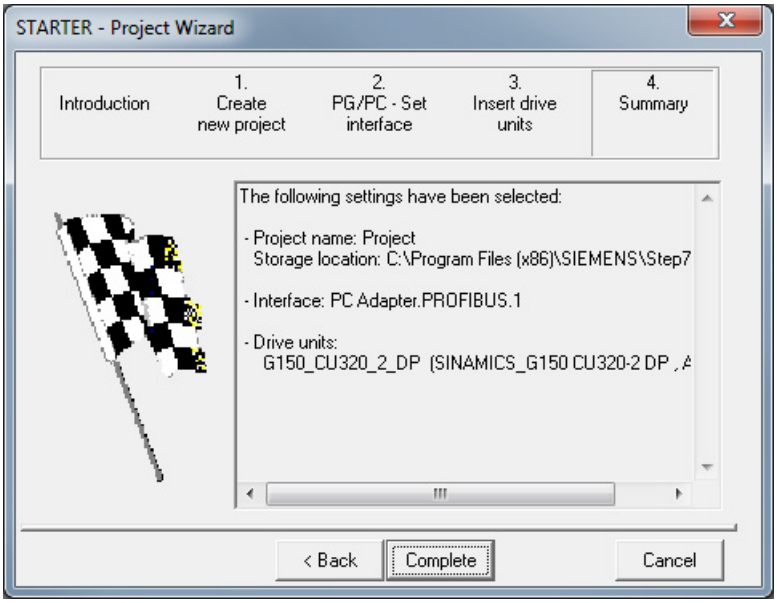


Figure 5-11 Summary

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

5.3.2 Configuring the drive unit

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

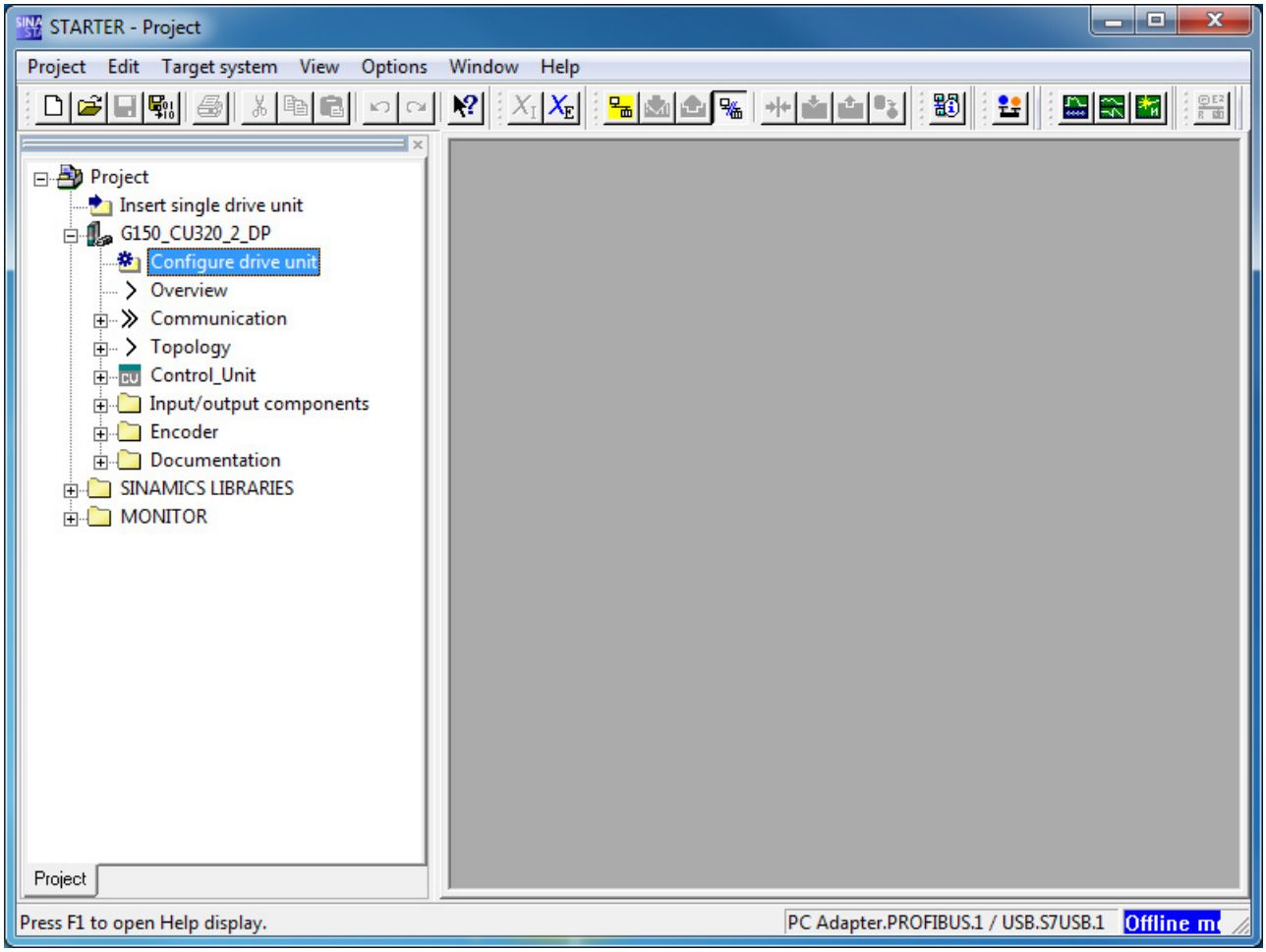


Figure 5-12 Project navigator - Configuring the drive unit

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

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

Configuring the drive unit

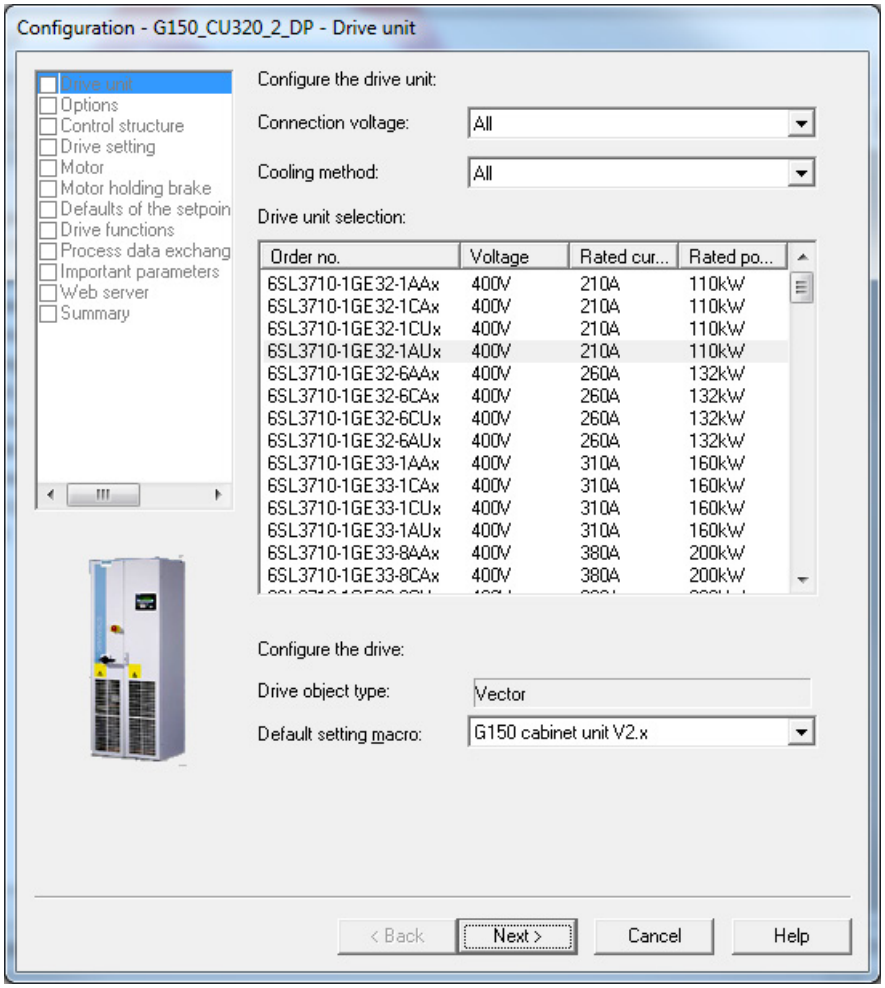


Figure 5-13 Configuring the drive unit

⇒ Under **Connection voltage:**, choose the correct voltage. Under **Cooling method:**, choose the correct cooling method for your drive unit.

Note

Make a pre-selection

This is a preliminary selection of the enclosed drives. You do not define the line voltage yet.

⇒ A list is now displayed under **Drive unit selection:**. Choose the corresponding drive unit according to type (order no.) (see nameplate).

⇒ Click **Continue >**.

Selecting options

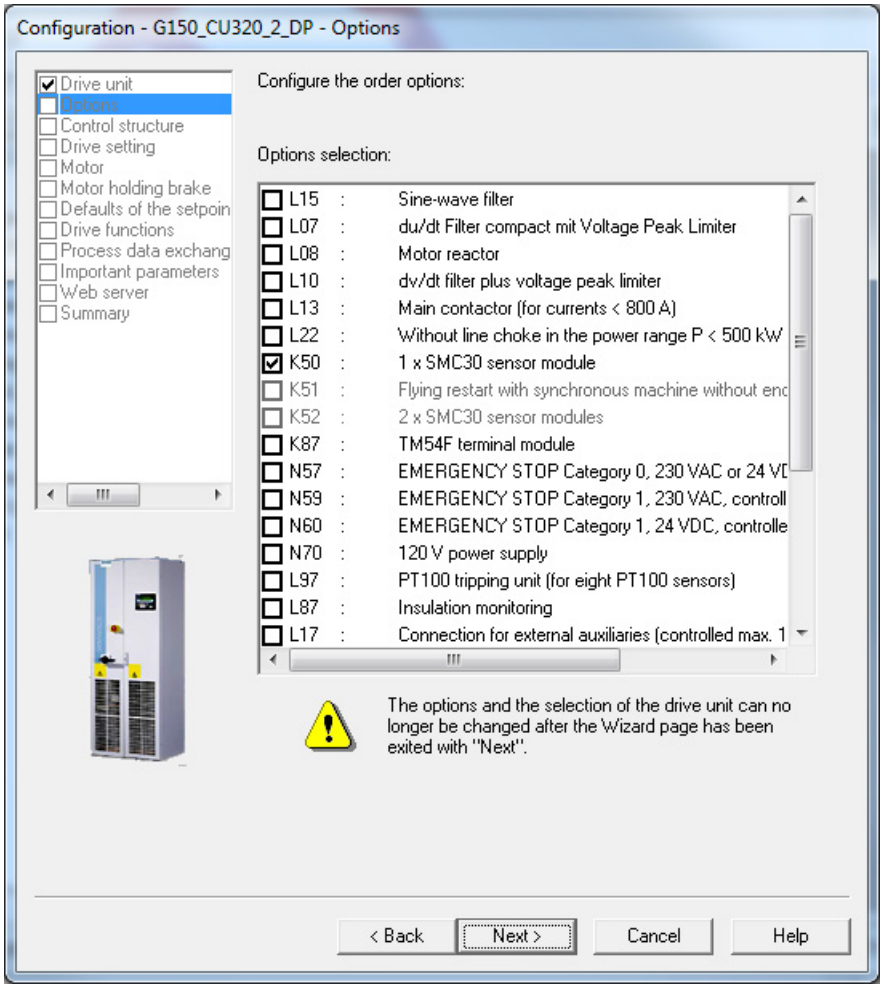


Figure 5-14 Selecting options

⇒ Under **Options selection:** , choose the options for your drive unit by selecting the appropriate check boxes (see nameplate).

NOTICE
Damage to the dv/dt filter if it is not activated during commissioning The dv/dt filter may be damaged if it is not activated during commissioning. • Activate the dv/dt filter during commissioning by selecting the corresponding check box (option L10).

Note

Motor reactor

An existing motor reactor (option L08) must be activated during option selection. Otherwise, the motor control cannot operate optimally.

Note

Check option selection

Check your options carefully against the options specified on the nameplate.

Since the wizard establishes internal interconnections on the basis of the options selected, you cannot change the selected options by clicking **< Back**.
If you make an incorrect entry, delete the entire drive unit from the project navigator and create a new one.

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

Selecting the control structure

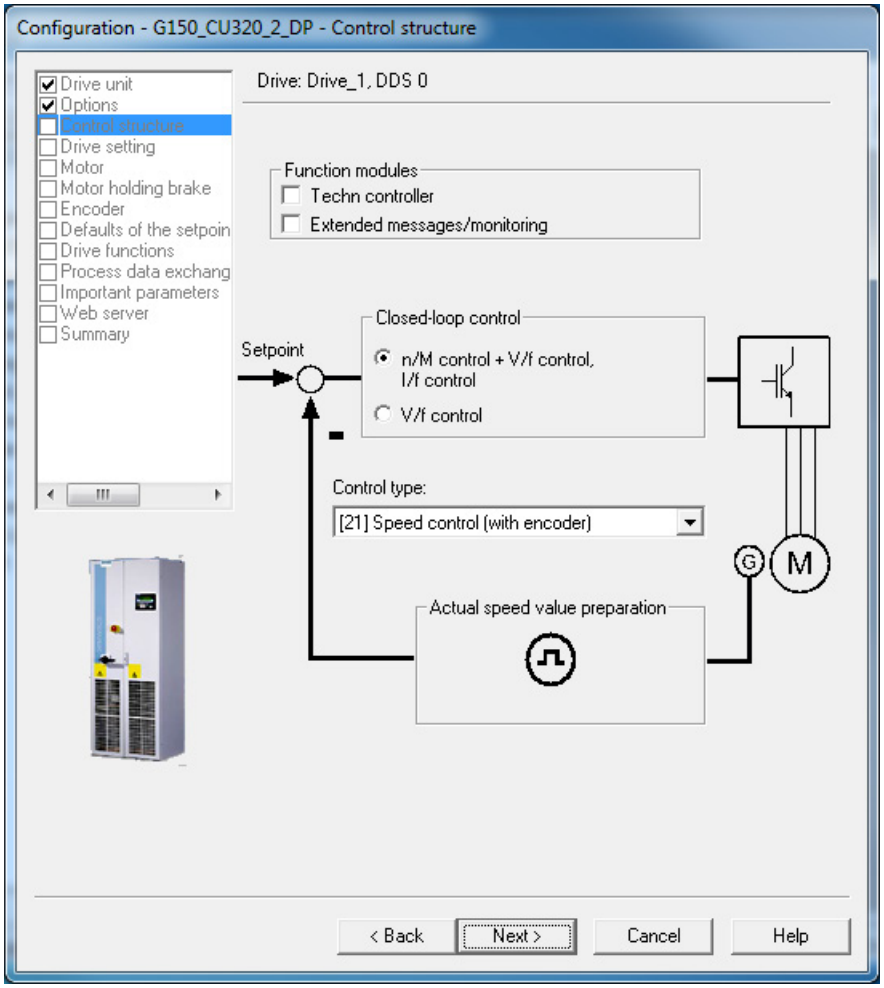


Figure 5-15 Selecting the control structure

⇒ Select the corresponding settings for the control structure:

- **Function modules:**
  - Technology controller
  - Extended signals/monitoring
- **Control:**
  - n/M control + V/f control, I/f control
  - V/f Control

- **Control type:**
  Depending on the selected control, you can select from the following open-loop/closed-loop control types:
  - 0: V/f control with linear characteristic
  - 1: V/f control with linear characteristic and FCC
  - 2: V/f control with parabolic characteristic
  - 3: V/f control with assignable characteristic
  - 4: V/f control with linear characteristic and ECO
  - 5: V/f control for drive requiring a precise frequency (e.g., textiles)
  - 6: V/f control for drive requiring a precise frequency and FCC
  - 7: V/f control with parabolic characteristic and ECO
  - 15: Operation with braking resistor
  - 18: I/f control with fixed current
  - 19: V/f control with independent voltage setpoint
  - 20: Speed control (without encoder)
  - 21: Speed control (with encoder)
  - 22: Torque control (without encoder)
  - 23: Torque control (with encoder)

⇒ Click **Continue >**.

Configuring the drive properties

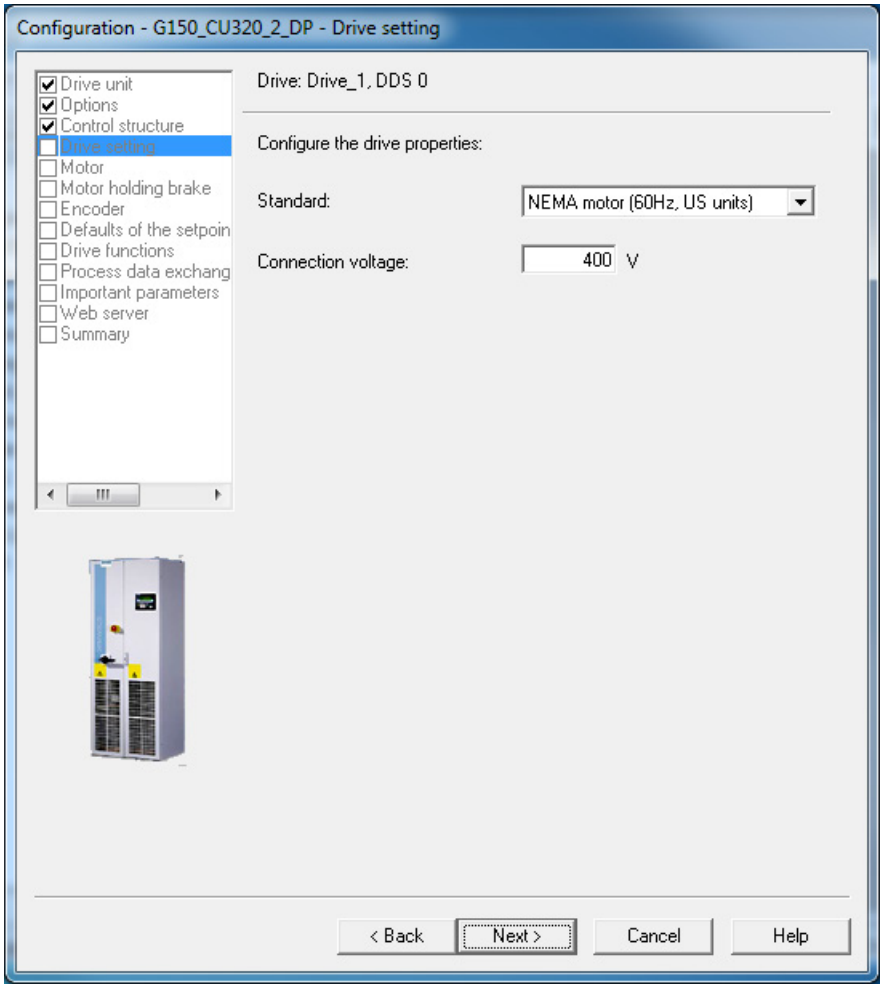


Figure 5-16 Configuring the drive properties

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

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

⇒ Under **Connection voltage:**, enter the appropriate input voltage for the enclosed drive.

⇒ Click **Continue >**.

The connected motor can be selected or entered in different ways:

- By selecting a standard motor from a list
- By entering the motor data

Selecting the motor type by selecting a standard motor from a list

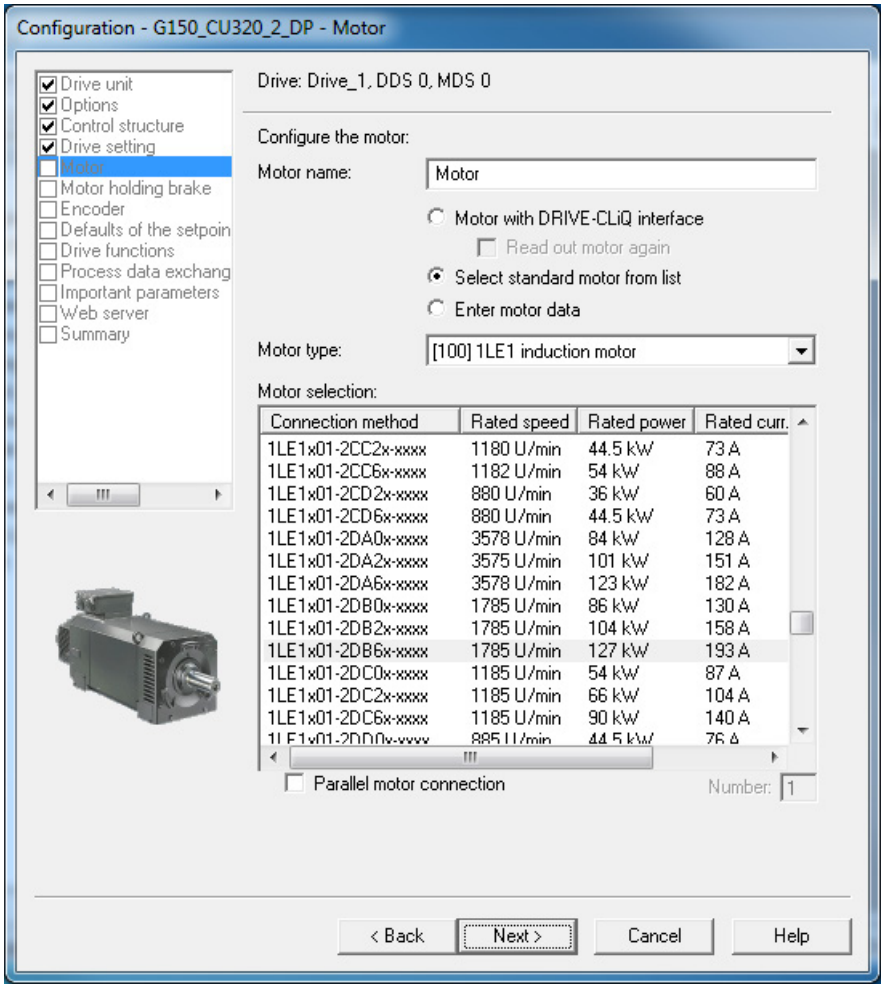


Figure 5-17 Configuring a motor – Selecting the motor type, selecting standard motor from list

⇒ Under **Motor name:**, enter a name for the motor.

⇒ Select **Select standard motor from list**.

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

⇒ From the **Motor selection:** list, select the appropriate motor.

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

⇒ Click **Continue >** in order to configure the motor holding brake

Selecting the motor type by entering motor data

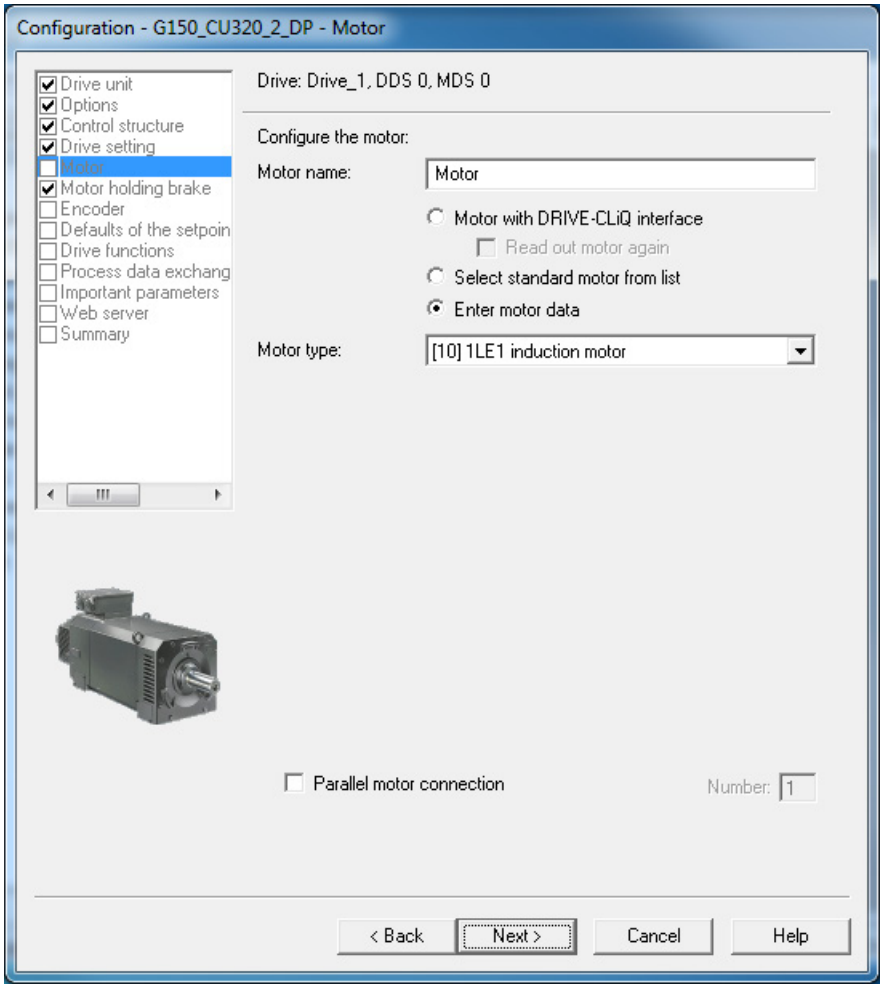


Figure 5-18 Configuring a motor – Selecting the motor type, entering motor data

⇒ Under **Motor name:**, enter a name for the motor.

⇒ Select **Enter motor data**.

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

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

Note

Selecting motor type

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

Note

Commissioning an induction motor

The steps described below also apply to commissioning an induction motor.

When commissioning a permanent-magnet synchronous motor, a few special conditions apply. These are detailed in a separate section (see "Setpoint channel and closed-loop control / Permanent-magnet synchronous motors").

⇒ Click **Continue >**.

Configuring the motor – Entering motor data

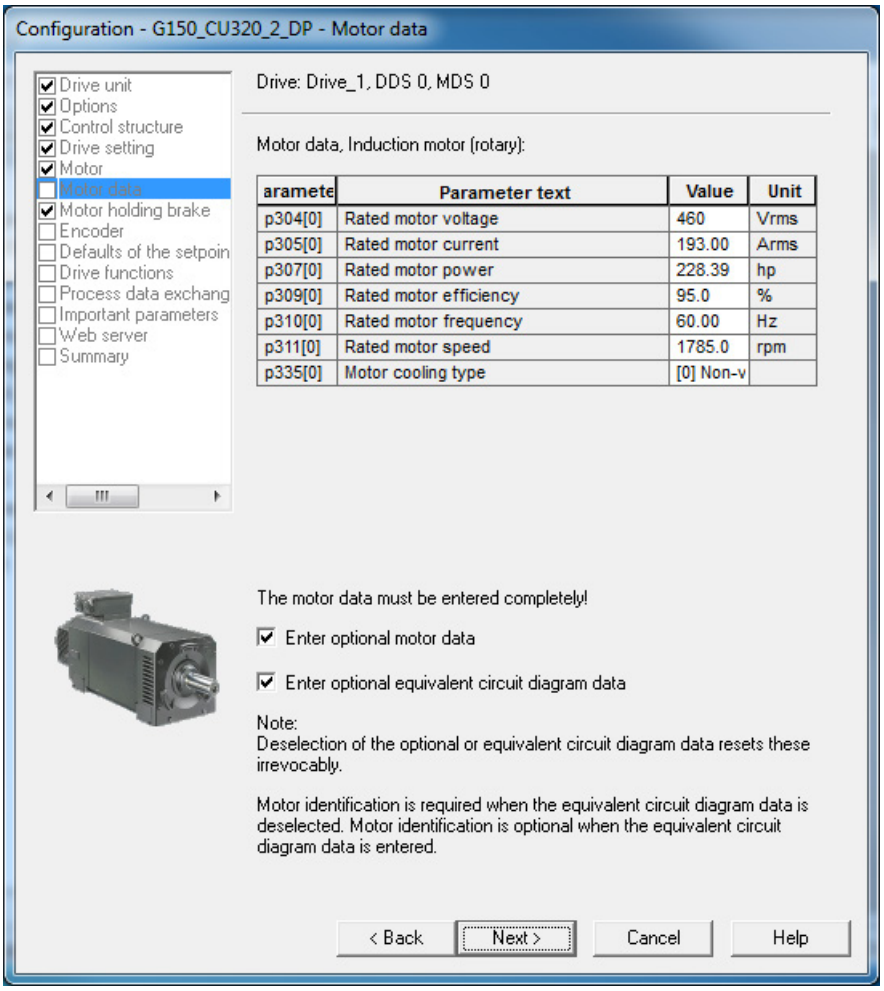


Figure 5-19 Configuring the motor – Entering motor data

⇒ Enter the motor data (see motor nameplate).

⇒ Select **Enter optional motor data**, if necessary.

⇒ Select **Enter optional equivalent circuit diagram data**, if necessary

Note

Entering the equivalent circuit diagram data

You should only select the **Enter optional equivalent circuit diagram data** option if the data sheet with equivalent circuit diagram data is available. If any data is missing, an error message will be output when the system attempts to load the drive project to the target system.

⇒ Click **Continue >**.

Configuring the motor – Entering optional data

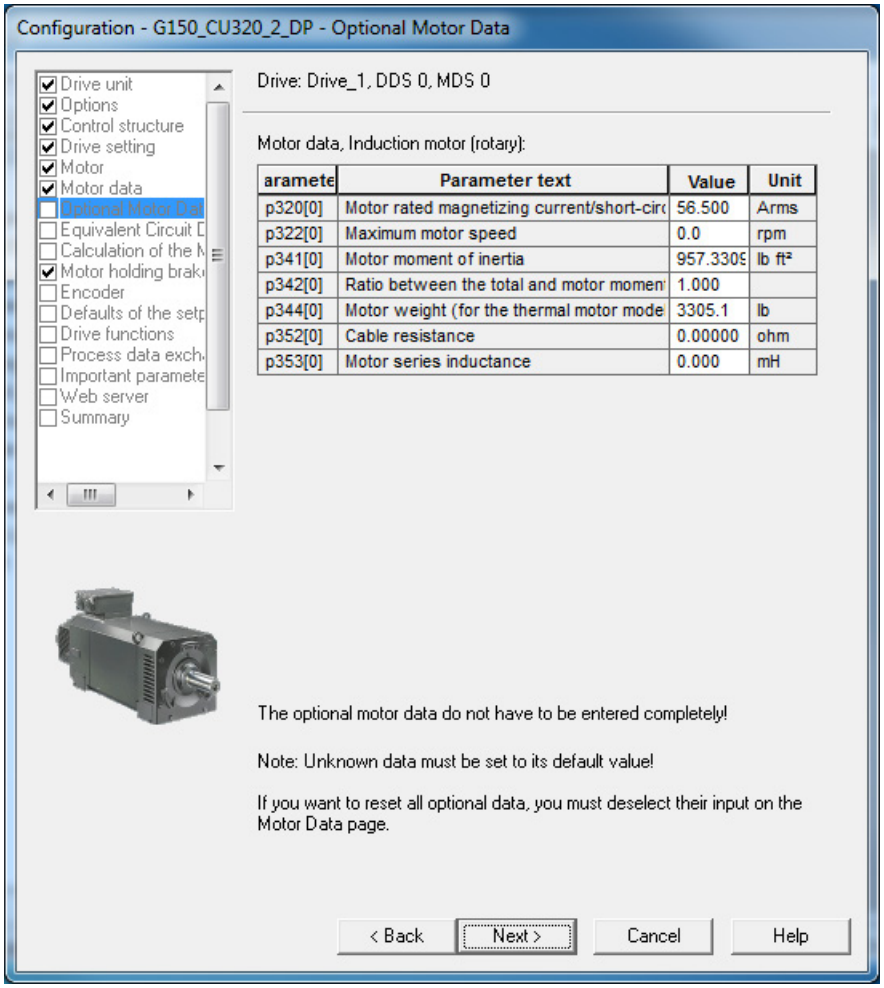


Figure 5-20 Entering optional motor data

⇒ Enter the optional motor data.

⇒ Click **Continue >**.

Configuring the motor – Entering the equivalent circuit diagram data

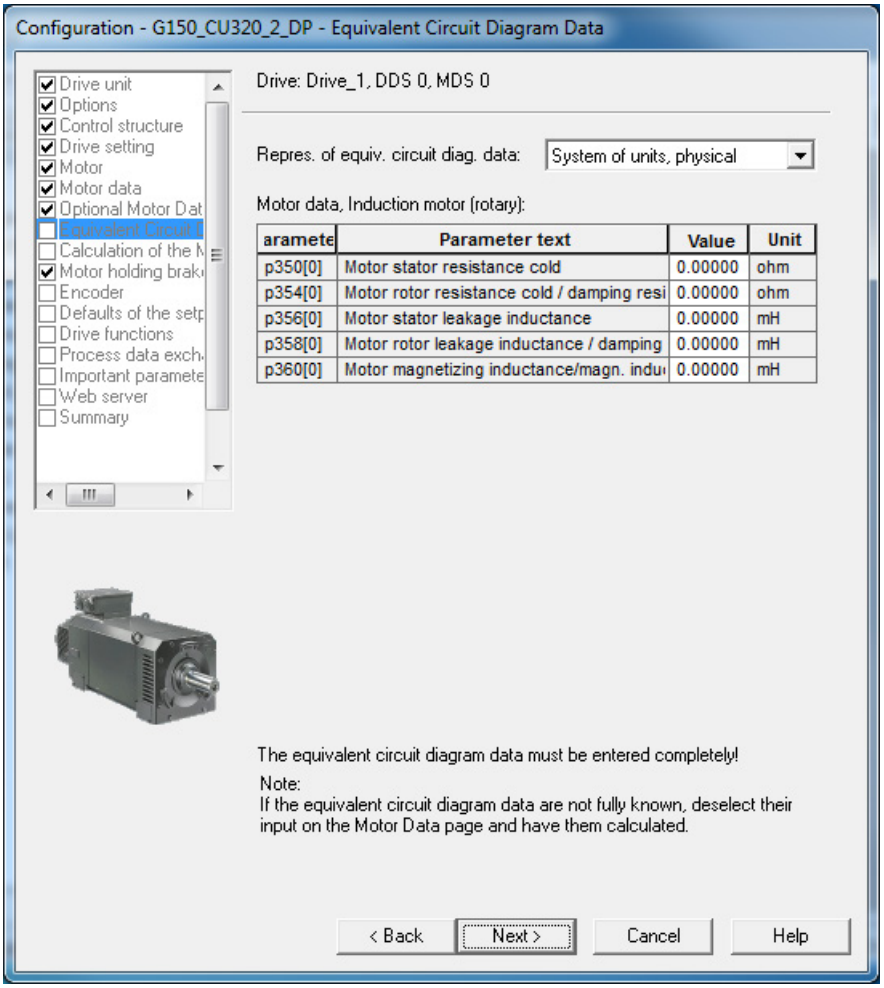


Figure 5-21 Entering the equivalent circuit diagram data

⇒ Select one of the equivalent circuit diagram data representations:

- **System of units, physical**
  The equivalent circuit diagram data are represented in the physical system of units.
- **System of units, relative**
  The equivalent circuit diagram data are represented as a percentage (%) of the motor rating data.

⇒ Enter the equivalent circuit diagram data completely.

⇒ Click **Continue >**.

Calculating the motor/controller data

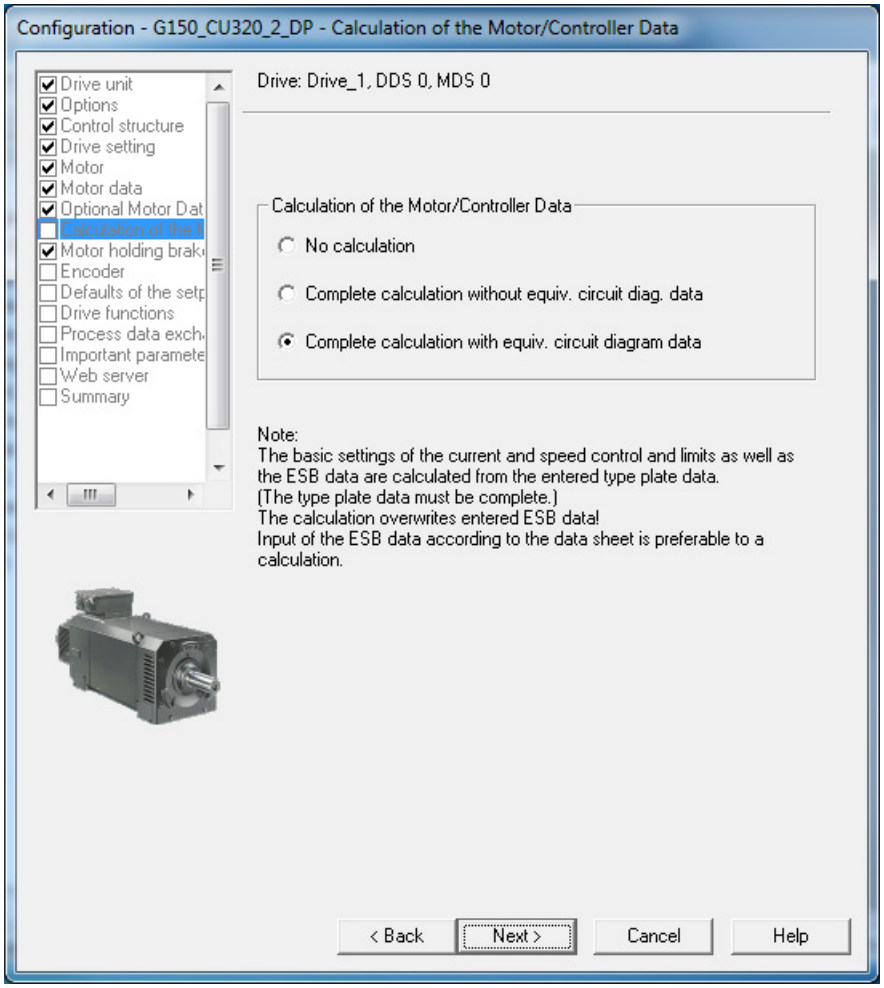


Figure 5-22 Calculating the motor/controller data

⇒ Under **Calculation of the motor/controller data**, select the appropriate default settings for your device configuration.

Note

Manual input of the equivalent circuit diagram data

If the equivalent circuit diagram data was entered manually (see "Entering the equivalent circuit diagram data"), the motor/controller data should be calculated **without** calculating the equivalent circuit diagram data.

⇒ Click **Continue >**.

Configuring the motor holding brake

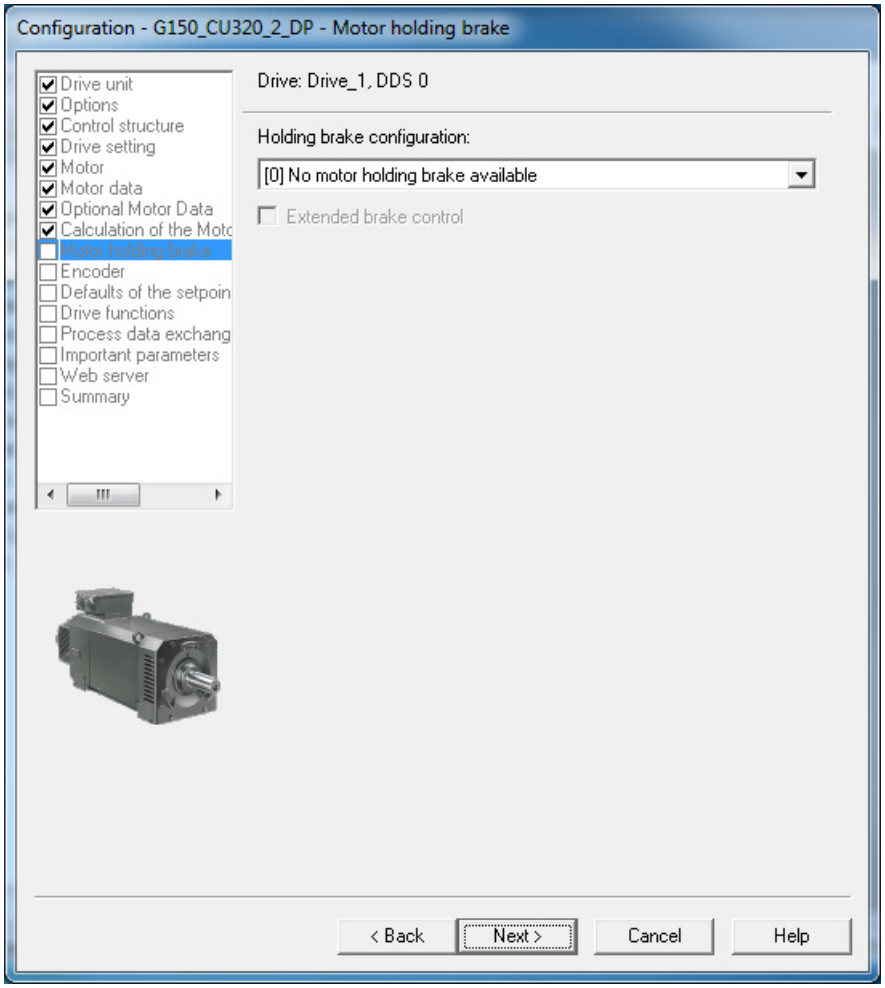


Figure 5-23 Configuring the motor holding brake

⇒ Under **Holding brake configuration:** choose the appropriate setting for your device configuration:

- 0: No motor holding brake being used
- 1: Motor holding brake like sequence control
- 2: Motor holding brake always open
- 3: Motor holding brake like sequence control, connection via BICO

⇒ When a motor holding brake is selected, you can also select the "Extended brake control" function module.

⇒ Click **Continue >**.

Entering the encoder data (option K50)

Note

Entering encoder data

If you have specified option K50 (SMC30 Sensor Module Cabinet-Mounted), the following input screen is displayed for you to enter the encoder data.

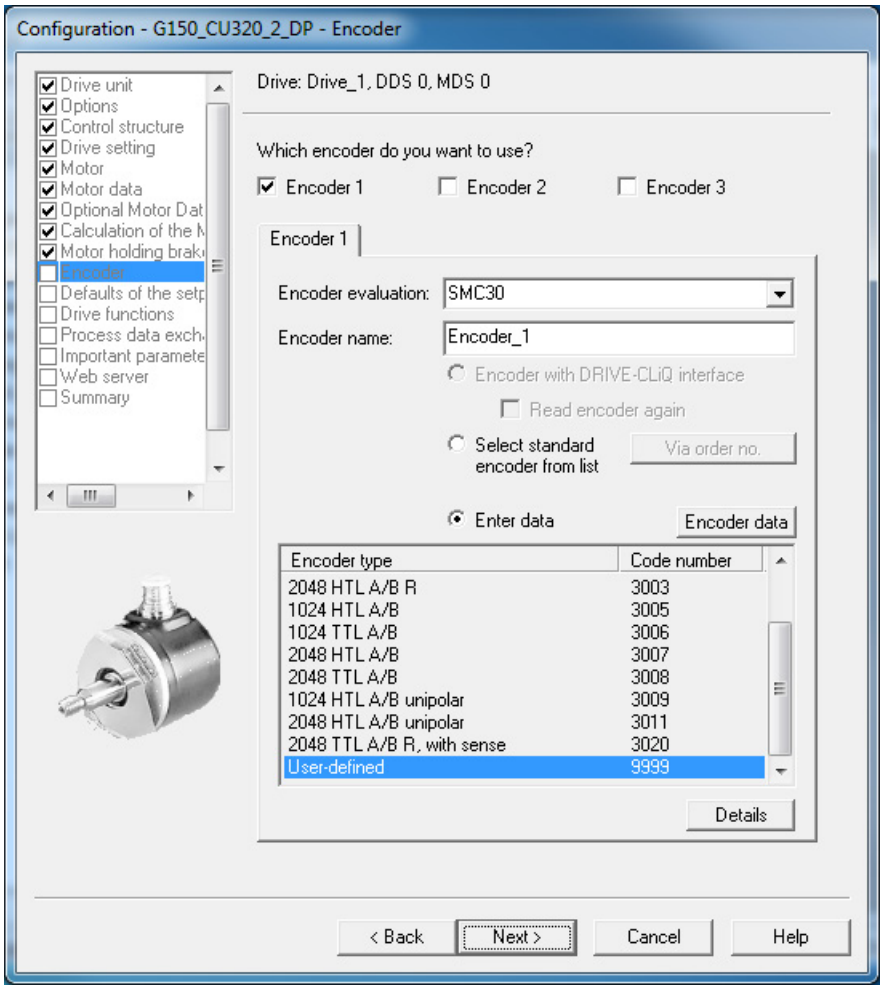


Figure 5-24 Entering the encoder data

⇒ Under **Encoder name:**, enter a name of your choice.

Note

Factory state

The factory state is a bipolar HTL encoder with 1024 pulses per revolution at terminal X521/X531.

⇒ To select a different predefined encoder configuration, click the **Select standard encoder from list** radio button and select one of the encoders from the list.

⇒ To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following input screen is displayed for you to enter the required data.

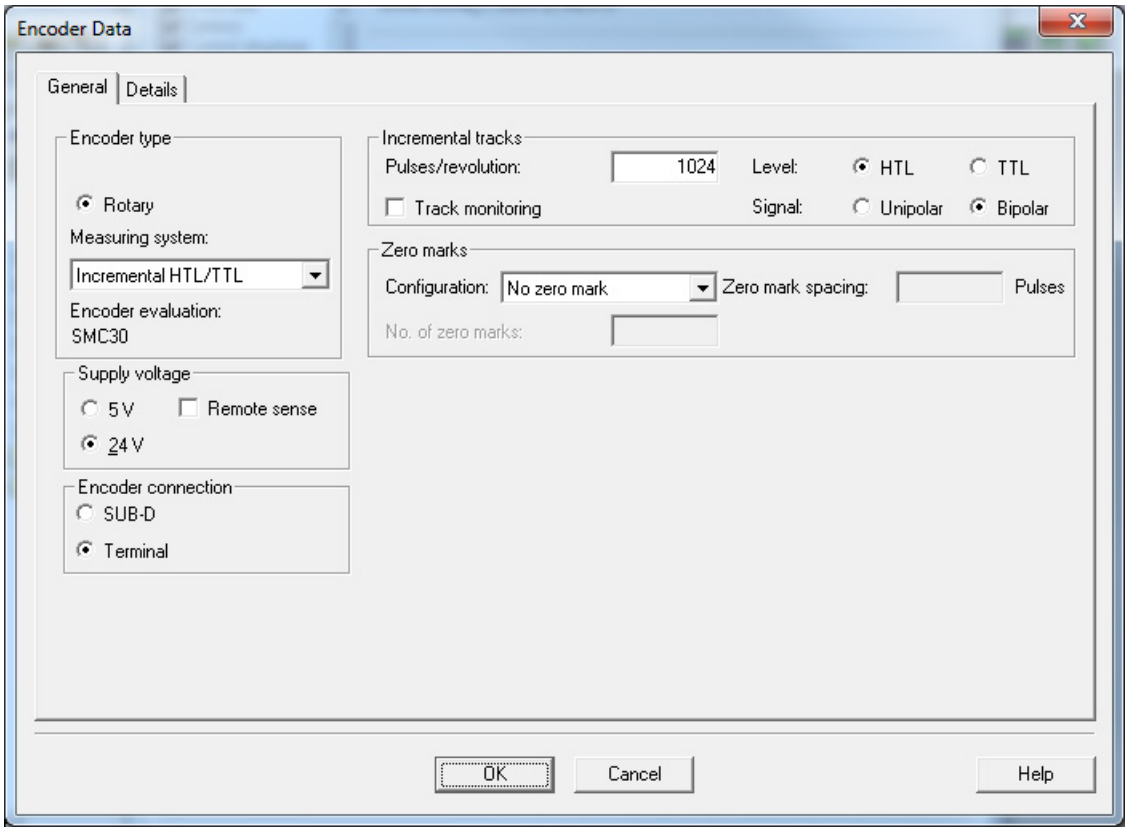


Figure 5-25 Entering encoder data – User-defined encoder data

⇒ Select the **measuring system**.

For SINAMICS G150 NA, the following encoders can be selected:

- HTL
- TTL

⇒ Enter the required encoder data.

⇒ In the **Details** tab, special encoder properties can be set, for example, gear ratio, fine resolution, inversion, measuring gear position tracking.

⇒ Click **OK**.

NOTICE
Property damage due to selection of incorrect supply voltage for the encoder Once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5 V encoder is connected and the supply voltage has not been set correctly, the encoder may be damaged. • Set the correct supply voltage for the connected encoder.

Default settings for setpoints/command sources

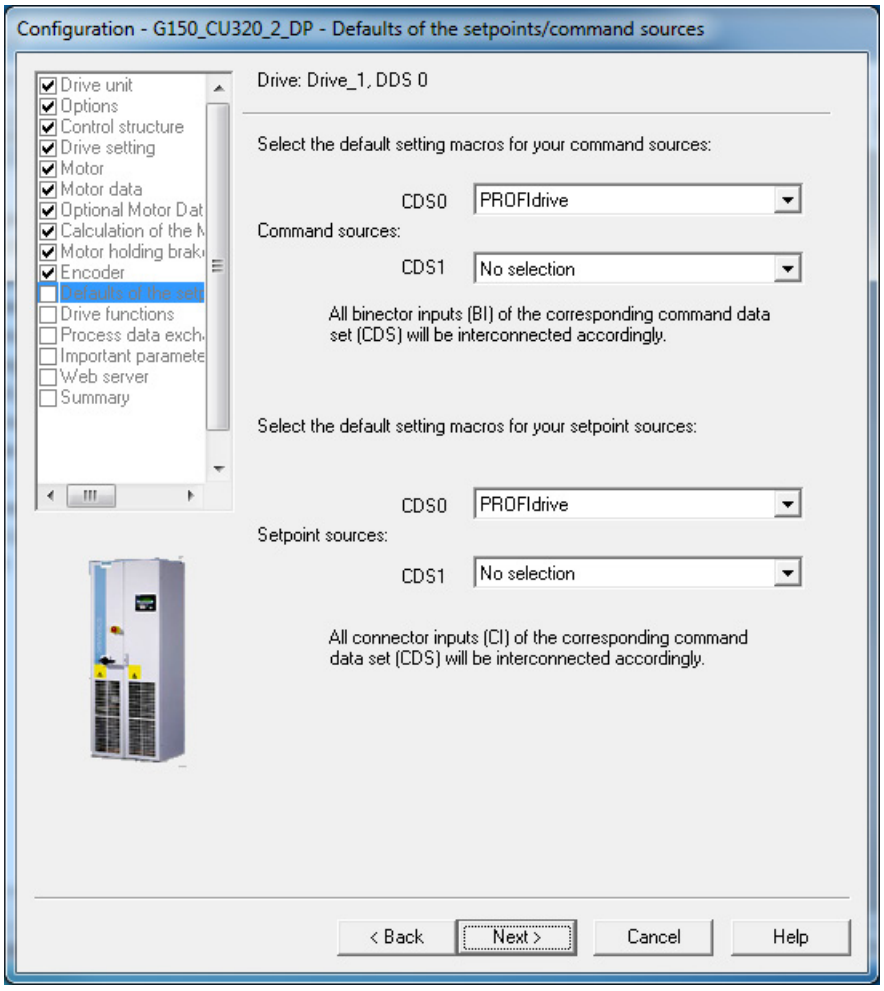


Figure 5-26 Default settings for setpoints/command sources

⇒ Under **Command sources:** and **Setpoint sources:**, choose the appropriate predefined settings for your device configuration.

The following command and setpoint source options are available:

Command sources:	Profidrive (default setting)
	TM31 terminals
	NAMUR - Do not select!
	PROFIdrive NAMUR - Do not select!
Setpoint sources:	Profidrive (default setting)
	TM31 terminals
	Motorized potentiometer
	Fixed setpoint

Note

Use of CDS0

With SINAMICS G150, only CDS0 is normally used as a default setting for the command and setpoint sources.

Make sure that the selected default setting is compatible with the actual system configuration.

Note

Do not use a selection

The choice "No selection" is also available as default setting for the command and setpoint sources; if selected, no default settings are applied for the command and setpoint sources.

⇒ Check your default settings carefully and then click **Continue >**.

Selecting the drive functions

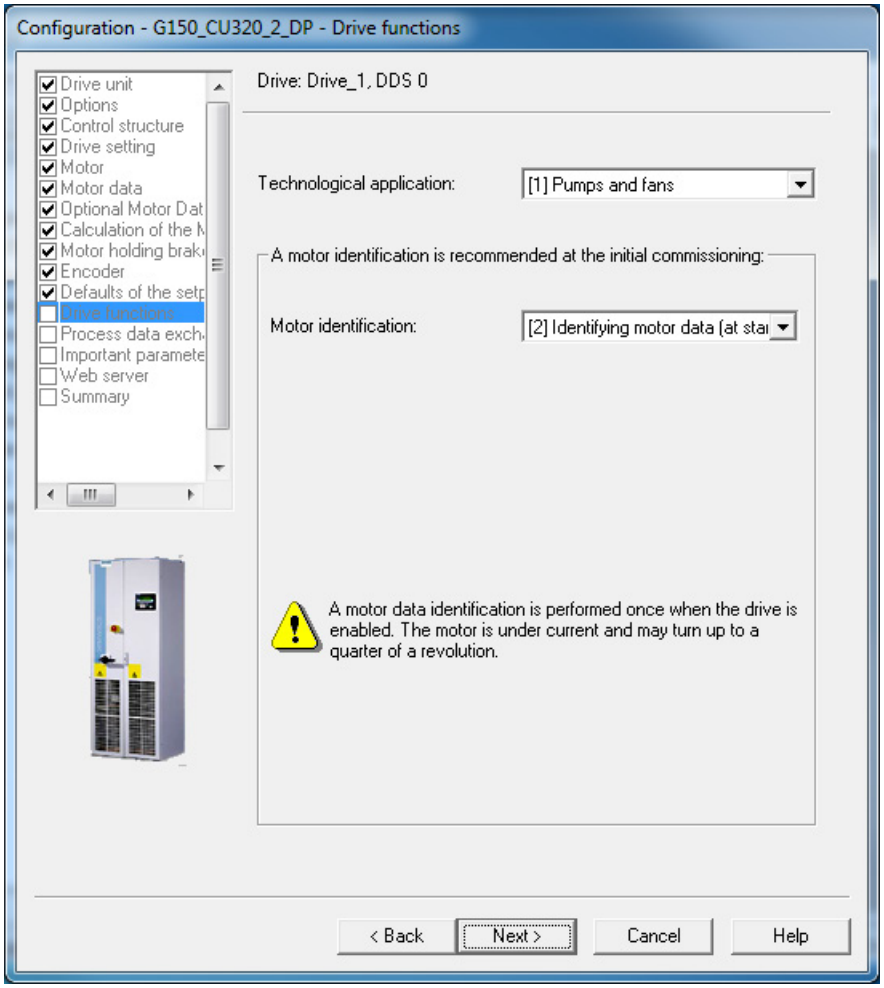


Figure 5-27 Selecting the drive functions

⇒ Select the required data:

- **Technological application:**
  - **"(0) Standard drive (VECTOR)"**
    Edge modulation is not enabled.
    The dynamic voltage reserve is increased (10 V), which reduces the maximum output voltage.
  - **"(1) Pumps and fans"**(default setting)
    Edge modulation is enabled.
    The dynamic voltage reserve is reduced (2 V), which increases the maximum output voltage.
  - **"(2) Sensorless control down to f = 0 (passive loads)"**
    Closed-loop controlled operation down to zero speed is possible for passive loads. These include applications in which the load cannot produce a regenerative torque on startup and the motor comes to a standstill when pulses are inhibited (no overhauling load).
  - **"(4) Dynamic response in the field-weakening range"**
    Space vector modulation with overmodulation is enabled.
    The dynamic voltage reserve is increased (30 V), which reduces the maximum output voltage.
- **Motor identification:**
  - (0): Disabled
  - (1): Identify the motor data and optimize the speed control
  - (2): Identify the motor data (at standstill)
  - (3): Optimize the speed control (during rotating operation)

Note

Motor data identification at standstill

In many cases, "Identify motor data (at standstill)" is the correct selection for SINAMICS G150.
For speed control with encoder, the "Identify motor data and optimize speed control" selection is recommended. This measurement is normally performed when a machine is not connected.

⚠ WARNING

Danger to life due to unexpected movement of the motor in the case of motor identification during rotating operation

When motor identification with optimization during rotating operation is selected, after the drive is commissioned it initiates movements of the motor that can reach the maximum motor speed.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional during commissioning.

⇒ Click **Continue >**.

Selecting the process data exchange

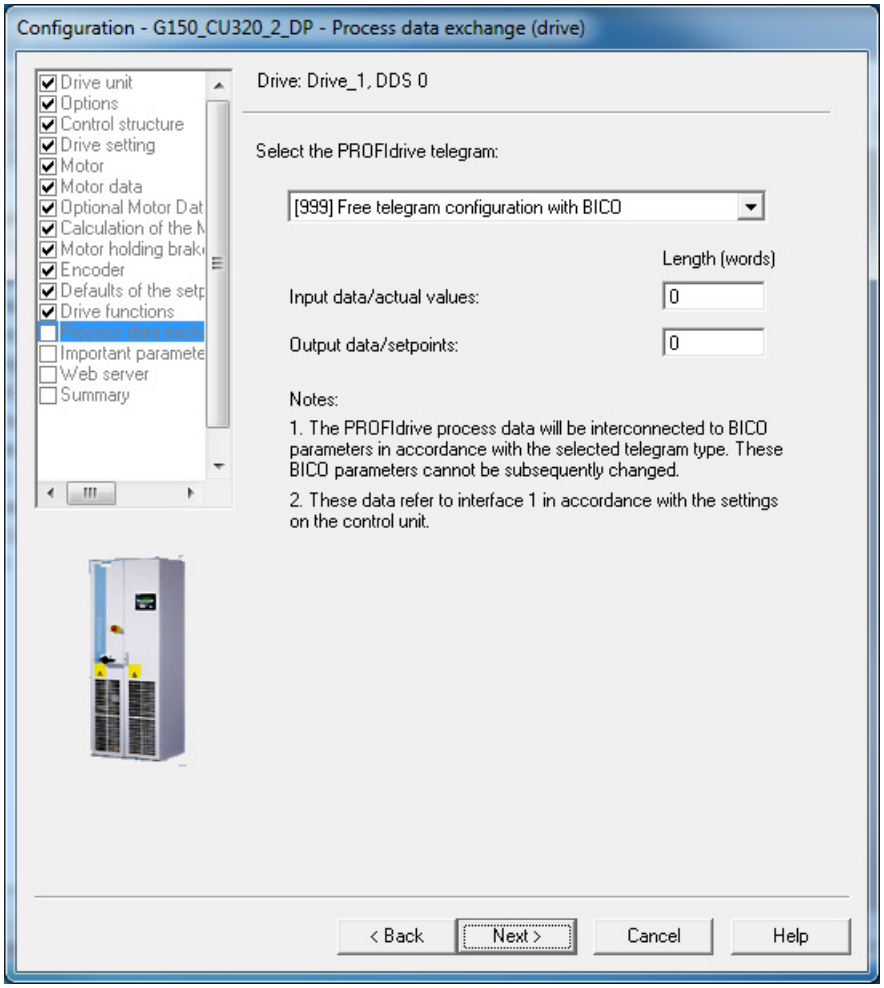


Figure 5-28 Selecting the process data exchange

⇒ Select the PROFIdrive message frame type.

Message frame types

- 1: Standard message frame 1, PZD-2/2
- 2: Standard message frame 2, PZD-4/4
- 3: Standard message frame 3, PZD-5/9
- 4: Standard message frame 4, PZD-6/14
- 20: SIEMENS message frame 20, PZD-2/6
- 220: SIEMENS message frame 220, PZD-10/10
- 352: SIEMENS message frame 352, PZD-6/6
- 999: Free frame configuration with BICO (default)

⇒ Click **Continue >**.

Entering important parameters

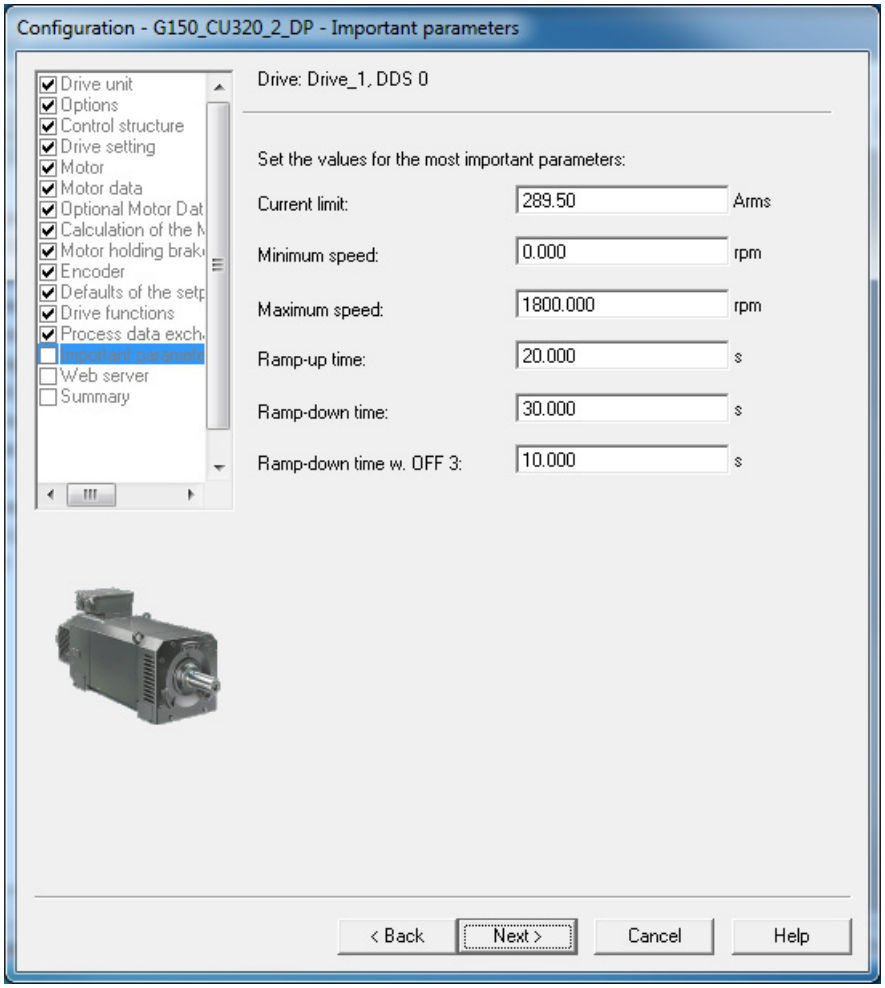


Figure 5-29 Important parameters

⇒ Enter the required parameter values.

Note

Tooltips

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

⇒ Click **Continue >**.

Configuring a web server

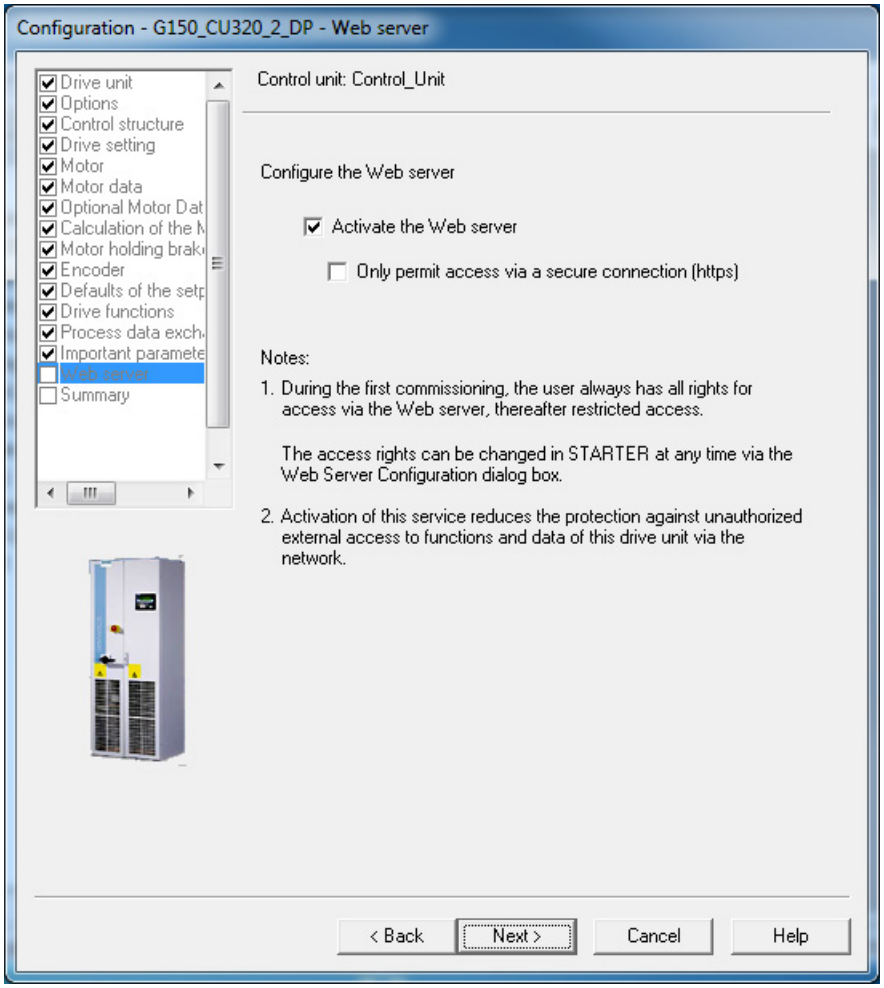


Figure 5-30 Configuring a web server

⇒ Configure the web server.

The Web server is activated in the factory setting.

Activate and deactivate the web server under **Activate web server**.

Select **Only allow access via secure connection (https)** if necessary.

⇒ Click **Continue >**.

Summary of the drive unit data

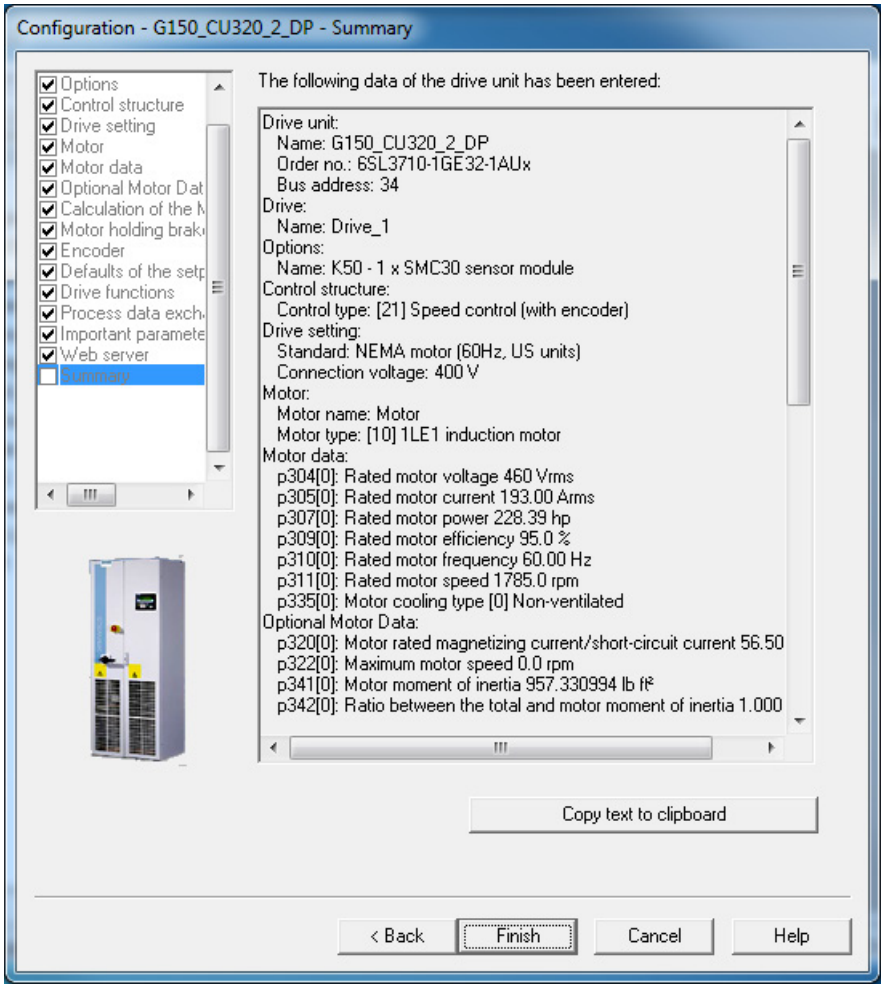


Figure 5-31 Summary of the drive unit data

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

⇒ Click **Finish**.

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

5.3.3 Transferring the drive project

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

Specifying the online access point

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

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

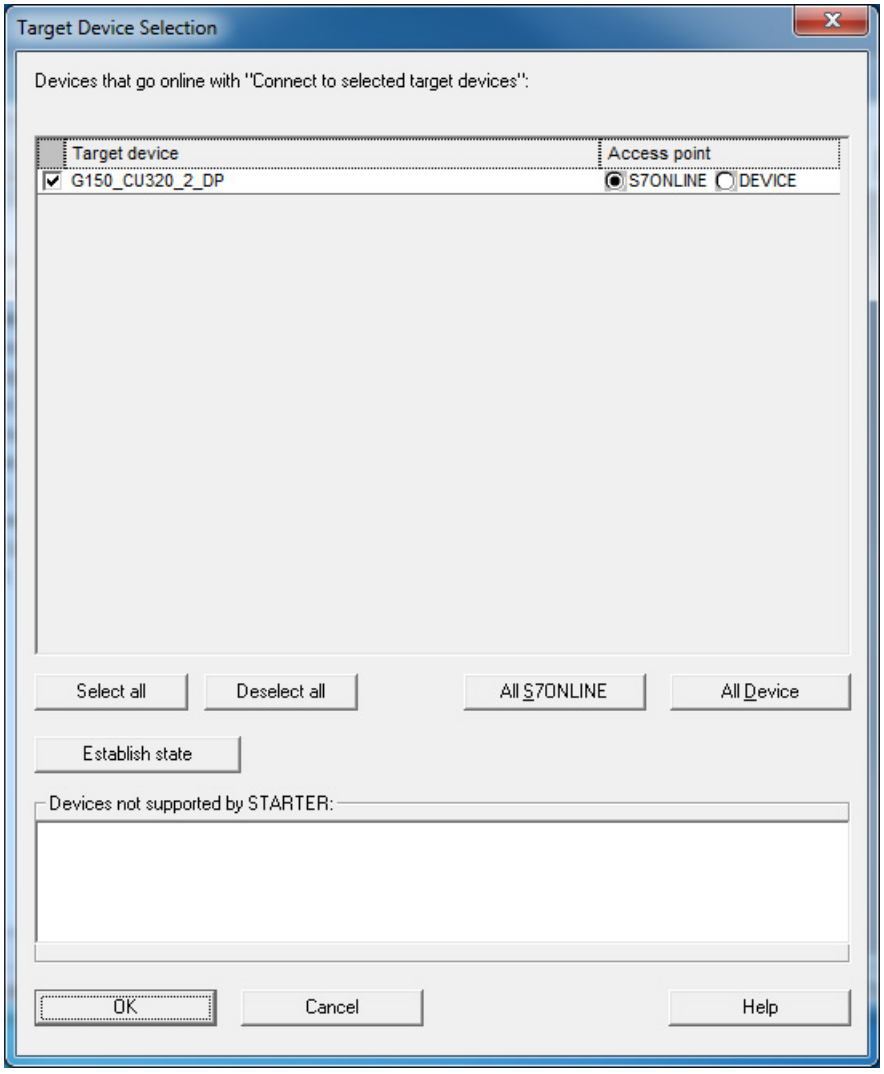


Figure 5-32 Target device selection and access points

The dialog screen lists all existing devices in the project.

Specify access point:

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

Transferring the STARTER project to the drive unit

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

Step		Toolbar selection
1	Choose **Project > Connect to selected target systems**	
2	Choose **Target system > Load > Load project to target system**	

Note

Save project data so it is protected from power failure

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

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

Step		Toolbar selection
3	Choose **Target system > Copy RAM to ROM**	

Note

Copy RAM to ROM

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

Results of the preceding steps

- You have created a project for your drive unit offline using STARTER.
- You have saved the project data to the hard disk on your PC.
- You have transferred the project data to the drive unit.
- You have saved your project data to your drive unit's memory card so that it is protected in the event of a power failure.

Note

Tip for working with STARTER

The STARTER commissioning tool assists you in performing complex interventions on the drive system.

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

5.3.4 Commissioning with STARTER via Ethernet

Description

The Control Unit can be commissioned using a programming device (PG/PC) via the integrated Ethernet interface. This interface is provided for commissioning purposes only and cannot be used to control the drive in operation.

Routing from the integrated Ethernet interface using an (optionally) inserted expansion card CBE20 is not possible.

Requirements

- STARTER, version 4.1.5 or higher
- Control Unit CU320-2 DP device version "C" or higher, Control Unit CU320-2 PN

STARTER via Ethernet (example)

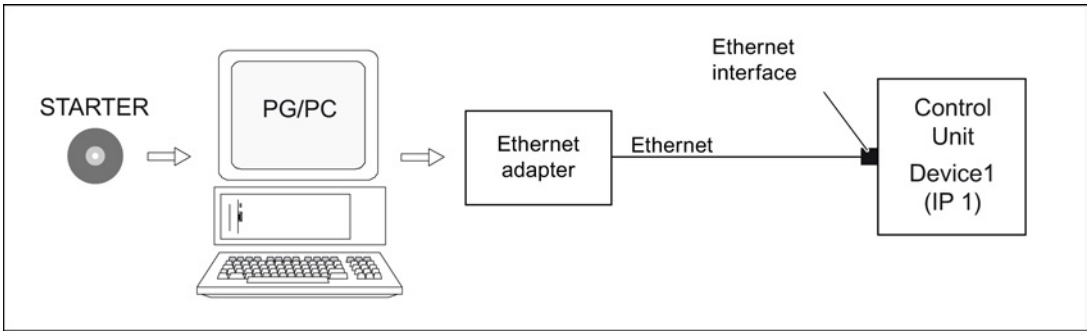


Figure 5-33 STARTER via Ethernet (example)

Procedure for establishing online operation via Ethernet

1. Install the Ethernet interface in the PG/PC according to the manufacturer's specifications.
2. Set the IP address of the Ethernet interface in Windows.
   - Assign the PG/PC a free IP address (e.g., 169.254.11.1).
   - The factory setting of the internal Ethernet interface -X127 of the Control Unit is 169.254.11.22.
3. Set the access point of the STARTER commissioning tool.
4. Use the STARTER commissioning tool to specify a name for the Control Unit interface.

   The Ethernet interface must be initialized so that STARTER can establish communication. Select online operation in STARTER.

Setting the IP address in Windows 7

Note

The following procedure refers to the Windows 7 operating system. The procedure can differ slightly for other operating systems (e.g., Windows XP).

1. In the programming device (PG/PC), open the Control Panel using the "Start > Control Panel" menu command.
2. In the Control Panel of your PG/PC, under "Network and Internet", select the "Network and Sharing Center" function.
3. Click the connection link for your indicated network adapter.
4. Click "Properties" in the status dialog of the connection and acknowledge the subsequent confirmation prompt with "Yes".
5. In the properties dialog of the connection, select the "Internet Protocol Version 4 (TCP/IPv4)" element and then click "Properties".
6. In the properties dialog, select the "Use the following IP address" option.

7. Set the IP address of the access interface of the PG/PC to the Control Unit to 169.254.11.1 and the subnet mask to 255.255.0.0.

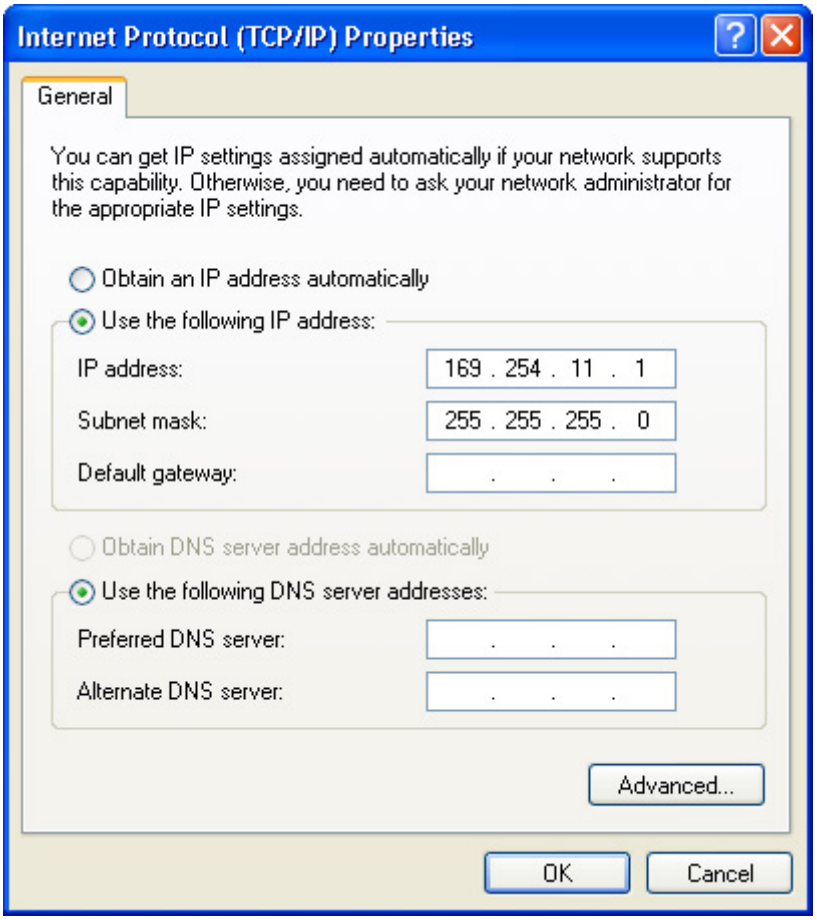


Figure 5-34 Properties of the Internet Protocol (TCP/IP)

8. Click "OK" and close the Windows-specific window of the network connections.

Assigning the IP address and the name via STARTER, "Accessible nodes" function

Use STARTER to assign an IP address and a name to the Ethernet interface.

1. Connect the PG/PC and the Control Unit using an Ethernet cable.
2. Switch on the Control Unit.
3. Open STARTER.
4. Create a new project or open an existing project.
5. Use Project -> Accessible nodes or the "Accessible nodes" button to search for nodes available on the Ethernet.

6. The SINAMICS drive object is detected and displayed as a bus node with IP address 169.254.11.22, without a name.

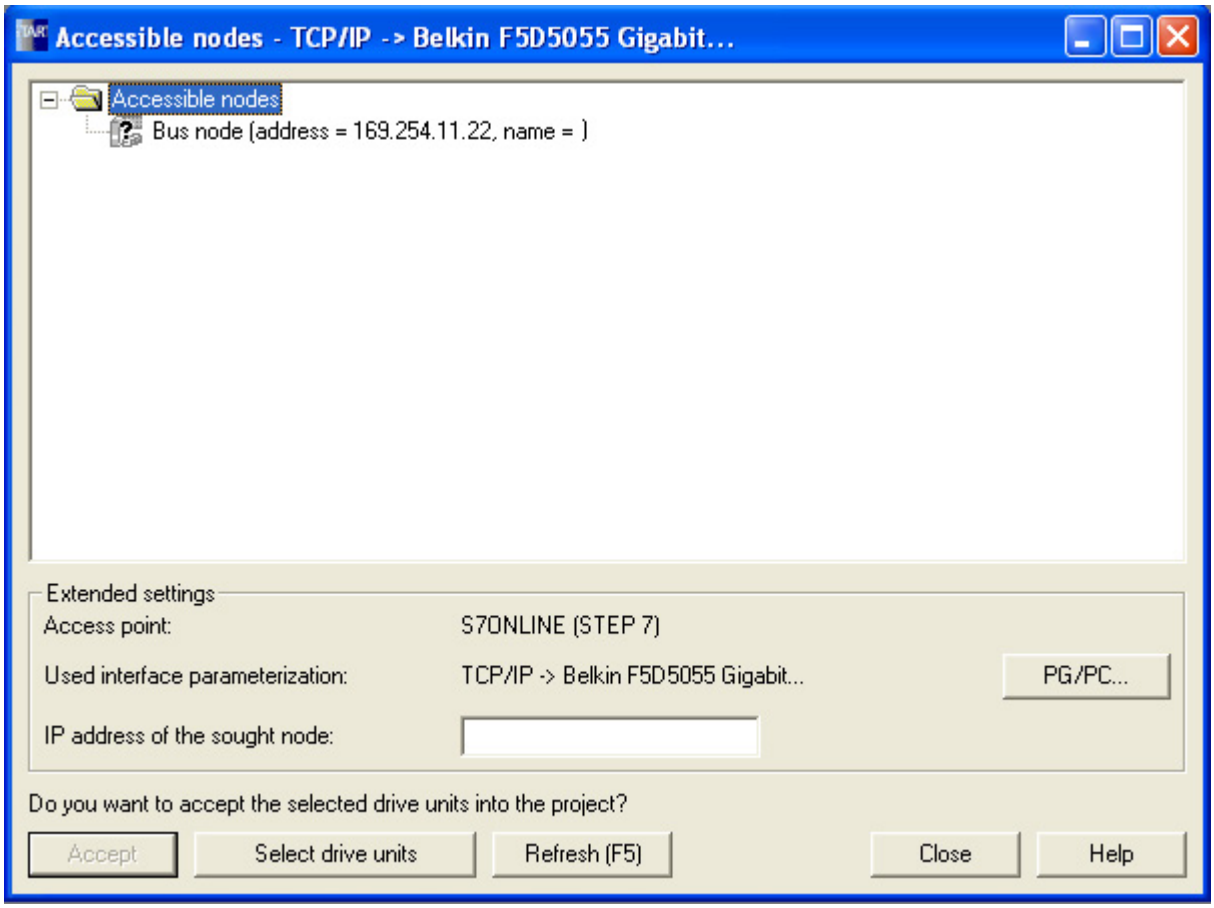


Figure 5-35 Accessible nodes

7. Mark the bus node entry and select the displayed menu command "Edit Ethernet node" with the right mouse button.
8. In the "Edit Ethernet Node" screen, enter the device name for the Ethernet interface (e.g., "drive1") and click the "Assign name" button. Enter the IP address (e.g., 169.254.11.10) and subnet mask (e.g., 255.255.255.0) in the IP configuration. Then click the "Assign IP configuration" button and close the mask.

Note

Naming devices

ST (Structured Text) conventions must be satisfied for the name assignment of IO devices in Ethernet (SINAMICS components). The names must be unique within Ethernet.

Rules for assigning names:

- Other than "-" and ".", no special characters (such as accented characters, spaces, brackets) are permitted in the name of an IO device.
- The device name must not begin or end with the "-" character.
- The device name must not begin with a number.
- Maximum total length of 240 characters (lowercase characters, numbers, hyphen, or period).
- A name component within the device name, i.e., a string between two periods, must not exceed 63 characters.
- The device name must not take the form n.n.n.n (n = 0, ... 999).
- The device name must not begin with the character sequence "port-xyz" or "port-xyz-abcde" (a, b, c, d, e, x, y, z = 0, ... 9).

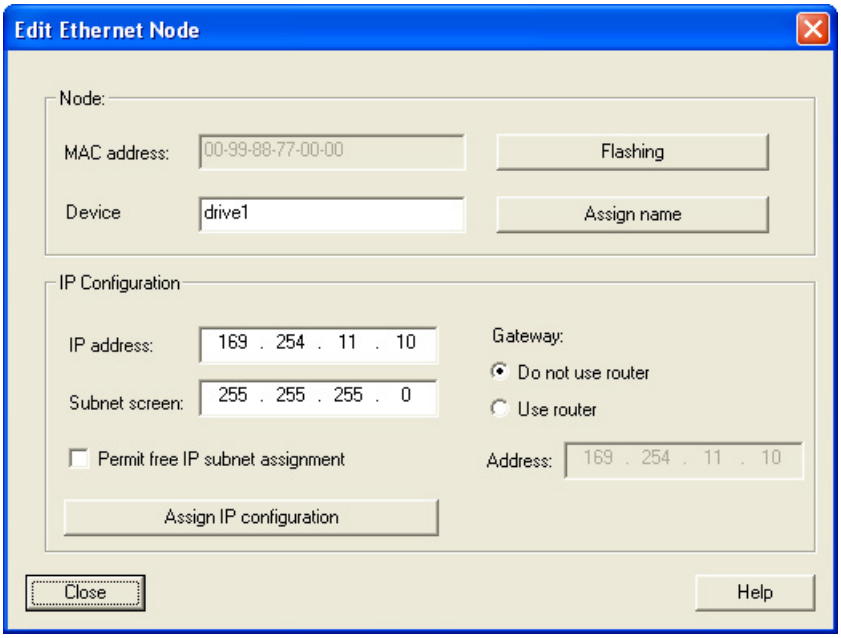


Figure 5-36 Editing the Ethernet node

9. When you press the "Refresh (F5)" button, the IP address and name will be displayed in the entry for the bus node. If not, close the "Accessible nodes" screen and perform another search for accessible nodes.
10. If the Ethernet interface is displayed as a bus node, select the entry and click the "Accept" button.

11.The SINAMICS drive will be displayed as a drive object in the project navigator.

12.You can now configure the drive unit; see "Configuring the drive unit".

Note

Storage location of the IP address

The IP address and device name are stored retentively on the memory card of the Control Unit.

Parameters

The Ethernet interface properties can also be modified and displayed using parameters.

- p8900 IE Name of Station
- p8901 IE IP Address of Station
- p8902 IE Default Gateway of Station
- p8903 IE Subnet Mask of Station
- p8904 IE DHCP Mode
- p8905 IE Interface Configuration
- r8910 IE Name of Station active
- r8911 IE IP Address of Station active
- r8912 IE Default Gateway of Station active
- r8913 IE Subnet Mask of Station active
- r8914 IE DHCP Mode of Station active
- r8915 IE MAC Address of Station

5.4 Operator panel AOP30

Description

An operator panel with the following features is located in the enclosure door of the drive for operating, monitoring, and commissioning tasks:

- Graphical, back-lit LCD for plain-text display and a "bar graph display" of process variables
- LEDs for indicating the operating modes
- Help function describing causes of and remedies for faults and alarms
- Keypad for operational control of the drive
- LOCAL/REMOTE changeover for selecting the point of operator control (right of control assigned to operator panel or customer terminal block/PROFIBUS)
- Numeric keypad for entering setpoint or parameter values
- Function keys for guided navigation through the menus
- Two-stage safety concept to protect against accidental or unauthorized changes to settings
- IP54 degree of protection (when installed)

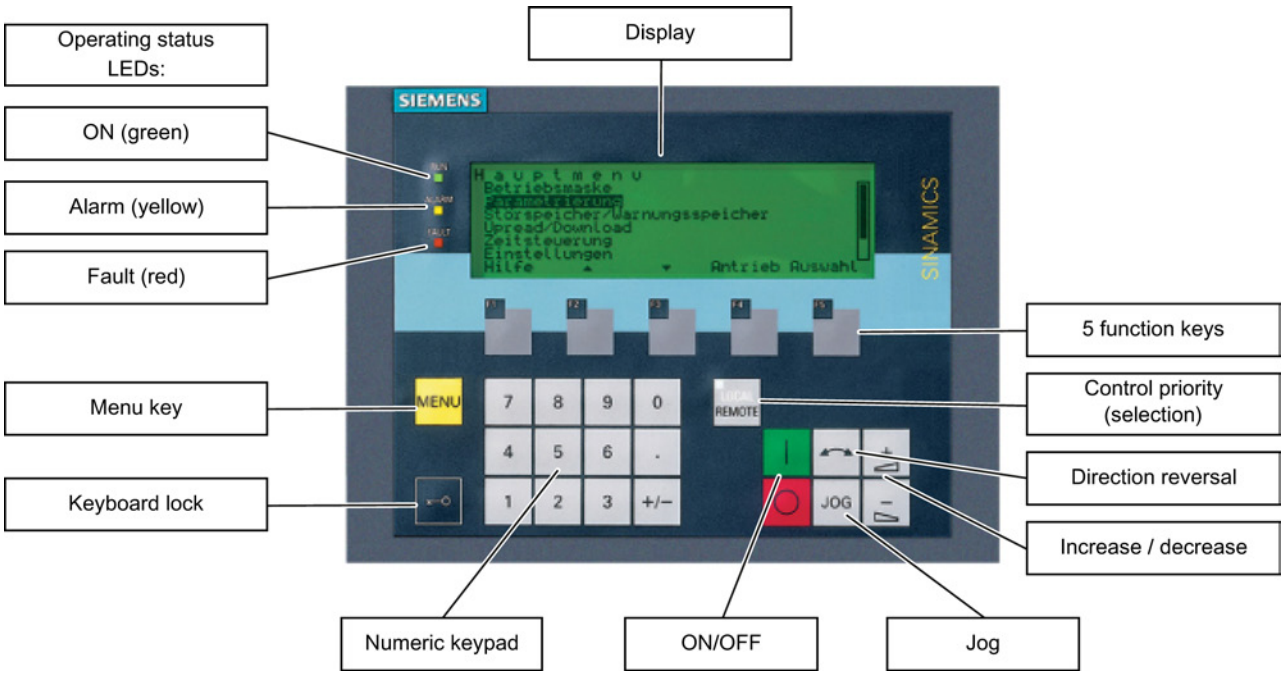


Figure 5-37 Components of the drive operator panel (AOP30)

5.5 First commissioning with the AOP30

5.5.1 Initial startup

Start screen

When the system is switched on for the first time, the Control Unit is initialized automatically. The following screen is displayed:

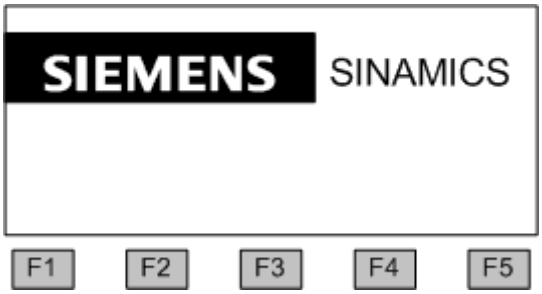


Figure 5-38 Splash screen

When the system starts up, the parameter descriptions are loaded into the operating field from the CompactFlash card.

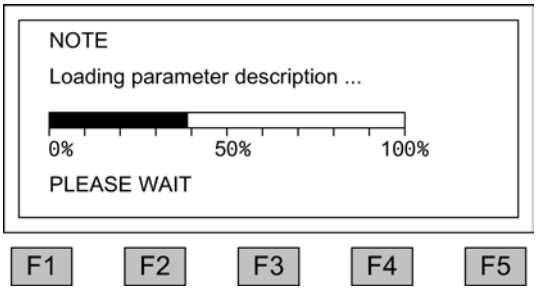
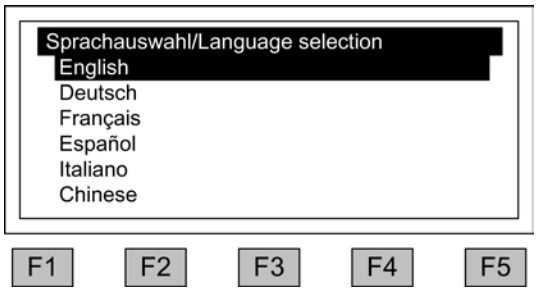


Figure 5-39 Loading parameter descriptions during system startup

Selecting the language

When the system starts up for the first time, a language selection screen appears.



Select a language in the dialog screen.

To change the language, choose <F2> or <F3>.
To select a language, choose <F5>.

Once the language has been selected, the startup process continues.

When the system has completed its startup, the drive has to be commissioned when the system is turned on for the first time after delivery. The drive can then be switched on.

For subsequent startups, direct operation is possible.

Navigation within the interactive screens

Within an interactive screen, the selection boxes can usually be selected using the <F2> and/or <F3> keys. Selection fields are generally texts surrounded by a frame. When they are selected, they are highlighted with a white text on a black background.
The present value of a highlighted selection box can usually be changed by pressing <F5> "OK" or "Change". Another entry box then appears and the value you want is entered directly using the numerical keypad or can be selected from a list.

You can change from one interactive 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 field "Continue" only appears at the bottom of the screen. This is because every single parameter in this interactive screen has to be checked and/or corrected thoroughly before the next interactive screen can be accessed.

For some commissioning steps, the entire commissioning can be interrupted by selecting "Interrupt commissioning".

5.5.2 Basic commissioning

Entering the motor data

During basic commissioning, you must enter motor data using the operator panel. Use the data shown on the motor nameplate.

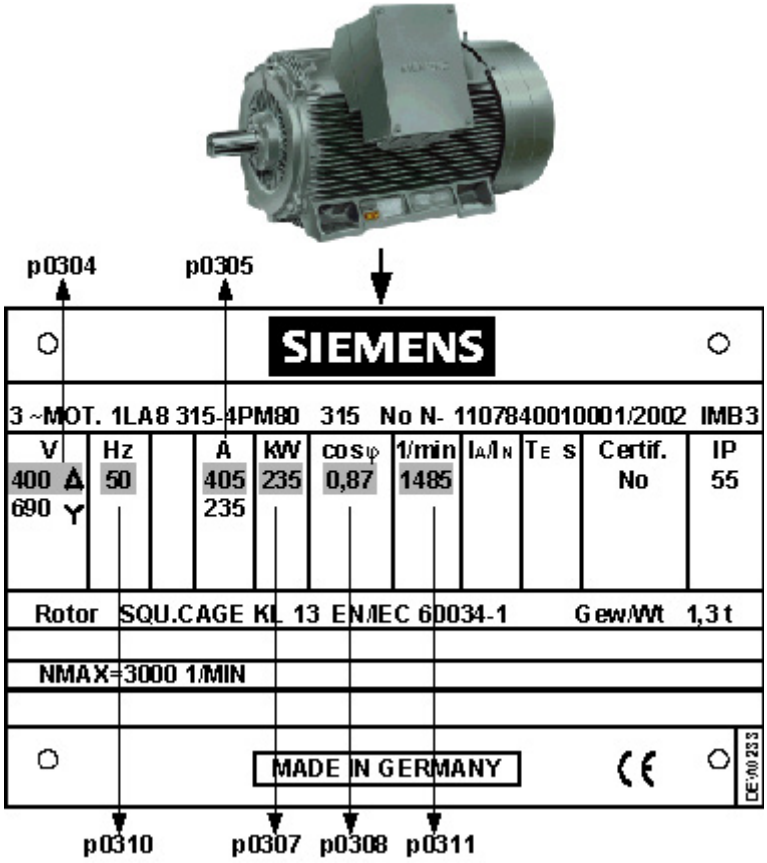
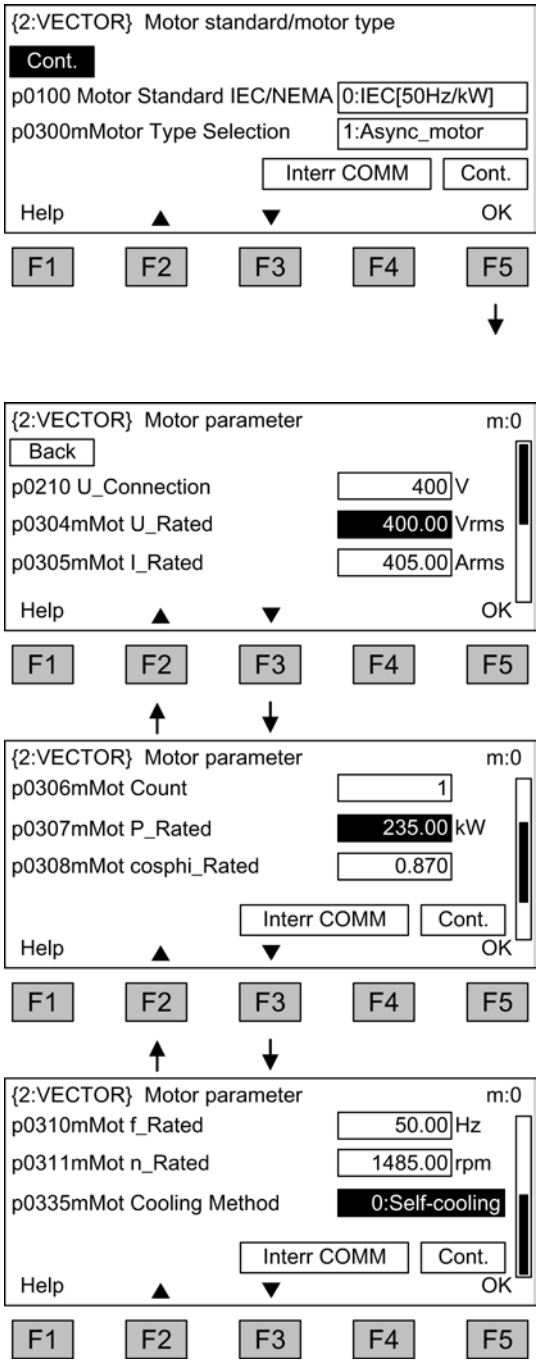


Figure 5-40 Example of a motor nameplate

Table 5- 1 Motor data

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

Basic commissioning: Selecting motor type and entering motor data



Select the motor standard and type in the dialog screen.

The following is defined for the motor standard:

0: Line frequency 50 Hz, motor data in kW
1: Line frequency 60 Hz, motor data in HP

The corresponding motor is selected for the motor type.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Entering the motor data specified on the type plate.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

The system displays another window in which you can:

- Enter the value directly, or
- Select the value from a list

When you have finished entering the motor data, choose "Continue" underneath the final parameter value and activate with <F5>.

Note

Selecting motor type

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

Note

Selecting a list motor (p0300 ≥ 100)

When selecting a motor type ≥ 100, you can select the order number of the associated motor using a drop-down list.

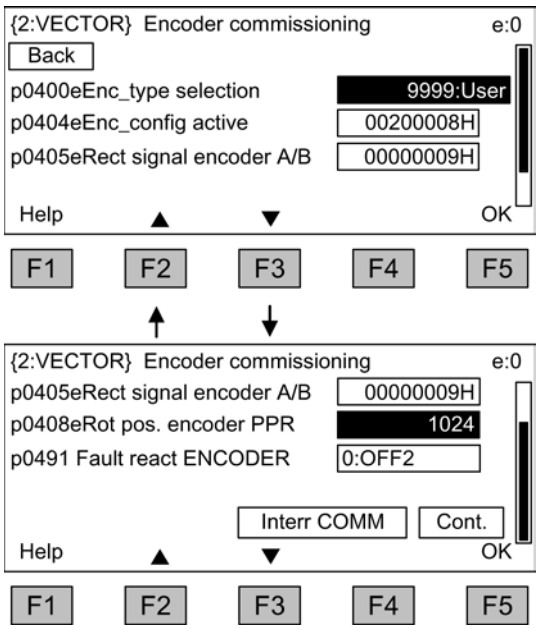
Note

Commissioning an induction motor

The steps described below also apply to commissioning an induction motor.

When commissioning a permanent-magnet synchronous motor (p0300 = 2), there are a few special conditions which are detailed in a separate section (see "Setpoint channel and closed-loop control / Permanent-field synchronous motors").

Basic commissioning: Entering encoder data (if available)



When the SMC30 is connected for encoder evaluation (with option K50), it is recognized by the AOP30 and a screen is displayed for you to enter the encoder data.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Predefined encoders can be easily set by selecting parameter p0400 (encoder type selection):

3001: 1024 HTL A/B R at X521/X531
3002: 1024 TTL A/B R at X521/X531
3003: 2048 HTL A/B R at X521/X531
3005: 1024 HTL A/B at X521/X531
3006: 1024 TTL A/B at X521/X531
3007: 2048 HTL A/B at X521/X531
3008: 2048 TTL A/B at X521/X531
3009: 1024 HTL A/B unipolar at X521/X531
3011: 2048 HTL A/B unipolar at X521/X531
3020: 2048 TTL A/B R with sense to X520

Note

Factory state

The factory state is a bipolar HTL encoder with 1024 pulses per revolution and a 24 V supply voltage.

The section "Electrical Installation" contains two connection examples for HTL and TTL encoders.

Note

Pre-defined encoder type

If a predefined encoder type is selected via p0400, then the settings of parameters p0404, p0405, and p0408 cannot be changed.

If the connected encoder does not match any of the encoders predefined in p0400, follow the simple procedure below to enter encoder data:

- Via p0400, select an encoder type with data similar to that of the connected encoder.
- Select "User-defined" (p0400 = 9999). Previously set values are stored here.
- Adjust the bit fields of p0404, p0405, and p0408 to the data for the connected encoder.

Table 5- 2 Meaning of the bit setting for p0404

Bit	Meaning	Value 0	Value 1
20	Voltage 5 V	No	Yes
21	Voltage 24 V	No	Yes

Table 5- 3 Meaning of the bit settings for p0405

Bit	Meaning	Value 0	Value 1
0	Signal	Unipolar	Bipolar
1	Level	HTL	TTL
2	Track monitoring	None	A/B>< -A/B
3	Zero pulse	24 V unipolar	Same as A/B track
4	Switching threshold	Low	High
5	Pulse/direction	No	Yes

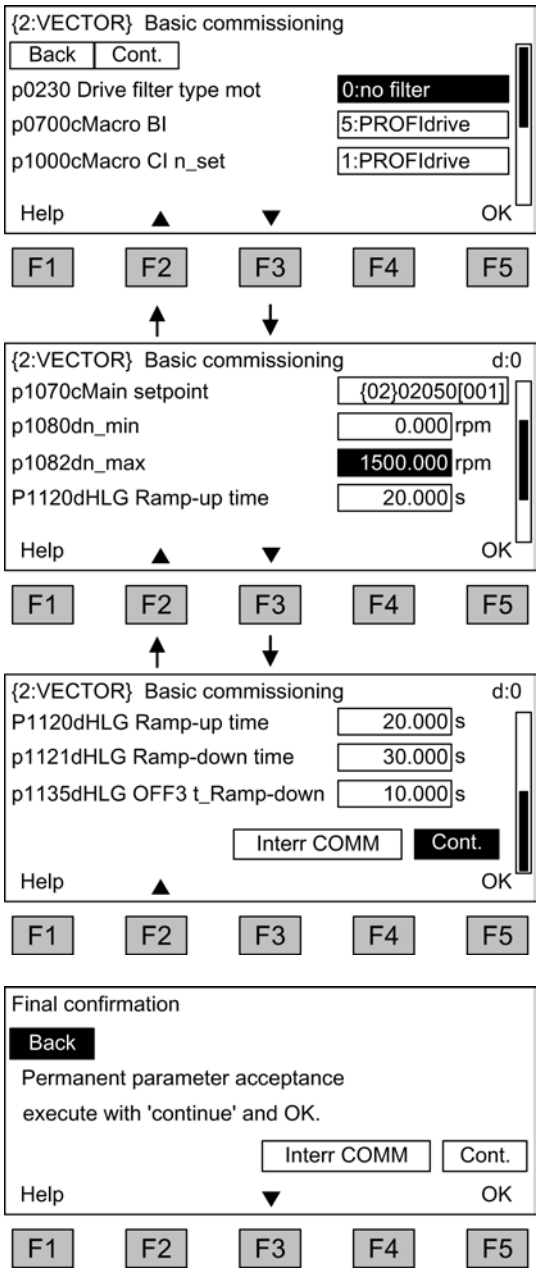
NOTICE

Property damage due to selection of incorrect supply voltage for the encoder

Once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5-V encoder is connected and the supply voltage has not been set correctly (bit 20 = "Yes", bit 21 = "No"), the encoder may be damaged.

- Set the correct supply voltage for the connected encoder.

Basic commissioning: Entering basic parameters



Enter the basic commissioning parameters:
p0700: Preset command source
5: PROFIdrive
6: TM31 terminals
7: NAMUR - Do not select!
10: PROFIdrive NAMUR - Do not select!

p1000: Preset setpoint source
1: PROFIdrive
2: TM31 terminals
3: Motorized potentiometer
4: Fixed setpoint

Once a setpoint source has been selected (p1000), the main setpoint p1070 is defaulted accordingly.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

Another window appears, where you can
- enter the required value directly, or
- select the value from a list.

Final confirmation

Confirm the basic parameters to save them.

Once you have selected "Continue" and activated your entries with <F5>, the basic parameters you entered are permanently saved and the calculations required for closed-loop control are carried out.

Note

Enter the motor-side filter

A filter on the motor side must be entered in p0230:

- Option L07 – dV/dt filter compact plus voltage peak limiter: p0230 = 2
- Option L08 – motor reactor: p0230 = 1
- Option L10 – dv/dt filter plus voltage peak limiter: p0230 = 2.

When p0230 = 4 "External sinusoidal filter", a separate sinusoidal filter can be entered. An input mask for specific filter data then appears.

NOTICE

Damage to the dv/dt filter if it is not activated during commissioning

The dv/dt filter may be damaged if it is not activated during commissioning.

- Activate the dv/dt filter during commissioning.

Note

Motor reactor

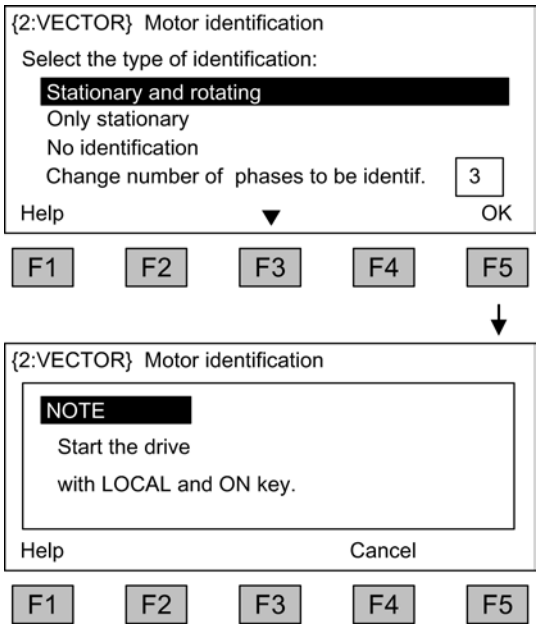
An existing motor reactor (option L08) must be activated during option selection. Otherwise, the motor control cannot operate optimally.

Note

Do not use a selection

The choice "No selection" is also available as default setting for the command and setpoint sources; if selected, no default settings are applied for the command and setpoint sources.

Basic commissioning: Motor identification



Selecting the motor identification

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Stationary measurement increases the control performance, as this minimizes deviations in the electrical characteristic values due to variations in material properties and manufacturing tolerances.

Rotary measurement determines the data required (e.g., moment of inertia) for setting the speed controller. It also measures the magnetization characteristic and rated magnetization current of the motor.

Change the number of phases to be identified:

- For identification with one phase, the time of the measurement significantly reduced.
- For identification with several phases, the measurement results are averaged.

To activate this function, press the LOCAL key (wait until the LED in the LOCAL key lights up) and then ON.

If motor identification is not carried out, the motor control uses the motor characteristic values calculated from the nameplate data rather than the measured values.

Note

Complete motor identification

When motor identification is complete, press the OFF key to cancel the power-on inhibit.

WARNING

Danger to life due to unexpected movement of the motor in the case of motor identification during rotating operation

When motor identification with optimization during rotating operation is selected, after the drive is commissioned it initiates movements of the motor that can reach the maximum motor speed.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional during commissioning.

Note

Activate enable signals

Make sure that the necessary enables have been assigned; otherwise motor identification cannot be carried out.

Note

Fault with stationary or rotating measurements

If a fault is present when stationary or rotary measurement is selected, motor identification cannot be carried out.
To rectify the fault, you must choose "No identification" to close the screen, then eliminate the fault.
After this, motor identification can be selected again via <MENU> - <Commissioning/service> - <Drive commissioning> - <Motor identification>.

5.6 Status after commissioning

LOCAL mode (control via operator panel)

- Switch to LOCAL mode by pressing the "LOCAL/REMOTE" key.
- Control (ON/OFF) is carried out via the "ON" and "OFF" keys.
- You can specify the setpoint using the "increase" and "decrease" keys or by entering the appropriate numbers using the numeric keypad.

Analog outputs

- The actual speed (r0063) is output as a current output in the range 0 to 20 mA at analog output 0 (X522:2 and 3).
  A current of 20 mA is equal to the maximum speed in p1082.
- The actual current value (r0068) is output as a current output in the range 0 to 20 mA at analog output 1 (X522:5 and 6).
  A current of 20 mA corresponds to the current limit (p0640), which is set to 1.5 times the rated motor current (p0305).

Digital outputs

- The "enable pulses" signal is output at digital output 0 (X542:2 and 3).
- The “no fault active” signal is output at digital output 1 (X542:5 and 6) (protection against wire breakage).
- The "ready for power up" signal is output at digital output 8 (X541:2).

5.7 Commissioning an encoder with gear factor

Description

When encoders are commissioned (p0010 = 4), a gearbox must be parameterized using parameters p0432 (counter), p0433 (denominator), and p0410 (sign).

To ensure that the commutation position can be accurately determined from the encoder angle, the following applies:

- For resolvers: $\frac{z_{p_Motor}}{z_{p_Resolver}} \times \frac{1}{n} \geq 1, \text{Integer}$ zp = number of poles
- For all other absolute encoders: $\frac{z_{p_Motor}}{n} \geq 1, \text{Integer}$ zp = number of poles
- Where n is the gear factor: $n = \frac{\text{Encoder speed}}{\text{Motor speed}} = \frac{p0432}{p0433}$

The encoder commissioning program ensures that this uniqueness condition is observed and, if necessary, prevents the system from exiting the commissioning program or outputs an error message.

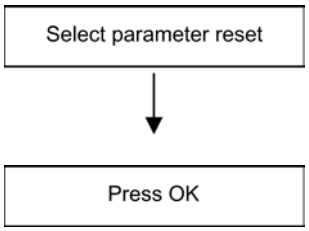
Sign bit p0410 inverts the calculated encoder angle and the speed, thereby yielding a negative gear factor.

5.8 Parameter reset to factory settings

The factory settings represent the defined original status of the basic device per catalog.

Resetting the parameters to the factory settings means that all the parameter settings made for specific configurations or options, as well as those made since the system was delivered are reset.

Resetting parameters via AOP30

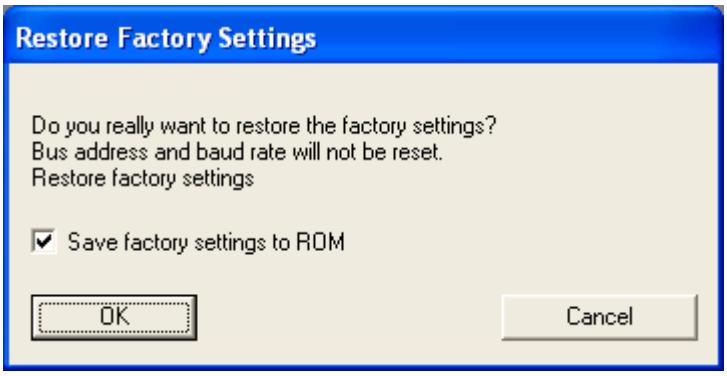


Set parameter filter to "Parameter reset":
<MENU> <Commissioning/Service> <Device commissioning> <OK> <30: Parameter Reset> <OK>

Reset all parameters to the factory settings:
Factory settings for all the device parameters are restored.

Resetting parameters via STARTER

With STARTER, parameters are reset in online mode. The required steps are described below:

Step	Toolbar selection
Choose **Project > Connect to target system**	
Click the drive unit whose parameters you want to reset to the factory settings and click the **Restore factory settings** button on the toolbar.	
To confirm, click **OK**. 	
Choose **Target system > Copy RAM to ROM**	

Note

Copy RAM to ROM

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

After a reset of parameters to factory settings, an initial commissioning must be performed.

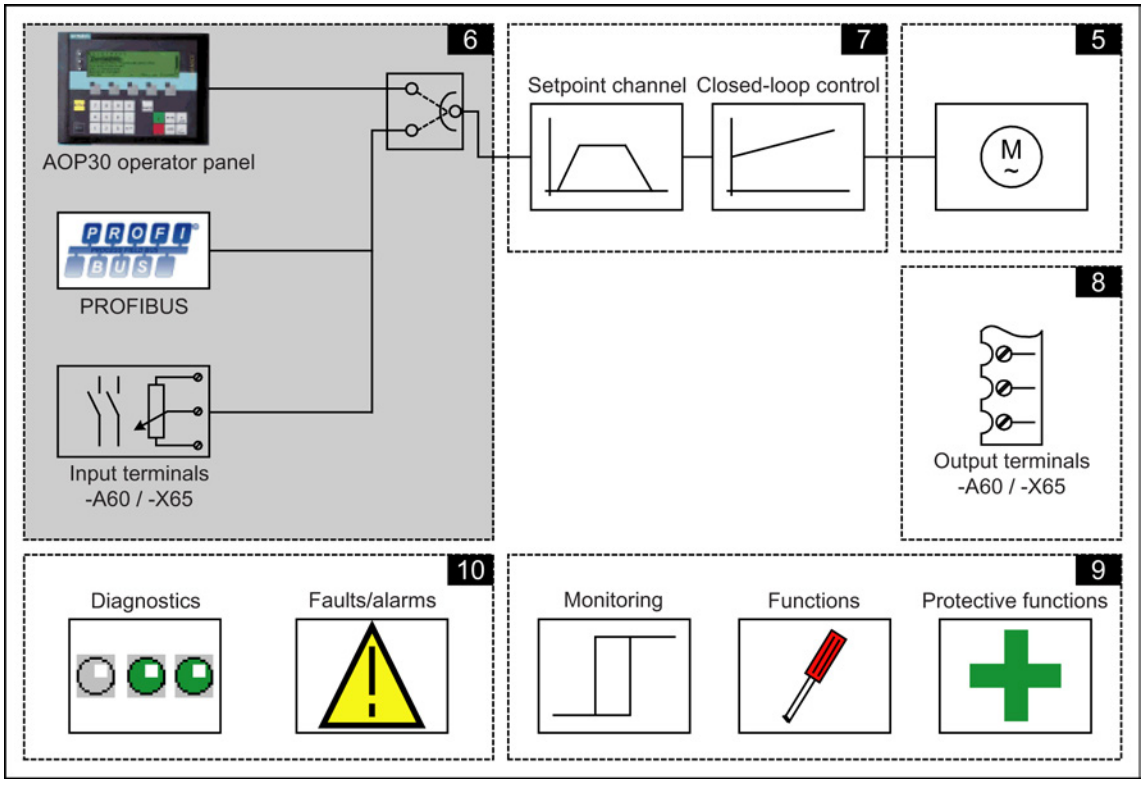
Operation

6

6.1 Chapter content

This section provides information on the following:

- Basic information about the drive system
- Command source selection via
  - PROFIdrive
  - Terminal block
- Setpoint input via
  - PROFIdrive
  - Analog inputs
  - Motorized potentiometer
  - Fixed setpoints
- Control via the AOP30 operator panel
- Communication according to PROFIdrive
- Communication via
  - PROFIBUS DP
  - PROFINET IO
  - SINAMICS Link



6.2 General information about command and setpoint sources

Description

Two default settings are available for selecting the command sources and four for selecting the setpoint sources for the SINAMICS G150 NEMA enclosed drive. The choice "No selection" is also available; if selected, no default settings are applied for the command and setpoint sources.

Command sources

- PROFIdrive
- TM31 terminals

Setpoint sources

- PROFIdrive
- Analog inputs
- Motorized potentiometer
- Fixed setpoints

The various assignments are explained in the following sections.

Note

Defaults

Make sure that the default settings you choose during commissioning are compatible with the drive configuration (see "Commissioning").

The EMERGENCY OFF signals (N57, N59, N60) are always active (regardless of the command source).

Function diagrams

At certain points in this section, reference is made to function diagrams. These can be found on the customer DVD in the "SINAMICS G130/G150 List Manual", which provides experienced users with detailed descriptions of all the functions.

6.3 Basic information about the drive system

6.3.1 Parameters

Overview

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

The parameters can be accessed via the following operator control units:

- PC with the "STARTER" commissioning tool via PROFIBUS
- The user-friendly AOP30 Operator Panel

Parameter types

The following adjustable parameters and display parameters are available:

- Adjustable parameters (write/read)

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

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

  These parameters are used to display internal variables.

  Example: Current motor current

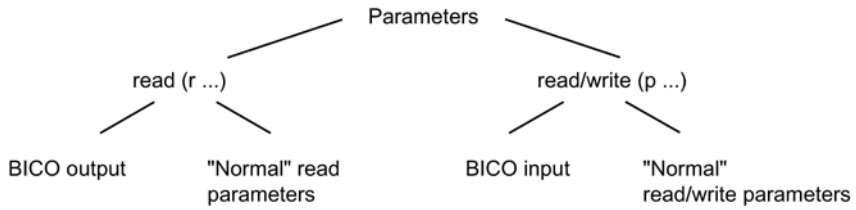


Figure 6-1 Parameter types

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

Parameter categories

The parameters for individual drive objects (see "Drive objects") are categorized according to data sets as follows (see "Operation/data sets"):

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

  CDS and DDS can be switched over during normal operation. Further types of data set also exist, however these can only be activated indirectly by means of a DDS changeover.

  - EDS: encoder Data Set
  - MDS: Motor Data Set

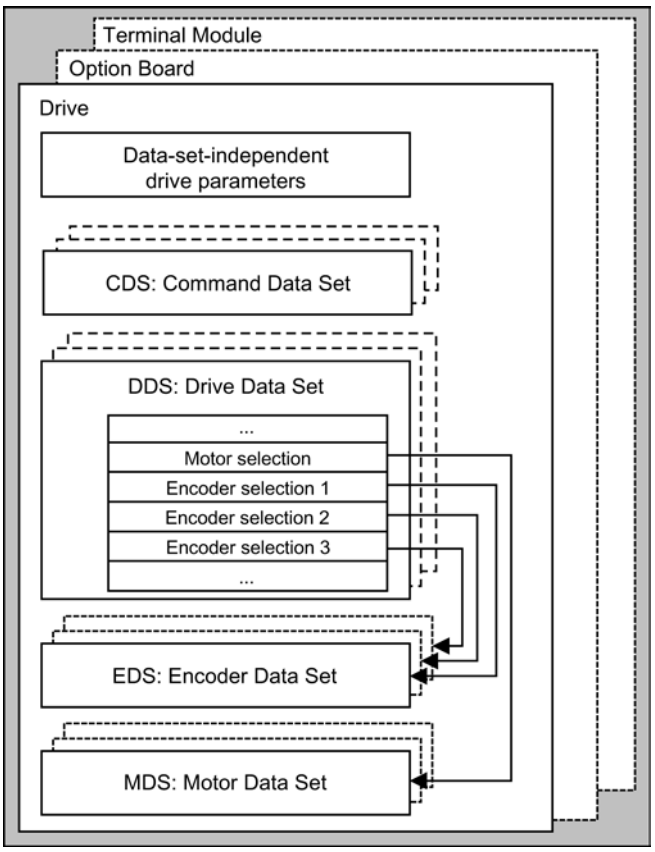


Figure 6-2 Parameter categories

6.3.2 Drive objects

A drive object is a self-contained software function with its own parameters and, if necessary, its own faults and alarms. Drive objects can be provided as standard (e.g., I/O evaluation), or you can add single (e.g., option board) or multiple objects (e.g., drive control).

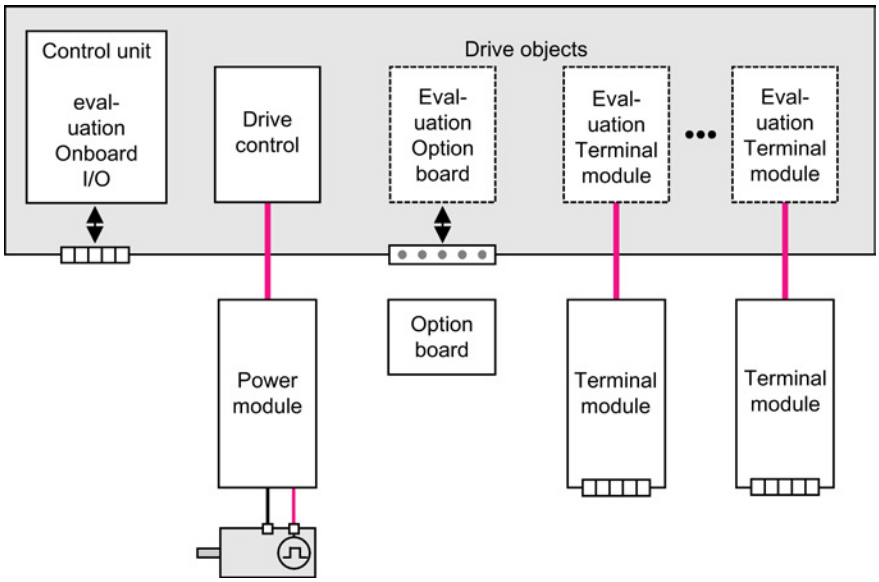


Figure 6-3 Drive objects

Standard drive objects

- Drive control
  Drive control handles closed-loop control of the motor. One Power Module and at least one motor and up to three encoders are assigned to the drive control.
- Control Unit, inputs/outputs
  The inputs/outputs on the Control Unit are evaluated within a drive object.

Optional drive objects

- Option Board evaluation

  A further drive object handles evaluation of an installed Option Board. The specific method of operation depends on the type of Option Board installed.
- Terminal Module evaluation

  A separate drive object handles the evaluation of each optional Terminal Module.

Properties of a drive object

- Separate parameter space
- Separate window in STARTER
- Separate fault/alarm system
- Separate PROFIdrive message frame for process data

Configuring drive objects

When you commission the system for the first time using the STARTER tool, you will use configuration parameters to set up the software-based "drive objects" that are processed on the Control Unit.. Various drive objects can be created within a Control Unit.

The drive objects are configurable function blocks and are used to execute specific drive functions.

If you need to configure additional drive objects or delete existing ones after initial commissioning, the drive system must be switched to configuration mode.

The parameters of a drive object cannot be accessed until the drive object has been configured and you have switched from configuration mode to configuration mode.

Note

Assignment during the initial commissioning

During initial commissioning, each installed drive object is allocated a number between 0 and 63 for unique identification.

Parameters

- p0101 Drive object numbers
- r0102 Drive object count
- p0107 Drive object type
- p0108 Drive object configuration

6.3.3 Data sets

Description

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

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

Note

Copying data sets

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

CDS: Command data set

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

By configuring 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)
  - Voltage setpoint for V/f control (p1330)
  - Torque limits and scaling factors (p1522, p1523, p1528, p1529)

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

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

Table 6- 1 Command data set: selection and display

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

If a command data set, which does not exist, is selected, the current data set remains active.

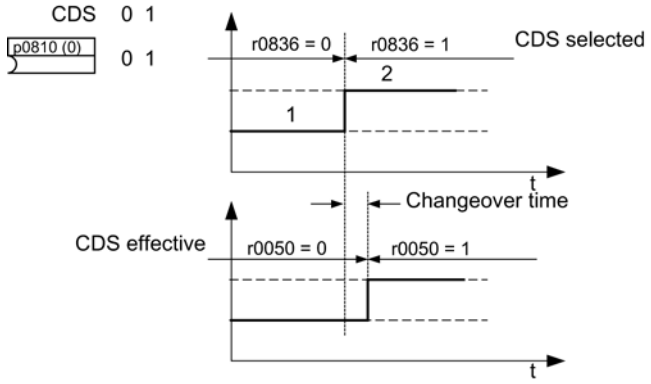


Figure 6-4 Example: Switching between command data set 0 and 1

DDS: Drive data set

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

- Numbers of the assigned motor and encoder data sets:
  - p0186: Assigned motor data set (MDS)
  - p0187 to p0189: up to 3 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
  - Fixed speed setpoints (p1001 to p1015)
  - Speed limits min./max. (p1080, p1082)
  - Characteristic data of ramp-function generator (p1120 ff)
  - Characteristic data of controller (p1240 ff)
  - ...

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

It is possible to configure several drive data sets. You can switch easily between different drive configurations (control type, motor, encoder) by selecting the corresponding drive data set.

One drive object can manage up to 32 drive data sets. The number of drive data sets is configured with p0180.

Binector inputs p0820 to p0824 are used to select a drive data set. They represent the number of the drive data set (0 to 31) in binary format (where p0824 is the most significant bit).

- p0820 BI: Drive data set selection DDS, bit 0
- p0821 BI: Drive data set selection DDS, bit 1
- p0822 BI: Drive data set selection DDS, bit 2
- p0823 BI: Drive data set selection DDS, bit 3
- p0824 BI: Drive data set selection DDS, bit 4

Supplementary conditions and recommendations

- Recommendation for the number of DDS in a drive
  The number of DDS in a drive should correspond with the number of changeover options; in other words
  p0180 (DDS) ≥ p0130 (MDS).
- Max. number of DDS for one drive object = 32 DDS

EDS: Encoder data set

An encoder data set contains various adjustable parameters describing the connected encoder for the purpose of 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 SINAMICS parameter list by "Data set EDS" and are assigned an index [0..n].

A separate encoder data set is required for each encoder controlled by the Control Unit. Up to 3 encoder data sets are assigned to a drive data set via parameters p0187, p0188, and p0189.

An encoder data set can only be changed using a DDS changeover.

Each encoder may only be assigned to one drive and within a drive must - in each drive data set - either always be encoder 1, always encoder 2 or always encoder 3.

One application for the EDS changeover would be a power component with which several motors are operated in turn. A contactor circuit is used to changeover between these motors. Each of the motors can be equipped with an encoder or be operated without an encoder. Each encoder must be connected to its own SMx.

If encoder 1 (p0187) is changed over via DDS, then an MDS must also be changed over.

One drive object can manage up to 16 encoder data sets. The number of encoder data sets configured is specified in p0140.

When a drive data set is selected, the assigned encoder data sets are selected automatically.

MDS: Motor data set

A motor data set contains various adjustable parameters describing the connected motor for the purpose of configuring the drive. It also contains certain display parameters with calculated data.

- Adjustable parameters, e.g.:
  - Motor component number (p0131)
  - Motor type selection (p0300)
  - Rated motor data (p0304 ff)
  - ...
- Display parameters, e.g.:
  - Calculated rated data (p0330 ff)
  - ...

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

A separate motor data set is required for each motor that is controlled by the Control Unit via a Motor Module. The motor data set is assigned to a drive data set via parameter p0186.

A motor data set can only be changed using a DDS changeover.

The motor data set changeover is used, for example, for:

- Changing over between different motors
- Changing over between different windings in a motor (e.g. star-delta changeover)
- Motor data adaptation

If several motors are operated alternately on one Motor Module, a corresponding number of drive data sets must be created. See "Functions / Drive functions" for additional information and instructions on changing over motors.

One drive object can manage up to 16 motor data sets. The number of motor data sets in p0130 may not exceed the number of drive data sets in p0180.

Example of data set assignment

Table 6- 2 Example, data set assignment

DDS	Motor (p0186)	Encoder 1 (p0187)	Encoder 2 (p0188)	Encoder 3 (p0189)
DDS 0	MDS 0	EDS 0	EDS 1	EDS 2
DDS 1	MDS 0	EDS 0	EDS 3	--
DDS 2	MDS 0	EDS 0	EDS 4	EDS 5
DDS 3	MDS 1	EDS 0	--	--

Copying the command data set (CDS)

Set parameter p0809 as follows:

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

Start copying.

Copying is finished when p0809[2] = 0.

Copying the drive data set (DDS)

Set parameter p0819 as follows:

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

Start copying.

Copying is finished when p0819[2] = 0.

Copy motor data set (MDS)

Set parameter p0139 as follows:

1. p0139[0] = Number of the motor data set that is to be copied (source)
2. p0139[1] = Number of the motor data set which should be copied into (target)
3. p0139[2] = 1

Start copying.

Copying has been completed, if p0139[2] = 0.

Function diagram

FP 8560	Command data sets (CDS)
FP 8565	Drive data set (DDS)
FP 8570	Encoder data set (EDS)
FP 8575	Motor data sets (MDS)

Parameters

- p0120 Power module data sets (PDS) number
- p0130 Motor data sets (MDS) number
- p0139[0...2] Copy motor data set (MDS)
- p0140 Encoder data sets (EDS) number
- p0170 Command data set (CDS) number
- p0180 Drive data set (DDS) number
- p0186 Assigned motor data set (MDS)
- p0187[0...n] Encoder 1 encoder data set number
- p0188[0...n] Encoder 2 encoder data set number
- p0189[0...n] Encoder 3 encoder data set number
- p0809 Copy command data set CDS
- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection, bit 0
- p0821 BI: Drive data set selection, bit 1
- p0822 BI: Drive data set selection, bit 2
- p0823 BI: Drive data set selection, bit 3
- p0824 BI: Drive data set selection, bit 4

6.3.4 BICO technology: Interconnecting signals

Description

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

BICO (BInector COnnector) technology allows the drive to be adapted to a wide variety of conditions.

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

Note

Using STARTER

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

Binectors, BI: Binector Input, BO: Binector output

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

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

Table 6- 3 Binectors

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

Connectors, CI: Connector Input, CO: Connector output

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

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

Table 6- 4 Connectors

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

Interconnecting signals using BICO technology

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

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

- Binectors: Parameter number, bit number, and drive object ID
- Connectors without an index: Parameter number and drive object ID
- Connectors with an index: Parameter number, index, and drive object ID

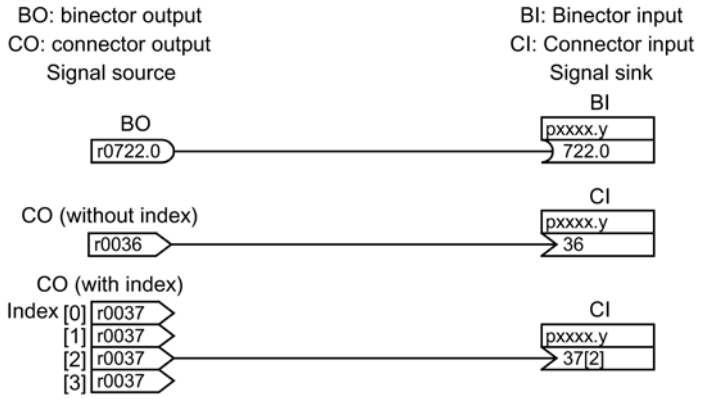


Figure 6-5 Interconnecting signals using BICO technology

Note

A Connector Input (CI) cannot be interconnected with just any Connector Output (CO, signal source). The same applies for a Binector Input (BI) and Binector Output (BO).

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

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

Notation:

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

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

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

Internal coding of the binector/connector output parameters

Internal codes are needed, for example, to write BICO input parameters via PROFIdrive.

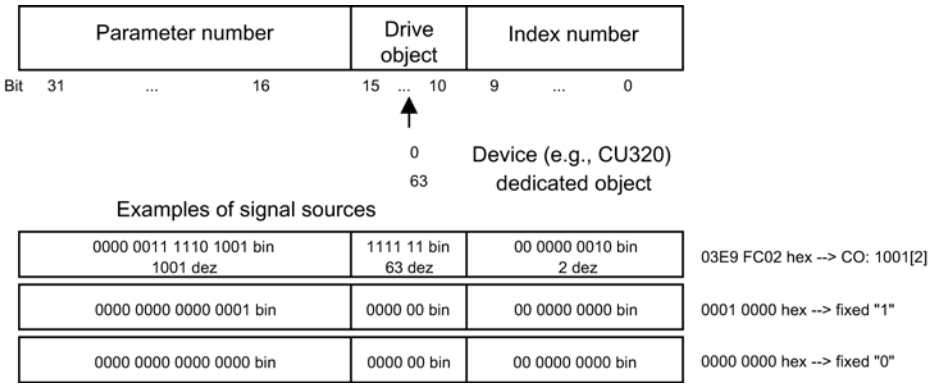


Figure 6-6 Internal coding of the binector/connector output parameters

Example 1: Interconnecting digital signals

In this example, we want to operate a drive via terminals DI 0 and DI 1 on the Control Unit using jog 1 and jog 2.

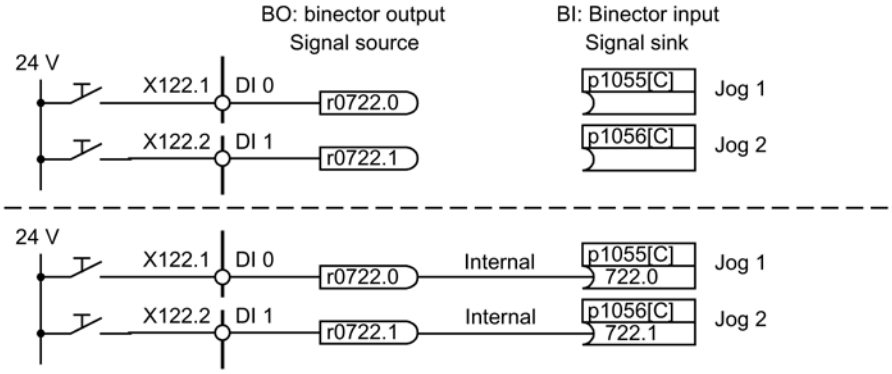


Figure 6-7 Interconnecting digital signals (example)

Example 2: Interconnecting OC/OFF3 with several drives

In this example, we want to interconnect the OFF3 signal with two drives via terminal DI 2 on the Control Unit.

Each drive has a binector input 1. OFF3 and 2. OFF3. Both signals are processed via an AND gate to STW1.2 (OFF3).

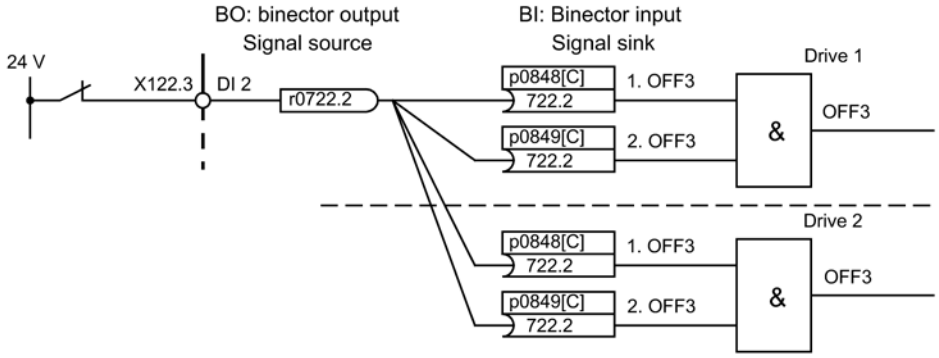


Figure 6-8 Interconnecting OFF3 with several drives (example)

BICO interconnections with other drives

The following parameters are available for BICO interconnections with other drives:

- r9490 Number of BICO interconnections with other drives
- r9491[0...15] BI/CI of BICO interconnections with other drives
- r9492[0...15] BO/CO of BICO interconnections with other drives
- p9493[0...15] Reset of BICO interconnections with other drives

Binector-connector converters and connector-binector converters

Binector-connector converter

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

Connector-binector converter

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

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.

6.3.5 Propagation of faults

Forwarding faults to the Control Unit

When faults are triggered on the "Control Unit" drive object, it is always assumed that central functions of the drive are affected. For this reason, these faults are also forwarded to all other drive objects. This is referred to as "propagation". The fault responses act on the Control Unit drive object and all other drive objects. This response also applies to the faults that are set in a DCC chart on the Control Unit with the aid of the DCC block.

A fault propagated from the Control Unit must be acknowledged at all drive objects to which this fault was forwarded. In this way, this fault on the Control Unit is automatically acknowledged. Alternatively, the faults of the drive objects can also be acknowledged on the Control Unit.

Alarms are not propagated from the Control Unit, i.e., they are not forwarded to other drive objects.

Example

Drive object faults are only forwarded to drives, i.e., a fault on a TB30 stops the drive, but a fault on the drive does not stop the TB30.

Forwarding of faults due to BICO interconnections

If two or more drive objects are connected via BICO interconnections, faults of drive objects of the Control Unit type, TB30, DMC20, DME20, all terminal modules, or ENCODER are forwarded to drive objects with closed-loop control functions, e.g. infeed units or Motor Modules. There is no forwarding of faults within these two groups of drive object types.

This response also applies to the faults set in a DCC chart on the above drive object types with the aid of DCC STM.

6.4 Command sources

6.4.1 "PROFIdrive" default setting

Requirements

The "PROFIdrive" default setting was chosen during commissioning:

- STARTER (p0700): "PROFIdrive"
- AOP30 (p0700): "5: PROFIdrive"

Command sources

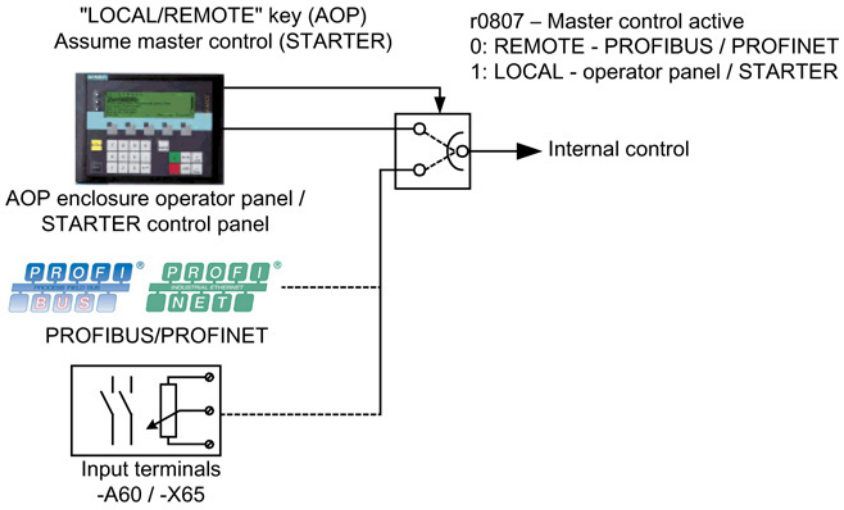


Figure 6-9 Command sources – AOP30 <--> PROFIdrive

Priority

The command source priorities are shown in the diagram "Command sources - AOP30 <-> PROFIdrive".

Note

Emergency OFF signals

The emergency OFF and motor protection signals are always active (regardless of the command source).

All supplementary setpoints are deactivated for LOCAL master control.

Terminal assignment with the "PROFIdrive" default setting

The "PROFIdrive" default setting uses the following terminal assignment:

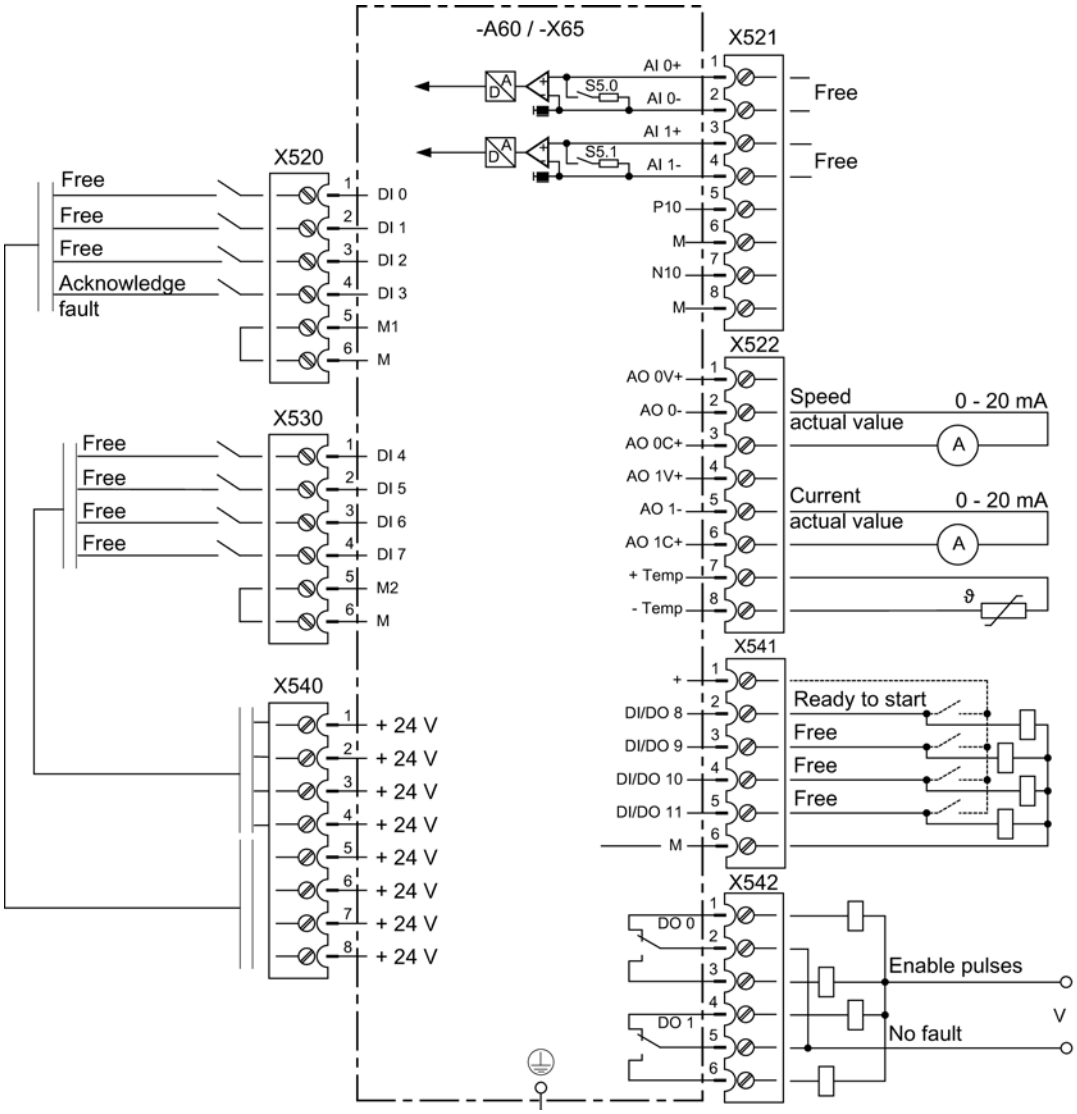


Figure 6-10 Terminal assignment with the "PROFIdrive" default setting

Control word 1

The bit assignment for control word 1 is described in "Description of the control words and setpoints".

Status word 1

The bit assignment for status word 1 is described in "Description of the status words and actual values".

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.2 "TM31 terminals" default setting

Requirements

The "TM31 terminals" default setting was chosen during commissioning:

- STARTER (p0700): "TM31 terminals"
- AOP30 (p0700): "6: TM31 terminals

Command sources

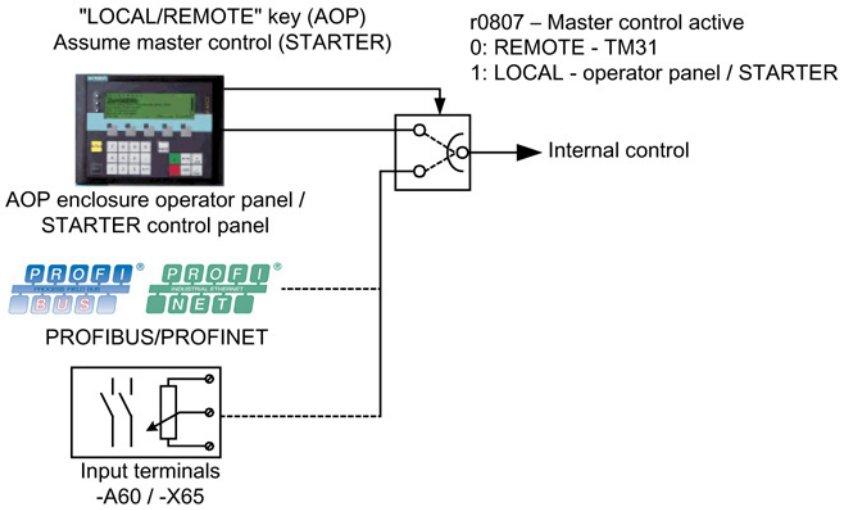


Figure 6-11 Command sources - AOP30 <-> TM31 terminals

Priority

The priority of the command sources is shown in the diagram "Command sources - AOP30 <-> TM31 terminals".

Note

Emergency OFF signals

The emergency OFF and motor protection signals are always active (regardless of the command source).

All supplementary setpoints are deactivated for LOCAL master control.

Terminal assignment with "TM31 terminals" default setting

The "TM31 terminals" default setting uses the following terminal assignment:

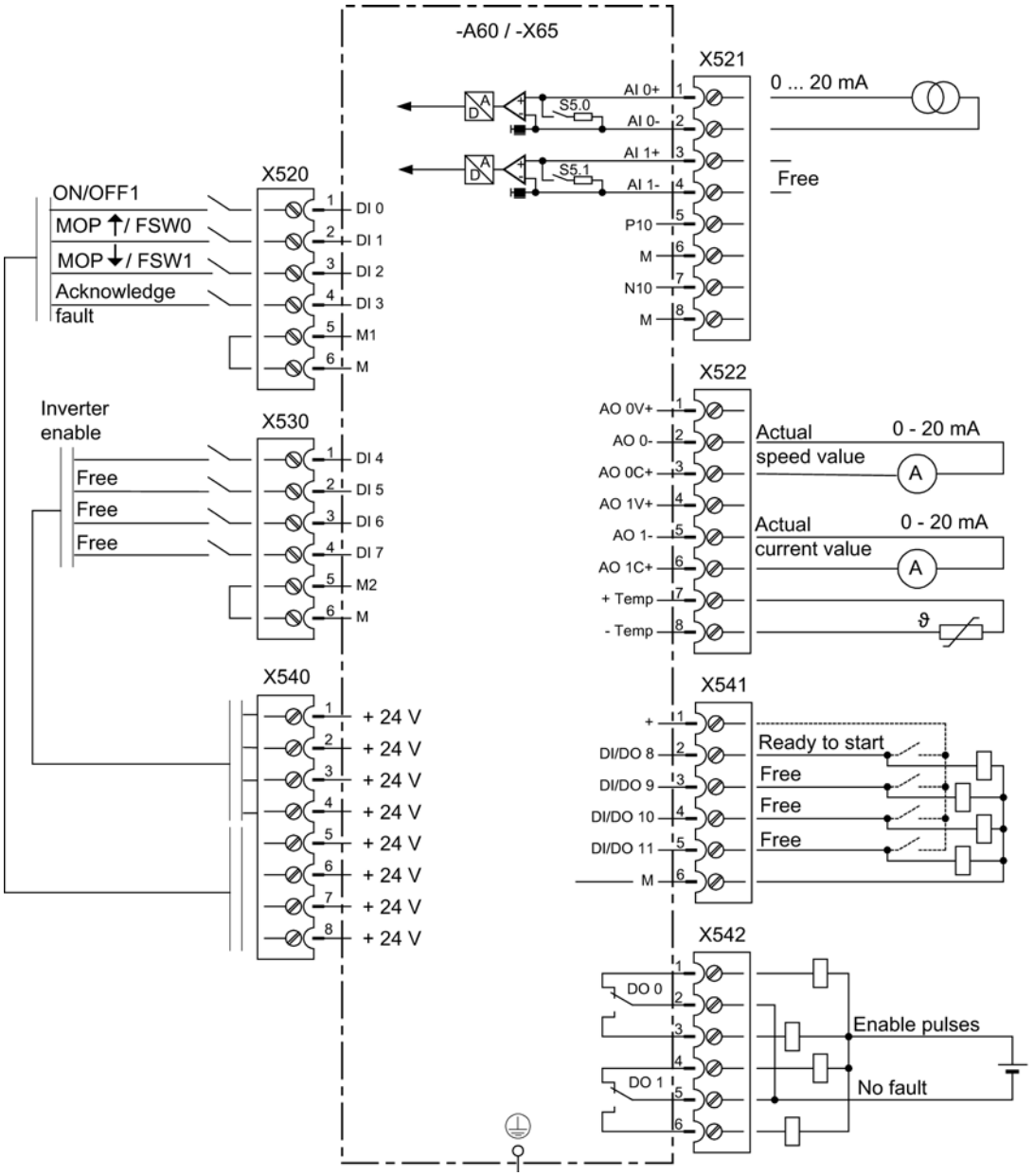


Figure 6-12 Terminal assignment with "TM31 terminals" default setting

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.5 Setpoint sources

6.5.1 Analog inputs

Description

The customer terminal module features two analog inputs for specifying setpoints via current or voltage signals.

With the factory setting, analog input 0 (terminal X521:1/2) is used as a current input in the 0 to 20 mA range.

Requirement

The default setting for analog inputs was chosen during commissioning:

- STARTER (p1000): "TM31 terminals"
- AOP30 (p1000): "2: TM31 terminals

Signal flow diagram

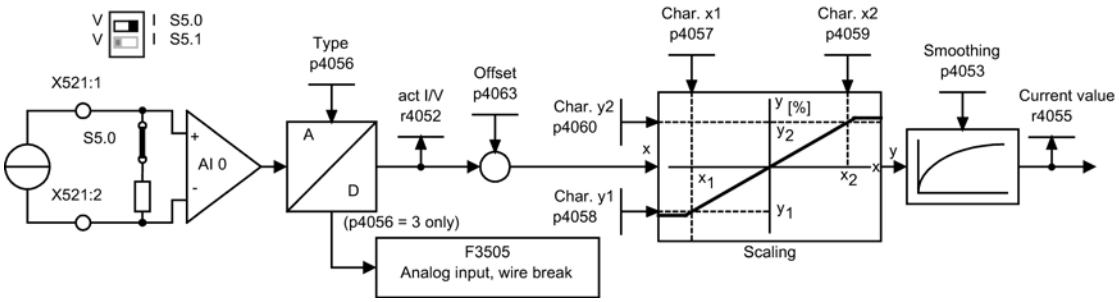


Figure 6-13 Signal flow diagram: analog input 0

Function diagram

FP 9566	TM31 – analog input 0 (AI 0)
FP 9568	TM31 – analog input 1 (AI 1)

Parameters

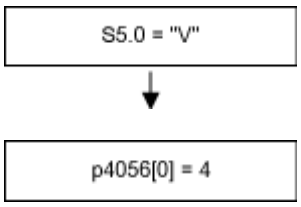
- r4052 Current input voltage/current
- p4053 Analog inputs, smoothing time constant
- r4055 Current referenced input value
- p4056 Analog input type
- p4057 Value x1 of analog input characteristic
- p4058 Value y1 of analog input characteristic
- p4059 Value x2 of analog input characteristic
- p4060 Value y2 of analog input characteristic
- p4063 Analog input offset

Note

Factory state

In the factory state and after basic commissioning, an input current of 20 mA is equal to the main setpoint 100 % reference speed (p2000), which has been set to the maximum speed (p1082).

Example for changing the analog input 0 from current input to voltage input -10 to +10 V



Current/voltage changeover
Set current/voltage selector to "Voltage" ("V").

Set analog input type 0 to -10 V... +10 V.

Note

Saving changes to protect against power failure

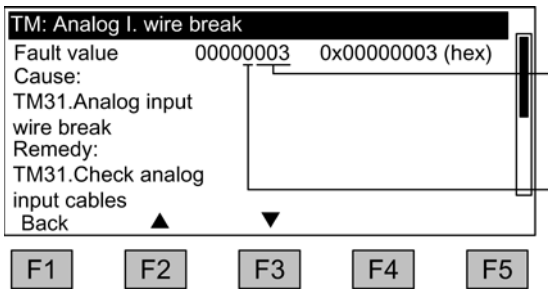
The new analog input must then be stored on the CompactFlash card so that it is protected in the event of a power failure.

F3505 – Fault: "Analog input wire break"

This fault occurs when analog input type (p4056) is set to 3 (4 mA to 20 mA with wire-break monitoring), and the input current of 2 mA has been undershot.

The fault value can be used to determine the analog input in question.

Table 6- 5 Fault screen



Component number
3: Module -A60 / -X65
4: Module -A61 (optional)
0: Analog input 0: -X521:1/2
1: Analog input 1: -X521:3/4

6.5.2 Motorized potentiometer

Description

The digital motorized potentiometer enables you to set speeds remotely using switching signals (+/- keys). It is activated via terminals or fieldbus. As long as a logical 1 is present at signal input "MOP up" (setpoint higher), the internal numerator integrates the setpoint. You can set the integration time (time taken for the setpoint to increase) using parameter p1047. In the same way, you can decrease the setpoint using signal input "MOP down". The deceleration ramp can be set using parameter p1048.
Configuration parameter p1030.0 = 1 (default setting = 0) is used to enable non-volatile storage of the current motorized potentiometer value when powering down the drive unit. When the drive unit is powered up, the start value of the motorized potentiometer is set to the last current value when the drive unit was powered down.

Requirement

The default setting for the motorized potentiometer was chosen during commissioning:

- STARTER (p1000): "Motorized potentiometer"
- AOP30 (p1000): "3: Motorized potentiometer"

Signal flow diagram

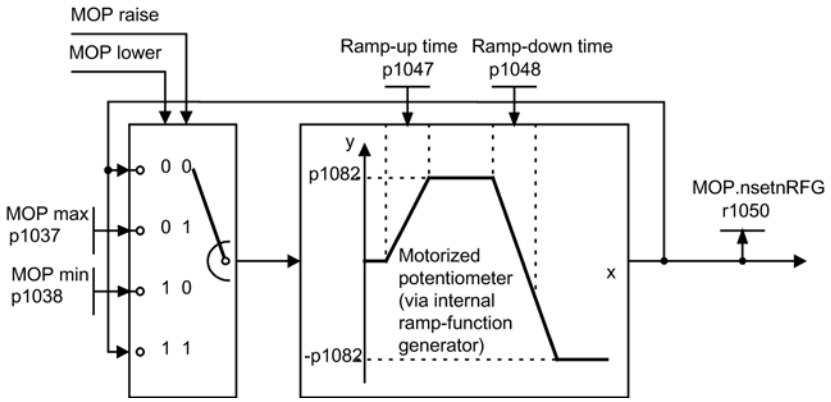


Figure 6-14 Signal flow diagram: Motorized potentiometer

Function diagram

FP 3020 Motorized potentiometer

Parameters

- p1030 Motorized potentiometer, configuration
- p1037 Motorized potentiometer, maximum speed
- p1038 Motorized potentiometer, minimum speed
- p1047 Motorized potentiometer, ramp-up time
- p1048 Motorized potentiometer, ramp-down time
- r1050 Motorized potentiometer, setpoint after the ramp-function generator

6.5.3 Fixed speed setpoints

Description

A total of 15 variable fixed speed setpoints are available.
The default setting specified for the setpoint sources during commissioning via STARTER or the operating panel makes 3 fixed speed setpoints available. They can be selected via terminals or fieldbus.

Requirement

The default setting for the fixed speed setpoints was chosen during commissioning:

- STARTER (p1000): "Fixed setpoint"
- AOP30 (p1000): "4: Fixed setpoint"

Signal flow diagram

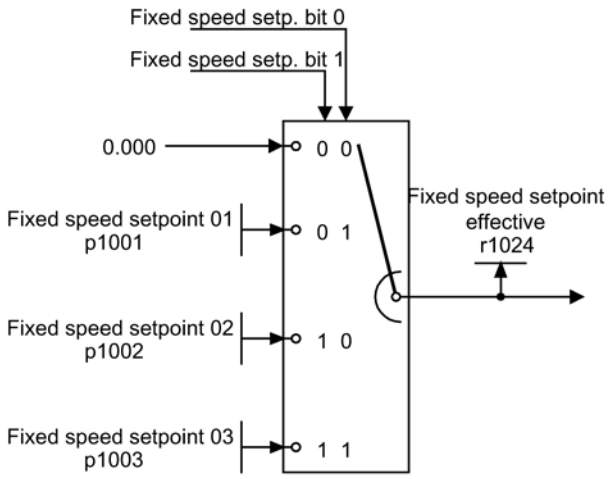


Figure 6-15 Signal flow diagram: Fixed speed setpoints

Function diagram

FP 3010 Fixed speed setpoints

Parameters

- p1001 Fixed speed setpoint 01
- p1002 Fixed speed setpoint 02
- p1003 Fixed speed setpoint 03
- r1024 Fixed speed setpoint effective

Note

Other fixed speed setpoints are available using p1004 to p1015. These can be selected using p1020 to p1023.

6.6 Control via the operator panel

6.6.1 Operator panel (AOP30) overview and menu structure

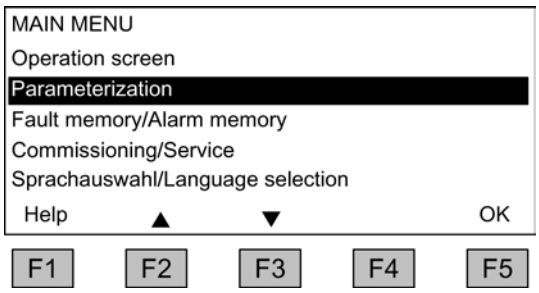
Description

The operator panel can be used for the following activities:

- Parameterization (commissioning)
- Monitoring status variables
- Controlling the drive
- Diagnosing faults and alarms

All functions can be accessed via a menu.

Your starting point is the main menu, which you can always access using the yellow MENU key:



Dialog screen for the main menu:
It can be accessed at any time with the "MENU" key.

Press "F2" or "F3" to navigate through the menu options in the main menu.

Note

AOP reset

To stop the AOP from responding, press the key pushbutton and the OFF key at the same time (and hold for longer than two seconds); the AOP reset will initiate as soon as you release the OFF key.

Menu structure of the operator panel

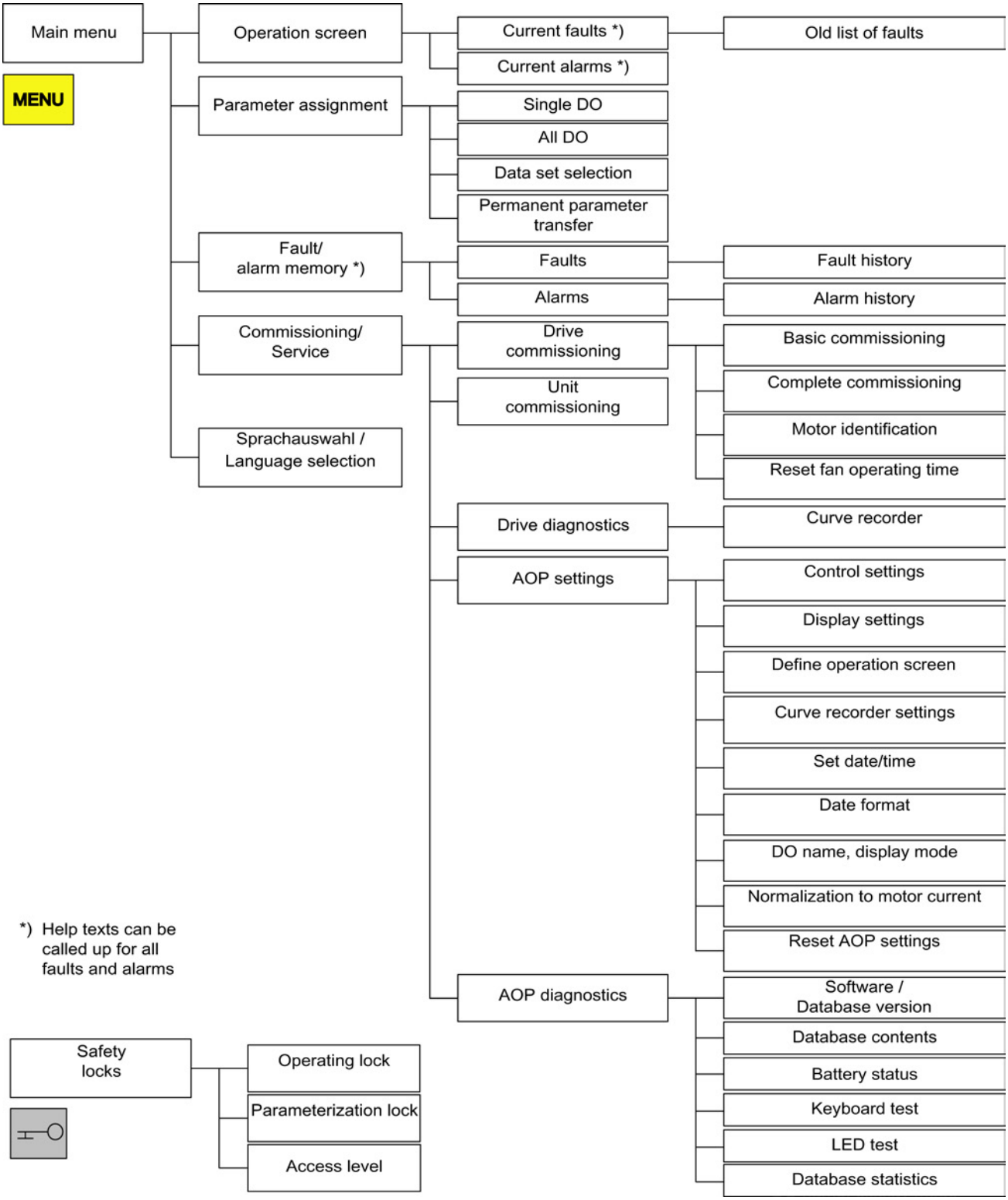


Figure 6-16 Menu structure of the operator panel

6.6.2 Operation screen menu

Description

The operation screen displays the most important status variables for the drive unit:

In the factory state, it displays the operating state of the drive, the direction of rotation, the time, as well as four drive variables (parameters) numerically and two in the form of a bar display for continuous monitoring.

There are two ways to access the operation screen:

1. After the power supply has been switched on and the system has powered up.
2. By pressing the MENU key twice and then F5 "OK".

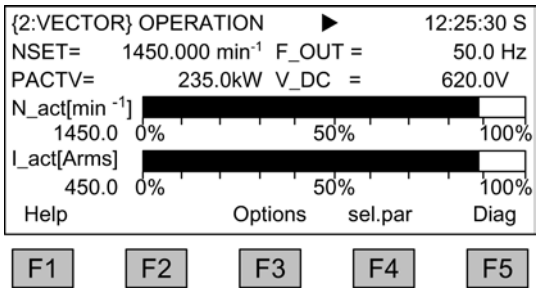


Figure 6-17 Operation screen

If a fault occurs, the system automatically displays the fault screen (see "Faults and alarms").

In LOCAL control mode, you can choose to enter the setpoint numerically (F2: setpoint).

The "Define operation screen" menu can be selected directly using F3 "Options".

The individual parameters of the operation screen can be selected using F4 "Sel. par". The corresponding parameter number of the short identifier is displayed using F1 "Help+" and a description of the parameter can be called up.

Settings

When you choose Commissioning / Service –> AOP settings –> Define operation screen, you can adjust the display type and the values displayed as required (see "AOP settings").

6.6.3 Parameterization menu

You can adjust the device settings in the Parameterization menu.

The drive software is modular. The individual modules are called DOs ("drive objects").

The following DOs are available in SINAMICS G150:

- CU: General parameters for the Control Unit
- VECTOR: Drive control
- TM31: Terminal Module TM31
- TM150: Temperature Sensor Module TM150 (option G51)

Parameters with identical functions may exist with the same parameter number in more than one DO (e.g., p0002).

The AOP30 handles devices comprising more than one drive in such a way that attention is focused on one drive (i.e., the "current" drive). You can switch between the drives either in the operation screen or in the main menu. The corresponding function key is labeled "Drive".

This drive determines the following:

- Operation screen
- Fault and alarm displays
- Control (ON, OFF, …) of a drive

You can choose between two AOP display types to suit your requirements:

1. All parameters
   All the parameters present in the device are listed here. The DO to which the currently selected parameter belongs (inverted) is displayed in curly brackets in the top left of the screen.
2. DO selection
   In this display, you can pre-select a DO. Only the parameters for this DO are then listed. (The expert list display in STARTER only uses this DO view)

In both cases, the set access level governs which parameters are displayed. You can set the access level in the "Safety inhibits" menu, which is 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.

In the data set selection menu, you can choose which of the data sets chosen is currently DISPLAYED.
Data set parameters are indicated by a "c", "d", "m", "e", or "p" between the parameter number and parameter designator.

When a data set parameter is changed, the data set selection dialog appears.

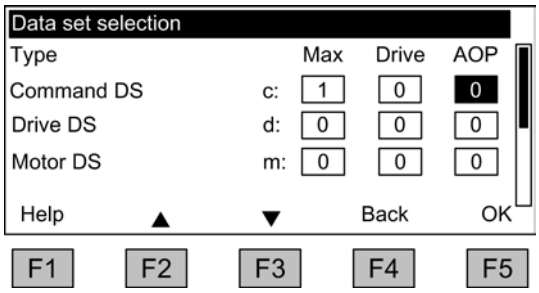


Figure 6-18 Data set selection

Explanation of the operation screen:

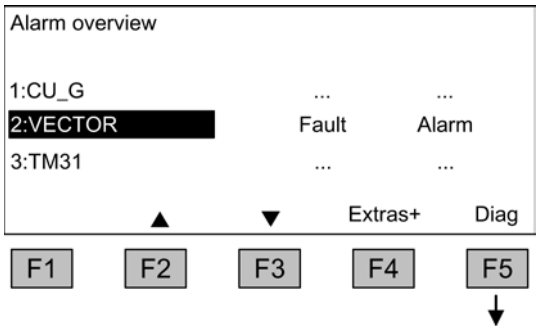
- "Max" shows the maximum number of data sets configured (and thereby available for selection) in the drive.
- "Drive" indicates which data set is currently active in the drive.
- "AOP" indicates which particular data set is currently being displayed on the operator panel.

6.6.4 Fault/alarm memory menu

When you select this menu, a screen appears containing an overview of faults and alarms that are present.

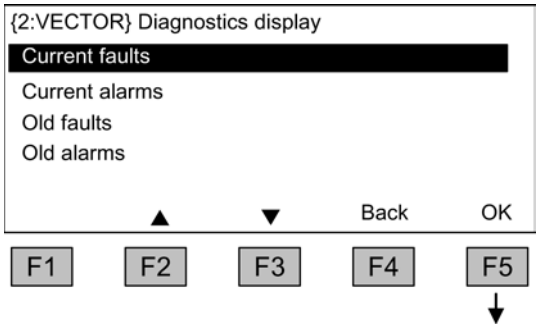
For each drive object, the system indicates whether any faults or alarms are present. ("Fault" or "Alarm" appears next to the relevant drive object).

In the screenshot below, you can see that at least one active fault/alarm is present for the "VECTOR" drive object. No faults/alarms are indicated for the other drive objects.



Fault memory/Alarm memory

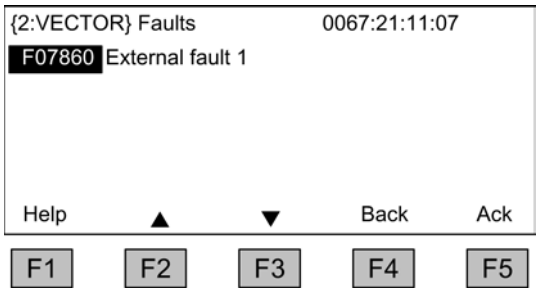
When you navigate to the line with active alarms/faults and then press the F5 <Diag> key, the system displays a screen in which you have to select the current or old alarms/faults.



Diagnostics display

When you navigate to the required line and then press the F5 <OK> key, the corresponding faults/alarms are displayed.

The list of current faults is selected here as an example.



Current faults display

A maximum of eight current faults are displayed along with their fault number and a description of the fault.

To display additional help regarding the cause of the problem and how to solve it, choose F1 <Help>.

To acknowledge the faults, choose F5 <Ack.>. If a fault cannot be acknowledged, the fault remains.

6.6.5 Commissioning/service menu

6.6.5.1 Drive commissioning

This option enables you to recommission the drive from the main menu.

Basic commissioning

Only the basic commissioning parameters are scanned and stored permanently.

Complete commissioning

Complete commissioning with motor and encoder data entry is carried out. Following this, key motor parameters are recalculated from the motor data. The parameter values calculated during previous commissioning are lost.

In a subsequent motor identification procedure, the calculated values are overwritten.

Motor identification

The selection screen for motor identification appears.

Reset fan operating time

The current operating hours of the fan in the power unit is displayed.

After a fan replacement, the operating hours counter for monitoring the fan running time must be reset.

6.6.5.2 Device commissioning

Device commissioning

In this menu, you can enter the device commissioning status directly. This is the only way to reset parameters to the factory setting, for example.

6.6.5.3 Drive diagnostics

Curve recorder

The curve recorder provides a slow trace function that can be used to monitor a signal trend. An signal selected using parameter assignment is displayed as a trend curve.

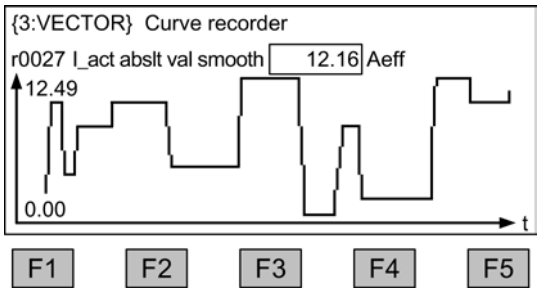


Figure 6-19 Curve recorder

You change settings relevant for the the curve recorder with the F5 key or the menu Commissioning / Service – AOP Settings - Curve recorder settings.

In addition to the curve, the value of the parameter selected in the curve recorder settings is output on the display and updated every 0.5 to 24.5 s (adjustable). If the time basis is running slowly (as of 20 minutes/picture), the time basis value flashes in the header at a rate of 1 second with the text "slow X".

The assignment of the function keys F1 to F5 is normally not visible on the display to maximized the space available to display the curve. Press a function key to show the function of the keys. The labels disappear again if no other key is pressed within 5 seconds.

The scaling of the curve can be set automatically or manually. The selection is made using the F3 key "Scale+" or the F4 key "Auto/Manual" followed by confirmation with F5 "OK".

- Auto

  The scaling of the curve varies dynamically and is based on the maximum value (e.g., 12.49) and minimum value (e.g., 0.00) visible on the display up until this moment. Scaling can be changed step-by-step using the F2 and F3 keys.
  If measured value noise is shown with an excessively high resolution as a result of the automatic scaling, then the resolution can be reduced in four steps by pressing the F2 key. This deactivates the automatic scaling. However, if the measured value leaves the display area, this is expanded. The F3 key can be used to change back to automatic scaling.

- **Manually**

  After selection of manual scaling and confirmation with "OK", a window opens where the maximum and minimum limits for the scaling can be set.

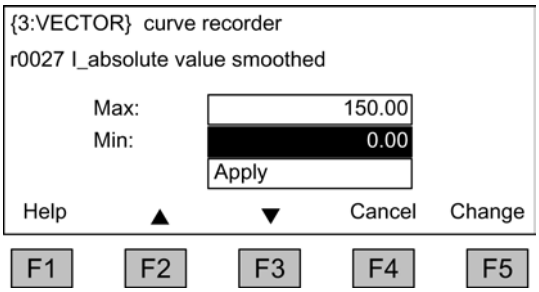


Figure 6-20 Curve recorder - manual scaling

After setting and applying the limits, the curve recorder is displayed and the manual scaling is used.

If the current measured values are outside the display area, the area is expanded automatically.

Note

Change of parameter for the curve recorder with manual scaling

The following procedure is used for manual scaling when the parameter for the curve recorder is changed:

- If the current parameter has lower values than the currently set scaling, the scaling is retained.
- If the current parameter has higher values than the currently set scaling, the scaling is adapted automatically.

The curve recorder help is opened using the F1 key.

The curve recorder is exited by pressing the MENU button.

Note

No recording of data

The values displayed in the curve recorder are not logged and saved, but serve only for display purposes until you exit the screen.

6.6.5.4 AOP settings

Control settings

This defines the settings for the control keys in LOCAL mode (see "Operation / Control via the operator panel / Operation via the operator panel").

Display settings

In this menu, you set the lighting, brightness, and contrast for the display.

Define operation screen

In this menu, you can switch between five operation screens. You can set the parameters to be displayed.

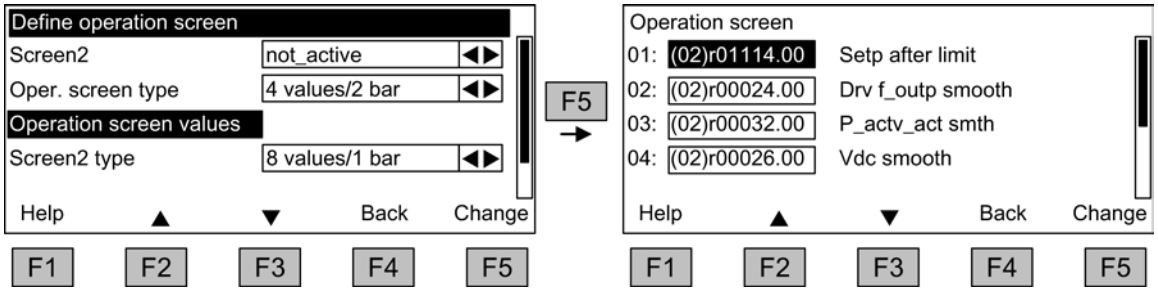


Figure 6-21 Define operation screen

The following screenshot shows how entries are assigned to the screen positions:

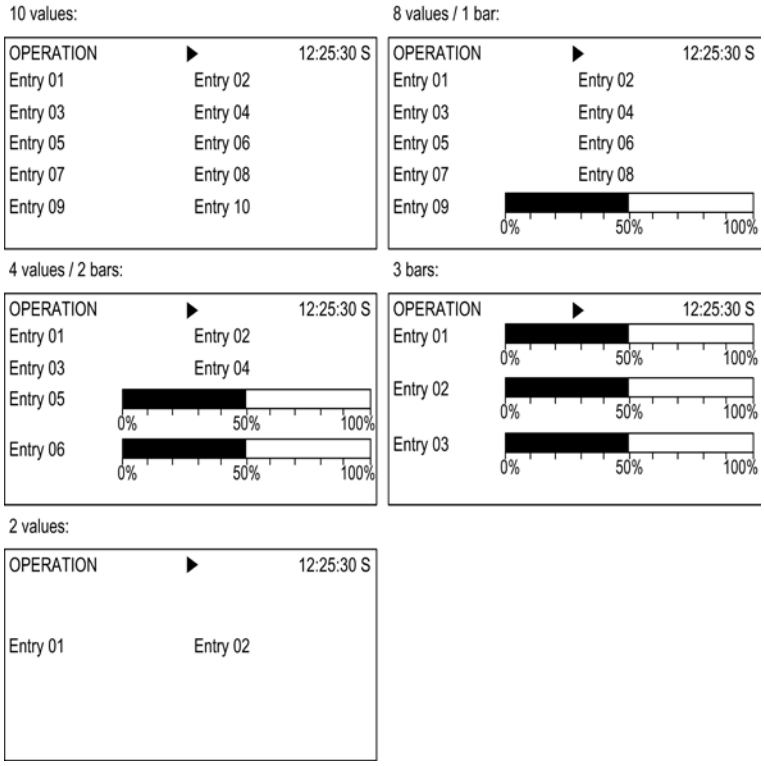


Figure 6-22 Layout of entries on the operation screen

Lists of signals for the operation screen

The following tables list some of the main signals for the operation screen along with the associated reference variables and default settings for fast commissioning.

VECTOR object

Table 6- 6 List of signals for the operation screen - VECTOR object

Signal		Parameter	Short name	Unit	Scaling (100% =...) See table below
Factory setting (entry no.)					
Speed setpoint upstream of ramp-function generator	(1)	r1114	NSET	rpm	p2000
Output frequency	(2)	r0024	F_OUT	Hz	Reference frequency
Power, smoothed	(3)	r0032	PACTV	kW	r2004
DC link voltage, smoothed	(4)	r0026	V_DC	V	p2001
Actual speed value, smoothed	(5)	r0021	N_ACT	rpm	p2000
Absolute actual value of current, smoothed	(6)	r0027	I_ACT	A	p2002
Motor temperature	(7)	r0035 [1)]	T_MOT	°C	p2006
Drive temperature	(8)	r0037	T_LT	°C	p2006
Actual torque, smoothed	(9)	r0031	M_ACT	Nm	p2003
Drive output voltage, smoothed	(10)	r0025	V_OUT	V	p2001
For diagnostic purposes					
Speed setpoint, smoothed		r0020	NSET	rpm	p2000
Modulation depth, smoothed		r0028	MODD	%	Reference modulation depth
Field-generating current component		r0029	IDACT	A	p2002
Torque-generating current component		r0030	IQACT	A	p2002
Drive overload Degree of thermal overload		r0036	LTI2T	%	100% = Shutdown
Speed actual value, motor encoder		r0061	N_ACT	rpm	p2000
Speed setpoint after filter		r0062	NSET	rpm	p2000
Actual speed value after smoothing		r0063	N_ACT	rpm	p2000
Speed controller system deviation		r0064	NDIFF	rpm	p2000
Slip frequency		r0065	FSLIP	Hz	Reference frequency
Output frequency		r0066	F_OUT	Hz	Reference frequency
Output voltage		r0072	VACT	V	p2001
Modulation depth		r0074	MODD	%	Reference modulation depth
Torque-generating actual current		r0078	IQACT	A	p2002
Actual torque value		r0080	M_ACT	Nm	p2003
For further diagnostics					
Fixed speed setpoint effective		r1024		rpm	p2000
Active motorized potentiometer setpoint		r1050		rpm	p2000
Resulting speed setpoint		r1119	NSET	rpm	p2000
Speed controller output		r1508	NREGY	Nm	p2003
I component of speed controller		r1482	NREGI	Nm	p2003
PROFIBUS setpoint		r2050	PBSET	rpm	p2000

[1)] If a temperature sensor has not been installed, a value of -200°C is displayed.

VECTOR object scalings

Table 6- 7 VECTOR object scalings

Size	Scaling parameter	Default for quick commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 x rated motor torque
Reference power	100 % = r2004	r2004 = (p2003 x p2000 x π) / 30
Reference frequency	100 % = p2000 / 60	
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference flux	100 % = Rated motor flux	
Reference temperature	100 % = p2006	p2006 = 100 °C

TM31 object

Table 6- 8 List of signals for the operation screen – TM31 object

Signal	Parameter	Short name	Unit	Scaling (100% = ...)
Analog input 0 [V, mA]	r4052[0]	AI_IV	V, mA	V: 100 V / mA: 100 mA
Analog input 1 [V, mA]	r4052[1]	AI_IV	V, mA	V: 100 V / mA: 100 mA
Analog input 0, scaled	r4055[0]	AI_%	%	as set in p200x
Analog input 1, scaled	r4055[1]	AI_%	%	as set in p200x

Curve recorder settings

In this menu, you can make the following settings:

Parameter selection

Here you select the parameter whose signal is to be displayed in the form of a trend curve in the curve recorder.

Interpolation (Factory setting: No), used for improved display of values which change suddenly.

- **No:** Only the measured values are displayed as points, without a connecting line between points.
- **1:** The measured values are connected with a perpendicular line.
- **2:** The measured values are connected with a line that is offset from the center.

Time basis(Factory setting: 2 min/picture)

The rate of signal recording is set in minutes per picture. The value can be changed in integer multiples of 2. The value is rounded of when you enter odd numbers. After changing the time basis, the recording is started again.

Background recording(Factory setting: NO)

- **YES:** The value recording is also continued when the display screen is exited. When the screen is opened again, the recorded prehistory is displayed.
- **NO:** The value recording is stopped when the curve recorder is exited.

Y scale mode (Factory setting: Auto), defines the display of the curve

- **Auto:** Scaling takes place automatically (making the best possible use of the display height).
- **Manual:** scaling takes place by manually entering the MIN/MAX range limits. If values that are outside the defined window occur in this mode, the limit is automatically adapted for the display so that actual measured values are always recorded.

Set date/time (for date stamping of fault codes)

In this menu, you set the date and time.

You can also set whether and/or how the AOP and drive unit are to be synchronized. Synchronization of the AOP with the drive enables fault codes to be date- and time-stamped.

Note

Display format for the time

The drive unit displays the time in parameter r3102 in UTC format (days/milliseconds since 01.01.1970).

The setting for the synchronization can be made using "Additional settings":

Synchronization(Factory setting: None)

- **None**
  The times for the AOP and drive unit are not synchronized.
- **AOP -> Drive**
  - If you activate this option, the AOP and drive unit are synchronized immediately, and the current AOP time is transferred to the drive unit.
  - The current AOP time is transferred to the drive unit every time the AOP is started.
  - The current AOP time is transferred to the drive unit according to the set synchronization interval.

Note

Flashing "S"

If the AOP detects a difference between RAM and ROM during synchronization to the drive unit, this is indicated by a flashing "S" at the top right in the display or, if operator input and/or parameter assignment has been disabled, by a flashing key symbol.

- **Drive -> AOP**
  - If you activate this option, the AOP and drive unit are synchronized immediately, and the current drive unit time is transferred to the AOP.
  - The current drive unit time is transferred to the AOP every time the AOP is started.
  - The current drive unit time is transferred to the AOP according to the set synchronization interval.

Note

Time-of-day master

The time in the drive must be set by a time-of-day master (e.g. SIMATIC).

Synchronization interval

The interval for the time synchronization is set from 1 hour (factory setting) to 99 hours.

The time in the AOP from the time of the last change of the interval is decisive for the interval.

Daylight saving time(Factory setting: no)

- **No**
  The time does not automatically change to daylight saving time.
- **Yes**
  Selection is only possible if synchronization is set to "None" or "AOP -> Drive".
  The time is then automatically set to summer or winter time.
  After the changeover - for synchronization "AOP -> Drive" - synchronization is immediately carried out, irrespective of the synchronization interval set.

Changes to the synchronization must be saved with "Save".

Date format

In this menu, the date format can be set:

- **DD.MM.YYYY**: European date format
- **MM/DD/YYYY**: North American date format

DO name display mode

In this menu, you can toggle the display of the DO name between the standard abbreviation (e.g., VECTOR) and a DO name of your choice (e.g., Motor_1).

User-defined DO name (factory setting: NO)

- **Yes:** The "User-defined DO name" stored in parameter p0199 is displayed instead of the standard DO abbreviation.
- **No:** The standard DO abbreviation is displayed.

Normalization to motor current

This menu allows a changeover of the reference value for the bar display of parameter r0027 (smoothed absolute value of actual current value) in the operation screens.

Normalization to motor current(factory setting: NO)

- **Yes:** The bar display of parameter r0027 in the operation screen is displayed with reference to parameter p0305 (rated motor current).
- **No:**The bar display of parameter r0027 in the operation screen is displayed with reference to parameter p2002 (reference current).

Reset AOP settings

When you choose this menu option, the AOP factory settings for the following are restored:

- Language
- Display (brightness, contrast)
- Operation screen
- Control settings

Note

Restoring the factory setting

When you reset parameters, all settings that are different to the factory settings are reset immediately. This may cause the enclosed drive to switch to an unwanted operating state.

For this reason, you should always take great care when resetting parameters.

6.6.5.5 AOP diagnostics

Software/database version

This menu shows the versions of the firmware and database.

The database version must be compatible with the drive software status (refer to parameter r0018).

Database contents

For service purposes, the contents of the database are displayed in the screen form.

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 is equal to 100 %.

Data is secure 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: "Warning: 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 determined using 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

In 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

Exit keyboard test

Alternatively, you can exit the keyboard test screen by pressing any key and holding it down.

LED test

In this screen, you can check that the 4 LEDs are functioning properly.

Database statistics

The statistics of the database are indicated in the mask for service purposes.

6.6.6 Language selection

The operator panel downloads the texts for the different languages from the drive.

You can change the language of the operator panel via the "Sprachauswahl/Language selection" menu.

Note

Additional languages for the display

Languages in addition to those currently available for the display are available on request.

6.6.7 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

OFF in REMOTE

If the "OFF in REMOTE" function is activated, the LED in the LOCAL-REMOTE key flashes.

All supplementary setpoints are deactivated for LOCAL master control.

After the master control has been transferred to the operator panel, the BICO interconnections at bit 0 to bit 10 of the control word of the sequence control are not effective (refer to function diagram 2501).

Note

Message "Other device has master control"

If STARTER is exercising master control, the message "Other device has master control" appears when the LOCAL-REMOTE key is pressed and the assumption of master control is denied.

6.6.7.1 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 (fieldbus, customer terminal block, NAMUR terminal block).
  WARNING: This function is not an EMERGENCY OFF function!
- **No**: The OFF key only functions in LOCAL mode.

LOCAL/REMOTE also during operation (factory setting: No)

- **Yes**: You can switch between LOCAL and REMOTE when the drive is switched on (motor is running).
- **No**: Before switching to LOCAL, a check is carried out to determine whether the drive is in the operational status. If so, the system does not switch to LOCAL and outputs the error message "Local mode during operation not possible". Before switching to REMOTE, the drive is switched off and the setpoint is set to 0.

6.6.7.2 ON key / OFF key



ON key: always active in LOCAL when the operator input inhibit is deactivated.

OFF key: in the factory setting, acts as OFF1 = ramp-down at the deceleration ramp (p1121); when n = 0: voltage disconnection (only if an input contactor is installed)
The OFF key is effective in the LOCAL mode and when the "OFF in REMOTE" function is active.

Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

Red OFF key acts as: (factory setting: OFF1)

- **OFF1**: Ramp-down on the deceleration ramp (p1121)
- **OFF2**: Immediate pulse inhibit, motor coasts to a standstill
- **OFF3**: Ramp-down on the emergency stop ramp (p1135)

6.6.7.3 CCW/CW selection



Settings: Menu – Commissioning/Service – AOP Settings – Control Settings

CCW/CW selection (factory setting: No)

- **Yes**: Switching between CW/CCW rotation by means of the CW/CCW key possible in LOCAL mode
- **No**: The CW/CCW key has no effect in LOCAL mode

For safety reasons, the CW/CCW key is disabled in the factory setting (pumps and fans must normally only be operated in one direction).

In the "Operation" status in LOCAL mode, the current direction of rotation is indicated by an arrow next to the operating state.

Note

You have to make additional settings when switching between CW/CCW rotation.

6.6.7.4 Jog

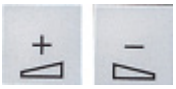


Settings: Menu – Commissioning/Service – AOP Settings – Control Settings

JOG key active (factory setting: No)

- **Yes**: The JOG key functions in LOCAL mode in the "Ready for power up" status (not in "Operation enabled" status). The speed that is set in parameter p1058 is approached.
- **No**: The JOG key has no effect in LOCAL mode

6.6.7.5 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 keys. To do so, press F2 in the operation screen. The system displays an editing field for entering the required speed. Enter the required value using the numeric keypad. Press F5 "OK" to confirm the setpoint.

Using the number keys, any speed ranging between the maximum speed (p1080) and minimum speed (p1082) can be entered.

Setpoint entry in LOCAL mode is unipolar. You can change the direction of rotation by pressing the key that allows you to switch between CW/CCW rotation.

- CW rotation and "Increase key" mean:
  The displayed setpoint is positive and the output frequency is increased.
- CCW rotation and "Increase key" mean:
  The displayed setpoint is negative and the output frequency is increased.

6.6.7.6 AOP setpoint

Settings: Menu – Commissioning / Service – AOP Settings – Control Settings

Save AOP setpoint (factory setting: No)

- **Yes**: In LOCAL mode, the last setpoint (once you have released the INCREASE or DECREASE key or confirmed a numeric entry) is saved.
  The next time you switch the system on in LOCAL mode, the saved value is selected. This is also the case if you switched to REMOTE in the meantime or the power supply was switched off.
  When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the motorized potentiometer setpoint and saved.
  If the system is switched from REMOTE to LOCAL mode while the drive is switched off, the motorized potentiometer setpoint that was last saved is used.
- **No**: On power-up in LOCAL mode, the speed is always set to the value entered under "AOP starting setpoint". When the system is switched from REMOTE to LOCAL mode while the drive is switched on (motor is running), the actual value that was last present is set as the output value for the AOP setpoint.

AOP setpoint ramp-up time (factory setting: 10 s)

AOP setpoint ramp-down time (factory setting: 10 s)

- **Recommendation**: set as ramp-up/ramp-down time (p1120 / p1121).
  Changing the ramp-up/ramp-down times does not affect the settings for parameters p1120 and p1121 because this is an AOP-specific setting.

AOP starting setpoint (factory setting: 0.000 rpm)

Note

Internal ramp-function generator

The internal drive ramp-function generator is always active.

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

Lock LOCAL

LOCAL functionality can also be inhibited on the drive by means of the p0806 parameter (BI: Inhibit master control).

Settings: Menu – Commissioning/Service – AOP settings – Control settings

Acknowledge fault from the AOP (factory setting: yes)

- **Yes**: Faults can be acknowledged via the AOP.
- **No**: Faults cannot be acknowledged via the AOP.

Settings: Menu – Commissioning/Service – AOP Settings – Control Settings

CDS changeover via AOP (factory setting: No)

- **Yes**: The active CDS can be changed by one in LOCAL mode in the operation screen. This is useful if operation via AOP would not be possible due to an activated standard frame.
  If CDS0 or CDS2 is active, "CDS+1" triggers a change to CDS1 or CDS3.
  If CDS1 or CDS3 is active, "CDS-1" triggers a change to CDS0 or CDS2.
- **No**: The active CDS cannot be changed in LOCAL mode in the operation screen.

6.6.7.7 Timeout monitoring

In "LOCAL" mode or if "OFF in REMOTE" is active, the drive is shut down after an assignable time if the data cable between the the AOP and drive is disconnected (factory setting: 3000 ms).

6.6.7.8 Operator input inhibit / Parameterization inhibit



To prevent users from accidentally actuating the control keys and changing parameters, you can activate an operator input / configuration inhibit using a key-operated pushbutton. Two key icons appear in the top right of the display when these safety inhibits are enabled.

Table 6- 9 Display of operator input / configuration inhibit

Inhibit type	Online mode	Offline mode
No safety inhibit		
Operating lock		
Parameterization lock		
Operating lock + configuration inhibit		

Settings

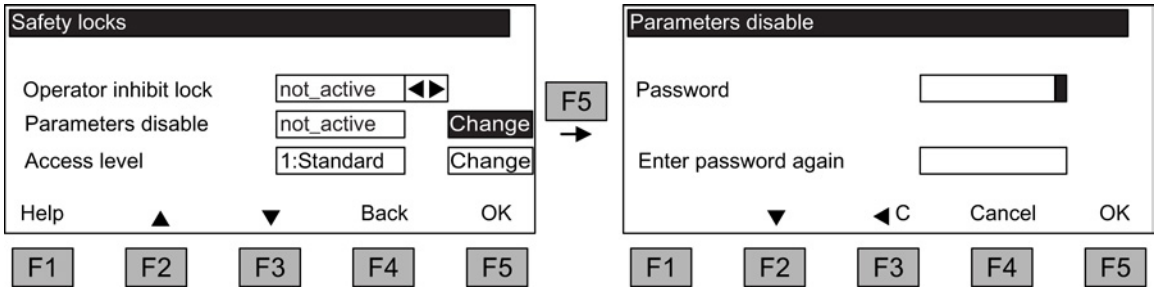


Figure 6-23 Set safety inhibits

The "Operating lock" setting can be changed directly via <F5> "Change" once you have selected the selection field.

When "Parameterization lock" is activated, you have to enter a numeric password (repeat this entry). You must also enter this password when deactivating "Parameterization lock".

Operating lock (factory setting: Not active)

- **Active**: The parameters can still be viewed, but a parameter value cannot be saved (message: "Note: operating lock active"). The OFF key (red) is enabled. The LOCAL, REMOTE, ON (green), JOG, CW/CCW, INCREASE, and DECREASE keys are disabled.

Parameterization lock (factory setting: Not active)

- **Active**: Parameters cannot be changed unless a password is entered. The configuration is the same as with the operating lock mode. If you try to change parameters, the message "Note: Parameterization lock active" is displayed. All the control keys, however, can still be actuated.

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.

Note

Copy RAM to ROM

When the operating lock or configuration inhibit is activated, a "Copy RAM to ROM" is automatically executed to back the parameter settings up in non-volatile memory on the memory card.

6.6.8 Faults and alarms

Fault and alarm displays

If a fault occurs, the drive displays the fault and/or alarm on the operator panel. Faults are indicated by the red "FAULT" LED and a fault screen is automatically displayed. You can use the F1 Help function 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.

Alarms are indicated by means of the yellow "ALARM" LED. The system also displays a note in the status bar providing information on the cause.

What is a fault?

A fault is a message from the drive indicating an error or other exceptional (unwanted) status that results in the drive being switched off. This could be caused by a fault within the drive or an external fault triggered, for example, by the winding temperature monitor for the motor. The faults are displayed and can be reported to a higher-level control system via PROFIBUS. In the factory default setting, the message "Drive fault" is also sent to a relay output. Once you have eliminated the cause of the fault, you must acknowledge the fault code.

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.

Fault and alarm displays

Every fault and alarm is entered in the fault/alarm buffer along with time the fault occurred. The time stamp refers to the system time (r2114).

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 memory / alarm memory.

A context menu featuring the "Back" and "Ack" options appears when you press F4 "Others". The function required can be selected using F2 and F3 and executed by pressing F5 "OK". The "Acknowledge" function sends an acknowledgement signal to each drive object. The red FAULT LED extinguishes once all the faults have been acknowledged.

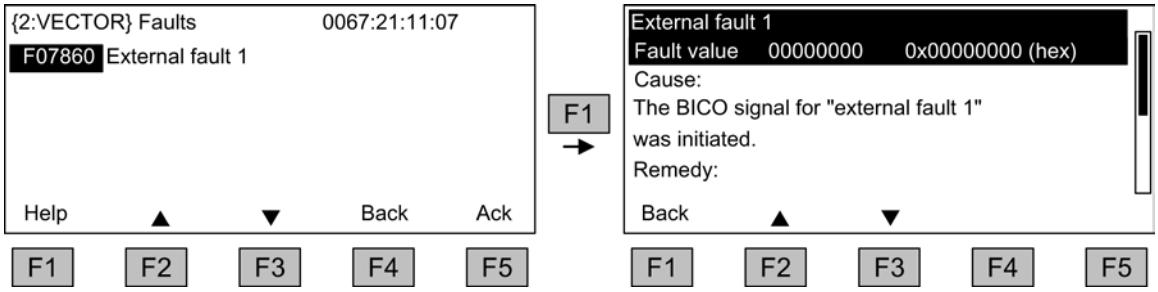


Figure 6-24 Fault screen

You can use F5 Ack. to acknowledge a stored fault.

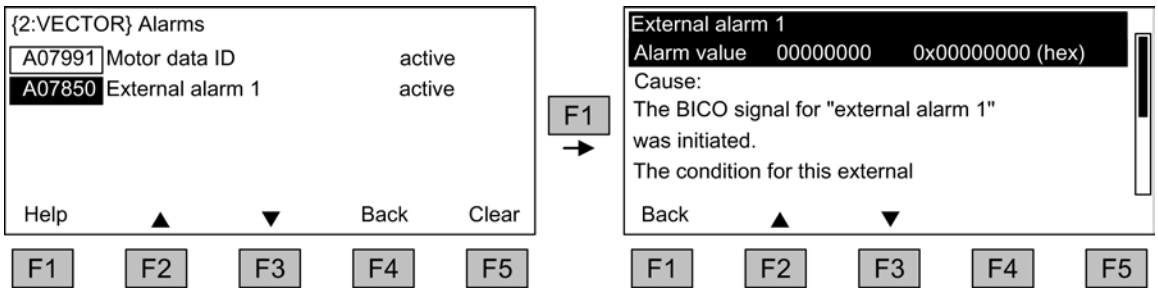


Figure 6-25 Alarm screen

Alarms that are no longer active are removed from the alarm memory with F5 Clear.

6.6.9 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 to a permanent memory. This indicates that at least 1 parameter has been changed and not yet stored permanently.

Two 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 OK, press the OK key for more than 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.

6.6.10 Parameterization errors

If an error occurs when reading or writing parameters, a popup window containing the cause of the problem is displayed.

The system displays:

Parameter write error (d)pxxxx.yy:0xnn

and a plain-text explanation of the type of parameterization error.

6.7 Communication according to PROFIdrive

6.7.1 General information

PROFIdrive V4.1 is the PROFIBUS and PROFINET profile for drive technology with a wide range of applications in production and process automation.

PROFIdrive is independent of the bus system used (PROFIBUS, PROFINET).

Note

References

PROFIdrive for drive technology is described in the following document:

- PROFIdrive system description
  PROFIBUS User Organization e. V.
  Haid-und-Neu-Straße 7, D-76131 Karlsruhe, http://www.profibus.com
  IEC 61800-7

PROFIdrive device classes

Table 6- 10 PROFIdrive device classes

PROFIdrive	PROFIBUS DP	PROFINET
Peripheral device (P device)	DP slave	IO device
Motion controller (higher-level controller or host of the automation system)	Class 1 DP master	IO controller
Supervisor (engineering station)	Class 2 DP master	IO supervisor

- Drive unit (PROFIBUS: Slave, PROFINET IO: IO device)

  Example: CU320-2 Control Unit

- Controller (PROFIBUS: Master Class 1, PROFINET IO: IO controller)

  A controller is typically a higher-level controller in which the automation program runs.

  Example: SIMATIC S7 and SIMOTION

- Supervisor (PROFIBUS: Master Class 2, PROFINET IO: IO Supervisor)

  Devices for configuring, commissioning and operator control and monitoring while the bus is in operation and devices that exchange data with drive units and controllers only acyclically.

  Examples: Programming devices, operator control and monitoring devices

Properties of controllers, supervisors, and drive units

Table 6- 11 Properties of the Controller, Supervisor, and Drive Unit

Properties	Controller, Supervisor	Drive unit
As bus node	Active	Passive
Sending of messages	Permitted without external request	Only possible at request of controller
Receiving of messages	Possible without any restrictions	Only receiving and acknowledging permitted

Communication services

Four communication services are defined in the PROFIdrive profile:

- Cyclic data exchange via a cyclic data channel
  Motion control systems require cyclically updated data during operation for open-loop and closed-loop control tasks. This data must be sent to the drive units in the form of setpoints or transmitted from the drive units in the form of actual values, via the communications system. Transmission of this data is usually time-critical.
- Acyclic data exchange via an acyclic data channel
  An acyclic parameter channel for exchanging parameters between the controller/supervisor and drive units is additionally available. Access to this data is not time-critical.
- Alarm channel
  Alarms are output on an event-driven basis, and indicate the the incoming and outgoing status of error conditions.
- Isochronous mode

Interface IF1 and IF2

The Control Unit can communicate via two different interfaces (IF1 and IF2).

Table 6- 12 Properties of IF1 and IF2

	IF1	IF2
PROFIdrive and SIEMENS frame	Yes	No
Isochronous mode	Yes	Yes
Drive object types	All	All
Can be used for	PROFINET IO, PROFIBUS DP, SINAMICS Link, PN Gate, Ethernet/IP	PROFINET IO, PROFIBUS DP, CANopen, SINAMICS Link, PN Gate, Ethernet/IP
Cyclic operation	Yes	Yes
PROFIsafe	Yes	Yes

Note

For additional information on the IF1 and IF2 interfaces, see section "Parallel operation of communication interfaces".

6.7.2 Application classes

Description

There are different application classes for PROFIdrive according to the scope and type of the application processes. PROFIdrive features a total of 6 application classes, 4 of which are discussed here.

Application class 1 (standard drive)

In the most basic case, the drive is controlled via a speed setpoint by means of PROFIBUS/PROFINET. In this case, speed control is fully handled in the drive controller. Typical application examples include simple frequency converters for controlling pumps and fans.

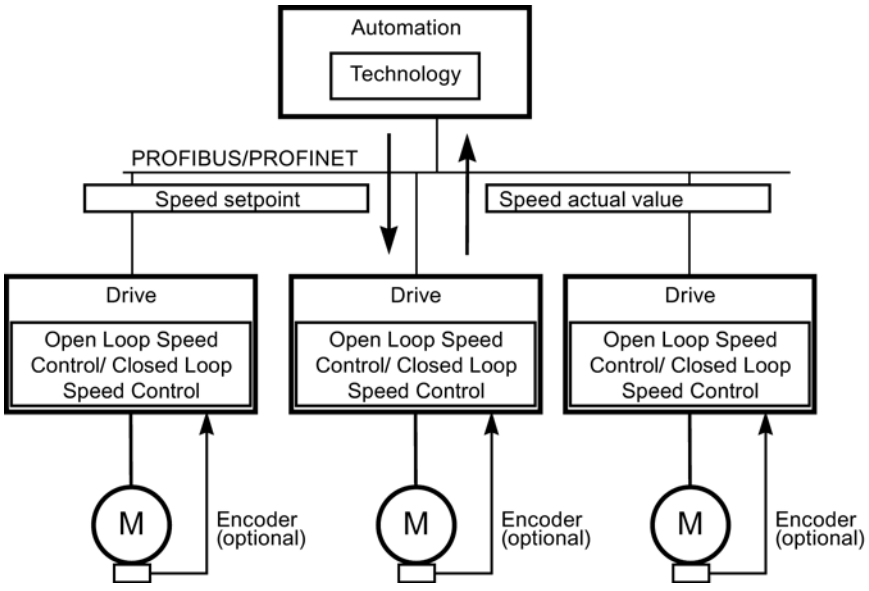


Figure 6-26 Application class 1

Application class 2 (standard drive with technology function)

The overall process is subdivided into a number of small subprocesses and distributed among the drives. This means that the automation functions no longer reside exclusively in the central automation device but are also distributed in the drive controllers.
Of course, this distribution assumes that communication is possible in every direction, i.e., also cross-communication between the technology functions of the individual drive controllers. Specific applications include setpoint cascades, winding drives, and speed synchronization applications for continuous processes with a continuous web.

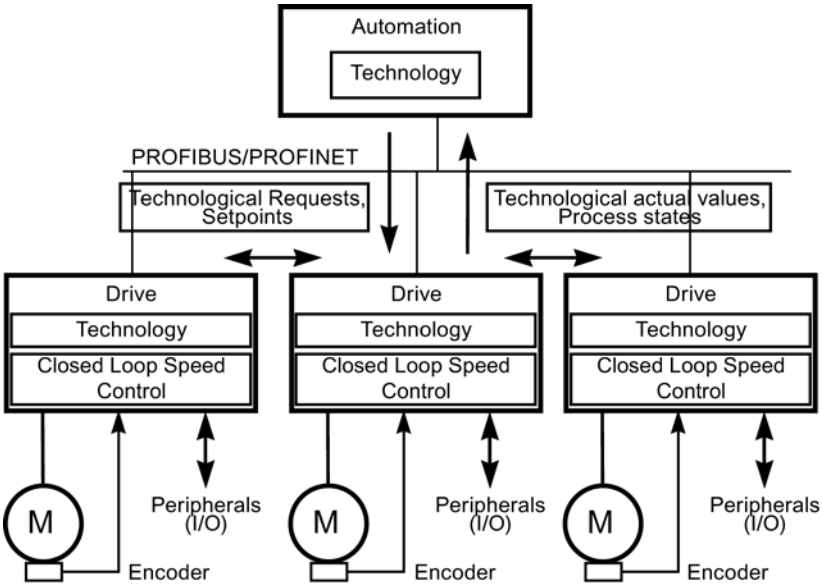


Figure 6-27 Application class 2

Application class 3 (positioning drive)

In addition to the drive control, the drive also includes a positioning control, which means that it operates as a self-contained single-axis positioning drive while the higher-level technological processes are performed on the controller. Positioning requests are transmitted to the drive controller via PROFIBUS/PROFINET and launched. Positioning drives have a very wide range of applications, e.g., the screwing and unscrewing of caps in a bottle filling plant or the positioning of cutters on a film cutting machine.

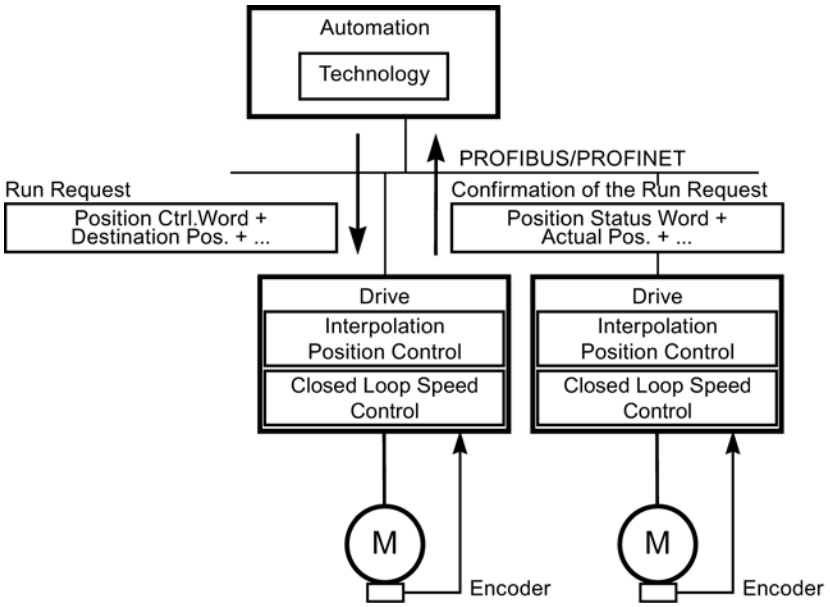


Figure 6-28 Application class 3

Application class 4 (central motion control)

This application class defines a speed setpoint interface with a sequence of the speed control on the drive and of the positioning control in the controller, such as is required for robotics and machine tool applications with coordinated motion sequences on multiple drives.

Motion control is primarily implemented by means of a central numerical controller (CNC). The position control loop is closed via the bus. The synchronization of the position control cycles in the open-loop and closed-loop controllers in the drive requires clock synchronization of the kind provided by PROFIBUS DP and PROFINET IO with IRT.

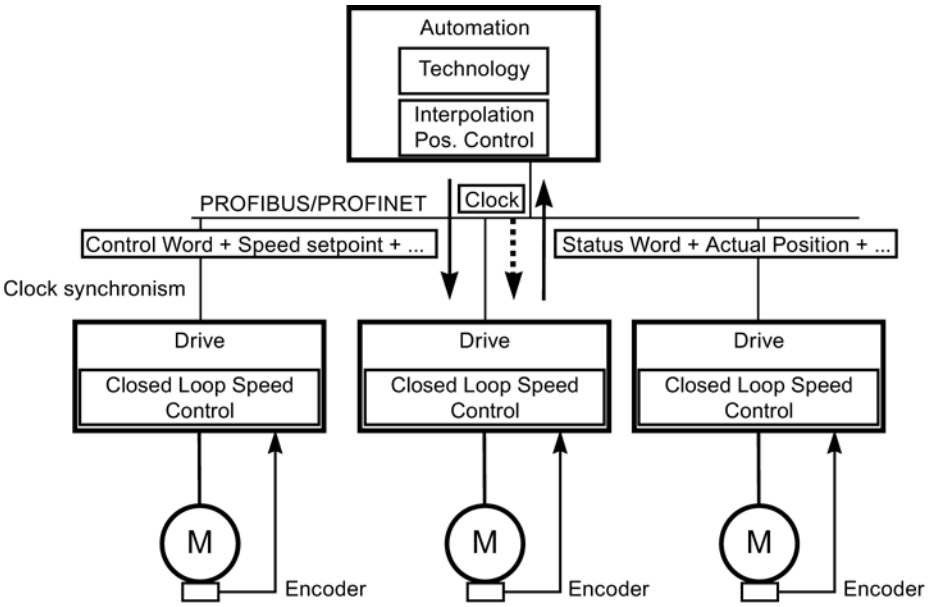


Figure 6-29 Application class 4

Selection of message frames as a function of the application class

The message frames listed in the table below can be used in the following application classes:

Table 6- 13 Selection of message frames as a function of the application class

Message frame (p0922 = x)	Description	Class 1	Class 2	Class 3	Class 4
1	Speed setpoint, 16 bit	x	x		
2	Speed setpoint, 32 bit	x	x		
3	Speed setpoint, 32 bit with 1 position encoder		x		x
4	Speed setpoint, 32 bit with 2 position encoders				x
5	Speed setpoint, 32 bit with 1 position encoder and DSC				x
6	Speed setpoint, 32 bit with 2 position encoders and DSC				x
7	Positioning, message frame 7 (basic positioner)			x	
9	Positioning, message frame 9 (basic positioner with direct input)			x	
20	Speed setpoint, 16 bit VIK-NAMUR	x	x		
81	Encoder message frame, 1 encoder channel				x
82	Extended encoder message frame, 1 encoder channel + speed actual value 16 bits				x
83	Extended encoder message frame, 1 encoder channel + speed actual value 32 bits				x
102	Speed setpoint, 32 bit with 1 position encoder and torque reduction				x
103	Speed setpoint, 32 bit with 2 position encoders and torque reduction				x
105	Speed setpoint, 32 bit with 1 position encoder, torque reduction and DSC				x
106	Speed setpoint, 32 bit with 2 position encoders, torque reduction and DSC				x
110	Basic positioner with MDI, override and XIST_A			x	
111	Basic positioner in MDI mode			x	
116	Speed setpoint, 32 bits with 2 position encoders, torque reduction, and DSC, plus actual load, torque, power, and current values				x
118	Speed setpoint, 32 bits with 2 external position encoders, torque reduction, and DSC, plus actual load, torque, power, and current values				x
125	DSC with torque feedforward control, 1 position encoder (encoder 1)				x
126	DSC with torque feedforward control, 2 position encoders (encoder 1 and encoder 2)				x
136	136 DSC with torque feedforward control, 2 position encoders (encoder 1 and encoder 2), 4 trace signals				x
139	Closed-loop speed/position control with DSC and torque feedforward control, 1 position encoder, clamping status, supplementary actual values				x

Message frame (p0922 = x)	Description	Class 1	Class 2	Class 3	Class 4
220	Speed setpoint, 32 bit, metal industry	x			
352	Speed setpoint, 16 bit, PCS7	x	x		
370	Infeed	x	x	x	x
371	Infeed, metal industry	x			
390	Control unit with digital inputs/outputs	x	x	x	x
391	Control unit with digital inputs/outputs and 2 measuring probes	x	x	x	x
392	Control unit with with digital inputs/outputs and 6 measuring probes	x	x	x	x
393	Control unit with digital inputs/outputs and 8 measuring probes	x	x	x	x
394	Control unit with digital inputs/outputs	x	x	x	x
395	Control Unit with digital inputs/outputs and 16 measuring probes	x	x	x	x
396	Message frame for transmission of DU-global status data (DO CU), for control of the digital I/O on SOC-CUs as well as of 8 CU probe channels and 8 CU cam controllers	x	x	x	x
999	Free message frames	x	x	x	x

6.7.3 Cyclic communication

Cyclic communication is used to exchange time-critical process data (e.g., setpoints and actual values).

6.7.3.1 Message frames and process data

General information

Through selection of a message frame via CU parameter p0922, the process data to be transferred is defined.

From the perspective of the drive unit, the received process data represents the receive words and the process data to be sent represents 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

"Profidrive" default setting

When the "Profidrive" default setting is chosen for command and setpoint selection (see "Command sources / "Profidrive" default settings"), "Free frame" (p0922 = 999) is selected.

The receive frame is parameterized as follows as a result of the default setting:

STW1	NSET_A

The send frame is as follows (factory setting):

STW1	NACT_SMOOTH	IAACT_SMOOTH	MACT_SMOOTH	PACT_SMOOTH	FAULT_CODE

No additional settings are necessary to use these message frames.

User-defined message frame selection

a. Standard message frames

Standard message frames are structured in accordance with PROFIdrive profile or internal company specifications. Internal interconnection of process data is performed automatically in accordance with the message frame number setting in parameter p0922.

The following standard message frames can be set via parameter p0922:

- p0922 = 1 -> Speed setpoint, 16-bit
- p0922 = 2 -> Speed setpoint, 32-bit
- p0922 = 3 -> Speed setpoint 32-bit with 1 position controllers
- p0922 = 4 -> Speed setpoint 32-bit with 2 position controllers
- p0922 = 20 -> Speed setpoint, 16-bit VIK-NAMUR
- p0922 = 352 -> Speed setpoint, 16 bit PCS7

The interface mode of the control and status word is automatically set based on the setting in p0922.

- p0922 = 1, 352, 999:
  STW 1/STW 1: Interface Mode SINAMICS/MICROMASTER, p2038 = 0
- p0922 = 20:
  STW 1/STW 1: Interface Mode PROFIdrive VIK-NAMUR, p2038 = 2

b. Manufacturer-specific message frames

The manufacturer-specific message frames are structured in accordance with internal company specifications. The internal process data links are set up automatically in accordance with the frame number setting.

The following manufacturer-specific message frames can be set via p0922:

- p0922 = 220 Speed setpoint, 32 bit, metal industry

c. Free message frames (p0922 = 999)

Send and receive message frames 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)

Refer to function diagrams FP2460 and FP2470 for details on interconnection options.

Message frame interconnections

When p0922 = 999 (factory setting) is changed to p0922 ≠ 999, the message frames are interconnected and blocked automatically.

Note

Exceptions

Exceptions here are message frames 20, 220, and 352. In addition to the fixed interconnections, selected process data (PZD) can be interconnected as required in the send/receive frame.

When you change p0922 ≠ 999 to p0922 = 999, the previous message frame interconnection is retained and can be changed.

Note

Easy method for creating extended message frame interconnections

If p0922 = 999, a message frame can be selected in p2079. A message frame interconnection is automatically made and blocked. However, the message frame can also be extended.

This is an easy method for creating extended message frame interconnections on the basis of existing message frames.

6.7.3.2 Structure of the message frames

Table 6- 14 Structure of the message frames

Frame	PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9	PZD 10
1	STW1	NSET_A								
	STW1	NACT_A								
2	STW1	NSET_B		STW2						
	STW1	NACT_B		STW2						
3	STW1	NSET_B		STW2	G1_STW					
	STW1	NACT_B		STW2	G1_STW	G1_XACT1		G1_XACT2		
4	STW1	NSET_B		STW2	G1_STW	G2_STW				
	STW1	NACT_B		STW2	G1_STW	Further assignment, see FP2420				
20	STW1	NSET_A								
	STW1	NACT_A_ SMOOTH	IAACT_ SMOOTH	MACT_ SMOOTH	PACT_ SMOOTH	MELD_ NAMUR				
220	STW1_ BM	NSET_B		STW2_BM	M_ADD	M_LIM	free	free	free	free
	STW1_ BM	NACT_A	IAACT	MACT	WARN_ CODE	FAULT_ CODE	STW2_ BM	free	free	free
352	STW1	NSET_A	PCS7_3	PCS7_4	PCS7_5	PCS7_6				
	STW1	NACT_A_ SMOOTH	IAACT_ SMOOTH	MACT_SM OOTH	WARN_ CODE	FAULT_ CODE				
999	STW1	free	free	free	free	free	free	free	free	free
	STW1	free	free	free	free	free	free	free	free	free

6.7.3.3 Overview of control words and setpoints

Table 6- 15 Overview of control words and setpoints

Abbreviation	Description	Parameter	Function diagram
STW1	Control word 1 (interface mode SINAMICS, p2038 = 0)	See table "Control word 1 (interface mode SINAMICS, p2038 = 0)"	FP2442
STW1	Control word 1 (interface mode VIK-NAMUR, p2038 = 2)	See table "Control word 1 (interface mode VIK-NAMUR, p2038 = 2)"	FP2441
STW1_BM	Control word 1, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Control word 1, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2425
STW2	Control word 2 (interface mode SINAMICS, p2038 = 0)	See table "Control word 2 (interface mode SINAMICS, p2038 = 0)"	FP2444
STW2_BM	Control word 2, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Control word 2, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2426
NSET_A	Speed setpoint A (16-bit)	p1070	FP3030
NSET_B	Speed setpoint B (32-bit)	p1155	FP3080
PCS7_x	PCS7-specific setpoints		

6.7.3.4 Overview of status words and actual values

Table 6- 16 Overview of status words and actual values

Abbreviation	Description	Parameter	Function diagram
STW1	Status word 1 (interface mode SINAMICS, p2038 = 0)	See table "Status word 1 (interface mode SINAMICS, p2038 = 0)"	FP2452
STW1	Status word 1 (interface mode VIK-NAMUR, p2038 = 2)	See table "Status word 1 (interface mode VIK-NAMUR, p2038 = 2)"	FP2451
STW1_BM	Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 1, metal industry (interface mode SINAMICS, p2038 = 0)"	FD2428
STW2	Status word 2 (interface mode SINAMICS, p2038 = 0)	See table "Status word 2 (interface mode SINAMICS, p2038 = 0)"	FD2454
STW2_BM	Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)	See table "Status word 2, metal industry (interface mode SINAMICS, p2038 = 0)"	FP2429
NACT_A	Speed setpoint A (16-bit)	r0063[0]	FP4715
NACT_B	Speed setpoint B (32-bit)	r0063	FP4710
IAACT	Actual value of current	r0068[0]	FP6714
MACT	Actual torque value	r0080[0]	FP6714
PACT	Actual power value	r0082[0]	FP6714
NACT_SMOOTH	Actual speed value, smoothed	r0063[1]	FP4715
IAACT_SMOOTH	Actual value of current, smoothed	r0068[1]	FP6714
MACT_SMOOTH	Actual torque value, smoothed	r0080[1]	FP6714
PACT_SMOOTH	Actual power value, smoothed	r0082[1]	FP6714
MELD_NAMUR	VIK-NAMUR message bit bar	r3113, see table "NAMUR message bit bar"	--
WARN_CODE	Alarm code	r2132	FD8065
FAULT_CODE	Fault code	r2131	FP8060

6.7.4 Acyclic communication

Acyclic communication, as opposed to cyclic communication, means data is transferred only when an explicit request is made (e.g., in order to read and write parameters).

The "Read data record" and "Write data record" services are available for acyclic communication.

The following options are available for reading and writing parameters:

- S7 protocol

  This protocol uses the STARTER commissioning tool, for example, in online mode via PROFIBUS.

- PROFIdrive parameter channel with the following data records:
  - PROFIBUS: Data block 47 (0x002F)

    The DPV1 services are available for master class 1 and master class 2.
  - PROFINET: Data block 47 and 0xB02F as global access, data block 0xB02E as local access

Note

References

Refer to the following documentation for a detailed description of acyclic communication:
Reference: PROFIdrive Profile V4.1, May 2006, Order No: 3.172

Addressing:

- PROFIBUS DP, addressing is carried out via the logical address or the diagnostics address.
- PROFINET IO, addressing is carried out exclusively via a diagnostics address that is assigned to a module starting from slot 1. Parameters cannot be accessed using slot 0.

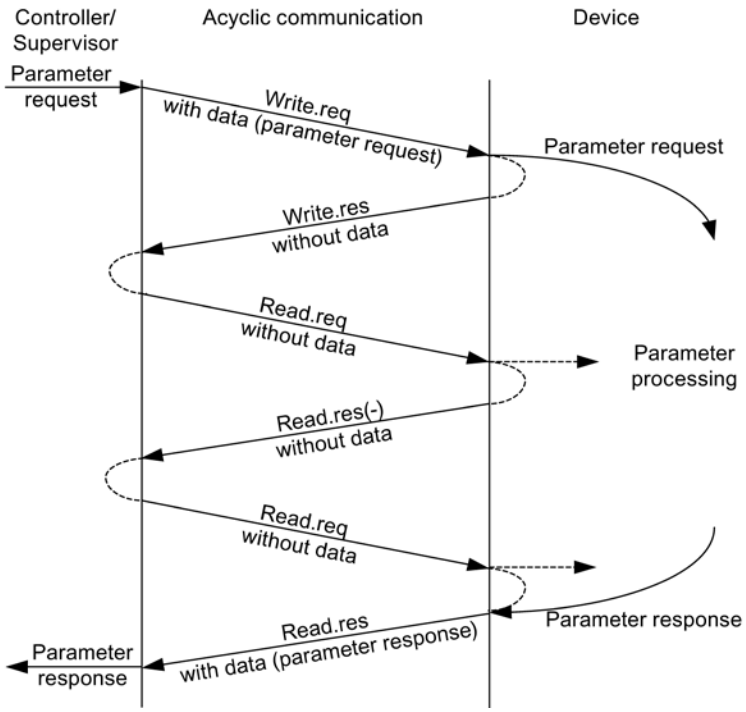


Figure 6-30 Reading and writing data

Characteristics of the parameter channel

- One 16-bit address each for parameter number and subindex.
- Concurrent access by several additional PROFIBUS masters (master class 2) or PROFINET IO Supervisor (e.g., commissioning tool).
- Transfer of different parameters in one access (multiple parameter request).
- Transfer of complete arrays or part of an array possible.
- Only one parameter request is processed at a time (no pipelining).
- A parameter request/response must fit into one data record (max. 240 bytes).
- The request and response header are counted as user data.

6.7.4.1 Structure of requests and responses

Structure of parameter request and parameter response

Table 6- 17 Structure of the parameter request

	Parameter request			**Offset**
Values for write access only	Request header	Request reference	Request ID	0
		Axis	Number of parameters	2
	1. parameter address	Attribute	Number of elements	4
		Parameter number		6
		Subindex		8
	...			
	nth parameter address	Attribute	Number of elements	
		Parameter number		
		Subindex		
	1. parameter value(s)	Format	Number of values	
		Values		
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values		
		...		

Table 6- 18 Structure of the parameter response

	Parameter response			Offset
Values for read access only Error values for negative response only	Response header	Request reference mirrored	Response ID	0
		Axis mirrored	Number of parameters	2
	1. parameter value(s)	Format	Number of values	4
		Values or error values		6
		...		
	...			
	nth parameter value(s)	Format	Number of values	
		Values or error values		
		...		

Description of fields in the parameter request and response

Table 6- 19 Fields in parameter request and response

Field	Data type	Values	Comments
Request reference	Unsigned8	0x01 ... 0xFF	
	Unique identification of the request/response pair for the master. The master changes the request reference with each new request. The slave mirrors the request reference in its response.		
Request ID	Unsigned8	0x01 0x02	Read request Write request
	Specifies the type of request. In the case of a write request, the changes are made in a volatile memory (RAM). A save operation is needed in order to transfer the modified data to the non-volatile memory (p0971, p0977).		
Response ID	Unsigned8	0x01 0x02 0x81 0x82	Read request (+) Write request (+) Read request (-) Write request (-)
	Mirrors the request ID and specifies whether request execution was positive or negative. Negative means: Cannot execute part or all of request. The error values are transferred instead of the values for each subresponse.		
Drive object number	Unsigned8	0x00 ... 0xFF	Number
	Setting for the drive object number of a drive unit with more than one drive object. Different drive objects with separate parameter number ranges can be accessed via the same DPV1 connection.		
Number of parameters	Unsigned8	0x01 ... 0x27	Number 1 ... 39 Limited by DPV1 frame length
	Defines the number of adjoining areas for the parameter address and/or parameter value for multi-parameter requests. The number of parameters = 1 for single requests.		

Field	Data type	Values	Comments
Attribute	Unsigned8	0x10 0x20 0x30	Value Description Text (not implemented)
	Type of parameter element accessed.		
Number of elements	Unsigned8	0x00 0x01 ... 0x75	Special function Number 1 ... 117 Limited by DPV1 frame length
	Number of array elements accessed.		
Parameter number	Unsigned16	0x0001 ... 0xFFFF	No. 1 ... 65535
	Addresses the parameter accessed.		
Subindex	Unsigned16	0x0000 ... 0xFFFF	No. 0 ... 65535
	Addresses the first array element of the parameter to be accessed.		
Format	Unsigned8	0x02 0x03 0x04 0x05 0x06 0x07 0x08 Other values	Data type Integer8 Data type Integer16 Data type Integer32 Data type Unsigned8 Data type Unsigned16 Data type Unsigned32 Data type FloatingPoint See PROFIdrive profile V3.1
		0x40 0x41 0x42 0x43 0x44	Zero (without values as a positive subresponse a write request) Byte Word Double word Error
	The format and number specify the adjoining space containing values in the message frame. It is preferable to specify data types according to the PROFIdrive Profile for write access. Bytes, words and double words are also possible as a substitute.		
Number of values	Unsigned8	0x00 ... 0xEA	Number 0 ... 234 Limited by DPV1 frame length
	Specifies the number of subsequent values.		
Error values	Unsigned16	0x0000 ... 0x00FF	Meaning of error values --> see following table
	The error values in the event of a negative response. If the values make up an odd number of bytes, a zero byte is appended. This ensures the integrity of the word structure of the message frame.		
Values	Unsigned16	0x0000 ... 0x00FF	
	The values of the parameter for read or write access. If the values make up an odd number of bytes, a zero byte is appended. This ensures the integrity of the word structure of the message frame.		

Error values in parameter responses

Table 6- 20 Error values in parameter responses

Error value	Meaning	Comments	Additional info
0x00	Illegal parameter number.	Access to a parameter that does not exist.	–
0x01	Parameter value cannot be changed.	Modification access to a parameter value that cannot be changed.	Subindex
0x02	Lower or upper value limit exceeded.	Modification access with value outside value limits.	Subindex
0x03	Invalid subindex.	Access to a subindex that does not exist.	Subindex
0x04	No array.	Access with subindex to an unindexed parameter.	–
0x05	Wrong data type.	Modification access with a value that does not match the data type of the parameter.	–
0x06	Illegal set operation (only reset allowed)	Modification access with a value not equal to 0 in a case where this is not allowed.	Subindex
0x07	Description element cannot be changed	Modification access to a description element that cannot be changed.	Subindex
0x09	No description data	Access to a description that does not exist (the parameter value exists).	–
0x0B	No parameter change rights.	Modification access with no parameter change rights.	–
0x0F	No text array exists	Access to a text array that does not exist (the parameter value exists).	–
0x11	Request cannot be executed due to operating status.	Access is not possible temporarily for unspecified reasons.	–
0x14	Illegal value.	Modification access with a value that is within the limits but is illegal for other permanent reasons (parameter with defined individual values).	Subindex
0x15	Response too long.	The length of the present response exceeds the maximum transfer length.	–
0x16	Illegal parameter address.	Impermissible or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these.	–
0x17	Illegal format.	Write request: illegal or unsupported parameter data format.	–
0x18	Number of values inconsistent.	Write request: a mismatch exists between the number of values in the parameter data and the number of elements in the parameter address.	–
0x19	Drive object does not exist.	You have attempted to access a drive object that does not exist.	–
0x65	Parameter presently deactivated.	You have tried to access a parameter that, although available, does not currently perform a function (e.g., n control set and access to a V/f control parameter).	–
0x6B	Parameter %s [%s]: no write access for the enabled controller.	–	–
0x6C	Parameter %s [%s]: unit unknown.	–	–

Error value	Meaning	Comments	Additional info
0x6D	Parameter %s [%s]: write access only in the commissioning state, encoder (p0010 = 4).	–	–
0x6E	Parameter %s [%s]: write access only in the commissioning state, motor (p0010 = 3).	–	–
0x6F	Parameter %s [%s]: write access only in the commissioning state, power module (p0010 = 2).	–	–
0x70	Parameter %s [%s]: write access only in quick commissioning (p0010 = 1).	–	–
0x71	Parameter %s [%s]: write access only in the ready state (p0010 = 0).	–	–
0x72	Parameter %s [%s]: write access only in the commissioning state, parameter reset (p0010 = 30).	–	–
0x73	Parameter %s [%s]: write access only in the commissioning state, safety (p0010 = 95).	–	–
0x74	Parameter %s [%s]: write access only in the commissioning state, tech. application/units (p0010 = 5).	–	–
0x75	Parameter %s [%s]: write access only in the commissioning state (p0010 not equal to 0).	–	–
0x76	Parameter %s [%s]: write access only in the commissioning state, download (p0010 = 29).	–	–
0x77	Parameter %s [%s] must not be written during download.	–	–
0x78	Parameter %s [%s]: write access only in the commissioning state, drive configuration (device: p0009 = 3).	–	–
0x79	Parameter %s [%s]: write access only in the commissioning state, define drive type (device: p0009 = 2).	–	–
0x7A	Parameter %s [%s]: write access only in the commissioning state, database configuration (device: p0009 = 4).	–	–
0x7B	Parameter %s [%s]: write access only in the commissioning state, device configuration (device: p0009 = 1).	–	–

Error value	Meaning	Comments	Additional info
0x7C	Parameter %s [%s]: write access only in the commissioning state, device download (device: p0009 = 29).	–	–
0x7D	Parameter %s [%s]: write access only in the commissioning state, device parameter reset (device: p0009 = 30).	–	–
0x7E	Parameter %s [%s]: write access only in the commissioning state, device ready (device: p0009 = 0).	–	–
0x7F	Parameter %s [%s]: write access only in the commissioning state, device (device: p0009 mot 0).	–	–
0x81	Parameter %s [%s] must not be written during download.	–	–
0x82	Transfer of the control authority is inhibited by BI: p0806.	–	–
0x83	Parameter %s [%s]: requested BICO interconnection not possible.	BICO output does not supply float values. The BICO input, however, requires a float value.	–
0x84	Parameter %s [%s]: parameter change inhibited (refer to p0300, p0400, p0922)	–	–
0x85	Parameter %s [%s]: access method not defined.	–	–
0xC8	Below currently valid limit.	Modification request for a value that, although within "absolute" limits, is below the currently valid lower limit.	–
0xC9	Above currently valid limit.	Modification request for a value that, although within "absolute" limits, is above the currently valid upper limit (e.g., governed by the current converter rating).	–
0xCC	Write access not permitted.	Write access is not permitted because an access key is not available.	–

6.7.4.2 Determining the drive object numbers

Additional information about the drive system (e.g., drive object numbers) can be determined as follows from parameters p0101, r0102, and p0107/r0107:

1. The value of parameter r0102 ("Number of drive objects") is read via a read request to drive object 1.

   The drive object with drive object number 1 is the Control Unit (CU), which is always present in every drive system, at a minimum.

2. Depending on the result of the initial read request, further read requests to drive object 1 are used to read the indices of parameter p0101 ("Drive object numbers"), as specified by parameter r0102.

   Example:
   If the number of drive objects is "5", the values of indices 0 to 4 of parameter p0101 are read. The relevant indexes can also be read at once. The relevant indexes can also be read at once.

3. Following this, parameter r0107/p0107 ("Drive object type") is read for each drive object (indicated by the drive object number).

   Depending on the drive object, parameter 107 can be either an adjustable parameter or a display parameter.

   The value in parameter r0107/p0107 indicates the drive object type. The coding for the drive object type can be found in the parameter list.

6.7.4.3 Example 1: Reading parameters

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data records in conformance with PROFINET/PROFIBUS.

Task description

Following the occurrence of at least one fault (STW1.3 = "1") on drive 2 (also drive object number 2), the active fault codes are to be read from the fault buffer r0945[0] ... r0945[7].

The request is to be handled using a request and response data block.

Basic procedure

1. Create a request to read the parameters.
2. Initiate the request.
3. Evaluate the response.

Creating the request

Table 6- 21 Parameter request

Parameter request			Offset
Request header	Request reference = 25 hex	Request ID = 01 hex	0 + 1
	Axis = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter address	Attribute = 10 hex	Number of elements = 08 hex	4 + 5
	Parameter no. = 945 dec		6
	Subindex = 0 dec		8

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request identifier:
  01 hex → This identifier is required for a read request.
- Axis:
  02 hex → Drive 2, fault buffer with drive- and device-specific faults
- Number of parameters:
  01 hex → One parameter is read.
- Attribute:
  10 hex → The parameter values are read.
- Number of elements:
  08 hex → The current incident with eight faults is to be read.
- Parameter number:
  945 dec → p0945 (fault code) is read.
- Subindex:
  0 dec → Reading starts from index 0.

2. Initiate parameter request

Initiating the request

If STW1.3 = "1" → Initiate parameter request

Evaluating the response

Table 6- 22 Parameter response

Parameter response			Offset
Response header	Request reference mirrored = 25 hex	Response ID = 01 hex	0 + 1
	Axis mirrored = 02 hex	Number of parameters = 01 hex	2 + 3
Parameter value	Format = 06 hex	Number of values = 08 hex	4 + 5
	1. value = 1355 dec		6
	2. value = 0 dec		8
	...		...
	8. value = 0 dec		20

Information about the parameter response:

- Request reference mirrored:
  This response belongs to the request with request reference 25.
- Response identifier:
  01 hex → Read request positive, values available starting from 1st value
- Axis mirrored, number of parameters:
  The values correspond to the values from the request.
- Format:
  06 hex → Parameter values are in the Unsigned16 format.
- Number of values:
  08 hex → 8 parameter values are available.
- 1. Value ... value 8:
  A fault is only entered in value 1 of the fault buffer for drive 2.

6.7.4.4 Example 2: Writing parameters (multi-parameter request)

Requirements

- The PROFIdrive controller has been commissioned and is fully operational.
- PROFIdrive communication between the controller and the device is operational.
- The controller can read and write data records in conformance with PROFINET/PROFIBUS.

  Special requirements for this example:
- Control type: Vector control (with extended setpoint channel)

Task description

Jog 1 and 2 are to be set up for drive 2 (also drive object number 2) via the input terminals of the Control Unit. A parameter request is to be used to write the corresponding parameters as follows:

- BI: p1055 = r0722.4 — Jog bit 0
- BI: p1056 = r0722.5 — Jog bit 1
- p1058 = 300 rpm — Jog 1 speed setpoint
- p1059 = 600 rpm — Jog 2 speed setpoint

The request is to be handled using a request and response data block.

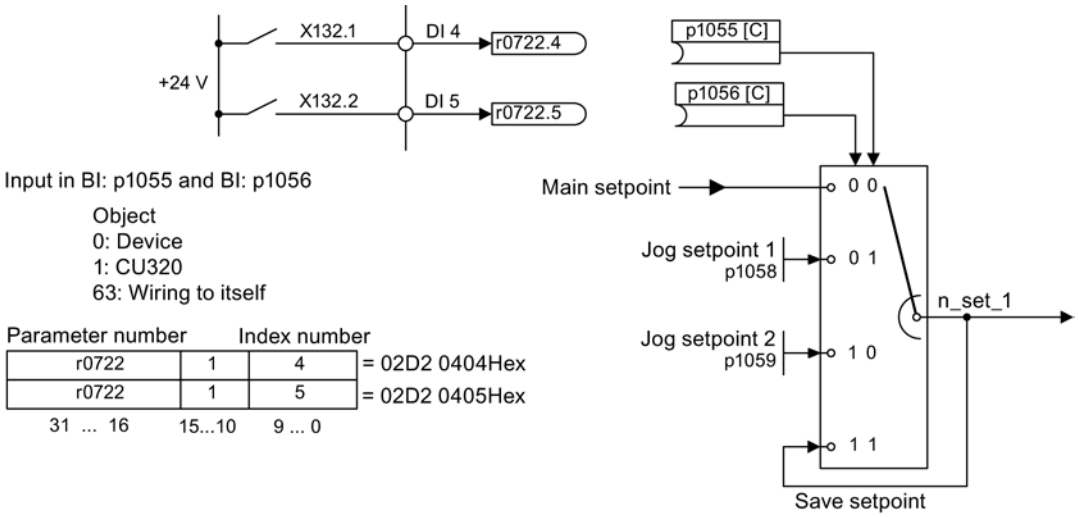


Figure 6-31 Task description for multi-parameter request (example)

Basic procedure

1. Create a request to write the parameters.
2. Initiate the request.
3. Evaluate the response.

Creating the request

Table 6- 23 Parameter request

Parameter request			Offset
Request header	Request reference = 40 hex	Request ID = 02 hex	0 + 1
	Axis = 02 hex	Number of parameters = 04 hex	2 + 3
1. parameter address	Attribute = 10 hex	Number of elements = 01 hex	4 + 5
	Parameter no. = 1055 dec		6
	Subindex = 0 dec		8
2. parameter address	Attribute = 10 hex	Number of elements = 01 hex	10 + 11
	Parameter no. = 1056 dec		12
	Subindex = 0 dec		14
3. parameter address	Attribute = 10 hex	Number of elements = 01 hex	16 + 17
	Parameter no. = 1058 dec		18
	Subindex = 0 dec		20
4. parameter address	Attribute = 10 hex	Number of elements = 01 hex	22 + 23
	Parameter no. = 1059 dec		24
	Subindex = 0 dec		26
1. parameter value(s)	Format = 07 hex	Number of values = 01 hex	28 + 29
	Value = 02D2 hex		30
	Value = 0404 hex		32
2. parameter value(s)	Format = 07 hex	Number of values = 01 hex	34 + 35
	Value = 02D2 hex		36
	Value = 0405 hex		38
3. parameter value(s)	Format = 08 hex	Number of values = 01 hex	40 + 41
	Value = 4396 hex		42
	Value = 0000 hex		44
4. parameter value(s)	Format = 08 hex	Number of values = 01 hex	46 + 47
	Value = 4416 hex		48
	Value = 0000 hex		50

Information about the parameter request:

- Request reference:
  The value is selected at random from the valid value range. The request reference establishes the relationship between request and response.
- Request identifier:
  02 hex → This identifier is required for a write request.
- Axis:
  02 hex → The parameters are written to drive 2.
- Number of parameters:
  04 hex → The multi-parameter request comprises four individual parameter requests.

1st parameter address ... 4th parameter address

- Attribute:
  10 hex → The parameter values are to be written.
- Number of elements:
  01 hex → 1 array element is written.
- Parameter number:
  Specifies the number of the parameter to be written (p1055, p1056, p1058, p1059).
- Subindex:
  0 dec → Identifier of the first array element.

1st parameter value ... 4th parameter value

- Format:
  07 hex → Data type Unsigned32
  08 hex → Data type FloatingPoint
- Number of values:
  01 hex → A value in the specified format is written to each parameter.
- Value:
  BICO input parameter: Enter signal source
  Adjustable parameter: enter value

Initiating the request

Evaluating the response

Table 6- 24 Parameter response

Parameter response			Offset
Response header	Request reference mirrored = 40 hex	Response ID = 02 hex	0
	Axis mirrored = 02 hex	Number of parameters = 04 hex	2

Information about the parameter response:

- Request reference mirrored:
  This response belongs to the request with request reference 40.
- Response identifier:
  02 hex → Write request positive
- Axis mirrored:
  02 hex → The value matches the value from the request.
- Number of parameters:
  04 hex → The value matches the value from the request.

6.7.5 Further information about PROFIdrive communication

Further information about PROFIdrive communication

For more information about PROFIdrive communication, refer to "PROFIdrive communication" in the accompanying "SINAMICS S120 Function Manual".

6.8 Communication via PROFIBUS DP

6.8.1 PROFIBUS port

Position of the PROFIBUS connection, address switch, and diagnostics LED

The PROFIBUS connection, address switch, and diagnostics LED are located on the Control Unit CU320-2 DP.

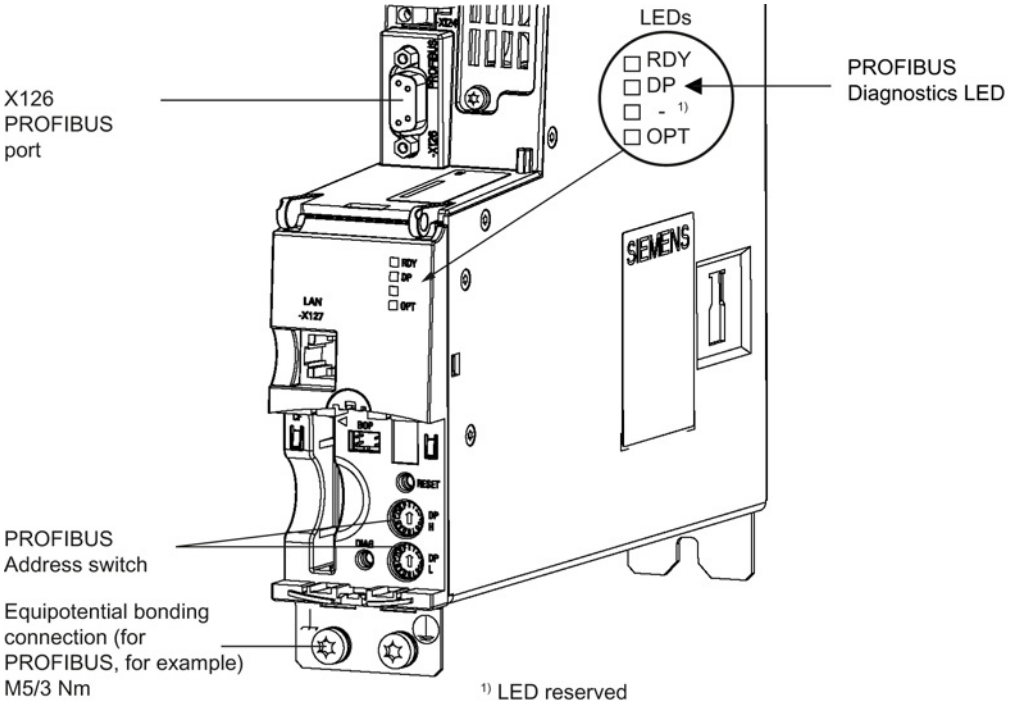
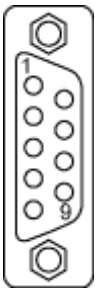


Figure 6-32 View of the control unit with PROFIBUS interface

PROFIBUS connection

PROFIBUS is connected by means of a 9-pin sub D socket (X126); the terminals are isolated.

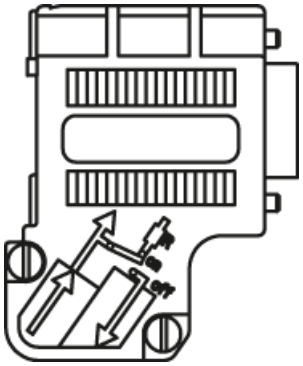
Table 6- 25 X126 - PROFIBUS connection

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

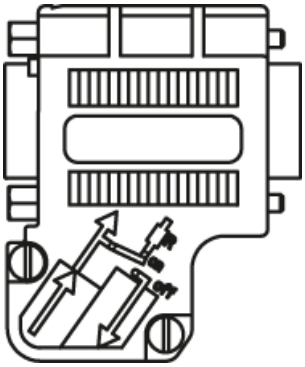
Connectors

Cables must be connected via PROFIBUS connectors because they have the necessary bus terminating resistors.

The figure below shows the correct PROFIBUS connector with and without a PG/PC connector.



PROFIBUS connector
without PG/PC connection
6ES7972-0BA42-0XA0



PROFIBUS connector
with PG/PC connection
6ES7972-0BB42-0XA0

Bus terminating resistor

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

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

The cable shield must contact at both ends with the greatest possible surface area.

Note

Connector type

The proper connector assignment (IN/OUT) in conjunction with the terminating resistor must be observed according to the connector type.

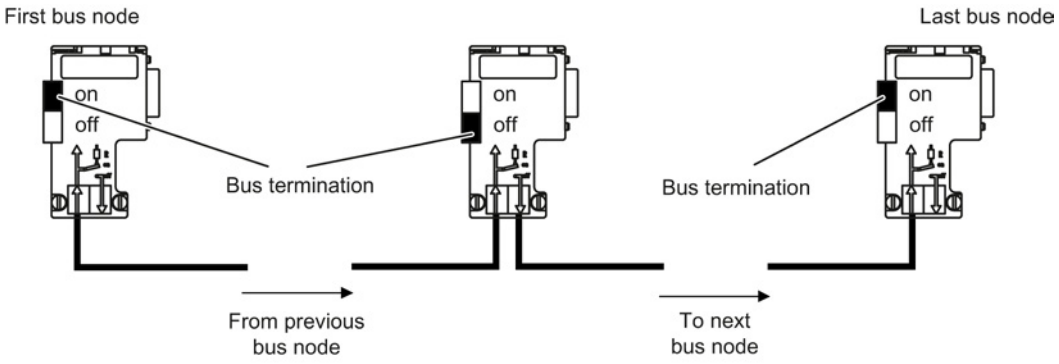


Figure 6-33 Position of the bus terminating resistors

Cable routing

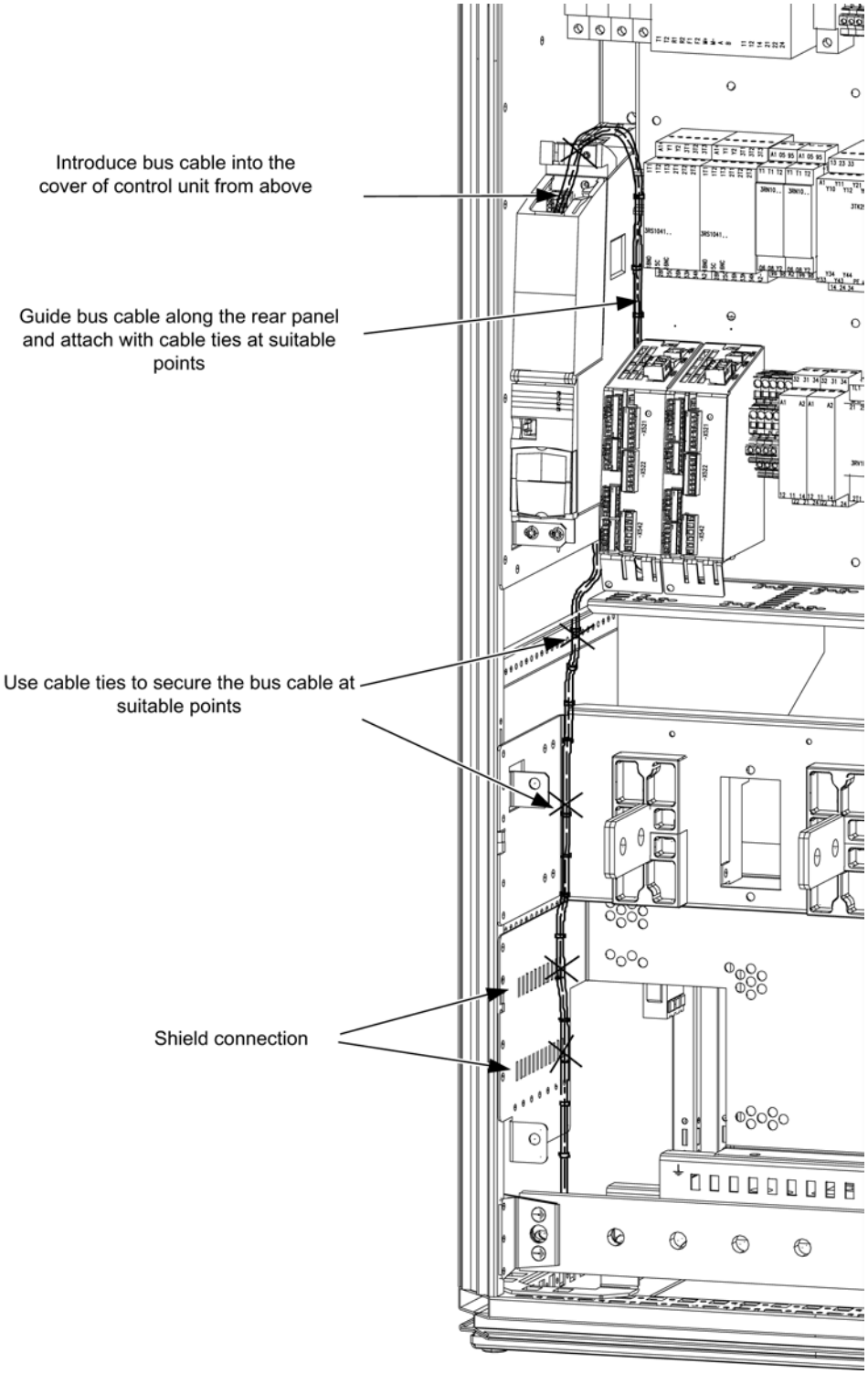


Figure 6-34 Cable routing for Type A cabinets

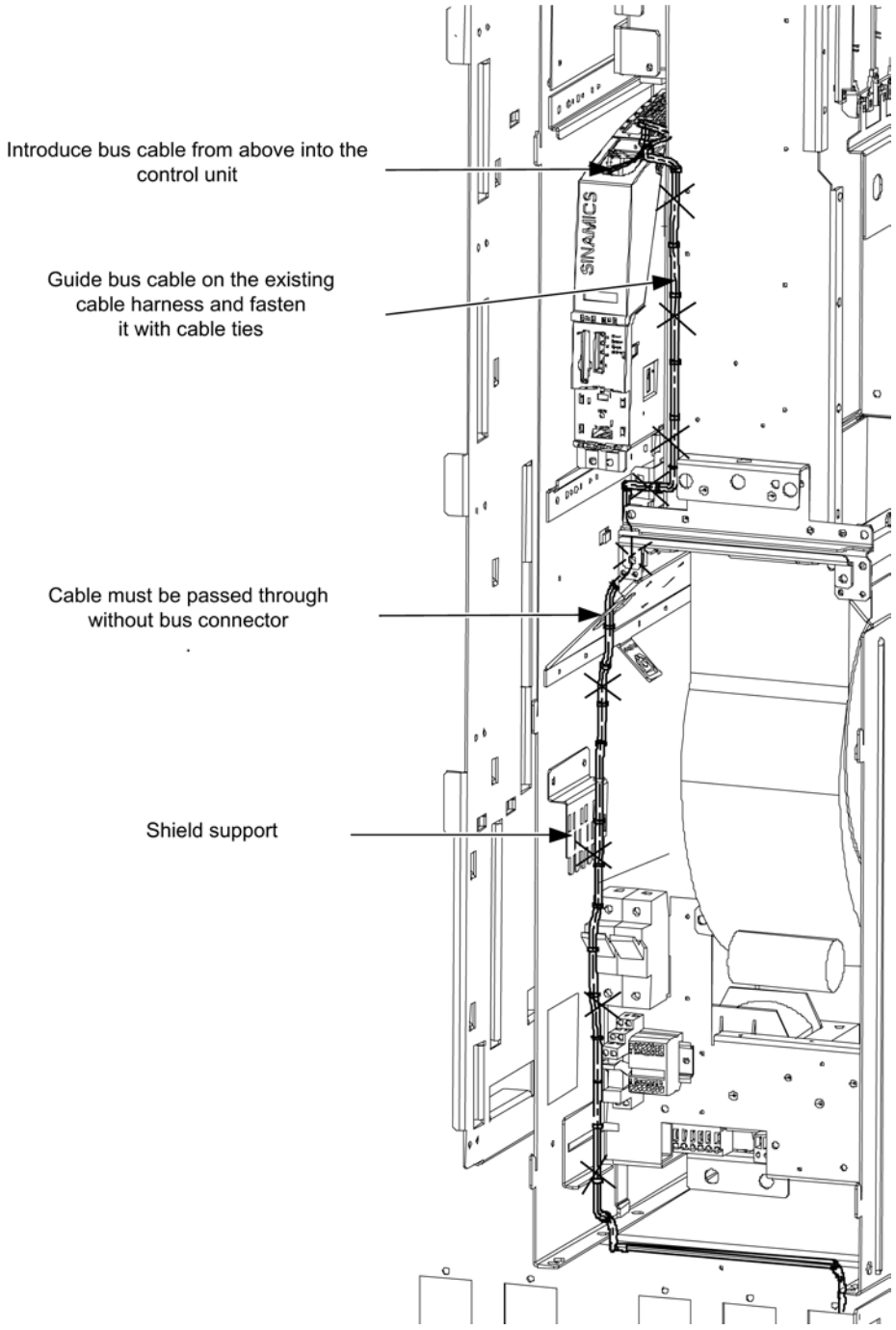


Figure 6-35 Cable routing for Type C cabinets

6.8.2 Control via PROFIBUS

"COM (PROFIdrive)" diagnostics LED

The PROFIBUS diagnostics LED is located on the front of the Control Unit. Its meaning is described in the following table.

Table 6- 26 Description of the "COM" LED

Color	Status	Description
-----	Off	Cyclic communication has not (yet) occured. Note: PROFIdrive is ready for communication when the Control Unit is ready for operation (see RDY LED).
Green	Continuous light	Cyclic communication is taking place.
Green	Flashing 0.5 Hz	Cyclic communication has not yet fully occured. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not transmit a Global Control (GC) or it transmitted an incorrect Global Control.
Red	Flashing 0.5 Hz	PROFIBUS master is sending incorrect parameter assignment/configuration data
Red	Flashing 2 Hz	Cyclic bus communication has been interrupted or could not be established.

Setting the PROFIBUS address

There are two ways to set the PROFIBUS address:

1. Via p0918
   - To set the bus address for a PROFIBUS node using STARTER, first set the rotary code switches to 0_{dec} (00_{hex}) and 127_{dec} ($7F_{hex}$).
   - Then use parameter p0918 to set the address to a value between 1 and 126.
2. Via the PROFIBUS address switches on the Control Unit
   - The address is set manually to values between 1 and 126 using the rotary coding switches. In this case, p0918 is only used to read the address.

Note

The rotary coding switches used to set the PROFIBUS address are located beneath the cover.

Note

Address 126 is used for commissioning. Permitted PROFIBUS addresses are 1 ... 126.

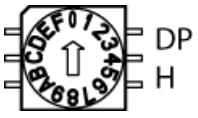
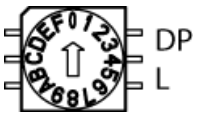
When several Control Units are connected to a PROFIBUS line, you set the addresses differently compared to the the factory setting. Each PROFIBUS address in a PROFIBUS line can only be assigned once. Either set the PROFIBUS address in absolute terms using the rotary coding switches or selectively in parameter p0918. Any change to the bus address takes effect only after a POWER ON.

The currently set address of the rotary coding switch is displayed in parameter r2057.

PROFIBUS address switches

The PROFIBUS address is set as a hexadecimal value via two rotary coding switches. Values between 0_{dec} (00_{hex}) and 127_{dec} ($7F_{hex}$) can be set as the address. The upper rotary coding switch (H) is used to set the hexadecimal value for 16^1, and the lower rotary coding switch (L) is used to set the hexadecimal value for 16^0.

Table 6- 27 PROFIBUS address switches

Rotary coding switches	Significance	Examples		
		21_{dec}	**35_{dec}**	**126_{dec}**
		15_{hex}	**23_{hex}**	**$7E_{hex}$**
	$16^1 = 16$	1	2	7
	$16^0 = 1$	5	3	E

The factory setting for the rotary coding switches is 0_{dec} (00_{hex}).

Setting the PROFIBUS ID number

The PROFIBUS ID number (PNO-ID) can be set using p2042.

SINAMICS can be operated on PROFIBUS with various identities. This allows a PROFIBUS GSD that is independent of the device to be used (e.g., PROFIdrive VIK-NAMUR with ID number 3AA0 hex).

- 0: SINAMICS S/G
- 1: VIK-NAMUR

New settings do not take effect until after POWER ON, reset, or download.

Note

Totally Integrated Automation

The benefits of Totally Integrated Automation (TIA) are only available when "0" is selected.

6.8.3 Monitoring: Message frame failure

Description

There are two cases for monitoring message frame failure:

- Message frame failure with a bus fault

  After a message frame failure and the additional monitoring time has elapsed (p2047), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for an emergency stop, for example.

  Once the delay time (p2044) has elapsed, fault F01910 is output.
  Fault F01910 triggers fault response OFF2 (pulse inhibit) for the infeed and OFF3 (quick stop) in the drive.
  If an OFF response is not required, the fault response can be reconfigured accordingly.

  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIBUS.

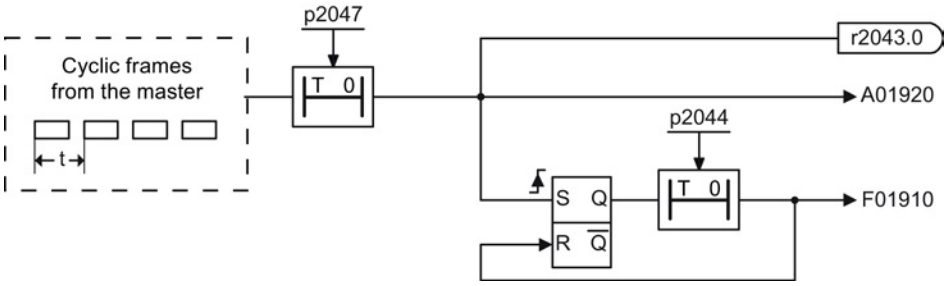


Figure 6-36 Monitoring message frame failure with a bus fault

- Message frame failure with a CPU stop

  After message frame failure, bit r2043.0 is set to "1". Binector output r2043.0 can be used for an emergency stop, for example.

  Once the delay time (p2044) has elapsed, fault F01910 is output.
  Fault F01910 triggers fault response OFF2 (pulse inhibit) for the infeed and OFF3 (quick stop) in the drive.
  If an OFF response is not required, the fault response can be reconfigured accordingly.

  Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIBUS.

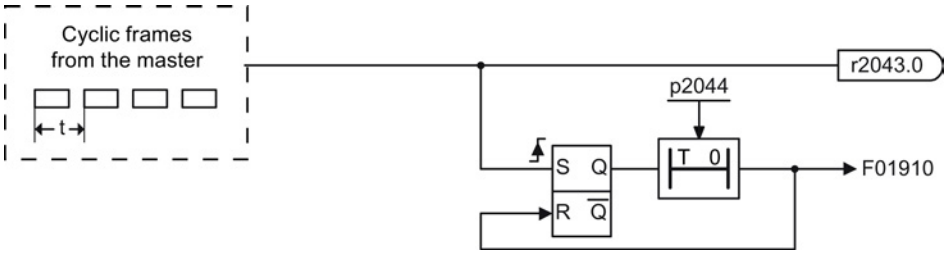


Figure 6-37 Monitoring message frame failure for a CPU stop

6.8.4 Further information about communication via PROFIBUS DP

Further information about communication via PROFIBUS DP

For more information about communication via PROFIBUS DP, refer to "Communication via PROFIBUS DP" in the accompanying "SINAMICS S120 Function Manual".

6.9 Communication via PROFINET IO

6.9.1 Activating online operation: STARTER via PROFINET IO

Description

Online operation with PROFINET IO takes place via TCP/IP.

Requirements

- STARTER Version 4.2 or higher
- Control Unit CU320-2 PN or CBE20

STARTER via PROFINET IO (example)

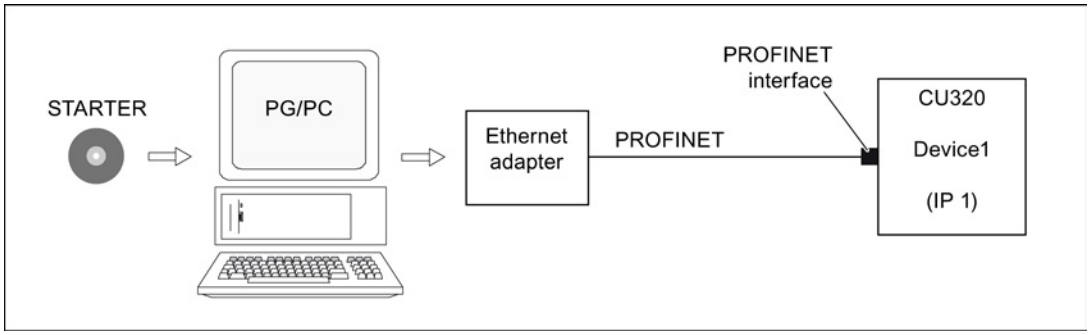


Figure 6-38 STARTER via PROFINET (example)

Procedure, Establishing online operation with PROFINET

1. Setting the IP address in Windows XP

   An available fixed IP address is assigned to the PC/PG.
2. Settings in STARTER
3. Assigning the IP address and the name

   The PROFINET interface must be given a name so that the STARTER can establish communication.
4. Select online operation in STARTER.

Setting 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.

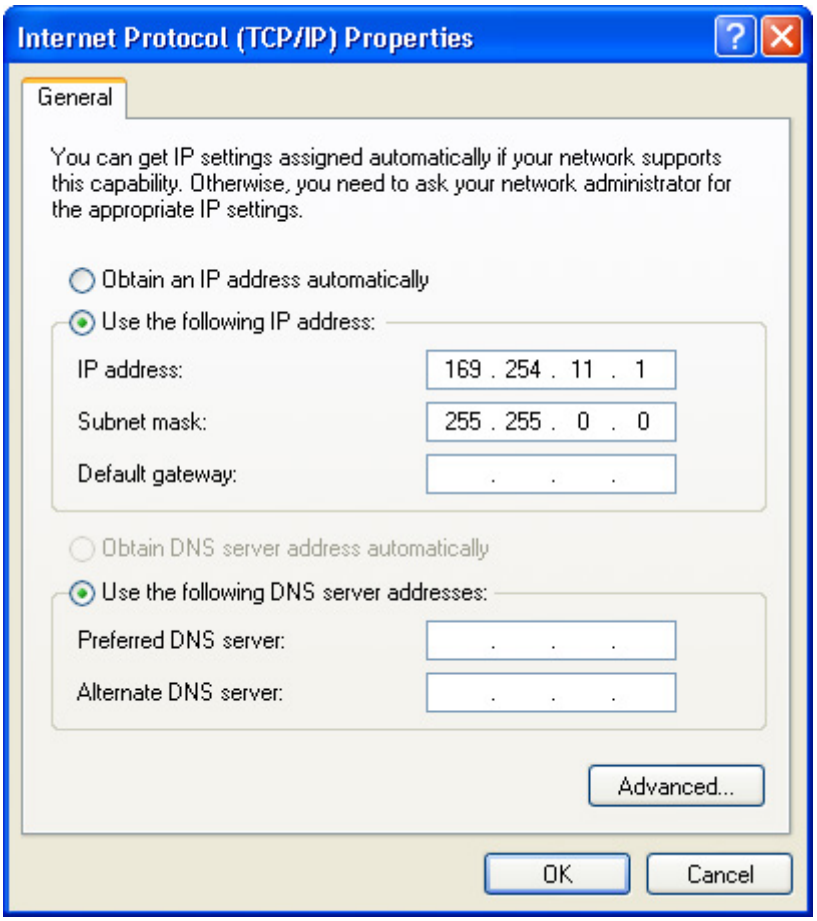


Figure 6-39 Properties of the Internet Protocol (TCP/IP)

Settings in STARTER

The following settings are required in STARTER for communication via PROFINET:

- Tools -> Set PG/PC Interface...

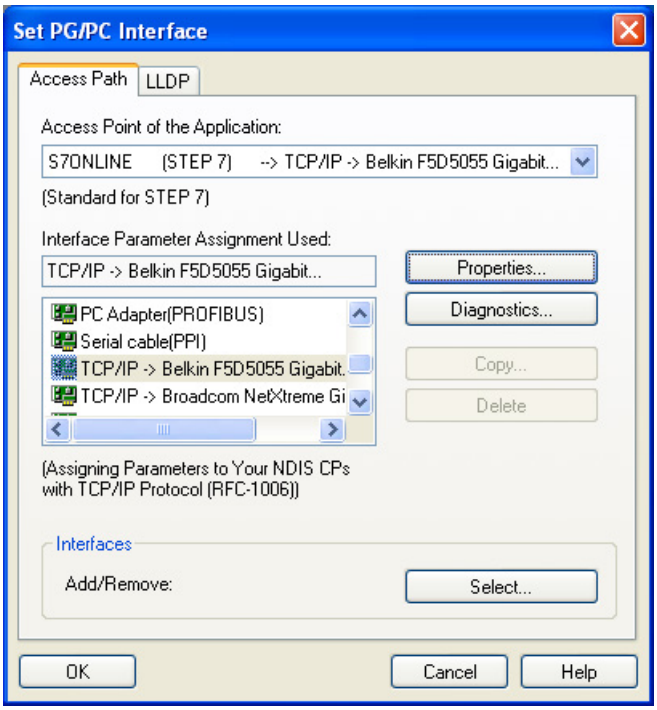


Figure 6-40 Set PG/PC Interface

- Right-click Drive unit -> Target device -> Online access -> Module address

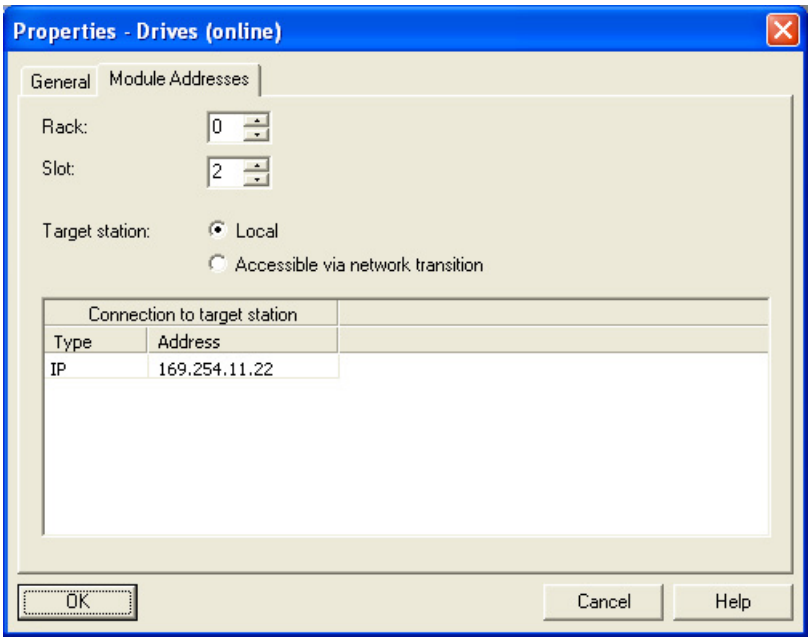


Figure 6-41 Establishing online access

Assigning the IP address and the name

Note

Naming devices

ST (Structured Text) conventions must be satisfied for the name assignment of IO Devices in PROFINET (SINAMICS components). The names must be unique within PROFINET.
The characters "-" and "." are not permitted in the name of an IO device.

Assignment with STARTER, "Accessible nodes" function

Use the STARTER to assign an IP address and a name to the PROFINET interface.

- Connect the direct Ethernet cable from the PG/PC to the PROFINET interface.
- Switch on the Control Unit.
- Open STARTER.
- A search is performed for available nodes in PROFINET via Project -> Accessible nodes or the "Accessible nodes" button.
- The SINAMICS drive object is detected and displayed as a bus node with IP address 0.0.0.0 and without a name.
- Mark the bus node entry and select the displayed menu item "Edit Ethernet node" with the right mouse button.
- In the following "Edit Ethernet node" screen, enter the device name for the PROFINET interface and click the "Assign name" button. Enter the IP address (e.g., 169.254.11.22) in the IP configuration and specify the subnet mask (e.g., 255.255.0.0). Then click the "Assign IP configuration" button. Close the screen.
- The "Update (F5)" button displays the IP address and name in the entry for the bus node. If not, close the "Accessible nodes" screen and perform another search for accessible nodes.
- If the PROFINET interface is displayed as a bus node, select the entry and click the "Accept" button.
- The SINAMICS drive is displayed as a drive object in the project tree.
- Further configurations can be performed for the drive object.
- Click "Connect to target system" and load the project to the Control Unit's memory card with Target system -> Load -> To target device.

Note

Storage location of the IP address

The IP address and device name for the Control Unit are stored on the memory card (non-volatile).

6.9.2 General information about PROFINET IO

6.9.2.1 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.

Deterministic signal processing in real time is important in industrial networks. PROFINET IO satisfies these requirements.

The international standard IEC 61158 ensures vendor neutrality and openness.

PROFINET IO is optimized for high-speed, time-critical data transmissions at field level.

PROFINET IO

Within the context of Totally Integrated Automation (TIA), PROFINET IO is the systematic development of the following systems:

- PROFIBUS DP, the established fieldbus
- Industrial Ethernet, the communication bus for the cell level

Experience gained from both systems was integrated into PROFINET IO. An Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS Nutzerorganisation e. V.), PROFINET IO is a manufacturer-independent 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. A PROFINET IO system is configured by virtually the same method used for PROFIBUS.

A PROFINET IO system is assembled from the following devices:

- The IO controller controls automation tasks.
- An IO device is controlled and monitored by an IO controller. An IO device can consist of several modules and submodules.
- An IO supervisor is an engineering tool, typically based on a PC, to configure e and diagnose the individual IO devices (drive units).

IO devices: Drive units with PROFINET interface

- SINAMICS G150 with CU320-2 DP and inserted CBE20
- SINAMICS G150 with CU320-2 PN

With SINAMICS G150 and CBE20 or with CU320-2 PN, communication via PROFINET IO with RT is possible.

Note

CU320-2 DP and inserted CBE20

The cyclic process data channel for PROFIBUS DP is initially deactivated for CU320-2 DP and inserted CBE20. However, it can be activated again with parameter p8839 = 1 (see "Parallel operation of communication interfaces").

References

Note

References

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,

76131 Karlsruhe, Germany

http://www.profibus.com,

Order no. 3.172, spec. Section 6

- IEC 61800-7

6.9.2.2 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

When communication is via TCP/IP, runtimes may occur that are too long and are not defined for the requirements of production automation. When communicating time-critical IO user data, PROFINET IO therefore uses its own real-time channel, rather than TCP/IP.

Real time means that a system processes external events over a defined period.

Determinism

Determinism means that a system will react in a predictable ("deterministic") manner. With PROFINET IO with IRT, it is possible to precisely determine (predict) the transmission instant.

PROFINET IO with RT (Real Time)

Real-time data is treated with a higher priority than TCP(UDP)/IP data. Transmission of time-critical data takes place at guaranteed time intervals. RT communication provides the basis for PROFINET IO data exchange.

PROFINET IO with IRT (Isochronous Real Time)

Isochronous Real Time: Real time property of PROFINET IO in which IRT frames are transmitted deterministically and via planned communication paths in a defined sequence to achieve the best possible synchronism and performance between the IO controller and IO device (drive unit). IRT is also known as scheduled communication in which knowledge about the network structure (topology) is utilized. IRT requires special network components that support scheduled data transmission.

SINAMICS cycle times of minimum 250 µs (onboard)/500 µs (CBE20) and a jitter accuracy of less than 1 µs are achieved with this transmission method.

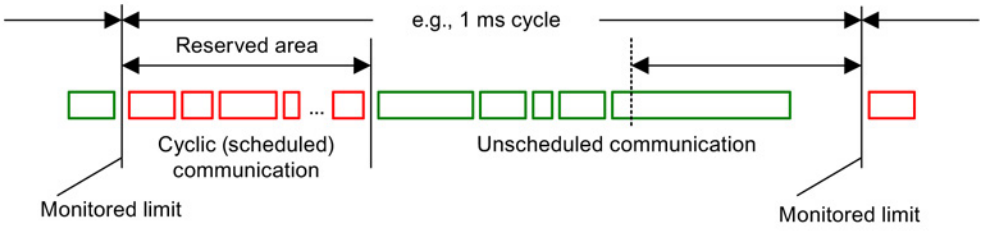


Figure 6-42 Bandwidth distribution/reservation, PROFINET IO

6.9.2.3 Addresses

MAC address

Every Ethernet and PROFINET interface is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address consists of:

- 3-byte manufacturer identification
- 3-byte device identification (consecutive number)

The MAC address is printed on a label (CBE20) or specified on the type plate (CU320-2 PN), e.g.: 08-00-06-6B-80-C0.

The Control Unit CU320-2 PN has two onboard interfaces:

- One Ethernet interface
- A PROFINET interface with two ports

The two MAC addresses of the Ethernet and PROFINET interfaces are stamped on the type plate.

IP address

The TCP/IP protocol is a prerequisite for establishing a connection and for parameter assignment. For 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 a period. The IP address comprises:

- the address of the node (also called host or network node)
- the address of the (sub) network.

IP address assignment

The IP addresses of IO devices can be assigned by the IO controller and always have the same subnet mask as the IO controller. In this case, the IP address is not stored permanently. The IP address entry is lost after POWER ON/OFF. The IP address can be assigned retentively via the STARTER function "Accessible nodes".

This function can also be performed in STEP 7 HW Config. Here, the function is called "Edit Ethernet node".

Note

IP addresses of the onboard interfaces

It is not permissible that the IP address band of the Ethernet interface and the PROFINET interface are the same. The factory setting of the IP address of the Ethernet interface X127 is 169.254.11.22; the subnet mask is 255.255.0.0.

Note

Part of a company network

If the network is part of an existing Ethernet company network, obtain the information (IP address) from your network administrator.

Device name (NameOfStation)

An IO device does not have a device name upon delivery. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

Note

Non-volatile saving of the device name

The device name must be stored retentively either with STARTER or with HW Config of STEP 7.

Note

Address data for ports

You can enter the address data for the internal PROFINET ports X150 P1 and P2 in STARTER in the expert list using parameters p8920, p8921, p8922, and p8923.

You can enter the address data for the ports of the CBE20 module in STARTER in the expert list using parameters p8940, p8941, p8942, and p8943.

Replacement of Control Unit (IO device)

If the IP address and device name are stored in non-volatile memory, this data is also forwarded with the memory card of the Control Unit. The memory card allows the module to be replaced without an IO supervisor when a fault occurs in a PROFINET device.

If an entire Control Unit needs to be replaced due to a device or module defect, the new Control Unit automatically carries out parameter assignment and configuration based on the data on the memory card. Following this, cyclic exchange of user data is restarted.

6.9.2.4 Data transmission

Properties

The Communication Board CBE20 supports:

- IRT – isochronous real-time Ethernet
- RT – real-time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive frame for cyclic data transmission, acyclic services

Message frames for sending and receiving 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 parameter assignment and configuration of the drive. These acyclic services can be utilized by the IO supervisor or IO controller.

Sequence of drive objects in the message frame

On the drive side, the sequence of drive objects in the message frame is displayed via a list in p0978[0...24] where it can also be changed.

You can use the STARTER commissioning tool to display the sequence of drive objects for a commissioned drive system in online mode under "Drive unit" > "Communication" > "Message frame configuration".

When you create the configuration on the controller side (e.g. HW Config), the process-data-capable drive objects for the application are added to the message frame in this sequence.

Note

Order of the drive objects

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

Drive objects after the first zero in p0978 must not be configured in HW Config.

The frame structure depends on the drive objects taken into account during configuration. Configurations that do not take into account all of the drive objects present in the drive system are permitted.

6.9.2.5 Communication channels

PROFINET connection channels

- A Control Unit has an integrated Ethernet interface (X127).
- The Control Unit CU320-2 PN has a PROFINET interface (X150) with two ports onboard: P1 and P2
- A Control Unit CU320-2 PN can establish a total of 8 communication connections simultaneously via the integrated PROFINET interfaces.

Control Unit with CBE20

The CBE20 communication board can be optionally inserted into Control Unit CU320-2 PN or CU320-2 DP:

- The Communication Board CBE20 is a PROFINET switch with 4 additional PROFINET ports.

Note

PROFINET routing

Routing is not possible between the onboard interfaces X127 and X150 of the CU320-2 PN or between the onboard interfaces of the CU320-2 PN and an inserted CBE20.

6.9.3 PROFIenergy

6.9.3.1 Description

PROFIenergy is an energy management system for production plants, based on the PROFINET communication protocol. The functionality is certified in the PROFIenergy profile of the PNO. Drive units which have PROFIenergy functionality, can be certified in an approved laboratory. Certified devices support the PROFIenergy commands and respond accordingly to the requirements and operating states.

SINAMICS supports PROFIenergy profile V1.1. PROFIenergy commands are transferred from the controller to the drive with PROFINET data sets in acyclic operation. The PROFIenergy commands are transferred using the PROFINET data set 0x80A0.

The following table provides an overview of the PROFIenergy functionality and the support of the various SINAMICS devices.

Functions		SINAMICS support								
		S120 SERVO	S120 VECTOR	S150	G110M	G120D	G120x (other not G120D)	G130	G150	ET200 pro FC-2
Control commands		X	X	X	X	X	X	X	X	X
Query commands		X	X	X	X	X	X	X	X	X
Measured values	ID 34	X	X	X	X	X	X	X	X	X
	ID 166	–	X	X	X	X	X	X	X	X
	ID 200	X	X	X	X	X	X	X	X	X
Measurement value access		X	X	X	X	X	X	X	X	X
PROFIenergy energy saving mode 1	Switch off digital outputs	–	–	–	–	X	–	–	–	–
	Switch-off encoders	–	–	–	–	X	–	–	–	–
PROFIenergy energy saving mode 2	Start precondi-tioning circuit	X	X	X	X	–	X	X	X	X
Disable PROFIenergy		X	X	X	X	X	X	X	X	X
PROFIenergy energy saving mode in PROFIdrive state S4		–	–	–	X	X	X	X	X	X

Figure 6-43 PROFIenergy functions

6.9.3.2 Tasks of PROFIenergy

PROFIenergy is a data interface based on PROFINET. It allows loads to be shut down during non-operational periods in a controlled fashion, and irrespective of the manufacturer and device. Consequently, the process should be given only the energy it actually requires. The majority of the energy is saved by the process, the PROFINET device itself contributes only a few watts to the saving potential.

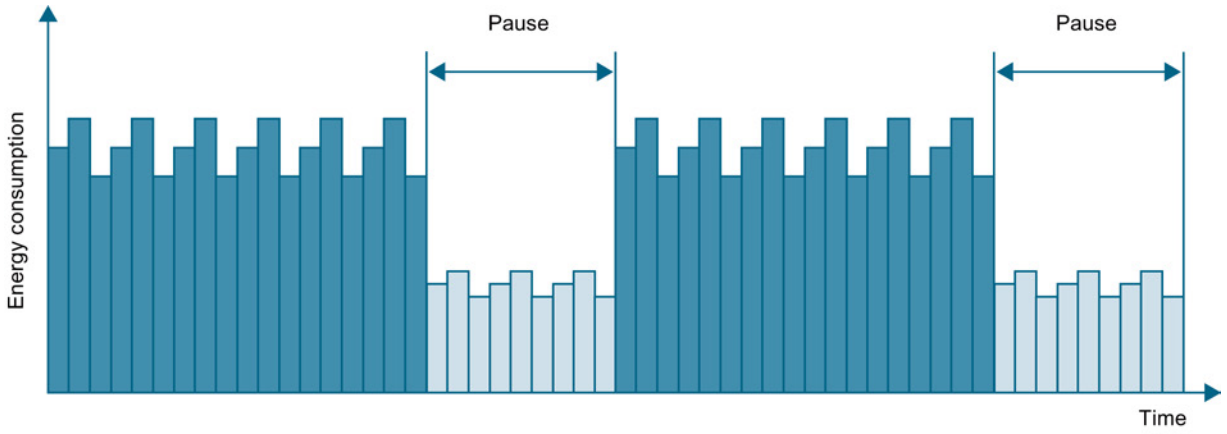


Figure 6-44 Energy saving during pauses with PROFIenergy

The following objectives are reached in detail by temporarily shutting down or stopping unused drives and equipment:

- Lower energy costs.
- Reduction of thermal emissions.
- Longer service life by reducing the effective operating times.
- The drive units provide standardized consumption data for analysis.
- The PROFIenergy state of the participating devices is displayed.
- The PROFIenergy state is available with BICO interconnections for further processing, e.g. to shutdown secondary systems that are not required.

Basics

The PROFINET devices and the power modules are shut down using special commands in the user program of the PROFINET IO controller. No additional hardware is required; the PROFIenergy commands are interpreted directly by the PROFINET devices.

6.9.3.3 PROFIenergy - Properties of the drive system

SINAMICS drive system devices meet the following requirements:

- The devices are certified for PROFIenergy.
- The devices support the PROFIenergy Class 3 functional unit.
- The devices support the PROFIenergy energy-saving mode 2.

6.9.3.4 PROFIenergy - Commands

Principle of operation

At the start and end of pauses, the plant operator activates or deactivates the pause function of the plant after which the IO controller sends the PROFIenergy "START_Pause" / "END_Pause" command to the PROFINET devices. The device then interprets the content of the PROFIenergy command and switches off or on again.

Further PROFIenergy functions can be used to fetch device information during the pauses. The user can use them to transfer the "START_Pause" / "END_Pause" command in time.

PROFIenergy control commands

Control commands	Description
START_Pause	Switches from the operating state to the energy-saving mode depending on the pause duration. Switches from the energy-saving mode to the operating state depending on the pause duration.
START_Pause_with_time_response	Switches from the operating state to the energy-saving mode and also specifies the transition times in the command response.
END_Pause	Switches from the energy-saving mode to the operating state. Cancels a switch from the operating state to the energy-saving mode.

PROFIenergy query commands

Query commands	Description
List_Energy_Saving_Modes	Determines all supported energy-saving modes.
Get_Mode	Determines the energy-saving mode.
PEM_Status	Determines the current PROFIenergy status.
PEM_Status_with_CTTO	Determines the current PROFIenergy status, such as the PEM status and together with the regular transition time to the operating state.
PE_Identify	Determines the supported PROFIenergy commands.
Query_Version	Shows the implemented PROFIenergy profile.
Get_Measurement_List	This command returns the measured value IDs that can be accessed using the "Get_Measurement_Values" command.
Get_Measurement_List_with_object_number	This command returns the measured value IDs and the associated object number that can be accessed using the "Get_Measurement_Values_with_object_number" command.
Get_Measurement_Values	The command returns the requested measured value using the measured value ID: • For power measured values: The command addresses the sum of the measured value over all control drive objects. • For energy measured values: The command returns the sum of the measured value over all control drive objects. • For power factors: This measured value is supported only for a SINAMICS with a control drive object.
Get_Measurement_Values_with_object_number	This command returns the measurement values requested using the measurement value ID and the object number. The object number corresponds to the drive object ID. The drive object ID of the Control Unit is used to address the measured values as with "Get_Measurement_Value".

6.9.3.5 PROFIenergy - Measurement values

Table 6- 28 Overview of the PROFIenergy measured values

PROFIenergy measured value ID	PROFIenergy measured value	Unit	SINAMICS source parameters	SINAMICS source parameters Name	PROFIenergy accuracy		Value range
					Domain	Class	
34	Active power	W	r0032	Active power smoothed	1	12	Largest value for r2004 of all drive objects
166	Power factor	1	r0038	Smoothed power factor	1	12	0 ... 1
200	Active energy import	Wh	r0039[1]	Energy accepted	2	11	-

6.9.3.6 PROFIenergy - Energy-saving mode

The drive devices support the PROFIenergy energy-saving mode 2. The following two parameters indicate the effective PROFIenergy mode:

- Parameter r5600 indicates the currently active PROFIenergy mode.
- Using interconnectable bits, the r5613 parameter indicates whether the PROFIenergy energy saving is active.

The energy-saving mode can activated or deactivated for the drive devices using the PROFIenergy control commands (see also PROFIenergy commands).

The active energy-saving mode is indicated with alarm A08800.

The energy-saving mode also remains active in the drive units when the following events occur:

- PROFINET disconnection
- CPU goes to STOP

While the PROFIenergy energy-saving mode is active, all diagnostic alarms are switched off in the drive device. These alarms are therefore not sent during energy-saving mode.

6.9.3.7 Transition to energy-saving mode from PROFIdrive Operation state (S4)

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

To do so, you must make one of the following settings:

- p5611.1 = 1: with the transition to energy-saving mode, the drive issues an OFF1 command and enters the Switching On Inhibited state (S1).
- p5611.1 = 0: You use p5614 to interconnect a signal source that you use to switch off the drive and place it in Switching On Inhibited state (S1).

If the controller sends the "End_Pause" or "Start_Pause" command with a pause time of 0, the drive starts up automatically again – if the enables are still set.

6.9.3.8 Disabling PROFIenergy

The parameter setting p5611.0 = 1 can be used to disable PROFIenergy in the drive unit. This causes the control commands to be ignored.

6.9.3.9 PROFIenergy applications

Applications for PROFIenergy and for programming with SIMATIC S7 are available at the following link: PROFIenergy applications (http://support.automation.siemens.com/WW/view/en/20229805/136000&cspltfrm=12&cssw=0&csbinh=0).

6.9.3.10 Function diagrams and parameters

Function diagram

FP 2381	PROFIenergy - Control commands / query commands
FP 2382	PROFIenergy - States
FP 2610	Sequence control - Sequencer

Parameters

- r5600 Pe hibernation ID
- p5602[0...1] Pe hibernation pause time, minimum
- p5606[0...1] Pe hibernation duration, maximum
- p5611 Pe energy-saving properties, general
- p5612[0...1] Pe energy-saving properties, mode-dependent
- r5613.0...1 CO/BO: Pe energy-saving active/inactive

6.9.4 Further information about communication via PROFINET IO

Further information about communication via PROFINET IO

For more information about communication via PROFINET IO, refer to "Communication via PROFINET IO" in the accompanying "SINAMICS S120 Function Manual".

6.10 Communication via SINAMICS Link

6.10.1 Basic principles of SINAMICS Link

SINAMICS Link allows data to be directly exchanged between a maximum of 64 Control Units (CU320-2 PN and CU320-2 DP). The participating Control Units must be equipped with the CBE20 supplementary module. Other nodes cannot be integrated into this communication.

Possible applications include:

- 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

Requirements

The following requirements must be met to operate SINAMICS Link:

- r2064[1]: The bus cycle time (T_{dp}) must be an integer multiple of p0115[0] (current controller cycle).
- r2064[2]: The master cycle time (T_{mapc}) must be an integer multiple of p0115[1] (speed controller cycle).
- p0115[0]: The current controller cycle must be set to 250 µs or 500 µs. A cycle with 400 µs is not permitted. At 400 µs, alarm A01902 is output with alarm value "4". To remedy this, set the current controller cycle p0115[0] to 500 µs.

Send and receive data

The SINAMICS Link message frame contains 16 slots (0...15) for the process data (PZD1...16). Each PZD is exactly 1 word long (= 16 bits). Slots that are not required are automatically filled with zeros.

Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PZD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

SINAMICS Link message frame contents

Each transfer cycle, every SINAMICS Link node can send 1 message frame with 16 PZD. Each node receives all of the message frames that are sent. For each transfer cycle, a node can select and process up to 16 PZD from all message frames that have been received. Single words and double words can be sent and received. You must write double words in two consecutive PZD.

Limitations:

- In a message frame, a PZD may only be sent and received once. If a PZD occurs more than once in a message frame, then alarm A50002 or A50003 is output.
- Reading in of a node's own transmit data is not possible; otherwise alarm A50006 is output.
- The maximum number of PZD that can be received and sent also depends on the drive object. The number of PZD that can be evaluated corresponds to communication according to PROFIdrive; however, for SINAMICS Link, it is limited to a maximum of 16 PZD.

Transmission time

With SINAMICS Link, a transfer time of up to 1000 µs is possible (with a max. controller cycle of 500 µs; synchronous bus cycle of 500 µs).

Bus cycle and number of nodes

The bus cycle of the SINAMICS Link may be operated either synchronized with the current controller cycle or not synchronized.

- Synchronized operation is set with p8812[0] = 1.

  Up to 16 nodes can communicate with each other via SINAMICS Link with a 500 µs bus cycle. To do this, the maximum number of nodes must be set with p8811 = 16.

  Up to 64 nodes can communicate with each other via SINAMICS Link with a 1000 µs or 2000 µs bus cycle. To do this, the maximum number of nodes must be set with p8811 = 64.
- In non-synchronized operation (p8812[0] = 0), the PZD sampling time (p2048/p8848) is active instead of the bus cycle (p8812[1]).

After changing over parameter p8811 and p8812, a POWER ON must be carried out to accept the settings.

6.10.2 Topology

Only a line topology with the following structure is permitted for SINAMICS Link.

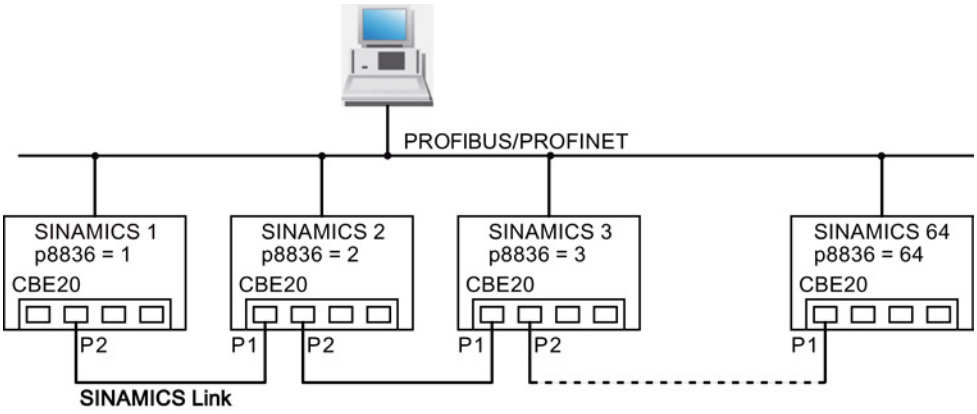


Figure 6-45 Maximum topology

Features

The CBE20 can also be assigned to IF1 or IF2 when SINAMICS Link is used.

IF2 should be used for SINAMICS Link because IF1 supports PROFIdrive conformity. However, IF2 must be switched to synchronous operation for this.

The following parameter settings must be made:

- For IF1: p8839[0] = 1 (Control Unit onboard)
- For IF2: p8839[1] = 2 (COMM BOARD)
- For isochronous mode: p8815[0] = 2 (IF2)

Settings

The following entries must be made in the expert list of the Control Units:

- The number of the respective node must be entered manually in parameter p8836. A different number must be assigned for each node.
  Enter the numbers is ascending order, starting with "1".
- If p8836 = 0 is set, the node and the complete following line is switched off for SINAMICS Link.
- Gaps in the numbering are not permitted.
- The associated IP addresses are assigned automatically and are visible in r8951.
- The node with the number 1 is automatically the sync master of the communication link.
- For non-synchronized operation (p8812[0] = 0), a maximum of 64 nodes is possible (p8811 = 64).

- With synchronized operation (p8812[0] = 1), up to 16 nodes (p8811 = 16) are possible with a 500 µs bus cycle and up to 64 nodes (p8811 = 64) with a 1000 µs or 2000 µs bus cycle.
- For the CBE20 connection, the ports must always be used as shown in the diagram above. This means that Port 2 (P2) of node **n** is always connected with Port 1 (P1) of node **n+1**.
- Ports 3 and 4 of the CBE20 are disabled for communication via SINAMICS Link.

6.10.3 Configuring and commissioning

Commissioning

When commissioning, proceed as follows:

1. Set the Control Unit parameter p0009 = 1 (device configuration).
2. Set the Control Unit parameter p8835 to 3 (SINAMICS Link).
3. Set parameter p2037 of the drive objects to 2 (do not freeze setpoints).
4. Using parameter p8836, assign node numbers to the nodes (the first Control Unit is always assigned the number 1). Observe the specifications under "Topology". Node number 0 means that SINAMICS Link is shut down.
5. Set the Control Unit parameter p0009 = 0 (ready).
6. Then execute a "Copy RAM to ROM".
7. Perform a POWER ON (switch-off/switch-on).

Sending data

In this example, the first node "Control Unit 1" has two drive objects: "Drive 1" and "Drive 2". Proceed as follows to send data:

1. For each drive object, in its associated parameter p2051[0...15], define which data (PZD) is to be sent. The data is simultaneously reserved in the send slot of the p8871[0...15].
2. You must enter double words in p2061[x]. Double word data is simultaneously written to p8861[0...15].
3. For each drive object, assign the send parameters in p8871[0...15] to a send slot of its own node.

Table 6- 29 Compiling send data of drive 1 (DO2)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	PZD
0	-	STW1	r0899	0	PZD 1
-	1	Actual speed value part 1	r0061[0]	1	PZD 2
-		Actual speed value part 2		2	PZD 3
-	3	Actual torque value part 1	r0080	3	PZD 4
-		Actual torque value part 2		4	PZD 5
5	-	Current fault code	r2131	5	PZD 6
...		...		...	...
15	-	0	0	15	PZD 16

Table 6- 30 Compiling send data of drive 2 (DO3)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	PZD
0	-	STW1	r0899	6	PZD 7
-	1	Actual speed value part 1	r0061[0]	7	PZD 8
-		Actual speed value part 2		8	PZD 9
-	3	Actual torque value part 1	r0080	9	PZD 10
-		Actual torque value part 2		10	PZD 11
5	-	Current fault code	r2131	11	PZD 12
...		...		...	...
15	-	0	0	15	PZD 16

Table 6- 31 Compiling send data of Control Unit 1 (DO1)

p2051[x] Index	p2061[x] Index	Contents	From parameter	Slots in the send buffer p8871[x]	
				x	PZD
0	-	Control word, faults/alarms	r2138	12	PZD 13
-	1	Missing enables part 1	r0046	13	PZD 14
-		Missing enables part 2		14	PZD 15
15	-	0	0	15	PZD 16

Send slot PZD 16 is not required for this frame and is therefore filled with a zero.

1. Double words (e.g., 1 + 2) are assigned two consecutive send slots, e.g., p2061[1] => p8871[1] = PZD 2 and p8871[2] = PZD 3.
2. Enter the following PZD into the next parameter slots of p2051[x] or p2061[2x].

3. Unused slots of p8871[0...15] are filled with zeros.
4. The order of the PZDs in the send frame of this node is defined in parameter p8871[0...15] by the entries in the required slots.
5. The frame is sent during the next bus cycle.

Receiving data

The sent frames of all nodes are simultaneously available on the SINAMICS Link. Each frame has a length of 16 PZDs. Each frame bears a marking of the sender. For each node, you select from all frames the PZDs that you want to receive. You can process a maximum of 16 PZDs.

Note

The first word of the receive data

If you have not deactivated the evaluation of bit 10 with p2037 = 2, the first word of the receive data (PZD 1) must be a control word, where bit 10 = 1 is set.

In this example, Control Unit 2 receives all data from the frame of Control Unit 1. Proceed as follows to receive data:

1. In parameter p8872[0…15], enter the address of the node from which you want to read one or more PZDs (e.g., p8872[3] = 1 → from node 1, read in PZD 4, p8872[15] = 0 → do not read in PZD 16).
2. After setting the parameters, you can read out the values via parameters r2050[0…15] or r2060[0…15].

Table 6- 32 Receive data for Control Unit 2

From the sender		Receiver					
Sent from	Frm.word p8871[x]	Address p8872[x]	Receive buffer p8870[x]	Data sent to		Parameter	Contents
				r2050[x]	r2060[x]		
p2051[0]	0	1	PZD 1	0	-	r0899	STW1
p2061[1]	1	1	PZD 2	-	1	r0061[0]	Actual speed value part 1
	2	1	PZD 3	-		r0061[0]	Actual speed value part 2
p2061[3]	3	1	PZD 4	-	3	r0080	Actual torque value part 1
	4	1	PZD 5	-			Actual torque value part 2
p2051[5]	5	1	PZD 6	5	-	r2131	Current fault code
p2051[4]	6	1	PZD 7	6	-	r0899	STW1
p2061[5]	7	1	PZD 8	-	7	r0061[0]	Actual speed value part 1
	8	1	PZD 9	-			Actual speed value part 2
p2061[6]	9	1	PZD 10	-	9	r0080	Actual torque value part 1
	10	1	PZD 11	-			Actual torque value part 2
p2051[7]	11	1	PZD 12	11	-	r2131	Current fault code

From the sender		Receiver					
Sent from	Frm.word p8871[x]	Address p8872[x]	Receive buffer p8870[x]	Data sent to		Parameter	Contents
				r2050[x]	r2060[x]		
p2051[8]	12	1	PZD 13	12	-	2138	Control word, faults/alarms
p2061[9]	13	1	PZD 14	-	13	r0046	Missing enables part 1
	14	1	PZD 15	-			Missing enables part 2
-	15	0	PZD 16	15	-	0	Empty

Frm. word = frame word

Note

For double words, two PZDs must be read in succession. Read in a 32-bit setpoint that is located at PZD 2+PZD 3 of the frame of node 2, and map this to PZD 2+PZD 3 of node 1: p8872[1] = 2, p8870[1] = 2, p8872[2] = 2, p8870[2] = 3

Activation

To activate SINAMICS Link connections, perform a POWER ON for all nodes. The assignments of p2051[x]/2061[2x] and the links of the read parameters r2050[x]/2060[2x] can be changed without a POWER ON.

Settings for enclosed drives with 1.25 kHz rated pulse frequency

For the following enclosed drives with 1.25 kHz rated pulse frequency must also the set parameter p0115[0] from 400 µs to 250 µs or 500 µs can be set:

- 380 - 480 V AC, 3 phase: All enclosed drives with rated output current $I_N \geq 605$ A
- 500 - 600 V AC, 3 phase: All enclosed drives

The following conditions must be generally met:

1. r2064[1] Bus cycle time (Tdp) must be an integer multiple of p0115[0] (current controller clock cycle).
2. r2064[2] Master cycle time (Tmapc) must be an integer multiple of p0115[1] (speed control cycle).

6.10.4 Example

Task

Configure SINAMICS Link for two nodes and the transfer of the following values:

- Send data from node 1 to node 2
  - r0898 CO/BO: Control word sequence control drive 1 (1 PZD), in the example PZD 1
  - r0079 CO: Total torque setpoint (2 PZD), in the example PZD 2
  - r0021 CO: Smoothed actual speed (2 PZDs), in the example PZD 3
- Send data from node 2 to node 1
  - r0899 CO/BO: Status word sequence control drive 2 (1 PZD), in the example PZD 1

Procedure

1. For all nodes, set p0009 = 1, in order to change the device configuration.
2. For all CBE20 nodes, set the "SINAMICS Link" mode using p8835 = 3.
3. Assign the node numbers for the devices involved:
   - Node 1: p8836 = 1 and
   - Node 2: p8836 = 2
4. For both nodes, set p0009 = 0, perform "Copy RAM to ROM" followed by a POWER ON.
5. You can set all CBE20 to isochronous mode with p8812[0] = 1.
6. Make the following interface setting for all nodes:
   - For IF1: p8839[0] = 2 (COMM BOARD)
   - For IF2: p8839[1] = 1 (Control Unit onboard)
7. Limit the maximum number of nodes for all nodes with p8811 = 16.
8. For both nodes, set p0009 = 0, perform "Copy RAM to ROM" followed by a POWER ON to activate the modified firmware variant and the new settings in the CBE20.
9. Define the send data for node 1:
   - Define the PZD that node 1 is to send:
     p2051[0] = drive1:r0898 (PZD length is 1 word)
     p2061[1] = drive1:r0079 (PZD length is 2 words)
     p2061[3] = drive1:r0021 (PZD length is 2 words)
   - Place this PZD in the send buffer (p8871) of node 1:
     p8871[0] = 1 (r0898)
     p8871[1] = 2 (r0079 1st part)
     p8871[2] = 3 (r0079 2nd part)
     p8871[3] = 4 (r0021 1st part)
     p8871[4] = 5 (r0021 2nd part)

10. Define the receive data for node 2:
    - Specify that the data placed in the receive buffer p8872 of node 2 in locations 0 to 4 will be received by node 1:

      p8872[0] = 1
      p8872[1] = 1
      p8872[2] = 1
      p8872[3] = 1
      p8872[4] = 1
    - Specify that PZD1, PZD2, and PZD3 of node 1 will be placed in the receive buffer p8870 of node 2 in locations 0 to 4:

      p8870[0] = 1 (PZD1)
      p8870[1] = 2 (PZD2 1st part)
      p8870[2] = 3 (PZD2 2nd part)
      p8870[3] = 4 (PZD3 1st part)
      p8870[4] = 5 (PZD3 2nd part)
    - r2050[0], r2060[1], and r2060[3] now contain the values of PZD 1, PZD 2, and PZD 3 of node 1.
11. Define the send data for node 2:
    - Specify the PZDs that node 2 is to send:
      p2051[0] = drive1:r0899 (PZD length is 1 word)
    - Place this PZD in the send buffer (p8871) of node 2:
      p8871[0] = 1
12. Define the receive data for node 1:
    - Specify the data that will be placed in the receive buffer p8872 of node 1 in location 0, received from node 2:
      p8872[0] = 2
    - Specify that PZD1 of node 2 is stored in the receive buffer p8870 of node 1 in location 0:
      p8870[0] = 1
    - r2050[0] now contains the value of PZD 1 of node 2.
13. Perform a "Copy RAM to ROM" for both nodes to back up the parameterization and the data.
14. For both nodes, perform a POWER ON in order to activate the SINAMICS Link connections.

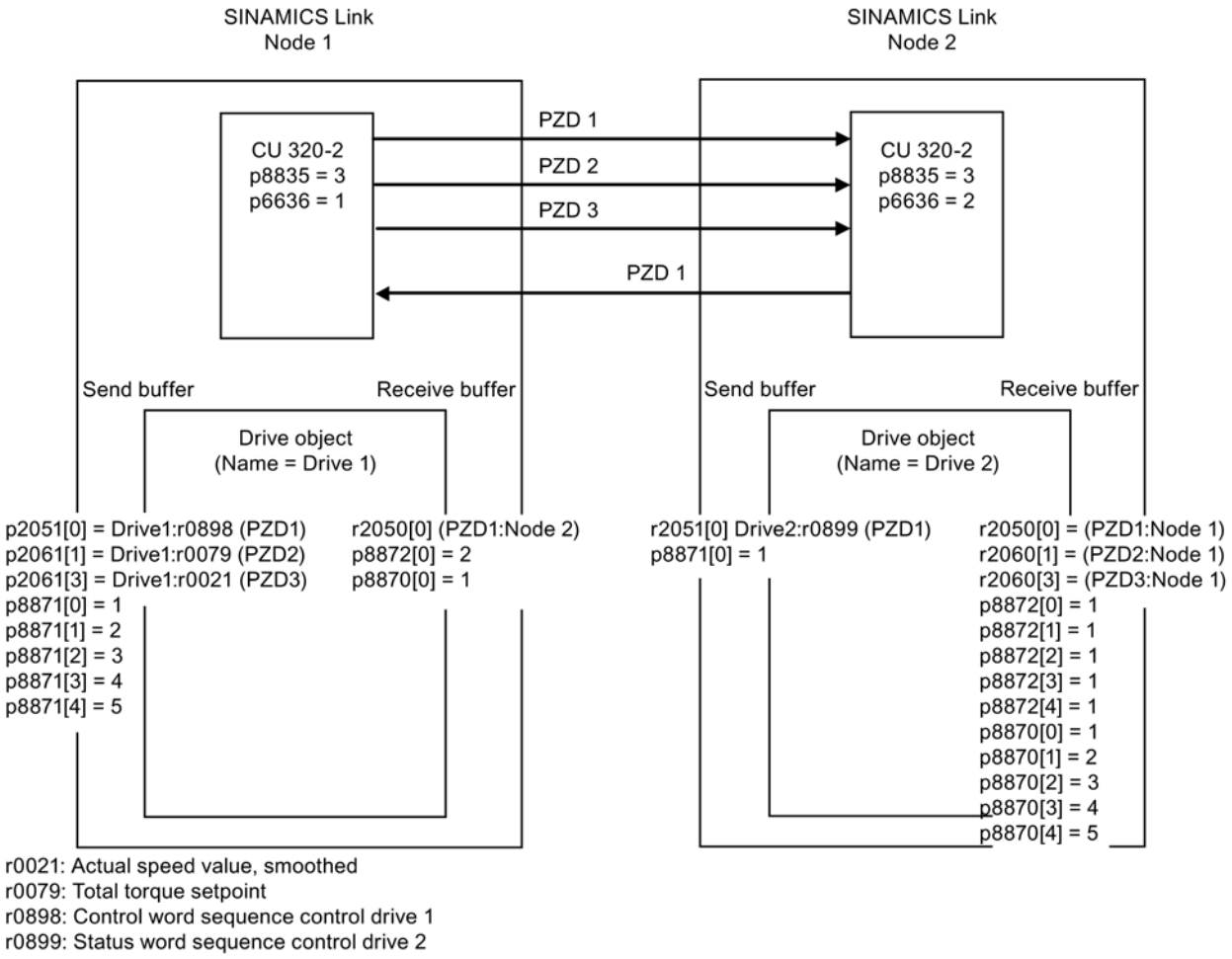


Figure 6-46 SINAMICS Link: Configuration example

6.10.5 Communication failure when booting or in cyclic operation

If at least one SINAMICS Link node does not correctly boot after commissioning or fails during cyclic operation, then alarm A50005 "Sender was not found on the SINAMICS Link" is output to the other nodes.
The alarm value contains the number of the sender that could not be found. Once the problem is eliminated on the node involved, the warning is automatically canceled.

If several nodes are involved, the message occurs a multiple number of times consecutively with different node numbers. The alarm is automatically canceled after the fault has been eliminated in the node involved.

When a node fails in cyclic operation, in addition to alarm A50005, fault F08501 "COMM BOARD: Setpoint timeout" is output.

6.10.6 Transmission times for SINAMICS Link

Transmission times at a communication cycle of 1 ms

p2048/p8848 = 1 ms

Bus cycle [ms]	Transmission times [ms]			
	Sync both	Sync send	Sync receive	Async both
0.5	1.0	1.5	1.3	1.6
1.0	1.5	2.1	2.1	2.2
2.0	3.0	3.6	3.1	2.8

Transmission times at a communication cycle of 4 ms

p2048/p8848 = 4 ms

Bus cycle [ms]	Transmission times [ms]			
	Sync both	Sync send	Sync receive	Async both
0.5	1.0	3.0	2.8	4.6
1.0	1.5	3.6	3.6	5.2
2.0	3.0	5.1	4.6	5.8

6.10.7 Function diagrams and parameters

Key statement

FP 2198	Data transfer - SINAMICS Link (p8835 = 3)
FP 2199	Data transfer - SINAMICS Link, PZD assignment (p8835 = 3)

Parameters

- p0115 Sampling time for additional functions
- p2037 IF1 PROFIdrive STW1.10 = 0 mode
- r2050[0...31] CO: IF1 PROFIdrive PZD receive word
- p2051[0...31] CI: IF1 PROFIdrive PZD send word
- r2060[0...30] CO: IF1 PROFIdrive PZD receive double word
- p2061[0...30] CI: IF1 PROFIdrive PZD send double word
- p8811 SINAMICS Link project selection
- p8812[0...1] SINAMICS Link settings
- p8835 CBE20 firmware selection
- p8836 SINAMICS Link address
- p8839 PZD interface hardware assignment
- p8870 Receive SINAMICS Link frame word PZD
- p8871 SINAMICS Link frame word, send PZD
- p8872 SINAMICS Link address, receive PZD

6.11 Communication services and used port numbers

The drive unit supports the protocols listed in the following table. The address parameters, the relevant communication layer as well as the communication role and the communication direction are specified for each protocol.

This information allows you to match the security measures for the protection of the automation system to the used protocols (e.g. firewall). As the security measures are limited to Ethernet and PROFINET networks, no PROFIBUS protocols are listed in the table.

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

Layers and protocols

Report	Port number	(2) Link layer (4) Transport layer	Function	Description
PROFINET protocols				
DCP Discovery and configuration protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	Accessible nodes, PROFINET Discovery and configuration	DCP is used by PROFINET to determine PROFINET devices and to make basic settings. DCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
LLDP Link Layer Discovery protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88CC (PROFINET)	PROFINET Link Layer Discovery protocol	LLDP is used by PROFINET to determine and manage neighborhood relationships between PROFINET devices. LLDP uses the special multicast MAC address: 01-80-C2-00-00-0E
MRP Media Redundancy Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88E3 (PROFINET)	PROFINET medium redundancy	MRP enables the control of redundant routes through a ring topology. MRP uses the special multicast MAC address: xx-xx-xx-01-15-4E, xx-xx-xx = Organizationally Unique Identifier
PTCP Precision Transparent Clock Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET send clock and time synchronisation, based on IEEE 1588	PTC enables a time-delay measurement between RJ45 ports and thus enables the send cycle synchronization and time synchronization. PTCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
PROFINET IO data	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	PROFINET Cyclic IO data transfer	The PROFINET IO frames are used to cyclically transfer I/O data between the PROFINET IO controller and IO devices via Ethernet.
PROFINET Context Manager	34964	(4) UDP	PROFINET connection less RPC	The PROFINET context manager provides an endpoint mapper in order to establish an application relationship (PROFINET AR).

Report	Port number	(2) Link layer (4) Transport layer	Function	Description
Connection-oriented communication protocols				
HTTP Hypertext transfer protocol	80	(4) TCP	Hypertext transfer protocol	HTTP is used for the communication with the CU internal Web server. Is open in the delivery state and can be deactivated.
ISO on TCP (according to RFC 1006)	102	(4) TCP	ISO-on-TCP protocol	ISO on TCP (according to RFC 1006) is used for the message-oriented data exchange to a remote CPU, WinAC or devices of other suppliers. Communication with ES, HMI, etc. Is open in the delivery state and is always required.
SNMP Simple network management protocol	161	(4) UDP	Simple network management protocol	SNMP enables the reading out and setting of network management data (SNMP managed Objects) by the SNMP manager. Is open in the delivery state and is always required.
HTTPS Secure Hypertext transfer protocol	443	(4) TCP	Secure Hypertext transfer protocol	HTTPS is used for the communication with the CPU internal Web server via Secure Socket Layer (SSL). Is open in the delivery state and can be deactivated.
Reserved	49152...65535	(4) TCP (4) UDP	-	Dynamic port area that is used for the active connection endpoint if the application does not specify the local port.

6.12 Parallel operation of communication interfaces

General information

The two cyclic interfaces for the setpoints and actual values differ by the parameter ranges used (BICO technology, etc.) and the functions that can be used. The interfaces are designated as cyclic interface 1 (IF1) and cyclic interface 2 (IF2).

Cyclic process data (setpoints/actual values) are processed using interfaces IF1 and IF2. The following interfaces are used:

- Onboard interfaces of the Control Unit for PROFIBUS DP or PROFINET.
- An optional interface (COMM Board) for PROFINET (CBE20) or CANopen (CBC10) for insertion in the Control Unit.

Parameter p8839 is used to set the parallel use of the Control Unit onboard interfaces and COMM-Board. The functionality is assigned to interfaces IF1 and IF2 using indices.

For example, the following applications are possible:

- PROFIBUS DP for drive control and PROFINET for 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)
- SINAMICS Link via IF2 (CBE20); standard frames and PROFIsafe via IF1
- Operation of redundant communication interfaces

Assignment of communication interfaces to cyclic interfaces

With the factory setting p8839 = 99, the communication interfaces are permanently assigned to one of the cyclic interfaces (IF1, IF2), depending on the communication system, e.g., PROFIBUS DP, PROFINET, or CANopen.

The user is essentially free to define the assignment to the cyclic interfaces (via parameter assignment) for parallel operation of the communication interfaces.

Table 6- 33 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

Table 6- 34 Implicit assignment of hardware to cyclic interfaces for p8839[0] = p8839[1] = 99

Plugged hardware interface	IF1	IF2
No option, only Control Unit onboard interface (PROFIBUS, PROFINET, or USS)	Control Unit onboard	--
CU320-2 DP with CBE20 (optional PROFINET interface)	COMM BOARD	Control Unit onboard PROFIBUS or Control Unit onboard USS
CU320-2 PN with CBE20 (optional PROFINET interface)	Control Unit onboard	COMM BOARD PROFINET
CAN option CBC10	Control Unit onboard	COMM BOARD CAN

Parameter p8839[0,1] is used to set the parallel operation of the hardware interfaces and the assignment to the cyclic interfaces IF1 and IF2 for the Control Unit drive object.

The object sequence for process data exchange via IF2 depends on the object sequence of IF1; see "List of drive objects" (p0978).

The factory setting of p8839[0,1] = 99 enables the implicit assignment (see table above).

An alarm is output in case of invalid or inconsistent definition of the assignment via parameter assignment.

Note

Parallel operation of PROFIBUS and PROFINET

The data of isochronous applications can only be processed via one of the two interfaces IF1 or IF2 (p8815). Two parameter assignment options are possible if the CBE20 PROFINET module is additionally inserted in the CU320-2 DP:

- p8839[0] = 1 and p8839[1] = 2: PROFIBUS isochronous, PROFINET cyclic

- p8839[0] = 2 and p8839[1] = 1: PROFINET isochronous, PROFIBUS cyclic

Parameters for IF2

The following parameters are available in order to optimize the IF2 for a PROFIBUS or PROFINET interface:

- Receive and send process data:
  r8850, p8851, r8853, r8860, p8861, r8863[1)]
- Diagnostic parameters:
  r8874, r8875, r8876[1)]
- Binector-connector converters:
  p8880, p8881, p8882, p8883, p8884, r8889[1)]
- Connector-binector converters:
  r8894, r8895, p8898, p8899[1)]

[1)] Meaning of 88xx is identical to 20xx

Note

A PROFIBUS slave/PROFINET device with two interfaces cannot be shown with the HW Config configuration tool. In the case of parallel operation, a SINAMICS drive therefore appears twice in the project or in two projects, although physically it is just one device.

Parameters

p8839	PZD interface hardware assignment
Description:	Assignment of the hardware for cyclic communication via PZD interface 1 and interface 2.
Value:	0: Inactive
	1: Control Unit onboard
	2: COMM BOARD
	99: Automatic

For p8839, the following rules apply:

- The setting of p8839 applies to all drive objects of a Control Unit (device parameter).
- When setting p8839[0] = 99 and p8839[1] = 99 (automatic assignment, factory setting), the hardware used is automatically assigned to interfaces IF1 and IF2. Both indices must be selected so that the automatic assignment is activated. If both indices are not selected, then an alarm is output and the setting p8839[x] = 99 is treated just like 'inactive'.
- An alarm is output if the same hardware (Control Unit onboard or COMM BOARD) is selected in p8839[0] and p8839[1]. The following then applies: the setting of p8839[0] and the setting of p8839[1] is treated like 'inactive'.
- If the CAN board (CBC10) is used, the entry of p8839[0] = 2 is not permissible (no assignment of the CAN board to IF1). An alarm is then output.
- If p8839[x] = 2 is set and the COMM BOARD is missing or defective, then the corresponding interface is not supplied by the Control Unit onboard interface. Message A08550 is output instead.

Parameters

- p0922 IF1 PROFIdrive frame selection
- p0978[0...24] List of drive objects
- p8815[0...1] IF1/IF2 PZD functionality selection
- p8839[0...1] PZD interface hardware assignment

6.13 Engineering Software Drive Control Chart (DCC)

Graphical configuring and expansion of the device functionality by means of available closed-loop control, arithmetic, and logic function blocks

Drive Control Chart (DCC) expands the facility for the simplest possible configuring of technological functions for both the SIMOTION motion control system and the SINAMICS drive system. This provides the user with a new dimension of system adaptability for specific machine functions.
DCC does not restrict the number of functions that can be used; the only restriction is the performance of the target platform.

The user-friendly DCC Editor enables easy graphical configuration and a clear representation of control loop structures as well as a high degree of reusability of existing diagrams.

The open-loop and closed-loop control functionality is defined by using multi-instance-enabled blocks (Drive Control Blocks (DCBs)) from a pre-defined library (DCB library) that are selected and graphically linked by dragging and dropping.
Test and diagnostic functions allow verification of the program behavior, and troubleshooting in the event of a fault.

The block library encompasses a large selection of closed-loop, arithmetic and logic function blocks, as well as comprehensive open-loop and closed-loop control functions.

For combining, analyzing and acquiring binary signals, all commonly used logic functions are available for selection (AND, XOR, on/off delay, RS flipflop, counter, etc.). Numerous computation functions are available for monitoring and evaluating numerical variables; for example absolute value generation, division, min/max evaluation.
Besides drive control functions, it is also a simple matter to configure axis winding functions, PI controllers, ramp-function generators, and wobble generators.

Almost unlimited programming of control structures is possible in conjunction with the SIMOTION motion control system. These can then be combined with other program sections to form an overall program.

Drive Control Chart for SINAMICS also provides a convenient basis for resolving drive-level open-loop and closed-loop control tasks directly in the drive. This results in further adaptability of SINAMICS for the task set. On-site processing in the drive supports modular machine concepts and results in increased overall machine performance.

Note

Detailed documentation

A detailed description of the DCC Editor and the available Drive Control Blocks is given in the relevant documentation. This documentation is available on the accompanying customer DVD.

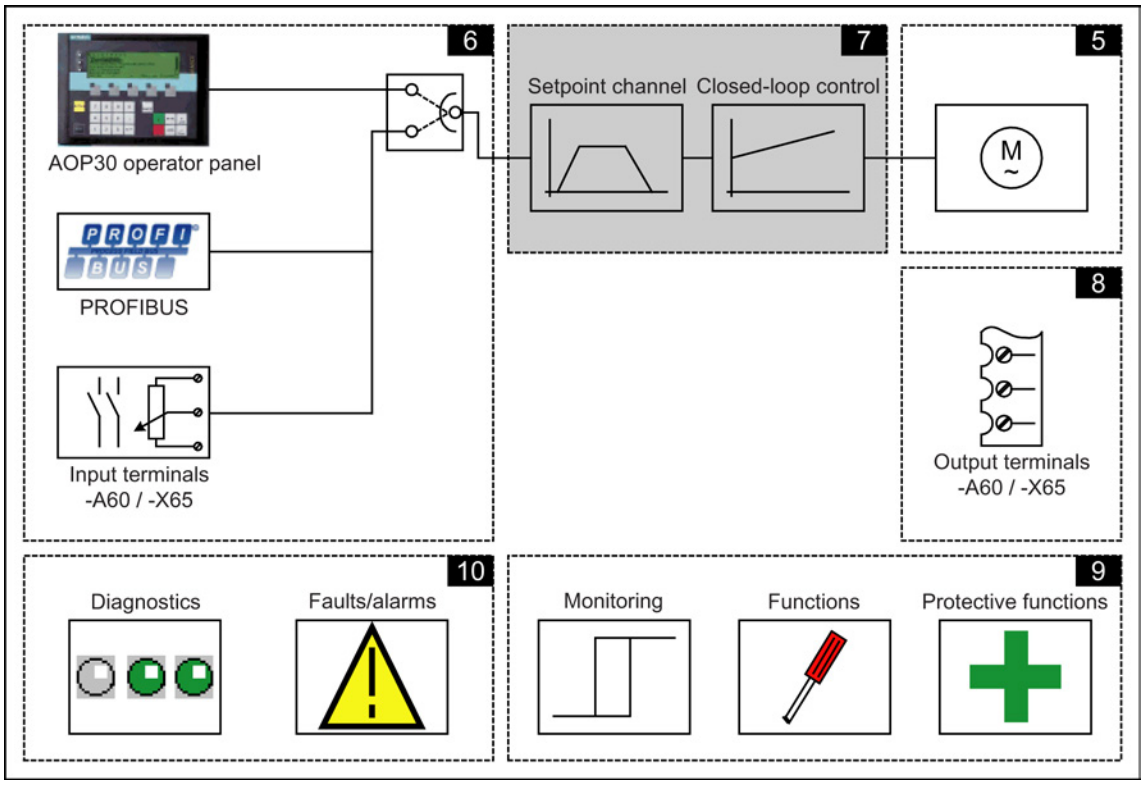
Setpoint channel and closed-loop control

7

7.1 Chapter content

This chapter provides information on the setpoint channel and closed-loop control functions.

- Setpoint channel
  - Direction reversal
  - Skip speed
  - Minimum speed
  - Speed limiting
  - Ramp-function generator
- V/f control
- Vector speed control with/without encoder



Function diagrams

At certain points in this section, reference is made to function diagrams. These can be found on the customer DVD in the "SINAMICS G130/G150 List Manual", which provides experienced users with detailed descriptions of all the functions.

7.2 Setpoint channel

7.2.1 Setpoint addition

Description

The supplementary setpoint can be used to enter correction values from higher-level closed-loop controls. This can be easily carried out using the addition point for the main/supplementary setpoint in the setpoint channel. Both variables are imported simultaneously via two separate or one setpoint source and added in the setpoint channel.

Function diagram

FP 3030	Main/supplementary setpoint, setpoint scaling, jogging

Parameters

- p1070 Main setpoint
- p1071 Main setpoint scaling
- r1073 Main setpoint effective
- p1075 Supplementary setpoint
- p1076 Supplementary setpoint scaling
- r1077 Supplementary setpoint effective
- r1078 Total setpoint effective

7.2.2 Direction reversal

Description

Due to the direction reversal in the setpoint channel, the drive can be operated in both directions of rotation with the same setpoint polarity.

Use the p1110 or p1111 parameter to block negative or positive direction of rotation.

Note

Incorrect rotating field during cable installation

If an incorrect rotating field was connected when the cables were installed and the cabling cannot be changed, the rotating field can be changed during drive commissioning via p1821 (rotating field direction reversal), thus enabling a direction reversal. Modifying parameter p1821 produces a direction reversal of the motor and the actual encoder value without changing the setpoint.

Requirements

Direction reversal is initiated:

- via PROFIBUS by means of control word 1, bit 11
- via the enclosed drive operator panel (LOCAL mode) with the "Direction reversal" key.

Note

Factory state

Note that only one direction of rotation is enabled in the factory state when control is carried out via the AOP30.

Function diagram

FP 3040 Direction limiting and direction reversal

Parameters

- p1110 BI: Inhibit negative direction
- p1111 BI: Inhibit positive direction
- p1113 BI: Setpoint inversion
- r1114 Setpoint after direction limiting

7.2.3 Skip frequency bands and minimum speed

Description

In the case of variable-speed drives, it is possible for the control range of the overall drive train to contain bending-critical speeds that the drive must not be be run at or near in steady-state condition. In other words, although the drive can pass through this range, it must not remain within it because resonant oscillations may be excited. The skip frequency bands allow this range to be blocked for steady-state operation. Because the points at which critical speed resonances occur in a drive train can vary depending on age or thermal factors, a broader control range must be blocked. To prevent constant speed step changes in the vicinity of these skip frequency bands (speeds), they are provided with a hysteresis.
The skip speed values apply in the positive and negative directions of rotation.

Specifying a minimum speed allows a specific range to be disabled around speed 0 rpm for steady-state operation.

Signal flow diagram

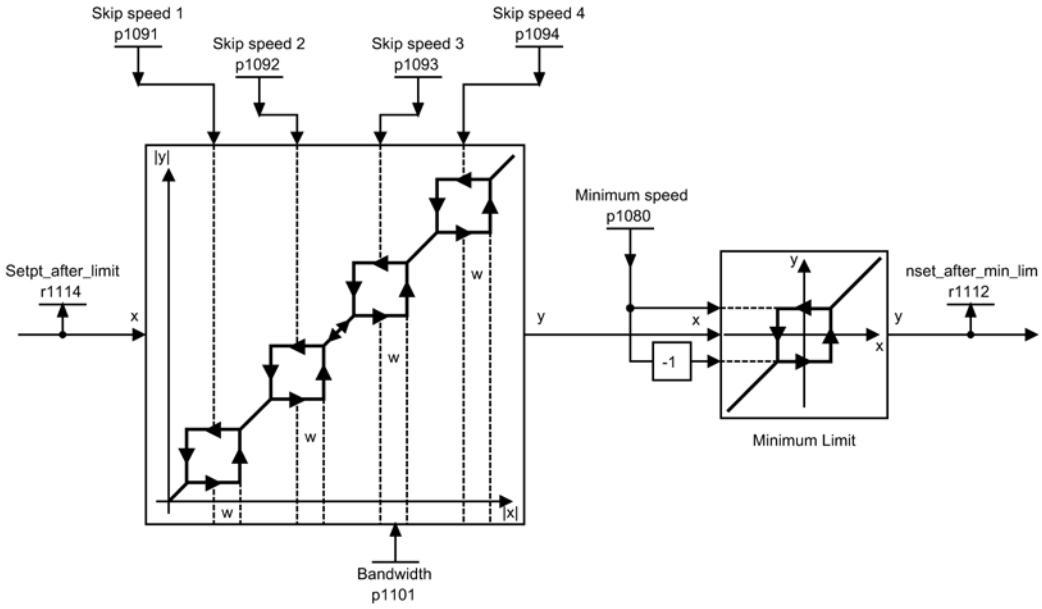


Figure 7-1 Signal flow diagram: Skip frequency bands and minimum speed

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameters

- p1080 Minimum speed
- p1091 Skip speed 1
- p1092 Skip speed 2
- p1093 Skip speed 3
- p1094 Skip speed 4
- p1098 Skip speed scaling
- r1099.0 Skip speed band status word
- p1101 Skip speed bandwidth
- p1106 Minimum speed signal source
- r1112 Speed setpoint after minimum limiting

7.2.4 Speed limiting

Description

The purpose of speed limiting is to limit the maximum permissible speed of the entire drive train to protect the drive and load machine/process against damage caused by excessive speeds.

Signal flow diagram

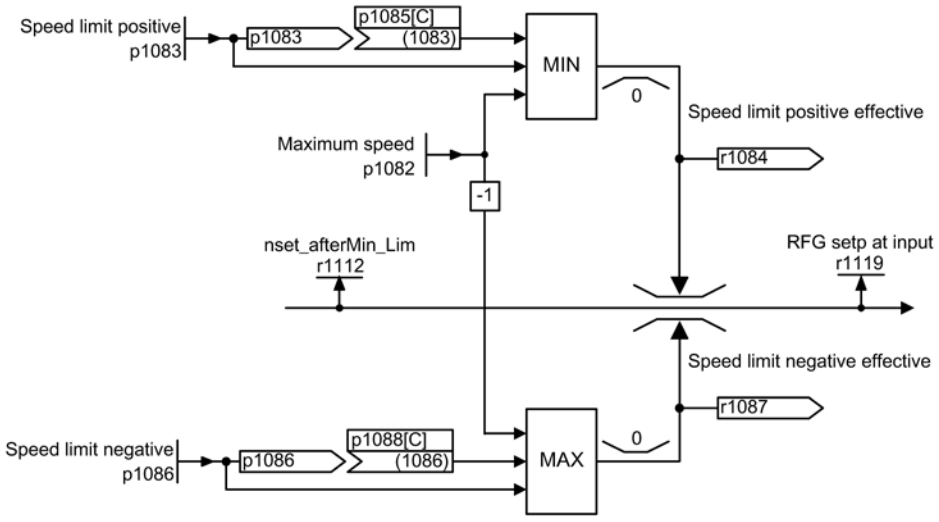


Figure 7-2 Signal flow diagram: Speed limiting

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameters

- p1082 Maximum speed
- p1083 CO: Speed limit in positive direction of rotation
- r1084 CO: Speed limit positive effective
- p1085 CI: Speed limit in positive direction of rotation
- p1086 CO: Speed limit in negative direction of rotation
- r1087 CO: Speed limit negative effective
- p1088 CI: Speed limit in negative direction of rotation
- r1119 CO: Ramp-function generator, setpoint at the input

7.2.5 Ramp-function generator

Description

The ramp-function generator limits the rate at which the setpoint changes when the drive is accelerating or decelerating. This prevents imposing unwanted setpoint step changes on the drive train. Additional rounding times can also be set in the lower and upper speed ranges to improve control quality and prevent load surges, thereby protecting mechanical components such as shafts and couplings.

The ramp-up and ramp-down times each refer to the maximum speed (p1082). The rounding times that can be set can prevent the speed actual value from being overshot when the setpoint is approached, thereby improving control quality.

When final rounding is set, a sudden reduction of the setpoint during ramp-up may cause a setpoint overshoot if continuous smoothing is selected via p1134 = 0. The longer the specified final rounding-off time, the greater the overshoot.

Rounding is also effective in the zero crossover; in other words, when the direction is reversed, the ramp-function generator output is reduced to zero via initial rounding, the ramp-down time, and final rounding before the new, inverted setpoint is approached via initial rounding, the ramp-up time, and final rounding. Rounding times that can be set separately are active in the event of a quick stop (OFF3). The actual ramp-up/ramp-down times increase with active rounding.

The rounding type can be set using p1134 and separately activated/deactivated using p1151.0 in the zero point.

The ramp-up time (p1120) can be scaled via the connector input p1138, and the ramp-down time (p1121) via connector input p1139. Scaling is deactivated in the factory setting.

Note

Effective ramp-up time

The effective ramp-up time increases when you enter initial and final rounding times.

Effective ramp-up time = p1120 + (0.5 x p1130) + (0.5 x p1131)

Signal flow diagram

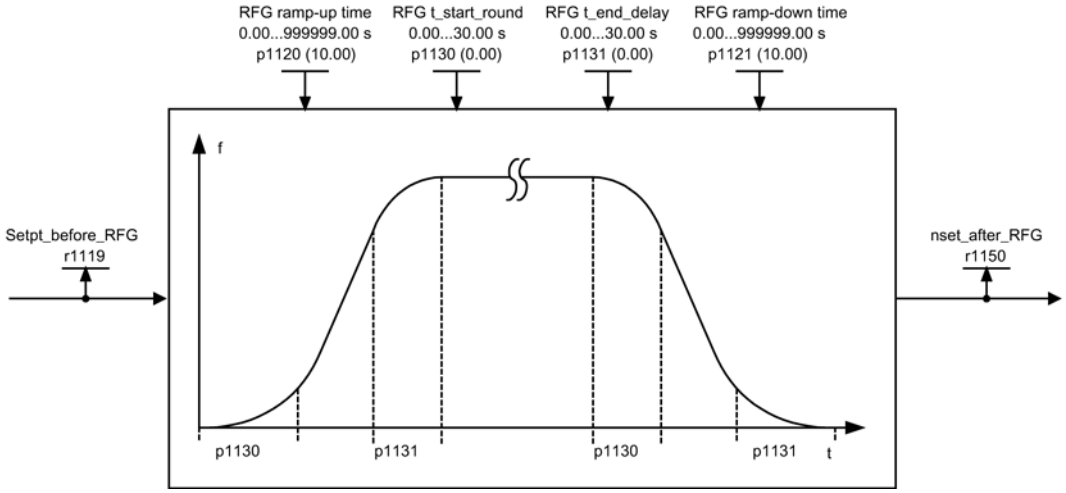


Figure 7-3 Signal flow diagram: Ramp-function generator

Ramp-function generator tracking

If the drive is in the range of the torque limits, the speed actual value is removed from the speed setpoint. The ramp-function generator tracking updates the speed setpoint in line with the speed actual value and so levels the ramp.

Parameter p1145 is used to deactivate ramp-function generator tracking (p1145 = 0) or set the permissible deviation (p1145 > 1). Once the permissible deviation is reached, the speed setpoint at the ramp-function generator output will only be further increased in proportion to the speed setpoint.

Parameters p1151.1 and p1151.2 can be used to set whether the ramp-function generator tracking is carried out with or without a change of polarity.

Parameter r1199.5 indicates whether the ramp-function generator tracking feature is active.

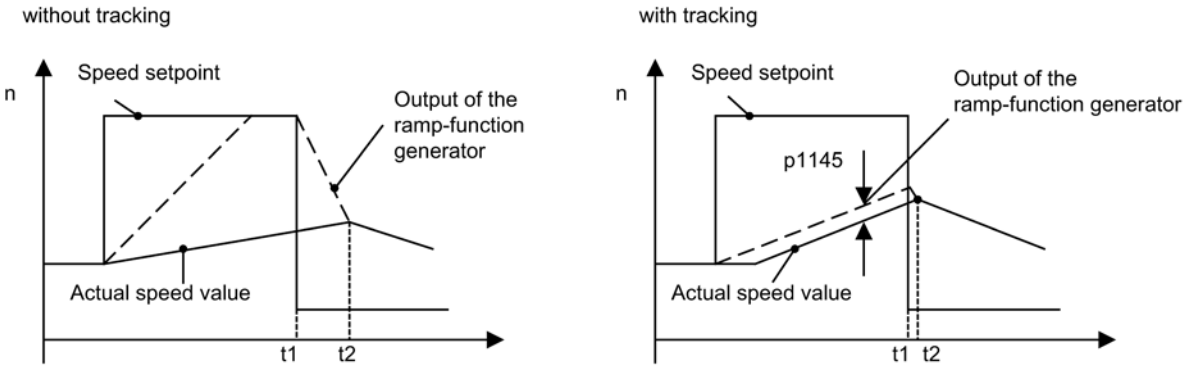


Figure 7-4 Ramp-function generator tracking

Without ramp-function generator tracking

- p1145 = 0
- The drive accelerates to t2, even though the setpoint after t1 is smaller than the actual value.

With ramp-function generator tracking

- At p1145 > 1 (values between 0 and 1 are not applicable), ramp-function generator tracking is activated when the torque limit is approached. The ramp-function generator output thereby only exceeds the speed actual value by the deviation value defined in p1145.
- t1 and t2 almost identical.

Function diagram

FP 3060	Basic ramp-function generator
FP 3070	Extended ramp-function generator
FP 3080	Ramp-function generator selection, status word, tracking

Parameters

- r1119 CO: Ramp-function generator, setpoint at the input
- p1120 Ramp-function generator, ramp-up time
- p1121 Ramp-function generator, ramp-down time
- p1130 Ramp-function generator, initial rounding time
- p1131 Ramp-function generator, final rounding time
- p1134 Ramp-function generator, rounding type
- p1135 OFF3 ramp-down time
- p1136 OFF3 initial rounding time
- p1137 OFF3 final rounding time
- p1138 CI: Ramp-function generator ramp-up time scaling
- p1139 CI: Ramp-function generator ramp-down time scaling
- p1140 BI: Enable ramp-function generator/disable ramp-function generator
- p1141 BI: Continue ramp-function generator/Freeze ramp-function generator
- p1142 BI: Enable setpoint/disable setpoint
- p1143 BI: Accept ramp-function generator setting value
- p1144 CI: Ramp-function generator setting value
- p1145 Ramp-function generator tracking intensity
- p1148 Ramp function generator tolerance for ramp-up and ramp-down active
- r1149 CO: Ramp-function generator acceleration
- r1150 Ramp-function generator, speed setpoint at the output
- p1151 CO: Ramp-function generator configuration
- r1199.0...8 Ramp-function generator status word

7.3 V/f (V/Hz) control

Description

The simplest solution for a control procedure is the V/f characteristic, whereby the stator voltage for the induction motor or synchronous motor is controlled proportionately to the stator frequency. This method has proven successful in a wide range of applications with low dynamic requirements, such as:

- Pumps and fans
- Belt drives
- Multi-motor drives

V/f control aims to maintain a constant flux (Φ) in the motor, whereby the flux is proportional to the magnetization current (Iμ) or the ratio of voltage (V) to frequency (f).

Φ ~ Iμ ~ V/f

The torque (M) generated by the induction motors is, in turn, proportional to the product (or, more precisely, the vector product (Φ x I)) of the flux and current.

M ~ Φ x I

To generate as much torque as possible with a given current, the motor must function using the greatest possible constant flux. To maintain a constant flux (Φ), therefore, the voltage (V) must change in proportion to the frequency (f) to ensure a constant magnetization current (Iμ). V/f characteristic control is derived from these basic premises.

The field-weakening range is above the rated motor frequency, where the maximum voltage is reached. The flux and maximum torque decrease as the frequency increases; this is illustrated in the following diagram.

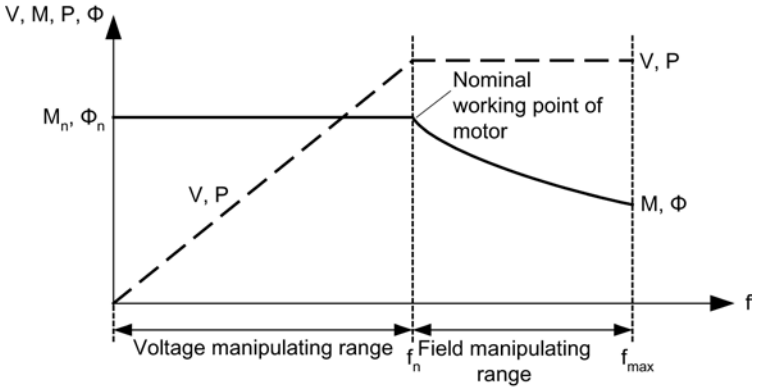
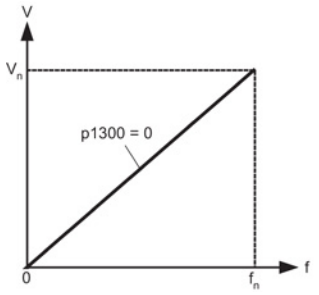
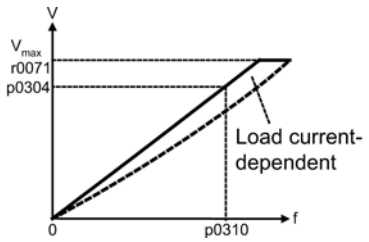
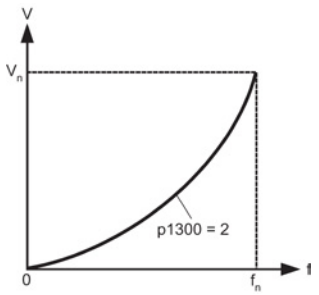
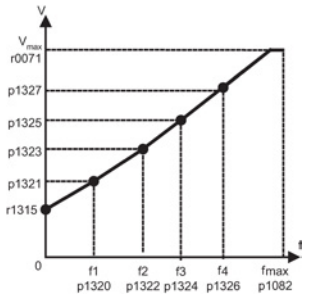


Figure 7-5 Operating ranges and characteristic curves for the induction motor with converter supply

Several variations of the V/f characteristic exist; these are listed in the following table.

Table 7- 1 p1300 V/f characteristics

Parameter value	Meaning	Application/property	
0	Linear characteristic	Standard with variable voltage boost	
1	Linear characteristic with flux current control (FCC)	Characteristic that compensates for voltage losses in the stator resistance for static/dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.	
2	Parabolic characteristic	Characteristic that takes into account the motor torque curve (e.g., fan/pump) • Quadratic characteristic (f² characteristic) • Energy saving because the low voltage also results in small currents and losses	
3	Programmable characteristic	Characteristic that takes into account the motor/machine torque characteristic	
4	Linear characteristic and ECO	Characteristic (see parameter value 0) and Eco mode at a constant operating point. • At a constant operating point, the efficiency is optimized by varying the voltage. • This requires active slip compensation; the scaling must be set such that the slip is fully compensated (p1335 = 100 %).	

Parameter value	Meaning	Application/property
5	Precise frequency drives (textiles)	Characteristic (see parameter value 0) that takes into account the technological specifics of an application (e.g., textile applications). • The current limitation (Imax controller) affects only the output voltage and not the output frequency. • Slip compensation and resonance damping are disabled.
6	Precise frequency drives with flux current control (FCC)	Characteristic (see parameter value 1) that takes into account the technological specifics of an application (e.g., textile applications). • The current limitation (Imax controller) affects only the output voltage and not the output frequency. • Slip compensation and resonance damping are disabled. Voltage losses in the stator resistor are also compensated for static / dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.
7	Parabolic characteristic and ECO	Characteristic (see parameter value 1) and Eco mode at a constant operating point. • At a constant operating point, the efficiency is optimized by varying the voltage. • This requires active slip compensation; the scaling must be set such that the slip is fully compensated (p1335 = 100 %).
19	Independent voltage setpoint	The user can define the output voltage of the Power Module independently of the frequency using BICO parameter p1330 via the interfaces (e.g., analog input AI0 of the TM31 –> p1330 = r4055[0]).

Function diagram

FP 6301 V/f characteristic and voltage boost

Parameters

- p1300 Open-loop/closed-loop control operating mode
- p1320 V/f control programmable characteristic frequency 1

  ...
- p1327 V/f control programmable characteristic voltage 4
- p1330 CI: V/f control independent of voltage setpoint
- p1331 Voltage limiting
- p1333 V/f control FCC starting frequency
- r1348 V/f control Eco-factor actual value
- p1350 V/f control soft startup

7.3.1 Voltage boost

Description

With low output frequencies, the V/f characteristics yield only a small output voltage.

With low frequencies, too, the ohmic resistance of the stator windings has an effect and can no longer be ignored vis-à-vis the machine reactance. With low frequencies, therefore, the magnetic flux is no longer proportional to the magnetization current or the V/f ratio.

Therefore. the output voltage may be too low to:

- Magnetize the induction motor
- Maintain the load
- Compensate for the voltage losses (ohmic losses in the winding resistors) in the system
- Induce a breakaway / accelerating / braking torque

You can choose whether the voltage boost is to be active permanently (p1310) or only during acceleration (p1311). Via p1312, you can also set a one-time voltage boost in the first ramp-up after the pulse enable.

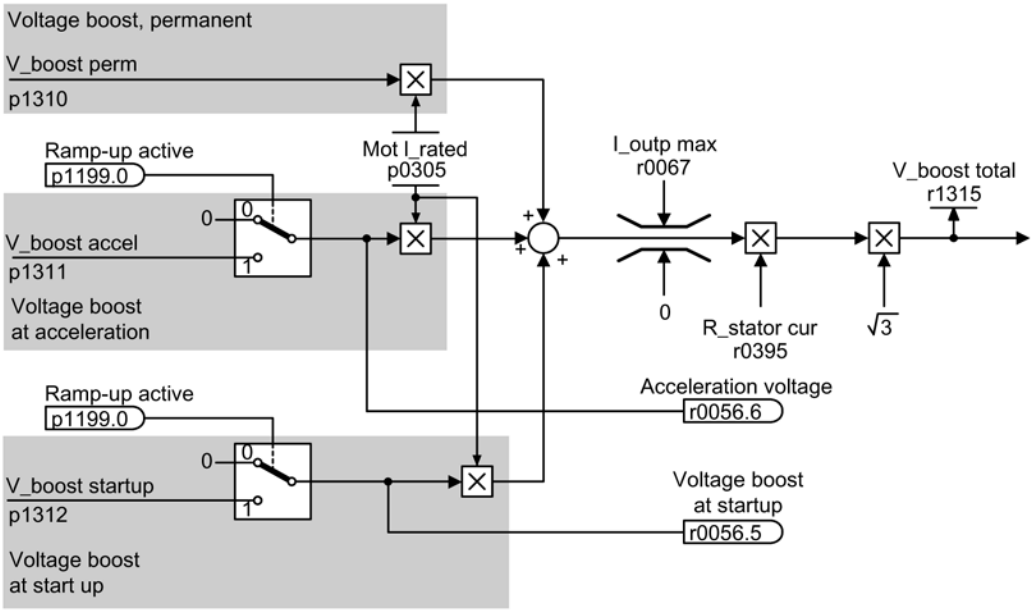


Figure 7-6 Voltage boost total

Note

Voltage boost effect

The voltage boost affects all V/f characteristics (p1300) from 0 to 7.

Note

Avoid thermal overload

If the voltage boost value is too high, this can result in a thermal overload of the motor winding.

Permanent voltage boost (p1310)

The voltage boost is active across the entire frequency range up to the rated frequency f_n; at higher frequencies, the value decreases continuously.

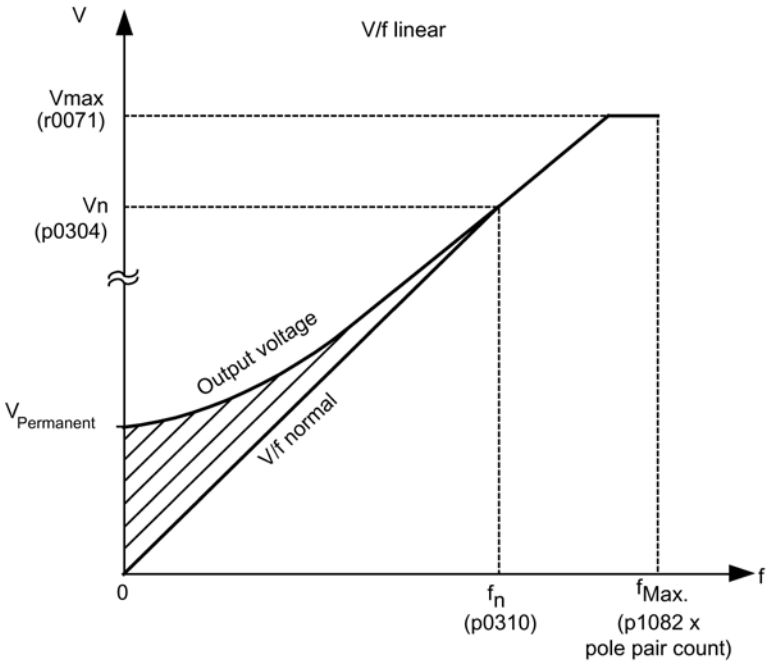


Figure 7-7 Permanent voltage boost (example: p1300 = 0, p1310 >0, p1311 = p1312 = 0)

Voltage boost on acceleration (p1311)

The voltage boost is effective only during an acceleration process and only until the setpoint is reached.

The voltage boost is effective only when the "ramp-up active" signal (r1199.0 = 1) is present.

Via parameter r0056.6, it is possible to observe whether the voltage boost at acceleration is active.

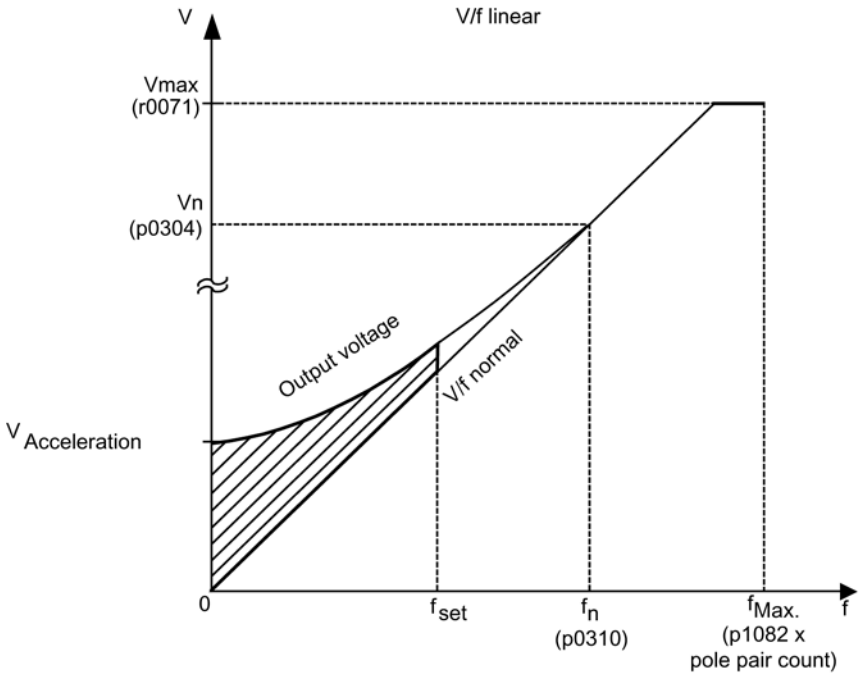


Figure 7-8 Voltage boost during acceleration (example: p1300 = 0, p1310 = 0, p1311 > 0)

Voltage boost at startup (p1312)

The voltage boost is effective only during the first acceleration after the pulse enable and only until the setpoint is reached.

The voltage boost is effective only when the "ramp-up active" signal (r1199.0 = 1) is present.

Via parameter r0056.5, it is possible to observe whether the voltage boost at startup is active.

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameters

- r0056.5 Voltage boost at start up active/inactive
- r0056.6 Acceleration voltage active/inactive
- p0304 Rated motor voltage
- p0305 Rated motor current
- r0395 Current stator resistance
- p1310 Startup current (voltage boost), continual
- p1311 Startup current (voltage boost) on acceleration
- p1312 Startup current (voltage boost) at startup
- r1315 Voltage boost total

7.3.2 Resonance damping

Description

The resonance damping function dampens active current oscillations that frequently occur under no-load conditions.

The resonance damping is active in a range from approximately 6 % of the rated motor frequency (p0310). The switch-off frequency is determined by p1349.

For p1300 = 5 and 6 (textiles) the resonance damping is internally disabled in order to be able to precisely set the output frequency.

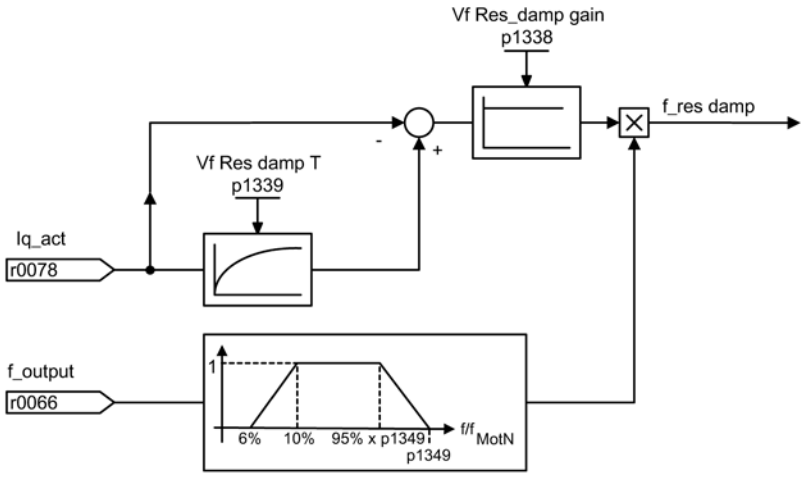


Figure 7-9 Resonance damping

Note

Automatic setting

When p1349 = 0, the changeover limit is automatically set to 95 % of the rated motor frequency, but only up to 45 Hz.

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- r0066 Output frequency
- r0078 Current actual value torque-generating
- p1338 V/f control resonance damping gain
- p1339 V/f control resonance damping filter time constant
- p1349 V/f control resonance damping maximum frequency

7.3.3 Slip compensation

Description

Slip compensation essentially keeps the speed of induction motors constant, irrespective of the load (M_1 or M_2).
When the load is increased from M_1 to M_2, the setpoint frequency is increased automatically so that the resulting frequency and thus also the motor speed remain constant. When the load is reduced from M_2 to M_1, the setpoint frequency is automatically decreased accordingly.

For p1300 = 4 and 7 (V/f controllers with ECO), the slip compensation must be activated to ensure correct operation.

For p1300 = 5 and 6 (textiles), the slip compensation is internally disabled in order to be able to precisely set the output frequency.

If a motor holding brake is used, a setting value can be specified at the slip compensation output via p1351. A parameter setting of p1351 > 0 turns on the slip compensation automatically (p1335 = 100 %).

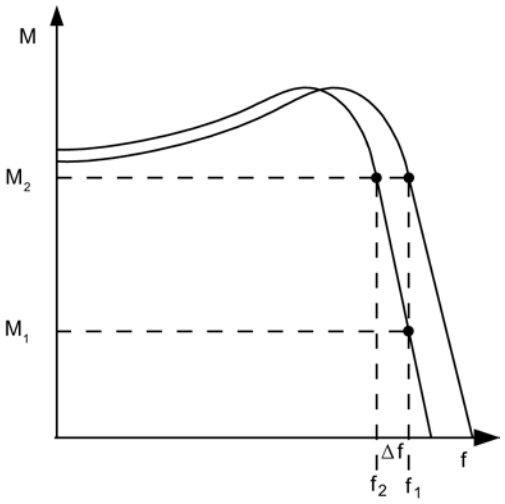


Figure 7-10 Slip compensation

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- r0330 Rated motor slip
- p1334 Slip compensation starting frequency
- p1335 Slip compensation scaling
  p1335 = 0.0 %: Slip compensation is disabled.
  p1335 = 100.0 %: Slip is fully compensated.
- p1336 Slip compensation limit value
- r1337 CO: Actual slip compensation
- p1351 CO: Motor holding brake start frequency

7.4 Vector speed/torque control with/without an encoder

Description

Compared with V/f control, vector control offers the following benefits:

- Stability vis-à-vis load and setpoint changes
- Short rise times with setpoint changes (–> better command behavior)
- Short settling times with load changes (–> better disturbance characteristic)
- Acceleration and braking are possible with maximum adjustable torque
- Motor protection due to variable torque limitation in motor and regenerative mode
- Drive and braking torque controlled independently of the speed
- Maximum breakaway torque possible at speed 0

These benefits are available without speed feedback.

Vector control can be used with or without an encoder.

The following criteria indicate when an encoder is required:

- Maximum speed accuracy requirements
- Maximum dynamic response requirements
  - Better command behavior
  - Shortest settling times when disturbances occur
- Torque control is required in a control range greater than 1:10
- Allows a defined and/or variable torque for speeds below approx. 10% of the rated motor frequency (p0310) to be maintained.
- A speed controller is normally always required for applications in which an unknown speed can represent a safety risk (where a load can be dropped, e.g., lifting gear, elevators, etc).

With regard to setpoint input, vector control is divided into:

- Closed-loop speed Control
- Torque/current control (in short: torque control)

7.4.1 Vector control without an encoder

Description

For encoderless vector control (SLVC: Sensorless Vector Control), the position of the flux and actual speed must be determined via the electric motor model. The model makes use of the available current and voltage actual value signals. At low frequencies (approx. 1 Hz), the model is unable to determine the speed.

For this reason and due to uncertainties in the model parameters or inaccurate measurements, the system is switched from closed-loop to open-loop operation in this range.

The changeover between closed-loop/open-loop operation is controlled on the basis of time and frequency conditions (p1755, p1756, p1758 - only for induction motors). The system does not wait for the time condition to elapse if the setpoint frequency at the ramp-function generator input and the actual frequency are below p1755 x (1 - (p1756 / 100 %)) simultaneously.

Transition from open-loop to closed-loop operation always takes place when the changeover speed in p1755 (characteristic "1" in the figure below). If the speed increase is set very slow and a changeover delay time > 0 is set in p1759, transition takes place after the changeover delay time (characteristic "2" in the figure below).

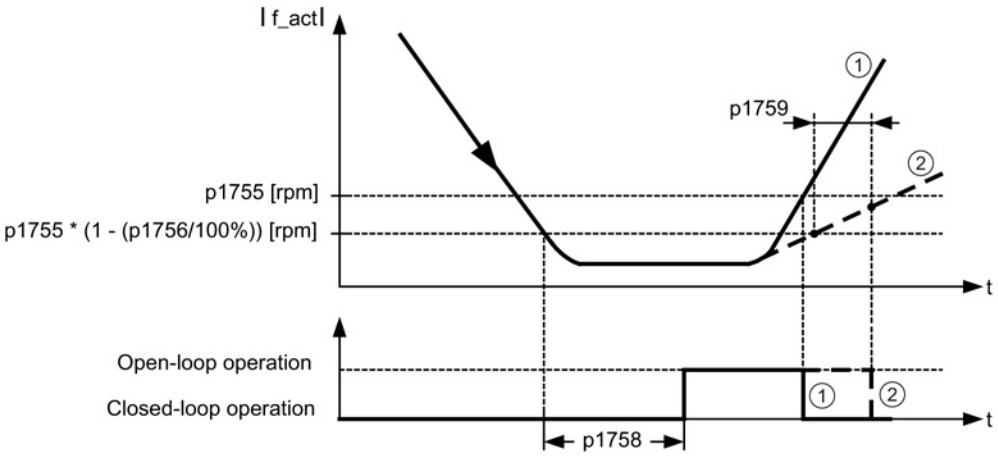


Figure 7-11 Changeover conditions

Setting the torque setpoint

In open-loop operation, the calculated actual speed value is the same as the setpoint value. For vertical loads and acceleration processes, parameters p1610 (static torque setpoint) and p1611 (additional acceleration torque) must be adapted to the necessary maximum torque in order to generate the static or dynamic load torque of the drive. If, on induction motors, p1610 is set to 0 %, only the magnetizing current r0331 is injected; at a value of 100 %, the rated motor current p0305 is injected.

For permanent-magnet synchronous motors, at p1610 = 0 %, a feedforward control absolute value derived from the supplementary torque r1515 remains instead of the magnetizing current for induction motors. To ensure that the drive does not stall during acceleration,

p1611 can be increased or acceleration feedfoward control for the speed controller can be used. This is also advisable to ensure that the motor is not subject to thermal overload at low speeds.

If the moment of inertia of the drive is almost constant, acceleration feedforward control via p1496 offers more advantages than the additional acceleration torque via p1611. The moment of inertia of the drive is determined with the rotating measurement via p1900 = 3 and p1960 = 1.

Encoderless vector control has the following characteristics at low frequencies:

- Closed-loop controlled operation for passive loads down to approx. 0 Hz output frequency (p0500 = 2), for p1750.2 = 1 and p1750.3 = 1.
- Starting of an induction motor in closed-loop controlled mode (after the motor has been completely excited), if the speed setpoint before the ramp-function generator is greater than p1755.
- Reversing without the need to change to open-loop controlled mode is possible, if the range of the changeover speed (p1755) is passed through in a shorter time than the changeover waiting time set (p1758), and the speed setpoint before the ramp-function generator lies outside the open-loop controlled speed range (p1755).
- In closed-loop torque controlled mode, at low speeds, the system always switches over to open-loop controlled mode.

Note

Requirement

In this case, the speed setpoint upstream of the ramp-function generator must be greater than the changeover speed in p1755.

Closed-loop controlled operation down to approx. 0 Hz (settable via parameter p1755) and the ability to start or reverse at 0 Hz directly in closed-loop operation (settable via parameter p1750) results in the following benefits:

- No switchover operation required within closed-loop control (bumpless behavior, no frequency dips, no discontinuities in the torque).
- Closed-loop speed control without encoder down to and including 0 Hz
- Passive loads down to a frequency of 0 Hz
- Steady-state closed-loop speed control down to approx. 0 Hz possible
- Higher dynamic performance when compared to open-loop controlled operation

Note

Automatic changeover

If during closed-loop controlled operation, starting from 0 Hz or reversing takes longer than 2 s or the time set in p1758, then the system automatically switches over from closed-loop controlled operation to open-loop controlled operation.

Note

Operation in encoderless torque control

Operation in encoderless closed-loop torque control only makes sense if, in the speed range below the changeover speed of the motor model (p1755), the setpoint torque is greater than the load torque. The drive must be able to follow the setpoint and the associated setpoint speed (p1499).

Closed-loop operation down to standstill for non-overhauling (passive) loads

With only non-overhauling load at the starting point, it is possible to maintain steady-state closed-loop operation down to zero frequency (standstill) without having to change over to open-loop operation.

Parameter p1750.2 must be set to 1.

Closed-loop control without changeover is restricted to applications with non-overhauling load:
These include applications in which the load cannot produce a regenerative torque on startup and the motor comes to a standstill when pulses are inhibited; for example, moments of inertia, brakes, pumps, fans, centrifuges, extruders, etc.

Standstill of any duration is possible without holding current, only the motor magnetization current is injected.

Steady-state regenerative operation at a frequency close to 0 Hz is not possible.

It is also possible to select encoderless control for non-overhauling loads during commissioning by setting p0500 = 2 (technology application = passive loads (for encoderless control down to f = 0)).

This function is activated automatically if quick commissioning is exited with p3900 > 0, or if automatic calculation is called (p0340 = 1, 3, 5 or p0578 = 1).

Blocking drives

If the load torque is higher than the torque limiting of the encoderless closed-loop vector control, the drive is braked to zero speed (standstill). To ensure that open-loop controlled mode is not switched to after time p1758, p1750.6 can be set to 1. It may be necessary to increase p2177 (Motor blocked delay time).

Note

Exception for reversing drives

It is not permissible to use this setting if the load can force the drive to reverse.

Active loads

Active loads that can be used to reverse the drive, e.g., hoisting gear, must be started in the open-loop speed control mode. In this case, bit p1750.6 must be set to 0 (open-loop controlled operation when the motor is blocked). The static (steady state) torque setpoint (p1610) must be greater than the maximum occurring load torque.

Note

Loads that can drive the motor

For applications with high regenerative load torques at low speeds, p1750.7 can also be set to 1. As a result, the speed changeover limits of the motor model are increased and a faster changeover to open-loop controlled operation is possible.

Permanent-magnet synchronous motors

Standard method: open-loop controlled operation at low speeds

Permanent-magnet synchronous motors are normally started and reversed in open-loop operation. The changeover speeds are set to 10 % or 5 % of the rated motor speed. Changeover is not subject to any time condition (p1758 is not evaluated). Prevailing load torques (motor or regenerative) are adapted in open-loop operation, facilitating constant-torque crossover to closed-loop operation even under high static loads. Whenever the pulses are enabled, the rotor position is identified.

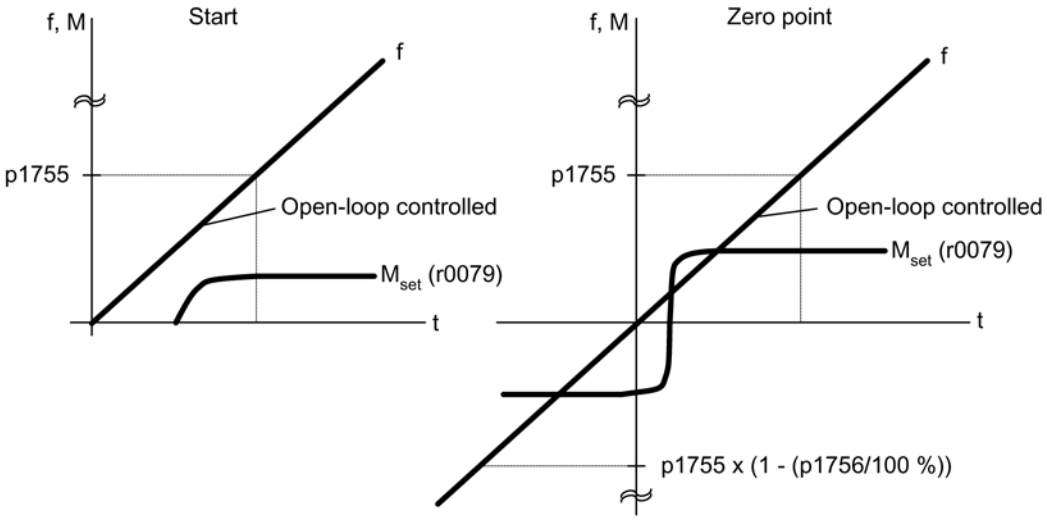


Figure 7-12 Zero point in open-loop operation at low speeds

Extended method: closed-loop operation down to zero speed

By superimposing high-frequency pulses onto the driving fundamental voltage and evaluating the superimposed pulses occurring as a result in the machine current, it is possible to determine the continuous rotor position down to zero frequency (standstill).

With Siemens series 1FW4 and 1PH8 torque motors, it is possible to approach the rated torque from a standstill at any load, or even to stop the load at a standstill.

This method is suitable for motors with internal magnets.

Note

Use of a sine-wave filter

When using a sine-wave filter, apply the open-loop method.

The following advantages are obtained by maintaining closed-loop controlled operation:

- No switchover required within closed-loop control (smooth switchover, no discontinuities in the torque).
- Closed-loop speed and torque control without encoder (sensorless) up to and including 0 Hz.
- Higher dynamic performance compared to open-loop controlled operation.
- Encoderless operation of drive line-ups (e.g., in the paper industry, master-slave operation) is possible.
- Active (including hanging/suspended) loads down to a frequency equal to zero.

Basic conditions for the use of third-party motors:

- Experience shows that this method is extremely well suited for interior permanent magnet synchronous motors (IPMSM).
- The ratio of stator quadrature-axis reactance (Lsq): Stator direct-axis reactance (Lsd) must be > 1 (recommendation: at least > 1.5).
- The asymmetrical reactance ratio (Lsq:Lsd) is maintained in the motor up to a certain current; this determines the possible operating limits of the method. If it you want to be able to operate the method up to the rated motor torque, the reactance ratio must be maintained up to the rated motor current.

The following parameter input is prerequisite for optimal performance:

- Input of the saturation characteristic: p0362 - p0369
- Input of the load characteristic: p0398, p0399

Commissioning sequence for closed-loop controlled operation down to zero speed:

- Perform commissioning with motor identification at standstill.
- Enter the parameters for saturation characteristic and load characteristic.
- Activate closed-loop operation down to zero speed via parameter p1750 bit 5.

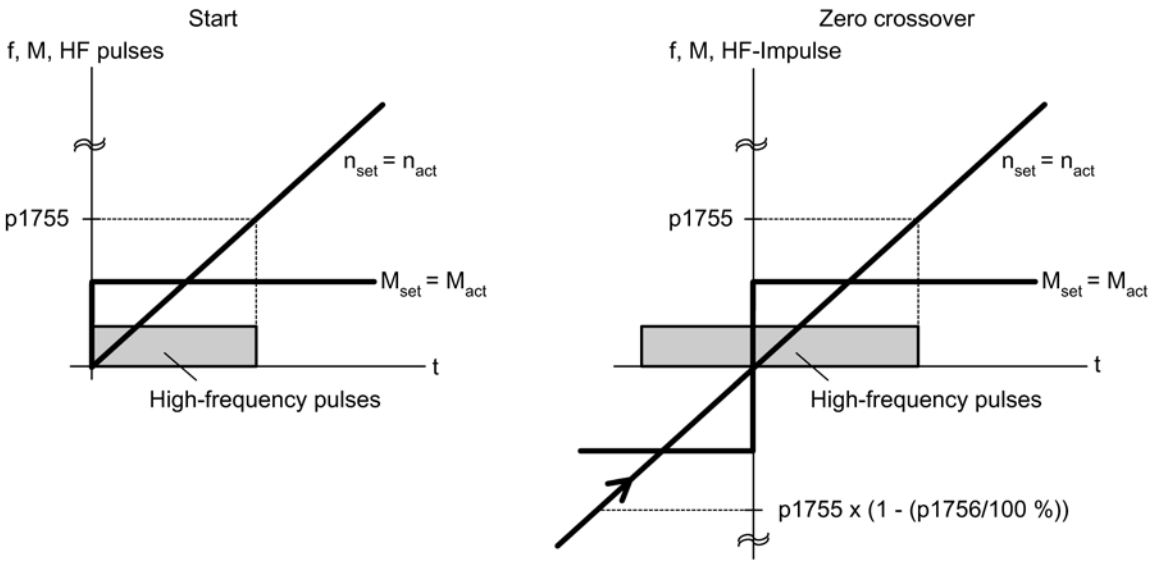


Figure 7-13 Zero point in closed-loop operation down to zero speed

Function diagram

FP 6730	Interface to the Motor Module (ASM), p0300 = 1)
FP 6731	Interface to the Motor Module (PEM), p0300 = 2)

Parameters

- p0305 Rated motor current
- r0331 Motor magnetizing current/short-circuit current
- p0362 Saturation characteristic flux 1
  ... ...
  p0365 Saturation characteristic flux 4
- p0366 Saturation characteristic I_mag 1
  ... ...
  p0369 Saturation characteristic I_mag 4
- p0398 Magnet angle. Decoupling (cross saturation) coefficient 1
- p0398 Magnet angle. Decoupling (cross saturation) coefficient 3
- p0500 Technology application
- p0578 Calculate technology/unit-dependent parameters
- p1605 Sample pulsing regime configuration
- r1606 CO: Sample pulsing regime current
- p1607 Pulsing regime stimulus
- r1608 CO: Pulsing regime response
- p1610 Torque setpoint static (SLVC)
- p1611 Supplementary accelerating torque (SLVC)
- p1750 Motor model configuration
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis
- p1758 Motor model changeover delay time, closed/open-loop control
- p1759 Motor model changeover delay time open/closed loop control
- r1762.1 Motor model deviation component 1 - deviation Model2
- p1798 Motor model pulsing regime speed adaptation Kp
- p1810.3 Modulator configuration - current measurement oversampling activated (for PEM pulsing regime)

7.4.2 Vector control with encoder

Description

Benefits of vector control with an encoder:

- The speed can be controlled right down to 0 Hz (standstill).
- Stable control response throughout the entire speed range
- Allows a defined and/or variable torque for speeds below approx. 10 % of the rated motor speed to be maintained
- Compared with speed control without an encoder, the dynamic response of drives with an encoder is significantly better because the speed is measured directly and integrated in the model created for the current components.

Motor model change

A model change takes place between the voltage model and the observer model within the speed range p1752 x (100 % - p1753) and p1752. In the voltage model range (i.e., at lower speeds), torque accuracy depends on whether thermal tracking of the rotor resistance is carried out correctly. In the observer-model range and at speeds of less than approx. 20 % of the rated speed, torque accuracy depends primarily on whether thermal tracking of the stator resistance is carried out correctly. If the resistance of the supply cable is greater than 20 to 30 % of the total resistance, this should be entered in p0352 before motor data identification is carried out (p1900/p1910).

To deactivate thermal adaptation, set p0620 = 0. This may be necessary if adaptation cannot function accurately enough due to the following general conditions. This may be the case, for example, if a KTY sensor is not used for temperature measurement and the ambient temperatures fluctuate significantly or the overtemperatures of the motor (p0626 to p0628) deviate significantly from the default settings due to the design of the motor.

Function diagram

FP 4715	Actual speed value and rotor position measurement, motor encoder
FP 6030	Speed setpoint, droop
FP 6040	Speed controller with/without encoder
FP 6050	Speed controller adaptation (Kp_n/Tn_n adaptation)
FP 6060	Torque setpoint
FP 6490	Speed control configuration

7.4.3 Actual speed value filter

Description

The actual speed value filter is used to suppress cyclic disturbance variables during speed acquisition.

The actual speed value filter can be set as follows:

- Low-pass 2nd order (PT2: -40 dB/decade)
- General 2nd order filter

STARTER converts band-stop and low-pass with reduction in the parameters of the general 2nd order filter.

The actual speed value filter is activated with p1656.4 = 1. The properties of the actual speed value filter are set with p1677 to p1681.

As long as changes to the data of the actual speed value filter are being made, the conversion of the new filter data can be prevented using p1699 = 1.
When p1699 = 0 is set, the calculation will be performed and the new values applied.

Note

For the vector control, there are two current setpoint filters and one actual speed value filter. The actual speed value filter has been allocated the number "5".

Function diagrams

FP 4715 Encoder evaluation - Actual speed value and pole position sensing, motor encoder (encoder 1), n_actual_filter 5

Parameters

- p1655[4] CI: Speed actual value filter 5 natural frequency tuning
- p1656.4 Actual speed value filter 5 activation
- p1677 Actual speed value filter 5 type
- p1678 Actual speed value filter 5 denominator natural frequency
- p1679 Actual speed value filter 5 denominator damping
- p1680 Actual speed value filter 5 numerator natural frequency
- p1681 Actual speed value filter 5 numerator damping
- p1699 Filter data acceptance

7.4.4 Speed controller

Description

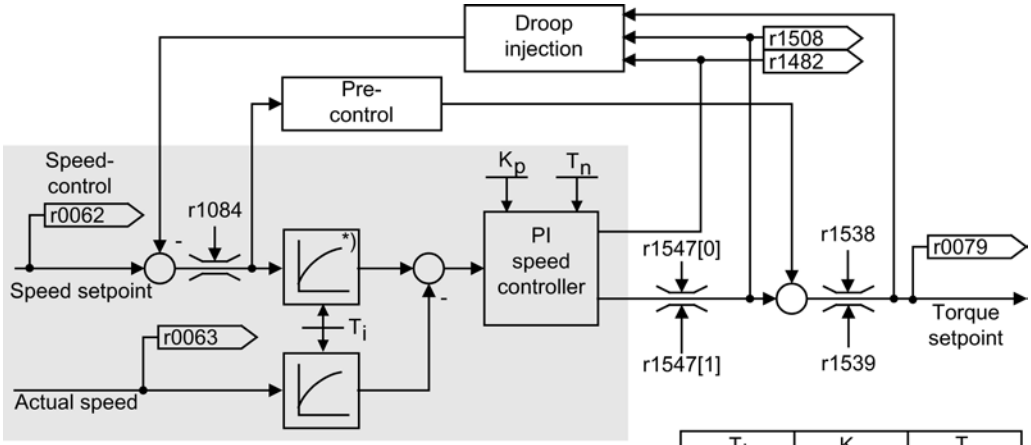
Both closed-loop control techniques with and without encoder (SLVC, VC) have the same speed controller structure that contains the following components as the kernel:

- PI controller
- Speed controller feedfoward control
- Droop

The total of the output variables forms the torque setpoint, which is reduced to the permissible size by means of the torque setpoint limitation.

The speed controller receives its setpoint (r0062) from the setpoint channel and its actual value (r0063) either directly from the actual speed value encoder (vector control with an encoder) or indirectly via the motor model (encoderless vector control). The system difference is increased by the PI controller and, in conjunction with the feedfoward control, results in the torque setpoint.

When the load torque increases, the speed setpoint is reduced proportionately when droop is active, which means that the single drive within a group (two or more mechanically connected motors) is relieved when the torque becomes too great.



	Ti	Kp	Tn
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-14 Speed controller

The optimum speed controller setting can be determined via the automatic speed controller optimization function (p1900 = 1, rotating measurement).

If the moment of inertia has been specified, the speed controller (Kp, Tn) can be calculated by means of automatic configuration (p0340 = 4). The controller parameters are defined in accordance with the symmetrical optimum as follows:

Tn = 4 x Ts

Kp = 0.5 x r0345 / Ts = 2 x r0345 / Tn

Ts = Sum of the short delay times (includes p1442 and p1452).

If vibrations occur with these settings, the speed controller gain (Kp) will need to be reduced manually. Actual-speed-value smoothing can also be increased (standard procedure for gearless or high-frequency torsion vibrations) and the controller calculation performed again because this value is also used to calculate Kp and Tn.

The following relationships apply for optimization:

- If Kp is increased, the controller becomes faster, although overshoot is increased. However, signal ripples and vibrations in the speed control loop will increase.
- If Tn is reduced, the controller will speed up, However, this increases the overshoot.

When setting the speed control manually, you are advised to define the dynamic response via Kp (and actual-speed-value smoothing) first, so that the integral time can subsequently be reduced as much as possible. Please note that the closed-loop control must also remain stable in the field-weakening range.

To suppress any vibrations that occur in the speed controller, it is usually only necessary to increase the smoothing time in p1452 for operation without an encoder or p1442 for operation with an encoder, or reduce the controller gain.

The integral output of the speed controller can be monitored via r1482 and the limited controller output via r1508 (torque setpoint).

Note

Reduced dynamic response for encoderless operation

Compared with speed control with an encoder, the dynamic response of encoderless drives is significantly reduced. The actual speed is derived by means of a model calculation based on the drive output variables for current and voltage that have a corresponding interference level. To this end, the actual speed must be adjusted by means of filter algorithms in the software.

Function diagram

FP 6040	Speed controller with/without encoder

Parameters

- r0062 CO: Speed setpoint after filter
- r0063 CO: Actual speed value, smoothed
- p0340 Automatic calculation of motor/control parameters
- r0345 Rated motor startup time
- p1442 Speed controller actual speed value smoothing time
- p1452 Speed controller actual speed value smoothing time (without encoder)
- p1460 Speed controller P gain with encoder
- p1462 Speed controller integral time with encoder

- p1470 Speed controller encoderless operation P gain
- p1472 Speed controller encoderless operation integral time
- r1482 CO: Speed controller I-torque output
- r1508 CO: Torque setpoint before supplementary torque
- p1960 Rotating measurement selection

Examples of speed controller settings

A number of examples of speed controller settings with vector control without encoders (p1300 = 20) are provided below. These should not be considered generally valid and must be checked in terms of the control response required.

- **Fans (large centrifugal masses) and pumps**

  Kp (p1470) = 2 to 10

  Tn (p1472) = 250 ms to 500 ms

  The Kp = 2 and Tn = 500 ms settings result in asymptotic approximation of the actual speed to the setpoint speed after a setpoint step change. During many simple control procedures, this is satisfactory for pumps and fans.

- **Grinding mills, separators (large centrifugal masses)**

  Kp (p1470) = 12 to 20

  Tn (p1472) = 500 ms to 1000 ms

- **Kneader drives**

  Kp (p1470) = 10

  Tn (p1472) = 200 ms to 400 ms

  Note

  Check speed control gain

  We recommend checking the effective speed control gain (r1468) during operation. If this value changes during operation, Kp adaptation is being used (p1400.5 = 1). Kp adaptation can, if necessary, be deactivated or its behavior changed.

- **Operation with an encoder (p1300 = 21)**

  A smoothing value for the actual speed value (p1442) = 5 ms to 20 ms ensures quieter operation of motors with gear units.

7.4.4.1 Speed controller feedfoward control (integrated feedfoward control with balancing)

Description

The command behavior of the speed control loop can be improved by calculating the accelerating torque from the speed setpoint and connecting it on the input side of the speed controller. This torque setpoint mv is applied directly as an additive reference variable on the input side/supply side of the current controller by means of adaptation elements (enabled via p1496).
The torque setpoint (mv) is calculated from:

mv = p1496 x J x (dn/dt) = p1496 x p0341 x p0342 x (dn/dt)

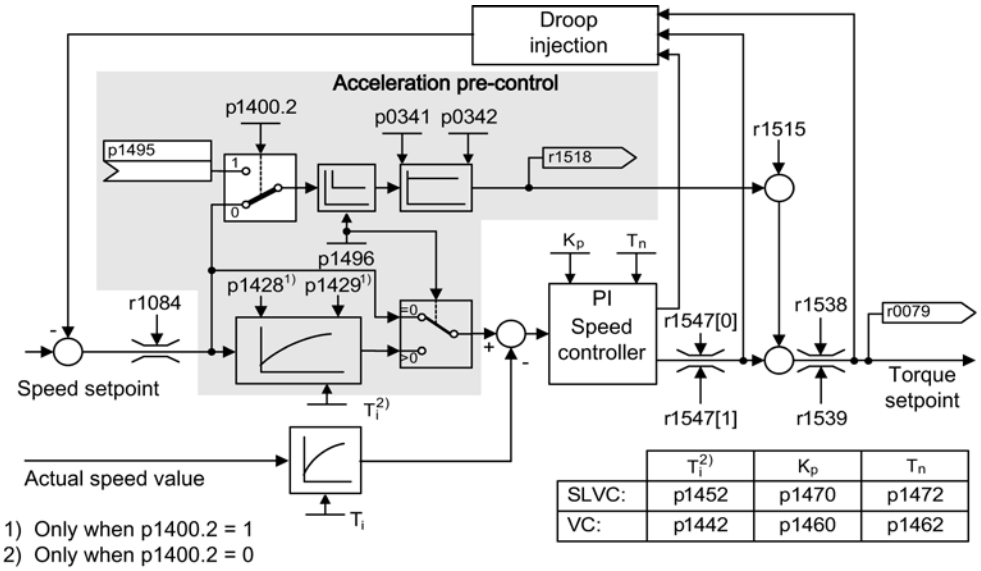
The motor moment of inertia p0341 is calculated when the drive system is commissioned. The factor p0342 between the total moment of inertia J and the motor moment of inertia must be determined manually or by optimizing the speed controller. The acceleration is calculated from the speed difference as a function of time dn/dt.

Note

Using speed controller optimization

When speed controller optimization is carried out, the ratio between the total moment of inertia and that of the motor (p0342) is determined and acceleration feedfoward control scaling (p1496) is set to 100 %.

If p1400.2 = p1400.3 = 0, then the feedfoward control balancing is automatically set.



	T_i 2)	K_p	T_n
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-15 Speed controller with feedfoward control

When correctly adapted, when accelerating, the speed controller only has to compensate disturbance variables in its control loop. This is achieved with a relatively minor controlled variable change at the controller output.

The effect of the feedfoward control variable can be adapted according to the application using the weighting factor p1496. For p1496 = 100 %, the feedfoward control is calculated according to the motor and load moment of inertia (p0341, p0342). A balancing filter is used automatically to prevent the speed controller from acting against the injected torque setpoint. The time constant of the balancing filter corresponds to the equivalent delay time of the speed control loop. The speed controller feedfoward control is correctly set (p1496 = 100 %, calibration using p0342) if the I component of the speed controller (r1482) does not change while ramping-up or ramping-down in the range n > 20 % x p0310. Thus, the precontrol allows a new speed setpoint to be approached without overshoot (prerequisite: the torque limitation does not act and the moment of inertia remains constant).

If the speed controller is feedfoward controlled by means of injection, the speed setpoint (r0062) is delayed with the same smoothing time (p1442 or p1452) as the actual value (r1445). This ensures that no target/actual difference (r0064) occurs at the controller input during acceleration, which would be attributable solely to the signal propagation time.

When speed feedfoward control is activated, the speed setpoint must be specified continuously or without a higher interference level (prevents sudden torque changes). An appropriate signal can be generated by smoothing the speed setpoint or activating the ramp-function generator rounding p1130 – p1131.

The startup time r0345 ($T_{startup}$) is a measure for the total moment of inertia J of the machine and describes the time during which the non-loaded drive can be accelerated with the rated motor torque r0333 ($M_{mot,rated}$) from standstill to the rated motor speed p0311 ($n_{mot,rated}$).

r0345 = $T_{startup}$ = J x (2 x π x $n_{mot,rated}$) / (60 x $M_{mot,rated}$) = p0341 x p0342 x (2 x π x p0311) / (60 x r0333)

The ramp-up and ramp-down times should always be set to values larger than the startup time.

Note

Setting the ramp-function generator

The ramp-up and ramp-down times (p1120; p1121) of the ramp-function generator in the setpoint channel should be set accordingly so that the motor speed can track the setpoint during acceleration and braking. This will optimize the function of speed controller feedfoward control.

Acceleration feedfoward control using a connector input (p1495) is activated by the parameter settings p1400.2 = 1 and p1400.3 = 0. For balancing, p1428 (dead time) and p1429 (time constant) can be set.

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameters

- p0311 Rated motor speed
- r0333 Rated motor torque
- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- r0345 Rated motor startup time
- p1400.2 Acceleration feedfoward control source
- p1428 Speed feedfoward control balancing dead time
- p1429 Speed feedfoward control balancing time constant
- p1496 Acceleration feedfoward control scaling
- r1518 Acceleration torque

7.4.4.2 Reference model

Description

The reference model is activated with p1400.3 = 1.

The reference model is used to emulate the speed control loop with a P speed controller.

The loop emulation can be set in p1433 to p1435. It takes effect if p1437 is connected to the output of the model r1436.

The reference model delays the setpoint-actual value deviation for the integral component of the speed controller so that settling (stabilizing) operations can be suppressed.

The reference model can also be externally emulated and the external signal entered via p1437.

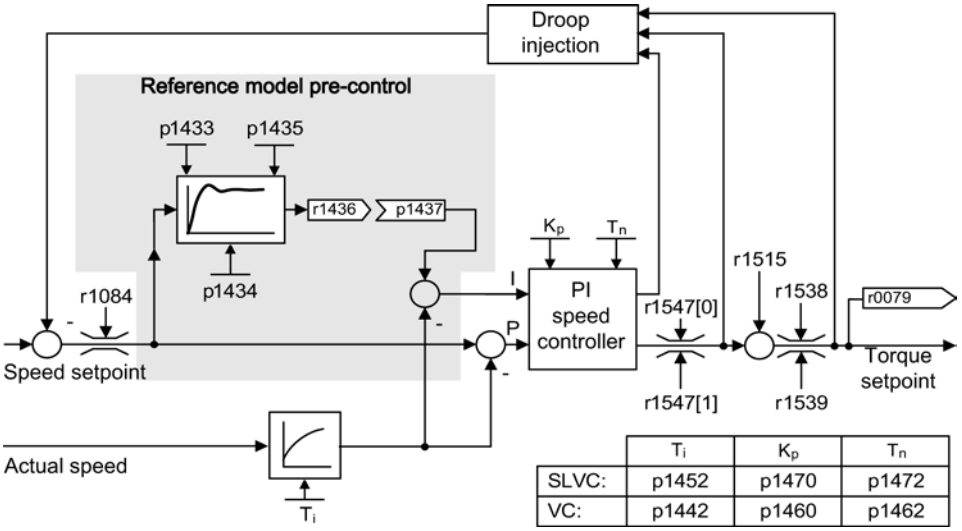


Figure 7-16 Reference model

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameters

- p1400.3 Reference model speed setpoint I component
- p1433 Speed controller reference model natural frequency
- p1434 Speed controller reference model damping
- p1435 Speed controller reference model deadtime
- r1436 Speed controller reference model speed setpoint output
- p1437 Speed controller reference model I component input

7.4.4.3 Speed controller adaptation

Description

Two adaptation methods are available, namely free Kp_n adaptation and speed-dependent Kp_n/Tn_n adaptation.

Free Kp_n adaptation is also active in "operation without encoder" mode and is used in "operation with encoder" mode as an additional factor for speed-dependent Kp_n adaptation.

Speed-dependent Kp_n/Tn_n adaptation is only active in "operation with encoder" mode and also affects the Tn_n value.

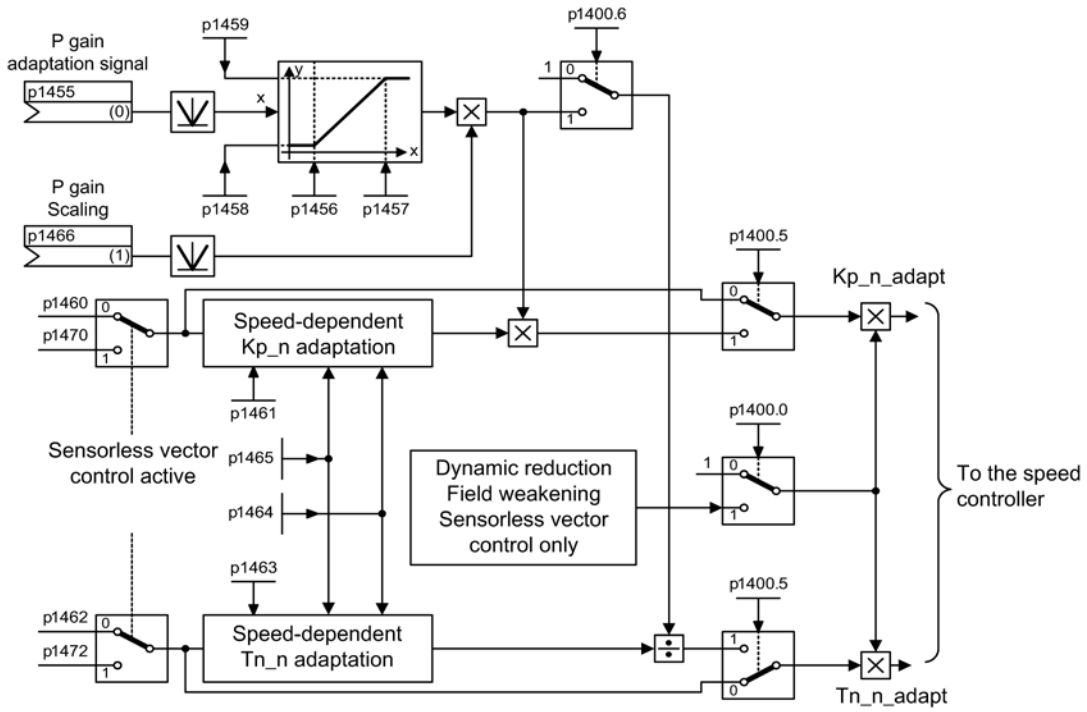


Figure 7-17 Free Kp adaptation

Dynamic response reduction in the field-weakening range can be activated in encoderless operation (p1400.0). This is activated when the speed controller is optimized in order to achieve a greater dynamic response in the base speed range.

Example of speed-dependent adaptation

Note

Only for operation with encoder

This type of adaptation is only active in "operation with encoder" mode.

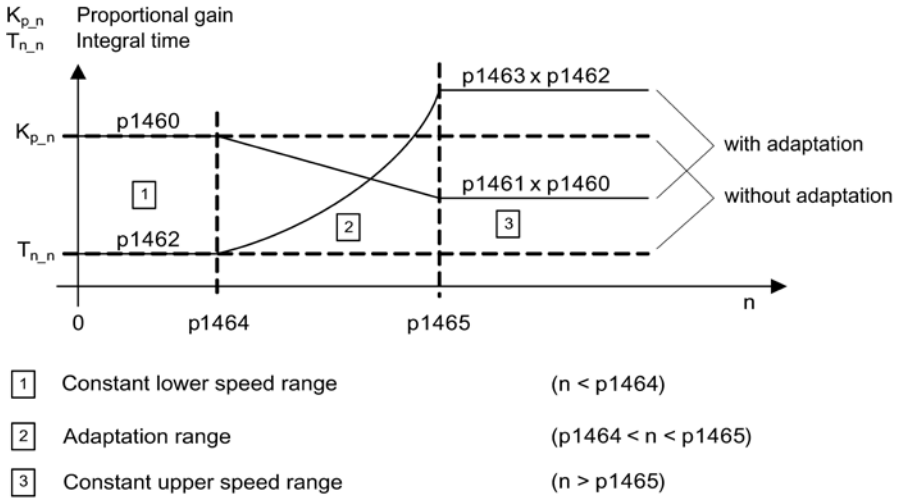


Figure 7-18 Example of speed-dependent adaptation

Function diagram

FP 6050 Speed controller adaptation (Kp_n/Tn_n adaptation)

Parameters

- p1400.5 Speed control configuration: Kp/Tn adaptation active
- p1400.6 Speed control configuration: Free Tn adaptation active

Free Kp_n adaptation

- p1455 Speed controller P gain adaptation signal
- p1456 Speed controller P gain adaptation lower starting point
- p1457 Speed controller P gain adaptation upper starting point
- p1458 Adaptation factor. lower
- p1459 Adaptation factor. upper
- p1470 Speed controller encoderless operation P gain

Speed-dependent Kp_n/Tn_n adaptation (VC only)

- p1460 Speed controller P gain adaptation speed, lower
- p1461 Speed controller Kp adaptation speed, upper scaling
- p1462 Speed controller integral action time adaptation speed, lower
- p1463 Speed controller Tn adaptation speed, upper scaling
- p1464 Speed controller adaptation speed, lower
- p1465 Speed controller adaptation speed, upper
- p1466 Speed controller P gain scaling

Dynamic response reduction field weakening (encoderless VC only)

- p1400.0 Speed control configuration: Automatic Kp/Tn adaptation active

7.4.4.4 Droop

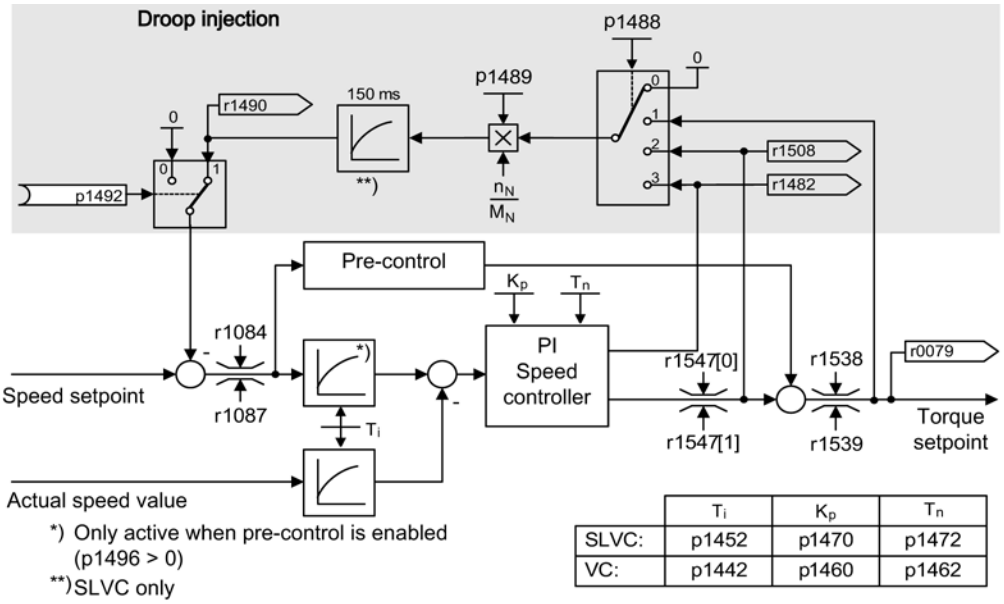
Description

Droop (enabled via p1492) ensures that the speed setpoint is reduced proportionally as the load torque increases.

The droop function has a torque limiting effect on a drive that is mechanically coupled to a different speed (e.g. lead roller on a conveyor). In this way, a very effective load distribution can also be realized in connection with the torque setpoint of a leading speed-controlled drive. In contrast to torque control or load distribution with overriding and limitation, with the appropriate setting, such a load distribution controls even a smooth mechanical connection.

This method is only suitable to a limited extent for drives that are accelerated and braked with significant changes in speed.

The droop feedback is used, for example, in applications in which two or more motors are connected mechanically or operate with a common shaft and fulfill the above requirements. It limits the torque differences that can occur as a result of the mechanical connection between the motors by modifying the speeds of the individual motors (drive is relieved when the torque becomes too great).



	Ti	Kp	Tn
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-19 Speed controller with droop

Requirement

- All connected drives must be operated with vector and speed control (with or without speed actual value encoder).
- The setpoints at the ramp function generators of the mechanically connected drives must be identical; the ramp function generators must have identical ramp-up and ramp-down times.

Function diagram

FP 6030 Speed setpoint, droop

Parameters

- r0079 Total speed setpoint
- r1482 Speed controller I torque output
- p1488 Droop input source
- p1489 Droop feedback scaling
- r1490 Droop feedback speed reduction
- p1492 Droop feedback enable
- r1508 Torque setpoint before supplementary torque

7.4.4.5 Open actual speed value

Description

Via the parameter p1440 (CI: speed controller actual speed value) is the signal source for the actual speed value of the speed controller. With the factory setting, the unsmoothed actual speed value r0063[0] is the default signal source.

Via parameter p1440, for example, a filter can be switched into the actual value channel or an external actual speed value can be fed in, according to the specific system requirements.

Parameter r1443 displays the actual speed value present at p1440.

Note

Feeding an external actual speed value

When feeding in an external actual speed value, ensure the monitoring functions continue to be derived from the motor model.

Behavior in conjunction with speed control with an encoder (p1300 = 21)

A motor encoder must always be available for the motor model's speed or position signal (for example, evaluation via SMC; see p0400). The actual speed of the motor (r0061) and the position information for synchronous motors continue to come from this motor encoder and are not influenced by the setting in p1440.

Interconnection of p1440:
When interconnecting connector input p1440 with an external actual speed value, ensure the speed scaling is the same (p2000).

The external speed signal should correspond on average to the speed of the motor encoder (r0061).

Behavior in conjunction with speed control without an encoder (p1300 = 20)

Depending on the transmission path of the external speed signal, dead times will accumulate; these dead times must be taken into account in the speed controller's parameter assignment (p1470, p1472) and can lead to commensurate losses in dynamic performance.
Signal transmission times must therefore be minimized.

Parameter setting p1750.2 = 1 is required so that the speed controller can operate even during a standstill. Otherwise, the system will switch over to open-loop controlled operation in the lower speed range; this will cause the speed controller to switch off, and the measured actual speed will no longer have any effect.

Monitoring the speed deviation between the motor model and the external speed

The external actual speed (r1443) is compared with the actual speed of the motor model (r2169). If the deviation is greater than the tolerance threshold set in p3236, after the switch-off delay time set in p3238 expires, fault F07937 (Drive: Speed deviation motor model to external speed) is generated and the drive switched-off corresponding to the set response (factory setting: OFF2).

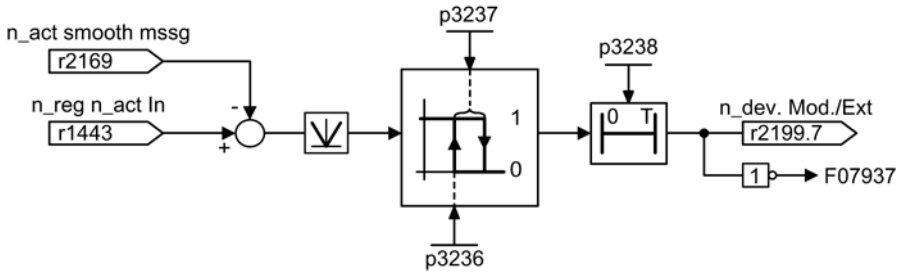


Figure 7-20 "Model / external speed deviation in tolerance" monitoring

Function diagram

FP 6040	Vector control – Speed controller with/without encoder
FP 8012	Signals and monitoring function – Torque messages, motor blocked/stalled

Parameters

- r0063[0] Actual speed unsmoothed
- p1440 CI: Speed controller actual speed value
- p1442 Speed controller actual speed value smoothing time
- r1443 CO: Speed controller actual speed value at actual value input
- p1452 Speed controller actual speed value smoothing time (without encoder)
- r2169 CO: Actual speed value smoothed, messages
- r2199.7 Model / external speed deviation in tolerance
- p3236 Speed threshold 7
- p3237 Hysteresis speed 7
- p3238 OFF delay n_act_motor_model = n_act_external

7.4.5 Torque control

Description

For encoderless speed control (p1300 = 20) or speed control with an encoder (p1300 = 21), it is possible to change over to closed-loop torque control using BICO parameter p1501. It is not possible to change over between speed control and torque control if closed-loop torque control is directly selected with p1300 = 22 or 23. The torque setpoint and/or supplementary setpoint can be entered using BICO parameter p1503 (CI: torque setpoint) or p1511 (CI: supplementary torque setpoint). The supplementary torque is effective for both closed-loop torque control and speed control. As a result of this characteristic, a feedforward control torque can be implemented for the speed control using the supplementary torque setpoint.

Note

No assignment to fixed torque setpoints

For safety reasons, assignments to fixed torque setpoints are currently not possible.

Note

Regenerative energy without feedback capability

If energy is regenerated and cannot be injected back into the line supply, then a braking module with a connected braking resistor must be used.

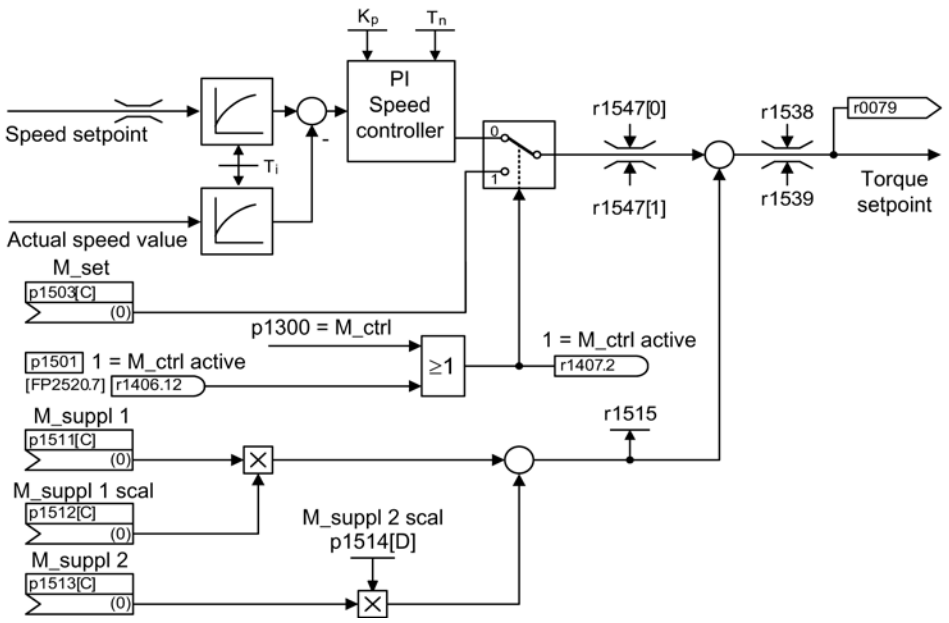


Figure 7-21 Closed-loop speed/torque control

The total of the two torque setpoints is limited in the same way as the speed control torque setpoint. Above the maximum speed (p1082), a speed limiting controller reduces the torque limits in order to prevent the drive from accelerating any further.

A "real" closed-loop torque control (with a speed that automatically sets itself) is only possible in the closed-loop control range but not in the open-loop control range of the encoderless closed-loop vector control. In the open-loop controlled range, the torque setpoint changes the setpoint speed via a ramp-up integrator (integrating time ~ p1499 x p0341 x p0342). This is the reason that encoderless closed-loop torque control close to standstill is only suitable for applications that require an accelerating torque there and no load torque (e.g. traversing drives). Closed-loop torque control with encoder does not have this restriction.

OFF responses

- OFF1 and p1300 = 22, 23
  - Response as for OFF2
- OFF1, p1501 = "1" signal and p1300 ≠ 22, 23
  - No separate braking response; the braking response is provided by a drive that specifies the torque.
  - The pulses are inhibited when the brake application time (p1217) expires. Standstill is detected when the actual speed value undershoots the speed threshold (p1226) or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Power-on inhibit is activated.

- OFF2
  - Immediate pulse suppression, the drive coasts to standstill.
  - The motor brake (if configured) is closed immediately.
  - Power-on inhibit is activated.
- OFF3
  - Switch to speed-controlled operation
  - n_set = 0 is input immediately to brake the drive along the OFF3 deceleration ramp (p1135).
  - When standstill is detected, the motor brake (if configured) is closed.
  - The pulses are inhibited when the motor brake closing time (p1217) has elapsed. Standstill is detected when the actual speed value undershoots the speed threshold (p1226) or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Power-on inhibit is activated.

Function diagram

FP 6060 Torque setpoint

Parameters

- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- p1300 Open-loop/closed-loop control mode
- p1499 Accelerating for torque control, scaling
- p1501 Change over between closed-loop speed/torque control
- p1503 Torque setpoint
- p1511 Supplementary torque 1
- p1512 Supplementary torque 1 scaling
- p1513 Supplementary torque 2
- p1514 Supplementary torque 2 scaling
- r1515 Supplementary torque total

7.4.6 Torque limiting

Description

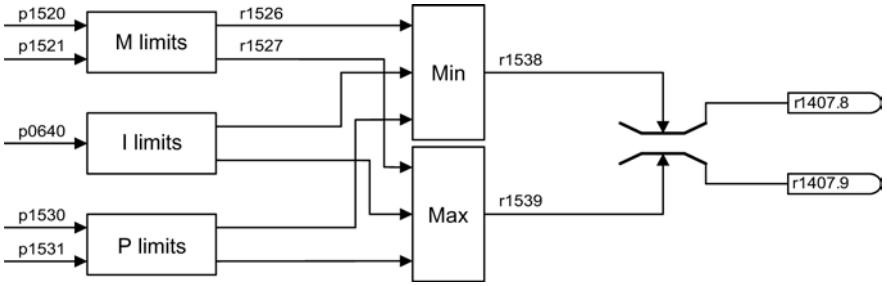


Figure 7-22 Torque limiting

This value specifies the maximum permissible torque; different limits can be parameterized for motor and regenerative mode.

- p0640 Current limit
- p1520 CO: Torque limit, upper/motoring
- p1521 CO: Torque limit, lower/regenerative
- p1522 CI: Torque limit, upper/motoring
- p1523 CI: Torque limit, lower/regenerative
- p1524 CO: Torque limit, upper/motoring, scaling
- p1525 CO: Torque limit, lower/regenerative scaling
- p1530 Power limit, motoring
- p1531 Power limit, regenerative

The currently active torque limits are displayed in the following parameters:

- r0067 Maximum drive output current
- r1526 Torque limit, upper/motoring without offset
- r1527 Torque limit, lower/regenerative without offset

All of the following limits act on the torque setpoint, which is present either at the speed controller output for speed control or as a torque input for closed-loop torque control. The minimum or the maximum of the various limits is used. This minimum or maximum is cyclically calculated and is displayed in r1538 or r1539.

- r1538 Upper effective torque limit
- r1539 Lower effective torque limit

These cyclical values therefore limit the torque setpoint at the speed controller output/torque input and indicate the maximum possible torque at a given moment If the torque setpoint is limited, then this is displayed using parameter p1407.

- r1407.8 Upper torque limit active
- r1407.9 Lower torque limit active

Function diagram

FP 6060 Torque setpoint
FP 6630 Upper/lower torque limit
FP 6640 Current/power/torque limits

7.4.7 Current setpoint filter

Description

The current setpoint filter is used to suppress cyclic disturbance variables that can be caused by mechanical vibrations in the drive train.

The current setpoint filter can be set as follows:

- Low-pass 2nd order (PT2: -40 dB/decade)
- General 2nd order filter

Band-stop and low-pass with reduction are converted into the parameters of the general 2nd order filter via STARTER.

The current setpoint filters are activated with p1656.0 = 1 and p1656.1 = 1. The properties of the current setpoint filter are set with p1657 to p1666.

As long as changes to the data of the current setpoint filter are being made, the conversion of the new filter data can be prevented using p1699 = 1.
When p1699 = 0 is set, the calculation will be performed and the new values applied.

Function diagrams

FP 6710 Current setpoint filter

Parameters

- p1655[0] CI: Current setpoint filter 1 natural frequency tuning
- p1655[1] CI: Current setpoint filter 2 natural frequency tuning
- p1656.0 Current setpoint filter 1 activation
- p1657 Current setpoint filter 1 type
- p1658 Current setpoint filter 1 denominator natural frequency
- p1659 Current setpoint filter 1 denominator damping
- p1660 Current setpoint filter 1 numerator natural frequency
- p1661 Current setpoint filter 1 numerator damping
- p1656.1 Current setpoint filter 2 activation
- p1662 Current setpoint filter 2 type
- p1663 Current setpoint filter 2 denominator natural frequency
- p1664 Current setpoint filter 2 denominator damping
- p1665 Current setpoint filter 2 numerator natural frequency
- p1666 Current setpoint filter 2 numerator damping
- p1699 Filter data acceptance

7.4.8 Permanent-magnet synchronous motors

Description

Permanent-magnet synchronous motors without encoders are supported during operations without encoders.

Typical applications include direct drives with torque motors, which are characterized by high torque at low speeds, e.g., Siemens 1FW3 series torque motors. When these drives are used, gear units and mechanical parts subject to wear can be dispensed with if the application allows this.



⚠ WARNING

Danger to life from electric shock due to rotating permanent-magnet synchronous motors

As soon as the motor turns, a voltage is generated at the connection terminals that when touched can result in death or serious injury.

- Disconnect the motor when working on the drive.
- If the connecting cables to the motor cannot be disconnected, secure the motor to prevent unintended rotating movements, e.g., by a holding brake.

Features

- Field weakening of up to approx. 1.2 times the rated speed (depending on the supply voltage of the drive and motor data, also see general conditions)
- Flying restart (during operation without encoders, only when a VSM module is used to record the motor speed and phase angle (option K51))
- Speed and torque vector control
- Vector V/f control for diagnostics
- Motor identification
- Speed controller optimization (rotary measurement)

General conditions

- Maximum speed and maximum torque are dependent on the drive output voltage available and the back EMF of the motor (calculation specifications: EMF must not exceed $U_{rated,\ drive}$).
- Calculating the maximum speed:

$$n_{max} = n_n \cdot \sqrt{\frac{3}{2}} \cdot \frac{U_{Vdc\ max} \cdot I_n}{P_n}$$

- Depending on the terminal voltage and load cycle, the maximum torque can be taken from the motor data sheets/configuration instructions.
- No thermal model is available for the closed-loop control of a permanent-magnet synchronous motor. The motor can only be protected against overheating through the use of temperature sensors (PTC, KTY). To achieve a high level of torque accuracy, we recommend the use of a temperature sensor (KTY) to measure the motor temperature.

Commissioning

The following sequence is recommended for commissioning:

- Configure the drive

  When the drive is commissioned using STARTER or the AOP30 operator panel, the permanent-magnet synchronous motor must be selected. The motor data specified in the table below must then be entered. Finally, the motor identification routine and speed optimization (p1900) are activated. Encoder adjustment is activated automatically together with the motor identification routine.
- Motor identification (standstill measurement, p1910)
- Speed controller optimization (rotary measurement, p1960)

Motor data for permanent-magnet synchronous motors

Table 7- 2 Motor data rating plate

Parameter	Description	Comments
p0304	Rated motor voltage	If this value is not known, the value "0" can also be entered. Entering the correct value, however, means that the stator leakage inductance (p0356, p0357) can be calculated more accurately.
p0305	Rated motor current	
p0307	Rated motor power	
p0310	Rated motor frequency	
p0311	Rated motor speed	
p0314	Motor pole pair number	If this value is not known, the value "0" can also be entered.
p0316	Motor torque constant	If this value is not known, the value "0" can also be entered.

If the torque constant k_T is not stamped on the rating plate or specified in the data sheet, you can calculate this value from the rated motor data or from the stall current I_0 and stall torque M_0 as follows:

$$k_T = \frac{M_N}{I_N} = \frac{60\frac{s}{min} \times P_N}{2\pi \times n_N \times I_N}$$

or

$$k_T = \frac{M_0}{I_0}$$

The optional motor data can be entered if it is known. Otherwise, this data is estimated from the rating plate data or determined using motor identification or speed controller optimization.

Table 7- 3 Motor data rating plate

Parameter	Description	Comments
p0320	Rated motor short-circuit current	This is used for the field weakening characteristic
p0322	Maximum motor speed	Maximum mechanical speed
p0323	Maximum motor current	De-magnetization protection
p0325	Rotor position identification current, 1st phase	-
p0327	Optional load angle	Optional; otherwise leave at 90 °
p0328	Reluctance torque constant	-
p0329	Rotor position identification current	-
p0341	Motor moment of inertia	For speed controller feedforward control
p0344	Motor weight	-
p0350	Stator resistance, cold	-
p0356	Quadrature axis stator inductance Lq	-
p0357	In-line stator inductance Ld	-

Short-circuit protection

For short circuits that can occur in the drive or in the motor cable, the rotating machine would supply the short-circuit until it comes to a standstill. An output contactor can be used for protection. This should be located as close as possible to the motor. This is particularly necessary if the motor can still be driven by the load when a fault develops. The contactor must be provided with a protective circuit against overvoltage on the motor side so that the motor winding is not damaged as a result of the shutdown.

Control signal r0863.1 (VECTOR) is used to control the contactor via a free digital output; the checkback contact of the contactor is connected to parameter p0864 via a free digital input.

This means that if the drive develops a fault with a shutdown response, at the instant in time that the pulses are inhibited, the motor is isolated from the drive so that energy is not fed back to the fault location.

Function diagram

FP 6721	Vector control - ID setpoint (PEM, p0300 = 2)
FP 6724	Vector control – field weakening controller (PEM, p0300 = 2)
FP 6731	Vector control - Interface to Motor Module (PEM, p0300 = 2)

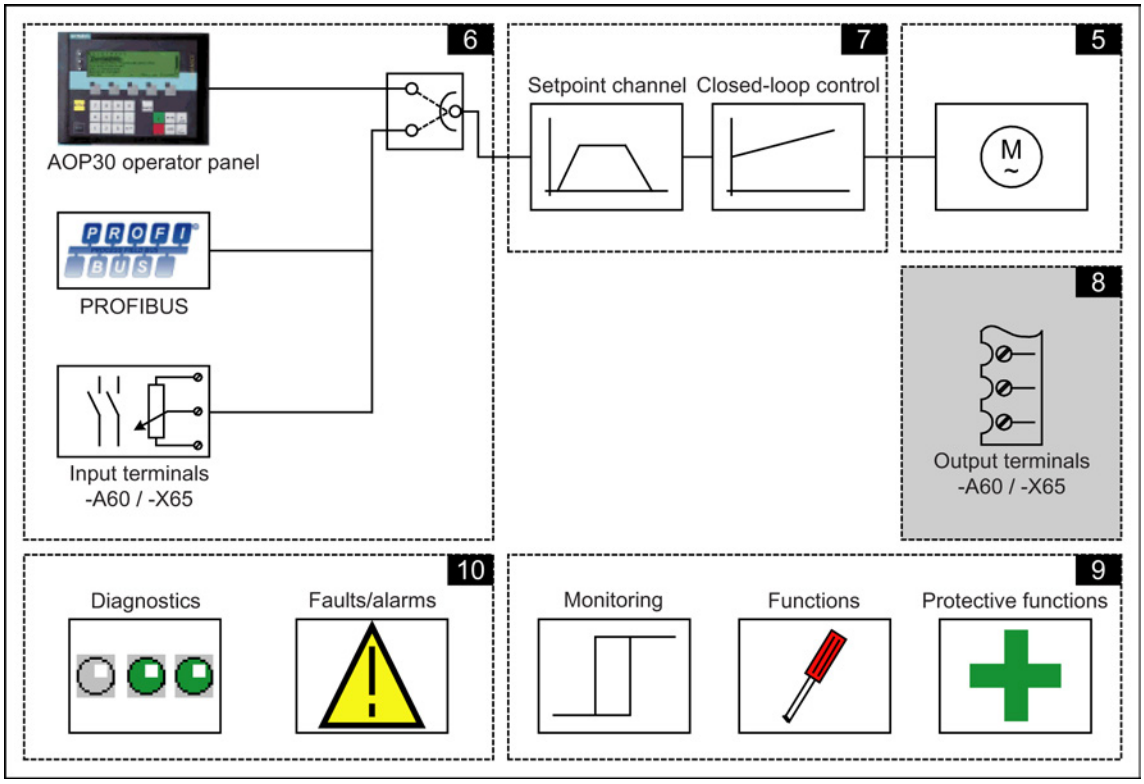
Output terminals

8

8.1 Chapter content

This section provides information on:

- Analog outputs
- Digital outputs



Function diagrams

At certain points in this section, reference is made to function diagrams. These can be found on the customer DVD in the "SINAMICS G130/G150 List Manual", which provides experienced users with detailed descriptions of all the functions.

8.2 Analog outputs

Description

The Customer Terminal Block features two analog outputs for outputting setpoints via current or voltage signals.

Delivery condition:

- AO0: Actual speed value 0 to 20 mA
- AO1: Actual motor value 0 to 20 mA

Signal flow diagram

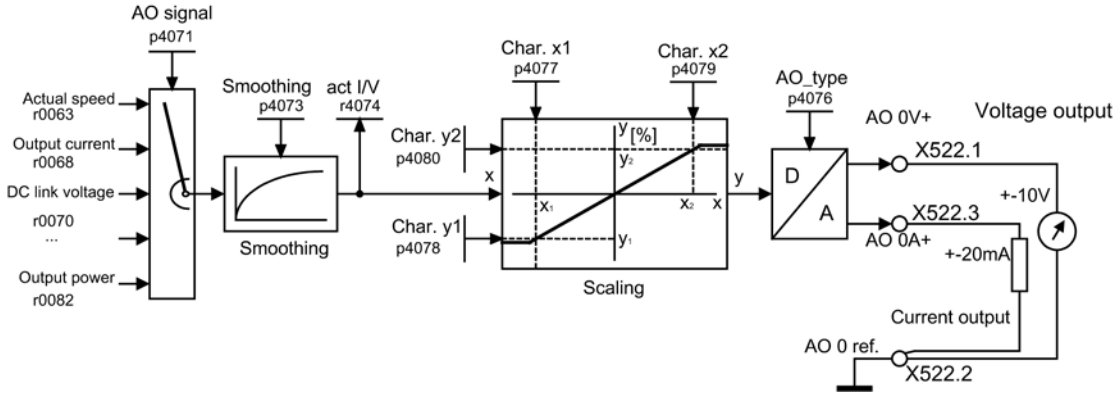


Figure 8-1 Signal flow diagram: analog output 0

Function diagram

FP 1840, FP 9572 TM31 - analog outputs (AO 0 to AO 1)

Parameters

- p4071 TM31 analog outputs signal source
- p4073 TM31 analog outputs smoothing time constant
- r4074 Analog outputs current output voltage/current
- p4076 TM31 analog outputs type
- p4077 TM31 analog outputs characteristic value x1
- p4078 TM31 analog outputs characteristic value y1
- p4079 TM31 analog outputs characteristic value x2
- p4080 TM31 analog outputs characteristic value y2

8.2.1 List of signals for the analog signals

List of signals for the analog outputs

Table 8- 1 List of signals for the analog outputs

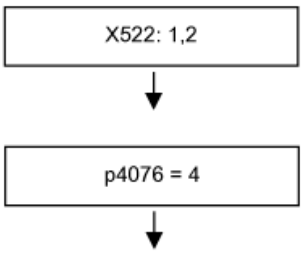
Signal	Parameters	Unit	Scaling (100% =...) See table below
Speed setpoint before the setpoint filter	r0060	rpm	p2000
Motor speed unsmoothed	r0061	rpm	p2000
Actual speed value after smoothing	r0063	rpm	p2000
Output frequency	r0066	Hz	Reference frequency
Output current	r0068	Aeff	p2002
DC link voltage	r0070	V	p2001
Torque setpoint	r0079	Nm	p2003
Output power	r0082	kW	r2004
For diagnostic purposes			
Speed controller system deviation	r0064	rpm	p2000
Modulation depth	r0074	%	Reference modulation depth
Torque-generating current setpoint	r0077	A	p2002
Torque-generating actual current	r0078	A	p2002
Flux setpoint	r0083	%	Reference flux
Actual flux	r0084	%	Reference flux
For further diagnostics			
Speed controller output	r1480	Nm	p2003
I component of speed controller	r1482	Nm	p2003

Scaling

Table 8- 2 Scaling

Size	Scaling parameter	Default for quick commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 x rated motor torque
Reference power	100 % = r2004	r2004 = (p2003 x p2000 x π) / 30
Reference frequency	100 % = p2000 / 60	
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference flux	100 % = Rated motor flux	
Reference temperature	100 % = p2006	p2006 = 100 °C

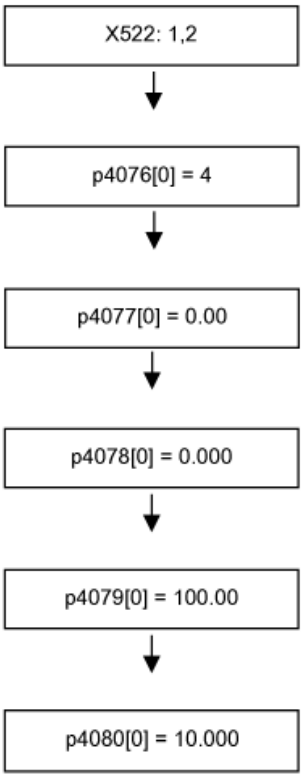
Example: Changing analog output 0 from current to voltage output -10 V ... +10 V



Voltage output present at terminal 1, ground is at terminal 2

Set analog output type 0 to -10 ... +10 V.

Example: Changing analog output 0 from current to voltage output -10 V ... +10 V and setting the characteristic



Voltage output present at terminal 1, ground is at terminal 2

Set TM31.AO_type [analog output 0] to -10 V ... +10 V.

Set TM31.AO_char. x1 to 0.00%.

Set TM31.AO_char. y1 to 0.000 V.

Set TM31.AO_char. x2 to 100.00%.

Set TM31.AO_char. y2 to 10.000 V.

8.3 Digital outputs

Description

Four bi-directional digital outputs (terminal X541) and two relay outputs (terminal X542) are available. These outputs are, for the most part, freely parameterizable.

Signal flow diagram

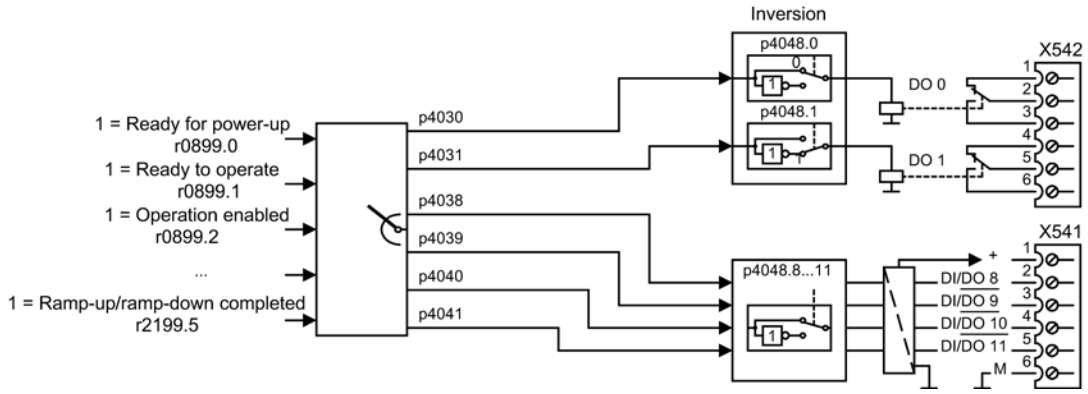


Figure 8-2 Signal flow diagram: Digital outputs

Delivery condition

Table 8- 3 Digital outputs, delivery condition

Digital output	Terminal	Delivery condition
DO0	X542: 2.3	"Enable pulses"
DO1	X542: 5.6	"No fault"
DI/DO8	X541: 2	"Ready to start"
DI/DO9	X541: 3	
DI/DO10	X541:4	
DI/DO11	X541: 5	

Selection of possible connections for the digital outputs

Table 8- 4 Selection of possible connections for the digital outputs

Signal	Bit in status word 1	Parameter
1 = Ready to start	0	r0899.0
1 = Ready for operation	1	r0899.1
1 = Operation enabled	2	r0899.2
1 = Fault present	3	r2139.3
0 = Coast to stop active (OFF2 active)	4	r0899.4
0 = Fast stop active (OFF3 active)	5	r0899.5
1 = Closing lockout active	6	r0899.6
1 = Alarm present	7	r2139.7
1 = Setpoint/actual speed deviation within tolerance band	8	r2197.7
1 = Master control requested	9	r0899.9
1 = f or n comparison value reached or exceeded	10	r2199.1
1 = I, M or P limit reached	11	r1407.7
1 = Open holding brake	12	r0899.12
0 = Alarm, motor overtemperature	13	r2135.14
1 = Motor rotates forward (n_act ≥ 0)0 = Motor rotates backwards (n_act < 0)	14	r2197.3
0 = Alarm thermal overload in power unit (A5000)	15	r2135.15
1 = Pulses enabled		r0899.11
1 = n_act ≤ p2155		r2197.1
1 = n_act > p2155		r2197.2
1 = Ramp-up/ramp-down completed		r2199.5
1 = |n_act| < p2161 (preferably as n_min or n=0 message)		r2199.0
1 = |M_set| < p2174		r2198.10
1 = LOCAL mode active (control via operator panel or control panel)		r0807.0
1 = Motor blocked		r2198.6

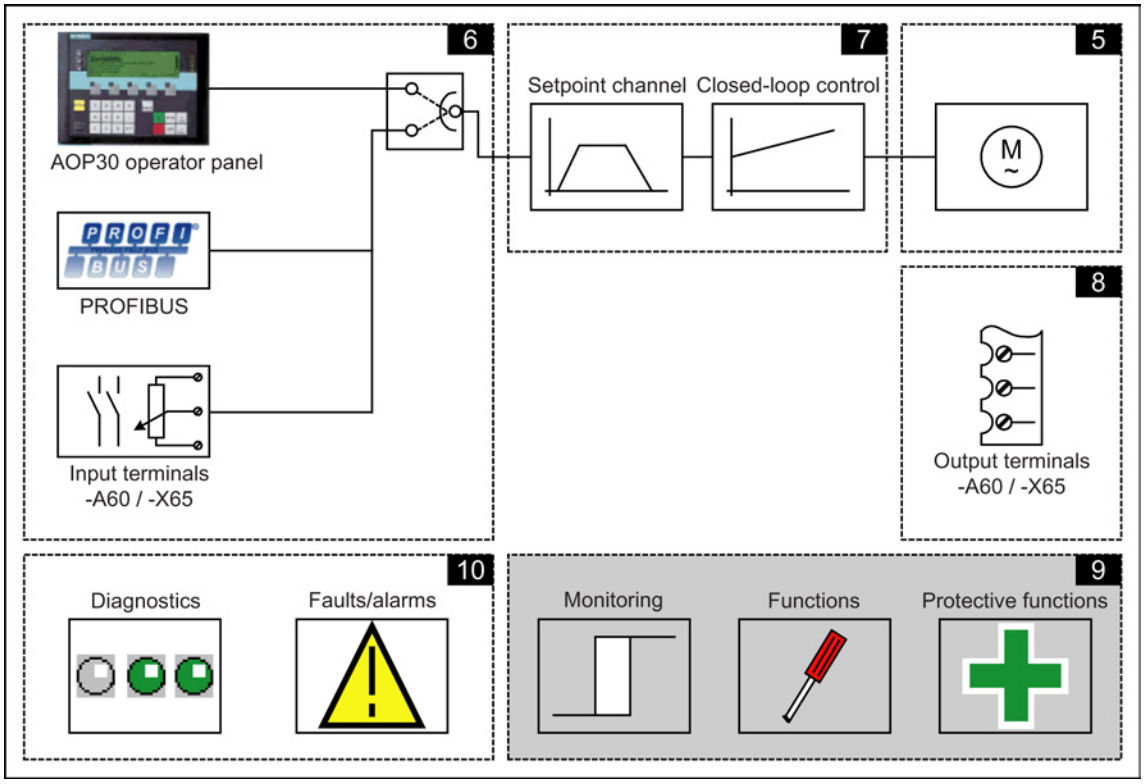
Functions, monitoring and protective functions

9

9.1 Content of this chapter

This section provides information on:

- Drive functions:
  Motor identification, efficiency optimization, quick magnetization for induction motors, Vdc control, automatic restart, flying restart, motor changeover, friction characteristic, armature short-circuit braking, DC braking, increase in the output frequency, pulse frequency wobbling, runtime, simulation operation, direction reversal, unit changeover, derating behavior with increased pulse frequency, simple brake control, energy savings indicator for fluid-flow machines, write protection, know-how protection, emergency operation, web server
- Extended functions:
  Technology controller, bypass function, extended brake control, extended monitoring functions
- Monitoring and protective functions:
  Power module protection, thermal monitoring functions and overload responses, blocking protection, stall protection, thermal motor protection



Function diagrams

At certain points in this section, reference is made to function diagrams. These can be found on the customer DVD in the "SINAMICS G130/G150 List Manual", which provides experienced users with detailed descriptions of all the functions.

9.2 Drive functions

9.2.1 Motor data identification and automatic speed controller optimization

Description

Two motor identification options, which are based on each other, are available:

- Motor identification with p1910 (standstill measurement)
- Rotating measurement with p1960 (speed controller optimization)

These can be selected more easily via p1900. p1900 = 2 selects the motor identification (motor not rotating). Parameter setting p1900 = 1 also activates the rotating measurement; p1910 is set to 1, and p1960 is set in accordance with the current control type (p1300).

Depending on p1300, parameter p1960 is set as follows:

- p1960 = 1, if p1300 = 20 or 22 (encoderless control)
- p1960 = 2, if p1300 = 21 or 23 (control with encoder)

The measurements configured using p1900 are started in the following sequence after the corresponding drive has been enabled:

- Motor identification at standstill, after the measurement has been completed, the pulses are inhibited and parameter p1910 is reset to 0.
- Encoder adjustment - after the measurement has been completed, the pulses are inhibited and parameter p1990 is reset to 0.
- Rotating measurement - after the measurement has been completed, the pulses are inhibited and parameter p1960 is reset to 0.
- After all of the measurements activated using p1900 have been successfully completed, p1900 itself is set to 0.

Note

Non-volatile saving

To make the new controller setting permanent, the data must be saved in non-volatile memory with p0977 or p0971.

⚠ WARNING

Danger to life due to unexpected movement of the motor in the case of motor identification during rotating operation

When motor identification with optimization during rotating operation is selected, after the drive is commissioned it initiates movements of the motor that can reach the maximum motor speed.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional during commissioning.

9.2.1.1 Motor data identification

Description

Motor identification with p1910 is used for determining the motor parameters at standstill (see also p1960: speed controller optimization):

- Equivalent circuit diagram data p1910 = 1
- Magnetization characteristic p1910 = 3

For control engineering reasons, you are strongly advised to carry out motor data identification because the equivalent circuit diagram data, motor cable resistance, IGBT on-state voltage, and compensation for the IGBT lockout time can only be estimated if the data on the nameplate is used. For this reason, the stator resistance for the stability of sensorless vector control or for the voltage boost with the V/f characteristic is very important.

Motor data identification is essential if long supply cables or third-party motors are used. When motor data identification is started for the first time, the following data is determined with p1910 = 1 on the basis of the data on the nameplate (rated data):

Table 9- 1 Data determined through p1910

	Induction motor	Permanent-magnet synchronous motor
p1910 = 1	• Stator resistance (p0350) • Rotor resistance (p0354) • Stator leakage inductance (p0356) • Rotor leakage inductance (p0358) • Magnetizing inductance (p0360) • Drive valve threshold voltage (p1825) • Drive valve interlock times (p1828 ... p1830)	• Stator resistance (p0350) • Stator leakage inductance q axis (p0356) • Stator inductance d axis (p0357) • Drive valve threshold voltage (p1825) • Drive valve interlock times (p1828 ... p1830)
p1910 = 3	• Saturation characteristic (p0362 ... p0366)	not recommended Notice: When encoder adjustment is complete, the motor is automatically rotated approx. one revolution in order to determine the encoder zero mark.

Since the nameplate data provides the initialization values for identification, you must ensure that it is entered correctly and consistently (taking into account the connection type (wye/delta)) so that the above data can be determined.

It is advisable to enter the motor supply cable resistance (p0352) before the standstill measurement (p1910) is performed, so that it can be subtracted from the total measured resistance when the stator resistance is calculated (p0350).

Entering the cable resistance improves the accuracy of thermal resistance adaptation, particularly when long supply cables are used. This governs behavior at low speeds, particularly during encoderless vector control.

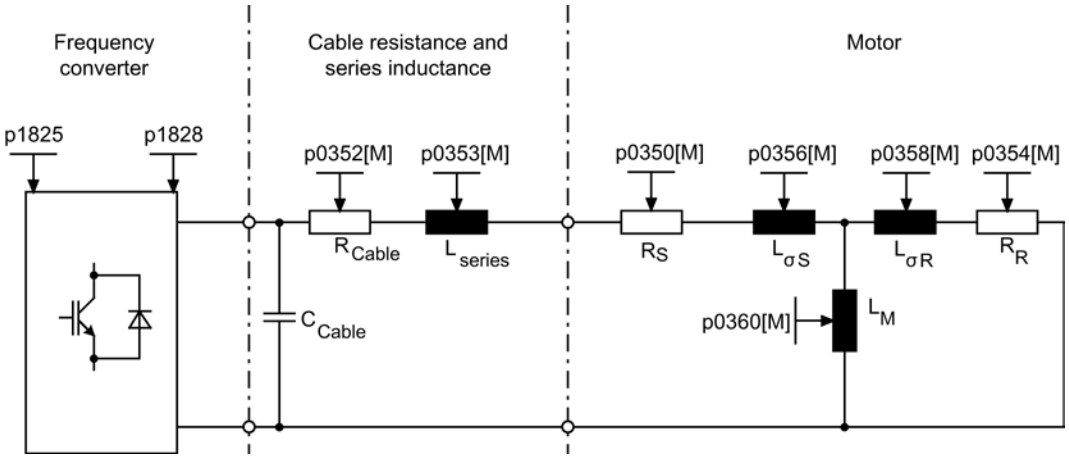


Figure 9-1 Equivalent circuit diagram for induction motor and cable

If an output filter (see p0230) or series inductance (p0353) is used, the data for this must also be entered before the standstill measurement is carried out.

The inductance value is then subtracted from the total measured value of the leakage. With sine-wave filters, only the stator resistance, valve threshold voltage, and valve interlocking time are measured.

Note

Large spread of the rated motor impedance

With diffusion of more than 35 % to 40 % of the motor nominal impedance, the dynamic response of the speed and current control is restricted to the area of the voltage limit and to field weakening mode.

Note

Perform standstill measurement with the motor in a cold state

The standstill measurement must be carried out when the motor is cold. In p0625, enter the estimated ambient temperature of the motor during the measurement (with KTY sensor: set p0600, p0601 and read r0035). This is the reference point for the thermal motor model and thermal R_S/R_R adaptation.

In addition to the equivalent circuit diagram data, motor data identification (p1910 = 3) can be used for induction motors to determine the magnetization characteristic of the motor. Due

to the higher accuracy, the magnetization characteristic should, if possible, be determined during the rotating measurement (without encoder: p1960 = 1, 3; with encoder: p1960 = 2, 4). If the drive is operated in the field-weakening range, this characteristic should be determined for vector control in particular. The magnetization characteristic can be used to calculate the field-generating current in the field-weakening range more accurately, thereby increasing torque accuracy.

Note

Results of the rotating measurement

In comparison with the standstill measurement (p1910), for induction motors, the rotating measurement (p1960) allows the rated magnetization current and saturation characteristic to be determined more accurately.

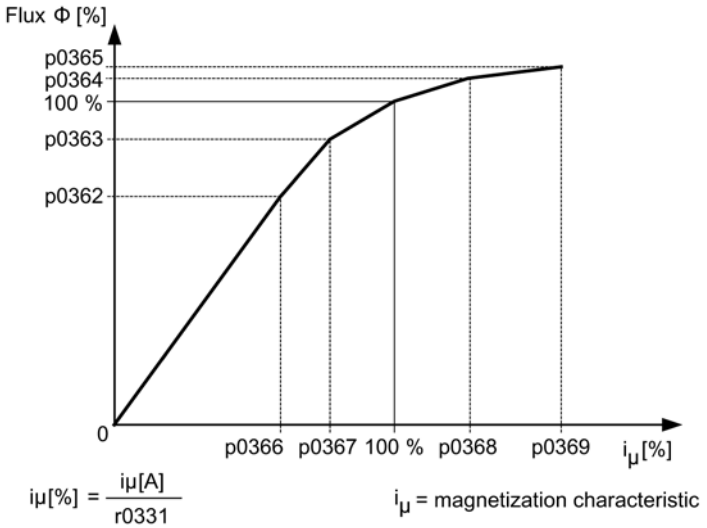


Figure 9-2 Magnetization characteristic

Carrying out motor identification

- Enter p1910 > 0. Alarm A07991 is displayed.
- Identification starts when the motor is switched on.
- p1910 resets itself to "0" (successful identification) or fault F07990 is output.
- r0047 displays the current status of the measurement.

Note

Non-volatile saving

To make the new controller setting permanent, the data must be saved in non-volatile memory with p0977 or p0971.

WARNING

Danger to life due to unexpected movement of the motor during motor identification

When motor identification is selected, movements of the motor can be initiated after the drive is commissioned.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional during commissioning.

9.2.1.2 Rotating measurement and speed controller optimization

Description

Rotating measurement can be activated via p1960 or p1900 = 1.

The main difference between rotating measurement and standstill measurement is speed control optimization, with which the drive's moment of inertia is ascertained and the speed controller is set. In addition, the saturation characteristic and rated magnetization current of induction motors are measured.

If the rotating measurement is not to be carried out using the speed set in p1965, this parameter can be changed before the measurement is started. Higher speeds are recommended.

The same applies to the speed in p1961, at which the saturation characteristic is determined and the encoder test is carried out.

The speed controller is set to the symmetrical optimum in accordance with dynamic factor p1967. p1967 must be set before the optimization run and only affects the calculation of the controller parameters.

If, during the measurement, it becomes clear that the drive cannot operate in a stable manner with the specified dynamic factor or that the torque ripples are too great, the dynamic response is reduced automatically and the result displayed in r1968. The drive must also be checked to ensure that it is stable across the entire range. The dynamic response might need to be reduced or Kp/Tn adaptation for the speed controller configured accordingly.

When commissioning induction machines, you are advised to proceed as follows:

- Before connecting the load, a complete "rotating measurement" (without encoder: p1960 = 1; with encoder: p1960 = 2) should be carried out. Since the induction machine is idling, you can expect highly accurate results for the saturation characteristic and the rated magnetization current.
- When the load is connected, speed controller optimization should be repeated because the total moment of inertia has changed. This is done by selecting parameter p1960 (without encoder: p1960 = 3; with encoder: p1960 = 4).
  During the speed optimization, the saturation characteristic plot is automatically deactivated in parameter p1959.

When permanent-magnet synchronous motors are commissioned, the speed controller should be optimized (p1960 = 2/4) when the load is connected.

Carrying out the rotating measurement (p1960 > 0)

The following measurements are carried out when the enable signals are set and a switch-on command is issued in accordance with the settings in p1959 and p1960.

- Encoder test
  If a speed encoder is used, the direction of rotation and the pulse number are checked.
- Induction motors only:
  - Measurement of the magnetization characteristic (p0362 to p0369)
  - Measurement of the magnetization current (p0320) and determination of the offset voltage of the drive for offset compensation
  - Measurement of the saturation of the leakage inductance and setting of the current controller adaptation (p0391…p0393)
    This is automatically activated with 1LA1 and 1LA8 motors (p0300 = 11, 18) (see p1959.5).
- Speed controller optimization
  - p1470 and p1472, if p1960 = 1 (encoderless operation)
  - p1460 and p1462, if p1960 = 2 (operation with encoder)
  - Kp adaptation switch-off
- Acceleration feedforward control setting (p1496)
- Setting for the total-moment-of-inertia-to-motor ratio (p0342)

Note

Non-volatile saving

To make the new controller setting permanent, the data must be saved in non-volatile memory with p0977 or p0971.

⚠ WARNING

Danger to life due to unexpected movement of the motor in the case of motor identification during rotating operation

When motor identification with optimization during rotating operation is selected, after the drive is commissioned it initiates movements of the motor that can reach the maximum motor speed.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional during commissioning.

Note

Speed controller optimization for operation with encoder

If speed control optimization is used for operation with encoder, then the control operating mode is automatically reset temporarily to speed control without encoder so that the encoder test can be carried out.

9.2.1.3 Shortened rotating measurement

A normal rotating measurement cannot always be performed when the load is connected. When switching on the motor for the first time, a moment of inertia measurement and the measurement of the magnetization current and the saturation characteristic can be performed with a simplified measuring procedure. There are two methods for this shortened rotating measurement:

- Measurement shortened (p1959.12 = 1)
- After measurement: Direct transfer to operation (p1959.13 = 1)

During the shortened rotating measurement, the drive is not moved up to the rated speed but up to the value set in p1965 (factory setting 40%). Parameter p1961 can be adjusted at the plant, but it must be high enough to ensure that the machine has left open-loop controlled operation. The machine should be operated in no-load operation (torque < 30% of M_{rated}) as far as is possible.

During the shortened rotating measurement the saving of parameters is disabled, because parameter adjustments are automatically made for the measurement, which are to be reassigned after the measurement.

Shortened measurement (p1959.12 = 1)

If p1959.12 = 1 is set, a shortened rotating measurement is carried out. In this case, the magnetizing current and moment of inertia are determined with a somewhat lower degree of accuracy; the vibration test is no longer required.

After the end of the measurement, the drive is moved to standstill and all the parameters modified for performing the measurement are set to their original values.

After measurement: Direct transfer to operation (p1959.13 = 1)

If p1959.13 = 1 is set, the drive is not stopped after the end of the shortened measurement, but is instead moved to the desired setpoint speed with the set ramp up.

Since braking to standstill cannot be performed during this measurement and no pulses are locked, no more parameters can be changed that could later be written back during operation.

Do not change controller parameters during the measurement (p1959.11 = 1)

With the rotating measurement, the drive independently changes its speed controller parameters during start-up. This also occurs if bits 3 and 4 of parameter 1959 are not set. In many cases, however, the decoupling of drives is linked to high cost. The loads have high moments of inertia. The controller parameters set by the drive do not always match the drive application and may therefore potentially cause damage to the mechanical system.

If p1959.11 = 1 is set, the recalculation of the speed controller parameters is prevented.

9.2.1.4 Parameters

- r0047 Motor data identification and speed controller optimization
- p1300 Open-loop/closed-loop control operating mode
- p1900 Motor data identification and rotating measurement
- p1959 Rotating measurement configuration
- p1960 Rotating measurement selection
- p1961 Saturation characteristic speed to determine
- p1965 Speed controller optimization speed
- p1967 Speed controller optimization dynamic factor
- r1968 Speed controller optimization actual dynamic factor
- r1969 Speed controller optimization inertia identified
- r1973 Rotating measurement encoder test pulse number determined
- p1980 Pole position identification procedure
- r3925 Identification final display
- r3927 Motor data identification, control word
- r3928 Rotating measurement configuration

9.2.2 Efficiency optimization

Description

The following can be achieved when optimizing efficiency using p1580:

- Lower motor losses in the partial load range
- Minimization of noise in the motor

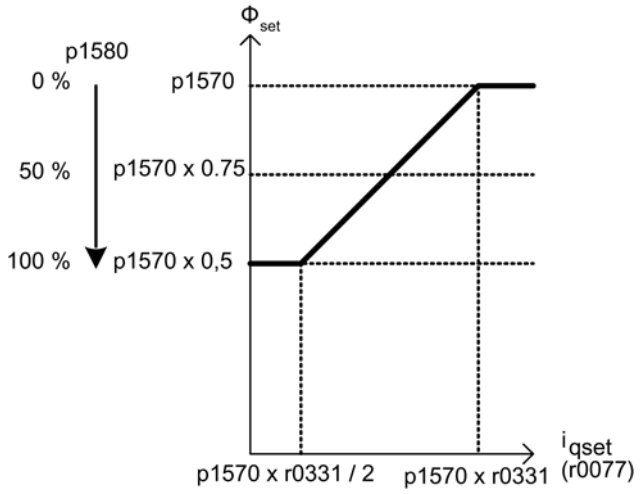


Figure 9-3 Efficiency optimization

It only makes sense to activate this function if the dynamic response requirements of the speed controller are low (e.g., pump and fan applications).

For p1580 = 100%, the flux in the motor under no-load operating conditions is reduced to half of the setpoint (reference flux) (p1570/2). As soon as load is connected to the drive, the setpoint (reference) flux increases linearly with the load and, reaching the setpoint set in p1570 at approx. r0077 = r0331 x p1570.

In the field-weakening range, the final value is reduced by the actual degree of field weakening. The smoothing time (p1582) should be set to approx. 100 ms to 200 ms. Flux differentiation (see also p1401.1) is automatically deactivated internally following magnetization.

Function diagram

FP 6722	Field weakening characteristic, Id setpoint (ASM, p0300 = 1)
FP 6723	Field weakening controller, flux controller for induction motor (p0300 = 1)

Parameters

- r0077 Current setpoints, torque-generating
- r0331 Motor magnetizing current/short-circuit current (actual)
- p1570 Flux setpoint
- p1580 Efficiency optimization
- p1582 Flux setpoint smoothing time

9.2.3 Fast magnetization for induction motors

Description

Fast magnetization for induction motors is used to reduce delay time during magnetization.

Features

- Rapid flux build-up by injecting a field-generating current at the current limit, which considerably reduces the magnetization time.
- If the "flying restart" function is activated, the excitation build-up time set in p0346 is still used.

Commissioning

Parameter setting p1401.6 = 1 is necessary to activate fast magnetization.

This setting initiates the following sequence during motor starting:

- The maximum excitation build-up current of the induction motor (in reference to the permitted rated power module current (r0207[0])) is set with parameter p0644 ("Current limit excitation build-up induction motor").
- The field-generating current setpoint jumps to the value set in p0644 or the maximum of Imax = 0.9 x r0067 (high limit field-generating current setpoint).
- The flux increases as fast as physically possible with the specified current.
- The flux setpoint r0083 is made to follow accordingly.
- As soon as the flux threshold value programmed in p1573 is reached (min.: 10 %, max. 200 %, factory setting: 100 %), excitation ceases and the speed setpoint is enabled. The flux threshold value must not be set too low for a large load because the torque-producing current is limited during magnetization.

  Note

  Influence of the flux threshold value

  The flux threshold value set in parameter p1573 is effective only if the actual flux during magnetization reaches the value programmed in p1573 before the timer set in p0346 runs down.

- The flux is increased further until the flux setpoint in p1570 has been reached.
- The field-producing current setpoint is reduced using a flux controller with P gain (p1590) and the assigned smoothing factor (p1616).

Notes

When quick magnetization is selected (p1401.6 = 1), soft starter is deactivated internally, and alarm A07416 displayed.

When the stator resistance identification function is active (see p0621 "Identification of stator resistance after restart"), quick magnetization is deactivated internally, and alarm A07416 displayed.

The parameter does not work when combined with the "flying restart" function (see p1200), i.e., flying restart is performed without quick magnetization.

Function diagram

FP 6491	Flux control configuration
FP 6722	Field weakening characteristic, Id setpoint (ASM, p0300 = 1)
FP 6723	Field weakening controller, flux controller (ASM, p0300 = 1)

Parameters

- p0320 Motor rated magnetization current/short-circuit current
- p0346 Motor excitation build-up time
- p0621 Stator resistance identification after restart
- p0640 Current limit
- p0644 Current limit excitation build-up induction motor
- p1401 Flux control configuration
- p1570 Flux setpoint
- p1573 Flux threshold value magnetization
- p1590 Flux controller P gain
- p1616 Current setpoint smoothing time

9.2.4 Vdc control

Description

The "Vdc control" function can be activated using the appropriate measures if an overvoltage or undervoltage is present in the DC link.

- Overvoltage in the DC link
  - Typical cause:
    The drive is operating in regenerative mode and is supplying too much energy to the DC link.
  - Remedy:
    Reduce the regenerative torque to maintain the DC link voltage within permissible limits.

    Note

    Fault F30002 "DC link overvoltage"

    If failure often arises and fault F30002 "DC link overvoltage" is reported when switching off or during rapid load changes, you may be able to improve the situation by increasing the gain factor for the Vdc controller p1250 (p1290), e.g., from "1.00" to "2.00".

- Undervoltage in the DC link
  - Typical cause:
    Failure of the mains voltage or supply for the DC link.
  - Remedy:
    Specify a regenerative torque for the rotating drive to compensate the existing losses, thereby stabilizing the voltage in the DC link. This process is known as kinetic buffering.
    Kinetic buffering is only possible as long as energy is generated by the movement of the drive.

Properties

- Vdc control
  - This comprises Vdc_max control and Vdc_min control (kinetic buffering), which are independent of each other.
  - It contains a joint PI controller. The dynamic factor is used to set Vdc_min and Vdc_max control independently of each other.
- Vdc_min control (kinetic buffering)
  - With this function, the kinetic energy of the motor is used for buffering the DC link voltage in the event of a momentary power failure, thereby decelerating the drive.
- Vdc_max control
  - This function is used to control momentary regenerative load without shutdown using "overvoltage in the DC link".
  - Vdc_max control is only recommended for a supply without active closed-loop control for the DC link and without feedback.

Description of Vdc_min control (kinetic buffering)

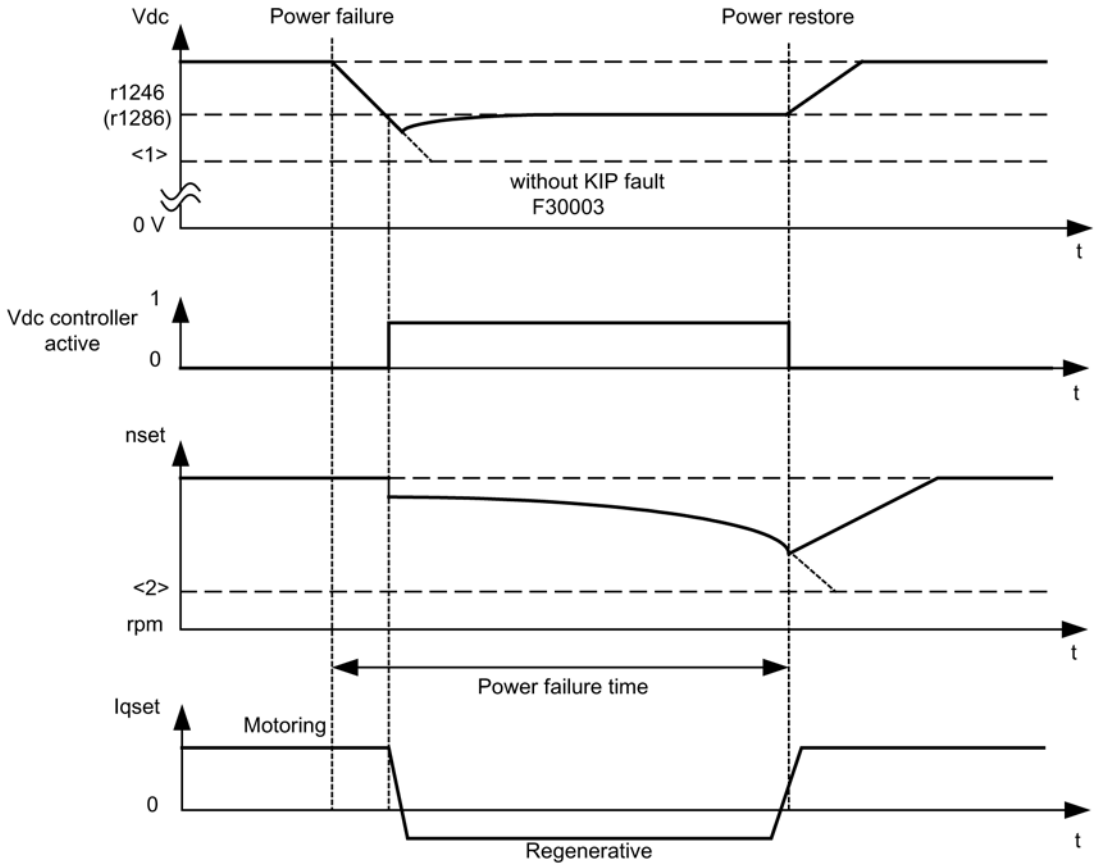


Figure 9-4 Switching Vdc_min control on/off (kinetic buffering)

Note

Activation of kinetic buffering

Kinetic buffering must only be activated in enclosed drive type A in conjunction with a secure external power supply.

When Vdc_min control is enabled with p1240 = 2.3 (p1280), it is activated if the power fails when the Vdc_min switch-in level (r1246 (r1286)) is undershot. In general, the regenerative power (braking energy) of the drive machine generated when the motor speed is reduced is used to buffer the DC link voltage of the drive; in other words, when Vdc_min control is active, the motor speed no longer follows the main setpoint and can be reduced to zero. The drive continues operating until the shutdown threshold of the DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>).

Note

Parameter specifications in brackets

All parameter specifications in parentheses refer to V/f control.

Distinction between V/f control and speed control:

- V/f control
  The Vdc_min controller acts on the speed setpoint channel. When Vdc_min control is active, the drive setpoint speed is reduced so that the drive becomes regenerative.
- Speed control
  The Vdc_min controller acts on the speed controller output and affects the torque-generating current setpoint. When Vdc_min control is active, the torque-generating current setpoint is reduced so that the drive becomes regenerative.

If the power fails, the DC link voltage decreases due to the lack of power from the supply system. When the DC link voltage threshold set via parameter p1245 (p1285) is reached, the Vdc_min controller is activated. Due to the PID properties of the controller, the motor speed is reduced to the extent that the regenerative drive energy maintains the DC link voltage at the level set in p1245 (p1285). The kinetic energy of the drive governs the dropout characteristic of the motor speed and, in turn, the buffering duration. In centrifugal mass drives (e.g., fans), buffering can last a few seconds. In drives with a low centrifugal mass (e.g., pumps), however, buffering can last just 100 – 200 ms. When the power is restored, the Vdc_min controller is deactivated and the drive is ramped up to its setpoint speed at the ramp-function generator ramp. As long as the Vdc_min controller is active, an alarm A7402 (drive: DC link voltage minimum controller active) will be issued.

If the drive can no longer generate any regenerative energy (because, for example, it is almost at a standstill), the DC link voltage continues to drop. If the minimum DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>), the drive will shut down with fault F30003 (power unit: DC link undervoltage).

If a speed threshold set with parameter p1257 (p1297) is undershot when Vdc_min control is active (see diagram "Switching Vdc_min control on/off" <2>), the drive is shut down with F7405 (drive: kinetic buffering minimum speed not reached).

If a shutdown with undervoltage in the DC link (F30003) occurs without the drive first coming to a standstill despite the fact that Vdc_min control is active, the controller may have to be optimized via dynamic factor p1247 (p1287). Increasing the dynamic factor in p1247 (p1287) causes the controller to intervene more quickly. The default setting for this parameter, however, should be sufficient for most applications.

Parameter p1256 = 1 (p1296) can be used to activate time monitoring for kinetic buffering. The monitoring time can be set in parameter p1255 (p1295). If buffering (i.e., the power failure) lasts longer than the time set here, the drive will shut down with fault F7406 (drive: kinetic buffering maximum time exceeded). The standard fault reaction for this fault is OFF3, which means that this function can be used for controlled drive deceleration in the event of a power failure. In this case, excess regenerative energy can only be dissipated via an additional braking resistor.

Description of Vdc_max control

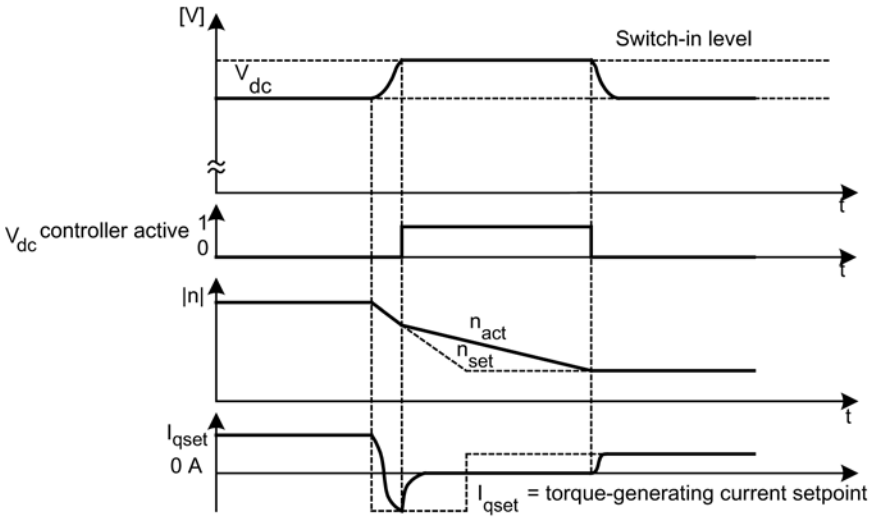


Figure 9-5 Switching Vdc_max control on/off

The switch-in level of the Vdc_max control (r1242 or r1282) is calculated as follows:

- when automatic switch-in level sensing is disabled (p1254 (p1294) = 0)
  - AC/AC device: r1242 (r1282) = 1.15 x √2 x p0210 (device supply voltage)
  - DC/AC device: r1242 (r1282) = 1.15 x p0210 (device supply voltage)
- when the automatic switch-in level sensing is enabled (p1254 = 1)
  r1242 (r1282) = Vdc_max - 50 V (Vdc_max: overvoltage threshold of the drive)

Function diagram

FP 6220 (FP 6320)	Vdc_max controller and Vdc_min controller

Parameters

- p1240 (p1280) Vdc controller or Vdc monitoring configuration
- r1242 (r1282) Vdc_min controller switch-in level
- p1243 (p1283) Vdc_max controller dynamic factor
- p1245 (p1285) Vdc_min controller switch-on level (kinetic buffering)
- r1246 (r1286) Vdc_min controller switch-on level (kinetic buffering)
- p1247 (p1287) Vdc_min controller dynamic factor (kinetic buffering)
- (p1288) Vdc_max controller feedback coupling factor ramp function generator (V/f)
- p1249 (p1289) Vdc_max controller speed threshold
- p1250 (p1290) Vdc controller proportional gain
- p1251 (p1291) Vdc controller integral time
- p1252 (p1292) Vdc controller rate time
- (p1293) Vdc_min controller output limit (V/f)
- p1254 (p1294) Vdc_max controller automatic ON level detection
- p1255 (p1295) Vdc_min controller time threshold
- p1256 (p1296) Vdc_min controller response (kinetic buffering)
- p1257 (p1297) Vdc_min controller speed threshold
- r1258 (r1298) Vdc controller output

9.2.5 Automatic restart function

Description

The automatic restart function automatically restarts the drive after an undervoltage or a power failure. The alarms present are acknowledged and the drive is restarted automatically.

The drive can be restarted using one of two procedures::

- The standard procedure starting from standstill, or
- The flying restart function.
  For drives with small moments of inertia and load torques that allow the drive to come to a standstill within a matter of seconds (e.g., pump drives operating against a pressure head), starting from standstill is recommended.

Note

Drives with high moments of inertia

The flying restart function can also be activated for drives with large moments of inertia (such as fan drives). This enables you to switch to the motor that is still rotating.

⚠ WARNING

Danger to life due to unexpected movement of the motor during automatic restart

If p1210 is set to values greater than (>) 1, the motor can be restarted automatically without the need to issue the ON command.

In the event of prolonged power failures when the automatic restart function is activated (p1210 > 1), the drive may have been at a standstill for a long time and mistakenly considered to have been switched off.

For this reason, entering the area around the drive when it is in this condition can result in death, serious injury, or property damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional.

Automatic restart mode

Table 9- 2 Automatic restart mode

p1210	Mode	Meaning
0	Disables automatic restart	Automatic restart inactive
1	Acknowledges all faults without restarting	If p1210 = 1, pending faults will be acknowledged automatically once their cause has been rectified. If further faults occur after faults have been acknowledged, these will also be acknowledged automatically. A minimum time of p1212 + 1 s must expire between successful fault acknowledgment and a fault re-occurring if the signal ON/OFF1 (control word 1, bit 0) is at a HIGH signal level. If the ON/OFF1 signal is set to LOW, the time between when a fault is acknowledged and another one occurs must be at least 1 s. If p1210 = 1, fault F07320 will not be generated if the acknowledge attempt fails (e.g., because the faults occurred too frequently).
4	Automatic restart after line supply failure, without additional startup attempts	If p1210 = 4, an automatic restart will only be performed if in addition fault F30003 occurs on the Motor Module or there is a high signal at binector input p1208[1], or in the case of an infeed drive object (A_Infeed), F06200 is pending. If additional faults are pending, then these faults will also be acknowledged; if this is successful, the startup attempt will be resumed. The failure of the CU's 24 V power supply will be interpreted as a line supply failure.
6	Restart after fault, with additional startup attempts	If p1210 = 6, an automatic restart will be performed after any fault or at p1208[0] = 1. If the faults occur one after the other, then the number of startup attempts is defined using p1211. Monitoring over time can be set using p1213.
14	Restart after line supply failure, after manual acknowledgment	Same as p1210 = 4; however, pending faults must be acknowledged manually.
16	Restart after fault, after manual acknowledgment	Same as p1210 = 6; however, pending faults must be acknowledged manually.

Startup attempts (p1211) and waiting time (p1212)

p1211 is used to specify the number of startup attempts. The number is decremented internally after each successful fault acknowledgment (line supply voltage must be restored or the infeed signals that it is ready). Fault F07320 is output when the number of configured startup attempts is reached.

If p1211 = x, x + 1 startup attempts will be made.

Note

Start of a startup attempt

A startup attempt starts immediately when the fault occurs.

The faults are acknowledged automatically at intervals of half the waiting time p1212.

Following successful acknowledgment and restoration of the voltage, the system is automatically powered up again.

The startup attempt has been completed successfully once the flying restart and magnetization of the motor (induction motor) has been completed (r0056.4 = 1) and one additional second has expired. The startup counter is not reset to the initial value p1211 until this point.

If additional faults occur between successful acknowledgment and the end of the startup attempt, then the startup counter, when it is acknowledged, is also decremented.

Automatic restart monitoring time (p1213)

- p1213[0] = monitoring time for automatic restart

  The monitoring time starts when the faults are detected. If the automatic acknowledgments are not successful, the monitoring time will continue. If the drive has not successfully restarted by the time the monitoring time expires (flying restart and motor magnetization must have been completed: r0056.4 = 1), fault F07320 is output.

  Monitoring is deactivated by setting p1213 = 0. If p1213 is set to a value lower than the sum of p1212, the magnetization time r0346 and the additional delay time due to flying restart, then fault F07320 will be generated on every restart attempt. If, for p1210 = 1, the time in p1213 is set to a value lower than p1212, then fault F07320 will also be generated on every restart attempt.

  The monitoring time must be extended if the faults that occur cannot be immediately and successfully acknowledged (e.g., when faults are permanently present).

  If p1210 = 14, 16, pending faults must be acknowledged manually within the time specified in p1213[0]. Otherwise, fault F07320 will be generated when the specified time runs out.

- p1213[1] = monitoring time for startup counter resetting

  The startup counter (see r1214) is only reset to starting value p1211 once the time in p1213[1] has expired after a successful restart. The wait time is not effective in the case of an error acknowledgment without an automatic restart (p1210 = 1). If the power supply fails (blackout), the wait time only starts once the power has been restored and the Control Unit is ramped up. The startup counter is set to starting value p1211 when F07320 has occurred, the switch-in command is withdrawn and the fault is acknowledged.

  If starting value p1211 or mode p1210 is changed, the startup counter is immediately updated.

Faults without automatic restart (p1206)

The automatic restart function can be disabled for up to 10 fault numbers via p1206[0...9].

This parameter only works if p1210 = 6 and p1210 = 16.

Parameters

- p1206[0…9] Faults without automatic restart
- p1210 Automatic restart mode
- p1211 Automatic restart, start attempts
- p1212 Automatic restart, delay time start attempts
- p1213 Automatic restart monitoring time
- r1214 Automatic restart status

Settings

To prevent the motor from switching to phase opposition when the drive is being restarted, there is a delay while the motor demagnetizes (t = 2.3 x motor magnetization time constant). Once this time has elapsed, the converter is enabled and the motor is supplied with power.

9.2.6 Flying restart

Description

The "flying restart" function (enabled via p1200) allows the drive to switch to a motor that is still rotating. Switching on the drive without the flying restart function would not allow any flux to build up in the motor while it is rotating. Since the motor cannot generate any torque without flux, this can cause it to switch off due to overcurrent (F07801).

The flying restart function first determines the speed of the drive with which V/f or vector control is initialized so that the drive and motor frequency can be synchronized.

During the standard start-up procedure for the drive, the motor must be at a standstill. The drive then accelerates the motor to the setpoint speed. In many cases, however, the motor is not at a standstill.

Two different situations are possible here:

1. The drive rotates as a result of external influences, such as water (pump drives) or air (fan drives). In this case, the drive can also rotate against the direction of rotation.
2. The drive rotates as a result of a previous shutdown (e.g. OFF 2 or a power failure). The drive slowly coasts to a standstill as a result of the kinetic energy stored in the drive train (example: induced-draft fan with a high moment of inertia and a steeply descending load characteristic in the lower speed range).

In accordance with the setting chosen (p1200), the flying restart function is activated in the following situations:

- Once power has been restored and the automatic restart function is active
- After a shutdown with the OFF2 command (pulse inhibit) when the automatic restart function is active
- When the ON command is issued

Note

Applications for flying restart function

The flying restart function must be used in cases where the motor may still be running or may still be driven by the load in order to prevent shutdowns due to overcurrent (F7801).

Note

Information on flying restart function

If the value set for parameter p1203 (search speed factor) is higher, the search curve is flatter and, as a result, the search time is longer. A lower value has the opposite effect.

In motors with a small moment of inertia, the flying restart function can cause the drive to accelerate slightly.

In group drives (multiple motors on a drive), the flying restart function should not be activated due to the different coasting properties of the individual motors.

9.2.6.1 Flying restart without an encoder

Description

Depending on parameter p1200, the flying restart function is started with the maximum search speed $n_{search,max}$ once the de-excitation time (p0347) has elapsed (see diagram "Flying restart").

$n_{Search,max} = 1.25 \times n_{max}$ (p1082)

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
  The search speed yielded from parameter p1203 reduces the search frequency in accordance with the motor current. The assignable search current (p1202) is injected here. If the search frequency is similar to the rotor frequency, a current minimum occurs.

Once the frequency has been found, the motor is magnetized. The output voltage during the magnetization time (p0346) is increased to the voltage value yielded from the V/f characteristic (see "Flying restart").

- Vector control without a speed encoder:
  The motor speed is determined using the speed adaptation control loop for the electric motor model. To begin with, the search current (p1202) is injected and then the controller is activated starting from the maximum search frequency. The dynamic response of the controller can be altered using the search speed factor (p1203). If the deviation of the speed adaptation controller is not too great, the motor continues to be magnetized for the duration assigned in p0346.

Once the excitation build-up time (p0346) has elapsed, the ramp-function generator is set to the speed actual value and the motor is ramped up to the current setpoint frequency.

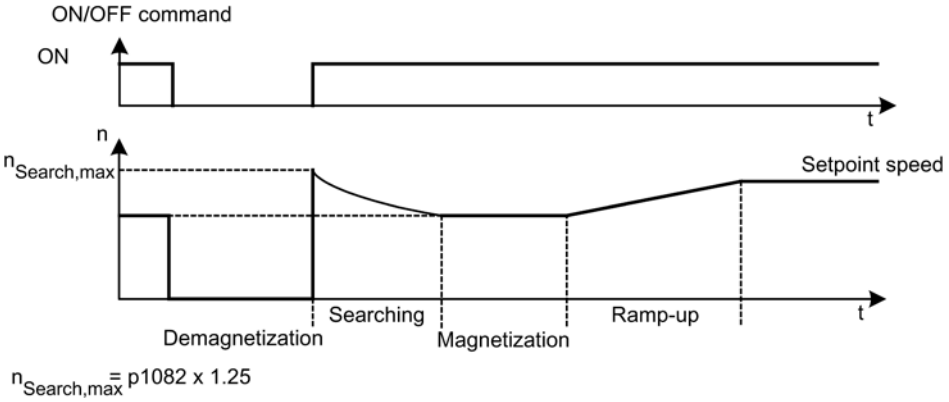


Figure 9-6 Flying restart

WARNING

Danger to life due to unexpected movement of the motor when flying restart is activated

When "flying restart" (p1200) is activated, the drive may still be accelerated by the search current despite the fact that it is at standstill and the setpoint is 0!

For this reason, entering the operating area of the motor when it is in this condition can result in death, serious injury, or property damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional.

Note

Flying restart without encoder for permanent-magnet synchronous motors

Flying restart without encoder for permanent-magnet synchronous motors is only possible when using a voltage sensing module VSM10 to record the motor speed (option K51).

Flying restart without encoder for long cables

In the case of long motor cables, the procedure described above lead to problems during a flying restart. In such cases, the following settings can improve the flying restart function:

- Enter the line resistance in parameter p0352 before motor data identification.
- Set the parameter p1203 to at least 300 %.
  With this setting, flying restart takes longer than for values below 300 %.

Note

Optimize the flying restart function

To optimize the flying restart, a trace recording should be used to check the function. If necessary, you can improve the result by making settings for parameters p1202 and p1203.

Fast flying restart (only for induction motors)

The "Fast flying restart" function can be activated during operation without encoder (vector control, V/f control linear and parabolic). For fast flying restart, the starting frequency is set to zero.
In this procedure, the flying restart function is performed successfully within a period of approximately 200 ms.

Fast flying restart function only works under the following conditions:

- With a current regulator cycle time of 250 µs or 400 µs (without motor-side filter and without long cables)
- Up to 4x the rated speed for vector control
- Up to the rated speed for V/f control

Note

The "fast flying restart" function is only possible for induction motors.

The settings for fast flying restart are configured in the expert list.

1. The "Fast flying restart" procedure is selected by setting p1780.11 = 1.

   For operation with encoder, settings of this bit are ignored because fast flying restart is not possible in this case.
2. Fast flying restart is activated using the p1200 parameter, as with the normal flying restart.
3. For the determination of the line resistance, a motor data identification must be carried out at standstill (p1900 = 2).

   The critical parameters are the motor stator resistance (p0350) and the motor stator leakage inductance (p0356).

The following condition code bits are available for the fast flying restart:

- For V/f control: r1204.14 (Fast flying start activated).
- For vector control: r1205.16 (fast flying restart activated) or r1205.17 (fast flying restart finished).

Note

Detection current must not become too small

If you have any problems with the fast flying restart it can be useful to set the search current (p1202) to values > 30 %. Problems can occur if the drive is operated far into the field weakening, or if it is operated with motor-side filters or long lines.

Fast flying restart with voltage measurement via VSM10

The time for the connection to a rotating induction motor can be shortened when the terminal voltage of the motor is measured.

Settings for fast flying restart with voltage measurement:

1. Select the voltage measurement for the fast flying restart: p0247.5 = 1.
2. Activate the flying restart: p1200 > 0.

The following status bits indicate the characteristic of the flying restart:

1. For V/f control: r1204.15
2. For vector control: r1205.18, r1205.19, r1205.20

Note

Voltage amplitude must not be too small

If the measured voltage amplitude undershoots the 1% limit of the converter rated voltage, the flying restart with voltage measurement is deactivated and the motor speed sought.

9.2.6.2 Flying restart with an encoder

Description

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
  Flying restart without an encoder (see "Flying restart without an encoder")
- Vector control with a speed encoder:
  Since the speed is known from the start, the motor can be magnetized immediately at the appropriate frequency. The duration of magnetization is specified in p0346. Once the excitation build-up time has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint speed.

WARNING

Danger to life due to unexpected movement of the motor when flying restart is activated

When "flying restart" (p1200) is activated, the drive may still be accelerated by the search current despite the fact that it is at standstill and the setpoint is 0!

For this reason, entering the operating area of the motor when it is in this condition can result in death, serious injury, or property damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional.

9.2.6.3 Parameters

- p0352 Line resistance
- p1200 Flying restart operating mode
  - 0: Flying restart inactive
  - 1: Flying restart always active (start in setpoint direction)
  - 2: Flying restart active after On, fault, OFF2 (start in setpoint direction)
  - 3: Flying restart active after fault, OFF2 (start in setpoint direction)
  - 4: Flying restart always active (start only in setpoint direction)
  - 5: Flying restart active after On, fault, OFF2 (start only in setpoint direction)
  - 6: Flying restart active after fault, OFF2 (start only in setpoint direction)
- p1202 Flying restart, search current
- p1203 Flying restart search rate factor
- r1204 Flying restart, V/f control status
- r1205 Flying restart, vector control status

Note

Set search direction for the flying restart

For p1200 = 1, 2, 3, the following applies: Search in both directions, start only in the setpoint direction.

For p1200 = 4, 5, 6, the following applies: Search only in the setpoint direction.

9.2.7 Motor changeover

9.2.7.1 Description

The motor data set changeover is used, for example, for:

- Changing over between different motors
- Motor data adaptation

Note

Switch to a rotating motor

To switch to a rotating motor, the "flying restart" function must be activated.

9.2.7.2 Example of changing over between two motors

Requirements

- First commissioning has been completed.
- 2 motor data sets (MDS), p0130 = 2
- 2 drive data sets (DDS), p0180 = 2
- 2 digital outputs to control the auxiliary contactors
- 2 digital inputs to monitor the auxiliary contactors
- 1 digital input to select the data set
- 2 auxiliary contactors with auxiliary switches (1 NO contact)
- 2 motor contactors with positively-driven auxiliary switches (1 NC contact, 1 NO contact)

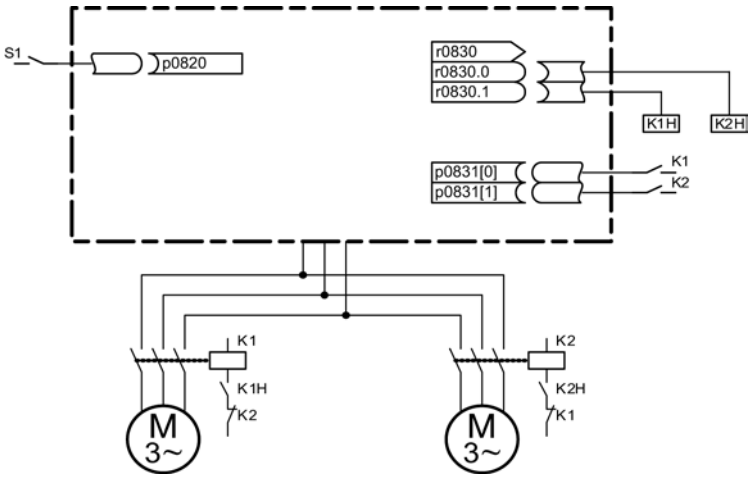


Figure 9-7 Example of motor changeover

Table 9- 3 Settings for the motor changeover example

Parameter	Settings	Comments
p0130	2	Configure 2 MDSs
p0180	2	Configure 2 DDSs
p0186[0..1]	0, 1	The MDSs are assigned to the DDSs.
p0820	Digital input, DDS selection	The digital input to change over the motor is selected via the DDS. Binary coding is used (p0820 = bit 0, etc.).
p0821 to p0824	0	
p0826[0..1]	1, 2	Different numbers mean different thermal models.
p0827[0..1]	0, 1	The bits of r0830 are assigned to the MDSs. If p0827[0] = 0, for example, bit r0830.0 is set via DDS0 when MDS0 is selected.
r0830.0 and r0830.1	Digital outputs, auxiliary contactors	The digital outputs for the auxiliary contactors are assigned to the bits.
p0831[0..1]	Digital inputs, auxiliary contacts	The digital inputs for the feedback signal of the motor contactors are assigned.
p0833.00 and .01	0, 0	The drive controls the contactor circuit and pulse inhibition.

Motor changeover sequence

1. Pulse inhibition:
   The pulses are inhibited following the selection of a new drive data set using p0820 to p0824.
2. Open motor contactor:
   Motor contactor 1 is opened (r0830 = 0), and the status bit "Motor changeover active" (r0835.0) is set.
3. Change over drive data set:
   The requested data set is activated (r0051 = data set currently effective, r0837 = requested data set).
4. Energize motor contactor:
   After the feedback signal (motor contactor opened) from motor contactor 1, the appropriate bit of r0830 is set and motor contactor 2 is energized.
5. Enable pulses:
   After the feedback signal (motor contactor closed) from motor contactor 2, the bit "motor data set changeover active" (r0835.0) is reset and the pulses are enabled. The motor has now been changed over.

9.2.7.3 Function diagrams

FP 8565 Drive Data Sets (DDS)
FP 8575 Motor Data Sets (MDS)

9.2.7.4 Parameter

- r0051 Drive data set DDS effective
- p0130 Motor Data Sets (MDS), count
- p0180 Drive Data Sets (DDS), count
- p0186 Motor data sets (MDS), number
- p0819[0...2] Copy Drive Data Set DDS
- p0820 BI: Drive Data Set DDS selection, bit 0
- p0821 BI: Drive Data Set DDS selection, bit 1
- p0822 BI: Drive Data Set DDS selection, bit 2
- p0823 BI: Drive Data Set DDS selection, bit 3
- p0824 BI: Drive Data Set DDS selection, bit 4
- p0826 Motor changeover, motor number
- p0827 Motor changeover status word bit number
- p0828 Motor changeover, feedback signal
- r0830 Motor changeover, status
- p0831 Motor changeover, contactor feedback signal
- p0833 Data set changeover configuration

9.2.8 Friction Characteristic

Description

The friction characteristic curve is used to compensate the friction torque for the motor and the driven machine. A friction characteristic allows the speed controller to be feedforward controlled and improves the control response.

Ten (10) interpolation points are used for the friction characteristic. The coordinates of every interpolation point are defined by a speed parameter (p382x) and a torque parameter (p383x) (point 1 = p3820 and p3830, point 10 = p3829 and p3839).

Features

- There are 10 interpolation points to represent the friction characteristic.
- An automatic function supports the friction characteristic plot.
- A connector output (r3841) can be interconnected as friction torque (p1569).
- The friction characteristic can be activated and de-activated (p3842).

Commissioning

Speeds for making measurements as a function of the maximum speed p1082 are pre-assigned in p382x when commissioning the drive system for the first time. These can be appropriately changed corresponding to the actual requirements.

The automatic friction characteristic plot can be activated using p3845. The characteristic is then plotted the next time that it is enabled.

The following settings are possible:

- p3845 = 0 Friction characteristic plot de-activated
- p3845 = 1 Friction characteristic plot activated, all directions
  The friction characteristic is plotted in both directions of rotation. The result of the positive and negative measurement is averaged and entered into p383x.
- p3845 = 2 Friction characteristic plot activated, positive direction
- p3845 = 3 Friction characteristic plot activated, negative direction

Parameter p3847 (friction characteristic plot, warm-up time) is used to specify the time the drive will take to warm up to its operating temperature. During this time, the highest speed set for the friction characteristic plot is reached and maintained in order for the drive to warm up to its operating temperature. The measurement then begins at the highest speed.

⚠WARNING

Danger to life due to unexpected movement of the motor when recording the friction characteristic

When the friction characteristic is plotted, the drive can cause the motor to move. As a result, the motor may reach maximum speed.

For this reason, entering the area around the drive when it is in this condition can result in death, serious injury, or property damage.

- Observe the general safety instructions.
- Ensure that the EMERGENCY OFF functions are functional.

Function diagram

FP 7010 Friction characteristic

Parameters

- p3820 Friction characteristic, value n0
- ...
- p3839 Friction characteristic, value M9
- r3840 Friction characteristic, status word
- r3841 Friction characteristic, output
- p3842 Activate friction characteristic
- p3843 Friction characteristic smoothing time friction moment difference
- p3844 Friction characteristic number changeover point at the top
- p3845 Activate friction characteristic plot
- p3846 Friction characteristic plot ramp-up/ramp-down time
- p3847 Friction characteristic plot warm-up time

9.2.9 Armature short-circuit braking, DC braking

9.2.9.1 General information

The "External armature short circuit" function for permanent-magnet synchronous motors controls an external contactor, which short-circuits the motor through resistors in the event of pulse suppression. This decreases the motor's kinetic energy.

The "Internal armature short circuit" function for permanent-magnet synchronous motors short-circuits a half bridge in the power module to control the motor power consumption, thus braking the motor.

The "DC braking" function for induction motors injects direct current into the motor, thus braking the motor.

9.2.9.2 External armature short-circuit braking

Description

External armature short circuit braking is only available for synchronous motors. It is used preferably when braking in an emergency, if controlled braking via the drive is no longer possible (for example, in the event of a power failure, an EMERGENCY OFF, etc.) or if no regenerative infeed is used. In this case, the motor stator windings are short-circuited via external braking resistors. This creates additional resistance in the motor circuit, which helps reduce the kinetic energy of the motor.

The external armature short circuit is activated via p1231 = 1 (with contactor feedback signal) or p1231 = 2 (without contactor feedback signal). It is initiated when the pulses are suppressed.

This function uses output terminals to control an external contactor, which then short-circuits the motor through resistors when the pulses are suppressed.

A prerequisite for the use of the external armature short circuit is the use of a permanent-magnet synchronous motor (p0300 = 2xx).

NOTICE
Property damage due to use of motors that are not short-circuit proof
When motors that are not short-circuit proof are used, they can be damaged by external armature short-circuit braking. • Only use motors that are short-circuit proof. • Use suitable resistances for the short-circuiting.

Note

Consequences of incorrect configuration

In case of incorrect configuration (e.g., induction motor and external armature short-circuit selected), fault F07906 "Armature short circuit/internal voltage protection: Parameterization error" is generated.

Function diagram

FP 7014 Technology function - External armature short circuit

Parameters

- p0300 Motor type selection
- p1230 BI: Armature short circuit / DC brake activation
- p1231 Armature short-circuit/DC braking configuration
  - 1: External armature short circuit with contactor feedback signal
  - 2: External armature short-circuit without contactor feedback signal
- p1235 BI: External armature short circuit, contactor feedback signal
- p1236 External armature short circuit, contactor feedback signal monitoring time
- p1237 External armature short circuit, waiting time when opening
- r1238 CO: Armature short circuit, external state
- r1239 CO/BO: Armature short-circuit/DC braking status word

9.2.9.3 Internal armature short-circuit braking

Description

Internal armature short circuit braking is only available for synchronous motors. It is used preferably when braking in an emergency, if controlled braking via the drive is no longer possible (for example, in the event of a power failure, an EMERGENCY OFF, etc.) or if no regenerative infeed is used. In this case, the motor stator windings are short-circuited via a half bridge in the power module. This creates additional resistance in the motor circuit, which helps reduce the kinetic energy of the motor.

The internal armature short circuit is configured via p1231 = 4 and activated via p1230. It is initiated when the pulses are suppressed.

A prerequisite for the use of the internal armature short circuit is the use of a permanent-magnet synchronous motor (p0300 = 2xx).



DANGER

Danger to life from electric shock due to armature short-circuit braking

When the armature short-circuit is active, all the motor terminals are at half the DC-link potential after the pulse suppression.

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

- Observe the general safety instructions.

NOTICE

Property damage due to use of motors that are not short-circuit proof or use of an incorrectly dimensioned Power Module/Motor Module

When motors that are not short-circuit proof are used, the motors or the Power Module/Motor Module can be damaged when the internal armature short-circuit braking is activated.

- Only use motors that are short-circuit proof.
- Use suitable resistances for the short-circuiting.
- The Power Module / Motor Module must be dimensioned for 1.8 times the short-circuit current of the motor.

Function diagram

FP 7016 Technology function - Internal armature short circuit

Parameters

- p0300 Motor type selection
- p1230 BI: Armature short-circuit/DC braking activation
- p1231 Armature short-circuit/DC braking configuration
  - 4: Internal armature short circuit/DC braking
- r1239 CO/BO: Armature short-circuit/DC braking status word

9.2.9.4 DC braking

Description

DC braking is only available for induction motors. It is used preferably when braking in an emergency, if controlled braking via the drive is no longer possible (for example, in the event of a power failure, an EMERGENCY OFF, etc.) or if no regenerative infeed is used.

DC braking is activated via p1231 = 4 or p1231 = 14. It can be initiated via an input signal p1230 (signal = 1) or a fault response.

Activating the DC braking via an input signal

p1231 = 4 (internal armature short-circuit/DC braking)

If DC braking is activated with the digital input signal, the pulses are initially inhibited for the duration of the motor demagnetizing period (p0347) in order to demagnetize the motor – parameter p1234 (speed at the start of DC braking) is ignored.

After this, the braking current (p1232) is injected as long as the input is activated in order to brake the motor or keep it at a standstill.

p1231 = 14 (DC braking below starting speed)

DC braking is activated when a 1-signal is present at binector input p1230 during operation, and the current speed is less than the starting speed (p1234).

Following prior demagnetizing (p0347) of the motor for the period set in p1233, braking current p1232 is injected, then switched off automatically.

Withdrawing the input signal for DC braking

If DC braking is withdrawn, the drive returns to its selected operating mode.

The following applies:

- Vector control (controlled with or without encoder):
  If the "flying restart" function is activated, the drive is synchronized with the motor frequency and then returns to closed-loop controlled mode. If the "flying restart" function is not activated, the drive can only be restarted from standstill without overcurrent fault.

- V/f mode:
  If the "flying restart" function is activated, the drive frequency is synchronized with the motor frequency, and the drive then returns to V/f mode. If the "flying restart" function is not activated, the drive can only be restarted from standstill without overcurrent fault.

DC braking as a fault response

Activation via p0491 = 4, p2101 = 6 (internal armature short-circuit/DC braking)

If DC braking is activated as a fault response, the motor is initially braked in field-oriented mode along the braking ramp, down to the threshold set in p1234 (speed at the start of DC braking). The slope of the ramp is identical to that of the OFF1 ramp (configured via p1082, p1121). After this, the pulses are disabled for the period set in p0347 (demagnetizing time) in order to demagnetize the motor. Then DC braking starts for the period set in p1233 (DC braking duration).

- If an encoder is present, the braking operation lasts until the speed falls below the standstill threshold set in p1226.
- In the absence of an encoder, only the period set in p1233 is applied.

Activation via p1231 = 5 (DC braking for OFF1/OFF3)

DC braking is activated with OFF1 or OFF3.

- If the motor speed is ≥ p1234, the motor is braked down to p1234. As soon as the motor speed is < p1234, the pulses are inhibited and the motor is demagnetized.
- If the motor speed at OFF1/OFF3 is already < p1234, the pulses are immediately inhibited and the motor is demagnetized.

DC braking is then activated for the period set in p1233 (DC braking duration) and then switched off.

When OFF1/OFF3 is prematurely canceled, then normal operation is resumed.

DC braking as emergency braking of a fault response remains active.

Function diagram

FP 7017 Technology functions - DC braking

Parameters

- p0300 Motor type selection
- p0491 Motor encoder fault response: ENCODER
- p1226 Threshold for standstill detection
- p1230 BI: Armature short-circuit/DC braking activation
- p1231 Armature short-circuit/DC braking configuration
  - 4: Internal armature short circuit/DC braking
  - 5: DC braking with OFF1/OFF3
  - 14: DC braking below starting speed
- p1232 DC braking, braking current
- p1233 DC braking duration
- p1234 Speed at the start of DC braking
- r1239 CO/BO: Armature short-circuit/DC braking status word
- p1345 I_max voltage controller proportional gain
- p1346 I_max voltage controller integral time
- p2101 Setting for fault response

9.2.10 Increasing the output frequency

9.2.10.1 Description

In applications that require higher output frequencies, the pulse frequency of the drive may have to be increased.

It may also be necessary to change the pulse frequency to prevent resonances from occurring.

Since increasing the pulse frequency also increases the switching losses, a derating factor for the output current must be taken into account when the drive is configured.

Once the pulse frequency has been increased, the new output currents are automatically included in the calculation for power unit protection.

9.2.10.2 Default pulse frequencies

The specified maximum output frequencies can be achieved with the default pulse frequencies listed below.

Table 9- 4 Maximum output frequency with default pulse frequency

Drive rating [HP (kW)]	Default pulse frequency [kHz]	Maximum output frequency [Hz]
Line supply voltage 380 to 480 V AC, 3 phase		
150 ... 400 (110 ... 250)	2	160
500 ... 800 (315 ... 560)	1.25	100
Line supply voltage 500 to 600 V AC, 3 phase		
150 ... 800 (110 ... 560)	1.25	100

The pulse frequencies set in the factory are also the minimum frequencies.

The scanning times for the inputs and outputs of the customer terminal module are set in the factory to 4000 µs. This is also the minimum limit.

9.2.10.3 Increasing the pulse frequency

Description

The pulse frequency can be increased in a virtually continuously variable manner between the value preassigned in the factory and the maximum pulse frequency that can be set.

Procedure

1. Parameter p0009 on the Control Unit must be set to 3 "Basic drive configuration".
2. Parameter p0112 "Sampling times default setting p0115" of the DO VECTOR must be set to 0 "Expert".
3. Use p0113 to enter any pulse frequency between 1 kHz and 2 kHz. If a higher pulse frequency is to be set (e.g., 2.2 kHz), this value must be divided by 2 or by 4 to obtain a result between 1 kHz and 2 kHz (e.g., 2.2 kHz divided by 2 is 1.1 kHz).
4. Not all pulse frequencies are accepted in parameter p0113; in such cases, the alarm "Impermissible value" is output.
5. If the frequency entered in parameter p0113 is not accepted, parameter r0114[0] recommends a different frequency that can deviate from the entered pulse frequency by several hertz. This frequency should be entered in p0113.

6. After entering the frequency in p0113, parameter p0009 on the Control Unit must be set to 0 "Ready" again.
7. The Control Unit re-initializes. After startup, the pulse frequencies recommended in r0114[i] (i = 1, 2, ...) can be entered in parameter p1800 "Pulse frequency" of the DO VECTOR.

Note

Entering the pulse frequency

The pulse frequency entered in p1800 must correspond precisely to the value given in r0114[i]; otherwise, the entry will be rejected.

9.2.10.4 Maximum output frequency achieved by increasing the pulse frequency

By multiplying the base pulse frequency (with integers), the following output frequencies can be achieved (taking into account the derating factors):

Table 9- 5 Maximum output frequency achieved by increasing the pulse frequency

Pulse frequency [kHz]	Maximum output frequency [Hz]
1.25	100
2	160
2.5	200
≥4	300 [1]

[1] The maximum output frequency is limited to 300 Hz due to the closed-loop control.

9.2.10.5 Parameter

- p0009 Device commissioning parameter filter
- p0112 Sampling times pre-setting p0115
- p0113 Minimum pulse frequency, selection
- p0115 Sampling times
- p1800 Pulse frequency

9.2.11 Derating behavior with increased pulse frequency

Description

To reduce motor noise or to increase output frequency, the pulse frequency can be increased relative to the factory setting.

The increase in the pulse frequency normally results in a reduction of the maximum output current (see "Technical data/current derating depending on the pulse frequency").

During commissioning of the drive, the behavior at overload is automatically adjusted in such a way that the pulse frequency is variably reduced so that the required output power can be provided.

Properties:

- The reaction to overload depends on the setting of parameter p0290:
  - p0290 = 0: Reduce output current or output frequency
  - p0290 = 1: No reduction, shutdown when overload threshold is reached
  - p0290 = 2: Reduce the output current or output and pulse frequency (not using I^2t).
  - p0290 = 3: Reduce the pulse frequency (not using I^2t)
- p0290 = 2: On overload, the pulse frequency (and consequently the output frequency) is first reduced until it has dropped to the rated pulse frequency; then the output frequency is reduced if overload continues to persist.
  The rated pulse frequency is half the inverse value of the current controller cycle: 0.5 x 1/p0115[0].
- Reduction of the pulse frequency is executed in whole multiples based on the rated pulse frequency (5 kHz -> 2.5 kHz -> 1.25 kHz or 4 kHz -> 2 kHz).
- After entry of the maximum speed in p1082, the system automatically calculates whether the pulse frequency is sufficient for the entered maximum speed; if necessary the pulse frequency is increased automatically to a value that is necessary for this.
  On overload, this new pulse frequency will no longer be fallen below even when p0290 = 2 or 3; the downstream reaction (reduce output current or switch off) will be triggered.

Exceptions:

- With an activated sine-wave filter (p0230 = 3, 4), this behavior is not permitted because the factory set pulse frequency (2.5 kHz or 4 kHz) must not be changed through this measure. Consequently in this case the selection possibility for the parameter p0290 is limited to "0" and "1".

Activation of the variable pulse frequency

During commissioning, the parameter p 0290 is automatically set to "2". This activates pulse frequency reduction under overload.

Deactivation of the variable pulse frequency

By changing the parameter p0290 to "0" or "1" the variable pulse frequency is deactivated.

Function diagram

FP 8014	Signals and monitoring functions - thermal monitoring power module

Parameters

- r0036 Power module overload I2t
- r0037 CO: Power module temperatures
- p0115 Sampling times for internal control loops
- p0230 Drive filter type, motor side
- p0290 Power module overload response
- p1082 Maximum speed
- r2135.13 Fault: thermal overload in power module
- r2135.15 Alarm: thermal overload in power module

9.2.12 Pulse frequency wobbling

Description

Pulse frequency wobbling uses a statistical method to vary the pulse frequency slightly. The mean pulse frequency value still corresponds to the set value, but the statistical variation of the momentary value produces a modified noise spectrum.

This method reduces subjectively perceptible motor noise, particularly at the relatively low factory-set default pulse frequencies.

Pulse frequency wobbling is activated with p1810.2 = 1. The amplitude of the statistical wobble signal can be set in the range of 0 % to 20 % via p1811.

Restrictions

- Pulse frequency wobbling can only be activated (p1810.2 = 1) if the following prerequisites are met:
  - The drive is in pulse inhibiting mode.
  - p1800 < 2 x 1000 / p0115[0]
- p1811 (Pulse frequency wobbling amplitude) can only be activated if the following prerequisites are met:
  - p1802.2 = 1
  - p0230 (output filter) < 3 (no sine-wave filter)
- When pulse frequency wobbling is activated and pulse enable applied, the maximum pulse frequency (p1800) can be set as follows:
  - p1811 = 0: p1800 ≤ 2 x 1000 / p0115[0]
  - p1811 > 0: p1800 ≤ 1000 / p0115[0]
- Parameter p1811 is set to 0 if the pulse frequency (p1800) setting is greater than 1000 / p0115[0] when pulse frequency wobbling is activated and pulse enable applied.
- Parameter p1811 is set to 0 and parameter p1810.2 to 0 if the pulse frequency (p1800) setting is greater than 2 x 1000 / p0115[0] when pulse frequency wobbling is activated and pulse inhibit applied.

Note

Disable pulse frequency wobbling

If pulse frequency wobbling is deactivated (p1810.2 = 0), all the indices of parameter p1811 are set to 0.

Parameters

- p1800 Pulse frequency setpoint
- p1810.2 Wobbling activated
- p1811[D] Pulse frequency wobbling amplitude

9.2.13 Runtime (operating hours counter)

Total system runtime

The entire system runtime is displayed in r2114 (Control Unit); it is made up of r2114[0] (milliseconds) and r2114[1] (days).
Index 0 indicates the system runtime in milliseconds; after reaching 86,400,000 ms (24 hours), the value is reset. Index 1 indicates the system runtime in days.

The value is saved when the drive unit is switched off.
After the drive unit has been switched on, the counter continues to run with the value that was saved the last time the drive unit was switched off.

Relative system runtime

The relative system runtime since the last POWER ON is displayed in p0969 (Control Unit). The value is indicated in milliseconds and the counter overflows after 49 days.

Current motor operating hours

The motor operating hours counter p0650 (drive) resumes when the pulses are enabled. When the pulse enable is withdrawn, the counter is stopped and the value saved.

The counter is deactivated with p0651 = 0.

If the maintenance interval set in p0651 is reached, alarm A01590 is triggered. Once the motor has been serviced, the maintenance interval must be reset.

Note

If the motor data set (MDS) is changed over, e.g., in the case of a star-delta (wye-delta) changeover, without a change of motor, the two values in p0650 must be added to determine the correct number of operating hours of the motor.

Operating hours counter for the fan

The operating hours of the fan in the power module are displayed in p0251 (drive).

The number of hours operated can only be reset to 0 in this parameter (for example, after a fan has been replaced).

The service life of the fan is entered in p0252 (drive).

Alarm A30042 (service life of the fan reached or exceeded) is output when this figure is reached, and also 500 hours beforehand. Evaluation of the fault value in the alarm provides details of the cause of the alarm.

Monitoring is deactivated with p0252 = 0.

Time stamp mode

The mode for the time stamp can be set via parameter p3100.

Setting	Explanation
p3100 = 0	Time stamp operating hours
p3100 = 1	Time stamp UTC format
p3100 = 2	Time stamp operating hours + 01.01.2000 Additional setting for firmware V4.7 and above. With this setting, the value in p3102 is used as the time stamp of the error messages. For firmware versions prior to V4.7, the time base of p2114 was used with setting p3100 = 0.

Note

Time stamp settings depending on the firmware version

If a project is upgraded from firmware V4.6 to V4.7, the time stamp settings of the old project are retained. The indicated times of the error messages do not differ from those of the old firmware version.

If a new project is created in firmware version V4.7 and above, the factory setting is p3100 = 2 and therefore a different time base for error messages. If the behavior of versions earlier than V4.7 is desired, p3100 = 0 should be set.

9.2.14 Simulation mode

Description

Simulation mode is predominantly used to simulate the drive without a motor being connected and without a DC link voltage. In this case, it should be noted that the simulation mode can only be activated under an actual DC link voltage of 40 V. If the voltage lies above this threshold, simulation mode is reset, and a fault code F07826 is issued.

Communication with a higher-level automation system can be tested using simulation mode. If the drive is also to return actual values, note that it must be switched over to encoderless operation during simulation mode. This means that large parts of the SINAMICS software (e.g., software channel, sequence control, communications, technology function, etc.) can be tested in advance without requiring a motor.

Simulation mode also allows you test the correct functioning of the power module. Particularly with devices greater than 150 HP (110 kW) (400 V), you must check that the power semi-conductor can be activated properly after repairs. This is done by injecting a low DC voltage as DC link voltage (e.g., 12 V) and then switching on the device and enabling the pulses.

Note

Deactivated functions in simulation mode

The following functions are de-activated in simulation mode:

- Motor data identification
- Motor data identification, rotating without an encoder
- Pole position identification

No flying restart is carried-out for V/f control and encoderless closed-loop vector control.

Note

Activation of the binector output r0863.1 in simulation mode

Binector output r0863.1 = 1 is set in simulation mode. For this reason, a check must be made to determine whether additional devices are switched on by this signal before activating simulation mode. If necessary, the corresponding BICO interconnection must be disconnected temporarily.

Commissioning

Simulation is activated using p1272 = 1; the following pre-requisites must be fulfilled:

- First commissioning has been completed (default: standard induction motors).
- The DC link voltage is less than 40 V (observe the tolerance of the DC link voltage sensing).

Alarm A07825 (simulation mode activated) is output during simulation mode.

Parameters

- p1272 Simulation mode

9.2.15 Direction reversal

Description

The direction of rotation of the motor can be reversed using direction reversal via p1821 without having to change the motor rotating field by interchanging two phases on the motor and inverting the encoder signals using p0410.

Reversal via p1821 can be detected from the motor direction of rotation. The speed setpoint and actual value and torque setpoint and actual value remain unchanged, as does the relative position change.

A pulse inhibit must be set prior to attempting reversal.

The direction reversal can be set differently for each drive data set.

Note

Drive data set changeover with differently set direction reversal

Fault F7434 will be returned in the event of a drive data set changeover with different direction reversal settings and pulse enable.

A reversal can be observed by checking parameters r0069 (phase currents) and r0089 (phase voltage). The absolute position reference is lost on reversal.

The output direction of rotation of the drive can be reversed via p1820. This means that the rotating field can be changed without having to interchange the power connections. If an encoder is being used, the direction of rotation must be adapted using p0410, if necessary.

NOTICE

Property damage resulting from unintended acceleration of the drive due to external actual speed value

When external actual speed values are used for the speed controller via p1440, positive feedback can occur in the speed control loop, which can cause the drive to accelerate up to the speed limit and become damaged.

- When external actual speed values are used for the speed controller, change the polarity of the speed controller when there is a change of rotation direction (p1821 = 1).

Function diagram

FP 4704, 4715	Encoder evaluation
FP 6730, 6731	Interface to Motor Module

Parameters

- r0069 Phase currents, actual value
- r0089 Phase voltage, actual value
- p0410 Encoder inversion actual value
- p1820 Reverse the output phase sequence
- p1821 Direction of rotation

9.2.16 Switching unit systems (SI/US/%)

Description

Parameters and process variables for input and output can be switched to a suitable unit system (SI units, US units or referenced variables (%)) with the help of the unit changeover function.

The following constraints apply to the unit changeover:

- Unit changeover is only possible for the "VECTOR" drive object.
- Parameters of the nameplate of the drive and motor can be toggled between SI and US units; however, a relative representation is not possible.
- Once the changeover parameter has been changed, all parameters that are assigned to a unit group depending on this parameter are jointly changed over to the new unit.
- A separate parameter is available for selecting technological units (p0595) for the representation of technological variables in the technology controller.
- If a changeover is made to relative values and the reference value is subsequently changed, the % value entered in a parameter will not change.

  Example:

  – With a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a value of 1200 rpm.
  – If the reference speed is changed to 3000 rpm, the value of 80% is retained and is now 2400 rpm.

Restrictions

- When a unit changeover occurs, rounding to the decimal places is carried out. This can mean that the original value might change by up to one decimal place.
- If a referenced form is selected and the reference parameters (e.g., p2000) are changed retrospectively, the physical significance of some of the control parameters is also adjusted, which can affect the control behavior.

- If the reference variables (p2000 to p2007) are changed in offline mode in STARTER, there is a risk that the parameter value ranges will be violated. In this case, appropriate fault messages will be displayed when the parameters are loaded to the drive unit.

Switching units

The units can be switched via the AOP30 and via STARTER.

- Unit changeover via AOP30 is always carried out immediately. Once the corresponding parameters have been changed, the values affected are displayed in the new selected unit.
- If STARTER is used, unit changeover can only take place in offline mode in the configuration screen of the corresponding drive object. The new units are not displayed until after the download ("Load project to target system") and subsequent upload ("Load project to PG") have been completed.

Unit groups

Each parameter that can be switched is assigned to a unit group, which can be switched within certain limits depending on the group.

This assignment and the units groups for each parameter appear in the parameter list in the SINAMICS List Manual.

The unit groups can be individually switched using 4 parameters (p0100, p0349, p0505 and p0595).

Parameters

- p0010 Commissioning parameter filter
- p0100 IEC/NEMA mot stds
- p0349 Unit system, motor equivalent circuit diagram data
- p0505 Unit system selection
- p0595 Technological unit selection
- p0596 Technological unit reference value
- p2000 Reference speed reference frequency
- p2001 Reference voltage
- p2002 Reference current
- p2003 Reference torque
- r2004 Reference power
- p2005 Reference angle
- p2006 Reference temperature
- p2007 Reference acceleration

9.2.17 Simple brake control

Description

The "Simple brake control" is used exclusively for the control of holding brakes. The holding brake is used to secure drives against unwanted motion when deactivated.

The control command for releasing and applying the holding brake is transmitted directly to the drive via DRIVE-CLiQ from the Control Unit, which logically combines the signals with the system-internal processes and monitors these signals.

The drive then performs the action and controls the output for the holding brake appropriately.
The operating principle of the holding brake can be configured using parameter p1215.

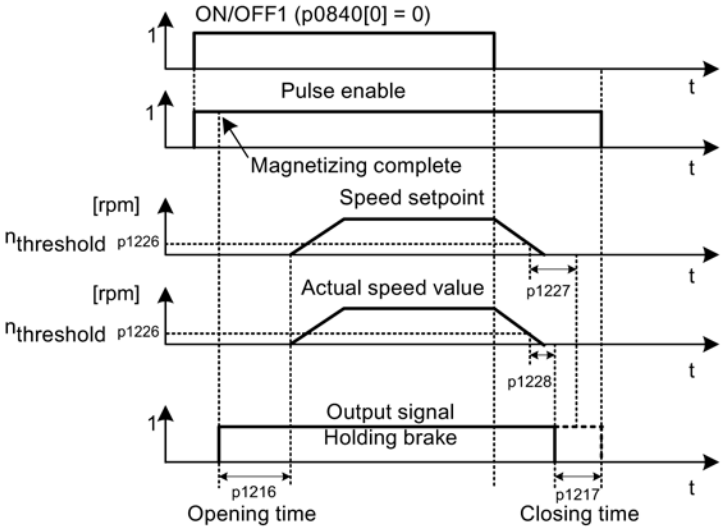


Figure 9-8 Sequence diagram, simple brake control

The start of the closing time for the brake depends on the expiration of the shorter of the two times p1227 (standstill detection monitoring time) and p1228 (pulse suppression delay time).

WARNING

Danger to life due to improper use of simple brake control

Accidents causing serious injury or death can occur if the basic brake control is incorrectly used.

- Do no use the simple brake control for operational braking.
- Observe the special technological and machine-specific requirements and standards for maintaining personnel and machine protection.
- Also take into consideration the risks that can result from suspended axes.

Features

- Automatic activation using sequence control
- Standstill monitoring
- Forced brake release (p0855, p1215)
- Application of brake for a 1 signal "unconditionally close holding brake" (p0858)
- Application of brake after "Enable speed controller" signal has been canceled (p0856)

Signal connections

The holding brake is controlled using free digital outputs on the Control Unit or the TM31. If necessary, control must be realized using a relay for connection of a holding brake with higher voltage or with higher power requirement.

For this, parameter p1215 must be set to "3" (motor holding brake like sequence control, connection via BICO) and the appropriate BICO parameters of the selected digital outputs must be interconnected.

Commissioning

If p1215 is set to "0" (no brake available) during initial commissioning and a connected brake is recognized, simple brake control is activated automatically (p1215 = 1). In this case, fault F07935 "Motor holding brake detected" appears and must be acknowledged.

NOTICE
Property damage resulting from destruction of the brake due to incorrect configuration settings When a motor holding brake is present, parameter setting p1215 = "0" (no motor holding brake present) causes the motor holding brake to remain applied. If the motor is in motion, this leads to destruction of the brake. • When a motor holding brake is present, set parameter p1215 to a value > 1.

Notes on setting up the release time (p1216):

- The release time (p1216) should be set greater than the actual release time of the holding brake. As a result, the drive will not accelerate when the brake is closed.

Notes for setting up the closing time (p1217):

- The closing time (p1217) should be set greater than the actual closing time of the holding brake. As a result, the pulses are suppressed only after the holding brake is closed.
- If the closing time (p1217) is set too low compared to the actual closing time of the holding brake, the load may drop suddenly.
- If the closing time (p1217) is set too high compared to the actual closing time of the holding brake, the controller acts against the holding brake and thus reduces its service life.

Function diagram

FP 2701	Simple brake control (r0108.14 = 0)

Parameters

- r0056.4 Magnetizing complete
- r0060 CO: Speed setpoint before the setpoint filter
- r0063[0...2] CO: Actual speed value
- r0108.14 Extended brake control
- p0855[C] BI: Unconditionally release holding brake
- p0856 BI: Speed controller enabled
- p0858 BI: Unconditionally apply holding brake
- r0899.12 BO: Holding brake released
- r0899.13 BO: Command, close holding brake
- p1215 Motor holding brake configuration
- p1216 Motor holding brake release time
- p1217 Motor holding brake closing time
- p1226 Threshold for standstill detection
- p1227 Standstill detection monitoring time
- p1228 Pulse suppression delay time
- p1278 Brake control diagnostic evaluation

9.2.18 Synchronization

Description

You can synchronize a motor with the supply using the "Synchronization" function and an existing voltage sensing module VSM10 (to measure the mains voltage). The connection to the mains or the required contactor control can take place using the existing bypass function or a higher-level controller.

Use of the bypass function supports temporary (for example, for maintenance work without plant standstill) or permanent operation of the motor on the mains.

Synchronization is activated with the p3800 parameter. Voltage measurement takes place via VSM10 which is assigned to a drive (using DRIVE-CLiQ) and measures the mains voltage.

Features

- Connector inputs for the actual voltage sensing of the motor via VSM10 (p3661, r3662)
- Setting a phase difference (p3809)
- Can be activated by parameter (p3800)
- Can be enabled by parameter (p3802)

Function diagram

FP 7020	Technology functions - Synchronizing

Parameters

- p3800[0...n] Sync network drive activation
- p3801[0...n] Sync-line-drive drive object number
- p3802[0...n] BI: Sync network drive enable
- r3803 CO/BO: Sync network drive control word
- r3804 CO: Sync network drive target frequency
- r3805 CO: Sync network drive frequency difference
- p3806[0...n] Sync network drive frequency difference threshold value
- r3808 CO: Sync network drive phase difference
- p3809[0...n] Sync network drive phase setpoint value
- p3811[0...n] Sync network drive frequency limitation
- r3812 CO: Sync network drive correction frequency
- p3813[0...n] Sync network drive phase synchronism threshold value
- r3814 CO: Sync network drive voltage difference
- p3815[0...n] Sync network drive voltage difference threshold value
- r3819.0...7 CO/BO: Sync network drive status word

9.2.19 Energy savings indicator for pumps, fans, and compressors

Function of the energy savings indicator

This function determines the amount of energy used by pumps, fans, and compressors and compares it with the extracted energy requirement for similar equipment equipped with a conventional throttle control.
The amount of energy saved is calculated over the last 100 operating hours and is displayed in kWh. For an operating time of less than 100 hours, the potential energy savings is extrapolated to 100 operating hours.
The pump, fan, or compressor characteristic with the conventional throttle control is specified using 5 adjustable interpolation points.

Background

In a conventionally controlled pump, fan or compressor, the flow rate of the medium is controlled using valves or throttles. In so doing, the driving machine runs constantly at the rated speed. The system efficiency decreases significantly if the flow rate is reduced by means of valves or throttles. The pressure in the system increases. The motor even consumes energy when the valves or throttles are completely closed, i.e., with flow rate Q = 0. In addition, undesirable process-related situations can occur; for example, cavitation in the pumps, fans, and compressors or increased heating of the pumps, fans, and compressors and the medium.

As a result of variable speed operation, a drive under partial load consumes considerably less energy than with conventional process control via valves or throttles. This applies in particular for pumps, fans, and compressors with parabolic load characteristics. With SINAMICS, a closed-loop control of the flow rate or pressure is achieved via a speed control of the pump, fan or compressor. As a consequence, the equipment is controlled close to its maximum efficiency over the complete operating range.

In comparison to pumps, fans, and compressors, machines with linear or constant load characteristic (e.g. conveyor drives or positive displacement pumps) have lower potential savings.

Energy savings through use of a variable speed drive

When a variable speed drive is used, the flow rate of the pump, fan, or compressor is controlled as a function of speed. The flow rate changes proportionally with the speed of the pump, fan, or compressor. Any existing valve or throttle remains open. Therefore, the equipment works close to optimum efficiency and consumes considerably less energy, particularly in the partial load range, than equipment controlled by means of valves or throttles.

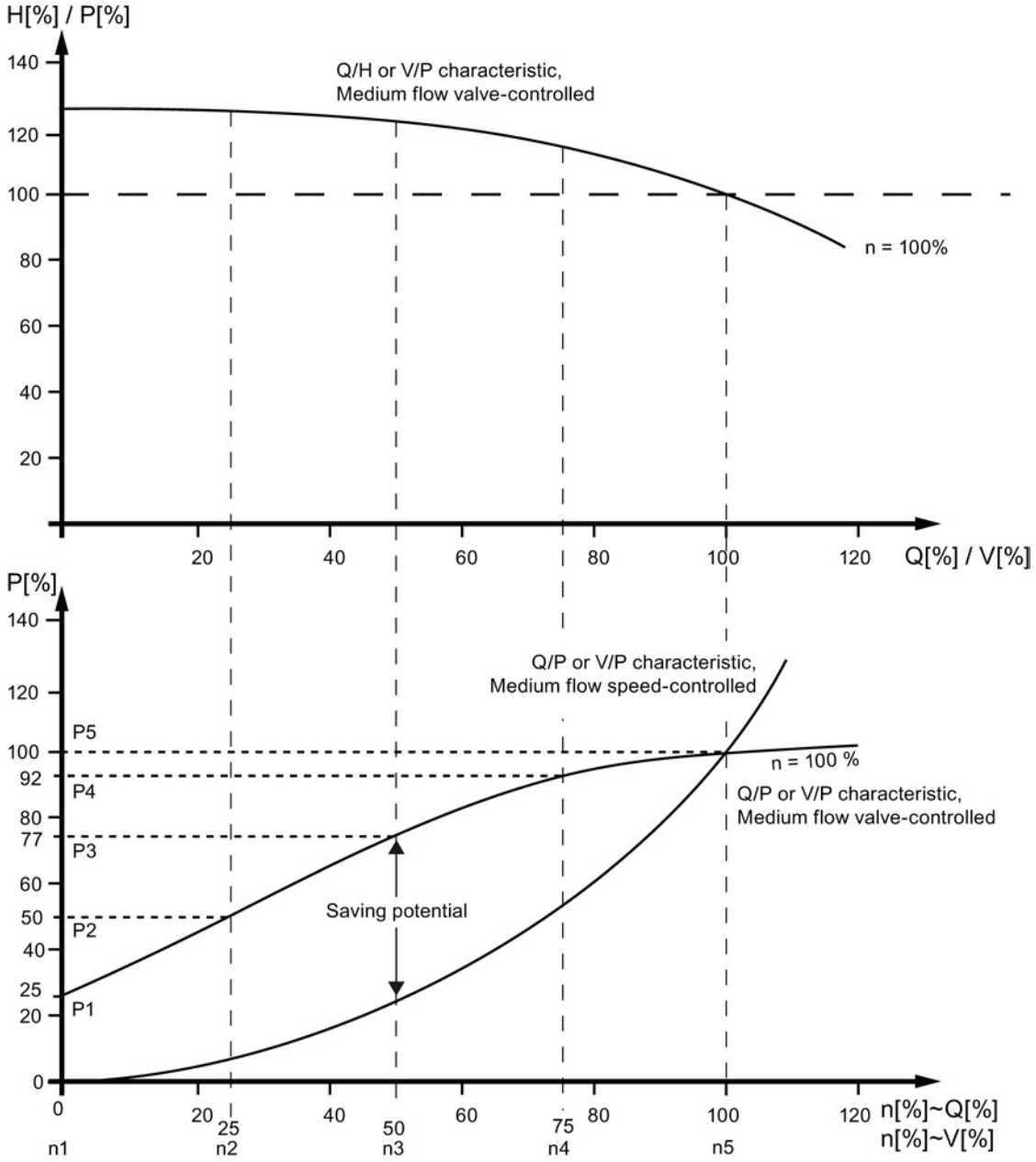


Figure 9-9 Potential for energy savings

Legend for top characteristic:
H[%] = Head, P[%] = Flow pressure, Q[%] = Flow rate, V[%] = Volumetric flow

Legend for bottom characteristic:
P[%] = Rated input of conveyor, n[%] = Speed of conveyor
Interpolation points p3320 to p3329 for equipment curve with n = 100 %:

P1...P5 = Rated input, n1...n5 = Speed in accordance with variable speed machine

Adapting the pump, fan, or compressor characteristic

The 5 interpolation points of the pump, fan, or compressor characteristic are entered using parameters p3320 to p3329. This characteristic can be configured individually for each drive data record.

Table 9- 6 Interpolation points of the pump, fan, or compressor characteristic

Interpolation point	Parameter	Factory setting: P: Power in % n: Speed in %	
1	p3320	P1 = 25.00	
	p3321	n1 = 0.00	
2	p3322	P2 = 50.00	
	p3323	n2 = 25.00	
3	p3324	P3 = 77.00	
	p3325	n3 = 50.00	
4	p3326	P4 = 92.00	
	p3327	n4 = 75.00	
5	p3328	P5 = 100.00	
	p3329	n5 = 100.00	

Note

Consequences of not adjusting the pump, fan, or compressor curve

If the interpolation points of the pump, fan, or compressor curve are not adapted, the factory setting will be used to calculate the energy savings indicator. The values of the factory setting could then deviate from the equipment characteristic and cause incorrect calculation of the actual energy savings.

Energy savings indication

The energy savings are displayed in parameter r0041.

By setting p0040 = 1, the value of the r0041 parameter is reset to 0. Parameter p0040 is then automatically set to 0.

9.2.20 Write protection

Description

The write protection is used to prevent unintended changes to adjustable parameters. No password is required for write protection.

Activating write protection

The write protection can be activated as follows:

- With the STARTER in online mode and after selecting the drive unit via**Project > Write protection for drive unit > Activate**.
- With the AOP30 operator panel via p7761 = 1.

All adjustable parameters affected by write protection can no longer be changed now.

In the STARTER, all write-protected adjustable parameters in the expert list and in operation screens are disabled (grayed out).

In AOP30, an attempt to change a write-protected adjustable parameter is denied and an error message is displayed.

Write requests of write-protected adjustable parameters via communication are handled differently:

- Parameter changes of controllers of class 1 (e.g. SIMATIC PLCs) are executed.
- Parameter changes of controllers of class 2 (engineering or commissioning tools, e.g. STARTER) are not executed.

Deactivating write protection

Write protection can be deactivated as follows:

- With the STARTER in online mode and after selecting the drive unit via**Project > Write protection for drive unit > Deactivate**.
- With the AOP30 operator panel via p7761 = 0.

Write protection status

The write protection status can be displayed using parameter r7760.0:

- r7760.0 = 0: Write protection is not active
- r7760.0 = 1: Write protection is active

Exceptions for activated write protection

The following functions or adjustable parameters are excluded from write protection:

- Changing the access level (p0003)
- Commissioning of parameter filter (p0009)
- Module detection via LED (p0124, p0144, p0154)
- Resetting parameters (p0972, p0976)
- Saving parameters (p0977)
- Acknowledging a fault (p2102, p3981)
- RTC time stamp, time setting, synchronization (p3100, p3101, p3103)
- Master control mode selection (p3985)
- Trace (p4700ff.)
- Function generator (p4800ff.)
- Activating/deactivating write protection (p7761)
- Flashing of component (p9210, p9211)

Note

List of exceptions for activated write protection

A list of the adjustable parameters that can be changed in spite of activated write protection can be found in the List Manual.
The list has the designation "WRITE_NO_LOCK".

Write protection for multi-master fieldbus systems

For fieldbus systems (e.g., CAN bus) that can be operated as multi-master bus systems, access to all the adjustable parameters is also possible when write protection is activated.

For these bus systems, the behavior when write protection is activated can be set via parameter p7762:

- p7762 = 0: Write access is independent of p7761
- p7762 = 1: Write access is dependent on p7761

Parameters

- r7760 Write protection/know-how protection status
- p7761 Write protection
- p7762 Write protection multi-master fieldbus system access behavior

9.2.21 Know-how protection

9.2.21.1 Description

Know-how protection is used, for example, so that a machine manufacturer can encrypt its configuration know-how and protect it against modification and duplication.

A password is required for know-how protection, and the saved data are encrypted.

When know-how protection is activated, most of the adjustable parameters cannot be changed or read. The monitoring parameters are displayed unchanged. The contents of screen forms in the STARTER are not displayed.

Know-how protection can be combined with copy protection.

Characteristics when know-how protection is activated

- Except for a small number of system parameters and the parameters specified in an exception list, all other parameters are locked.
- The values of these parameters are not visible in the expert list and so cannot be changed. The text "know-how protected" appears instead of the parameter values.
- Know-how protected parameters can be hidden in the expert list. This requires that the "not know-how protected" filter is set in the "Online value" column.
- The values of display parameters remain visible.
- The contents of screen forms are not displayed when know-how protection is active.
- Know-how protection can be combined with copy protection.
- The same know-how protection is used for scripts.
- The drive unit as well as the drive objects and DCC charts therein can be displayed as inconsistent.

Functions that can be executed when know-how protection is active

The following functions can be executed although know-how protection is active:

- Restoring the factory settings
- Saving parameters
- Acknowledging faults
- Displaying faults and alarms
- Displaying history of faults and alarms
- Reading out the diagnostic buffer
- Switching over to the control panel (complete control panel functionality: fetching master control, all buttons and adjustable parameters)
- Displaying created acceptance documentation

Note

List of exceptions with activated know-how protection

A list of the adjustable parameters which, in spite of activated know-how protection, can be changed, is provided in the List Manual.
The list has the designation "KHP_WRITE_NO_LOCK".

Functions that cannot be executed when know-how protection is active

The following functions cannot be executed when know-how protection is active:

- Download
- Automatic controller adjustment
- Stationary/rotating measurement
- Clearing fault buffer
- Creating acceptance documentation

Functions which can be executed as an option when know-how protection is active

The functions listed below can be executed with activated know-how protection provided diagnostic functions were permitted when it was activated:

- Trace function
- Function generator
- Measuring functions

Adjustable parameters that are read-only when know-how protection is active

The following adjustable parameters can be read but not changed when know-how protection is active:

- Motor parameters (p0100, p0300, p0304, p0305, p0349)
- Data sets (p0120, p0130, p0140, p0150, p0170, p0180)
- Encoder type (p0400)
- Reference values (p2000, p2001, p2002, p2003, p2005, p2006, and p2007)

These parameters are grayed out in the STARTER in the expert list.

Note

List of adjustable parameters that are read-only when know-how protection is active

A list of the setting parameters, which can only be read when know-how protection is activated, are provided in the List Manual.
The list has the designation "KHP_ACTIVE_READ".

AOP30 with activated know-how protection

The AOP30 operator panel does not display the parameters that are protected when know-how protection is active.

The adjustable parameters that are read-only when know-how protection is active are displayed. An attempt to change these adjustable parameters will be denied and an error message displayed.

9.2.21.2 Activating know-how protection

Know-how protection can be activated using STARTER in online mode.

Activating know-how protection

Know-how protection is activated via STARTER in online mode in the following way:

- Select the drive unit via **Project > Know-how protection for drive unit > Activate**.
- A dialog appears in which the following settings are made:
  - It can be selected whether to activate know-how protection with or without copy protection.
  - Clicking on **Specify** opens a further dialog in which the password is entered and confirmed. The password may consist of a maximum of 30 characters, and all characters are permissible.
  - If **Copy from RAM to ROM** is selected, the settings are permanently saved after exiting the screen form.
    If **Copy RAM to ROM** is not selected, then the settings for know-how protection are only saved non-retentively and are no longer available after the system has been switched on the next time.
- After the dialog is closed with **OK**, know-how protection is activated and the data (parameters, DCC) are saved as encrypted data on the memory card.
  All protected setting parameters in the expert list display the text "know-how protected" instead of the parameter value.

Note

Password check for know-how protection and Windows language settings

If the Windows language settings are changed after activating know-how protection, this can cause errors during a subsequent password verification. This is why you should use only ASCII characters for the password.

Note regarding know-how protection

Note

Secure deletion of existing unencrypted data

If unencrypted data are already saved on the memory card before the encrypted data are saved, reliable deletion of these unencrypted data is not ensured. No specific deletion method is used in order to remove the unencrypted data from the memory card for good.

In this case, the user must ensure that the unencrypted data are reliably deleted, e.g., through the use of special PC tools.

9.2.21.3 Deactivating know-how protection

Know-how protection can be deactivated using STARTER in online mode.

Deactivating know-how protection

Know-how protection is deactivated via STARTER in online mode in the following way:

- Select the drive unit via **Project > Know-how protection for drive unit > Deactivate**.
- A dialog appears in which know-how protection can be temporarily or permanently deactivated:
  - Temporary deactivation:
    Select **temporary**, and enter the password and confirm with **OK**.
  - Permanent deactivation:
    Select **permanent**, and enter the password, select**Copy RAM to ROM**, and confirm with **OK**.

Note regarding deactivation of know-how protection

Note

Deactivating know-how protection permanently or temporarily

Temporary deactivation means that know-how protection will be reactivated after a POWER ON. Data will continue to be saved on the memory card as encrypted data. The reactivation of know-how protection is carried out with the existing password.

Permanent deactivation means that know-how protection is no longer active even after a POWER ON. Data will be saved on the memory card as unencrypted data.

If know-how protection finally is deactivated permanently, it can be re-activated again if necessary.

9.2.21.4 Changing the know-how protection password

The password for know-how protection can be changed using STARTER in online mode.

Changing password

The password for know-how protection is changed via STARTER in online mode in the following way:

- Select the drive unit via **Project** > **Know-how protection for drive unit** > **Change password**.
- A dialog appears in which the following inputs are made:
  - Input of the old password
  - Input of the new password
    The password may consist of 1 to 30 characters, and all characters are permissible.
  - Confirmation of the new password
- After you close the dialog box with **OK**, the changed password is activated.

9.2.21.5 OEM exception list

Adjustable parameters can be designated as exempt from know-how protection using the OEM exception list. The parameters included in the exception list can be read and modified even when know-how protection is active.

The exception list can be created only via the expert list in STARTER in online mode. Parameter p7763 defines the number of parameters that are to be contained in the exception list. In parameter p7764, the parameter number that is to belong to the exception list is entered in each index. The exception list can be created separately for each drive object.

Note

Changing parameter p7763

After a change in parameter p7763, a "Load to PG" operation is required so that the index field of parameter p7764 is adapted.

With the factory setting, the exception list of the Control Unit consists of one parameter (p7763 = 1). p7766 (password input) is entered in parameter p7764[0] of the Control Unit so that the password for the deactivation can be entered when know-how protection is activated.

Note

Absolute know-how protection

If parameter p7766 is removed from the exception list and know-how protection is activated, then a password can no longer be entered. Consequently, the know-how protection can no longer be deactivated!
In this case, the drive can only be accessed after restoring the factory setting.

9.2.21.6 Memory card copy protection

Memory card copy protection allows you to ensure that the data encrypted and stored on the memory card (parameter and DCC data) cannot be copied to another memory card and used there.

Memory card copy protection can be activated during activation of know-how protection via STARTER.

When know-how protection and memory card copy protection are activated, the encryption of data (parameter and DCC data) includes the serial numbers of the memory card (r7843) and the control unit (r7758).

Saved during the ramp-up of the drive unit, the serial numbers of the memory card and the control unit compared to the actual serial numbers. If these serial numbers do not match, fault F13100 is output and the device cannot continue to be operated. The fault value can be evaluated to determined the individual cause.

9.2.21.7 Spare part replacement when know-how protection with copy protection is activated

For the transfer of configuration data with know-how protection and memory card copy protection between machine manufacturer (OEMs) and end customer, a possible scenario is the replacement of a damaged memory card or a defective control unit:

A process by which data are transferred between machine manufacturer (OEM) and end customer applies in this situation.

Replacement of a damaged memory card or a defective control unit at the end customer

Assumptions:

- The drive is protected with know-how protection and memory card copy protection
- The end customer has a replacement memory card or a replacement control unit on site.
- The required STARTER project is not saved at the end customer.
- The machine manufacturer has a control unit of the same type as the end customer.

Sequence:

- The end customer communicates the serial numbers of the memory card and control unit to the machine manufacturer.
- The machine manufacturer links the STARTER project with the serial numbers of the memory card (p7769) and control unit (p7759).
- The machine manufacturer loads the STARTER project into the drive unit.
- Following the download, the machine manufacturer activates the copy protection and know-how protection (p7765, p7767, p7768).
- The machine manufacturer saves the project via p0971 or p0977 to the memory card.
- The machine manufacturer takes the PS-ACX files and any generated DCC-YDB files from the ".. \USER\SINAMICS\DATA" area of the memory card and sends them to the end customer (e.g., via e-mail).
- The end customer copies the files to the "..\USER\SINAMICS\DATA" area of its memory card, inserts this memory card into the control unit and switches on the drive unit.
- After power-up, the end customer saves the project (via p0971 or p0977). Parameters from the OEM exception list must be re-entered if necessary.

9.2.21.8 Overview of important parameters

- r7758[0...19] KHP control unit serial number
- p7759[0...19] KHP control unit reference serial number
- r7760 Write protection/know-how protection status
- p7761 Write protection
- p7762 Write protection multi-master fieldbus system access behavior
- p7763 KHP OEM exception list number of indices for p7764
- p7764[0...n] KHP OEM exception list
- p7765 KHP memory card copy protection
- p7766[0...29] KHP password input
- p7767[0...29] KHP password new
- p7768[0...29] KHP password confirmation
- p7769[0...20] KHP memory card reference serial number
- r7843[0...20] Memory card serial number

KHP: Know-how protection (know-how protection)

9.2.22 Emergency operation

Description

The emergency operation, **E**ssential **S**ervice **M**ode (ESM), provides the option of operating the drive if needed, for as long as possible, even when errors occur.

This function can be used, for example, in applications in which an unintended stoppage can cause major secondary damage.
For example, fan drives in large buildings are intended to enable the evacuation of persons via escape routes when a fire occurs by exhausting the smoke that is generated.

Features

- In emergency operation, the automatic restart function is activated irrespective of the setting of parameter p1210. The result of this is that the drive is automatically switched back on if an OFF2 occurs due to an internal fault.
- In emergency operation, the switching off of the drive due to faults is suppressed. Exceptions to this rule are faults that would lead to the destruction of the device.
- The emergency operation is triggered by a continuous signal via the digital input, which is set as a signal source using p3880.
- If the drive is in bypass mode when emergency operation is activated, the motor is automatically switched over to drive operation.
- When emergency operation ends, the drive returns to normal operation and acts in accordance with the currently pending commands and setpoints.

Note

Loss of warranty for a drive in emergency operation

In the event of emergency operation, all warranty claims on the part of the customer are voided.

Emergency operation is an exceptional state, and is not suitable for continuous operation.

Note that emergency operation can lead both inside and outside the device to exceptionally high temperatures, including open flame, as well as emissions of light, noise, particles, gases, etc.

The drive logs emergency operation and the faults that occur while in emergency operation in a password-protected memory. This data is only accessible for the service and repair organization.

Activation of emergency operation

Emergency operation is activated via a continuous signal on the digital input, which is set as a signal source using p3880.

Only the digital inputs on the Control Unit are permitted as signal sources:

- r0722.x (high active)
- r0723.x (low active)

x = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21

Setpoint source for emergency operation

When emergency operation is activated, the setpoint set using p3881 is switched to:

- p3881 = 0: Last known setpoint (r1078 smoothed) - factory setting
- p3881 = 1: Fixed speed setpoint 15 (p1015)
- p3881 = 3: Fieldbus
- p3881 = 5: TB30/TM31 analog input
- p3881 = 6: Enable of reaction OFF1
- p3881 = 7: Enable of reaction OFF2

When using the analog setpoint value from TB30/TM31 (p3881 = 5) the setpoint is used that is set via p3886.

If, when setting p3881 = 3 or 5, the setpoint is lost (e.g., cable break or fieldbus failure), then the alternative setpoint that is set using p3882 is automatically switched to:

- p3882 = 0: Last known setpoint (r1078 smoothed) - factory setting
- p3882 = 1: Fixed speed setpoint 15 (p1015)
- p3882 = 2: Maximum speed (p1082)

Direction of rotation in emergency operation

Depending on your system, you may have to invert the setpoint locally for emergency operation. To do this, parameter p3883 can be linked with a free digital input:

- Signal in p3883 = 0: The direction of rotation of the setpoint configured for emergency operation is maintained
- Signal in p3883 = 1: Reversal of the direction of rotation of the setpoint configured for emergency operation

Automatic restart

In emergency operation, if the automatic restart function is activated, the parameter settings of p1206, 1210, and p1212 subsequently have no effect. The settings in p1211 (automatic restart, start attempts) and p1213 (automatic restart monitoring time) are still effective. The setting of p1213 [0] = p1213 [1] = 0.0 s allows an unlimited number of startup attempts.

Bypass as a fallback strategy

If the drive fails due to an internal, non-acknowledgeable error, emergency operation is no longer possible. In this case, the motor can be operated via the controller in bypass mode if the drive fails. For this purpose, bit 7 of the status word for the automatic restart (r1214.7) must be interconnected with p1266.
The bypass function must also be activated (p1260 ≠ 0). and the changeover source for the bypass must be set to "Bypass via signal (BI: p1266)" (p1267 = 1).

Behavior in the event of an encoder error

When operating in vector control with encoder in emergency operation, there is an automatic switchover to encoderless operation and movement of the drive continues in the event of an encoder error.

Function diagram

FP 3040	Setpoint channel - Direction limitation and direction reversal
FP 7033	Technology functions - Emergency operation (ESM, Essential Service Mode

Parameters

- p3880 BI: ESM activation signal source
- p3881 ESM setpoint source
- p3882 ESM setpoint source alternative
- p3883 BI: ESM direction of rotation signal source
- p3886 CI: ESM setpoint TB30/TM31 analog input
- r3887[0...1] ESM number of activations/faults
- p3888 ESM reset number of activations/faults
- r3889.0...10 CO/BO: ESM status word

9.2.23 Web server

9.2.23.1 Description

General information

The integrated Web server provides information about the drive unit via its Web pages. Access is via an Internet browser. The information on the Web pages is shown in English. For information about message texts, drive object statuses, and parameter names, there is a language selection that enables the display to be switched to the languages that are stored on the memory card.

The most important functions of the Web server are described below. However, the "Files" and "User´s Area" display areas of the Web server are described in detail in a separate document (see "User-defined Web pages"). For this reason, these display areas are not included in this description.

Activation/configuration

The Web server is activated in the factory setting.

The Web server is configured using parameter p8986 (Web server configuration).

Data transmission

Access is via unsecure transmission (http) or secure transmission (https).

The type of transmission is specified by the input of the corresponding address.

For safety reasons, secure transmission can be forced by deactivation of the http port.

Access

The Web server is accessed via the following interfaces:

- LAN interface of the Control Unit CU320-2 DP or CU320-2 PN
- PROFINET interface of the CU320-2 PN

The drive is addressed using the IP address.
The IP address can be taken from the following parameters:

- Integrated Ethernet interface (LAN interface): r8911[0...3]
- PROFINET interface: r8931[0...3]

Access rights

There are two users, each having different authorizations:

- "SINAMICS" user (activated in the factory setting):
  - Open diagnostics pages
  - Reset the fault memory
  - Create/expand/remove parameter lists
  - Read/write/back up parameters
- "Administrator" user, additionally:
  - Update configuration
  - Update firmware
  - Load user-defined pages to the drive

The settings for write-protection and know-how protection also apply for access via the Web server to drive parameters and the configuration.

Supported browsers

Access to the Web server is possible with the following Internet browsers:

- Microsoft Internet Explorer Version 8 and higher and Version 10 and higher
- Mozilla Firefox Version 24 and higher
- Opera Version 12.16 and higher
- Chrome Version 30.0 and higher

User-defined Web pages

You can add your own self-created Web pages to the standard Web pages of the Web server. The SIEMENS Industry Online Support contains detailed information on:

1. Go to the following SIEMENS website in your browser:

   SINAMICS Application Examples (https://www.automation.siemens.com/mc-app/sinamics-application-examples/Home/Index?language=en)
2. In the search screen, select "S120" as the DriveType and "Web Server" as the Speciality.
3. Click the desired brief information in the list of results.

   The corresponding brief information is then displayed in the SIEMENS Industry Online Support. From there, you can then download a detailed description as a PDF file.

9.2.23.2 Starting the Web server

Requirements

- The Web server is active in the factory setting.
- A functional, commissioned drive project.
- PG/PC is connected to the Control Unit (target device).

Starting the Web server

1. Enter the IP address of the SINAMICS drive in the address line of the Internet browser (e.g., http://169.254.11.22.
   The start page of the Web server opens.

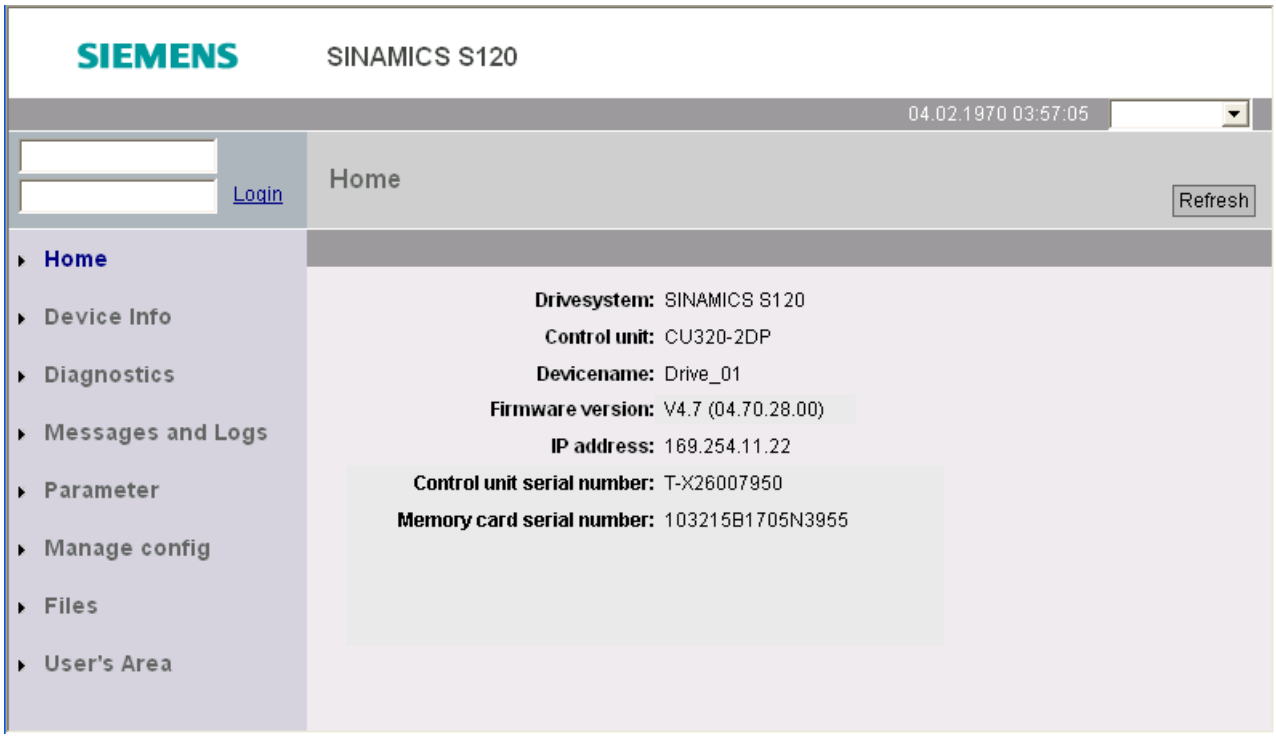


Figure 9-10 Start page of the Web server

2. At the top left, enter the Login name (e.g., SINAMICS) and, if necessary, the password.
   In the factory setting, only the "SINAMICS" user is activated. A password is not assigned.
3. Click "Login" to confirm the input.

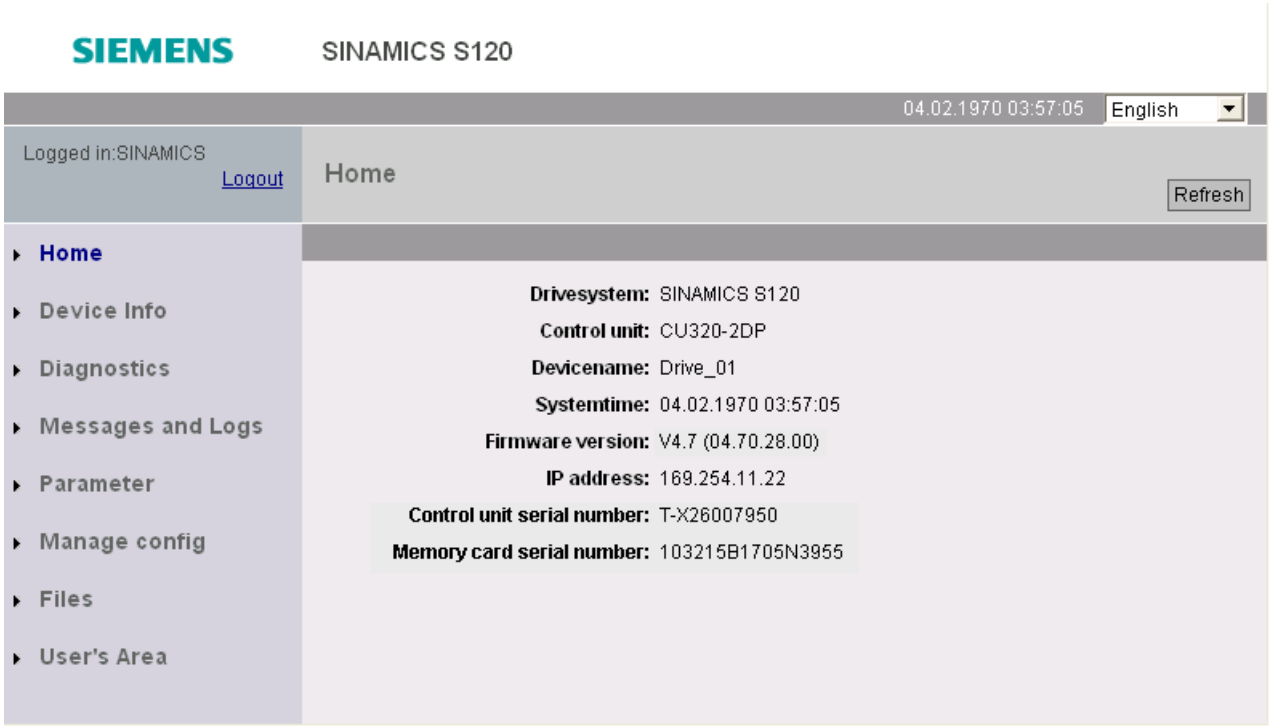


Figure 9-11 Start page after logging in

After logging in, you can open the various display areas of the Web server using the navigation on the left side.

Logout

If you no longer require the Web server or want to block the detailed display areas, you can log out.

To do so, click "Logout" at the top left in the navigation.

9.2.23.3 Web server configuration

Configuration using STARTER

The configuration dialog is called by selecting the drive in the project navigator and selecting "Web server" in the context menu.

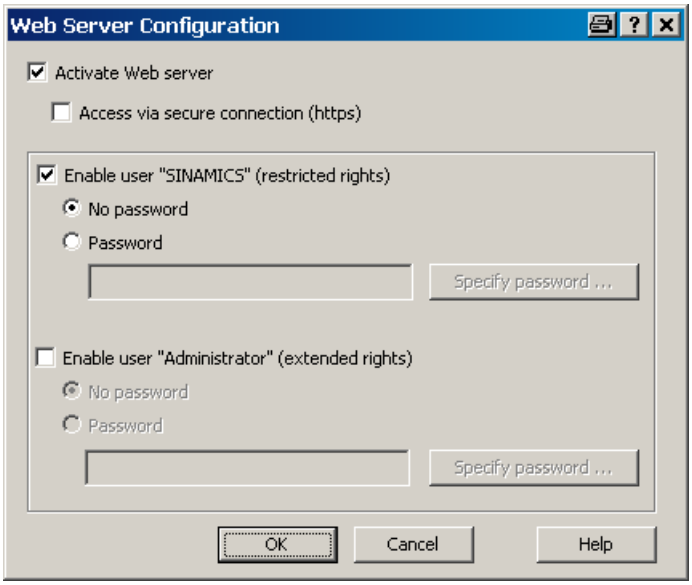


Figure 9-12 Configuring the Web server using STARTER

Activating the web server

The Web server is activated in the factory setting.

If required, access can be limited to a secure connection (https).

Note

Access via secure connection (https)

You require security certificates for both SINAMICS and the Internet Browser to access the Web server via an https connection. These security certificates must be installed on each computer from which the Web server is to be called.

Contact your System Administrator regarding this.

Enabling users

The "SINAMICS" user is activated in the factory setting. If required, a password can be assigned for this.

The "Administrator" user is not activated in the factory setting. If it is activated, a password can additionally be assigned.

Note

Secure passwords

SINAMICS does not specify any password rules for the assignment of passwords. You can therefore assign any passwords without restriction. No check is made for illegal characters or existing passwords. Therefore, as the user, you are responsible for the required password security.

Use a sufficiently long password (e.g., 10 characters). Use special characters and avoid passwords that you have already used elsewhere.

Please note that if the Windows language settings are changed, errors can occur when subsequently checking the password. If you use language-specific special characters, you must ensure that the same language setting is active for subsequent entry of the password.

Configuration using AOP30 or the expert list

The configuration is made using parameter p8986 (Web server configuration):

Bit 00: Activate the web server (factory setting: activated)
Bit 01: Permit access only with https (factory setting: not activated)
Bit 02: Activate "SINAMICS" user (factory setting: activated)
Bit 03: Activate "Administrator" user (factory setting: not activated)

Note

Password assignment after activation of the "Administrator" user

After activation of the "Administrator" user via parameter p8986 (using AOP30 or expert list), it is necessary to subsequently assign the password using STARTER. Otherwise the "Administrator" user cannot access the Web server.

9.2.23.4 Display areas

The Web server has various displays areas that are opened using the menu commands of the navigation.

Home

This menu command is used to open the start page of the Web server.

Device Info

This menu command is used to display the most important device information.

Diagnostics

This menu command is used to display the operating state for each drive object on the "Service overview" tab.
Color coding is also used to show whether a fault or alarm is pending for the respective drive object.

The "Trace files" tab displays the trace files that are located in the "USER/SINAMICS/DATA/TRACE" directory on the memory card.

Messages and Logs

This menu command is used to show the diagnostic buffer on the "Diag buffer" tab.

The fault and alarm messages of the drive are shown on the "Alarms drive" tab. The "Reset alarms" button can be used to reset the acknowledgeable faults.

Parameter

This menu command can be used to create and manage self-defined parameter lists. A maximum of 20 parameter lists with up to 40 parameters each can be managed.

For each parameter list, the access rights (read, write, change) of the two users ("SINAMICS" and "Administrator") can be specified separately.

The settings for write-protection and know-how protection also apply for access via the web server to the parameters.

The created parameter lists are saved on the memory card of the drive. Therefore, a parameter selection performed once is retained for further access even after the drive is switched off.

Manage config

This menu command can be used by the "Administrator" user to upload and update firmware and project files.

Files

This menu command can be used by the "Administrator" user to load user-defined pages in the drive.

User's Area

This menu command can be used by the "Administrator" user to open user-defined pages.

9.2.23.5 Overview of important parameters

- r8911 IE IP Address of Station active
- r8931 PN IP Address of Station active
- p8986 Web server configuration
- p8987[0...1] Web server port assignment

9.3 Extended functions

9.3.1 Technology controller

Description

The "technology controller" function module allows simple control functions to be implemented, for example:

- Liquid level control
- Temperature control
- Dancer position control
- Pressure control
- Flow control
- Simple control without higher-level control
- Tension control

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- Separate fixed values
- Separate motorized potentiometer
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched to the system deviation or actual value channel.
- The motorized potentiometer of the technology controller is only active when the drive pulses are enabled.

The technology controller is designed as a PID controller, whereby the derivative element 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.

The setpoints can be specified via separate fixed setpoints (p2201 to p2215), the motorized potentiometer, or via the field bus (e.g., PROFIBUS).

Feedforward 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 integrated, for example, via an analog input on the TM31.

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.

Note

Ramp-up/down time freeze

If you enter "0 s" for the power up time or ramp-down time for the ramp function generator of the technology controller, the current values of the respective ramp function generator will be frozen.

Commissioning

The "technology controller" function module can be activated by running the commissioning wizard. Parameter r0108.16 indicates whether the function module has been activated.

Example: Liquid 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 (e.g. AI0 TM31) 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.

In this example, a TM31 Terminal Module is used.

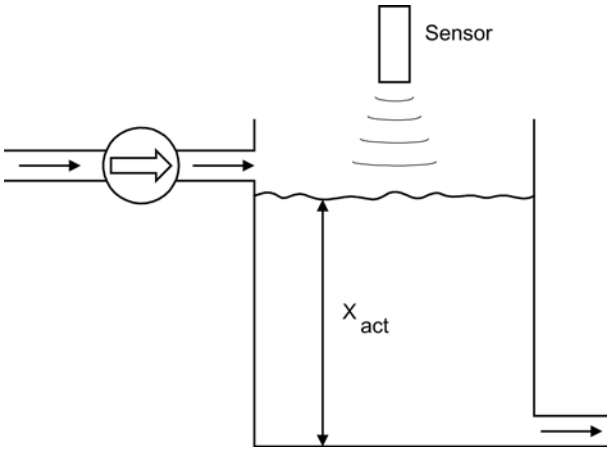


Figure 9-13 Level control: Application

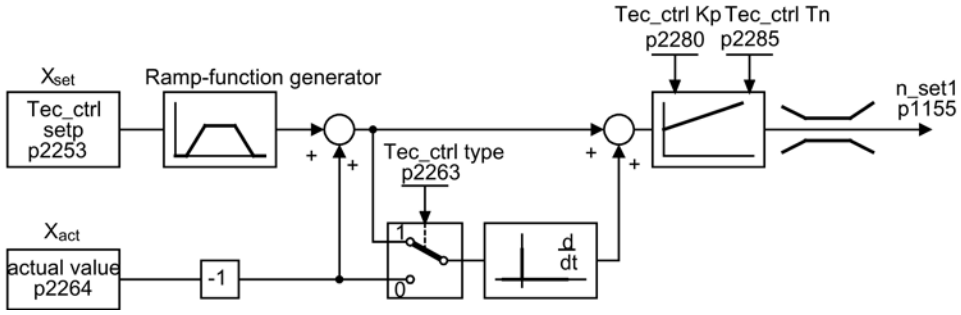


Figure 9-14 Level control: Controller structure

Function diagram

FP 7950	Technology controller – Fixed values, binary selection
FP 7951	Technology controller – Fixed values, direct selection
FP 7954	Technology controller – motorized potentiometer
FP 7958	Technology controller – closed-loop controller

Key control parameters

- p1155 = r2294 CI: Speed controller speed setpoint 1 [FP 3080]
- p2253 = r2224 Technology controller setpoint effective via fixed setpoint [FD 7950]
- p2263 = 1 D component in fault signal [FD 7958]
- p2264 = r4055 Actual value signal X_{actual} via AI0 of TM31 [FP 9566]
- p2280 = Kp Calculate P gain by means of optimization
- p2285 = Tn Calculate integral time by means of optimization
- p2200 = 1 Technology controller enabled

9.3.2 Bypass function

The drive firmware includes functions for use in, for example, automatic or synchronized bypass circuits.

The bypass function uses digital drive outputs to activate two contactors and uses digital inputs to evaluate the contactor's feedback (e.g., via TM31). This circuit allows the motor to be switched to the drive or directly onto the supply line. The contactors are activated by the drive. The feedback signals for the contactor positions must be returned to the drive.

The bypass circuit can be implemented in two ways:

- without synchronizing the motor to the supply and
- with synchronizing the motor to the supply.

The following applies to all bypass versions:

- The bypass switch is also shut down either the "OFF2" or "OFF3" control word signal is canceled.
- Exception:
  If necessary, the bypass switch can be interlocked by a higher-level controller such that the drive can be shut down completely (i.e., including the controller electronics) while the motor is operated on the supply.
  The protective interlocking must be implemented on the system side.
- When the drive is started up again after POWER OFF, the status of the bypass contactors is evaluated. After powering up, the drive can thereby change straight into "Ready to start and bypass" status. This is only possible if the bypass is activated via a control signal, the control signal (p1266) is still present once the system has been ramped up, and the automatic restart function (p1200 = 4) is active.
- Changing the drive o "Ready to start and bypass" status after powering up is of a higher priority than the automatic restart function.
- Monitoring of the motor temperatures using temperature sensors is active while the drive is in either the "Ready to start and bypass" state or the "Ready for operation and bypass" state.
- The two motor contactors must be designed for switching under load.

Note

Information on the examples

The examples contained in the following descriptions are only basic circuits designed to explain the basic function. The dimensions of specific circuit configurations (contactors, protective equipment) must be calculated for specific systems.

Requirement

The bypass function is only available for sped control without an encoder (p1300 = 20) or V/f- control (p1300 = 0...19) and when using an induction motor.

Establishing the bypass function

The bypass function is part of the "technology controller" function module that can be activated by running the commissioning wizard. Parameter r0108.16 indicates whether the function module has been activated.

9.3.2.1 Synchronized bypass with overlap (p1260 = 1)

Description

The "Bypass synchronized with overlap" is used for drives with low inertia. These are drives in which the speed would drop very quickly when contactor K1 is opened.

When “Synchronized bypass with overlap (p1260 = 1)” is activated, the synchronized motor transfer is synchronized to and from the supply. During the changeover, both contactors K1 and K2 are closed at the same time for a period (phase lock synchronization).

A voltage sensing module VSM10 is required for this type of bypass which measures the mains voltage required for the drive to be synchronized.

An output reactor is used to de-couple the drive from the line supply - the impedance value for the reactor is 10% (±2%).

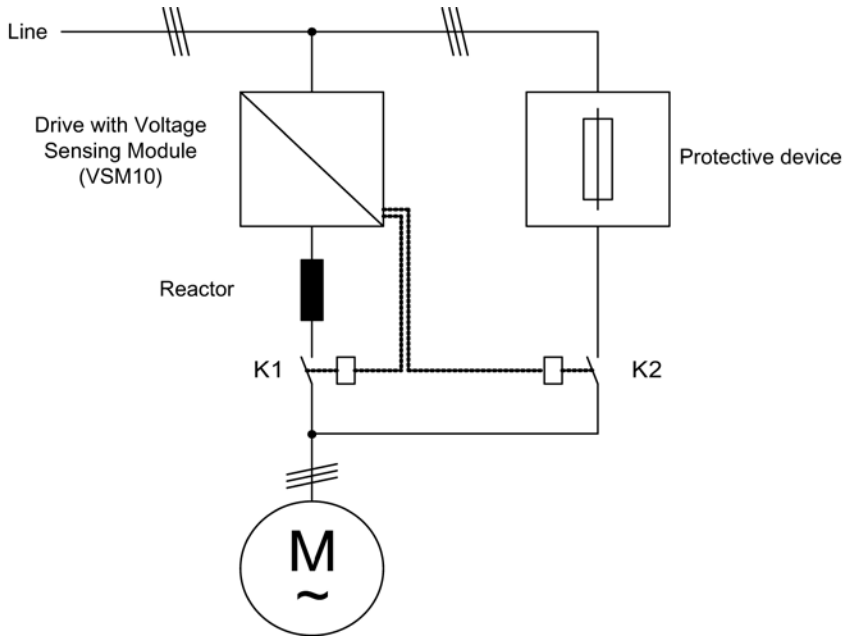


Figure 9-15 Typical circuit diagram for synchronized bypass overlap

Activation

The synchronized bypass with overlap (p1260 = 1) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameter assignment

Once the synchronized bypass with overlap (p1260 = 1) function has been activated, the following parameters must be set.

Table 9- 7 Parameter settings for synchronized bypass with overlap

Parameter	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	Synchronization is activated.
p3802 = r1261.2	Synchronization activation is triggered by the bypass function.

Transfer process

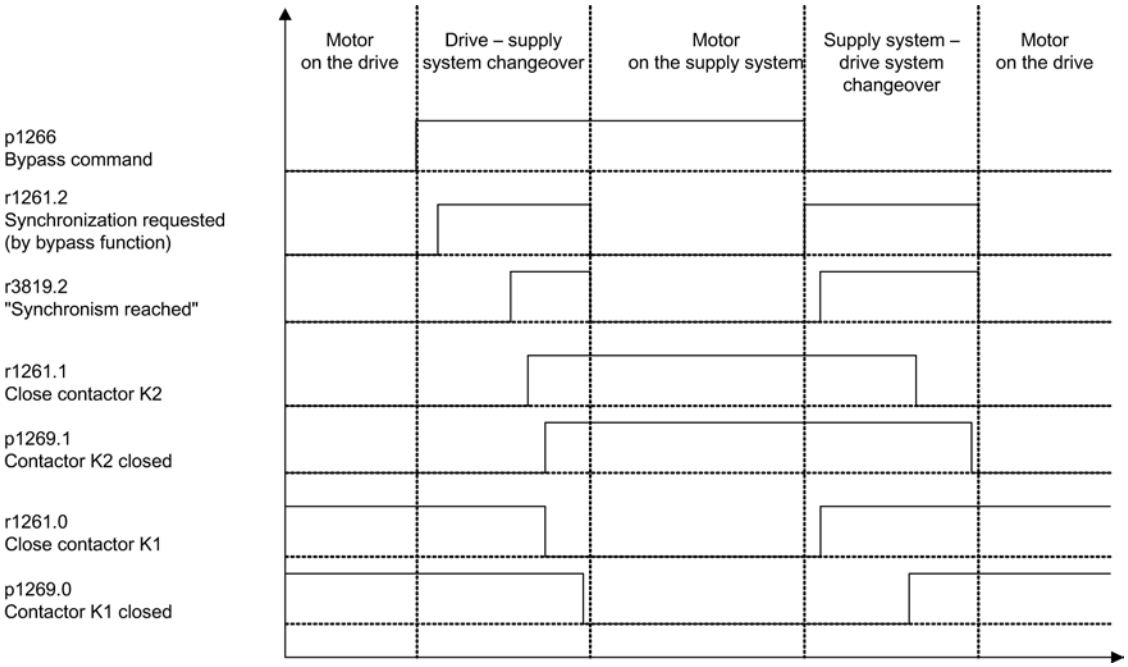


Figure 9-16 Signal diagram: Synchronized bypass with overlap

Transfer of motor to line supply
(contactors K1 and K2 are controlled by the drive):

- The initial state is as follows: Contactor K1 is closed, contactor K2 is open, and the motor is operated by the drive.
- The control bit "bypass command" (p1266) is set (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing" (r1261.2).
- Since the bit is set while the drive is running, the "Transfer motor to line supply" synchronization process is started.
- Once motor synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state (r3819.2).
- The bypass mechanism evaluates this signal and closes contactor K2 (r1261.1 = 1). The signal is evaluated internally - BICO wiring is not required.
- After contactor K2 has fed back the "closed" state (r1269[1] = 1), contactor K1 is opened and the drive inhibits the pulses. The drive is in "Ready to operate and bypass" state.
- If the On command is cancelled in this phase, the drive will change to "Ready to start and bypass" status. If the appropriate contactors are being used, the drive will be isolated from the line supply and the DC link discharged.

To transfer the motor back from the line supply, the sequence is simply reversed: At the start of the process, contactor K2 is closed and contactor K1 is open.

- The "Bypass command" control bit is canceled (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing".
- The pulses are enabled. Since "synchronizing" is set before "pulse enable", the drive interprets this as a command to retrieve the motor from the line supply.
- Once drive synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state.
- The bypass mechanism evaluates this signal and closes contactor K1. The signal is evaluated internally - BICO wiring is not required.
- Once contactor K1 has reported "closed" status, contactor K2 is opened and the motor is again operated by the drive.

9.3.2.2 Synchronized bypass without overlap (p1260 = 2)

Description

When “Synchronized bypass without overlap (p1260 = 2)” is activated, contactor K2 (to be closed) is only closed when contactor K1 is opened (anticipatory type synchronization). During this time, the motor is not connected to the mains, and its speed is determined by the load and the friction. This type for bypass is therefore suitable for drives with high inertia (see Note below). The phase position of the motor voltage before synchronization must be set to enable a "head start" before the power network to which synchronization should be carried out. This is done by setting the synchronization setpoint (p3809). Braking the motor in the brief period in which both contactors are open produces a phase and frequency difference of around zero when contactor K2 closes.

A voltage sensing module VSM10 is required for this type of bypass which measures the mains voltage required for the drive to be synchronized.

For the function to run correctly, the moment of inertia of the drive and the load must be sufficient.

Note

Sufficiently high moment of inertia

A sufficiently high moment of inertia is characterized by a change in the motor speed during opening of the contactors K1 and K2 that is approximately equal to the rated slip. The electrical angle difference of the motor relative to the phase difference of the power network may only change to the extent that it can be compensated via p3809.

By exerting the effort described above to determine the synchronization setpoint (p3809), the use of a decoupling reactor is no longer necessary.

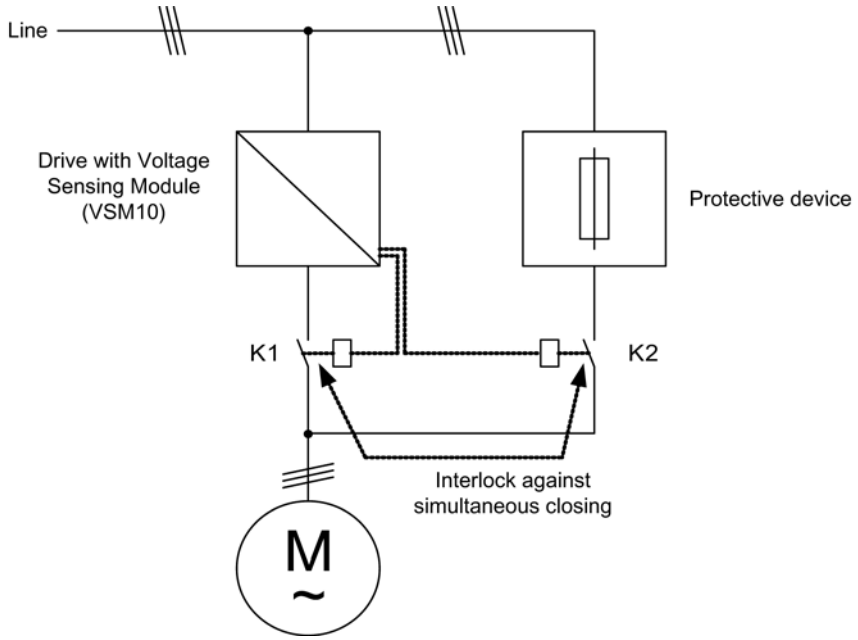


Figure 9-17 Example: Circuit for synchronized bypass without overlap

Activation

The synchronized bypass without overlap (p1260 = 2) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameter assignment

Once the synchronized bypass without overlap (p1260 = 2) function has been activated, the following parameters must be set.

Table 9- 8 Parameter setting for bypass function with synchronization without overlapping

Parameter	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	Synchronization is activated.
p3802 = r1261.2	Synchronization activation is triggered by the bypass function.
p3809 =	Setting of the phase setpoint for synchronizing the power network and drive

9.3.2.3 Bypass without synchronization (p1260 = 3)

Description

When the motor is transferred to the supply, contactor K1 is opened (following drive pulse inhibit). The system then waits for the motor excitation time to elapse, after which contactor K2 is closed, connecting the motor directly across the line.
If the motor is connected to the supply in a non-synchronized manner, an equalizing current flows when the motor is switched in, and this must be taken into account when designing the protective equipment (see diagram "Circuit for bypass without synchronization"). This is why this type of bypass is only suitable for drives with low power.

When the motor is transferred from the supply by the drive, contactor K2 opens first, then K1 closes after the de-excitation time. The drive then captures the rotating motor and the motor is operated on the drive.

A voltage sensing module VSM10 is required for this type of bypass.

Contactor K2 must be designed for switching under load.

Contactors K1 and K2 must be interlocked against closing at the same time.

The "flying restart" function must be activated (p1200 = 1).

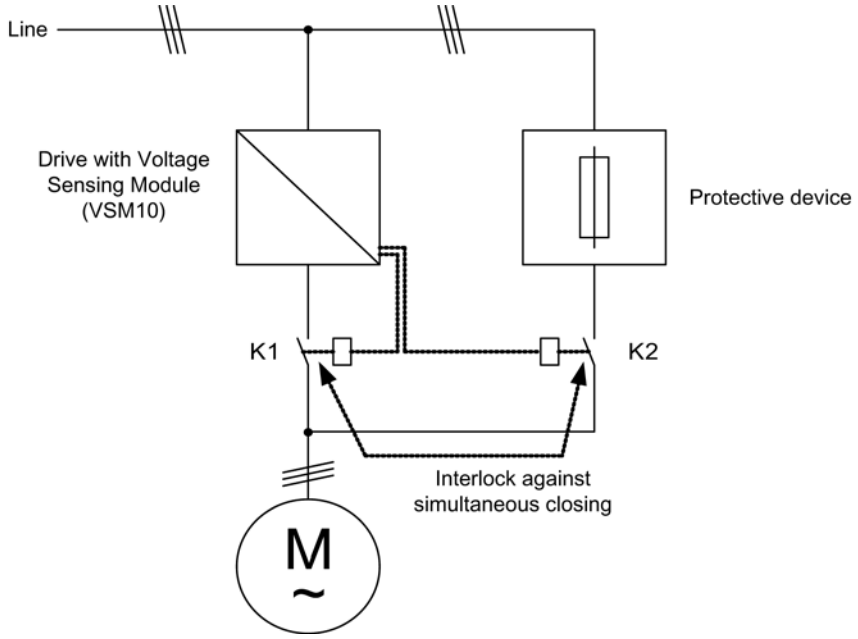


Figure 9-18 Example: Circuit for bypass without synchronization

Activation

The bypass without synchronization (p1260 = 3) can be triggered using the following signals (p1267):

- Bypass using control signal (p1267.0 = 1):
  The bypass is triggered using a digital signal (p1266) (e.g., from a higher-level automation system). If the digital signal is canceled, a changeover to drive operation is triggered once the debypass delay time (p1263) has expired.
- Bypass at speed threshold (p1267.1 = 1):
  Once a certain speed is reached, the system switches to bypass (i.e., the drive is used as a starting drive). The bypass cannot be connected until the speed setpoint is greater than the bypass speed threshold (p1265).
  The system reverts to drive operation when the setpoint (on the input of the ramp-function generator, r1119) falls below the bypass speed threshold (p1265). The setpoint > comparison value condition prevents the bypass from being reactivated right away if the actual speed is still above the bypass speed threshold (p1265) after switching back to drive operation.

The bypass time (switch to bypass), debypass time (revert to drive), bypass speed variables and the command source for changing over are set using parameters.

Parameter assignment

Once the bypass without synchronization (p1260 = 3) function has been activated, the following parameters must be set.

Table 9- 9 Parameter setting for bypass function with synchronization without overlapping

Parameter	Description
p1262 =	Bypass dead time setting
p1263 =	Debypass (revert to drive) dead time setting
p1264 =	Bypass delay time setting
p1265 =	Speed threshold setting when p1267.1 = 1
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = p1267.1 =	Trigger signal setting for bypass function
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 0	Synchronization is deactivated.
p1200 = 1	The "flying restart" function is always active.

9.3.2.4 Function diagram

FP 7020 Synchronization

9.3.2.5 Parameters

Bypass function

- p1200 Flying restart operating mode
- p1260 Bypass configuration
- r1261 CO/BO: Bypass control/status word
- p1262 Bypass dead time
- p1263 Debypass (revert to drive) delay time
- p1264 Bypass delay time
- p1265 Bypass speed threshold
- p1266 BI: Bypass control command
- p1267 Bypass changeover source configuration
- p1268 BI: Bypass feedback signal synchronization completed
- p1269 BI: Bypass switch feedback signal
- p1274 BI: Bypass switch monitoring time

Synchronization

- p3800 Sync–supply–drive activation
- p3801 Sync–supply–drive drive object number
- p3802 BI: Sync–supply–drive enable
- r3803 CO/BO: Sync–supply–drive control word
- r3804 CO: Sync–supply–drive target frequency
- r3805 CO: Sync–supply–drive frequency difference
- p3806 Sync–supply–drive frequency difference threshold
- r3808 CO: Sync–supply–drive phase difference
- p3809 Sync–supply–drive phase setpoint
- p3811 Sync–supply–drive frequency limitation
- r3812 CO: Sync–supply–drive correction frequency
- p3813 Sync–supply–drive phase synchronism threshold
- r3814 CO: Sync–supply–drive voltage difference
- p3815 Sync–supply–drive voltage difference threshold
- r3819 CO/BO: Sync–supply–drive status word

9.3.3 Extended brake control

Description

The "Extended brake control" function module allows complex braking control for motor holding brakes and holding brakes.

The brake is controlled as follows (the sequence reflects the priority):

- Via parameter p1215
- Via binector parameters p1219[0..3] and p0855
- Via standstill detection
- Via a connector interconnection threshold value

Commissioning

The "Extended brake control" function module can be activated by running the commissioning wizard. Parameter r0108.14 indicates whether the function module has been activated.

Parameter p1215 must be set to "3" and the brake controlled via a digital output on customer Terminal Module TM31.

Extended brake control for braking with checkback

For braking with feedback (p1275.5 = 1), the brake control reacts to the checkback contacts of the brake. If the timer p1216 is greater than the time until the checkback signal, then the approach is delayed by the corresponding time difference.

In order to be able to approach with as little delay as possible, the opening time set in p1216 must be shorter than the time until the checkback signal. However, if the timer in p1216 is set shorter, then alarm A07931 "Brake does not open" appears.

Remedy:

1. Activate "Enable with checkback" (p1275.6 = 1).

   The pulse enable (BO: r1229.3) and setpoint enable (BO: r0899.15) are now independent of the set timer (p1217, p1216). The associated enable is determined only by the feedback signal (BI: p1222, BI: p1223). The timers (p1216, p1217) only influence the alarms A07931 "Brake does not open" and A07932 "Brake does not close".

2. Optional: In order that the two alarms no longer appear, set both timers (p1217, p1216) to 0 ms.

   Result: The monitoring of the brake and the display of the alarms are switched off.

Example 1: Starting against applied brake

When the device is switched on, the setpoint is enabled immediately (if other enable signals are issued), even if the brake has not yet been released (p1152 = 1). The factory setting p1152 = r0899.15 must be separated here. The drive first builds up torque against the applied brake. The brake is not released until the motor torque or current (p1220) has exceeded braking threshold 1 (p1221).

Depending on the type and design of the brake, the time required to completely release the brake differs. It must be taken into consideration that, once the braking threshold torque has been exceeded, the operation enabling signal (p0899.2) is interrupted for the time interval that the brake is being released (p1216) to ensure that the motor current does not exceed the permissible limits during this period and the motor torque generated does not damage the brake. Time interval p1216 must be set on the basis of the time the brake actually requires to release.

This configuration is used, for example, when the drive is connected to a belt that is under tension (loop accumulator in the steel industry).

Example 2: Emergency brake

If emergency braking is required, electrical and mechanical braking must take place simultaneously. This can be achieved if OFF3 is used as a tripping signal for emergency braking:

p1219[0] = r0898.2 and p1275.00 = 1 (OFF3 to "apply brake immediately" and invert signal).

To prevent the drive from working in opposition to the brake, the OFF3 ramp (p1135) should be set to 0 seconds. Any regenerative energy produced must be converted into heat via a braking resistor.

This type of braking is often used, for example, for calendars, cutting tools, running gears, and presses.

Example 3: Service brake on crane drives

For cranes with manual control, it is important that the drive respond immediately when the control lever is moved (master switch). To ensure this, the drive is switched on using the On command (p0840) (pulses are enabled). The speed setpoint (p1142) and speed controller (p0856) are inhibited. The motor is magnetized. The magnetization time generally applicable for three-phase motors (1 to 2 seconds) is therefore eliminated.

Now, the only delay between the deflection of the master switch and the start of motor movement is the brake release time. Deflection of the master switch generates a "setpoint enable from the control" (bit interconnected with p1142, p1229.2, p1224.0). The speed controller is enabled immediately, and the speed setpoint is enabled once the brake release time (p1216) has elapsed. When the master switch is in the zero position, the speed setpoint is inhibited and the drive ramps down along the down ramp of the ramp-function generator. The brake closes once the standstill limit (p1226) is undershot. Once the brake closing time (p1217) has elapsed, the speed controller is inhibited (the motor is no longer generating any force). Extended braking control is used with the modifications described below.

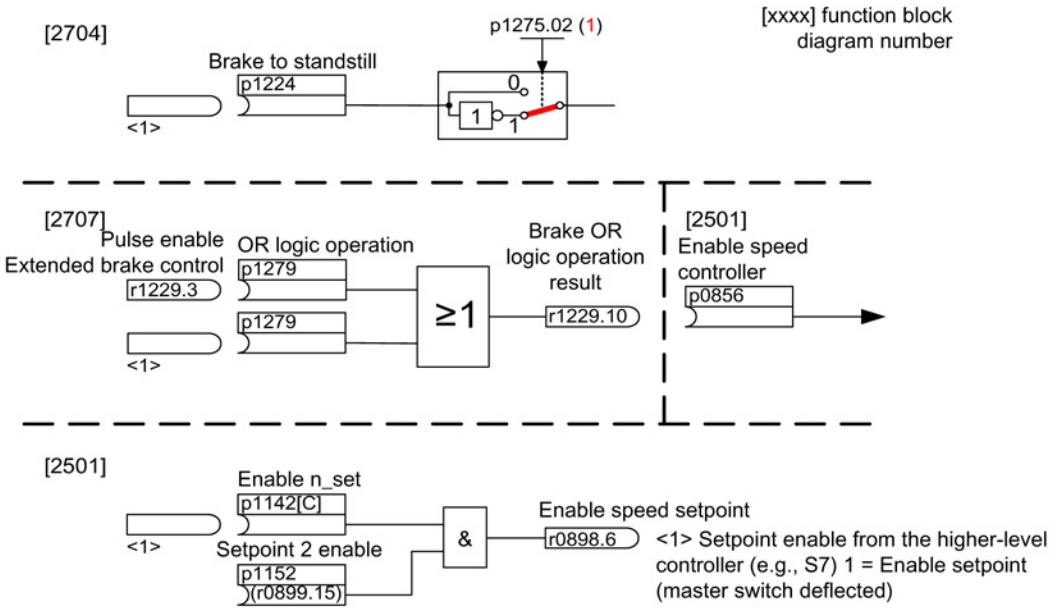


Figure 9-19 Example: Holding brake on a crane drive

Control and status messages for extended brake control

Table 9- 10 Control of extended brake control

Signal name	Binector input	Control word sequence control/interconnection parameters
Enable speed setpoint	p1142 BI: Enable speed setpoint	STWA.6
Enable setpoint 2	p1152 BI: Setpoint 2 enable	p1152 = r899.15
Unconditionally release holding brake	p0855 BI: Unconditionally release holding brake	STWA.7
Enable speed controller	p0856 BI: Enable speed controller	STWA.12
Unconditionally apply holding brake	p0858 BI: Unconditionally apply holding brake	STWA.14

Table 9- 11 Status message of extended brake control

Signal name	Parameter	Brake status word
Command, release brake (continuous signal)	r1229.1	B_STW.1
Pulse enable, extended brake control	r1229.3	B_STW.3
Brake does not release	r1229.4	B_STW.4
Brake does not close	r1229.5	B_STW.5
Brake threshold exceeded	r1229.6	B_STW.6
Brake threshold fallen below	r1229.7	B_STW.7
Brake monitoring time expired	r1229.8	B_STW.8
Request, pulse enable missing/n_ctrl inhibited	r1229.9	B_STW.9
Brake OR logic operation result	r1229.10	B_STW.10
Brake AND logic operation result	r1229.11	B_STW.11

Function diagram

FP 2704	Extended brake control – standstill detection (r0108.14 = 1)
FP 2707	Extended brake control – release/close brake (r0108.14 = 1)
FP 2711	Extended brake control – signal outputs (r0108.14 = 1)

Parameters

- r0108.14 Extended brake control
- r0899 CO/BO: Status word sequence control

Standstill monitoring

- r0060 CO: Speed setpoint before the setpoint filter
- r0063[0...2] CO: Actual speed value
- p1224[0...3] BI: Apply motor holding brake at standstill
- p1225 CI: Standstill detection threshold value
- p1226 Standstill monitoring speed threshold
- p1227 Standstill detection monitoring time
- p1228 Standstill detection delay time
- p1276 Motor holding brake standstill detection bypass

Release and apply brake

- p0855 BI: Unconditionally release holding brake
- p0858 BI: Unconditionally apply holding brake
- p1216 Motor holding brake release time
- p1217 Motor holding brake closing time
- p1218[0...1] BI: Release motor holding brake
- p1219[0...3] BI: Immediately apply motor holding brake
- p1220 CI: Release motor holding brake, signal source, threshold
- p1221 Release motor holding brake, threshold
- p1277 Motor holding brake, delay, braking threshold exceeded
- p1279 BI: Motor holding brake OR/AND logic operation

Brake monitoring functions

- p1222 BI: Motor holding brake, feedback signal, brake closed
- p1223 BI: Motor holding brake, feedback signal, brake released

Configuration, control/status words

- p1215 Motor holding brake configuration
- r1229 CO/BO: Motor holding brake status word
- p1275 Motor holding brake control word
- p1278 Motor holding brake type

9.3.4 Extended monitoring functions

Description

The "extended monitoring functions" function module enables additional monitoring functions:

- Speed setpoint monitoring: |n_set| ≤ p2161
- Speed setpoint monitoring: n_set > 0
- Load monitoring

Description of load monitoring

This function monitors power transmission between the motor and the working machine. Typical applications include V-belts, flat belts, or chains that loop around the belt pulleys or cog wheels of drive and outgoing shafts and transfer the peripheral speeds and forces. Load monitoring can be used here to identify blocking of the driven machine and interruptions to the power transmission.
During load monitoring, the current speed/torque curve is compared with the programmed speed/torque curve (p2182 to p2190). If the current value is outside the programmed

tolerance bandwidth, a fault or alarm is triggered depending on parameter p2181. The fault or alarm code can be delayed by means of parameter p2192 to prevent false alarms caused by brief transitional states.

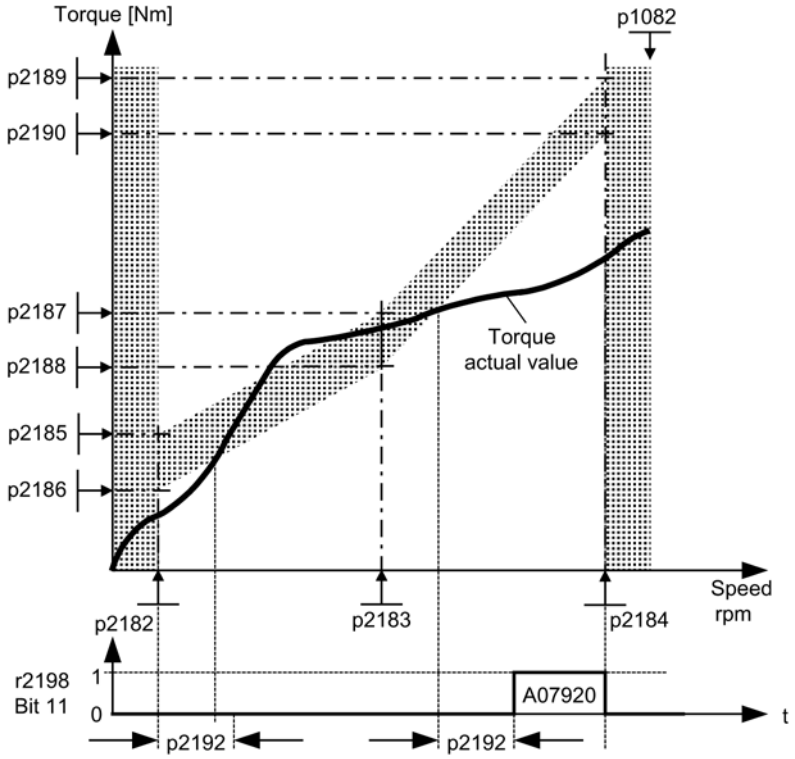


Figure 9-20 Load monitoring (p2181 =1)

Commissioning

The "extended monitoring functions" function module can be activated by running the commissioning wizard. Parameter r0108.17 indicates whether the function module has been activated.

Function diagram

FP 8010	Speed messages 1
FP 8011	Speed messages 2
FP 8013	Load monitoring

Parameters

- p2150 Hysteresis speed 3
- p2151 CI: Speed setpoint for messages
- p2161 Speed threshold 3
- p2181 Load monitoring, response
- p2182 Load monitoring, speed threshold 1
- p2183 Load monitoring, speed threshold 2
- p2184 Load monitoring, speed threshold 3
- p2185 Load monitoring, speed threshold 1 upper
- ...
- p2190 Load monitoring, speed threshold 3 lower
- p2192 Load monitoring, delay time
- r2198.4 |n_set| ≤ p2161
- r2198.5 n_set > 0
- r2198.11 Load monitoring signals alarm
- r2198.12 Load monitoring signals fault

9.4 Monitoring functions and protective functions

9.4.1 Power unit protection, general

Description

SINAMICS power modules offer comprehensive protection of power components.

Table 9- 12 General power module protection

Protection against:	Protective measure	Response
Overcurrent[1)]	Monitoring with two thresholds: • First threshold exceeded	A30031, A30032, A30033 Current limiting in phase U has responded. Pulsing in this phase is inhibited for one pulse period. F30017 -> OFF2 is triggered if the threshold is exceeded too often.
	• Second threshold exceeded	F30001 "Overcurrent" -> OFF2
DC link overvoltage [1)]	Comparison of DC link voltage with hardware shutdown threshold	F30002 "Overvoltage" -> OFF2
DC link undervoltage [1)]	Comparison of DC link voltage with hardware shutdown threshold	F30003 "Undervoltage" -> OFF2
Short circuit[1)]	Second monitoring threshold checked for overcurrent Uce monitoring of IGBT module	F30001 "Overcurrent" -> OFF2 F30022 "Monitoring Uce" -> OFF2
Ground fault	Monitoring of sum of all phase currents	After threshold in p0287 is exceeded: F30021 "Power module: ground fault" -> OFF2 Note: The sum of all phase currents is displayed in r0069[6]. For operation, the value in p0287[1] must be greater than the sum of the phase currents when the insulation is intact.
Line phase-failure detection [1)]		F30011 "Line phase-failure in main circuit" -> OFF2

[1)] Monitoring thresholds are permanently set in the converter and cannot be changed by the user.

9.4.2 Thermal monitoring and overload responses

Description

The thermal power module monitor is responsible for identifying critical situations. Possible reactions can be assigned and used when alarm thresholds are exceeded to enable continued operation (e.g., with reduced power) and prevent immediate shutdown. However, the parameter assignment options represent only interventions below the shutdown thresholds that cannot be changed by the user.

The following thermal monitoring options are available:

- i²t monitoring – A07805 – F30005
  i²t monitoring is used to protect components that have a high thermal time constant compared with semi-conductors. Overload with regard to i²t is present when the drive load (r0036) is greater than 100% (load as a % of rated operation).
- Heat-sink temperature – A05000 – F30004
  Used to monitor the temperature r0037[0] of the heat sinks on the power semiconductors (IGBT).
- Chip temperature – A05001 – F30025
  Significant temperature differences can occur between the barrier junction of the IGBT and the heat sink. The calculated barrier junction temperature is displayed in r0037[13...18]; the monitoring ensures that the specified maximum barrier junction temperature is not exceeded.

If an overload occurs with respect to any of these three monitoring functions, an alarm is first output. The alarm threshold p0294 (i²t monitoring) can be assigned relative to the shutdown (trip) values.

Example

The temperature difference between two sensors must not exceed 15 Kelvin (K); a temperature difference of 5 K is set for the temperature monitoring of the heat sink and the air intake. This means that 15 K or 5 K below the shutdown threshold an alarm is issued regarding the pending overtemperature. Parameter p0294 merely allows a change in the alarm threshold so that an alarm is received earlier and, if necessary, steps can be taken to intervene in the drive process (e.g., reduce the load, reduce the ambient temperature).

Overload responses

The power module responds with alarm A07805. The Control Unit initiates the responses assigned via p0290 at the same time that the alarm is issued. Possible responses include:

- Reduction in pulse frequency (p0290 = 2, 3)
  This is a highly effective method of reducing losses in the power module, since switching losses account for a very high proportion of overall losses. In many applications, a temporary pulse frequency reduction in favor of maintaining the process can be tolerated.
  Disadvantage:
  The pulse frequency reduction increases the current ripple, which can cause increased torque ripple on the motor shaft (when moment of inertia is low) and increased noise level. Reducing the pulse frequency does not affect the dynamic response of the current control circuit, since the sampling time for the current control circuit remains constant.
- Reduction in output frequency (p0290 = 0, 2)
  This response is recommended if pulse frequency reduction is not desired or if the pulse frequency has already been set to the lowest level. Further, the load should also have a characteristic similar to a fan, that is, a quadratic torque characteristic with falling speed. Reducing the output frequency has the effect of significantly reducing the drive output current which, in turn, reduces losses in the power module.
- No reduction (p0290 = 1)
  You should choose this option if it is not possible to reduce the pulse frequency or the output current. With this response, the drive does not change its operating point once an alarm threshold has been overshot, which means that the drive can be operated until it reaches its shutdown values. Once the shutdown threshold is reached, the drive switches off with an "overtemperature" or "overload" fault. The time until shutdown, however, is not defined and depends on the degree of overload. Only the alarm threshold can be changed so that an alarm is received earlier and, if necessary, steps can be taken to intervene in the drive process (e.g., reduce the load, reduce the ambient temperature).

Function diagram

FP 8014 Thermal monitoring, power module

Parameter

- r0036 CO: Power module overload I2t
- r0037 CO: Power module temperatures
- p0290 Power module overload response
- r0293 CO: Power module alarm threshold model temperature
- p0294 Power module warning I2t overload
- r2135.13 Fault: thermal overload in power module
- r2135.15 Alarm: thermal overload in power module

9.4.3 Blocking protection

Description

The "Motor blocked" fault is only triggered when the speed of the drive is below the adjustable speed threshold in p2175. With vector control, it must also be ensured that the speed controller is at the limit. With V/f control, the current limit must already have been reached.
Once the ON delay (p2177) has elapsed, the message "Motor blocked" and fault F07900 are generated.

The enable for the blocking monitoring can be deactivated via p2144.

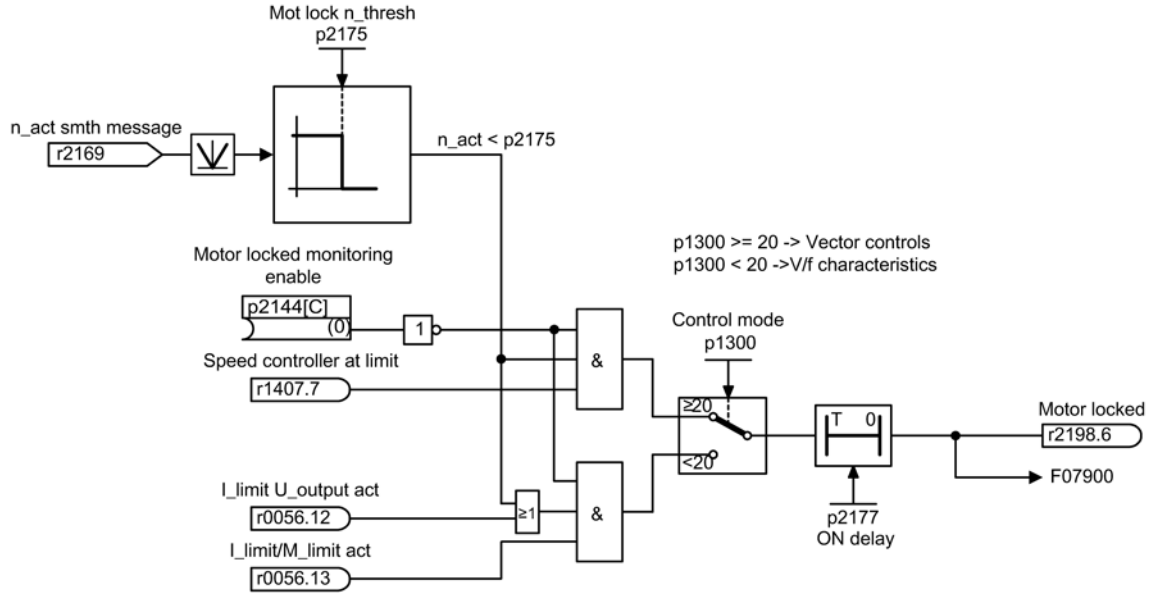


Figure 9-21 Blocking protection

Function diagram

FP 8012 Signals and monitoring functions - Torque messages, motor blocked/stalled

Parameter

- p2144 BI: Motor blocking monitoring enable (negated)
- p2175 Motor blocked speed threshold
- p2177 Motor blocked delay time

9.4.4 Stall protection (vector control only)

Description

During speed control with an encoder, if the speed threshold set in p1744 for stall detection is exceeded, then r1408.11 (speed adaptation, speed deviation) is set.

If the error threshold value set in p1745 is exceeded when in the low speed range (less than p1755 x (100% - p1756)), r1408.12 (motor stalled) is set.

If one of these two signals is set, then fault F07902 (motor stalled) is returned after the delay time in p2178.

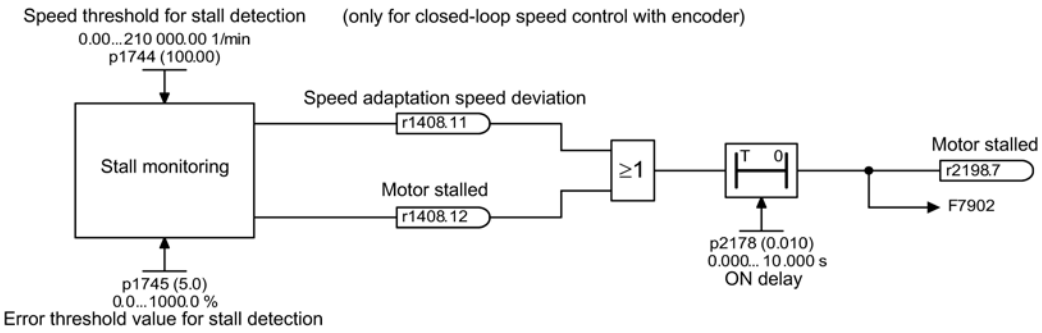


Figure 9-22 Stall protection

Function diagram

FP 6730	Vector control - Interface to Motor Module (ASM, p0300 = 1)
FP 8012	Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- r1408 CO/BO: Control status word 3
- p1744 Motor model speed threshold stall detection
- p1745 Motor model error threshold stall detection
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis encoderless operation
- p2178 Motor stalled delay time

9.4.5 Thermal motor protection

9.4.5.1 Description

Description

The priority of thermal motor protection is to identify critical situations. Possible reactions can be assigned (p0610) and used when alarm thresholds are exceeded to enable continued operation (e.g., with reduced power) and prevent immediate shutdown.

- Effective protection is also possible without a temperature sensor (p0600 = 0 or p4100 = 0). The temperatures of different motor components (stators, core, rotors) can be determined indirectly using a temperature model.
- Connecting temperature sensors allows the motor temperature to be determined directly. In this way, accurate start temperatures are available immediately when the motor is switched on again or after a power failure.

9.4.5.2 Temperature sensor connection to customer terminal module TM31 (option G60)

Temperature measurement via KTY

The sensor is connected to terminals X522:7 (temp+) and X522:8 (temp-) on the customer terminal module (-A60/-A65) in the forward direction of the diode. The measured temperature is limited to between -220 °F (-140 °C) and +371.5 °F (+188.6 °C) and is made available for further evaluation.

- Activate the motor temperature measurement via external sensor: p0600 = 10
  After completion of commissioning, the source for the external sensor is set to the customer terminal module (-A60/-A65) (p0603 = {TM31} r4105).
- Set the KTY temperature sensor type: p4100 = 2

Temperature measurement via PTC

The sensor is connected to terminal X522:7/8 on the customer terminal module (-A60/-A65). The threshold value for switchover to an alarm or fault is 1650 Ω. When this threshold is exceeded, the system switches internally from an artificially-generated temperature value of -58 °F (-50 °C) to +482 °F (+250 °C) and makes this value available for further evaluation.

- Activate the motor temperature measurement via external sensor: p0600 = 10
  After completion of commissioning, the source for the external sensor is set to the customer terminal module (-A60/-A65) (p0603 = {TM31} r4105).
- Set the PTC temperature sensor type: p4100 = 1

9.4.5.3 Temperature sensor connection to a sensor module (option K50)

Temperature measurement via KTY

The sensor is connected to the respective Temp- and Temp+ terminals on the Sensor Module in the forward direction of the diode (see the corresponding section in the chapter titled "Electrical installation").

- Activate motor temperature measurement via encoder 1: p0600 = 1.
- Set the KTY temperature sensor type: p0601 = 2.

Temperature measurement via PTC

The sensor is connected to the respective Temp- and Temp+ terminals on the Sensor Module (see the corresponding section in the chapter titled "Electrical installation"). The threshold for switching to an alarm or fault is 1650 Ω.

- Activate motor temperature measurement via encoder 1: p0600 = 1.
- Set the PTC temperature sensor type: p0601 = 1.

9.4.5.4 Temperature sensor connection directly to the control interface module

Temperature measurement via KTY

The sensor is connected to terminals X41:3 (temp-) and X41:4 (temp+) on the Control Interface Module in the forward direction of the diode.

- Activate motor temperature measurement via Motor Module: p0600 = 11.
- Set the KTY temperature sensor type: p0601 = 2.

Temperature measurement via PTC

The sensor is connected to terminals X41:3 (temp-) and X41:4 (temp+) on the Control Interface Module. The threshold for switching to an alarm or fault is 1650 Ω.

- Activate motor temperature measurement via Motor Module: p0600 = 11.
- Set the PTC temperature sensor type: p0601 = 1.

Temperature measurement using the bimetal normally closed contact

The sensor is connected to terminals X41:3 (temp-) and X41:4 (temp+) on the Control Interface Module. The threshold for switching to an alarm or fault is 100 Ω.

- Activate motor temperature measurement via Motor Module: p0600 = 11.
- Set the temperature sensor type bimetal normally closed contact: p0601 = 4.

Temperature measurement via PT100

The sensor is connected to terminals X41:3 (temp-) and X41:4 (temp+) on the Control Interface Module. The temperature offset for the PT100 reading can be set via p0624.

- Activate motor temperature measurement via Motor Module: p0600 = 11.
- Set the PT100 temperature sensor type: p0601 = 5.

9.4.5.5 Temperature sensor evaluation

Temperature measurement via KTY or PT100

- When the alarm threshold is reached (set via p0604; factory state after commissioning 248 °F (120 °C)), alarm A07910 is triggered.

  Parameter p0610 can be used to set how the drive responds to the alarm triggered:

  – 0: No response, only alarm, no reduction of I_max
  – 1: Alarm and reduction of I_max and fault (F07011)
  – 2: Alarm and fault (F07011), no reduction of I_max
  – 12: Alarm and fault (F07011), no reduction of I_max, temperature storage
- When the fault threshold is reached (set via p0605, factory state after commissioning 311 °F (155 °C)), fault F07011 is triggered in conjunction with the setting in p0610.

Temperature measurement via PTC or bimetallic NC contact

- Once the PTC or the bimetallic normally closed contact responds, alarm A07910 is initiated.
- Fault F07011 is returned once the waiting time defined in p0606 has elapsed.

Sensor monitoring for wire breakage/short-circuit

A sensor monitoring for short-circuit in the sensor cable is possible for a PTC and a KTY84 sensor. Wire break monitoring is possible for a KTY84 sensor:

If the temperature of the motor temperature monitoring is outside the designated range of -220 °F (-140 °C) to +482 °F (+250 °C), this means there is a wire break or short-circuit of the sensor cable. Alarm A07015 ("Motor temperature sensor alarm") is output. Fault F07016 (“Drive: Motor temperature sensor fault”) is triggered once the waiting time defined in p0607 has elapsed.

Fault F07016 can be suppressed using p0607 = 0. If an induction motor is connected, the drive continues operating with the calculated data of the thermal motor model.

If the system detects that the motor temperature sensor set in p0600 is not connected, alarm A07820 "Temperature sensor not connected" is triggered.

9.4.5.6 Thermal motor models

Thermal motor models are used so that thermal motor protection is ensured even without a temperature sensor or with a deactivated temperature sensor (p0600 = 0).

The simultaneous use of temperature sensors and a thermal motor model also makes sense. For example, a very fast temperature increase that is not detected by the sensors in sufficient time can potentially damage a motor. This situation can occur for motors with a low thermal capacity.

Depending on the particular temperature model, the temperature rise is either assigned to various motor parts (stator, rotor) or is calculated from the motor current and the thermal time constant. A combination of motor temperature model with additional temperature sensors can also be used.

NOTICE
Damage due to overheating when motor is operated without sensor A thermal motor model cannot fully replace a sensor. The thermal model cannot protect the motor in the event of incorrect installation, elevated ambient temperature, or incorrect parameter assignment. Without temperature sensors, thermal motor models are not in a position to identify or take into account the ambient temperatures or the initial motor temperature. This can result in overheating of the motor and cause damages. • Do not use the thermal motor models when an increased ambient temperature or an increased initial motor temperature can occur.

Thermal motor model 1 (for permanent-magnet synchronous machines)

By using the thermal I2t motor model, the temperature rise of the motor windings as a result of dynamic motor loads is also determined in addition to data acquired using a temperature sensor.

If the thermal I2t motor model is activated via p0612.0 = 1, it calculates the motor load (r0034) from the following values:

- Absolute value of the actual current, unsmoothed (r0068[0])
- Motor stall current (p0318)
- I2t motor model thermal time constant (p0611)
- Measured motor temperature (r0035) or motor ambient temperature (p0625) for operation without temperature sensor

If the fault threshold is exceeded (set via p0605; delivery state after commissioning 155 °C), alarm A07012 "I2t motor model overtemperature" is triggered.

When the I2t motor model fault threshold is reached (p0615), fault F07011 is triggered in conjunction with the setting in p0610.

Thermal motor model 2 (for induction motors)

The thermal motor model 2 is used for induction motors. It is a thermal 3-mass model.

This makes a thermal motor protection possible even for operation without temperature encoder or with temperature sensor deactivated (p0600 = 0).

The thermal 3-mass model is activated with p0612.1 = 1. The total motor mass is entered using p0344.

The 3-mass model splits up the total motor mass as follows:

- p0617 = thermally active iron mass (stator): laminated cores and frame) as a percentage of p0344
- p0618 = thermally active copper mass (stator: windings) as a percentage of p0344
- p0619 = thermally active rotor mass (rotor) as a percentage of p0344
- p0625 = ambient temperature
- p0626 = overtemperature, stator iron
- p0627 = overtemperature, stator winding
- p0628 = rotor winding temperature rise

Motor temperature rises are calculated on the basis of motor measured values. The calculated temperature rises are indicated in the parameters:

- r0630 Motor temperature model ambient temperature
- r0631 Motor temperature model stator iron temperature
- r0632 Motor temperature model stator winding temperature
- r0633 Motor temperature model rotor temperature

For operation with a KTY encoder, the calculated temperature value of the 3-mass model permanently tracks the measured temperature value. After the temperature sensor is switched off (p0600 = 0), the last temperature value continues to be used for calculation.

9.4.5.7 Function diagram

FP 8016	Thermal monitoring motor
FP 8017	Thermal motor models
FP 9576	TM31 - temperature evaluation (KTY/PTC)

9.4.5.8 Parameter

Temperature sensor evaluation

- r0035 CO: Motor temperature
- p0600 Motor temperature sensor for monitoring
- p0601 Motor temperature sensor type
- p0603 Motor temperature signal source
- p0604 Motor overtemperature fault threshold
- p0605 Motor overtemperature alarm threshold
- p0606 Motor overtemperature timer
- p0607 Temperature sensor fault timer
- p0610 Motor overtemperature response
- p0614 Thermal resistor adaptation reduction factor
- p0624 Motor temperature offset PT100
- p4100 TM31 temperature evaluation, sensor type
- r4105 CO: TM31 temperature evaluation, actual value

Thermal motor model 1 (for permanent-magnet synchronous machines)

- r0034 CO: Motor load
- r0068[0] CO: Absolute value of actual current value, unsmoothed
- p0318 Motor stall current
- p0605 Motor overtemperature alarm threshold
- p0610 Motor overtemperature response
- p0611 I2t motor model thermal time constant
- p0612 Thermal motor model configuration
- p0615 I2t motor model fault threshold
- p0625 Motor ambient temperature

Thermal motor model 2 (for induction motors)

- p0344 Motor weight
- p0612 Thermal motor model configuration
- p0617 Stator thermally relevant iron component
- p0618 Stator thermally relevant copper component
- p0619 Rotor thermally relevant mass
- p0625 Motor ambient temperature
- p0626 Motor overtemperature, stator iron
- p0627 Motor overtemperature, stator winding
- p0628 Motor overtemperature, rotor winding
- r0630 Mot_temp_mod ambient temperature
- r0631 Mot_temp_mod stator iron temperature
- r0632 Mot_temp_mod stator winding temperature
- r0633 Mot_temp_mod rotor temperature

9.4.6 Temperature measurement via TM150 (option G51)

9.4.6.1 Description

The Terminal Module 150 (TM150) has 6 4-pole terminals for temperature sensors. Temperature sensors can be connected in a 1x2-, 1x3-, or 1x4-wire system. In a 2x2-wire system, up to 12 input channels can be evaluated. Twelve (12) input channels can be evaluated in the factory setting. The temperature channels can be combined into as many as 3 groups and evaluated together.

Temperature sensors of type PTC, KTY84, bimetallic NC contact, PT100, and PT1000 can be connected and evaluated. The fault and alarm thresholds of the temperature values can be set from -99 °C to 251 °C.

The temperature sensors are connected to terminal strips X531 to X536 according to the following table.

The temperature inputs of the TM150 are not electrically isolated.

Selection of sensor types

- p4100[0...11] sets the sensor type for the respective temperature channel.
- r4105[0...11] indicates the actual value of the temperature channel.
  - For switching temperature sensors, such as PTC and bimetallic NC contact, two limits are displayed symbolically:

    - r4105[0...11] = -50 °C: The actual temperature value is below the rated response temperature.

    - r4105[0...11] = +250 °C: The actual temperature value is above the rated response temperature.

Note

PTC and bimetallic NC contact

The value indicated in r4105[0...11] does not correspond to the actual temperature value.

Table 9- 13 Selection of sensor types

Value of p4100[0...11]	Temperature sensor	Temperature display range r4105[0...11]
0	Evaluation disabled	-
1	PTC thermistor	-50 °C or +250 °C
2	KTY84	-99 ℃ to +250 ℃
4	Bimetallic NC contact	-50 °C or +250 °C
5	PT100	-99 ℃ to +250 ℃
6	PT1000	-99 ℃ to +250 ℃

Measurement of cable resistances

When using 2-wire sensors (1x2-, 2x2-wire system), the cable resistance can be measured and saved to increase the measuring accuracy.

Procedure for determining the cable resistance:

1. Select the measuring method (1x2/2x2) for the corresponding terminal block (p4108[0...5] = 0, 1).
2. Set the required sensor type for the relevant channel (p4100[x] = 1 ... 6, x = 0...5 or 0...11).
3. Jumper the sensor to be connected (short-circuit the sensor cable in the vicinity of the sensor).
4. Connect the sensor cables to the relevant terminals 1(+), 2(-) or 3(+), 4(-).
5. Start measurement of the cable resistance (p4109[x] = 1) for the relevant channel.
6. After p4109[x] = 0, check the measured resistance value in p4110[x].
7. Remove jumper across the temperature sensor again.

The measured cable resistance is then taken into account when evaluating the temperature. The cable resistance value is saved in p4110[0...11].

Note

Line resistance

The value for the cable resistance in p4110[0...11] can also be entered directly.

Line filter

A mains filter is available to suppress radiated noise. Using p4121, the filter can be set to a 50 Hz or 60 Hz rated line frequency.

9.4.6.2 Measurement with up to 6 channels

Temperature measurement with a sensor in 2-wire technology

With p4108[0...5] = 0, you measure using a sensor in 2-wire technology on a 4-wire connection to terminals 1(+) and 2(-).
Terminals 3 and 4 remain open.

Temperature measurement with a sensor in 3-wire technology

With p4108[0...5] = 2, you measure using a sensor in 3-wire technology on a 4-wire connection to terminals 3(+) and 4(-).
The measuring wire is connected to terminal 1(+).
You must short circuit terminals 2(-) and 4(-).

Temperature measurement with a sensor in 4-wire technology

With p4108[0...5] = 3, you measure using a sensor in 4-wire technology on a 4-wire connection to terminals 3(+) and 4(-).
The measuring wire is connected to terminals 1(+) and 2(-).

9.4.6.3 Measurement with up to 12 channels

Temperature measurement with two sensors in 2-wire system

With p4108[0...5] = 1 you measure using two sensors in 2-wire system.
The first sensor is connected to terminals 1(+) and 2(-).
The second sensor (number = first sensor + 6) is connected to terminals 3(+) and 4(-).

For connection of two sensors in 2-wire system to terminal X531, the first sensor is assigned to temperature channel 1 and the second sensor is assigned to channel 7 (1+6).

Note

Connection diagram for 12 temperature channels

The temperature sensors connected to a TM150 are not numbered consecutively. The first 6 temperature channels retain their numbering of 0 to 5. The other 6 temperature channels are consecutively numbered from 6 to 11, starting at terminal X531.

Example for 8 temperature channels:

- 2x2-wire at terminal X531: p4108[0] = 1 ≙ sensor 1 is at channel 0 and sensor 2 is at channel 6
- 2x2-wire at terminal X532: p4108[1] = 1 ≙ sensor 1 is at channel 1 and sensor 2 is at channel 7
- 1x3-wire at terminal X533: p4108[2] = 2 ≙ sensor 1 is at channel 2
- 1x3-wire at terminal X534: p4108[3] = 2 ≙ sensor 1 is at channel 3
- 1x4-wire at terminal X535: p4108[4] = 3 ≙ sensor 1 is at channel 4
- 1x2-wire at terminal X536: p4108[5] = 0 ≙ sensor 1 is at channel 5

9.4.6.4 Forming groups of temperature sensors

With p4111[0...2], temperature channels can be formed into groups. For each group, the following calculated values are provided from the actual temperature values (r4105[0...11]):

- Maximum: r4112[0...2], (index 0,1,2 = group 0,1,2)
- Minimum: r4113[0...2]
- Average value: r4114[0...2]

Example:

The actual temperature values from channels 0, 3, 7, and 9 are to be combined in group 1:

- p4111[1].0 = 1
- p4111[1].3 = 1
- p4111[1].7 = 1
- p4111[1].9 = 1

The calculated values from group 1 are available in the following parameters for interconnection:

- r4112[1] = maximum
- r4113[1] = minimum
- r4114[1] = average value

Note

Forming groups of temperature channels

Only form groups of continuously measuring temperature sensors. Only the two temperatures -50 °C and +250 °C are assigned to switching temperature sensors PTC and bimetallic NC contact, depending on the switch status.
Within a group including continuously measuring temperature sensors, the calculated maximum/minimum/mean values is significantly falsified by inclusion of switching temperature sensors.

9.4.6.5 Evaluation of temperature channels

One alarm threshold and one fault threshold can be set for each of the 12 temperature channels via p4102[0...23] (even parameter indices: warning thresholds, odd parameter indices: fault thresholds). The temperature thresholds can be set for each channel from -99 °C to +251 °C. For p4102[0...23] = 251, the evaluation of the corresponding threshold is deactivated.
Using p4118[0...11], a hysteresis for the fault/alarm thresholds can be set in p4102[0...23] for each channel.

The following applies to the warning thresholds:

- If the actual temperature value associated with a channel exceeds the specified warning threshold (r4105[x] > p4102[2x]), the corresponding alarm is output. Timer p4103[0...11] is started at the same time.
- The alarm remains until the actual temperature value (r4105[x]) has reached or fallen below the alarm threshold (p4102[2x]) - hysteresis (p4118[x]).
- If, after the timer has expired, the actual temperature value is still above the alarm threshold, then the corresponding fault is output.

The following applies to the fault thresholds:

- If the actual temperature value associated with a channel exceeds the specified fault threshold (r4105[x] > p4102[2x+1]), the corresponding fault is output.
- The fault remains until the actual temperature value (r4105[x]) has reached or fallen below the fault threshold (p4102[2x+1]) - hysteresis (p4118[x]) and the fault has been acknowledged.

Using p4119[0...11], a filter for smoothing the temperature signal can be activated for each channel.
The time constant of the filter depends on the number of active temperature channels and can be read off in r4120.

Failure of a sensor within a group

The response to the failure of a temperature sensor within a group can be set with parameter p4117[0...2]:

- p4117[x] = 0: The failed sensor is not taken into account in the group.
- p4117[x] = 1: In the event of a failed sensor, the value 300 °C is output for the maximum value, minimum value, and the mean value of the group.

9.4.6.6 Function diagram

FP 9625	TM150 - Temperature evaluation structure (channel 0...11)
FP 9626	TM150 - Temperature evaluation 1x2-, 3-, 4-wire (channel 0...5)
FP 9627	TM150 - Temperature evaluation 2x2-wire (channel 0...11)

9.4.6.7 Parameters

- p4100[0...11] TM150 sensor type
- r4101[0...11] TM150 sensor resistance
- p4102[0...23] TM150 fault threshold/alarm threshold
- p4103[0...11] TM150 delay time
- r4104.0...23 BO: TM150 temperature evaluation status
- r4105[0...11] CO: TM150 actual temperature value
- p4108[0...5] TM150 terminal block measurement method
- p4109[0...11] TM150 cable resistance measurement
- p4110[0...11] TM150 cable resistance value
- p4111[0...2] TM150 group channel assignment
- r4112[0...2] CO: TM150 group actual temperature value maximum value
- r4113[0...2] CO: TM150 group actual temperature value minimum value
- r4114[0...2] CO: TM150 group actual temperature value average
- p4117[0...2] TM150 group sensor fault effect
- p4118[0...11] TM150 fault threshold/alarm threshold hysteresis
- p4119[0...11] TM150 activate/deactivate smoothing
- r4120 TM150 Temperature filter time constant
- p4121 TM150 filter rated line frequency

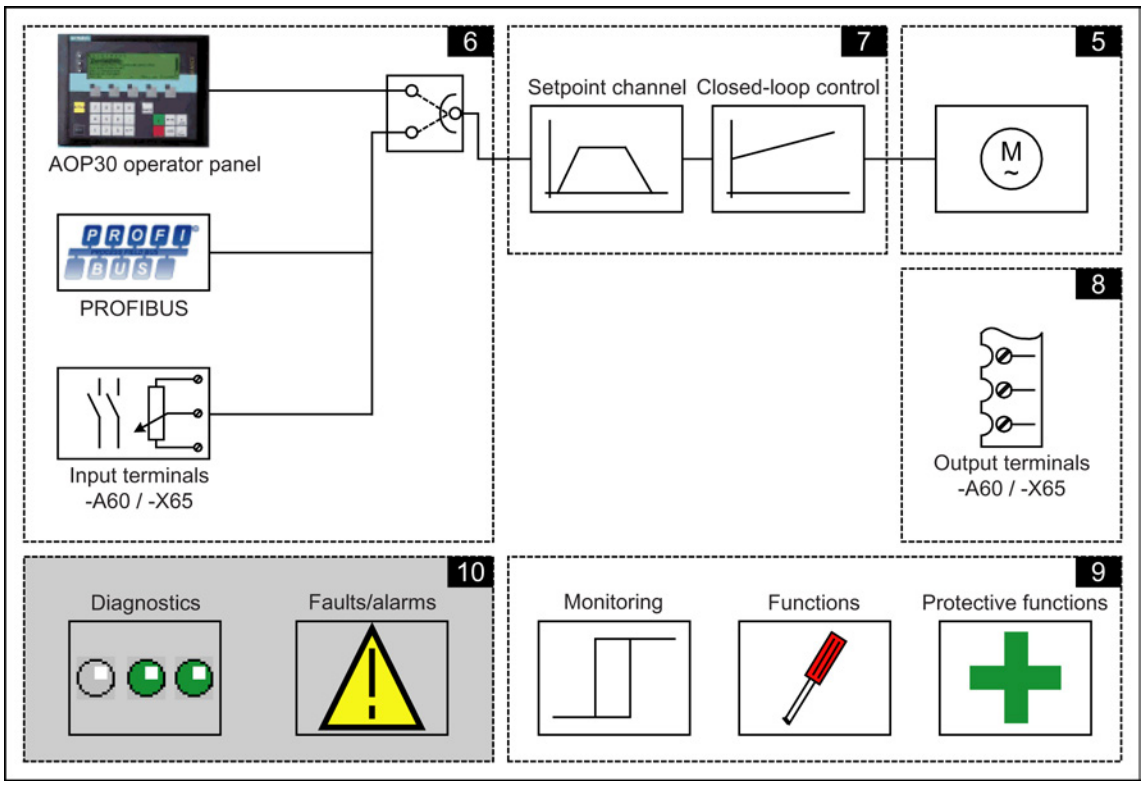
Diagnostics / faults and alarms

10

10.1 Chapter content

This section provides information on the following:

- Information on available diagnostics and on eliminating the causes of errors



10.2 Diagnostics

Description

This section describes procedures for identifying the causes of problems and the measures you need to take to rectify them.

Note

Errors or malfunctions

If faults or malfunctions occur in the device, you must carefully check the possible causes and take the necessary steps to rectify them. If you cannot identify the cause of the problem or you discover that components are defective, your regional office or sales office should contact Siemens Service and describe the problem in more detail. Addresses of contact persons are listed in the preface.

10.2.1 Diagnostics via LEDs

Control unit (-A10)

Table 10- 1 Description of the LEDs on the CU320-2 DP Control Unit

LED	Color	Status	Description
RDY (READY)	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Continuous light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The Control Unit is waiting for initial commissioning.
		Flashing 0.5 Hz	Commissioning/reset
		Flashing 2 Hz	Writing to memory card.
	Red	Flashing 2 Hz	General errors
	Red/green	Flashing 0.5 Hz	Control Unit is ready for operation. However, there are no software licenses.
	Orange	Flashing 0.5 Hz	Firmware update in progress for the connected DRIVE-CLiQ components.
		Flashing 2 Hz	Firmware update of components is complete. Waiting for POWER ON of the respective component.
	Green/ orange or red/orange	Flashing 2 Hz	Component detection via LED is activated (p0124[0]). Note: The two options depend on the LED status when component detection is activated via p0124[0] = 1.

LED	Color	Status	Description
COM PROFIdrive cyclic operation	---	OFF	Cyclic communication has not (yet) occured. Note: PROFIdrive is ready for communication when the Control Unit is ready for operation (see RDY LED).
	Green	Continuous light	Cyclic communication is taking place.
		Flashing 0.5 Hz	Cyclic communication has not yet fully occured. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not transmit a Global Control (GC) or it transmitted an incorrect Global Control.
	Red	Flashing 0.5 Hz	PROFIBUS master is sending incorrect parameter assignment/configuration data
		Flashing 2 Hz	Cyclic bus communication has been interrupted or could not be established.
OPT (OPTION)	---	OFF	Electronics power supply is missing or is outside the permissible tolerance range. The component is not ready for operation. The Option Board is missing or an associated drive object has not been created.
	Green	Continuous light	Option Board is ready for operation.
		Flashing 0.5 Hz	Depends on the Option Board used.
	Red	Flashing 2 Hz	At least one fault is pending on this component. The Option Board is not ready (e.g., after switching on).
RDY and COM	Red	Flashing 2 Hz	Bus error - communication has been interrupted.
RDY and OPT	Orange	Flashing 0.5 Hz	Firmware update in progress for connected option board CBE20.

Table 10- 2 Description of the LEDs on the CU320-2 PN Control Unit

LED	Color	Status	Description
RDY (READY)	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	Continuous light	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The Control Unit is waiting for initial commissioning.
		Flashing 0.5 Hz	Commissioning/reset
		Flashing 2 Hz	Writing to memory card.
	Red	Flashing 2 Hz	General errors
	Red/green	Flashing 0.5 Hz	Control Unit is ready for operation. However, there are no software licenses.
	Orange	Flashing 0.5 Hz	Firmware update in progress for the connected DRIVE-CLiQ components.
		Flashing 2 Hz	Firmware update of components is complete. Waiting for POWER ON of the respective component.
	Green/ orange or red/orange	Flashing 2 Hz	Component detection via LED is activated (p0124[0]). Note: The two options depend on the LED status when component detection is activated via p0124[0] = 1.
COM PROFIdrive cyclic operation	---	OFF	Cyclic communication has not (yet) occured. Note: PROFIdrive is ready for communication when the Control Unit is ready for operation (see RDY LED).
	Green	Continuous light	Cyclic communication is taking place.
		Flashing 0.5 Hz	Cyclic communication has not yet fully occured. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not transmit a Global Control (GC) or it transmitted an incorrect Global Control. - "Shared Device" is selected (p8929 = 2) and only one controller is connected.
	Red	Flashing 0.5 Hz	Bus error, incorrect parameter assignment/configuration
		Flashing 2 Hz	Cyclic bus communication has been interrupted or could not be established.
OPT (OPTION)	---	OFF	Electronics power supply is missing or is outside the permissible tolerance range. The component is not ready for operation. The Option Board is missing or an associated drive object has not been created.
	Green	Continuous light	Option Board is ready for operation.
		Flashing 0.5 Hz	Depends on the Option Board used.
	Red	Flashing 2 Hz	At least one fault is pending on this component. The Option Board is not ready (e.g., after switching on).
RDY and COM	Red	Flashing 2 Hz	Bus error - communication has been interrupted.
RDY and OPT	Orange	Flashing 0.5 Hz	Firmware update in progress for connected option board CBE20.

Customer terminal module TM31 (-A60)

Table 10- 3 Description of the LEDs on the TM31

LED	Color	Status	Description
READY	---	OFF	The electronics power supply is missing or lies outside the 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 pending in this component. Note: LED is activated irrespective of any reconfiguring of the corresponding messages.
	Green/red	Flashing 0.5 Hz	Firmware is being downloaded.
		Flashing 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green/ orange or red/orange	Flashing light	Component detection via LED is activated (p0154). Note: Both options depend on the LED status when component detection is activated via p0154 = 1.

Control Interface Module – Interface module in the Power Module (-T1)

Table 10- 4 Description of the "READY" and "DC LINK" LEDs on the Control Interface Module

LED, status		Description
READY	DC LINK	
Off	Off	The electronics power supply is missing or lies outside the permissible tolerance range.
Green	Off	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.
Orange	Orange	DRIVE-CLiQ communication is being established.
Red	---	At least one fault is pending in this component. Note: LED is activated irrespective of any reconfiguring of the corresponding messages.
Flashing, 0.5 Hz: Green / red	---	Firmware is being downloaded.
Flashing, 2 Hz: Green / red	---	Firmware download is complete. Waiting for POWER ON.
Flashing, 2 Hz: Green / orange or red / orange	---	Detection of the components via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.

Table 10- 5 Meaning of the "POWER OK" LED on the Control Interface Module

LED	Color	Status	Description
POWER OK	Green	Off	DC link voltage < 100 V and voltage at -X9:1/2 less than 12 V.
		On	The component is ready for operation.
		Flashing light	There is a fault. If the LED continues to flash after you have performed a POWER ON, please contact your Siemens service center.



WARNING

Danger to life when live parts of the DC link are touched

Hazardous DC link voltages may be present at any time regardless of the status of the "DC LINK" LED. This means the touching of live parts can result in death or serious injury.

- Observe the warning information on the component.

SMC30 – encoder evaluation (-B83)

Table 10- 6 Description of the LEDs on the SMC30

LED	Color	Status	Description
READY	---	OFF	The electronics power supply is missing or lies outside the 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 pending in this component. Note: LED is activated irrespective of any reconfiguring of the corresponding messages.
	Green/red	Flashing 0.5 Hz	Firmware is being downloaded.
		Flashing 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green/orange or red/orange	Flashing light	Component detection via LED is activated (p0144). Note: Both options depend on the LED status when component detection is activated via p0144 = 1.
OUT>5 V	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range. Voltage supply ≤ 5 V.
	Orange	Continuous light	Electronics power supply for measuring system is present. Voltage supply > 5 V. Notice: It must be ensured that the connected encoder is permitted to be operated with a 24 V voltage supply. Operating an encoder designed for a 5 V supply with a 24 V supply can damage the encoder electronics beyond repair.

CBE20 – Communication Board Ethernet

Table 10- 7 Description of the LEDs on ports 1-4 of the X1400 interface on the CBE20

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	Continuous light	Data is being received or sent at port x.

Table 10- 8 Description 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 error-free, and data is being exchanged with the configured IO controller.
	Red	Flashing light	- The watchdog timer has elapsed. - Communication has been interrupted. - The IP address is incorrect. - Incorrect or missing configuration. - Incorrect parameter assignment. - Incorrect or missing device name. - IO controller not present/switched off but Ethernet connection present. - 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 10- 9 Description of the OPT LED on the Control Unit

LED	Color	Status	Description
OPT	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range. Communication Board is either defective or not inserted.
	Green	Continuous light	The Communication Board is ready and cyclic communication is taking place.
		Flashing 0.5 Hz	The Communication Board is ready, but cyclic communication is not yet taking place. Possible causes: - At least one fault is pending. - Communication is being established.
	Red	Continuous light	Cyclic communication via PROFINET has not yet been established. However, acyclic communication is possible. SINAMICS is waiting for a parameterization/configuration frame.
		Flashing 0.5 Hz	The firmware download to the CBE20 has failed. Possible causes: - The CBE20 is defective. - The memory card for the Control Unit is defective. In this state, the CBE20 cannot be used.
		Flashing 2 Hz	Communication between the Control Unit and the CBE20 is faulty. Possible causes: - The CBE20 was removed following power-up. - The CBE20 is defective.
	Orange	Flashing 0.5 Hz	Firmware is being updated.

TM150 - Temperature Sensor Module (-A151)

Table 10- 10 Description of the LEDs on the TM150

LED	Color	Status	Description
READY	-	Off	The electronics power supply is missing or lies outside the 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.
	Green/red	Flashing 0.5 Hz	Firmware is being downloaded.
		Flashing 2 Hz	Firmware download is complete. Waiting for POWER ON.
	Green/orange or red/orange	Flashing 2 Hz	Component detection via LED is activated (p0154). Note: Both options depend on the LED status when component detection is activated via p0154 = 1.

10.2.2 Diagnostics via parameters

All Objects: Key diagnostic parameters (details in List Manual)

Parameter	Name
	Description
r0945	Fault code
	Displays the fault number. Index 0 is the most recent fault (last fault to have occurred).
r0948	Fault time received in milliseconds
	Displays the system runtime in ms at which the fault occurred.
r0949	Fault value
	Displays additional information about the fault. This information is required for detailed fault diagnosis.
r2109	Fault time removed in milliseconds
	Displays the system runtime in ms at which the fault was rectified.
r2122	Alarm code
	Displays the numbers of the alarms that have occurred.
r2123	Alarm time received in milliseconds
	Displays the system runtime in ms at which the alarm occurred.
r2124	Alarm value
	Displays additional information about the alarm. This information is required for detailed alarm diagnosis.
r2125	Alarm time removed in milliseconds
	Displays the system runtime in ms at which the alarm was rectified.

Control unit: Key diagnostic parameters (details in List Manual)

Parameter	Name
	Description
r0002	Control unit status display
	Status display for the Control Unit
r0018	Control unit firmware version
	Displays the firmware version of the Control Unit. The display parameters of the firmware version of other connected components can be found in the parameter description in the List Manual.
r0037	Control unit temperature
	Display of the measured temperature on the Control Unit.
r0721	CU digital inputs, actual terminal value
	Displays the actual value at the digital input terminals on the CU. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.
r0722	CO/BO: CU digital inputs status
	Displays the status of the digital inputs on the CU. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.

Parameter	Name
	Description
r0747	CU digital outputs status
	Display of the CU digital output status. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r2054	PROFIBUS status
	Displays the status of the PROFIBUS interface.
r8937	PN diagnostics
	Diagnostics display of the cyclic PROFINET connections.
r9976[0..7]	System utilization
	Displays the system load. The individual values (computation load and cyclic load) are measured over short time slices; from these values, the maximum, the minimum and the average value are generated and displayed in the appropriate indices. The degree of memory utilization of the data and program memory is also displayed.

VECTOR: Key diagnostic parameters (details in List Manual)

Parameter	Name
	Description
r0002	Drive operating display
	The value provides information about the current operating state and the conditions necessary to reach the next status.
r0020	Speed setpoint, smoothed
	Displays the current smoothed speed/velocity setpoint at the input of the speed/velocity controller or V/f characteristic (after the interpolator).
r0021	CO: Actual speed value, smoothed
	Displays the smoothed actual value of the motor speed/velocity.
r0024	CO: Output frequency smoothed
	Displays the smoothed converter frequency.
r0026	CO: DC link voltage, smoothed
	Displays the smoothed actual value of the DC link.
r0027	CO: Absolute actual value of current, smoothed
	Displays the smoothed actual value of the current.
r0031	Actual torque, smoothed
	Displays the smoothed actual torque.
r0034	CO: Motor load
	Displays the motor load from the thermal I2t motor model.
r0035	CO: Motor temperature

Parameter	Name
	Description
	If r0035 does not equal -200.0°C, the following applies: • This temperature indicator is valid. • An KTY sensor is connected. • If using an asynchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0). If r0035 equals -200.0°C, the following applies: • This temperature indicator is invalid (temperature sensor fault). • A PTC sensor is connected. If using a synchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0).
r0037	CO: Power module temperatures
	Displays the measured temperatures in the Power Module.
r0046	CO/BO: Missing enables
	Displays missing enable signals that are preventing the closed-loop drive control from being commissioned.
r0049	Motor data set/encoder data set effective (MDS, EDS)
	Displays the effective motor data set (MDS) and the effective encoder data sets (EDS).
r0050	CO/BO: Command data set CDS effective
	Displays the effective command data set (CDS)
r0051	CO/BO: Drive data set DDS effective
	Effective drive data set (DDS) display.
r0056	CO/BO: Status word closed-loop control
	Displays the status word of the closed-loop control.
r0063	CO: Actual speed value
	Displays the current actual speed value for speed control and V/f control.
r0066	CO: Output frequency
	Displays the output frequency of the Motor Module.
r0070	CO: Actual DC-link voltage value
	Displays the measured actual value of the DC link voltage.
r0072	CO: Output voltage
	Displays the current output voltage of the power unit (Motor Module).
r0082	CO: Active power actual value
	Displays the current active power.
r0206	Rated power unit power
	Displays the rated power unit power for various load duty cycles.
r0207	Rated power unit current
	Displays the rated power unit power for various load duty cycles.
r0208	Rated power unit line supply voltage
	Displays the rated line supply voltage of the power unit.
r0209	Power unit maximum current
	Display of the maximum output current of the power unit.

TM31: Key diagnostic parameters (details in List Manual)

Parameter	Name
	Description
r0002	TM31 status display
	Status display for the TM31 Terminal Module.
r4021	TM31 digital inputs actual terminal value
	Displays the actual value at the digital input terminals on the TM31. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.
r4022	CO/BO: TM31 digital inputs status
	Displays the status of the digital inputs on the TM31. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r4047	TM31 digital outputs status
	Displays the status of the TM31 digital outputs. Inversion via p4048 is taken into account.

10.2.3 Indicating and rectifying faults

The device features a wide range of functions that protect the drive against damage if a fault occurs (faults and alarms).

Indicating faults and alarms

If a fault occurs, the drive displays the fault and/or alarm on the AOP30 operator panel. Faults are indicated by the red "FAULT" LED and a fault screen is automatically displayed. You can use the F1 Help function 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 are displayed by the yellow flashing "ALARM" LED. The system also displays a note in the status bar providing information on the cause.

Every fault and alarm is entered in the fault/alarm buffer along with time the error occurred. The time stamp refers to the relative system time in milliseconds (r0969).

Activate the "Set date/time - AOP synchronization -> Drive" setting to date- and time-stamp errors on the AOP30.

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, from the winding temperature monitor for the induction motor. The faults are displayed and can be reported to a higher-level control system via PROFIdrive. In the delivery condition, the message "Drive fault" is also sent to a relay output. Once you have rectified the cause of the fault, you have to acknowledge the fault message.

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.

10.3 Overview of alarms and faults

If a fault occurs, the drive indicates the fault and/or alarm. Faults and alarms are listed in a fault/alarm list, together with the following information:

- Fault/alarm number
- Standard drive response
- Description of the possible cause of the fault/alarm
- Description of the procedure for rectifying the problem
- Standard fault acknowledgment after it has been rectified

Note

List of faults and alarms

The list of faults and alarms is included on the customer DVD.

The CD also includes descriptions of possible fault responses (OFF1, OFF2, etc.).

Note

Faults and alarms wired and preset at the factory

The faults and alarms described below have been wired specifically for the enclosed drives listed in this document and preset via macro. This ensures that the appropriate response is initiated when faults and alarms are generated due to additional components installed in the drive enclosure.

It is possible to reprogram the faults and alarms described, provided the stated options are not included in the scope of the equipment.

10.3.1 "External alarm 1"

Causes

Alarm A7850 ("External alarm 1") is triggered by the following optional protection device in the drive:

- Temperature Sensor for tripping the alarm threshold in the Line Harmonics Filter compact (option L01)
- PT100 tripping unit (option L97)

Remedy

When a fault is indicated, the following procedure is recommended:

1. Identify the cause by examining the specified devices (display or LEDs).
2. Check the fault display on the relevant protection device and establish the fault.
3. Rectify the displayed fault with the help of the relevant operating instructions provided in the "Additional Operating Instructions" section of this documentation package.

10.3.2 "External fault 1"

Causes

Fault code F7860 ("External Fault 1") is triggered by the following optional protection device in the drive:

- Temperature Sensor for tripping the fault threshold in the Line Harmonics Filter compact (option L01)
- PT100 tripping unit (option L97)

Remedy

When a fault is indicated, the following procedure is recommended:

1. Identify the cause by examining the specified devices (display or LEDs).
2. Check the fault display on the relevant protection device and establish the fault.
3. Rectify the displayed fault with the help of the relevant operating instructions provided in the "Additional Operating Instructions" section of this documentation package.

10.3.3 "External fault 2"

Causes

Fault code F7861 ("External Fault 2") is triggered when the braking resistor connected in options L61 and L62 experiences thermal overload, thereby activating the thermostat. The drive is switched off with OFF2.

Remedy

The cause of the braking resistor overload must be eliminated and the fault code acknowledged.

10.3.4 "External fault 3"

Causes

Fault code F7862 "External fault 3" is triggered when the braking unit fitted in options L61 and L62 triggers a fault. The drive is switched off with OFF2.

Remedy

The cause of the braking unit overload must be eliminated and the fault code acknowledged.

Maintenance and servicing 11

11.1 Chapter content

This section provides information on the following:

- Maintenance and servicing procedures that have to be carried out on a regular basis to ensure the availability of the enclosed drives
- Replacing device components when the unit is serviced
- Forming the DC link capacitors
- Upgrading the enclosed drive firmware
- Loading new operator panel firmware from the PC

⚠ WARNING

Danger to life resulting from failure to observe the basic safety instructions and residual risks

Failure to observe the basic safety instructions and residual risks in Chapter 1 can lead to accidents resulting in serious injury or death.

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



⚠ DANGER

Danger to life from electric shock due to residual charge in the DC link capacitors

Because of the DC link capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off.

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

- Only open the device after 5 minutes have elapsed.
- Measure the voltage before starting work on the DCP and DCN DC link terminals.



DANGER

Danger to life from electric shock due to external supply voltages

When an external supply voltage for individual options (L50 / L55) is connected or an external 115 V AC auxiliary supply is used, dangerous voltages are still present on the components even when the mains switch is open.

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

- Switch off external supply voltages and external 115 V AC auxiliary supply before opening the device.

11.2 Maintenance

The drive mainly comprises electronic components. Apart from the fan(s), the unit contains very few components that are subject to wear or require maintenance or servicing. The purpose of maintenance is to maintain the drive condition as per specification. Dirt and contamination must be removed regularly and parts subject to wear replaced.

The following points must generally be observed.

11.2.1 Cleaning

Dust deposits

Dust deposits inside the drive must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 14.5 Psi (1 bar)) for areas that cannot be easily reached.

Ventilation

The ventilation openings in the enclosure must never be obstructed. The fan must be checked to make sure that it is functioning correctly.

Cable and screw terminals

Cable and screw terminals must be checked regularly to ensure that they are securely in position and retightened if necessary. Cabling must be checked for defects. Defective parts must be replaced immediately.

Note

Maintenance intervals

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions (cabinet environment) and the operating conditions.

Siemens offers its customers support in the form of a service contract. For further details, contact your regional office or sales office.

11.3 Servicing

Servicing involves activities and procedures for maintaining and restoring the specified condition of the device.

Required tools

The following tools are required for replacing components:

- Wrench or socket wrench (w/f 10)
- Wrench or socket wrench (w/f 13)
- Wrench or socket wrench (w/f 16/17)
- Wrench or socket wrench (w/f 18/19)
- Hexagon-socket wrench (size 8)
- Torque wrench
- Screwdriver size 1 / 2
- Screwdriver Torx T20 / T25 / T30

A socket wrench set with two long extensions is recommended.

Tightening torques for screw connections

The following tightening torques apply when tightening current-conducting connections (DC link connections, motor connections, busbars, cable lugs) and other connections (ground connections, protective earth connections, steel threaded connections).

Table 11- 1 Tightening torques for screw connections

Thread	Ground connections, protective earth connections, steel threaded connections	Aluminum threaded connections, plastic, busbars, cable lugs
M3	1.3 Nm	0.8 Nm
M4	3 Nm	1.8 Nm
M5	6 Nm	3 Nm
M6	10 Nm	6 Nm
M8	25 Nm	13 Nm
M10	50 Nm	25 Nm
M12	88 Nm	50 Nm
M16	215 Nm	115 Nm

Note

Screw connections for protective covers

The threaded connections for the protective covers made of Makrolon may only be tightened with 2.5 Nm.

11.3.1 Installation device

Description

The installation device is used for installing and removing the power blocks.

It is used as an installation aid, which is placed in front of and secured to the module. The telescopic guide support allows the withdrawable device to be adjusted according to the height at which the power blocks are installed. Once the mechanical and electrical connections have been removed, the power block can be removed from the module, whereby the power block is guided and supported by the guide rails on the withdrawable devices.



Figure 11-1 Installation device

Order number

Order number for the installation device: 6SL3766-1FA00-0AA0.

11.3.2 Using lifting lugs to transport power blocks

Lifting lugs

The power blocks are fitted with lifting lugs for attaching a lifting harness to transport the power block in the event of replacement.

The locations of the lifting lugs are illustrated by arrows in the figures below.

NOTICE
Device damage due to improper transport Improper transport can cause mechanical stresses on the power block housing or the busbars that damage the device. • When transporting the power blocks, use a lifting harness in which the ropes or chains run vertically. • Do not use the power block busbars as lifting handles or for attaching a lifting harness.

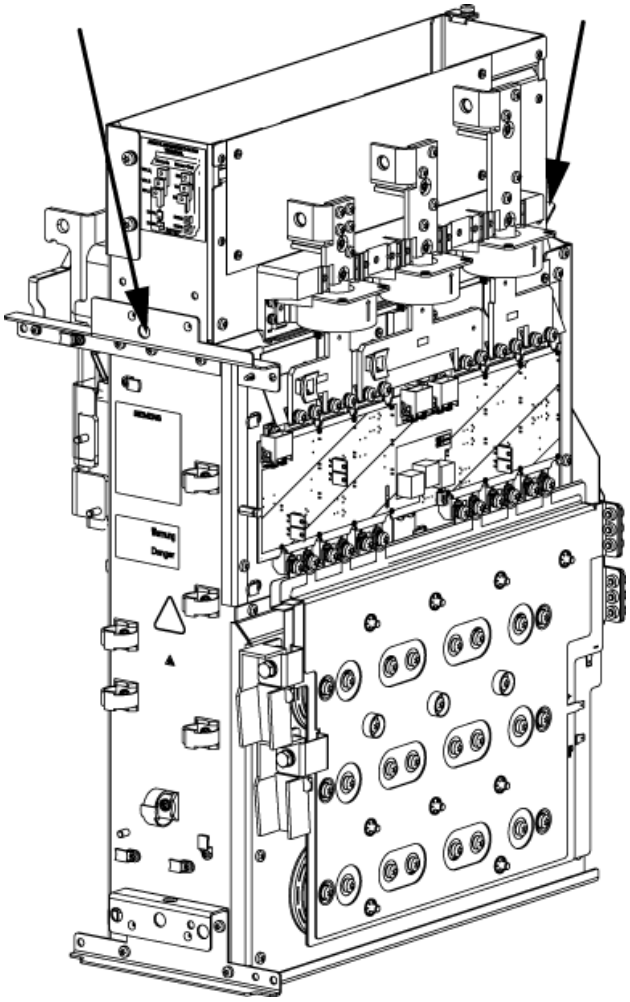


Figure 11-2 Lifting lugs on power block frame size FX, GX

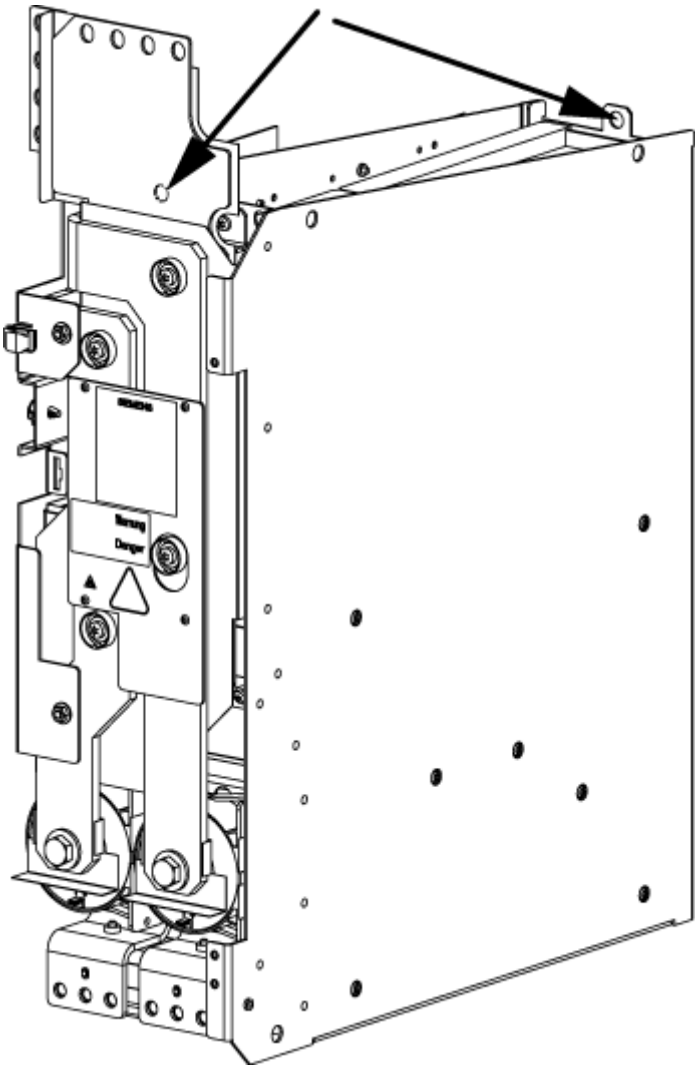


Figure 11-3 Lifting lugs on power block frame size HX, JX

Note

Crane lifting lugs on power blocks HX, JX

On size HX and JX power blocks, the front lifting lug is located behind the busbar.

11.4 Replacing components

WARNING

Danger to life due to improper transport or installation of devices and components

Improper transport or installation of the devices can result in serious or fatal injury and substantial property damage.

- Transport, install, and remove the devices and components only if you are qualified to do so.
- Note that devices and components are in some cases heavy and top-heavy, and take the necessary precautionary measures.
  The weights of the individual power blocks are listed in the corresponding section.

11.4.1 Replacing the filter mats

The filter mats must be checked at regular intervals. If the mats are too dirty to allow the air supply to flow normally, they must be replaced.

Note

Replacing the filter mats

Filter mat replacement is only relevant for options M23, M43 and M54.

Failure to replace dirty filter mats can cause premature thermal shutdown of the drive.

11.4.2 Replacing the Control Interface Module, frame size FX

Replacement of Control Interface Module

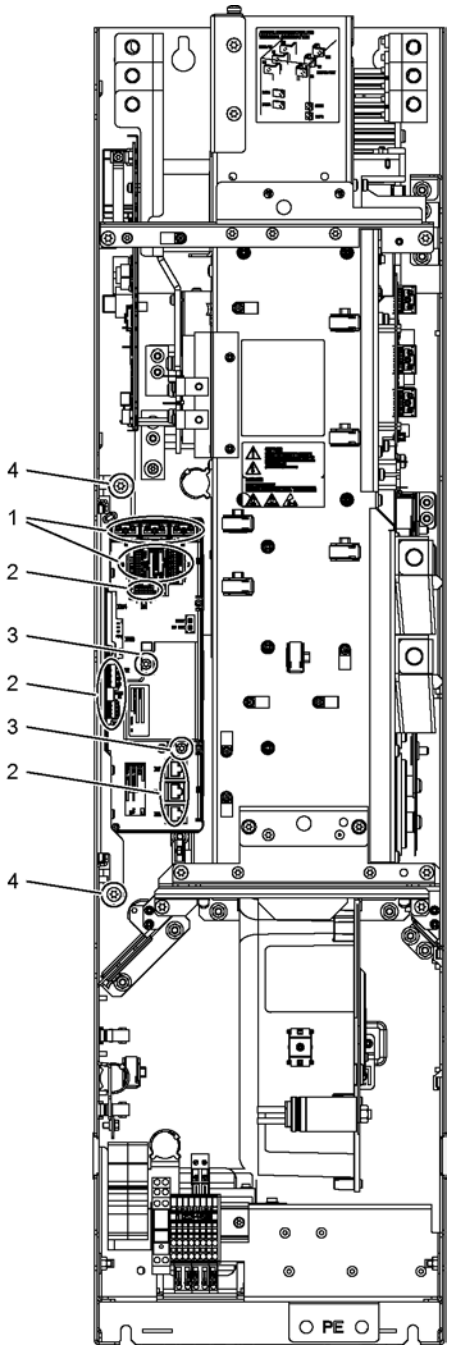


Figure 11-4 Replacement of Control Interface Module, frame size FX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 connectors). The DRIVE-CLiQ cables should be marked in order to ensure subsequent correct assembly.
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from connector -X45 on the Control Interface Module.
4. Remove the retaining screws for the Control Interface Module (2 screws).

When removing the Control Interface Module, you must remove 5 additional connectors one after the other (2 at the top, 3 below).

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the Control Interface Module is removed. This can cause the device to fail. • When removing the Control Interface Module, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Tightening torque for the retaining screws of the Control Interface Module (M6 x 16, item ④): 6 Nm.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

The fiber-optic cable connectors must be reinstalled at their original slot. The fiber-optic cables and sockets are labeled accordingly (U11, U21, U31) for correct assignment.

11.4.3 Replacing the Control Interface Module, frame size GX

Replacement of Control Interface Module

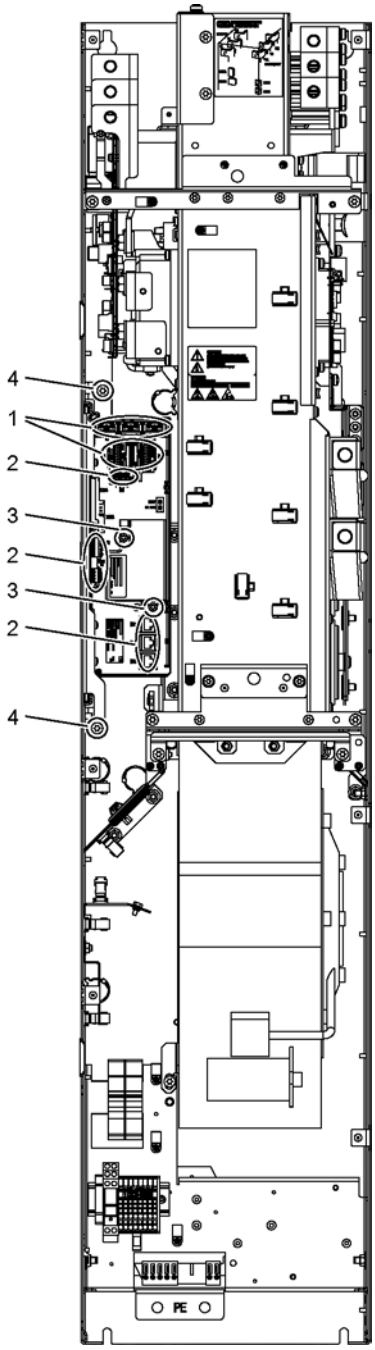


Figure 11-5 Replacement of Control Interface Module, frame size GX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 connectors). The DRIVE-CLiQ cables should be marked in order to ensure subsequent correct assembly.
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from connector -X45 on the Control Interface Module.
4. Remove the retaining screws for the Control Interface Module (2 screws).

When removing the Control Interface Module, you must remove 5 additional connectors one after the other (2 at the top, 3 below).

NOTICE

Device damage due to signal cable damage during removal

Signal cables can become damaged when the Control Interface Module is removed. This can cause the device to fail.

- When removing the Control Interface Module, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Tightening torque for the retaining screws of the Control Interface Module (M6 x 16, item ④): 6 Nm.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

The fiber-optic cable connectors must be reinstalled at their original slot. The fiber-optic cables and sockets are labeled accordingly (U11, U21, U31) for correct assignment.

11.4.4 Replacing the Control Interface Module, frame size HX

Replacement of Control Interface Module

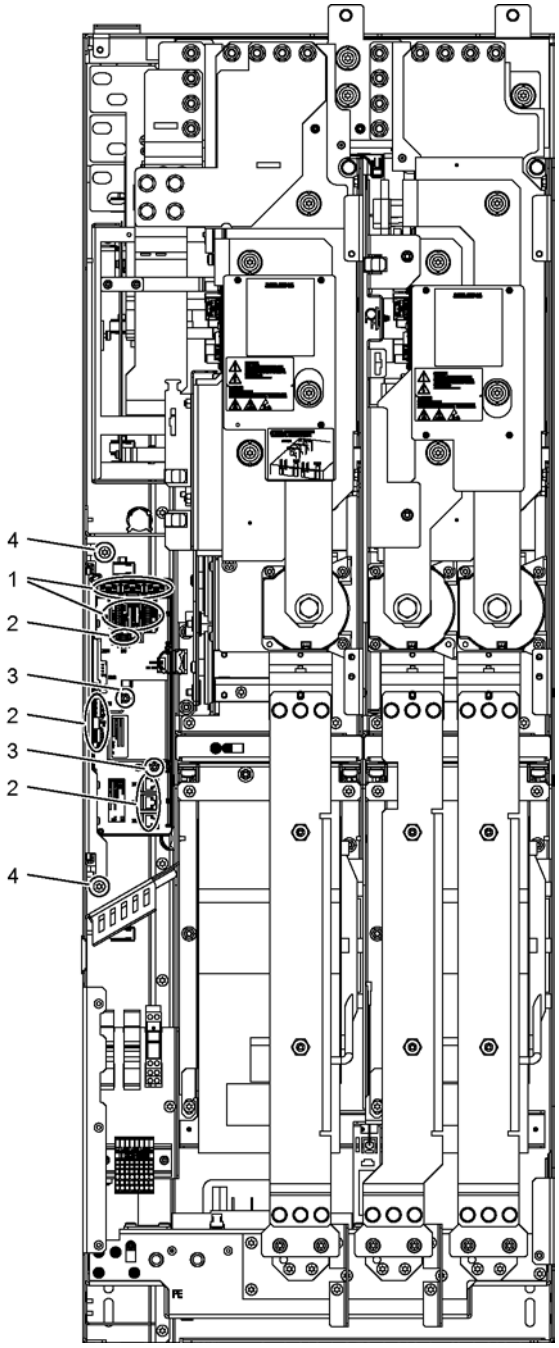


Figure 11-6 Replacement of Control Interface Module, frame size HX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 connectors). The DRIVE-CLiQ cables should be marked in order to ensure subsequent correct assembly.
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from connector -X45 on the Control Interface Module.
4. Remove the retaining screws for the Control Interface Module (2 screws).

When removing the Control Interface Module, you must remove 5 additional connectors one after the other (2 at the top, 3 below).

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the Control Interface Module is removed. This can cause the device to fail. • When removing the Control Interface Module, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Tightening torque for the retaining screws of the Control Interface Module (M6 x 16, item ④): 6 Nm.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

The fiber-optic cable connectors must be reinstalled at their original slot. The fiber-optic cables and sockets are labeled accordingly (U11, U21, U31) for correct assignment.

11.4.5 Replacing the Control Interface Module, frame size JX

Replacement of Control Interface Module

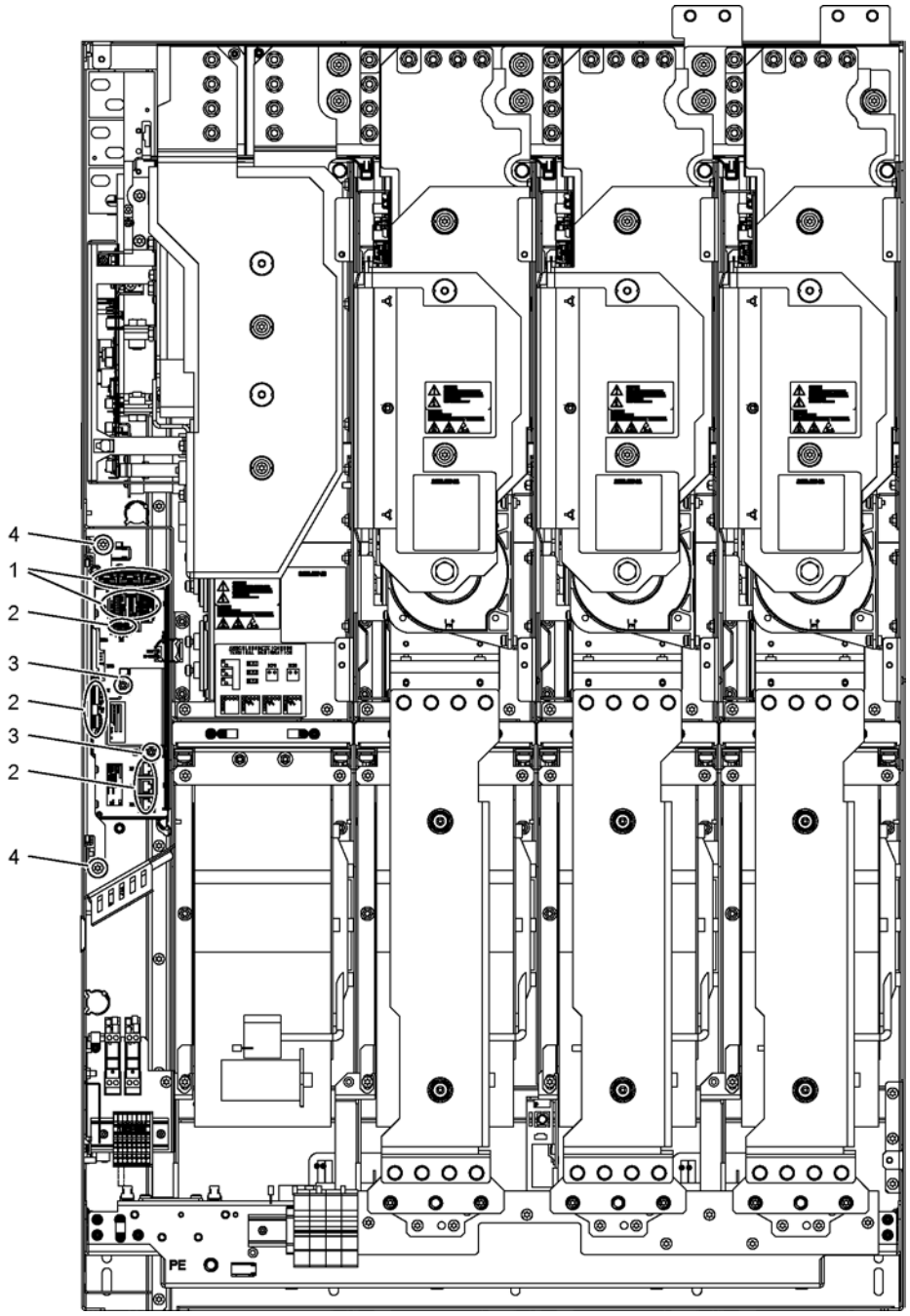


Figure 11-7 Replacement of Control Interface Module, frame size JX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Disconnect the plug connections for the fiber optic cables and signal cables (5 plugs).
2. Remove DRIVE-CLiQ cables and connections on -X41, -X42, -X46 (6 connectors). The DRIVE-CLiQ cables should be marked in order to ensure subsequent correct assembly.
3. Take out the retaining screws for the IPD card (2 screws) and remove the IPD card from connector -X45 on the Control Interface Module.
4. Remove the retaining screws for the Control Interface Module (2 screws).

When removing the Control Interface Module, you must remove 5 additional connectors one after the other (2 at the top, 3 below).

NOTICE

Device damage due to signal cable damage during removal

Signal cables can become damaged when the Control Interface Module is removed. This can cause the device to fail.

- When removing the Control Interface Module, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Tightening torque for the retaining screws of the Control Interface Module (M6 x 16, item ④): 6 Nm.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

The fiber-optic cable connectors must be reinstalled at their original slot. The fiber-optic cables and sockets are labeled accordingly (U11, U21, U31) for correct assignment.

11.4.6 Replacing the power block, frame size FX

Replacement of power block

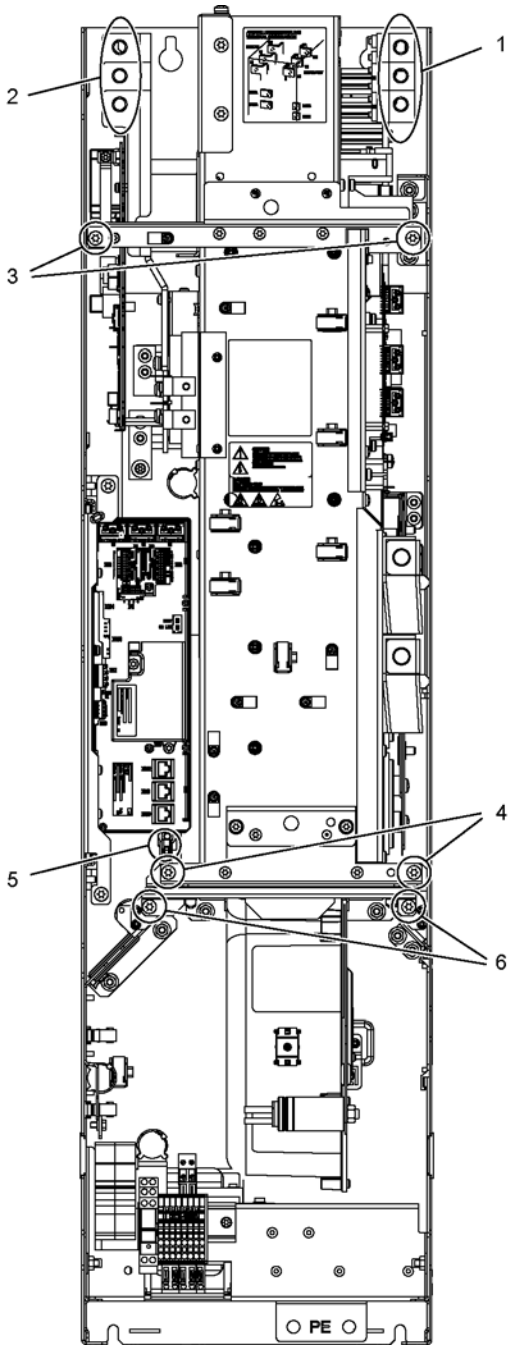


Figure 11-8 Replacement of power block, frame size FX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.
- Remove the Control Interface Module (see corresponding section).

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Unscrew the connection to the outgoing motor section (3 screws).
2. Unscrew the connection to the line supply (3 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug for the thermocouple.
6. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 70 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

Note

Connection clip to the interference-suppression capacitor

The connection clip to the interference-suppression capacitor is mounted on the spare power block together with a yellow warning label.

Note the information in "Removing the connection clip to the interference-suppression capacitor for operation on an ungrounded power network (IT power network)".

11.4.7 Replacing the power block, frame size GX

Replacement of power block

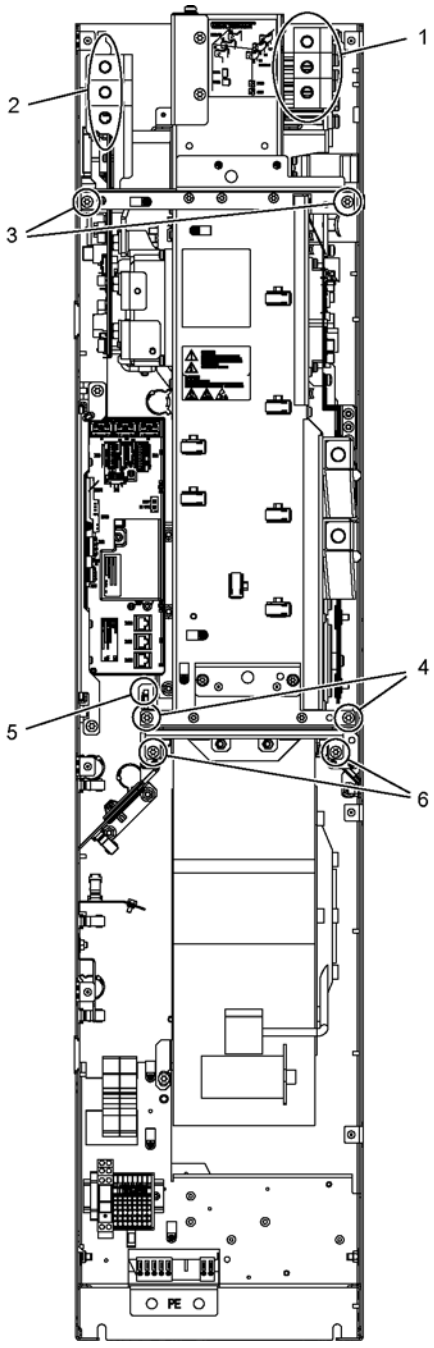


Figure 11-9 Replacement of power block, frame size GX

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.
- Remove the Control Interface Module (see corresponding section).

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Unscrew the connection to the outgoing motor section (3 screws).
2. Unscrew the connection to the line supply (3 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug for the thermocouple.
6. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 102 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

Note

Connection clip to the interference-suppression capacitor

The connection clip to the interference-suppression capacitor is mounted on the spare power block together with a yellow warning label.

Note the information in "Removing the connection clip to the interference-suppression capacitor for operation on an ungrounded power network (IT power network)".

11.4.8 Replacing the power block, frame size HX

Replacement of left power block

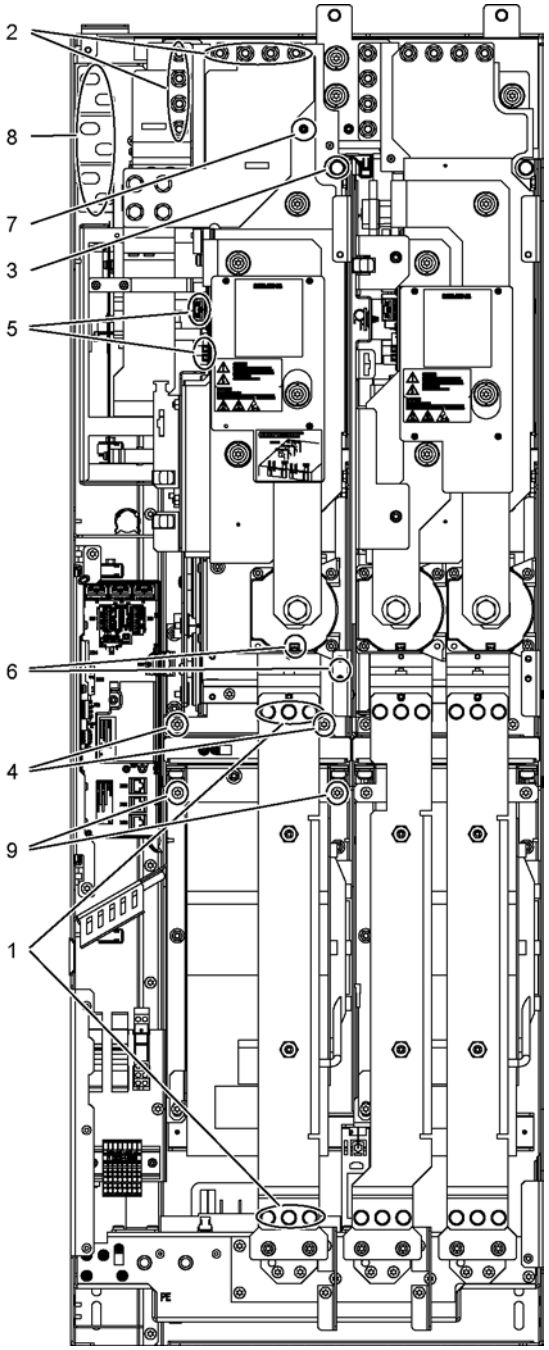


Figure 11-10 Replacement of power block, frame size HX: left power block

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbar (6 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug connections for the fiber optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated ground (PE) connection (1 plug).
7. Remove the connection for the DC link sensor (1 nut).
8. Remove the power connections (6 screws).
9. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 94 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

Note

Connection clip to the interference-suppression capacitor

The connection clip to the interference-suppression capacitor is mounted on the spare power block together with a yellow warning label.

Note the information in "Removing the connection clip to the interference-suppression capacitor for operation on an ungrounded power network (IT power network)".

Replacement of right power block

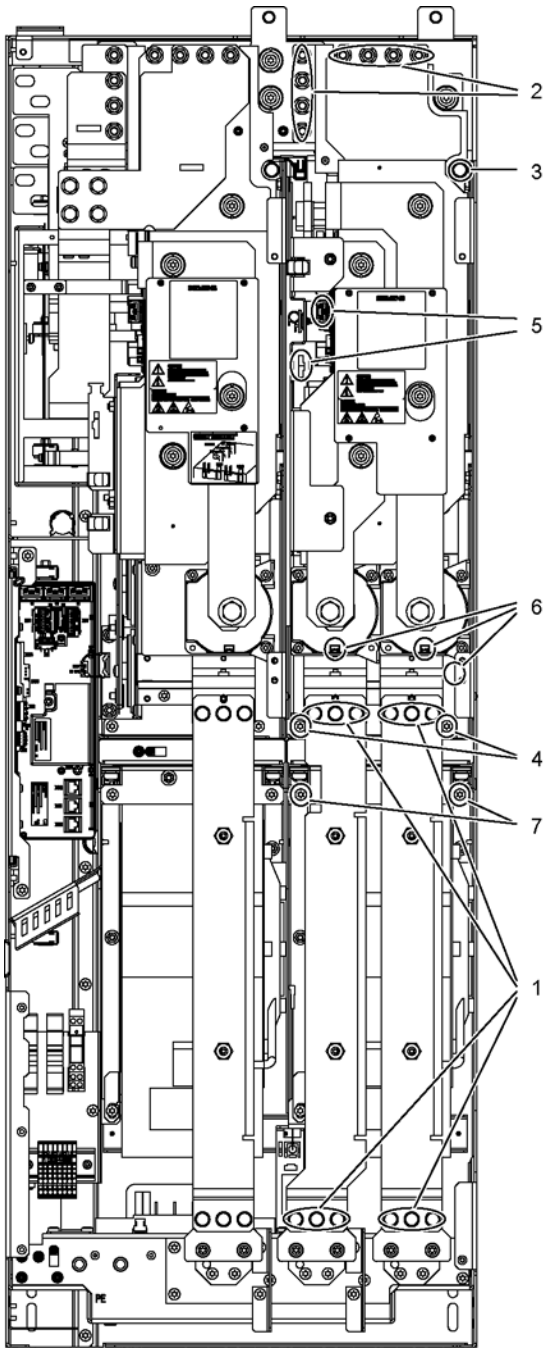


Figure 11-11 Replacement of power block, frame size HX: right power block

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbars (12 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug connections for the fiber optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated ground (PE) connection (2 plugs).
7. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 88 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

11.4.9 Replacing the power block, frame size JX

Replacement of left power block

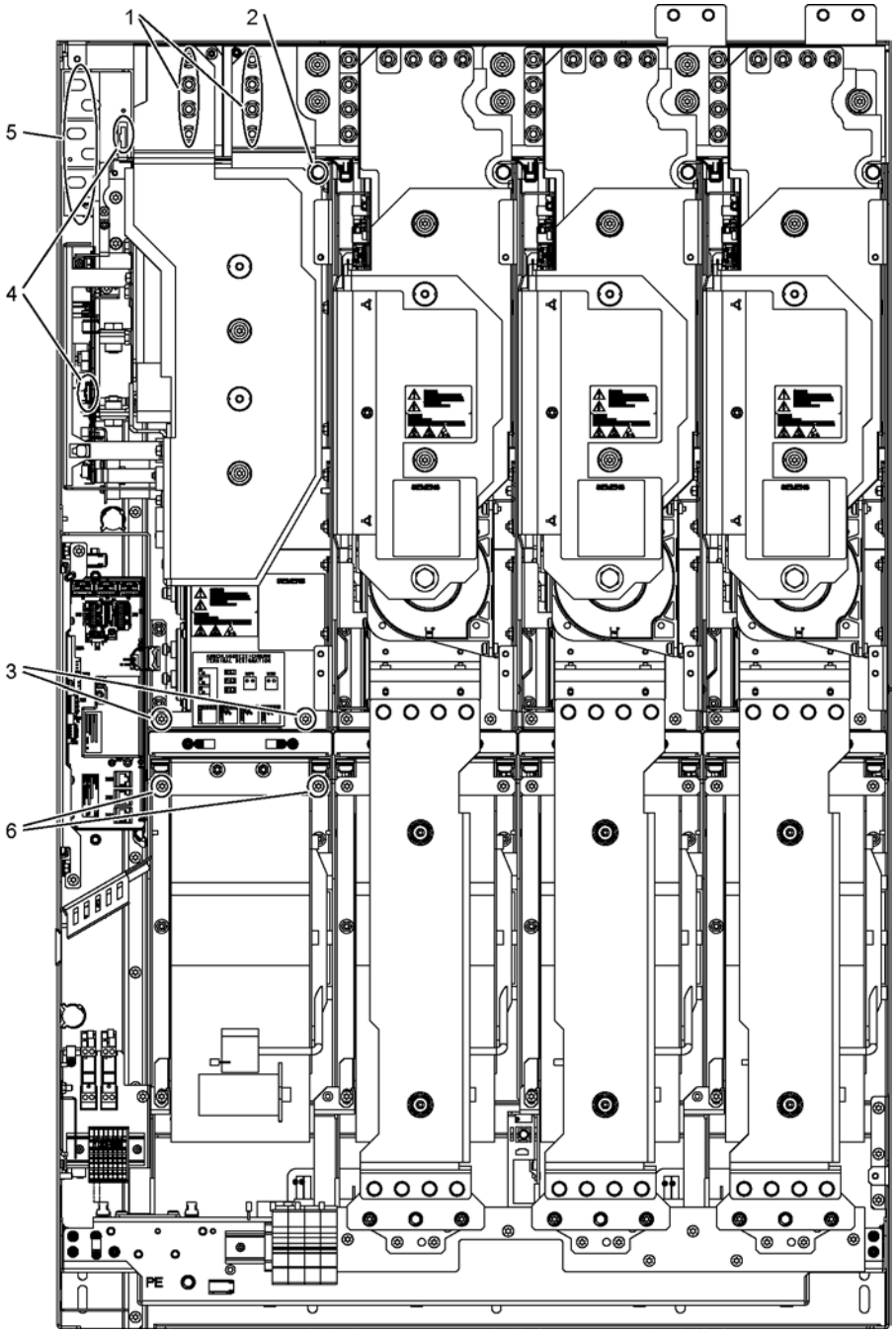


Figure 11-12 Replacement of power block, frame size JX: left power block

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Unscrew the connection to the DC link (8 nuts).
2. Remove the retaining screw at the top (1 screw).
3. Remove the retaining screws at the bottom (2 screws).
4. Disconnect the plug connections for the fiber optic cables and signal cables (2 plugs).
5. Remove the connections to the mains supply (6 screws).
6. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 102 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

Note

Connection clip to the interference-suppression capacitor

The connection clip to the interference-suppression capacitor is mounted on the spare power block together with a yellow warning label.

Note the information in "Removing the connection clip to the interference-suppression capacitor for operation on an ungrounded power network (IT power network)".

Replacement of right power block

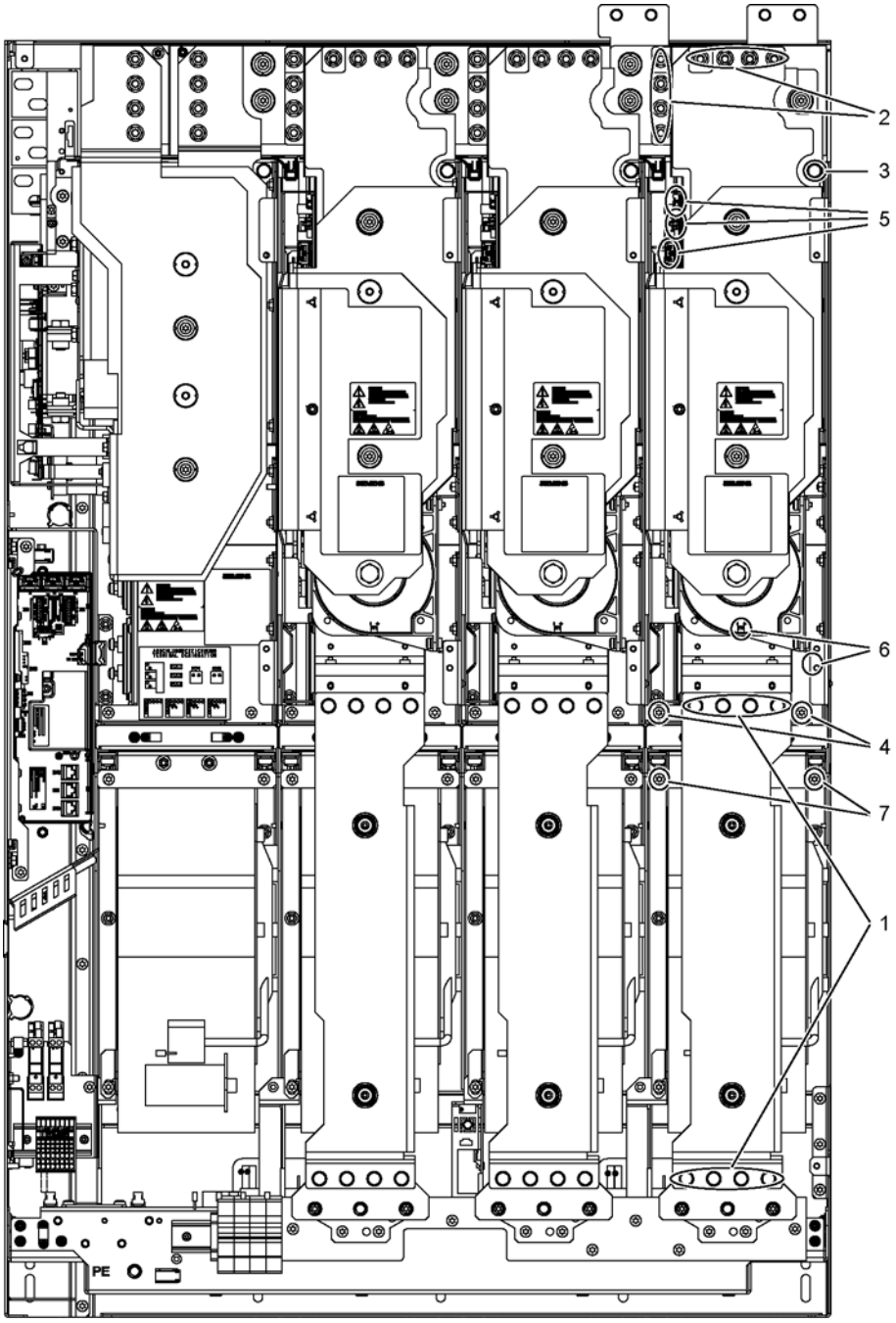


Figure 11-13 Replacement of power block, frame size JX: right power block

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbar (8 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plug connections for the fiber optic cables and signal cables (2 plugs).
6. Remove the connection for the current transformer and associated ground (PE) connection (1 plug).
7. Unscrew the 2 retaining screws for the fan and attach the fitting device for the power block at this position.

You can now remove the power block.

Note

The power block weighs approx. 90 kg!

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the power block is removed. This can cause the device to fail. • When removing the power block, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Specifications for the installation

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Carefully insert the plug-in connections and ensure that they are secure.

11.4.10 Replacing the fan, frame size FX

Replacement of fan

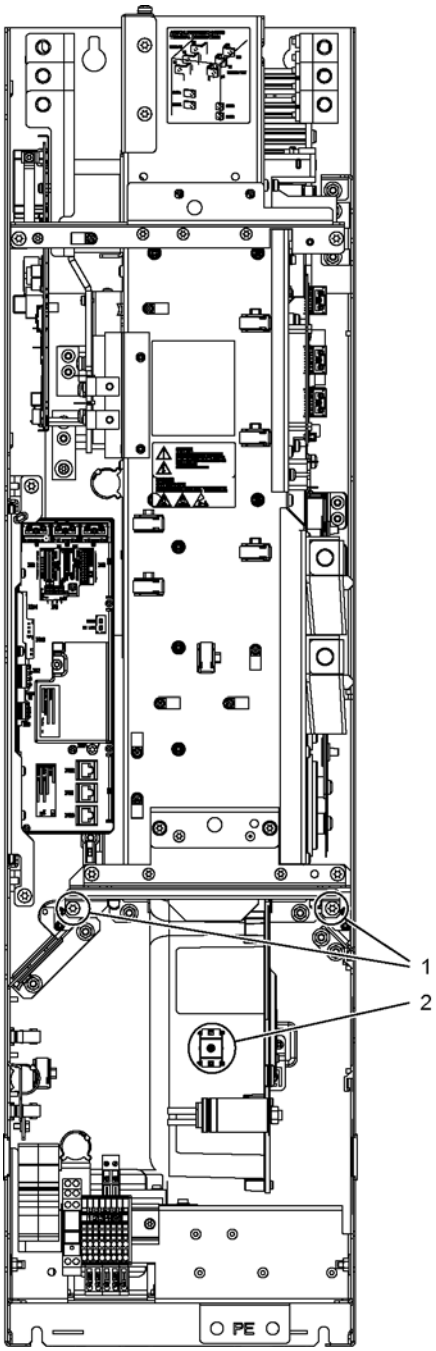


Figure 11-14 Replacement of fan, frame size FX

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the retaining screws for the fan (2 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

11.4.11 Replacing the fan, frame size GX

Replacement of fan

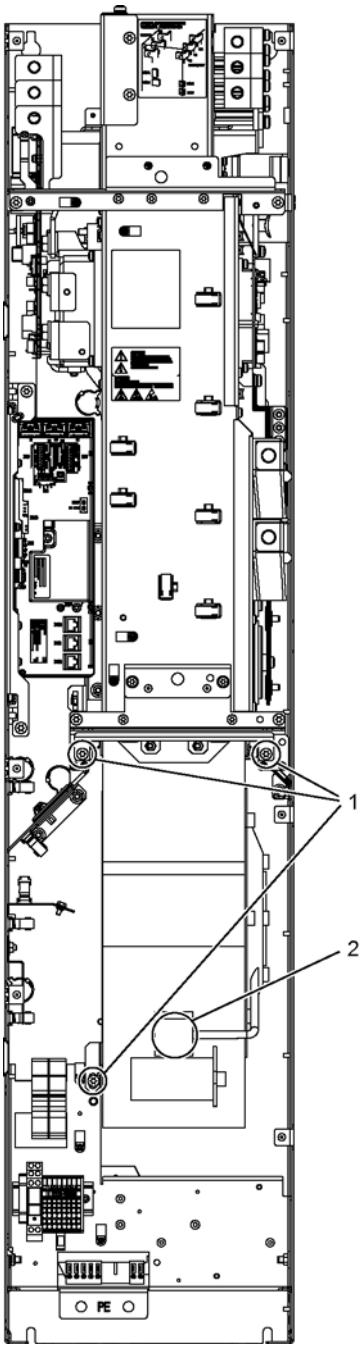


Figure 11-15 Replacement of fan, frame size GX

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

11.4.12 Replacing the fan, frame size HX

Replacement of fan, left power block

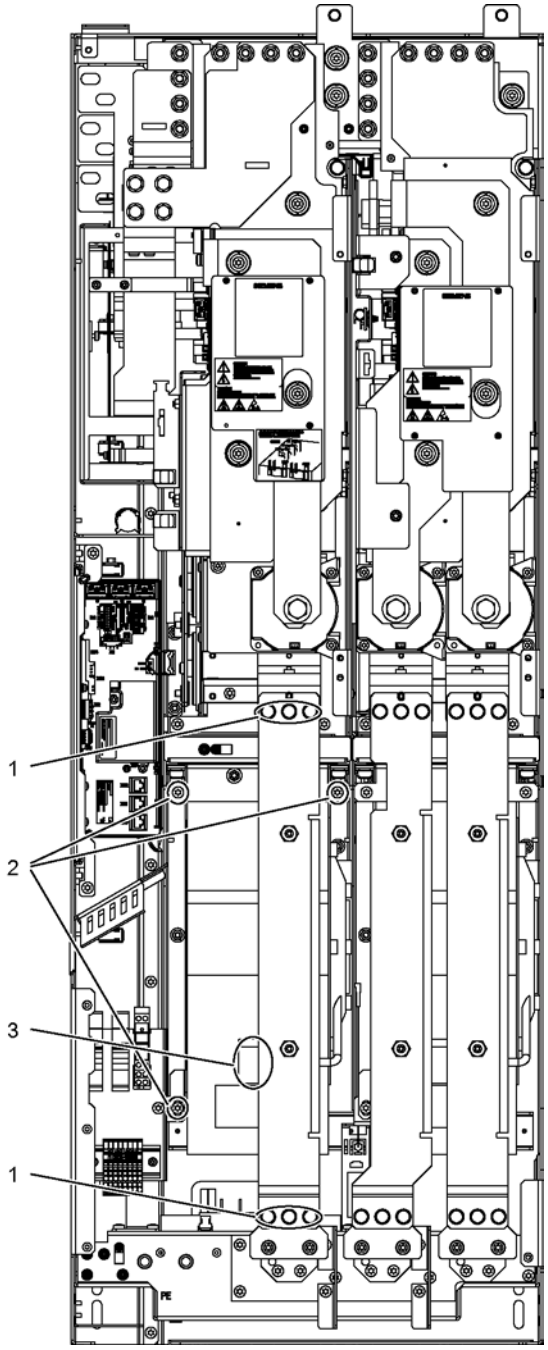


Figure 11-16 Replacement of fan, frame size HX: left power block

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbar (6 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

Replacement of fan, right power block

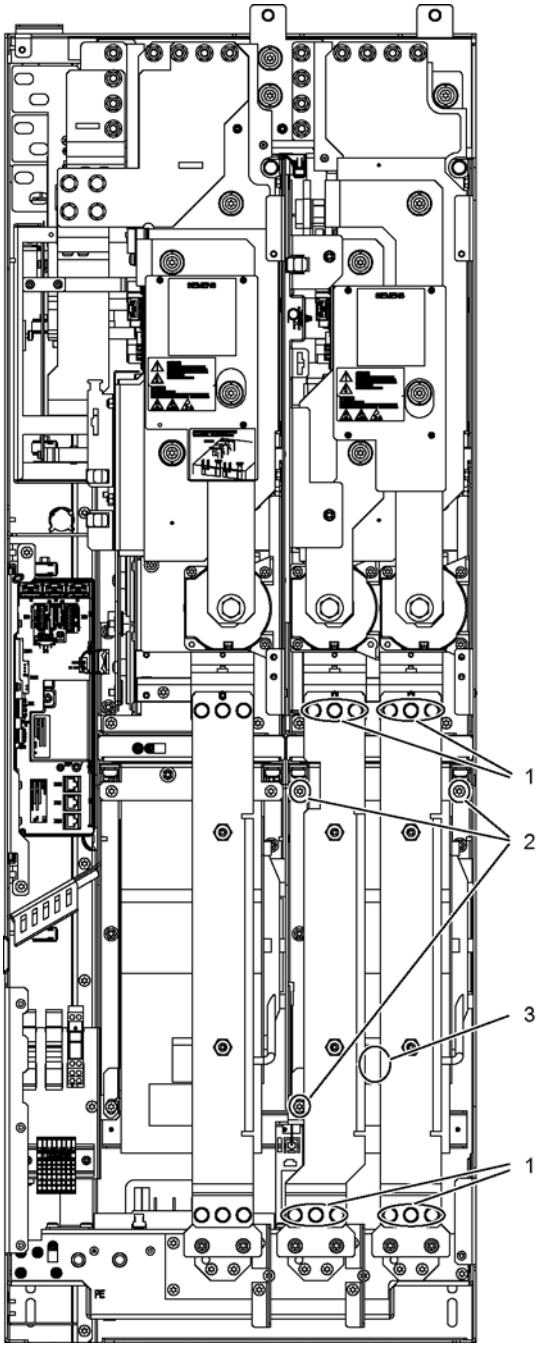


Figure 11-17 Replacement of fan, frame size HX: right power block

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbar (12 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

11.4.13 Replacing the fan, frame size JX

Replacement of fan, left power block

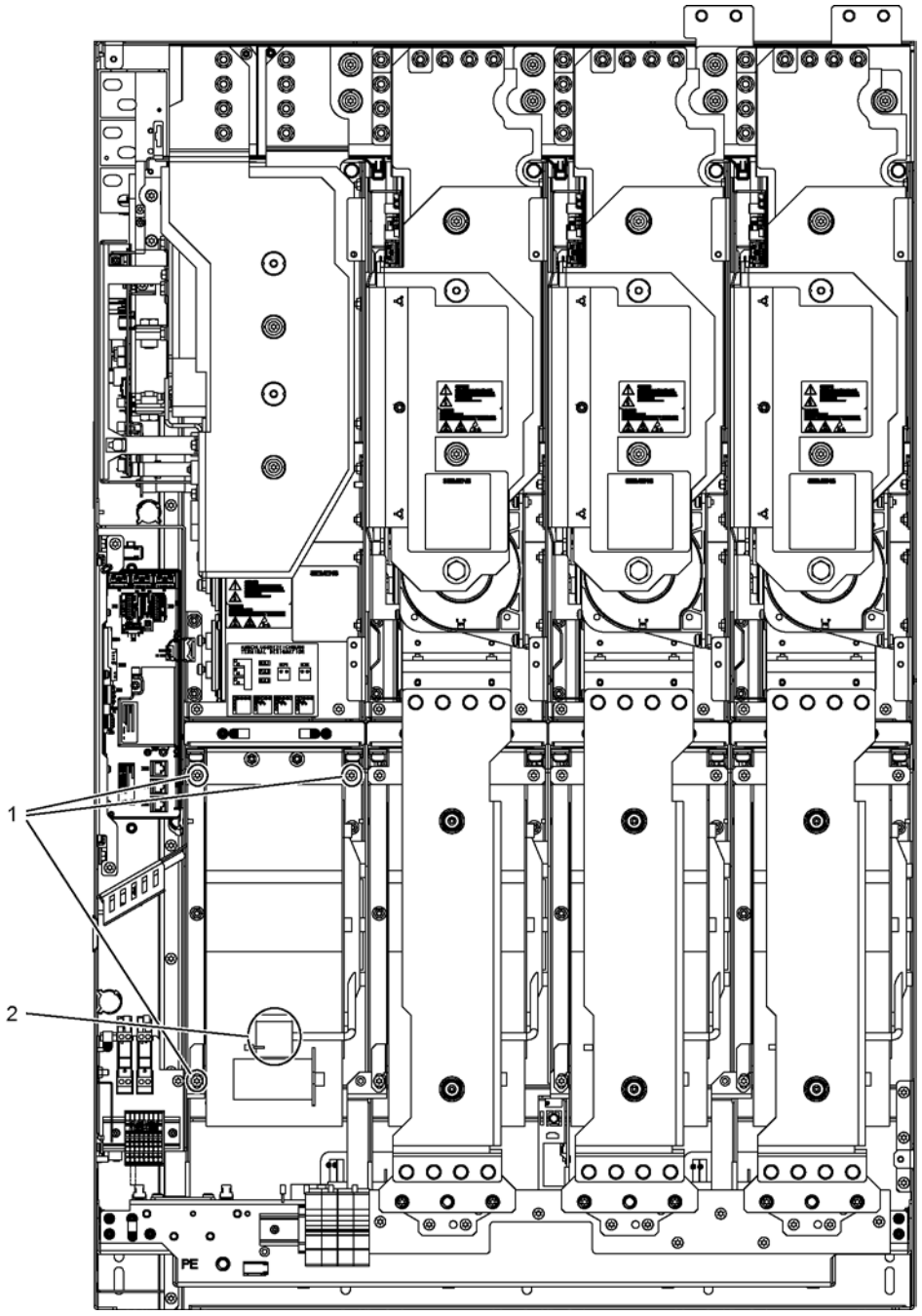


Figure 11-18 Replacement of fan, frame size JX: left power block

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

Replacement of fan, right power block

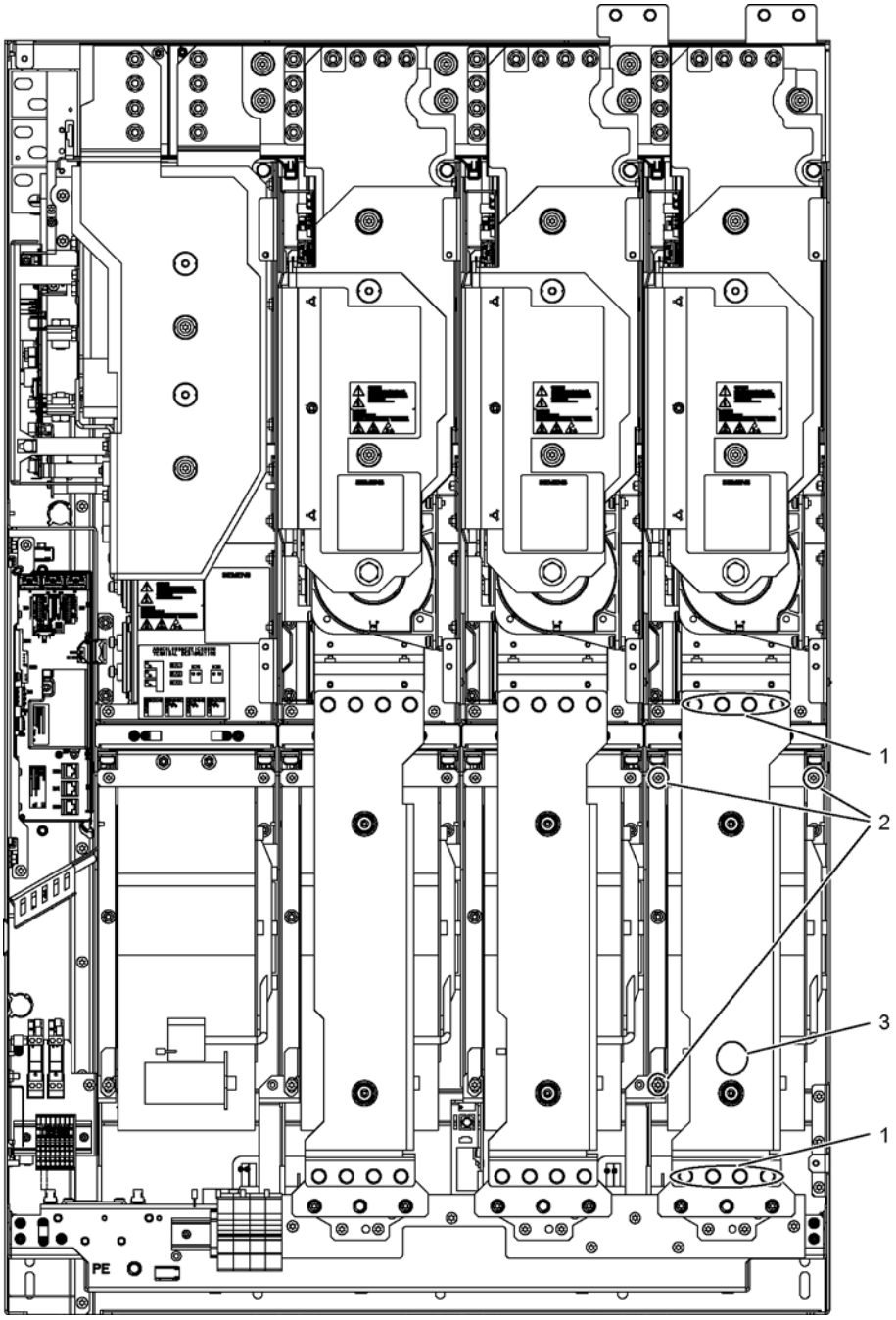


Figure 11-19 Replacement of fan, frame size JX: right power block

Description

The typical service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, cabinet enclosure, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to maintain the availability of the enclosed drive.

Preparatory steps

- Disconnect the enclosed drive from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps of the removal procedure correspond to the numbers shown in the figure.

1. Remove the busbar (8 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

NOTICE
Device damage due to signal cable damage during removal Signal cables can become damaged when the fan is removed. This can cause the device to fail. • When removing the fan, ensure that you do not damage any signal cables.

Installation steps

Installation is carried out the same as removal, but in the reverse order.

Note

Pay attention to the tightening torques

The tightening torques specified in the "Tightening torques for screw connections" table must be observed.

Note

Reset the operating hours counter

Following fan replacement, the operating hours counter of the fan should be reset via p0251 = 0.

11.4.14 Replacing cylindrical fuses

The following fuses are executed as cylindrical fuses:

- Fan fuses (-T1 -F10, -T1 -F11)
- Fuses for auxiliary power supply (-F11, -F12)
- Fuse for the internal 230 V AC supply (-F21)



Figure 11-20 Fuse holder

Order numbers for replacement of fuses that have blown can be found in the spare parts list.

Note

Eliminate the source of the error

Make sure that the source of the error is eliminated before your replace the fuse.

11.4.15 Replacing the LV HRC fuses

Description

LV HRC fuses (low-voltage high-rupturing capacity fuses), also called blade fuses, are used in the mains switches of the line supply, for example.



Figure 11-21 LV HRC fuse

Preparatory steps

- Have protective equipment at the ready: LV HRC fuse grip with sleeve for LV HRC fuse links
- National safety regulations must be observed.



Figure 11-22 LV HRC fuse grip with sleeve for LV HRC fuses

Note

If required, the LV HRC fuse grip can be ordered from Siemens using order number 3NX1.

Removal steps

The following steps are used to remove the LV HRC fuse:

1. Switch off the mains switch
2. Remove the front direct-contact protection cover on the cabinet.

   Note
   Cover over the line connections

   Do not remove the cover (direct-contact protection) over the line connections!

3. Slip the LV HRC fuse grip with sleeve for LV HRC fuse links onto the fuse.
4. Remove the defective fuse.

NOTICE
Device failure after a DC fuse trips
When a low-voltage high-rupturing-capacity fuse trips, the neighboring low-voltage high-rupturing-capacity fuses may also become damaged. Failure to replace all fuses at the same time can cause the device to fail. • After a low-voltage high-rupturing-capacity fuse trips, always replace all low-voltage high-rupturing-capacity fuses at the same time. Always use fuses of the same type.

Installation steps

The following steps are used to install the LV HRC fuse:

1. Insert the new fuse into the LV HRC fuse grip.
2. Insert fuse in the fuse holder.
3. Press the release button on the LV HRC fuse grip to release the grip from the new fuse.
4. Mount the front direct-contact protection cover.

The mains switch can then be switched on.

11.4.16 Replacing the door-mounted operator panel

1. De-energize the device.
2. Open the enclosure.
3. On the operator panel, disconnect the power supply and communication line.
4. Release the fastenings on the operator panel.
5. Remove the operator panel.
6. Install the new operator panel.
7. Carry out the remaining steps by reversing the sequence.

11.4.17 Replacing the backup battery for the door-mounted operator panel

Table 11- 2 Technical specifications for 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 (in operation)	> 2 years

Replacement

1. De-energize the device.
2. Open the cabinet.
3. On the operator panel, disconnect the 24 V DC power supply and communication line.
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 communication line.
9. Close the cabinet.

Note

Time for replacing the battery

The battery replacement procedure must not take longer than one minute to ensure that that AOP settings are retained.

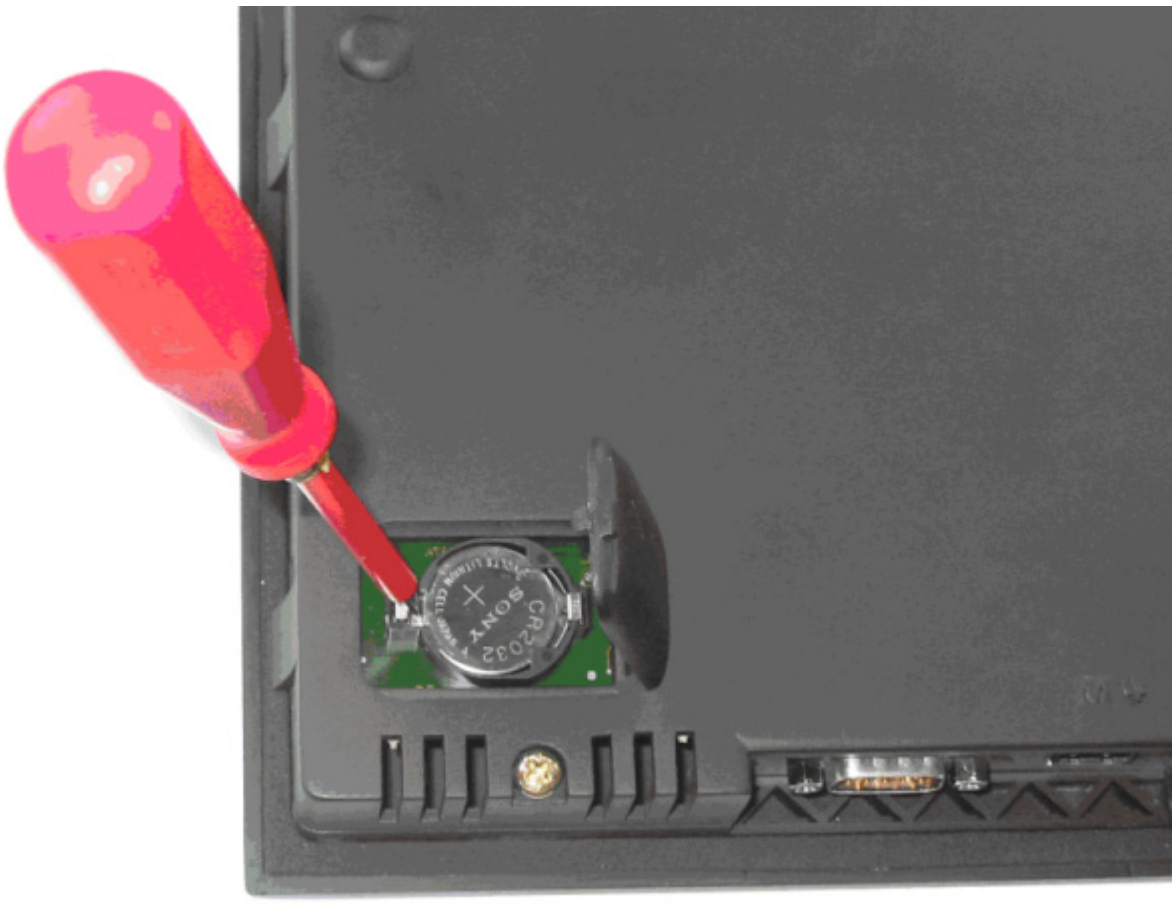


Figure 11-23 Replacing the backup battery for the door-mounted operator panel

Note

Battery disposal

The battery must be disposed of in accordance with the applicable country-specific guidelines and regulations.

11.5 Forming the DC link capacitors

Description

If the device is kept in storage for more than two years, the DC link capacitors must be re-formed.

If commissioning takes place within two years of the date of manufacture, the DC link capacitors do not need to be re-formed. The date of manufacture is indicated in the serial number on the rating plate (see "Device overview").

NOTICE
Damages due to neglected reforming If the device is not re-formed after having been in storage for more than two years, operation with load can result in damages to the device. • Form the device after it has been in storage for more than two years.

Note

Storage period

It is important that the storage period be calculated from the date of manufacture and not from the date that the equipment was shipped.

Procedure

The DC link capacitors are re-formed by applying the rated voltage without load for at least 30 minutes at room temperature.

- Operation via PROFIBUS:
  - Set bit 3 of control word 1 (operation enable) permanently to "0".
  - Switch on the drive using an ON signal (bit 0 of the control word); all other bits must be set in such a way that the drive can be operated.
  - Once the wait time has elapsed, switch off the drive and restore the original PROFIBUS setting.
- Operation via terminal block:
  - Set p0852 to "0" (factory setting is "1").
  - Switch on the drive (via digital input 0 on the customer terminal module).
  - Once the wait time has elapsed, switch off the drive and restore the original setting for p0852.

Note

Reforming via AOP30

Reforming cannot be carried out in LOCAL mode via the AOP30.

11.6 Messages after replacement of DRIVE-CLiQ components

When DRIVE-CLiQ components (Control Interface Module, TM31, SMCxx) are replaced, a message is not usually displayed on start-up, since the replacement part is identified as an identical component and accepted.

However, in the unlikely event that a fault code from the "Topology fault" category is displayed, one of the following faults might have occurred during the replacement procedure:

- A Control Interface Module with different firmware data was installed.
- When connecting DRIVE-CLiQ cables, the connections were reversed.

Automatic firmware update

A firmware update for the replaced DRIVE-CLiQ component may run automatically after switching on the electronics.

- The following LEDs will flash slowly to indicate that an automatic firmware update is in progress: the "RDY" LED on the Control Unit (orange, 0.5 Hz) and an LED on the relevant DRIVE-CLiQ component (green/red, 0.5 Hz).

  Note

  Do not shut down the drive

  Do not shut down the device during this process because the firmware update must otherwise be started once again.

- Once the automatic firmware update is complete, this is signaled be rapid flashing of the "RDY" LED on the Control Unit (orange, 2 Hz) and rapid flashing of an LED on the relevant DRIVE-CLiQ component (green/red, 2 Hz).
- To complete the automatic firmware update, a POWER ON must be performed (switch off the device and switch it on again).

11.7 Upgrading the drive firmware

Upgrading the enclosed drive firmware (by installing a new memory card with a new firmware version, for example) may also necessitate an upgrade of the firmware of the DRIVE-CLiQ components contained in the enclosed drive.

If the system detects that the firmware in the DRIVE-CLiQ components needs to be upgraded, it will do this independently as part of the automatic firmware update.

Automatic firmware update sequence

1. During an automatic firmware update, the "RDY" LED on the Control Unit flashes slowly (orange, 0.5 Hz).
2. The firmware update is performed sequentially in the DRIVE-CLiQ components as needed; during the update process, an LED of the respective component flashes slowly (green/red, 0.5 Hz).
3. Once the firmware update of an individual DRIVE-CLiQ component is complete, the LED of the relevant component flashes rapidly (green/red, 2 Hz).
4. Once the firmware update for all components is complete, the LED of the Control Unit flashes rapidly (orange, 2 Hz).
5. To complete the automatic firmware update, a POWER ON must be performed (switch off the device and switch it on again).

Note

Do not interrupt the power supply of the components during the upgrade because the firmware update must otherwise be started once again.

Note

New firmware should only be installed if there is a problem with the drive.

11.8 Downloading new operator panel firmware from the PC

Description

A necessary update of AOP functionality might require new firmware to be loaded on the AOP.

After the drive is switched on, if a newer version of the firmware is found on the memory card, a prompt will appear on the AOP30 asking whether to load the new firmware. This prompt should be answered "YES".
The firmware will then be loaded automatically to the operator panel and the following dialog screen will appear.

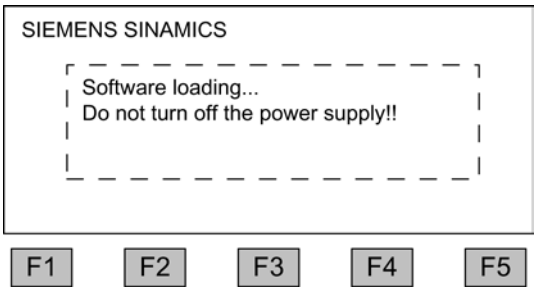


Figure 11-24 Dialog screen: Loading firmware

If the firmware cannot be loaded successfully, it can be loaded using the following manual method.

The load program LOAD_AOP30 and the firmware file can be found on the customer DVD.

Firmware loading procedure

1. Make the RS232 connection from the PC to the AOP30.
2. Provide the supply voltage (24 V DC).
3. Start the LOAD_AOP30 program on the PC.
4. Choose the PC interface (COM1, COM2).
5. Choose and open the firmware (AOP30.H86).
6. Following the instructions in the status window of the program, turn on the power supply for the AOP30 while pressing the red key (O).
7. The load procedure starts automatically.
8. Perform a POWER ON (cycle the power supply off and then back on).

Technical specifications

12

12.1 Chapter content

This chapter provides information on the following:

- General and specific technical specifications for the devices.
- Information on restrictions that apply when the devices are used in unfavorable climatic environmental conditions (derating)

12.2 General specifications

Table 12- 1 General technical specifications

Electrical data			
Power network configurations	Grounded TN/TT systems and non-grounded IT systems		
Line frequency	47 ... 63 Hz		
Output frequency	0 ... 300 Hz		
Power factor - Fundamental mode - Total	 ≥ 0.96 0.75 ... 0.93		
Converter efficiency	> 98%		
Switching at input	Once every 3 minutes		
Overvoltage category	III according to IEC 61800-5-1		
Mechanical specifications			
Type of enclosure	NEMA 1, optionally NEMA 1 filtered or NEMA 12 (ventilated)		
Protection class	I according to IEC 61800-5-1		
Cooling method	Forced air cooling AF according to IEC 60146		
Sound pressure level	≤ 75 dB(A) at power supply frequency of 60 Hz		
Touch protection	EN 50274 with intended use		
Cabinet system	Rittal TS 8, doors with double-barb lock, three-section base plates for cable entry		
Paint finish	RAL 7035 (indoor requirements)		
Compliance with standards			
Standards	IEC 60146-1, IEC 61800-2, IEC 61800-3, IEC 61800-5-1, IEC 60204-1, IEC 60529		
UL listing	Optional listing per UL508A		
RI suppression	According to EMC product standard for adjustable-speed electrical power drive systems EN 61800-3, category C3		
Environmental conditions			
	Storage	**Transport**	**Operation**
Ambient temperature	-13°F (-25 °C) ... +131°F (+55 °C)	-13°F (-25 °C) ... +158°F (+70 °C) from -40°F (-40 °C) for 24 hours	32°F ... 104°F (0 °C ... +40 °C) to +122°F (+50 °C) with derating
Relative humidity (no condensation) Corresponds to class	*5 to 95%* 1K4 according to IEC 60 721-3-1	5 ... 95 % at 104°F (40 °C) 2K3 according to IEC 60 721-3-2	5 ... *95%* 3K3 according to IEC 60 721-3-3
Pollution degree	2 according to IEC 61800-5-1		
Installation altitude	Up to 6600 ft (2000 m) above sea level without derating, > 6600 ft (2000 m) above sea level with derating (see "Derating data")		
Mechanical stability			
Vibrational load - Displacement - Acceleration	 1.5 mm at 5 to 9 Hz 5 m/s² at > 9 ... 200 Hz	3.1 mm at 5 to 9 Hz 10 m/s² at > 9 ... 200 Hz	0.075 mm at 10 to 58 Hz 10 m/s² at > 58 to 200 Hz
Shock load - Acceleration	 40 m/s² at 22 ms	100 m/s² at 11 ms	100 m/s² at 11 ms

Deviations from the defined classes are shown in *italics*.

12.2.1 Derating data

Permissible output current as a function of the ambient temperature

The enclosed drives and related system components are suited for an ambient temperature of 113°F (40°C) and altitudes up to 6600 ft (2000 m) above mean sea level (MSL). If the enclosed drives are operated at ambient temperatures above 113°F (40 C), the output current must be decreased. Ambient temperatures above 122°F (50 C) are not permissible. The following tables indicate the permissible output current as a function of the ambient temperature for the different degrees of protection.

Table 12- 2 Current derating factors as a function of the ambient temperature (inlet air temperature at the air inlet of the drive) for enclosed drives in a NEMA 1 enclosure

Installation altitude above sea level	**Current derating factor** at an ambient temperature (air intake temperature) of						
	68°F (20°C)	**77°F (25°C)**	**86°F (30°C)**	**95°F (35°C)**	**104°F (40°C)**	**113°F (45°C)**	**122°F (50°C)**
0 ... 6600 ft (0 ... 2000 m)	100 %	100 %	100 %	100 %	100 %	93.3 %	86.7 %

Table 12- 3 Current derating factors as a function of the ambient temperature (inlet air temperature at the air inlet of the drive) for enclosed drives in a NEMA 12 enclosure

Installation altitude above sea level	**Current derating factor** at an ambient temperature (air intake temperature) of						
	68°F (20°C)	**77°F (25°C)**	**86°F (30°C)**	**95°F (35°C)**	**104°F (40°C)**	**113°F (45°C)**	**122°F (50°C)**
0 ... 6600 ft (0 ... 2000 m)	100 %	100 %	100 %	100 %	93.3 %	86.7 %	80.0 %

Installation altitudes over 6,600 ft and up to 16,500 ft (2000 m to 5000 m) above MSL

When operating SINAMICS G150 NEMA enclosed drives at altitudes over 6,600 ft (2,000 m) above MSL, keep in mind that as the altitude increases, the air pressure and therefore also the density of the air decrease. Lower density means that the air cannot cool or insulate as effectively.

The drive units can be installed at altitudes over 6,600 ft and up to 16,500 ft (2000 m to 5000 m) if the following measures are applied.

Decreasing the ambient temperature and the output current

Due to the reduced cooling efficiency, it is necessary, on the one hand, to reduce the ambient temperature and, on the other hand, to lower heat loss in the cabinet unit by reducing the output current, whereby ambient temperatures lower than 104°F (40 °C) may be offset for compensation purposes and are taken into account in the tables. The following tables indicate the permissible output currents as a function of the installation height and ambient temperature for the different degrees of protection. The specified values already include the permissible compensation between installation altitude and ambient temperatures lower than 104°F (40 °C) (incoming air temperature at the inlet to the enclosed drive). Theses values are only applicable if the cabinet installation provides a flow of cooling air through the drive units as indicated in the technical specifications.

Table 12- 4 Current derating as a function of the ambient temperature (inlet air temperature at the air inlet of the enclosed drive) and installation altitude for enclosed drives in a NEMA 1 enclosure

Installation altitude above mean sea level	Current derating factor at an ambient temperature (air intake temperature) of						
	68°F (20 °C)	77°F (25 °C)	86°F (30 °C)	95°F (35 °C)	104°F (40 °C)	113°F (45 °C)	122°F (50 °C)
0 ... 6600 ft (0 ... 2000 m)	100%	100%	100%	100%	100%	93.3%	86.7%
... 8250 ft (... 2500 m)	100%	100%	100%	100%	96.3%		
... 9900 ft (... 3000 m)	100%	100%	100%	98.7%			
... 11550 ft (... 3500 m)	100%	100%	100%				
... 13200 ft (... 4000 m)	100%	100%	96.3%				
... 14850 ft (... 4500 m)	100%	97.5%					
... 16500 ft (... 5000 m)	98.2%						

Table 12- 5 Current derating as a function of the ambient temperature (inlet air temperature at the air inlet of the enclosed drive) and installation altitude for enclosed drives in a NEMA 12 enclosure

Installation altitude above mean sea level in m	Current derating factor at an ambient temperature (air intake temperature) of						
	68°F (20 °C)	77°F (25 °C)	86°F (30 °C)	95°F (35 °C)	104°F (40 °C)	113°F (45 °C)	122°F (50 °C)
0 ... 6600 ft (0 ... 2000 m)	100%	100%	100%	100%	93.3%	86.7%	80.0%
... 8250 ft (... 2500 m)	100%	100%	100%	96.3%	89.8%		
... 9900 ft (... 3000 m)	100%	100%	98.7%	92.5%			
... 11550 ft (... 3500 m)	100%	100%	94.7%				
... 13200 ft (... 4000 m)	100%	96.3%	90.7%				
... 14850 ft (... 4500 m)	97.5%	92.1%					
... 16500 ft (... 5000 m)	93.0%						

Use of an isolation transformer to reduce transient overvoltages to IEC 61800-5-1

This reduces overvoltage category III to overvoltage category II, which lowers the air insulation capacity requirements. An additional (input) voltage derating is not necessary if the following basic conditions are met:

- The isolation transformer must be fed from a low-voltage or medium-voltage network; it must not be supplied directly from a high-voltage network.
- It is permissible to use the isolation transformer to supply one or more enclosed drives.
- The lines between the isolation transformer and the enclosed drive(s) must be installed in such as way that the possibility of a direct lightning strike is ruled out; in other words, overhead lines must not be used.
- The following power network configurations are permissible:
  - TN power networks with grounded star point (no grounded phase conductor)
  - IT power networks (operation with a ground fault must be limited to the shortest time possible)

Current derating as a function of the pulse frequency

When the pulse frequency is increased, the derating factor of the output current must be taken into account. This derating factor must be applied to the currents specified in the technical specifications for the enclosed drives.

Table 12- 6 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 2 kHz

Order No.	Type rating	Output current at 2 kHz	Derating factor for pulse frequency				
6SL3710-...	[hp / kW]	[A]	2.5 kHz	4 kHz	5 kHz	7.5 kHz	8 kHz
Supply voltage 380 to 480 V AC, 3 phase							
1GE32-1_Ux	150 / 110	210	95%	82%	74%	54%	50%
1GE32-6_Ux	200 / 132	260	95%	83%	74%	54%	50%
1GE33-1_Ux	250 / 160	310	97%	88%	78%	54%	50%
1GE33-8_Ux	300 / 200	380	96%	87%	77%	54%	50%
1GE35-0_Ux	400 / 250	490	94%	78%	71%	53%	50%

Table 12- 7 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 1.25 kHz

Order No.	Type rating	Output current at 1.25 kHz	Derating factor for pulse frequency				
6SL3710-...	[hp / kW]	[A]	2 kHz	2.5 kHz	4 kHz	5 kHz	7.5 kHz
Supply voltage 380 to 480 V AC, 3 phase							
1GE36-1_Ux	500 / 315	605	83%	72%	64%	60%	40%
1GE37-5_Ux	600 / 400	745	83%	72%	64%	60%	40%
1GE38-4_Ux	700 / 450	840	87%	79%	64%	55%	40%
1GE41-0_Ux	800 / 560	985	92%	87%	70%	60%	50%
Supply voltage 500 to 600 V AC, 3 phase							
1GF31-8_Ux	150 / 110	175	92%	87%	70%	60%	40%
1GF32-2_Ux	200 / 132	215	92%	87%	70%	60%	40%
1GF32-6_Ux	250 / 160	260	92%	88%	71%	60%	40%
1GF33-3_Ux	300 / 200	330	89%	82%	65%	55%	40%
1GF34-1_Ux	400 / 250	410	89%	82%	65%	55%	35%
1GF34-7_Ux	450 / 315	465	92%	87%	67%	55%	35%
1GF35-8_Ux	600 / 400	575	91%	85%	64%	50%	35%
1GF37-4_Ux	700 / 500	735	87%	79%	64%	55%	35%
1GF38-1_Ux	800 / 560	810	83%	72%	61%	55%	35%

Note

Derating factors for pulse frequencies in the range between fixed values

The relevant derating factors can be determined by linear interpolation for pulse frequencies in the range between the specified fixed values.

12.2.2 Overload capability

The drive is equipped with an overload reserve to deal with breakaway torques, for example.

In drives with overload requirements, the appropriate base-load current must therefore be used as a basis for the required load.

The overloads apply under the precondition that the converter is operated at its base-load current before and after the overload (a duty cycle duration of 300 s is used as a basis here).

Low overload

The base-load current for low overload (I_L) is based on a load duty cycle of 110% for 60 s or 150% for 10 s.

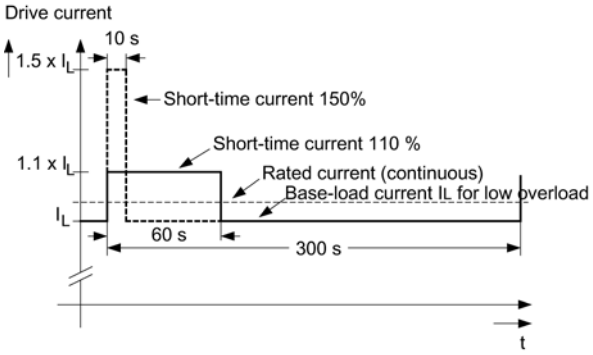


Figure 12-1 Low overload

High overload

The base-load current for a high overload I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s.

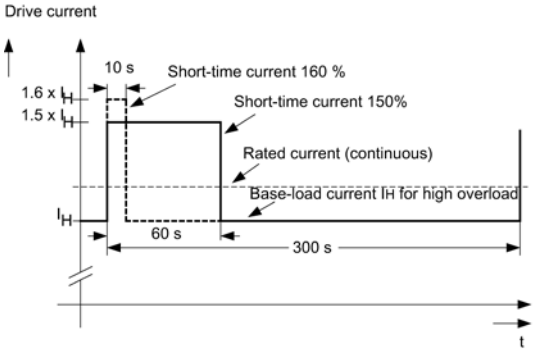


Figure 12-2 High overload

12.3 Technical specifications

12.3.1 Enclosed drive type A, 380 V - 480 V 3 AC

Table 12- 8 Type A, 380 to 480 V AC, 3 phase, part 1

Order number	6SL3710-	1GE32-1AUx	1GE32-6AUx	1GE33-1AUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 110 150	 132 200	 160 250
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	239	294	348
Rated output current	A	210	260	310
Base-load current I_L [2]	A	205	250	302
Base-load current I_H [3]	A	178	233	277
Max. output frequency [4]	Hz	160	160	160
Power loss	kW	2.9	3.8	4.4
Cooling air requirement	CFM m^3/s	360 0.17	487 0.23	763 0.36
Sound pressure level at 50/60 Hz	dB(A)	67/68	69/73	69/73
Line connection		2 x 3/0 AWG to 250 kcmil [6]	2 x 3/0 AWG to 250 kcmil [6]	2 x 2 AWG to 600 kcmil [7]
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	950 430	950 430	1250 570
Power block frame size		FX	FX	GX
Dimensions (standard version) width x height x depth	inch mm	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600
Fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1230-2 315 1	3NE1331-2 350 2	3NE1334-2 500 2

Order number	6SL3710-	1GE32-1AUx	1GE32-6AUx	1GE33-1AUx
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	65	65	65
Minimum short-circuit current [8]	A	3000	3600	4400

1) The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

6) Stripped lengths of the power cables: front 0.71" (18 mm), rear 1.46" (37 mm).
Tightening torque: 275 lb.in. (31 Nm).

7) Stripped lengths of the power cables: front 1" (25.4 mm), rear 2" (50.8 mm).
Tightening torque: 375 lb.in. (42.4 Nm).

8) Minimum current required for reliable triggering of the protective devices.

Table 12- 9 Type A, 380 to 480 V AC, 3 phase, part 2

Order number	6SL3710-	1GE33-8AUx	1GE35-0AUx	1GE36-1AUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 200 300	 250 400	 315 500
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	405	519	639
Rated output current	A	380	490	605
Base-load current I_L [2]	A	370	477	590
Base-load current I_H [3]	A	340	438	460
Max. output frequency [4]	Hz	160	160	100
Power loss	kW	5.3	6.4	8.2
Cooling air requirement	CFM m^3/s	763 0.36	763 0.36	1653 0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	70/73
Line connection		2 x 2 AWG to 600 kcmil [6]	3 x 1/0 AWG to 500 kcmil [6]	3 x 1/0 AWG to 500 kcmil [6]
Motor connection		2 x 3/0 AWG to 500 kcmil	3 x 1/0 AWG to 500 kcmil	3 x 2/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	1250 570	1250 570	2000 900
Power block frame size		GX	GX	HX
Dimensions (standard version) width x height x depth	inch mm	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600	47.2 x 94.5 x 23.6 1200 x 2400 x 600
Fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1334-2 500 2	3NE1436-2 630 3	3NE1438-2 800 3
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	65	65	65
Minimum short-circuit current [7]	A	4400	8000	10000

1) The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

6) Stripped lengths of the power cables: front 1" (25.4 mm), rear 2" (50.8 mm).
Tightening torque: 375 lb.in. (42.4 Nm).

7) Minimum current required for reliable triggering of the protective devices.

Table 12- 10 Type A, 380 to 480 V AC, 3 phase, part 3

Order number	6SL3710-	1GE37-5AUx	1GE38-4AUx	1GE41-0AUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 400 600	 450 700	 560 800
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current 1)	A	785	883	1034
Rated output current	A	745	840	985
Base-load current I_L 2)	A	725	820	960
Base-load current I_H 3)	A	570	700	860
Max. output frequency 4)	Hz	100	100	100
Power loss	kW	9.6	10.1	14.4
Cooling air requirement	CFM m^3/s	1653 0.78	1653 0.78	3136 1.48
Sound pressure level at 50/60 Hz	dB(A)	70/73	70/73	72/75
Line connection		4 x 2/0 AWG to 600 kcmil 6)	4 x 2/0 AWG to 600 kcmil 6)	4 x 2/0 AWG to 600 kcmil 6)
Motor connection		3 x 2/0 AWG to 500 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Approx. weight (standard version)	lb kg	2000 900	2000 900	3100 1400
Power block frame size		HX	HX	JX
Dimensions (standard version) width x height x depth	inch mm	47.2 x 94.5 x 23.6 1200 x 2400 x 600	47.2 x 94.5 x 23.6 1200 x 2400 x 600	63 x 94.5 x 23.6 1600 x 2400 x 600
Fuse type per phase 5) Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1448-2 850 3	2 x 3NE1436-2 2 x 630 3	2 x 3NE1437-2 2 x 710 3
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	65	65	65
Minimum short-circuit current 7)	A	10500	16000	18400

1) The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

6) Stripped lengths of the power cables: front 1" (25.4 mm), rear 2" (50.8 mm).
Tightening torque: 375 lb.in. (42.4 Nm).

7) Minimum current required for reliable triggering of the protective devices.

12.3.2 Enclosed chassis type C, 380 V - 480 V 3 AC

Table 12- 11 Type C, 380 to 480 V AC, 3 phase, part 1

Order number	6SL3710-	1GE32-1CUx	1GE32-6CUx	1GE33-1CUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 110 150	 132 200	 160 250
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	229	284	338
Rated output current	A	210	260	310
Base-load current I_L [2]	A	205	250	302
Base-load current I_H [3]	A	178	233	277
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	2.9	3.8	4.4
Cooling air requirement	CFM m^3/s	360 0.17	487 0.23	763 0.36
Sound pressure level at 50/60 Hz	dB(A)	67/68	69/73	69/73
Line connection		2 x 3/0 AWG to 250 kcmil	2 x 3/0 AWG to 250 kcmil	2 x 2 AWG to 600 kcmil
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	480 220	480 220	640 290
Power block frame size		FX	FX	GX
Dimensions (standard version) width x height x depth	inch mm	15.8 x 94.5 x 23.6 400 x 2400 x 600	15.8 x 94.5 x 23.6 400 x 2400 x 600	15.8 x 94.5 x 23.6 400 x 2400 x 600
Circuit breaker max. current rating	A	500	600	700
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	A	3NE1230-2 315 1	3NE1331-2 350 2	3NE1334-2 500 2
Recommended fuse base per phase [5], UL file no. E171267		3NH3320	3NH3320	3NH3420

Order number	6SL3710-	1GE32-1CUx	1GE32-6CUx	1GE33-1CUx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	65	65	65
Minimum short-circuit current [6]	A	3000	3600	4400

[1] The input current is based on the rated output current.

[2] The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[4] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[5] To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 65 kA, 480 V AC for motor branch circuit protection may not exceed the current rating shown.

[6] Minimum current required for reliable triggering of the protective devices.

Table 12- 12 Type C, 380 to 480 V AC, 3 phase, part 2

Order number	6SL3710-	1GE33-8CAx	1GE35-0CAx	1GE36-1CAx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 200 300	 250 400	 315 500
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	395	509	629
Rated output current	A	380	490	605
Base-load current I_L [2]	A	370	477	590
Base-load current I_H [3]	A	340	438	460
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	5.3	6.4	8.2
Cooling air requirement	CFM m^3/s	763 0.36	763 0.36	1653 0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	70/73
Line connection		2 x 2 AWG to 600 kcmil	2 x 1/0 AWG to 500 kcmil	3 x 1/0 AWG to 500 kcmil
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 1/0 AWG to 500 kcmil	3 x 2/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	640 290	640 290	1400 640
Power block frame size		GX	GX	HX
Dimensions (standard version) width x height x depth	inch mm	15.8 x 94.5 x 23.6 400 x 2400 x 600	15.8 x 94.5 x 23.6 400 x 2400 x 600	23.6 x 94.5 x 23.6 600 x 2400 x 600
Circuit breaker max. current rating	A	800	1200	1200
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1334-2 500 2	3NE1436-2 630 3	3NE1438-2 800 3
Recommended fuse base per phase [5], UL file no. E171267		3NH3420	3NH3420	3NH3420

Order number	6SL3710-	1GE33-8CAx	1GE35-0CAx	1GE36-1CAx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	65	65	65
Minimum short-circuit current [6]	A	4400	8000	10000

[1] The input current is based on the rated output current.

[2] The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[4] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[5] To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 65 kA, 480 V AC for motor branch circuit protection may not exceed the current rating shown.

[6] Minimum current required for reliable triggering of the protective devices.

Table 12- 13 Type C, 380 to 480 V AC, 3 phase, part 3

Order number	6SL3710-	1GE37-5CAx	1GE38-4CAx	1GE41-0CAx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 400 600	 450 700	 560 800
Rated input voltage	V	380 to 480 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	775	873	1024
Rated output current	A	745	840	985
Base-load current I_L [2]	A	725	820	960
Base-load current I_H [3]	A	570	700	860
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	9.6	10.1	14.4
Cooling air requirement	CFM m^3/s	1653 0.78	1653 0.78	3136 1.48
Sound pressure level at 50/60 Hz	dB(A)	70/73	70/73	72/75
Line connection		4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Motor connection		3 x 2/0 AWG to 500 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Approx. weight (standard version)	lb kg	1400 640	1400 640	2250 1020
Power block frame size		HX	HX	JX
Dimensions (standard version) width x height x depth	inch mm	23.6 x 94.5 x 23.6 600 x 2400 x 600	23.6 x 94.5 x 23.6 600 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600
Circuit breaker max. current rating	A	1600	2000	2000
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	A	3NE1448-2 850 3	2 x 3NE1436-2 2 x 630 3	2 x 3NE1437-2 2 x 710 3
Recommended fuse base per phase [5], UL file no. E171267		3NH3420	2 x 3NH3420	2 x 3NH3420

Order number	6SL3710-	1GE37-5CAx	1GE38-4CAx	1GE41-0CAx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	65	65	65
Minimum short-circuit current [6]	A	10500	16000	18400

[1] The input current is based on the rated output current.

[2] The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[4] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[5] To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 65 kA, 480 V AC for motor branch circuit protection may not exceed the current rating shown.

[6] Minimum current required for reliable triggering of the protective devices.

12.3.3 Enclosed drive type A, 500 V - 600 V 3 AC

Table 12- 14 Type A, 500 to 600 V AC, 3 phase, part 1

Order number	6SL3710-	1GF31-8AUx	1GF32-2AUx	1GF32-6AUx
Rated motor output at 500 V, 50 Hz at 575 V, 60 Hz	 kW HP	 110 150	 132 200	 160 250
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	201	234	280
Rated output current	A	175	215	260
Base-load current I_L [2]	A	171	208	250
Base-load current I_H [3]	A	157	192	233
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	3.8	4.2	5.0
Cooling air requirement	CFM m^3/s	763 0.36	763 0.36	763 0.36
Sound pressure level at 50/60 Hz	dB(A)	69/73	68/73	69/73
Line connection		2 x 3/0 AWG to 250 kcmil [6]	2 x 3/0 AWG to 250 kcmil [6]	2 x 3/0 AWG to 250 kcmil [6]
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	1200 550	1200 550	1200 550
Power block frame size		GX	GX	GX
Dimensions (standard version) width x height x depth	inch mm	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600
Fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1227-2 250 1	3NE1230-2 315 1	3NE1331-2 350 2
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	25	25	25
Minimum short-circuit current [7]	A	2400	3000	3600

1) The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

6) Stripped lengths of the power cables: front 0.71" (18 mm), rear 1.46" (37 mm).
Tightening torque: 275 lb.in. (31 Nm).

7) Minimum current required for reliable triggering of the protective devices.

Table 12- 15 Type A, 500 to 600 V AC, 3 phase, part 2

Order number	6SL3710-	1GF33-3AUx	1GF34-1AUx	1GF34-7AUx
Rated motor output at 500 V, 50 Hz at 575 V, 60 Hz	 kW HP	 200 300	 250 400	 315 450
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	353	436	493
Rated output current	A	330	410	465
Base-load current I_L [2]	A	320	400	452
Base-load current I_H [3]	A	280	367	416
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	6.1	8.1	7.8
Cooling air requirement	CFM m^3/s	763 0.36	1653 0.78	1653 0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	72/75	72/75
Line connection		2 x 2 AWG to 600 kcmil [7]	2 x 2 AWG to 600 kcmil [7]	3 x 1/0 AWG to 500 kcmil [7]
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	3 x 1/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	1200 550	1700 780	1700 780
Power block frame size		GX	HX	HX
Dimensions (standard version) width x height x depth	inch mm	39.4 x 94.5 x 23.6 1000 x 2400 x 600	47.2 x 94.5 x 23.6 1200 x 2400 x 600	47.2 x 94.5 x 23.6 1200 x 2400 x 600
Fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1334-2 500 2	3NE1334-2 500 2	3NE1435-2 560 3
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	25	25	30/35 [6]
Minimum short-circuit current [8]	A	5200	5200	6200

[1] The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

[2] The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[4] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[5] The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

[6] SCCR = 30 kA if a contactor is installed (options L13). SCCR = 35 kA without contactor.

[7] Stripped lengths of the power cables: front 1" (25.4 mm), rear 2" (50.8 mm).
Tightening torque: 375 lb.in. (42.4 Nm).

[8] Minimum current required for reliable triggering of the protective devices.

Table 12- 16 Type A, 500 to 600 V AC, 3 phase, part 3

Order number	6SL3710-	1GF35-8AUx	1GF37-4AUx	1GF38-1AUx
Rated motor output at 500 V, 50 Hz at 575 V, 60 Hz	 kW HP	 400 600	 500 700	 560 800
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	608	774	852
Rated output current	A	575	735	810
Base-load current I_L [2]	A	560	710	790
Base-load current I_H [3]	A	514	657	724
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	8.7	12.7	14.1
Cooling air requirement	CFM m^3/s	1653 0.78	3136 1.48	3136 1.48
Sound pressure level at 50/60 Hz	dB(A)	72/75	72/75	72/75
Line connection		3 x 1/0 AWG to 500 kcmil [6]	4 x 2/0 AWG to 600 kcmil [6]	4 x 2/0 AWG to 600 kcmil [6]
Motor connection		2 x 3/0 AWG to 500 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Approx. weight (standard version)	lb kg	1700 780	3100 1360	3100 1400
Power block frame size		HX	JX	JX
Dimensions (standard version) width x height x depth	inch mm	47.2 x 94.5 x 23.6 1200 x 2400 x 600	63 x 94.5 x 23.6 1600 x 2400 x 600	63 x 94.5 x 23.6 1600 x 2400 x 600
Fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1447-2 670 3	3NE1448-2 850 3	2 x 3NE1334-2 2 x 500 2
SCCR (short circuit current rating) for G150 type A enclosed drive per UL508A file no. E83449	kA IC	35	35	35
Minimum short-circuit current [7]	A	8400	10500	10400

1) The input current is based on the rated output current and includes 10 A for optional external auxiliaries.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) The SCCR value of the enclosed drive is based on the fuses listed. Substitutes are not permitted.

6) Stripped lengths of the power cables: front 1" (25.4 mm), rear 2" (50.8 mm).
Tightening torque: 375 lb.in. (42.4 Nm).

7) Minimum current required for reliable triggering of the protective devices.

12.3.4 Enclosed chassis type C, 500 V - 600 V 3 AC

Table 12- 17 Type C, 500 to 600 V AC, 3 phase, part 1

Order number	6SL3710-	1GF31-8CUx	1GF32-2CUx	1GF32-6CUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 110 150	 132 200	 160 250
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	191	224	270
Rated output current	A	175	215	260
Base-load current I_L [2]	A	170	208	250
Base-load current I_H [3]	A	157	192	233
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	3.8	4.2	5.0
Cooling air requirement	CFM m^3/s	763 0.36	763 0.36	763 0.36
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	69/73
Line connection		2 x 3/0 AWG to 250 kcmil	2 x 3/0 AWG to 250 kcmil	2 x 3/0 AWG to 250 kcmil
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	640 290	640 290	640 290
Power block frame size		GX	GX	GX
Dimensions (standard version) width x height x depth	inch mm	15.8 x 94.5 x 23.6 400 x 2400 x 600	15.8 x 94.5 x 23.6 400 x 2400 x 600	15.8 x 94.5 x 23.6 400 x 2400 x 600
Circuit breaker max. current rating	A	400	500	600
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1227-2 250 1	3NE1230-2 315 1	3NE1331-2 350 2
Recommended fuse base per phase [5], UL file no. E171267		3NH3320	3NH3320	3NH3320

Order number	6SL3710-	1GF31-8CUx	1GF32-2CUx	1GF32-6CUx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	35	35	35
Minimum short-circuit current [6]	A	2400	3000	3600

1) The input current is based on the rated output current.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 35 kA, 600 V AC for motor branch circuit protection may not exceed the current rating shown.

6) Minimum current required for reliable triggering of the protective devices.

Table 12- 18 Type C, 500 to 600 V AC, 3 phase, part 2

Order number	6SL3710-	1GF33-3CUx	1GF34-1CUx	1GF34-7CUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 200 300	 250 400	 315 450
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	343	426	483
Rated output current	A	330	410	465
Base-load current I_L [2]	A	320	400	452
Base-load current I_H [3]	A	280	367	416
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	6.1	8.1	7.8
Cooling air requirement	CFM m^3/s	763 0.36	1653 0.78	1653 0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	72/75	72/75
Line connection		2 x 2 AWG to 600 kcmil	2 x 2 AWG to 600 kcmil	3 x 1/0 AWG to 500 kcmil
Motor connection		2 x 3/0 AWG to 500 kcmil	2 x 3/0 AWG to 500 kcmil	3 x 1/0 AWG to 500 kcmil
Approx. weight (standard version)	lb kg	640 290	1400 640	1400 640
Power block frame size		GX	HX	HX
Dimensions (standard version) width x height x depth	inch mm	15.8 x 94.5 x 23.6 400 x 2400 x 600	23.6 x 94.5 x 23.6 600 x 2400 x 600	23.6 x 94.5 x 23.6 600 x 2400 x 600
Circuit breaker max. current rating	A	800	1000	1000
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	 A	3NE1334-2 500 2	3NE1334-2 500 2	3NE1435-2 560 3
Recommended fuse base per phase [5], UL file no. E171267		3NH3420	3NH3420	3NH3420

Order number	6SL3710-	1GF33-3CUx	1GF34-1CUx	1GF34-7CUx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	35	35	35
Minimum short-circuit current [6]	A	5200	5200	6200

1) The input current is based on the rated output current.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 35 kA, 600 V AC for motor branch circuit protection may not exceed the current rating shown.

6) Minimum current required for reliable triggering of the protective devices.

Table 12- 19 Type C, 500 to 600 V AC, 3 phase, part 3

Order number	6SL3710-	1GF35-8CUx	1GF37-4CUx	1GF38-1CUx
Rated motor output at 400 V, 50 Hz at 460 V, 60 Hz	 kW HP	 400 600	 500 700	 560 800
Rated input voltage	V	500 to 600 V AC , 3 phase ±10% (-15% < 1 min)		
Rated input current [1]	A	598	764	842
Rated output current	A	575	735	810
Base-load current I_L [2]	A	560	710	790
Base-load current I_H [3]	A	514	657	724
Max. output frequency [4]	Hz	100	100	100
Power loss	kW	8.7	12.7	14.1
Cooling air requirement	CFM m^3/s	1653 0.78	3136 1.48	3136 1.48
Sound pressure level at 50/60 Hz	dB(A)	72/75	72/75	72/75
Line connection		3 x 1/0 AWG to 500 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Motor connection		3 x 3/0 AWG to 500 kcmil	4 x 2/0 AWG to 600 kcmil	4 x 2/0 AWG to 600 kcmil
Approx. weight (standard version)	lb kg	1400 640	2150 980	2250 1020
Power block frame size		HX	JX	JX
Dimensions (standard version) width x height x depth	inch mm	23.6 x 94.5 x 23.6 600 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600	39.4 x 94.5 x 23.6 1000 x 2400 x 600
Circuit breaker max. current rating	A	1200	1600	2000
Recommended fuse type per phase [5] Rated current frame size to IEC 60269 UL file no. E167357	A	3NE1447-2 670 3	3NE1448-2 850 3	2 x 3NE1334-2 2 x 500 2
Recommended fuse base per phase [5], UL file no. E171267		3NH3420	3NH3420	2 x 3NH3420

Order number	6SL3710-	1GF35-8CUx	1GF37-4CUx	1GF38-1CUx
SCCR (short circuit current rating) for G150 type C enclosed drive per UL508A file no. E83449 when used with the fuse & fuse base listed above and a UL-listed circuit breaker	kA IC	35	35	35
Minimum short-circuit current [6]	A	8400	10500	10400

1) The input current is based on the rated output current.

2) The base-load current I_L is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) The base-load current I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

4) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

5) To obtain the SCCR value for the enclosed drive, it is necessary to use the fuses with fuse base listed above. Substitutes are not permitted. Also, the UL-listed circuit breaker with minimum SCCR of 35 kA, 600 V AC for motor branch circuit protection may not exceed the current rating shown.

6) Minimum current required for reliable triggering of the protective devices.

Appendix

A

A.1 Acronyms and abbreviations

A	
A...	Alarm
AC	Alternating Current
AI	Analog Input
AO	Analog Output
AOP	Advanced Operator Panel (with plain-text display)
B	
BI	Binector Input
BICO	BInector/COnnector
BO	Binector Output
C	
C	Capacitance
CAN	Serial bus system
CB	Communication Board
CDS	Command Data Set
CI	Connector Input
COM	Center contact on a changeover contact
CU	Control Unit
D	
DC	Direct Current
DDS	Drive Data Set
DI	Digital Input
DI/DO	Digital Input/Digital Output bidirectional
DO	Digital Output
E	
ESD	Electrostatic Sensitive Device
EMC	ElectroMagnetic Compatibility
EN	European Standard
F	
F ...	Fault
FAQ	Frequently Asked Questions
FW	FirmWare
H	
RFG	Ramp-Function Generator
HW	HardWare

I	
I/O	Input/Output
IEC	International Electrotechnical Commission Standard
IGBT	Insulated Gate Bipolar Transistor
J	
JOG	Jog mode
L	
L	Inductance
LED	Light-Emitting Diode
M	
M	Reference ground
MDS	Motor Data Set
N	
NC	Normally Closed contact
NEMA	Standardization body in the USA (United States of America)
NO	Normally Open contact
P	
p ...	Adjustable parameter
PDS	Power unit Data Set
PE	Protective Earth (ground)
PROFIBUS	Serial data bus
PTC	Positive Temperature Coefficient
R	
r...	Display parameter (read-only)
RAM	Random Access Memory (read-write)
RS 232	Serial interface
RS 485	Standard describing the physical characteristics of a digital serial interface.
S	
SI	Safety Integrated
STW	PROFIdrive control word
SW	SoftWare
T	
TIA	Totally Integrated Automation
TM	Terminal Module
U	
UL	Underwriters Laboratories Inc.
V	
Vdc	DC link voltage
Z	
ZSW	PROFIdrive status word

A.2 Parameter macros

Parameter macro p0015 = G150 enclosed drive

This macro is used to make default settings for operating the drive.

Table A- 1 Parameter macro p0015 = G150 enclosed drive

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0400[0]	Encoder type selection	Vector	9999	User-defined	Vector
p0404[0]	Encoder configuration	Vector	200008h		Vector
p0405[0]	Square-wave encoder track A/B	Vector	9h	Bipolar, like A/B track	Vector
p0408[0]	Rotary encoder pulse no.	Vector	1024	1024 pulses per revolution	Vector
p0420[0]	Encoder connection	Vector	0x2	Encoder connection = terminal	Vector
p0500	Technology application	Vector	1	Pumps, fans	Vector
p0600	Motor temperature sensor for monitoring	Vector	0	No sensor	Vector
p0601	Motor temperature sensor type	Vector	0	No sensor	Vector
p0603	CI: Motor temperature	Vector	r4105	Sensor on TM31	TM31
p0604	Motor overtemperature alarm threshold	Vector	120	120°C	Vector
p0605	Motor overtemperature fault threshold	Vector	155	155°C	Vector
p0606	Motor overtemperature timer	Vector	0	0 s	Vector
p0610	Response to motor overtemperature condition	Vector	1	Alarm with reduction of I_max and fault	Vector
p0700[0]	Macro binector input (BI)	Vector	70005	PROFIdrive	Vector
p0864	Infeed operation	Vector	1		Vector
p1000[0]	Macro Connector Inputs (CI) for speed setpoints	Vector	100001	PROFIdrive	Vector
p1001	CO: Fixed speed setpoint 1	Vector	300	300 rpm	Vector
p1002	CO: Fixed speed setpoint 2	Vector	600	600 rpm	Vector
p1003	CO: Fixed speed setpoint 3	Vector	1500	1500 rpm	Vector
p1083	CO: Speed limit in positive direction of rotation	Vector	6000	6000 rpm	Vector
p1086	CO: Speed limit in negative direction of rotation	Vector	-6000	-6000 rpm	Vector
p1115	Ramp-function generator selection	Vector	1	Extended ramp-function generator	Vector
p1120	Ramp-function generator, ramp-up time	Vector	20	20 s	Vector
p1121	Ramp-function generator, ramp-down time	Vector	30	30 s	Vector
p1135	OFF3 ramp-down time	Vector	10	10 s	Vector
p1200	Flying restart operating mode	Vector	0	Flying restart not active	Vector

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p1240	Vdc controller configuration	Vector	1	Vdc-max controller enabled	Vector
p1254	Vdc controller automatic ON level detection	Vector	1	Automatic detection enabled	Vector
p1280	Vdc controller configuration (V/f)	Vector	1	Vdc-max controller enabled	Vector
p1300	Open-loop/closed-loop control operating mode	Vector	20	Encoderless speed control	Vector
p1911	Number of phases to be identified	Vector	3	3 phases	Vector
p2051[0]	CI: PROFIBUS PZD send word	Vector	r2089[0]	ZSW1	Vector
p2051[1]	CI: PROFIBUS PZD send word	Vector	r0063[0]	n-act unsmoothed	Vector
p2051[2]	CI: PROFIBUS PZD send word	Vector	r0068[0]	I-act unsmoothed	Vector
p2051[3]	CI: PROFIBUS PZD send word	Vector	r0080[0]	M-act unsmoothed	Vector
p2051[4]	CI: PROFIBUS PZD send word	Vector	r0082[0]	P-act unsmoothed	Vector
p2051[5]	CI: PROFIBUS PZD send word	Vector	r2131	FAULT	Vector
p2080[0]	BI: PROFIBUS send status word 1	Vector	r0899.0	Ready to start	Vector
p2080[1]	BI: PROFIBUS send status word 1	Vector	r0899.1	Ready to operate	Vector
p2080[2]	BI: PROFIBUS send status word 1	Vector	r0899.2	Operation enabled	Vector
p2080[3]	BI: PROFIBUS send status word 1	Vector	r2139.3	Fault	Vector
p2080[4]	BI: PROFIBUS send status word 1	Vector	r0899.4	OFF2 inactive	Vector
p2080[5]	BI: PROFIBUS send status word 1	Vector	r0899.5	OFF3 inactive	Vector
p2080[6]	BI: PROFIBUS send status word 1	Vector	r0899.6	Power-on inhibit active	Vector
p2080[7]	BI: PROFIBUS send status word 1	Vector	r2139.7	Alarm present	Vector
p2080[8]	BI: PROFIBUS send status word 1	Vector	r2197.7	Speed setpoint - actual value deviation within tolerance	Vector
p2080[9]	BI: PROFIBUS send status word 1	Vector	r0899.9	Control requested	Vector
p2080[10]	BI: PROFIBUS send status word 1	Vector	r2199.1	Comparison value reached	Vector
p2080[11]	BI: PROFIBUS send status word 1	Vector	r1407.7	I. M or P limit not reached	Vector
p2080[12]	BI: PROFIBUS send status word 1	Vector	0		Vector
p2080[13]	BI: PROFIBUS send status word 1	Vector	r2129.14	No alarm for motor overtemperature	Vector
p2080[14]	BI: PROFIBUS send status word 1	Vector	r2197.3	Clockwise	Vector
p2080[15]	BI: PROFIBUS send status word 1	Vector	r2129.15	No Therm. alarm Power unit overload	Vector
p2088	PROFIBUS Invert status word in bits	Vector	B800h		Vector
p2128[14]	Select fault/alarm code for trigger	Vector	7910	A7910: Alarm, motor overtemperature	Vector
p2128[15]	Select fault/alarm code for trigger	Vector	5000	A5000: Therm. alarm Power unit overload	Vector
p2153	Speed actual value filter time constant	Vector	20	20 ms	Vector
p4053[0]	TM31 analog inputs, smoothing time constant	TM31	0	0 ms	TM31
p4053[1]	TM31 analog inputs, smoothing time constant	TM31	0	0 ms	TM31

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p4056[0]	Type of analog inputs	TM31	2	Current 0...20 mA	TM31
p4056[1]	Type of analog inputs	TM31	2	Current 0...20 mA	TM31
p4076[0]	Type of analog outputs	TM31	0	Current 0...20 mA	TM31
p4076[1]	Type of analog outputs	TM31	0	Current 0...20 mA	TM31
p4071[0]	Signal analog output 0	TM31	r0063	Actual speed value, smoothed	Vector
p4071[1]	Signal analog output 1	TM31	r0068	Absolute current actual value	Vector
p4100	Type of temperature sensor	TM31	0	Evaluation disabled	TM31
p4102[0]	Temperature evaluation, alarm threshold	TM31	251°C	When this value is exceeded, alarm A35211 is triggered.	TM31
p4102[1]	Temperature evaluation, fault threshold	TM31	251°C	When this value is exceeded, fault F35207 is triggered.	TM31
p7003	Winding system	Vector	1	Separate winding systems	Vector

Parameter macro p0700 = 5: PROFIdrive (70005)

This macro is used to set the PROFIdrive interface as the default command source.

Table A- 2 Parameter macro p0700 = 5: PROFIdrive

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r2090.0	PZD 1 bit 0	Vector
p0844[0]	No OFF2_1	Vector	r2090.1	PZD 1 bit 1	Vector
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r0722.2	CU DI2	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Command Data Set selection CDS bit 0	Vector	0		Vector
p0852	Operation enable	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control requested	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	PROFIdrive PZD telegram (message frame) selection	Vector	999	Free telegram (message frame) configuration	
p1020	Fixed speed setpoint selection, bit 0	Vector	0		Vector
p1021	Fixed speed setpoint selection, bit 1	Vector	0		Vector
p1035	Motorized potentiometer (MOP) raise setpoint	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	Motorized potentiometer (MOP) lower setpoint	Vector	r2090.14	PZD 1 bit 14	Vector
p1113	Setpoint inversion	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	RFG enable	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Continue RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	n_set enable	Vector	r2090.6	PZD 1 bit 6	Vector

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p2103	Acknowledge fault 1	Vector	r2090.7	PZD 1 bit 7	Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Power-on inhibit active	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	r2090.7	PZD 1 bit 7	Vector
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready to start	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 6: Terminal module TM31 (70006)

This macro is used to set customer terminal module TM31 as the command source.

Table A- 3 Parameter macro p0700 = 6: Terminal module TM31

Sink			Source		
Parameter	Description	DO	Parameter	Description	DO
p0840[0]	ON/OFF1	Vector	r4022.0	TM31 DI0	TM31
p0844[0]	No OFF2_1	Vector	1		CU
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	1		Vector
p0849[0]	No OFF3_2	Vector	r0722.2	CU DI2	CU
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Command Data Set selection CDS bit 0	Vector	0		Vector
p0852	Operation enable	Vector	r4022.4	TM31 DI4	TM31
p0854	Control requested	Vector	1		Vector
p0922	PROFIdrive PZD telegram (message frame) selection	Vector	999	Free telegram (message frame) configuration	
p1020	Fixed speed setpoint selection, bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	Fixed speed setpoint selection, bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	Motorized potentiometer (MOP) raise setpoint	Vector	r4022.1	TM31 DI1	TM31
p1036	Motorized potentiometer (MOP) lower setpoint	Vector	r4022.2	TM31 DI2	TM31
p1113	Direction of rotation reversal	Vector	0		TM31
p1140	RFG enable	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	n_set enable	Vector	1		Vector
p2103	Acknowledge fault 1	Vector	0		Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Power-on inhibit active	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready to start	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 7: NAMUR (70007)

This macro is used to set the NAMUR terminal block as the default command source.

Table A- 4 Parameter macro p0700 = 7: NAMUR

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	r4022.0	TM31 DI0	TM31
p0844[0]	No OFF2_1	Vector	r4022.4	TM31 DI4	TM31
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	r4022.5	TM31 DI5	TM31
p0849[0]	No OFF3_2	Vector	1		Vector
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Command Data Set selection CDS bit 0	Vector	0		Vector
p0852	Operation enable	Vector	1		Vector
p0854	Control requested	Vector	1		Vector
p0922	PROFIdrive PZD telegram (message frame) selection	Vector	999	Free telegram (message frame) configuration	
p1020	Fixed speed setpoint selection, bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	Fixed speed setpoint selection, bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	Motorized potentiometer (MOP) raise setpoint	Vector	r4022.1	TM31 DI1	TM31
p1036	Motorized potentiometer (MOP) lower setpoint	Vector	r4022.2	TM31 DI2	TM31
p1113	Direction of rotation reversal	Vector	r4022.6	TM31 DI6	TM31
p1140	RFG enable	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	n_set enable	Vector	1		Vector
p2103	Acknowledge fault 1	Vector	0		Vector
p2104	Acknowledge fault 2	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	
p0728.10	Set DI/DO10 input or output	CU	1	Output	

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Power-on inhibit active	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4048.1	Invert DO1	TM31	1	Inverted	
p4038	DO8	TM31	r0899.0	Ready to start	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p0700 = 10: PROFIdrive NAMUR (70010)

This macro is used to set the PROFIdrive NAMUR interface as the default command source.

Table A- 5 Parameter macro p0700 = 10: PROFIdrive NAMUR

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	0	Assignment with p0922 = 20	Vector
p0844[0]	No OFF2_1	Vector	1	Assignment with p0922 = 20	Vector
p0845[0]	No OFF2_2	Vector	r0722.3	CU DI3	CU
p0848[0]	No OFF3_1	Vector	0	Assignment with p0922 = 20	Vector
p0849[0]	No OFF3_2	Vector	1		Vector
p0806	Inhibit LOCAL mode	Vector	0		Vector
p0810	Command Data Set selection CDS bit 0	Vector	r2090.15		Vector
p0852	Operation enable	Vector	1	Assignment with p0922 = 20	Vector
p0854	Control requested	Vector	1	Assignment with p0922 = 20	Vector
p0922	PROFIdrive PZD telegram (message frame) selection	Vector	20	PROFIdrive NAMUR	
p1020	Fixed speed setpoint selection, bit 0	Vector	0		Vector
p1021	Fixed speed setpoint selection, bit 1	Vector	0		Vector
p1035	Motorized potentiometer (MOP) raise setpoint	Vector	0		Vector
p1036	Motorized potentiometer (MOP) lower setpoint	Vector	0		Vector
p1113	Direction of rotation reversal	Vector	0	Assignment with p0922 = 20	Vector
p1140	RFG enable	Vector	1	Assignment with p0922 = 20	Vector
p1141	Start RFG	Vector	1	Assignment with p0922 = 20	Vector
p1142	n_set enable	Vector	1	Assignment with p0922 = 20	Vector
p2103	Acknowledge fault_1	Vector	0	Assignment with p0922 = 20	Vector
p2104	Acknowledge fault_2	Vector	0		Vector
p2106	Ext. fault_1	Vector	r0722.1	CU DI1	CU
p2107	Ext. fault_2	Vector	1		Vector
p2112	Ext. alarm_1	Vector	r0722.0	CU DI0	CU
p2116	Ext. alarm_2	Vector	1		Vector
p0738	DI/DO8	CU	1	+24 V	CU
p0748.8	Invert DI/DO8	CU	0	Not inverted	
p0728.8	Set DI/DO8 input or output	CU	1	Output	
p0739	DI/DO9	CU	1	+24 V	CU
p0748.9	Invert DI/DO9	CU	0	Not inverted	
p0728.9	Set DI/DO9 input or output	CU	1	Output	
p0740	DI/DO10	CU	1	+24 V	CU
p0748.10	Invert DI/DO10	CU	0	Not inverted	

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p0728.10	Set DI/DO10 input or output	CU	1	Output	
p0741	DI/DO11	CU	1	+24 V	CU
p0748.11	Invert DI/DO11	CU	0	Not inverted	
p0728.11	Set DI/DO11 input or output	CU	1	Output	
p0742	DI/DO12	CU	1	+24 V	CU
p0748.12	Invert DI/DO12	CU	0	Not inverted	
p0728.12	Set DI/DO12 input or output	CU	1	Output	
p0743	DI/DO13	CU	r0899.6	Power-on inhibit active	Vector
p0748.13	Invert DI/DO13	CU	1	Inverted	
p0728.13	Set DI/DO13 input or output	CU	1	Output	
p0744	DI/DO14	CU	1	+24 V	CU
p0748.14	Invert DI/DO14	CU	0	Not inverted	
p0728.14	Set DI/DO14 input or output	CU	1	Output	
p0745	DI/DO15	CU	r2138.7	Ack. fault	Vector
p0748.15	Invert DI/DO15	CU	0	Not inverted	
p0728.15	Set DI/DO15 input or output	CU	1	Output	
p2103	Acknowledge fault 1	TM31	0		TM31
p2104	Acknowledge fault 2	TM31	0		TM31
p4030	DO0	TM31	0		Vector
p4031	DO1	TM31	0		Vector
p4038	DO8	TM31	0		Vector
p4028.8	Set DI/DO8 input or output	TM31	0	Input	
p4039	DO9	TM31	0		TM31
p4028.9	Set DI/DO9 input or output	TM31	0	Input	
p4040	DO10	TM31	0		TM31
p4028.10	Set DI/DO10 input or output	TM31	0	Input	
p4041	DO11	TM31	0		TM31
p4028.11	Set DI/DO11 input or output	TM31	0	Input	

Parameter macro p1000 = 1: PROFIdrive (100001)

This macro is used to set the default setpoint source via PROFIdrive.

Table A- 6 Parameter macro p1000 = 1: PROFIdrive

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p1070	Main setpoint	Vector	r2050[1]	PROFIdrive PZD2	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 2: TM31 terminals (100002)

This macro is used to set analog input 0 on customer terminal module TM31 as the setpoint source.

Table A- 7 Parameter macro p1000 = 2: TM31 terminals

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p1070	Main setpoint	Vector	r4055	AI0 TM31	TM31
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 3: Motorized potentiometer (100003)

This macro is used to set the motorized potentiometer as the setpoint source.

Table A- 8 Parameter macro p1000 = 3: Motorized potentiometer

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p1070	Main setpoint	Vector	r1050	Motorized potentiometer	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 4: Fixed setpoint (100004)

This macro is used to set the fixed setpoint as the setpoint source.

Table A- 9 Parameter macro p1000 = 4: Fixed setpoint

Sink			Source		
Parameter	**Description**	**DO**	**Parameter**	**Description**	**DO**
p1070	Main setpoint	Vector	r1024	Fixed speed setpoint effective	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Index

3

3-contactor bypass (option L29), 117
3-mass model, 522

A

A7850 – External alarm 1, 545
Accessory kit
  Original roof screws, 52
Acknowledge fault from the AOP, 291
Actual speed value filter, 392
Acyclic communication, 307
  Determining drive object numbers, 315
  Error values in parameter responses, 312
  Parameter request and parameter response, 309
  Parameter request and response, 310
Additional customer terminal block (option G61), 163
Additional SMC30 Sensor Module (option K52), 163
Alarms, 544
ALL STOP, coast to stop (Option N55), 121
Analog inputs, 107, 265
Analog outputs, 108, 416
AOP setpoint, 290
AOP30, 228
Application classes, 298
Area of application, 29
Armature short-circuit braking
  External, 451
  Internal, 453
Automatic restart, 438
Automatic speed controller optimization, 422
Auxiliary supply, 82
  115 V AC, 83
  24 V DC, 83
Auxiliary voltage, 109

B

Basic commissioning
  Entering basic parameters, 236
  Entering encoder data, 233
  Entering motor data, 232
  Motor identification, 238
  Selecting motor type, 232
Basic information
  BICO technology, 255
  Binector Input (BI), 256
  Binector Output (BO), 256
  Command data set (CDS), 250
  Connector Input (CI), 256
  Connector Output (CO), 256
  Copy motor data set (MDS), 254
  Copying the command data set (CDS), 254
  Copying the drive data set (DDS), 254
  Data sets, 249
  Drive data set (DDS), 251
  Drive objects, 248
  Encoder data set (EDS), 252
  Interconnecting signals, 257
  Motor data set (MDS), 253
  Parameter categories, 246
  Parameter types, 245
  Parameters, 245
Basic information about the drive system, 245
BICO technology, 255
  Interconnecting signals, 257
Bimetallic NC contact, 520
Binector Input (BI), 256
Binector Output (BO), 256
Blade fuse
  Replacement, 592
Block diagram, 34
Blocking protection, 516
Brake control
  Extended, 506
  Simple, 468
Braking unit, 25 kW (Option L61), 126
Braking unit, 50 kW (Option L62), 126
Bypass
  Synchronized with overlap, 498
  Synchronized without overlap, 500
  Without synchronization, 502
Bypass function, 497

C

Cabinet anti-condensation heating (Option L55), 120
Cabinet illumination with service socket (option L50), 120
Cable lengths, 70
Cable lugs, 69
CAN bus, 141
CBC10, 141

CBC10 Communication Board
CAN bus, 141
CBE20, 144
CBE20 Ethernet Communication Board (option G33), 144
CDS (command data set), 250
Copy, 254
CDS changeover via AOP, 291
Center of gravity of the cabinet, 51
Certification, 7
Changing languages, 287
Checklist
Electrical installation, 58
Mechanical installation, 44
Cleaning, 548
Command data set, 250
Command sources
General information, 244
PROFIdrive, 261
TM31 terminals, 263
Communication
Communication services, 358
Used port numbers, 358
via PROFIdrive, 296
Communication interfaces
Parallel operation, 361
Conductor cross-sections, 70
Connector Input (CI), 256
Connector Output (CO), 256
Control Interface Module
Message frame size FX, replacing, 555
Message frame size GX, replacing, 557
Message frame size HX, replacing, 559
Message frame size JX, replacing, 561
Control power supply, 115 V AC, 5 A (option N70), 140
Control Unit CU320-2 DP, 83
Control Unit CU320-2 PN, 169
Control via PROFIBUS, 326
Crane transport aid, 51
Disassembling, 52
CU320-2 DP, 84
CU320-2 PN, 170
CU320-2 PN Control Unit, 170
Current setpoint filter, 409
Customer terminal module, 99
Customer terminal module, connection overview, 104
Customer terminal module, front view, 103
Cyclic communication, 303

D

Data sets, 249
Data transmission
PROFINET, 339
Date of manufacture, 37
DC braking, 454
DCC, 30, 364
DDS (drive data set), 251
Copy, 254
Decrease key, 289
Derating behavior with increased pulse frequency, 459
Derating data, 603
Current derating as a function of the pulse frequency, 605
Decreasing the ambient temperature and the output current, 604
Installation altitudes over 6,600 ft and up to 16,500 ft (2000 m to 5000 m) above MSL, 603
Permissible output current as a function of the ambient temperature, 603
Using an isolation transformer, 605
Design, 31
Determining drive object numbers, 315
Determinism, 336
Diagnostics, 532
LEDs, 532
Parameters, 540
Digital inputs, 105, 106
Digital inputs/outputs, 88, 90, 110, 174, 176
Digital outputs, 419
Direction of motor rotation, 73
Direction reversal, 367, 465
Disconnecting the basic interference suppression module, 77
Drive Control Chart, 364
Drive Control Chart (DCC), 30
Drive data set, 251
Drive objects, 248
DRIVE-CLiQ interface, 87, 173
Droop, 402
dv/dt filter plus voltage peak limiter (option L10), 112

E

EDS (encoder data set), 252
Efficiency optimization, 429
Electrical installation
Checklist, 58
Electromagnetic compatibility
EMC-compliant design, 66
Introduction, 64
Noise emissions, 65
Operational reliability and noise immunity, 64
Electromagnetic fields, 23

Electrostatic sensitive devices, 24
EMERGENCY OFF category 0 (option N57), 122
Emergency operation, 484
EMERGENCY STOP category 1 (option N59), 123
EMERGENCY STOP category 1 (option N60), 125
Enclosed chassis type C, design, 33
Enclosed drive type A, design, 32
Encoder data set, 252
Encoder with gear factor, 241
Energy savings indicator, 472
Error values in parameter responses, 312
Essential service mode, 484
Ethernet interface, 146, 222
Extended braking control, 506
Extended monitoring functions, 510
External alarm 1, 545
External fault 1, 545
External fault 2, 546
External fault 3, 546
External supply, 82

F

F7860 – External fault 1, 545
F7861 – External fault 2, 546
F7862 – External fault 3, 546
Factory setting, 241
Fan
  Message frame size FX, replacing, 579
  Message frame size GX, replacing, 581
  Message frame size HX, replacing, 583
  Message frame size JX, replacing, 587
Fan voltage, adjustment, 74
Fast magnetization, 431
Faults, 544
Faults and alarms, 293, 544
  BICO interconnections, 260
  Forwarding, 260
  Propagation, 260
Faults and alarms, 293, 544
Features, 30
Feeder for external auxiliaries / motor blower (option L17), 115
Filter mats, replacing, 554
Firmware update, 598
Firmware, upgrading, 598
Fixed setpoints, 268
Fixed speed setpoints, 268
Floor levelness, 46
Flying restart, 441
  Fast flying restart, 444
  Fast flying restart with voltage measurement via VSM10, 445
  With an encoder, 445
  Without an encoder, 442
Forming the DC link capacitors, 596
Friction characteristic, 449
Fuse
  Auxiliary power supply (-F11, -F12), 591
  Fans -T1 -F10 / -T1 -F11, 591
  Internal 230 V AC supply (-F21), 591
  LV HRC fuse, replacing, 592

G

G20, 141
G33, 144
G51, 147
G61, 163
G65, 164
Gear factor, 241

H

High overload, 607
Hotline, 6

I

I2t motor model, 521
IF1, 361
IF2, 361
Increase key, 289
Increasing the output frequency, 456
Inhibit AOP LOCAL mode, 291
Input contactor (Option L13), 115
Installation
  Connection to the foundation, 53
  Lifting from the transport pallet, 50
  Motor connection from above, 54
Installation device, 551
Installation location, 45
Insulation monitor (option L87), 137
IO controller, 334
IO device, 334
IO supervisor, 334
IT power network, 77

J

Jog, 289

JOG, 289

K

K01, 164
K50, 153
K51, 162
K52, 163
K82, 165
K82, terminal module for activating Safe Torque Off and "Safe STOP 1, 165
K87, 166
K88, 168
K95, 169
Kinetic buffering, 434
Know-how protection, 477
  Activating, 479
  Changing password, 481
  Copy protection, 482
  Deactivating, 480
  Device replacement, 482
  OEM exception list, 481
KTY, 520

L

L10, 112
L13, 115
L17, 115
L29, 117, 118
L50, 120
L55, 120
L61, 126
L62, 126
L87, 137
L96, 136
L97, 136
Line-side surge arrester (option L96), 136
Load monitoring, 510
Loading firmware (operator panel), 599
LOCAL/REMOTE key, 288
Low overload, 607
LV HRC fuse
  Replacement, 592

M

M39, 55
M78, 54
Maintenance, 548
Maintenance and servicing, 547
MDS (motor data set), 253
  Copy, 254
Mechanical door lock (slam latch) (option M39), 55
Mechanical installation
  Checklist, 44
Memory card
  Slot, 97, 181
Menu
  AOP diagnostics, 285
  AOP30 settings, 279
  Basic commissioning, 276
  Battery status, 286
  Commissioning/service, 276
  Complete commissioning, 276
  Control settings, 279
  Curve recorder, 277
  Curve recorder settings, 282
  Database contents, 286
  Database statistics, 286
  Database version, 285
  Date format, 284
  Define operation screen, 279
  Device commissioning, 276
  Display settings, 279
  DO name display mode, 285
  Drive commissioning, 276
  Drive diagnostics, 277
  Fault memory/Alarm memory, 275
  Keyboard test, 286
  LED test, 286
  Motor identification, 276
  Normalization to motor current, 285
  Operation screen, 272
  Reset AOP settings, 285
  Reset fan operating time, 276
  Set date, 283
  Set time, 283
  Software version, 285
  Sprachauswahl/Language selection, 287
  Structure, 271
Message frame selection, user-defined, 304
Message frames and process data, 303
Minimum speed, 368
Monitoring functions, 513
Motor changeover, 447
Motor data identification, 423
Motor data set, 253
Motor identification, 422
Motorized potentiometer, 267

N

N55, 121
N57, 122
N59, 123
N60, 125
N70, 140

O

OFF key, 288
ON key, 288
Online operation with STARTER, 330
Open actual speed value, 403
Operating hours counter, 462
Operating lock / Parameterization lock key, 291
Operation on an ungrounded power network, 77
Operation screen, 272
Operator panel, 228
  Overview, 270
Operator panel, replacing the battery, 594
Option K95, 169
Option M90 (crane transport aid), 51
Option short codes, 38
Original roof screws, 52
Output terminals, 415
Overload capability, 607
Overload responses, 514

P

Parallel operation of communication interfaces, 361
Parameter request and parameter response, 309
Parameter request and response, 310
Parameter reset, 241
  Resetting parameters via AOP30, 241
  Resetting parameters via Starter, 242
Parameterization errors, 295
Permanent-magnet synchronous motors, 410
Power block
  Lifting lugs, 552
  Message frame size FX, replacing, 563
  Message frame size GX, replacing, 566
  Message frame size HX, replacing, 569
  Message frame size JX, replacing, 574
Power connections, 68
  Connecting the motor and power cables, 71
Power module protection, 513
Power supply, internal, 76
Preparation
  Mechanical installation, 45
PROFIBUS, 321
  Address switches, 94, 327
  Bus terminating resistor, 93, 323
  Connectors, 93, 322
  Setting the address, 94, 326
  Setting the PROFIBUS address, 326
PROFIBUS connection, 92, 321
PROFIdrive, 296
  Acyclic communication, 307
  Application classes, 298
  Controller, 297
  Cyclic communication, 303
  Device classes, 296
  Drive unit, 297
  Supervisor, 297
PROFIenergy, 340
  Certification, 340
  Commands, 343
PROFINET
  Connection channels, 339
  Data transmission, 339
PROFINET interface, 179
PROFINET IO, 334
  Addresses, 336
  Device name (NameOfStation), 338
  IP address, 337
  IP address assignment, 337
  MAC address, 336
  RT and IRT, 335
PROFINET IO with IRT, 336
PROFINET IO with RT, 336
Propagation, 260
Protective functions, 513
PT100, 520
PT100 monitor (option L97), 136
PTC, 520
Pulse frequency wobbling, 460

Q

Quality, 31

R

Ramp-function generator, 370
Ramp-function generator tracking, 372
Rating plate, 36
  Data, 37
  Date of manufacture, 37
  Option short codes, 38
Real-time communication, 335
Reference model, 399

Relay outputs, 111
Replacement
Automatic firmware update, 597
Control Interface Module, frame size FX, 555
Control Interface Module, frame size GX, 557
Control Interface Module, frame size HX, 559
Control Interface Module, frame size JX, 561
Fan, frame size FX, 579
Fan, frame size GX, 581
Fan, frame size HX, 583
Fan, frame size JX, 587
Fault codes, 597
Filter mats, 554
Installation device, 551
Lifting lugs, 552
Operator panel, 594
Operator panel battery, 594
Power block, frame size FX, 563
Power block, frame size GX, 566
Power block, frame size HX, 569
Power block, frame size JX, 574
Replacing components, 554
Replacing the operator panel, 594
Residual risks, 26
Resonance damping, 380
Rotating measurement, 426
Shortened, 428
Runtime, 462

S

S5 – Selector for voltage/current AI0, AI1, 108
Safe Brake Adapter, 168
230 V AC, 168
Safe Brake Adapter 230 V AC (option K88), 168
Safe brake control, 168
Safety instructions
Electromagnetic fields, 23
Electrostatic sensitive devices, 24
General safety instructions, 20
Safety license for one axis (option K01), 164
Saving the Parameters permanently, 295
SBC (Safe Brake Control), 168
Sensor Module Cabinet-Mounted SMC30 (option K50), 153
Serial interface (RS232), 96, 178
Service, 31
Service and Support, 6
Servicing, 549
Setpoint addition, 366
Setpoint channel, 366
Setpoint sources, 265
Analog inputs, 265
Fixed speed setpoints, 268
General information, 244
Motorized potentiometer, 267
Setting the PROFIBUS address, 326
Shield connection, 99
Shipping and handling indicators, 47
Shock indicator, 47
Tilt indicator, 47
Shock indicator, 47
Shortened rotating measurement, 428
Signal connections, 99
Simple brake control, 468
Simulation mode, 463
SINAMICS Link, 347
Activation, 353
Bus cycle, 348
Commissioning, 350
Communication failure, 356
Configuration example, 354
Diagnostics, 356
Number of nodes, 348
Receive data, 347
Receiving data, 352
Requirements, 347
Send data, 347
Sending data, 350
Topology, 349
Transmission time, 348
Skip frequency bands, 368
Slip compensation, 381
SMC30, 153
SMC30: connection examples, 161
Soft starter bypass (option L29), 118
Speed controller, 393
Speed controller adaptation, 400
Speed controller feedfoward control, 396
Speed controller optimization, 426
Speed limiting, 369
Stall protection, 517
Standstill measurement, 423
STARTER, 184
Access point, 220
Commissioning, 188
Creating a project, 188
DEVICE, 221
Installation, 186
Online operation via PROFINET, 330
S7ONLINE, 221
Target device selection:, 220
Transferring the drive project, 221
User interface, 187

STARTER via Ethernet, 222
Parameters, 227
Setting the IP Address of the drive, 224
Setting the IP address of the PG/PC interface, 223
Storage, 42
Support, 6
Switching between clockwise and counter-clockwise rotation, 289
Switching unit systems (SI/US/%), 466
Synchronization, 470

T

Technical specifications
General, 602
Type A, 380 to 480 V AC, 3 phase, 608
Type A, 500 to 600 V AC, 3 phase, 618
Type C, 380 to 480 V AC, 3 phase, 612
Type C, 500 to 600 V AC, 3 phase, 621
Technical support, 6
Technology controller, 494
Temperature sensor, 108
Temperature sensor connection
Control Interface Module, 519
Sensor Module, 519
TM31, 518
Temperature sensor evaluation, 518
3-mass model, 522
Bimetallic NC contact, 520
I2t motor model, 521
KTY, 520
PT100, 520
PTC, 520
Wire-break monitoring, 520
Terminal Module TM150, 147
Thermal monitoring, 514
Thermal motor models, 521
Thermal motor protection, 518
Tightening torques, 550
Tilt indicator, 47
Timeout monitoring, 291
TM150, 147
Connecting, 148
Forming groups, 527
Protective earth connection and shield support, 150
Sensor failure in a group, 529
Temperature evaluation, 528
Temperature measurement, 524
Temperature sensor types, 525
TM31, 99
TM31 wired to customer terminal block (option G65), 164
TM31, connection overview, 102
TM31, front view, 101
TM54F, 166
TM54F Terminal Module, 166
TM54F Terminal Module (option K87), 166
Tool, 49, 62, 549
Torque control, 405
Torque limiting, 408
Transport, 41
Transport eyebolts, 51

U

Ungrounded power network, 77
Unpacking, 49

V

V/f (V/Hz) control, 374
Vdc control, 433
Vdc_max control, 436
Vdc_min control, 434
Vector control
With an encoder, 391
Without an encoder, 384
Vector speed/torque control with/without an encoder, 383
Voltage boost, 377
At startup, 379
During acceleration, 379
Permanent, 378
Voltage Sensing Module VSM10 (option K51), 162
VSM10, 162

W

Web server, 487
Login, 489
Logout, 490
Start page, 489
User-defined Web pages, 488
Wire-break monitoring, 520
Write protection, 475

X

X100, 87, 173
X101, 87, 173
X102, 87, 173
X103, 87, 173

X122, 88, 174
X126, 92
X127, 95, 177
X132, 90, 176
X140, 96, 178
X1400, 146
X150, 179
X451 (CAN bus), 143
X452 (CAN bus), 143
X520, 105
    SMC30, 157
X521, 107
    SMC30, 159
X522, 108
X530, 106
X531
    SMC30, 159
X540, 109
X541, 110
X542, 111

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